SB- **SB(XXXX) MAIN TITLE**
or
SB- **SB-SubTitle**

Main text

A. ABCD-Description of Work

Main Text

DESIGNER NOTE:

B. ABCD-General

Main Text

- bullet - 1
- bullet - 1

1. 1.main

C. ABCD-Materials

Main Text

1. 1.bold

sub main text

2. 1.bold

a. a.
b. a.

(1)
(2)

3. 1.bold

- bullet - 2
  - bullet - 3
    - bullet - 4

D. ABCD-Contractor Qualifications and Documentation

Main text

E. ABCD-Requirements for Construction

Main Text

F. ABCD-Method of Measurement

Main Text

G. ABCD-Basis of Payment

Main Text

Example - Table 1 Place Title Here	
Place Heading Here	Place Heading Here
General	
Other Heading	

INDEX SB2018 Book

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DIVISION SB Special Provisions starts here

SB2018-1

INDEX TO DIVISION SB
Use on all Bridge jobs let combined.
CREATED 10/30/1992
REVISED 6/2/2015

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Section No.	Item	Page No.
HERE		

BRIDGE PLANS

The plans for this project, consisting of the sheets tabulated below, were approved by the State Bridge Engineer.

BRIDGE NO.	TOTAL SHEETS	SHEET NO.	DATE OF APPROVAL

New or revised sheets were approved as listed below:

BRIDGE NO.	SHEET NO.	DATE OF APPROVAL

I hereby certify that the Special Provisions for bridge construction (Division SB) contained in this Proposal were prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

____
(   )

Date:______________ Lic. No.______________

DIVISION SB

SB2018-1
Use as required for projects needing plans of existing structures.
CREATED 8/3/1994
REVISED 2/6/2018 (7)

SB- BRIDGE PLANS

Plans of existing structures are available at the Minnesota Department of Transportation, Bridge Office, 3485 Hadley Ave N, Oakdale, MN, 55128-3307, for review and inspection by bidders; electronic copies are also available for viewing, printing and downloading on the MnDOT Consumer Access eDOCS (Electronic Document Management System) at http://dotapp7.dot.state.mn.us/eDIGS_guest/DMResultSet/. However, the state neither warrants nor represents that existing structures conform exactly to the details shown in those plans.

SB- (1502) PLANS AND WORKING DRAWINGS

The provisions of 1502, "Plans and Working Drawings," are supplemented as follows:

The Department will provide revised bridge drawings, bridge specifications, or provide bridge engineering analysis for the Contractor's means and methods if:

1. Deemed necessary by the Department, in its sole discretion, to rectify materials or workmanship not meeting specifications, or
2. Requested by the Contractor in writing.

The Department may, its option, perform the work with its own staff, or by engaging a consultant pre-qualified by the Department for Work Type 3.1 "Bridge and Structure Design". If the Department is unable to perform the work, the Department may require the Contractor to have the work performed by a consultant acceptable to the Department.

If the Department performs further bridge engineering studies, bridge redesign, or provides additional bridge engineering analysis, the Contractor must reimburse the costs incurred by the Department. Work performed by the Department will be charged at actual hourly rates of pay (including overtime premium when applicable) and customary additives and overhead. Work performed by a consultant will be charged at the amount invoiced by the consultant. The Department will prepare a Change Order for reimbursement, and will deduct the costs from any payment(s) due the Contractor.

When such work is performed by the Department or its consultant, the work will be considered a review for the Department's own purposes, and will not be considered work commissioned by the Contractor.

SB2018-1508
Use with deck repair jobs which include wearing courses.
CREATED 8/3/1994
REVISED 6/2/2015 (2)

SB- (1508) CONSTRUCTION STAKES, LINES AND GRADES

The provisions of 1508, "Construction Stakes, Lines and Grades," are supplemented as follows:

UAR

The Engineer may take profiles before any concrete removal operations begin and as s/he deems necessary after concrete removal. The Engineer will then establish a smooth profile grade across (the) (each) bridge and its approaches that will provide the minimum wearing course thickness and a smooth transition to the inplace roadway.

SB2018-1513

Use this special provision if the loads on a bridge need to be restricted more than those weights designated in the spec book. Designer will consider construction loading (including snoopers etc.) if rating is HS20 or less.

CREATED 5/16/2013

REVISED 9/1/2017

SB- (1513) RESTRICTIONS ON MOVEMENT AND STORAGE OF HEAVY LOADS AND EQUIPMENT

The Contractor shall haul Materials and move and store equipment in accordance with the Highway Traffic Regulation Act and applicable provisions of Minnesota Rules when using public Roads or completed Structures, base courses, and pavements within the Project that are open to traffic and becoming a part of the permanent improvement.

The Contractor shall comply with legal load restrictions and with special restrictions required by the Contract when hauling or storing Materials and moving or storing equipment on Structures, completed Subgrades, base courses, and pavements within the Project, under construction or completed but not yet open to traffic.

The Contractor shall complete and place a cab card in each vehicle used for hauling bituminous mixture, aggregate, batch concrete, and grading material (including borrow and excess) before starting work. This cab card shall identify the truck or tractor and trailer by Minnesota or prorated license number and shall contain the tare, maximum allowable legal gross mass, supporting information, and the signature of the owner. The Contractor shall make the card available to the Engineer upon request. The Contract Unit Prices include Contractor-related costs in providing, verifying, and spot checking the cab card information, including weighing empty and loaded trucks on certified commercial scales.

The Contractor shall not operate equipment mounted on crawler tracks or steel tired wheels on or across concrete or bituminous surfaces.

When construction operations require crossing an existing pavement, Bridges, or completed portions of the Pavement Structure with otherwise prohibited equipment or loads, the Contractor shall submit methods or load distribution or bridging in writing and obtain the Engineer's written approval. This approval does not relieve the Contractor of responsibility for any damages to the work.

The Contractor will not be relieved of liability for damages resulting from the operation and movement of construction equipment because of the issuance of a special permit, or by adherence to any other restrictions imposed.

The Contractor may temporarily store or park construction Materials and Equipment on a Bridge deck during Bridge construction. Storage of Materials and Equipment shall be limited as follows:

1. No stockpiles weighing greater than ________ lb per 1,000 ft^2,
2. No individual stockpiles of Materials (including pallets of products, reinforcing bar bundles, and aggregate piles) weighing greater than _______ lb per 100 ft^2,
3. No single vehicle or equipment exceeding _______ lb, and
4. No combination of more than ________ lb of vehicles, Materials, and other equipment per span with lengths greater than _____ ft.

If loading exceeds the above defined limits, the Contractor shall submit the proposed loads and structural analysis of the deck and beams certified by a Professional Engineer to the Bridge Engineer for the Bridge Engineer’s review within a minimum of 7 calendar days before placement of loads.

SB2018-1706
Use on ALL BRIDGES.
CREATED 12/4/1994
REVISED 9/25/2015 (2)

SB- (1706) EMPLOYEE HEALTH AND WELFARE

The provisions of 1706, "Employee Health and Welfare," are supplemented as follows:

The Contractor shall submit a safety plan at the preconstruction conference providing all OSHA required safety equipment (safety nets, static lines, false decks, etc.) for all work areas whose working surface is 6 feet or more above the ground, water, or other surface. Submittal of this plan will in no way relieve the Contractor of his/her responsibility for providing a safe working area.

All safety equipment, in accordance with the Contractor's plan, must be in place and operable in adequate time to allow Department personnel to perform their required inspection duties at the appropriate time. Don't place concrete in any areas affected by such required inspection until the inspection has been completed.

The installation of safety lines, safety nets, or other systems whose purpose is to reduce the hazards of bridge work may require the attachment of anchorage devices to beams, girders, diaphragms, bracing or other components of the structure. Clamp type anchorage systems which do not require modification of structural members may be used, provided they do not interfere with proper execution of the work; if using an anchorage system which requires modification of structural members, request approval, in writing, for plan modifications as provided in MnDOT specifications. Requests to install systems which require field welding or drilling of primary stress carrying members of a bridge will not be approved. The Contractor shall indicate any portions of anchorage devices which will remain permanently in the structure.

On both ends of each pier cap extending 6 feet or more above the ground, the Contractor shall install an insert or other suitable anchorage to which safety lines can be attached. Remove any portion of said device extending outside the finished lines of the pier cap unless otherwise approved by the Engineer. The Contractor shall repair or seal any void or cavity resulting from the installation or removal of this device to prevent the ponding or entry of water as directed by the Engineer.

The Contractor shall furnish, install and remove approved anchorage systems at no increased cost to the state for materials, fabrication, erection, or removal of the bridge component or anchorage system.

1 - DESIGNER NOTE: Use the next paragraph when lead paint is present.

Paint systems on Bridge No. ____________contain lead. Protect worker health and safety if operations result in removal or detachment of paint from metal surfaces.

2 - DESIGNER NOTE: Use the next paragraph when pcbs are present in paint.

Paint systems on Bridge No. ____________contain pcbs. Protect worker health and safety if operations result in removal or detachment of paint from metal surfaces.

SB2018-1707
Use as required for projects adjacent to roadways which are open to traffic during construction operations.
CREATED 8/3/1994
REVISED 6/2/2015 (1)

SB- CONSTRUCTION OPERATIONS ADJACENT TO ROADWAYS

The Contractor shall perform work in accordance with 1404, "Maintenance of Traffic," 1502, "Plans and Working Drawings," and 1707, "Public Convenience and Safety," provisions except as modified below:

When necessary to adequately prevent undermining of the existing roadbed and protect traffic, sheet and shore the roadway side and end of each footing excavation having a traveled roadway adjacent thereto. The Contractor shall leave sheeting and shoring in place until the excavated area has been properly backfilled.

1 - DESIGNER NOTE: Use the next paragraph when required.
The Contractor shall construct protective installations so as to just clear the neat lines of the footings along the roadway sides of those footings, having a traveled roadway adjacent thereto.

The Contractor shall at least six weeks before starting construction of the ______________, supply the Engineer with five copies of the detailed plans and specifications and two copies of the associated calculations of the proposed system for constructing an installation adjacent to traveled roadways. Design the protective installations in accordance with AASHTO "Guide Design Specifications for Bridge Temporary Works". The plans and specifications shall be prepared by an engineer, thoroughly checked by a second engineer for completeness and accuracy, and certified by one of the aforementioned professional engineers licensed in the state of Minnesota. Include in the documents sufficient details so that construction of the proposed system – whether staged or not staged – can be completed solely by reference to the plans and specifications. No work will be permitted adjacent to traveled roadways until these plans have been approved by the Engineer.

SB2018-1709

Used ONLY for a bridge that is considered to be over "Navigable" waters requiring a Coast Guard permit. Verify need for permit by contacting Preliminary Design Engineer.

CREATED 8/3/1994

REVISED 4/28/2017 (4)

SB- (1709) NAVIGABLE WATERWAYS

Perform all work on navigable waterways in accordance with 1709, "Navigable Waterways," and the following:

All work on or in navigable waters is subject to regulations formulated by the United States Coast Guard, Department of Transportation.

Prepare plans showing the location and dimensions of proposed cofferdams and other temporary construction which may directly or indirectly affect navigation clearances or impede or divert stream flow, as well as proposed method of furnishing, installing, operating and maintaining temporary navigation lights.

1 - DESIGNER NOTE: Use the next paragraph when located in the 8th District below 46°-20' North Latitude approximately south of a line through Breckenridge and the north end of Mille Lacs Lake.

Forward 8 sets of prints to the Commander (DWB), Eighth Coast Guard District, 1222 Spruce Street, St. Louis, Missouri 63103 for approval. When approval has been obtained from the Coast Guard, furnish two sets of prints with such approval noted thereon to the Project Engineer.

2 - DESIGNER NOTE: Use the next paragraph when located in the 9th District above 46°-20' North Latitude approximately north of a line through Breckenridge and the north end of Mille Lacs Lake.

Forward 8 sets of prints to the Commander (DPW3), Ninth Coast Guard District, 1240 East 9th Street, Cleveland, Ohio 44199 for approval. When approval has been obtained from the Coast Guard, furnish two sets of prints with such approval noted thereon to the Project Engineer.

Don’t start construction that requires approval of the above noted governmental agency until notice of approval has been furnished to the Project Engineer.

Coast Guard approval of the location and dimensions of cofferdams and other temporary construction does not in any way relieve the Contractor of his/her responsibility for providing adequate and safe construction; nor does it in any way alter requirements for forwarding plans of cofferdams and other temporary construction to the Project Engineer for approval as to type of construction.

All costs incurred by compliance with the above requirements are considered incidental expense for which no direct compensation will be made.

SB2018-1717
Use ON ALL BRIDGE PROJECTS.
CREATED 8/3/1994
REVISED 9/25/2015 (5)

SB- (1717) AIR, LAND, AND WATER POLLUTION

The provisions of 1717, "Air, Land, and Water Pollution," are supplemented as follows:

The Contractor's attention is hereby directed to MPCA Rule 7011.0150 (http://www.pca.state.mn.us) as it relates to sandblasting and/or concrete removal operations.

1 - DESIGNER NOTE: Use the next eight paragraphs for ALL paint projects.

The Contractor shall contain waste materials on the project site and provide for their handling, storage, transportation and disposal in accordance with all pertinent environmental regulations and MnDOT criteria. The Contractor shall document the storage, transfer and disposal of waste materials in accordance with the MnDOT Environmental Stewardship publication titled "MnDOT Steel Structure Paint Removal Program for Contractors", a current copy of which is available at http://www.dot.state.mn.us/environment/regulatedmaterials/contractors.html. Waste materials are defined as paint overspray and drippings, used paint pails, rags, spent solvents, cleaning solutions, and other related debris from cleaning operations including spent abrasive materials or paint chips. Painting, and all work associated therewith, shall be so conducted as to preclude waste materials from falling upon the ground or water.

It is the responsibility of the Contractor to provide the following safeguards at all times during cleaning and painting operations. All safeguards shall be in place and operable before cleaning and painting operations begin.

1. Primary safeguards such as containment (curtains and floor coverings), together with adequate structural support such as scaffolding or rope nets, shall be utilized to contain waste materials in the work area. Catchment systems shall be emptied as often as necessary to maintain their structural integrity.

2. Safeguards such as floating booms, mats of absorbent material, skimmers, or similar systems shall be placed in streams to avoid nuisance conditions in the stream caused by cleaning or painting operations.

3. Locked storage of cleaning and painting materials to prevent access by vandals.

2 - DESIGNER NOTE: Replace 1, 2, and 3, above with 1 and 2 below if all paint removal is performed with hand scraping or power tools.

1. Lead Paint Removal by Hand Scraping or Power Tools
   a. Sufficient tarps must be used as ground cover and as curtains to contain waste materials in the work area.
   b. Ground cover and curtains are not required if the power tool is equipped with a vacuum that removes visual air emissions.
   c. To determine if paint chips are non-lead, the paint chips must pass a laboratory test by Toxicity Characteristic Leaching Procedure (TCLP) for Resource Conservation and Recovery Act (RCRA) metals. The other option is to manage as lead paint chips without the laboratory test.
   d. Lead paint chips will be managed as a hazardous waste and disposed of through MnDOT's hazardous waste contractor. http://www.dot.state.mn.us/environment/regulatedmaterials/contractors.html and http://www.dot.state.mn.us/environment/regulatedmaterials/pdf/paint/12-haztransferdisposal.pdf.

2. Locked storage of cleaning and painting materials to prevent access by vandals.

Suspend cleaning and painting operations during periods when unfavorable weather conditions may reduce the effectiveness of the above noted safeguards. In situations where use of some of the safeguards listed are not feasible, other innovative safeguards shall be employed. Emphasis shall be placed on containment of waste materials rather than placing reliance on safeguards such as booms, straw dams, skimmers, or absorbent mats. These shall be considered backup systems to guard against water pollution which may result from the failure of primary safeguards.

Materials such as paint chips and abrasives which are readily recoverable from bridge decks or stream banks, empty paint pails, and rags and debris from cleaning operations shall be disposed of in a proper manner. Paint chips and spent abrasives shall be removed from the bridge deck on a daily basis and in an approved manner. Recoverable abrasives and paint chips from blasting operations may be recycled, but the ultimate disposal shall be to an appropriate waste facility. Spent aqueous cleaning solutions shall be discharged to a recognized sewage collection and treatment system. Spent solvents and cans or pails containing waste paint shall be taken to an incinerator approved by the MPCA for disposal, or to an MPCA approved hazardous waste storage area.

In the event of an accidental loss of painting or cleaning materials or debris into public waters, the Contractor shall take immediate action to recover the lost materials, and the incident shall be promptly reported by telephone to the State Duty Officer at 1 800 422 0798 followed by a written report addressed to MPCA, Water Quality Division, Compliance and Enforcement Section, 520 Lafayette Road, St. Paul, Minnesota, 55155.

3 - DESIGNER NOTE: Use the next paragraph only when required by pollution control or fish and wildlife agencies.

Unless otherwise provided in these special provisions, construction, demolition and/or removal operations conducted over or in the vicinity of public waters shall be so controlled as to prevent materials from falling into the water. Any materials which do fall into the water, or onto areas where there is a likelihood that they will be picked up by rising water levels, shall be retrieved and stored in areas where such likelihood does not exist.

SB- (1803) PROGRESS SCHEDULES

The provisions of 1803, "Progress Schedules," are supplemented as follows:

The Contractor's attention is hereby called to the requirements for stage construction as indicated in the Plans and/or Special Provisions. The Contractor shall submit plans and schedules to the Engineer for approval detailing his/her proposed scheme and sequence of operations, including traffic channelization, flagging, protective installations, and other pertinent procedures to be employed both on and off of the structure.

No compensation, other than for plan pay items, will be made for complying with the above requirements.

SB2018-1807.1
Use when 2476.1 is used.
CREATED 12/12/2001
REVISED 6/2/2015 (2)

SB- (1807) FAILURE TO COMPLETE THE WORK ON TIME

The provisions of 1807.1, "Assessment of Liquidated Damages," are supplemented as follows:

See requirements for *Methods for Paint Removal and Waste Disposal of Non-Lead Paint* as indicated in these special provisions SB-______.

The Contractor is subject to a daily charge for failure to submit documentation of the testing and disposal of hazardous and non-hazardous waste as required under these special provisions. A $150.00 monetary deduction per calendar day, per shipment will be assessed and the amount deducted from any monies due the Contractor, until all work is complete to the satisfaction of the Engineer.

The monetary deduction as set forth above may apply equally, separately and may be assessed concurrently with other damages as described in these special provisions and the Standard Specifications for Construction.

SB- (1807) FAILURE TO COMPLETE THE WORK ON TIME

The provisions of 1807.1, "Assessment of Liquidated Damages," are supplemented as follows:

See requirements for *Methods for Paint Removal and Waste Disposal of Lead Paint* as indicated in these special provisions SB-______.

The Contractor is subject to a daily charge for failure to submit documentation of the testing and disposal of hazardous and non-hazardous waste as required under these special provisions. A $150.00 monetary deduction per calendar day, per shipment will be assessed and the amount deducted from any monies due the Contractor, until all work is complete to the satisfaction of the Engineer.

The monetary deduction as set forth above may apply equally, separately and may be assessed concurrently with other damages as described in these special provisions and the Standard Specifications for Construction.

SB2018-1807.3
Use when 2476.3 is used.
CREATED 9/1/2017
REVISED 9/1/2017

SB- (1807) FAILURE TO COMPLETE THE WORK ON TIME

The provisions of 1807.1, "Assessment of Liquidated Damages," are supplemented as follows:

See requirements for *Methods for Paint Removal and Waste Disposal of Paint Containing PCBs and/or Lead* as indicated in these special provisions SB-______.

The Contractor is subject to a daily charge for failure to submit documentation of the testing and disposal of hazardous and non-hazardous waste as required under these special provisions. A $150.00 monetary deduction per calendar day, per shipment will be assessed and the amount deducted from any monies due the Contractor, until all work is complete to the satisfaction of the Engineer.

The monetary deduction as set forth above may apply equally, separately and may be assessed concurrently with other damages as described in these special provisions and the Standard Specifications for Construction.

SB2018-2104

Use on Bridge jobs when:

- *Concrete Barrier removal,*
- *Metal Railing removal,*
- *Widening of deck where partial deck removal,*
- *Full deck removal,*
- *Full bridge removal, or*
- *When Asbestos and Regulated Waste Report was completed.*

CREATED 12/1/2004
REVISED 9/1/2017 (9)

SB- REMOVAL OF ASBESTOS AND REGULATED WASTE (BRIDGE)

Remove and dispose of any regulated waste found on existing bridges or from the utilities located on the bridge in accordance with the applicable MnDOT Standard Specifications and the following:

If, during the course of removal or renovation of utility or bridge, additional asbestos materials or regulated wastes other than that noted in the Assessment Summary are encountered, notify the MnDOT Project Engineer to suspend work and furnish a documented inspection and evaluation by a MnDOT approved certified MDH contractor prior to resuming work. The work, as outlined in this paragraph, will be paid for as Extra Work.

Dispose of all asbestos and/or regulated waste in accordance with MnDOT's manual. Only those listed in this manual as pre-approved for asbestos and/or regulated waste will be allowed to work on this project. Use MnDOT approved companies for testing, waste transport and disposal as provided and described in MnDOT's manual "*Asbestos and Regulated Waste Manual For Structure Demolition Or Relocations for Construction Projects*" available on the following website: http://www.dot.state.mn.us/environment/buildingbridge/index.html. Contact Mark Vogel at 651.366.3630 or Jackie Klein at 651.366.3637, Office of Environmental Stewardship, 651.366.3630, with any questions regarding the manual.

A pre-activity meeting will be conducted to outline the action items to the satisfaction of the Engineer prior to removing any regulated materials and any bridge renovation or demolition activities.

All material shall be removed, identified, and disposed of in accordance with Section S-1701 (LAWS TO BE OBSERVED (BRIDGE)) of these Special Provisions. Permission to begin the regulated waste removals, with the exception of material needed for hazardous and regulated waste assessment or testing, will not be granted until the Engineer has copies of all required notices.

Permission to proceed with the demolition or renovation of bridges will not be granted until the Engineer has received copies of all required notifications as indicated in Section S-1701 (LAWS TO BE OBSERVED (BRIDGE)) of these Special Provisions.

Notify any utility owners at least three (3) days prior to the removal of any regulated waste which may affect the utility, allowing the utility owner time to have a representative on site.

See the attached "Asbestos and Regulated Waste Inspection Report" for information on whether or not asbestos or regulated waste was detected in the bridge(s) to be removed or renovated.

The assessment summary along with the plan or Special Provisions is intended for informational purposes. Quantity, type and analysis of any asbestos or regulated waste containing material are estimates intended as a general guide.

1 - DESIGNER NOTE: Use the next paragraph when the assessment report identifies non-utility related ACM's or regulated waste.

No measurement will be made of any portion of the asbestos or regulated waste material removal, but the complete removal thereof as specified shall be construed to be included in the single lump sum for which payment is made under Item 2104.601 "REMOVE REGULATED WASTE MATERIAL (BRIDGE)".

2 - DESIGNER NOTE: Use the next paragraph when the assessment report identifies utility related (i.e. piping insulation, piping materials, etc.) ACM's or regulated waste

Remove items _____, _____ & _____ identified in the attached assessment. No measurement will be made of any portion of the asbestos or regulated waste material removal from any utility, but the complete removal thereof as specified shall be construed to be included in the single lump sum for which payment is made under Item 2104.601 "REMOVE REGULATED WASTE MATERIAL (UTILITY)".

SB2018-2105
See designer notes below.
CREATED 11/2/1994
REVISED 2/24/2016 (3)

SB- BRIDGE ABUTMENT CONSTRUCTION

1 - DESIGNER NOTE: Use the following paragraph where Foundations & Other Recommendations require a time delay.

Do not start construction of each abutment until (at least 72 hours after) (______ months after) the approach fill at that abutment has been constructed to the full height and cross section (plus ______ feet tall surcharge requirement).

2 - DESIGNER NOTE: Include for footings with piling:

Extend the approach fill construction a distance of at least 50 feet behind the abutment as measured along the centerline of the roadway.

3 - DESIGNER NOTE: Include for spread footings:

Extend the approach fill construction a distance of at least 50 feet behind the toe of footing of abutment as measured along the centerline of the roadway.

4 - DESIGNER NOTE: Include on all footings:

See Standard Plan Sheet 5-297.233 and .234 in the roadway plans for additional information.

5 - DESIGNER NOTE: For spread footings, make sure grading designer modifies Sheet 5-297.233 "approach surcharge limits" line to front face of abutment footing.

6 - DESIGNER NOTE: Consult w/ Regional Bridge Construction Engineer, use when there is insufficient room to place 1:1.5 slope at front edge of surcharge.

Construct abutment approach fill to the dimensions shown in the plans using temporary shoring or sheeting. The relevant contract unit price for Structure Excavation includes the cost of providing, installing, and removing temporary shoring or sheeting as included in the cost of structure excavation.

SB2018-2360
Use on repair and widening jobs where bituminous wearing course is required.
CREATED 8/3/1994
REVISED 6/2/2015 (3)

SB- PLANT MIXED ASPHALT PAVEMENT

This work consists of (describe work) .

1 - DESIGNER NOTE: The designer is required to attach a note to his/her specs notifying the Special Provisions Engineer of the need for MnDOT 2360 special provision to be placed in the Division "S" section of the Proposal.

2 - DESIGNER NOTE: The designer is also required to contact the Bituminous Office (John Garrity 651/366-5577) for the mix number(s) and the pay item(s).

SB2018-2401
Use on all projects.
CREATED 8/3/1994
REVISED 6/6/2018 (15)

SB- (2401) CONCRETE BRIDGE CONSTRUCTION

The provisions of 2401, "Concrete Bridge Construction," are supplemented as follows:

SB2018-2401.2 A

Use when self-consolidating concrete is recommended on a job by the Regional Bridge Construction Engineer. SCC is recommended for concrete collars and infill walls. Infill walls may be placed with a 3B52 mix and windows, but a better product is obtained with SCC.

CREATED 9/1/2017
REVISED 6/6/2018 (2)

SB- **STRUCTURAL CONCRETE – SELF CONSOLIDATING CONCRETE (SCC) (CONTRACTOR CONCRETE MIX DESIGN)**

Delete the contents of 2401.2.A, "Concrete," and replace with the following:

Design a **Self-Consolidating Concrete (SCC)** mixture. Perform the work in accordance with the applicable requirements of 2401, "Concrete Bridge Construction," 2461, "Structural Concrete," and the following:

2.A.1 Fine Aggregate Requirements

Provide fine aggregates complying with quality requirements of 3126.2.D, "Deleterious Material," 3126.2.E, "Organic Impurities," and 3126.2.F, "Structural Strength."

2.A.1.a Fine Aggregate Alkali Silica Reactivity (ASR) Requirements

The Department will routinely test fine aggregate sources for alkali silica reactivity (ASR) in accordance with the following:

(1) Multiple sources of certified Portland cement in accordance with ASTM C1260 MnDOT Modified; and

(2) Multiple combinations of certified Portland cement and supplementary cementitious materials in accordance with ASTM C1567 MnDOT Modified.

The Concrete Engineer, in conjunction with the Engineer, will review the 14-day fine aggregate expansion test results to determine the acceptability of the proposed fine aggregate and cement combination in accordance with the following:

(1) For fine aggregate and cement combinations previously tested by the Department, the Concrete Engineer will use the average of all 14-day unmitigated test results for an individual source to determine necessary mitigation in accordance with Table HPC-1.

(2) If the previously tested proposed fine aggregate and cement combination requires less mitigation than the average 14-day unmitigated test result, the Concrete Engineer will allow mitigation at the lesser rate in accordance with Table HPC-1.

(3) Alkali silica reactivity (ASR) ASTM C1260 and ASTM C1567 test results are available on the MnDOT Concrete Engineering Unit website.

<table>
<tr><th colspan="9">Table HPC-1
Fine Aggregate ASR Mitigation Requirements</th></tr>
<tr><th>14-day Fine Aggregate Unmitigated Expansion Limits</th><th>Class F Fly Ash</th><th>Class C Fly Ash</th><th>Slag</th><th>Slag/Class F Fly Ash</th><th>Slag/Class C Fly Ash</th><th>IS(20)/Class F Fly Ash</th><th>IS(20)/Class C Fly Ash</th></tr>
<tr><td>≤ 0.150</td><td colspan="7">No mitigation required</td></tr>
<tr><td>>0.150 - 0.200</td><td>Minimum 20%</td><td>Minimum 20%</td><td>35%</td><td rowspan="2">20% Slag with a minimum of 15% Class F fly ash</td><td rowspan="2">20% Slag and 20% Class C fly ash</td><td rowspan="2">Type IS(20) with a minimum of 15% Class F</td><td rowspan="2">Type IS(20) with a minimum of 15% Class C</td></tr>
<tr><td>> 0.200 – 0.300</td><td>Minimum 20%</td><td>Minimum 30%</td><td>35%</td></tr>
<tr><td>> 0.300</td><td colspan="7">The Department will reject the fine aggregate</td></tr>
</table>

The Contractor may use 100% Portland cement for High Early Concrete, provided no mitigation is required for the fine aggregate in accordance with Table HPC-1. If mitigation is required, the Contractor is required to use a minimum of 15% of any supplementary cementitious material when designing High Early Concrete.

The Concrete Engineer may reject the fine aggregate if mortar bar specimens exhibit an indication of external or internal distress not represented by the expansion results. The Concrete Engineer will make the final acceptance of the aggregate.

2.A.2 Intermediate Aggregate Requirements

Provide intermediate aggregates complying with the quality requirements of 3137.2.D.2, "Coarse Aggregate for Bridge Superstructure," except as modified in Table HPC-2. If the intermediate aggregate is from the same source as the ¾ inch- fraction, the aggregate quality is determined based upon the composite of the ¾ inch- and intermediate aggregate.

The Concrete Engineer classifies intermediate aggregate in accordance with Table HPC-2.

Table HPC-2
Intermediate Aggregate for Use in Concrete

If the gradation meets the following:	Classify material type as:	Gradation Test Procedures	Quality Test Requirements
100% passing the $^{1}/_{2}$" and ≤90% passing #4	Intermediate Aggregate	Coarse Aggregate (+4 Portion)	Spec. 3137.2.D.2 except 3137.2.D.2(i) modified to maximum 40% carbonate
		Fine Aggregate (-4 Portion)	Shale in Sand (-4 Portion)
100% passing the $^{1}/_{2}$" and >90% passing #4	Intermediate Aggregate	Fine Aggregate (Minimum 1000 g sample)	Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)
			Shale in Sand (-4 Portion)
100% passing the $^{3}/_{8}$" and ≤90% passing #4	Coarse Sand	Fine Aggregate	Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)
			Shale in Sand (-4 Portion)

For any intermediate aggregate size not previously tested by the Department, the Concrete Engineer reserves the right to test for alkali silica reactivity, in accordance with ASTM C1260, prior to allowing incorporation into the concrete mix design.

2.A.3 Coarse Aggregate Requirements

Provide Class A, B, or C coarse aggregate meeting the quality requirements in accordance with 3137.2.D.2, "Coarse Aggregate for Bridge Superstructure."

When providing Class B aggregate, the maximum absorption percent by weight is 1.10%.

2.A.3.a Coarse Aggregate Alkali Silica Reactivity (ASR) Requirements

When using coarse aggregate identified as quartzite or gneiss, the Concrete Engineer will review ASTM C1293 testing to determine the necessary ASR mitigation requirements in accordance with Table HPC-3.

ASR ASTM C1293 test results are available on the MnDOT Concrete Engineering Unit website.

Table HPC-3 Coarse Aggregate ASR Mitigation Requirements*							
ASTM C1293 Expansion Results	**Class F Fly Ash**	**Class C Fly Ash**	**Slag**	**Slag/Class F Fly Ash**	**Slag/Class C Fly Ash**	**IS(20)/Class F Fly Ash**	**IS(20)/Class C Fly Ash**
≤ 0.040	No mitigation required						
>0.040	Minimum 30%	Not Allowed	35%	20% Slag with a minimum of 15% Class F fly ash	20% Slag and 20% Class C fly ash	Type IS(20) with a minimum of 15% Class F	Type IS(20) with a minimum of 15% Class C
* The Engineer will allow the Contractor to substitute a portion of the minimum required supplementary cementitious material with up to 5% silica fume by weight for mitigation purposes.							

2.A.4 Cementitious Materials

Provide only cementitious materials from the Approved/Qualified Products List.

2.A.4.a Cement

Use Type I or Type I/II cement complying with Specification 3101, "Portland Cement," or blended cement in accordance with Specification 3103, "Blended Hydraulic Cement."

(1) Total alkalis (Na_2Oe) no greater than 0.60 percent in the Portland cement, and

(2) Total alkalis (Na_2Oe) no greater than 3.0 lb per yd^3 of concrete resulting from the Portland cement.

2.A.4.b Fly Ash

Use fly ash conforming with Specification 3115, "Fly Ash for use in Portland Cement." The Concrete Engineer defines Class F fly ash for the purposes of ASR mitigation as having a maximum C_aO content of 18.0%.

2.A.4.c Ground Granulated Blast Furnace Slag

Use ground granulated blast furnace slag conforming to Specification 3102, "Ground Granulated Blast-Furnace Slag."

2.A.4.d Silica Fume

Use silica fume conforming to ASTM C1240.

2.A.4.e Ternary Mixes

Ternary mixes are defined as Portland cement and two other supplementary cementitious materials, or blended cement and one other supplementary cementitious material with a maximum replacement of 40% by weight.

2.A.5 Allowable Admixtures

Use any of the following admixtures on the MnDOT Approved/Qualified Products as listed under "Concrete Admixtures A-S":

(A) Type A, Water Reducing Admixture,
(B) Type B, Retarding Admixture,
(C) Type C, Accelerating Admixture,
(D) Type D, Water Reducing and Retarding Admixture,
(E) Type F, High Range Water Reducing Admixture, and
(F) Type S, Specific Performance Based Admixture

Obtain a written statement from the manufacturer of the admixtures verifying:
(1) Compatibility of the combination of materials, and
(2) Manufacturer recommended sequence of incorporating the admixtures into the concrete.

The manufacturer will further designate a technical representative to dispense the admixture products.

Utilize the technical representative in an advisory capacity and have them report to the Contractor any operations or procedures which are considered as detrimental to the integrity of the placement. Verify with the Engineer whether the Manufacturer's technical representative's presence is required during the concrete placement.

2.A.6 Concrete Mix Design Requirements

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 21 calendar days before the initial concrete placement. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

2.A.6.a Concrete Mix Design Requirements

Design and produce SCCHPC concrete mixes based on an absolute volume of 27.0 ft^3 in accordance with the Table HPC-4 and the following requirements:

Table HPC-4
High Performance Bridge Deck Concrete Mix Design Requirements

Concrete Grade	Mix Number *	w/c ratio	Target Air Content	Maximum %SCM (Fly Ash/Slag/ Silica Fume/ Ternary) ‖	Visual Stability Index(VSI)	Spread Range †, *inches*	Minimum Compressive Strength, f'c (28-day)	3137 Spec.
HPC	SCCHPC	0.40-0.45	6.5%	30/35/5/40	1 or less	4"	4000 psi	2.D.2

* Provide a Job Mix Formula in accordance with 2401.2.A.7. Use any good standard practice to develop a job mix formula and gradation working range by using procedures such as but not limited to 8-18, 8-20 gradation control, Shilstone process, FHWA 0.45 power chart or any other performance related gradation control to produce a workable and pumpable concrete mixture meeting all the requirements of this contract.
‖ The individual limits of each SCM shall apply to ternary mixtures.
† Keep the consistency of the concrete uniform during entire placement. The max spread shall be 28"

2.A.6.b Required Preliminary Testing

Prior to placement of any SCCHPC Concrete, the Engineer will require preliminary batching and testing of the concrete mix design.

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 14 calendar days prior to the beginning of preliminary laboratory mixing and testing of the proposed mix designs. Any changes or adjustments to the material or mix design require a new Contractor mix design submittal. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

Test the concrete for the following hardened concrete properties in accordance with Table HPC-5:

1 - DESIGNER NOTE: Consult with the Regional Bridge Engineer to change from 2500 to 3000 coulombs after consulting with the Concrete Engineer when used in a region that may need to develop a new mix.

Table HPC-5
Required Hardened Concrete Properties for Mixes SCCHPC

Test	Requirement	Test Method
Required Strength (Average of 3 cylinders)	4000 psi at 28 days	ASTM C31
Rapid Chloride Permeability	$\leq$ 2500 coulombs at 28 days (For Preliminary Approval) $\leq$ 1500 coulombs at 56 days	ASTM C1202
Shrinkage	No greater than 0.040 percent at 28 days	ASTM C157

The Engineer will allow the maturity method for subsequent strength determination. Perform all maturity testing in accordance with ASTM C1074 and the MnDOT Concrete Manual.

If a mix is approved, the Concrete Engineer will consider the mix design and testing as acceptable for a period of 5 years provided the actual concrete mixed and placed in the field meets the Contract Requirements. The Concrete Engineer will not require new testing within that 5-year period as long as all the constituents (including the aggregates) of the proposed mix design are the same as the original mix design.

The Engineer determines final acceptance of concrete for payment based on satisfactory field placement and performance.

2.A.7 Job Mix Formula

A Job Mix Formula (JMF) contains the following:

(a) Proportions for each aggregate fraction,
(b) Individual gradations for each aggregate fraction, and
(c) Composite gradation of the combined aggregates including working ranges on each sieve in accordance with Table HPC-6.

Table HPC-6
Job Mix Formula Working Range

Sieve Sizes	Working Range, %*
1 inch and larger	±5
¾ inch	±5
½ inch	±5
⅜ inch	±5
No.4	±5
No.8	±4
No.16	±4
No.30	±4
No.50	±3
No.100	±2
No.200	$\leq$ 1.6

* Working range limits of the composite gradation based on a moving average of 4 tests (N=4).

2.A.7.a Verification of JMF

Prior to beginning placements of bridge deck concrete, perform gradation testing to ensure current materials comply with the approved JMF. Perform gradation testing in accordance with the Schedule of Materials Control.

(1) Take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work as approved by the Engineer.

(2) Add fill-in sieves as needed during the testing process to prevent overloading.

The Producer and Engineer will test and record the individual gradation results using the Concrete Aggregate Worksheet.

(1) Using the JMF Moving Average Summary Worksheet, calculate the moving average of Producer aggregate gradation test results during production.

(2) The Engineer will randomly verify Producer combined aggregate gradation results as defined in the Schedule of Materials Control.

If, during production, the approved JMF falls outside of the allowable working range immediately sample and test additional gradation and continue production.

2.A.7.b JMF Adjustment

If it is determined that the current aggregates do not meet the approved JMF, submit a new mix design including JMF to the Concrete Engineer in accordance with 2401.2.A.7, of this special provision.

2.A.7.c JMF Acceptance

The Engineer will make monetary adjustments for the quantity of bridge deck concrete represented by the JMF Working Range failure, from the failing test to the next passing test, at a minimum rate of $500.00 or $5.00 per cubic yard, whichever is greater.

2.A.8 Laboratory batching, testing requirements and submittals:

To determine the characteristics of the Contractor proposed mix design, the Concrete Engineer will require the Contractor to prepare test batches and do laboratory testing. Conduct all batching and testing of concrete at a **single** AMRL certified laboratory using the exact materials proposed in the mix design.

Lab testing requirements:

(a) Slump and air content at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing,

(b) Compressive strength (Make cylinders in accordance with AASHTO T126 and tested in accordance with AASHTO T22) at 1, 3, 7, 28, 56 days (sets of 3),

(c) Rapid chloride permeability (ASTM C1202) at 28 days and 56 days (2 specimens for 28 day test and 2 test specimens for 56 day test (Take 2 specimens from each batch of a 2 batch mix)),

(d) Concrete Shrinkage (ASTM C157) at 28 days.

The Contractor is required to contact the MnDOT Concrete Engineering Unit a minimum of 2-days prior to any mixing so that a MnDOT representative can observe the process. This same 2-day notification is required prior to any physical testing on hardened concrete samples. Additionally, retain any hardened concrete test specimens for a minimum of 90 days and make available for MnDOT to examine.

Perform all testing for plastic concrete after all admixtures additions to the concrete mixture.

After completion of the laboratory testing specified herein and, at least, 15 working days prior to the trial placement, submit the laboratory test data to the MnDOT for review and acceptance.

Include the following information in the laboratory reports of the design mixes:

(a) Exact batch weights and properties of all ingredients used and all aggregate gradations,

(b) Slump and air content,

(c) Cylinder identification, including mix designation,

(d) Date and time of cylinder preparation,

(e) Date and time cylinder specimen was tested,
(f) Compressive strength of each cylinder specimen at 1, 3, 7, 28, and 56 day (sets of 3),
(g) A graphic plot of age, from 0 to 56 days, vs. strength for each mix design,
(h) Rapid chloride permeability at 28 days and 56 days, and
(i) Concrete Shrinkage at 28 days.

2.A.9 Prior to Actual Bridge Placement

2.A.9.a Trial Placement

A minimum of 14 calendar days prior to the actual placement of the concrete, successfully complete a separate trial placement utilizing a minimum of one (2) - 10 yd^3 loads.

The Engineer may allow the incorporation of the concrete for trial batches into the bridge footings, abutments or end diaphragms. The Contractor may also choose to incorporate the trial batches into residential /commercial construction in the immediate vicinity of the project. In any case, the Engineer will require mixing, transporting, and placing the concrete using the same methods as the actual placement.

If the concrete is incorporated into the permanent work, the Engineer will test the plastic concrete in accordance with the Schedule of Materials Control. The Engineer may require additional trial batches if the concrete delivered to the project does not comply with the plastic concrete requirements of the Contract.

The concrete mix design, laboratory batching and mixing, and the trial placement is incidental to the concrete furnished and placed.

Use the same materials, same supplier, and same supplier's manufacturing plant, and proportions in the permanent work as in the trial placement. Strength requirements specified for each mix are applicable to the cylinder tests taken during the production work.

2.A.9.b Placement

Attend a pre-placement meeting 2 days to 4 days before the slab placement to review the information and details provided in the placement and curing plan. The following project personnel are required to attend the pre-placement meeting:

(1) Contractor,
(2) Engineer,
(3) Concrete supplier, and
(4) If required by the Engineer, the concrete pump supplier.

SB-XX.1 Method of Measurement

Measure SCC concrete by cubic yard, the Engineer will base the measurement on the basis of the dimensions of the structure shown in the plans.

SB-XX.2 Basis of Payment

Payment for Item No. 2401.607 "STRUCTURAL CONCRETE (SCC)" will be made at the Contract price per cubic yard and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to construct the Plans in accordance with these specifications. Where STRUCTURAL CONCRETE (SCC) is cast against existing structure, removal of unsound concrete and cleaning exposed reinforcement by sandblasting is considered incidental to item 2401.607 "STRUCTURAL CONCRETE (SCC)".

SB2018-2401.2 B

Use on projects requiring High Performance Concrete (3YHPC) when required by the Regional Construction Eng.

CREATED 2/11/2015

REVISED 6/6/2018 (10)

SB- STRUCTURAL CONCRETE – HIGH PERFORMANCE CONCRETE BRIDGE DECKS (CONTRACTOR CONCRETE MIX DESIGNS)

Delete the contents of 2401.2.A, "Concrete," and replace with the following:

For Bridge No. ________, design a **3YHPC-M** or **3YHPC-S** concrete mixture that will minimize cracking. Perform the work in accordance with the applicable requirements of MnDOT 2401, "Concrete Bridge Construction," 2461, "Structural Concrete," and the following:

2.A.1 Fine Aggregate Requirements

Provide fine aggregates complying with quality requirements of 3126.2.D, "Deleterious Material," 3126.2.E, "Organic Impurities," and 3126.2.F, "Structural Strength."

2.A.1.a Fine Aggregate Alkali Silica Reactivity (ASR) Requirements

The Department will routinely test fine aggregate sources for alkali silica reactivity (ASR) in accordance with the following:

1. Multiple sources of certified Portland cement in accordance with ASTM C1260 MnDOT Modified; and
2. Multiple combinations of certified Portland cement and supplementary cementitious materials in accordance with ASTM C1567 MnDOT Modified.

The Concrete Engineer, in conjunction with the Engineer, will review the 14-day fine aggregate expansion test results to determine the acceptability of the proposed fine aggregate and cement combination in accordance with the following:

1. For fine aggregate and cement combinations previously tested by the Department, the Concrete Engineer will use the average of all 14-day unmitigated test results for an individual source to determine necessary mitigation in accordance with Table HPC-1.
2. If the previously tested proposed fine aggregate and cement combination requires less mitigation than the average 14-day unmitigated test result, the Concrete Engineer will allow mitigation at the lesser rate in accordance with Table HPC-1.
3. Alkali silica reactivity (ASR) ASTM C1260 and ASTM C1567 test results are available on the MnDOT Concrete Engineering Unit website.

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The Contractor may use 100% Portland cement for High Early Concrete, provided no mitigation is required for the fine aggregate in accordance with Table HPC-1. If mitigation is required, the Contractor is required to use a minimum of 15% of any supplementary cementitious material when designing High Early Concrete.

The Concrete Engineer may reject the fine aggregate if mortar bar specimens exhibit an indication of external or internal distress not represented by the expansion results. The Concrete Engineer will make the final acceptance of the aggregate.

2.A.2 Intermediate Aggregate Requirements

Provide intermediate aggregates complying with the quality requirements of 3137.2.D.2, "Coarse Aggregate for Bridge Superstructure," except as modified in Table HPC-2. If the intermediate aggregate is from the same source as the ¾ inch- fraction, the aggregate quality is determined based upon the composite of the ¾ inch- and intermediate aggregate.

The Concrete Engineer classifies intermediate aggregate in accordance with Table HPC-2.

<table>
<tr><th colspan="4">Table HPC-2
Intermediate Aggregate for Use in Concrete</th></tr>
<tr><th>If the gradation meets the following:</th><th>Classify material type as:</th><th>Gradation Test Procedures</th><th>Quality Test Requirements</th></tr>
<tr><td rowspan="2">100% passing the 1/2" and ≤90% passing #4</td><td rowspan="2">Intermediate Aggregate</td><td>Coarse Aggregate (+4 Portion)</td><td>Spec. 3137.2.D.2 except 3137.2.D.2(i) modified to maximum 40% carbonate</td></tr>
<tr><td>Fine Aggregate (-4 Portion)</td><td>Shale in Sand (-4 Portion)</td></tr>
<tr><td rowspan="2">100% passing the 1/2" and >90% passing #4</td><td rowspan="2">Intermediate Aggregate</td><td rowspan="2">Fine Aggregate (Minimum 1000 g sample)</td><td>Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)</td></tr>
<tr><td>Shale in Sand (-4 Portion)</td></tr>
<tr><td rowspan="2">100% passing the 3/8" and ≤90% passing #4</td><td rowspan="2">Coarse Sand</td><td rowspan="2">Fine Aggregate</td><td>Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)</td></tr>
<tr><td>Shale in Sand (-4 Portion)</td></tr>
</table>

For any intermediate aggregate size not previously tested by the Department, the Concrete Engineer reserves the right to test for alkali silica reactivity, in accordance with ASTM C1260, prior to allowing incorporation into the concrete mix design.

2.A.3 Coarse Aggregate Requirements

Provide Class A, B or C coarse aggregate meeting the quality requirements in accordance with 3137.2.D.2, "Coarse Aggregate for Bridge Superstructure."

When providing Class B aggregate, the maximum absorption percent by weight is 1.10%.

2.A.3.a Coarse Aggregate Alkali Silica Reactivity (ASR) Requirements

When using coarse aggregate identified as quartzite or gneiss, the Concrete Engineer will review ASTM C1293 testing to determine the necessary ASR mitigation requirements in accordance with Table HPC-3.

ASR ASTM C1293 test results are available on the MnDOT Concrete Engineering Unit website.

Table HPC-3 Coarse Aggregate ASR Mitigation Requirements*							
ASTM C1293 Expansion Results	**Class F Fly Ash**	**Class C Fly Ash**	**Slag**	**Slag/Class F Fly Ash**	**Slag/Class C Fly Ash**	**IS(20)/Class F Fly Ash**	**IS(20)/Class C Fly Ash**
≤ 0.040	No mitigation required						
>0.040	Minimum 30%	Not Allowed	35%	20% Slag with a minimum of 15% Class F fly ash	20% Slag and 20% Class C fly ash	Type IS(20) with a minimum of 15% Class F	Type IS(20) with a minimum of 15% Class C
* The Engineer will allow the Contractor to substitute a portion of the minimum required supplementary cementitious material with up to 5% silica fume by weight for mitigation purposes.							

2.A.4 Cementitious Materials
Provide only cementitious materials from the Approved/Qualified Products List.

2.A.4.a Cement
Use Type I or Type I/II cement complying with Specification 3101, "Portland Cement," or blended cement in accordance with Specification 3103, "Blended Hydraulic Cement."
1. Total alkalis (Na_2Oe) no greater than 0.60 percent in the Portland cement, and
2. Total alkalis (Na_2Oe) no greater than 3.0 lb per yd^3 of concrete resulting from the Portland cement.

2.A.4.b Fly Ash
Use fly ash conforming with Specification 3115, "Fly Ash for use in Portland Cement." The Concrete Engineer defines Class F fly ash for the purposes of ASR mitigation as having a maximum CaO content of 18.0%.

2.A.4.c Ground Granulated Blast Furnace Slag
Use ground granulated blast furnace slag conforming to Specification 3102, "Ground Granulated Blast-Furnace Slag."

2.A.4.d Silica Fume
Use silica fume conforming to ASTM C1240.

2.A.4.e Ternary Mixes
Ternary mixes are defined as Portland cement and two other supplementary cementitious materials, or blended cement and one other supplementary cementitious material with a maximum replacement of 40% by weight.

2.A.5 Additional Ingredients
Combine and blend as required.

2.A.5.a Allowable Admixtures
Use any of the following admixtures on the MnDOT Approved/Qualified Products as listed under "Concrete Admixtures A-S":
1. Type A, Water Reducing Admixture,
2. Type B, Retarding Admixture,
3. Type C, Accelerating Admixture,
4. Type D, Water Reducing and Retarding Admixture,
5. Type F, High Range Water Reducing Admixture, and
6. Type S, Specific Performance Based Admixture

Obtain a written statement from the manufacturer of the admixtures verifying:

1. Compatibility of the combination of materials, and
2. Manufacturer recommended sequence of incorporating the admixtures into the concrete.

The manufacturer will further designate a technical representative to dispense the admixture products.

Utilize the technical representative in an advisory capacity and have them report to the Contractor any operations or procedures which are considered as detrimental to the integrity of the placement. Verify with the Engineer whether the Manufacturer's technical representative's presence is required during the concrete placement.

1 - DESIGNER NOTE: Always include 2.A.5.b unless the Regional Bridge Construction Engineer states not to use.

2.A.5.b Fiber Reinforcement

Furnish only one of the materials listed on the Department's Approved/Qualified Product List (A/QPL) for Concrete Products, "Nonmetallic Fibers," (www.dot.state.mn.us/products). Provide fibers at a dosage as prescribed on the A/QPL per the manufacturer. Incorporate the fibers into the mix design in accordance with the applicable requirements of 2401, "Concrete Bridge Construction," and 2461, "Structural Concrete" and the following:

2.A.5.b (1) Materials

Supply Type III fibers in accordance with ASTM C1116. A minimum dosage rate of 4 lbs/cy is required. The fibers on the A/QPL are a combination of micro and macro non-metallic fibers to provide crack control and improve the long-term performance of the bridge decks. The stated manufacturer purpose of the non-metallic fibers is for controlling plastic shrinkage cracks in concrete (micro fibers) and to provide increased residual flexural strength in the concrete (macro fibers). Single component macro fibers conforming to the requirements of table HPC-4 may be submitted for approval by the Engineer.

2.A.5.b (2) Acceptance and Testing

Test Fiber-reinforced concrete for the following hardened properties in accordance with the Table HPC-4:

Table HPC-4
Required Hardened Fiber-Reinforced Concrete Properties

Test	Requirement	Test Method
Equivalent Flexural Strength Ratio ($R^{D}_{T,150}$)	Minimum of 25%	ASTM C1609
Crack Reduction Ratio (CRR)	Minimum reduction >85%	ASTM C1579

Test beam specimens when the concrete strength is between 3500 and 4500 psi. In all cases the trial placement with the contractor-designed mix will be required to demonstrate slump, air loss, and workability with the Contractor's mix design.

2.A.5.b (3) Dosage and Documentation

Supply a written statement from the manufacturer of the fibers verifying the compatibility of the combination of materials and the sequence in which they are combined, to the Engineer prior to using it in this project.

2.A.5.b (4) Application Requirements

Mix non-metallic fiber reinforcement in concrete mixer in accordance with mixing time and speed of ASTM C94, "Standard Specification for Ready-Mixed Concrete" to ensure uniform distribution and random orientation of fibers throughout concrete. Notify the Engineer in writing of the dedicated personnel for this task and the procedures for distributing fibers.

The following fiber addition methods are acceptable on all jobs:

1. Open bag and distribute fibers on aggregate belt at ready-mix concrete plant;
2. Open bag, break apart any fiber clumps, and introduce fibers into ready-mix concrete truck in a well-distributed manner (i.e., "chicken feed")

Any alternate methods to add fibers to the concrete mix must be submitted for acceptance by the Engineer and be demonstrated by a successful trial placement. Allowing bags to dissolve in the ready-mix concrete trucks will not be allowed. Balling of fibers is defined as a 2 inch diameter or greater conglomerate of fibers at the point of placement. Any balling more prevalent than 1 location in 20 CYDs will be considered a failed trial placement. Ensure the manufacturer's technical representative is available by phone or in person to troubleshoot fiber inclusion into the mix during the trial placement and bridge deck placement.

2.A.6 Concrete Mix Design Requirements

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 21 calendar days before the initial concrete placement. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

2.A.6.a Concrete Mix Design Requirements

Design and produce 3YHPC-M or 3YPHC-S concrete mixes based on an absolute volume of 27.0 ft^3 in accordance with the Table HPC-4 and the following requirements:

Table HPC-5
High Performance Bridge Deck Concrete Mix Design Requirements

Concrete Grade	Mix Number *	Intended Use	w/c ratio	Target Air Content	Maximum %SCM (Fly Ash/Slag/ Silica Fume/ Ternary) ‖	Slump Range †, *inches*	Minimum Compressive Strength, f'c (28-day)	3137 Spec.
HPC	3YHPC-M	Bridge Deck – Monolithic	0.42-0.45	6.5%	30/35/5/40	1 - 4	4000 psi	2.D.2
	3YHPC-S	Bridge – Structural Slab						

* Provide a Job Mix Formula in accordance with 2401.2.A.7. Use any good standard practice to develop a job mix formula and gradation working range by using procedures such as but not limited to 8-18, 8-20 gradation control, Shilstone process, FHWA 0.45 power chart or any other performance related gradation control to produce a workable and pumpable concrete mixture meeting all the requirements of this contract.
‖ The individual limits of each SCM shall apply to ternary mixtures.
† Keep the consistency of the concrete uniform during entire placement. Where fibers are used as specified in this specification the slump range may be adjusted to 1 – 5 inches.

2.A.6.b Required Preliminary Testing

Prior to placement of any 3YHPC-M or 3YHPC-S Concrete, the Engineer will require preliminary batching and testing of the concrete mix design.

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 14 calendar days prior to the beginning of preliminary laboratory mixing and testing of the proposed mix designs. Any changes or adjustments to the material or mix design require a new Contractor mix design submittal. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

Test the concrete for the following hardened concrete properties in accordance with Table HPC-5:

Table HPC-6 **Required Hardened Concrete Properties for Mixes 3YHPC-M and 3YHPC-S**		
Test	Requirement	Test Method
Required Strength (Average of 3 cylinders)	4000 psi at 28 days	ASTM C31
Rapid Chloride Permeability	≤ 2500 coulombs at 28 days (For Preliminary Approval) ≤ 1500 coulombs at 56 days	ASTM C1202
Freeze-Thaw Durability	Greater than 90% at 300 cycles	ASTM C666 Procedure A
Shrinkage	No greater than 0.040 percent at 28 days	ASTM C157
Scaling	Visual rating not greater than 1 at 50 cycles	ASTM C672

The Engineer will allow the maturity method for subsequent strength determination. Perform all maturity testing in accordance with ASTM C1074 and the MnDOT Concrete Manual.

If a mix is approved, the Concrete Engineer will consider the mix design and testing as acceptable for a period of 5 years provided the actual concrete mixed and placed in the field meets the Contract Requirements. The Concrete Engineer will not require new testing within that 5-year period as long as all the constituents (including the aggregates) of the proposed mix design are the same as the original mix design.

The Engineer determines final acceptance of concrete for payment based on satisfactory field placement and performance.

2.A.7 Job Mix Formula

A Job Mix Formula (JMF) contains the following:

1. Proportions for each aggregate fraction,
2. Individual gradations for each aggregate fraction, and
3. Composite gradation of the combined aggregates including working ranges on each sieve in accordance with Table HPC-7.

Table HPC-7 **Job Mix Formula Working Range**	
Sieve Sizes	**Working Range, %***
1 inch and larger	±5
¾ inch	±5
½ inch	±5
⅜ inch	±5
No. 4	±5
No. 8	±4
No. 16	±4
No. 30	±4
No. 50	±3
No.100	±2
No. 200	≤ 1.6
* Working range limits of the composite gradation based on a moving average of 4 tests (N=4).	

2.A.7.a Verification of JMF

Prior to beginning placements of bridge deck concrete, perform gradation testing to ensure current materials comply with the approved JMF. Perform gradation testing in accordance with the Schedule of Materials Control.

1. Take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work as approved by the Engineer.
2. Add fill-in sieves as needed during the testing process to prevent overloading.

The Producer and Engineer will test and record the individual gradation results using the Concrete Aggregate Worksheet.

1. Using the JMF Moving Average Summary Worksheet, calculate the moving average of Producer aggregate gradation test results during production.
2. The Engineer will randomly verify Producer combined aggregate gradation results as defined in the Schedule of Materials Control.

If, during production, the approved JMF falls outside of the allowable working range immediately sample and test additional gradation and continue production.

2.A.7.b JMF Adjustment

If it is determined that the current aggregates do not meet the approved JMF, submit a new mix design including JMF to the Concrete Engineer in accordance with 2401.2.A.7 (of this SP).

2.A.7.c JMF Acceptance

The Engineer will make monetary adjustments for the quantity of bridge deck concrete represented by the JMF Working Range failure, from the failing test to the next passing test, at a minimum rate of $500.00 or $5.00 per cubic yard, whichever is greater.

2.A.8 Laboratory batching, testing requirements and submittals:

To determine the characteristics of the Contractor proposed mix design, the Concrete Engineer will require the Contractor to prepare test batches and do laboratory testing. Conduct all batching and testing of concrete at a **single** AMRL certified laboratory using the exact materials proposed in the mix design.

Lab testing requirements:

1. Slump and air content at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing,
2. Compressive strength (Make cylinders in accordance with AASHTO T126 and tested in accordance with AASHTO T22) at 1, 3, 7, 28, 56 days (sets of 3),
3. Hardened air content (ASTM C457) at a minimum of 7 days,
4. Rapid chloride permeability (ASTM C1202) at 28 days and 56 days (2 specimens for 28 day test and 2 test specimens for 56 day test (Take 2 specimens from each batch of a 2 batch mix)),
5. Concrete Durability (ASTM C666, Procedure A) at 300 cycles, and
6. Concrete Shrinkage (ASTM C157) at 28 days.

The Contractor is required to contact the MnDOT Concrete Engineering Unit a minimum of 2-days prior to any mixing so that a MnDOT representative can observe the process. This same 2-day notification is required prior to any physical testing on hardened concrete samples. Additionally, retain any hardened concrete test specimens for a minimum of 90 days and make available for MnDOT to examine.

Perform all testing for plastic concrete after all admixtures additions to the concrete mixture.

After completion of the laboratory testing specified herein and, at least, 15 working days prior to the trial placement, submit the laboratory test data to the MnDOT for review and acceptance.

Include the following information in the laboratory reports of the design mixes:

1. Exact batch weights and properties of all ingredients used and all aggregate gradations;
2. Slump and air content;
3. Cylinder identification, including mix designation;

4. Date and time of cylinder preparation;
5. Date and time cylinder specimen was tested;
6. Compressive strength of each cylinder specimen at 1, 3, 7, 28, and 56 day (sets of 3);
7. A graphic plot of age, from 0 to 56 days, vs. strength for each mix design;
8. Hardened air content at a minimum of 7 days;
9. Rapid chloride permeability at 28 days and 56 days;
10. Concrete Durability at 300 cycles; and
11. Concrete Shrinkage at 28 days.

2.A.9 Prior to Actual Bridge Deck Placement

2.A.9.a Trial Placement

A minimum of 14 calendar days prior to the actual placement of the bridge deck slab concrete, successfully complete a separate trial placement utilizing a minimum of two (2) - 10 yd^3 loads.

The Engineer may allow the incorporation of the concrete for trial batches into the bridge footings, abutments or end diaphragms. The Contractor may also choose to incorporate the trial batches into residential /commercial construction in the immediate vicinity of the project. In any case, the Engineer will require mixing, transporting, and placing the concrete using the same methods as the actual placement of the bridge deck.

If the concrete is incorporated into the permanent work, the Engineer will test the plastic concrete in accordance with the Schedule of Materials Control. The Engineer may require additional trial batches if the concrete delivered to the project does not comply with the plastic concrete requirements of the Contract.

The Engineer will waive a trial placement, at the contractor's request, provided the contractor submits a history of at least three successful bridge deck placements in the last 5 years using the same mix design and similar pumping or placement configuration.

The concrete mix design, laboratory batching and mixing, and the trial placement is incidental to the concrete furnished and placed.

Use the same materials, same supplier, and same supplier's manufacturing plant, and proportions in the permanent work as in the trial placement. Strength requirements specified for each mix are applicable to the cylinder tests taken during the production work.

2.A.9.b Slab Placement and Curing Plan

At least 14 calendar days prior to slab placement, provide a slab placement and curing plan for each bridge to the Engineer for approval. Include the following information in the placement and curing plan:

1. Anticipated concrete delivery rates
2. Estimated start and finish time
3. Material, labor and equipment proposed for placing, finishing, and curing including placement of wet burlap, soaker hose, or other system to maintain the deck in a moist condition during the curing period
4. Number of work bridges proposed for use
5. Number of people responsible for the various tasks and
6. Bulkheading methods and materials proposed for use if the Contractor cannot maintain the proposed concrete placement rates.

For full depth monolithic decks, the finishing machine will consist of a cylindrical finisher mated with horizontal adjustable augers, both of which are mounted on a transversely moving carriage unless otherwise approved by the State Bridge Construction Engineer.

A 10 ft modified straight-edge is required for full-depth decks prior to carpet dragging regardless of whether texture planing is specified for the final ride surface. Float slab in accordance with MnDOT Construction Manual 5-393.358 to ensure the final surface does not vary by greater than ⅛ inch within a 10 ft straightedge laid longitudinally on the final surface. This surface tolerance includes areas near expansion devices and other breaks in the continuity of the bridge slab.

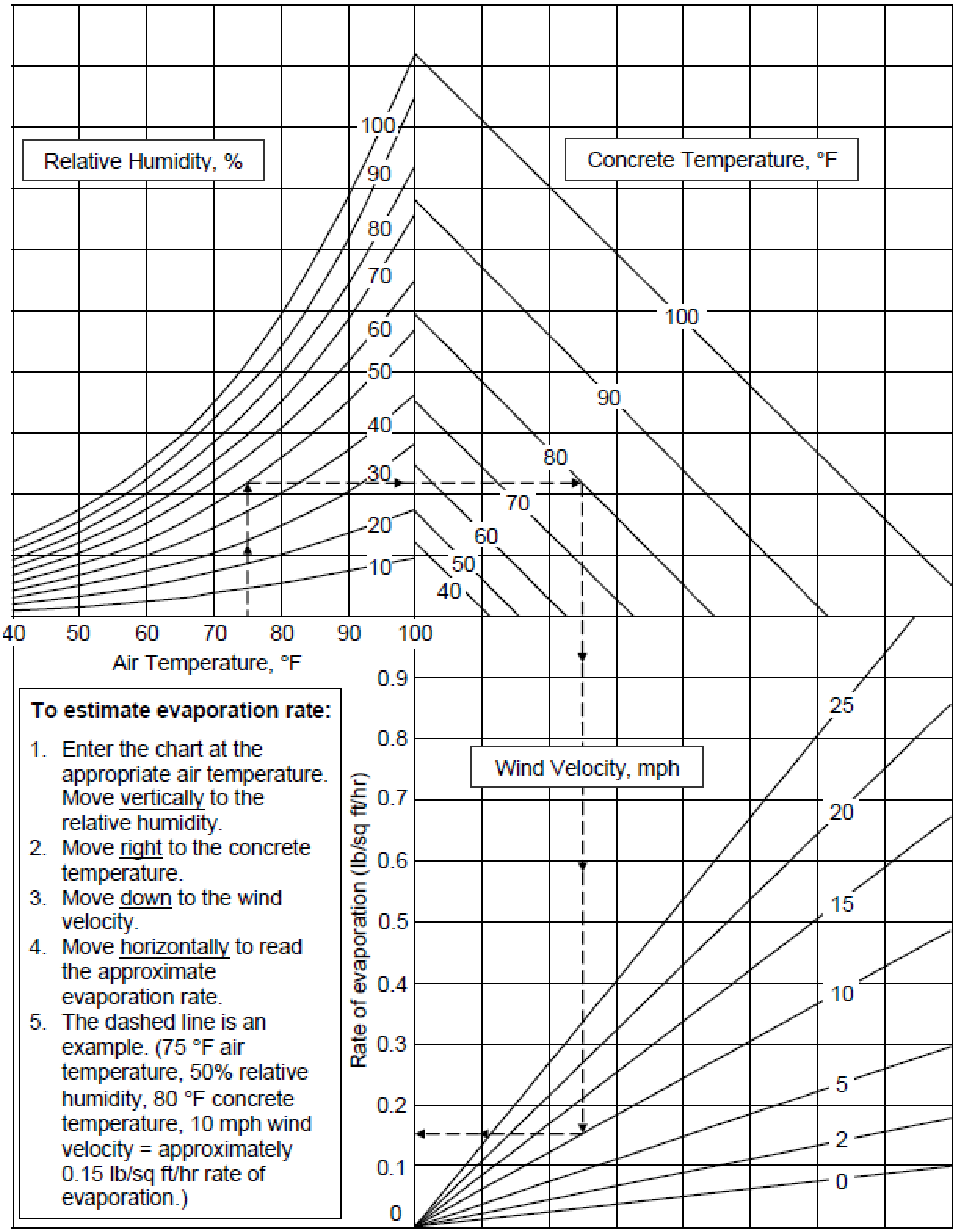
Attend a pre-placement meeting 2 days to 4 days before the slab placement to review the information and details provided in the placement and curing plan. The following project personnel are required to attend the pre-placement meeting:

1. Contractor
2. Engineer
3. Concrete supplier and
4. If required by the Engineer, the concrete pump supplier.

2.A.9.c Three (3) Hours Prior to Beginning Bridge Deck Concrete Placement

The Engineer requires the Contractor to comply with all of the following conditions prior to allowing the Contractor to begin the bridge deck concrete placement:

1. Provide a forecast to the Engineer three (3) hours before placement. The Engineer will review the forecast for the following:
    a. No forecasted precipitation two (2) hours prior to the scheduled placement duration, nor up to two (2) hours after the anticipated completion of the placement, and
    b. Less than 30% chance of precipitation for the entire placement window and
2. Only if the combination of air temperature, relative humidity, concrete temperature and wind velocity produces an evaporation rate of less than 0.20 pounds per square foot of surface area per hour, according Figure HPC-1:



[1] Based on ACI 305 R, "Hot Weathering Concreting"

FIGURE HPC-1

SB- X.X.1 Concrete Curing and Protection

Delete the 16^{th} paragraph through 18^{th} paragraphs of 2401.3.G, "Concrete Curing and Protection," and replace with the following:

2.A.9.d Actual Bridge Deck Placement and Curing Requirements

In addition to the requirements set forth in 2461.3.G.4, "Field Adjustments," if any adjustments are necessary on site, comply with the following:

1. The Engineer will only allow the addition of admixtures originally incorporated into the mix, except Viscosity Modifying Admixture (VMA) is allowed to adjust slump even if they were not used in the original testing
2. The Engineer will allow a maximum of 1 gal of water additions per yd^3 of concrete on site provided additional water is available to add per the Certificate of Compliance, including any water necessary to dilute admixtures and
3. Mix the load a minimum of 5 minutes or 50 revolutions after any additions.

The Engineer will not allow finishing aids or evaporation retarders for use in finishing of the concrete.

The Contractor is fully responsible for curing methods. Comply with the following curing methods unless other methods are approved by the Engineer in writing.

<table>
<tr><th colspan="3">Table HPC-8
Required Curing Method Based on Final Bridge Deck Surface</th></tr>
<tr><th>Bridge Deck Type</th><th>Final Bridge Deck Surface</th><th>Required Curing Method ‖</th></tr>
<tr><td>Bridge structural slab curing
(3YHPC-S)</td><td>Low Slump Wearing Course</td><td>Conventional wet curing after carpet drag</td></tr>
<tr><td rowspan="4">Bridge deck slab curing
for full-depth decks
(3YHPC-M)</td><td>Epoxy Chip Seal Wearing Course
or
Premixed Polymer Wearing Course</td><td>Conventional wet curing after carpet drag</td></tr>
<tr><td>Bridge Deck Planing</td><td>Conventional wet curing after carpet drag.</td></tr>
<tr><td>Tined Texturing*</td><td>Conventional wet curing after tine texturing AMS curing Compound after wet cure period</td></tr>
<tr><td>Finished Sidewalk or Trail Portion of Deck (without separate pour above)*</td><td>Conventional wet curing after applying transverse broom finish AMS curing Compound after wet cure period</td></tr>
<tr><td colspan="3">‖ Apply conventional wet curing to bridge slabs following the finishing machine or air screed.
* Prevent marring of broomed finish or tined textured surface by careful placement of wet curing.</td></tr>
</table>

Use conventional wet curing consisting of pre-wetted burlap covered with white plastic sheeting in accordance with the following:

1. Place the burlap to cover 100 percent of the deck area without visible openings
2. Place the wet curing within 30 min after the finishing machine completes the final strike-off of the concrete surface
3. If the Contractor fails to place the wet curing within 30 min, the Department will monetarily deduct $500 for every 5 min period, or any portion thereof, after the initial time period until the Contractor places the wet curing as approved by the Engineer, the Department may assess the deduction more than once

4. Keep the slab surface continuously wet for an initial curing period of at least 7 calendar days
5. Use a work bridge to follow the finish machine and
6. Provide an additional center rail on wide bridges, if necessary.

Where marring of the broomed finish or tined texturing surface finish is a concern, the Engineer may authorize curing as follows:

1. Apply a membrane curing compound meeting the requirements of 3754, "Poly-Alpha Methylsytrene (AMS) Membrane Curing Compound"
2. Apply curing compound using approved power-operated spray equipment
3. Provide a uniform, solid white, opaque coverage of membrane cure material on exposed concrete surfaces (equal to a white sheet of paper)
4. Place the membrane cure within 30 minutes of concrete placement unless otherwise directed by the Engineer
5. Provide curing compound for moisture retention until the placement of a conventional wet curing
6. Apply conventional wet curing when walking on the concrete will not produce imprints deeper than $^{1}/_{16}$ inch
7. Keep the deck slab surface continuously wet for an initial curing period of at least 7 calendar days including weekends, holidays, or both if these fall within the 7-calendar-day curing period
8. The Engineer will not allow placement of membrane curing compound on any concrete surface that expects future placement of additional concrete on that surface and
9. If the Contractor fails to meet these requirements, the Department may reduce the contract unit price for the concrete item in accordance with 1512, "Conformity with Contract Documents."

2 - DESIGNER NOTE: select the method that is required and remove the other.

A. Method of Measurement

If measuring bridge slab concrete by area, the Engineer will measure the bridge slab by surface area based on the dimensions shown on the plans. The Engineer will not deduct the surface area of expansion devices or other miscellaneous appurtenances.

If measuring bridge slab concrete by cubic yard, the Engineer will base the measurement on the basis of the dimensions of the structure shown in the plans of the slab.

3 - DESIGNER NOTE: select the payment that is required and remove the others.

B. Basis of Payment

Payment for Item No. 2401.618 "BRIDGE SLAB CONCRETE (3YHPC-M)" will be made at the Contract price per square foot and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

Payment for Item No. 2401.618 "BRIDGE SLAB CONCRETE (3YHPC-S)" will be made at the Contract price per square foot and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

Payment for Item No. 2401.607 "BRIDGE SLAB CONCRETE (3YHPC-M)" will be made at the Contract price per cubic yard and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

Payment for Item No. 2401.607 "BRIDGE SLAB CONCRETE (3YHPC-S)" will be made at the Contract price per cubic yard and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

SB- X.X.2 Crack Sealing

Delete the contents of 2401.3.I.2, "Crack Sealing," and replace with the following:

The Contractor is fully responsible for crack sealing all cracks in accordance with table 2401-5.

Table 2401-9 Crack Sealing Requirements Based on Final Bridge Deck Surface		
Bridge Deck Type	Final Bridge Deck Surface	Crack Sealing Requirements
Bridge structural slab *	Low Slump Wearing Course	Seal cracks in accordance with SB-X.X.2.2
Bridge deck slab for full-depth decks	Epoxy Chip Seal Wearing Course or Premixed Polymer Wearing Course	See wearing course special provision
	Bridge Deck Texture Planing	Seal cracks per workflow following this table – Figure 1
	Tined Texturing	Seal cracks per workflow following this table – Figure 1
	Finished Sidewalk or Trail Portion of Deck (without separate pour above)	Seal cracks per workflow following this table – Figure 1

* Shotblast the surface in preparation for low slump wearing course. Prior to placing the low slump wearing course, the Engineer will visually inspect the bridge structural slab, and will mark cracks that require sealing appearing on the top surface. Control the application of the crack sealer such that the maximum width of crack sealant does not exceed 1 inch. If exceeding the permitted width of 1 inch, remove excess by means of surface grinding to prevent debonding of concrete wearing course. The Engineer requires the sealer to cure completely prior to pre-wetting of the deck, as required for placement of a low slump concrete wearing course.

Use the following workflow chart for crack sealing of finished roadway, trail and sidewalk surfaces on bridges. Incorporate the referenced special provisions.

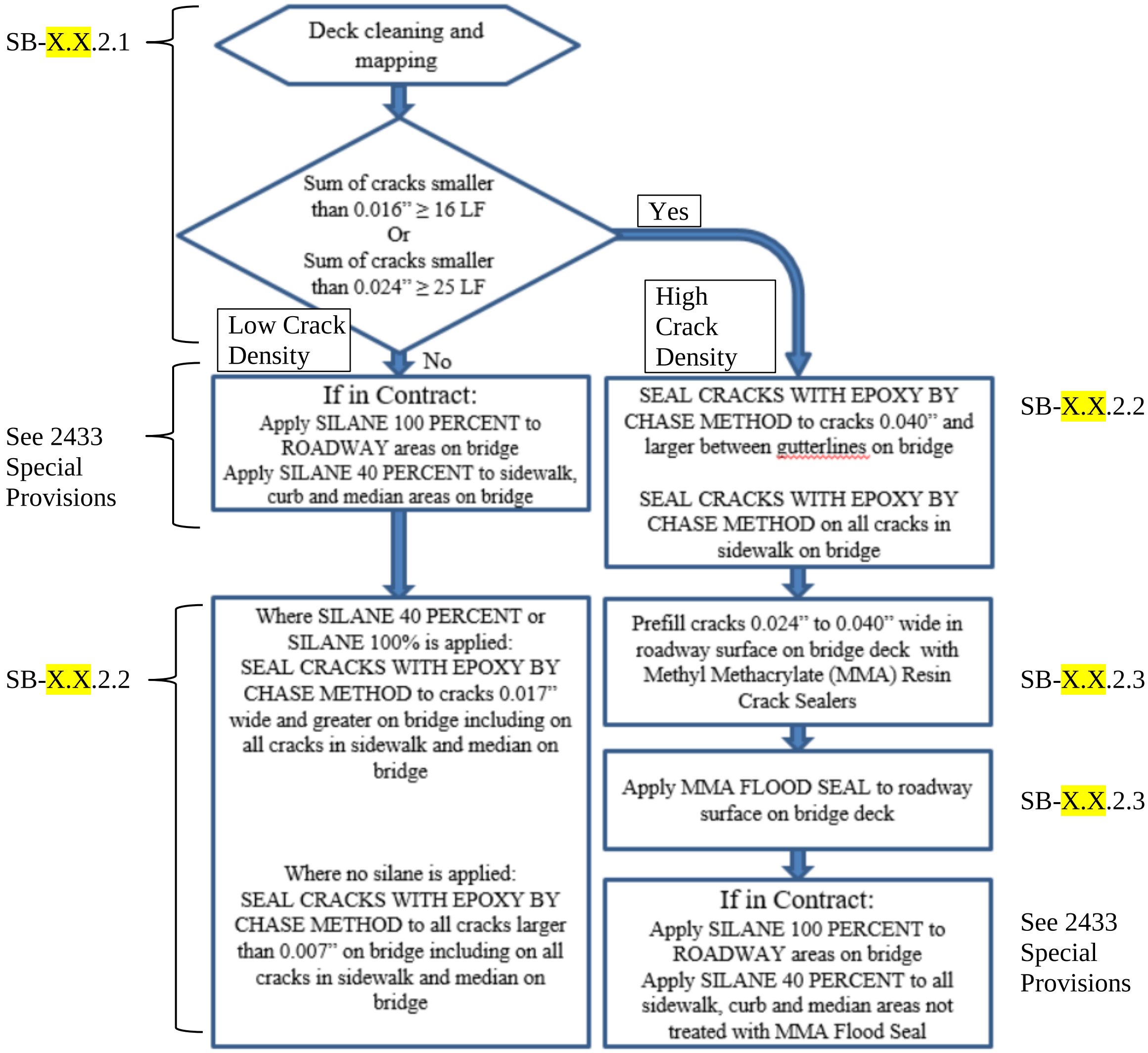


Figure 1: Workflow diagram and decision diagram for crack sealing in horizontal surfaces.

Determine crack density after clearing and cleaning the roadway and sidewalk surfaces in accordance with SB-X.X.2.1

SB-X.X.2.1 Deck Cleaning and Mapping Cracks

A. Description

This consists of cleaning the bridge deck and sidewalk for evaluation of crack density in advance of the actual crack sealing operations. Any grinding or Bridge Deck Planing should occur in advance of this phase. Where tining is the surface texture on new bridge surfaces, AMS curing compound may be present. Crack sealing will not require removal of the curing compound for cracks less than 0.017 inches wide unless treating surfaces are more than one year old.

B. Construction

The contractor is required to:

1. Fabricate crack mapping frames or otherwise produce a grid on the deck surface for mapping cracks at selected locations;
2. Provide 5 crack comparator gages, per bridge, conforming to standard crack widths of ACI 224R-01 (American Concrete Institute) (See sample gage below);
3. Produce crack mapping records; and
4. Summarize measured crack data in two designated areas per bridge to the Engineer. Based on observed crack density, a sealing treatment per contract requirements will be authorized by the Engineer.

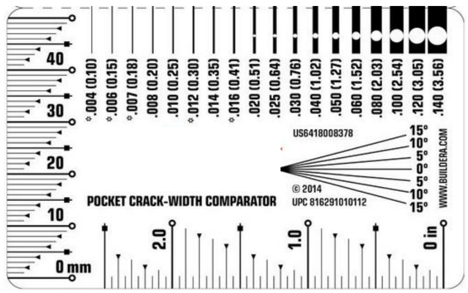


Image of an acceptable crack comparator gage (not scalable)

Remove all dirt, loose aggregate and other deleterious materials on bridge deck, approach panels, bridge joints, and sidewalks. Bridge joint cleaning may require hand-operated equipment such as blowers and power washers to thoroughly clean. Dispose of any loose material removed from swept and cleaned areas in accordance with 2104.3.C.3, "Concrete and Masonry Structures".

C. Evaluation

The Engineer will locate two areas to represent the general cracking condition of the deck. Power wash representative areas and then during the deck drying process utilize frames with stringlines at 1 foot grids or otherwise produce a grid to map cracks within areas as follows:

1. A 72 SF area in a 12 foot longitudinal by 6 foot transverse area near midspan; and
2. A 72 SF area 6 foot in width located between 24-ft and 12-ft from center of a pier (if multiple spans).

The above locations are general guidelines and actual locations will be selected by the Engineer but in all cases will be in a driving lane to capture crack density. Where varying crack levels exist within a 200-foot or longer bridge, crack evaluation may be performed at 50-foot intervals to substantiate a switch in crack sealing treatments. An illustrative example (without color – colorized version available upon request) of crack mapping locations is shown below:

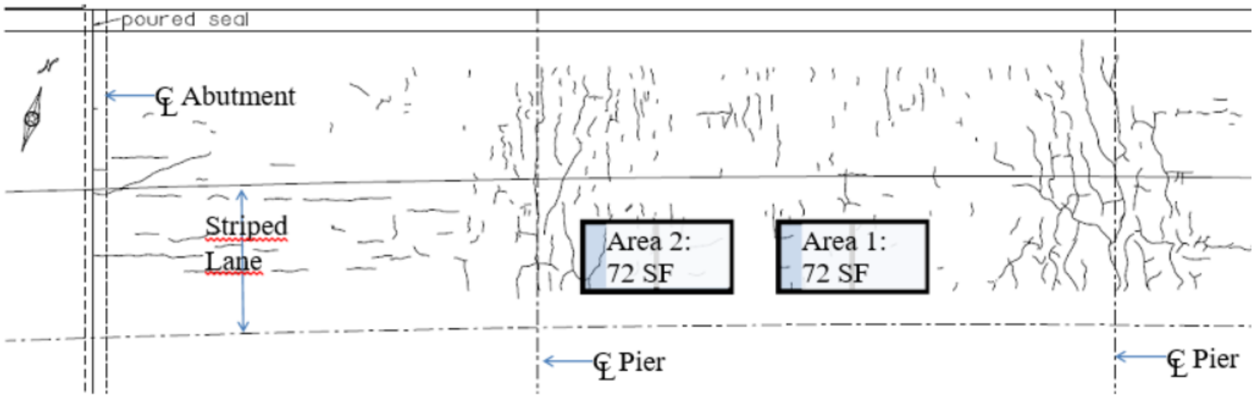


Figure 2: Illustration of crack mapping areas that will be used to characterize general cracking condition of the bridge deck surface.

Record crack frequency and the crack size range according to the following table.

Crack Classification	Crack Width	Pen Color
A1	< 0.010 in.	Black
A2	0.010 in. – 0.016 in.	Red
B1	0.017 in. – 0.024 in.	Green
B2	$\geq$ 0.025 in.	Blue

Record mapping on grid-lined engineering paper demarked with 1 inch squares and tenth inch increments, where one inch paper scale represents one foot measurement on bridge deck surface. Record with clarity the general crack path in the appropriate color from the table above. Map cracks with an accuracy of +/- 6-inches for path and using the largest portion of the crack shadow as the size. Re-evaluate crack size on bridge deck every 2 feet when mapping and determine corresponding color of pen for recording. A sample crack map will be furnished on request.

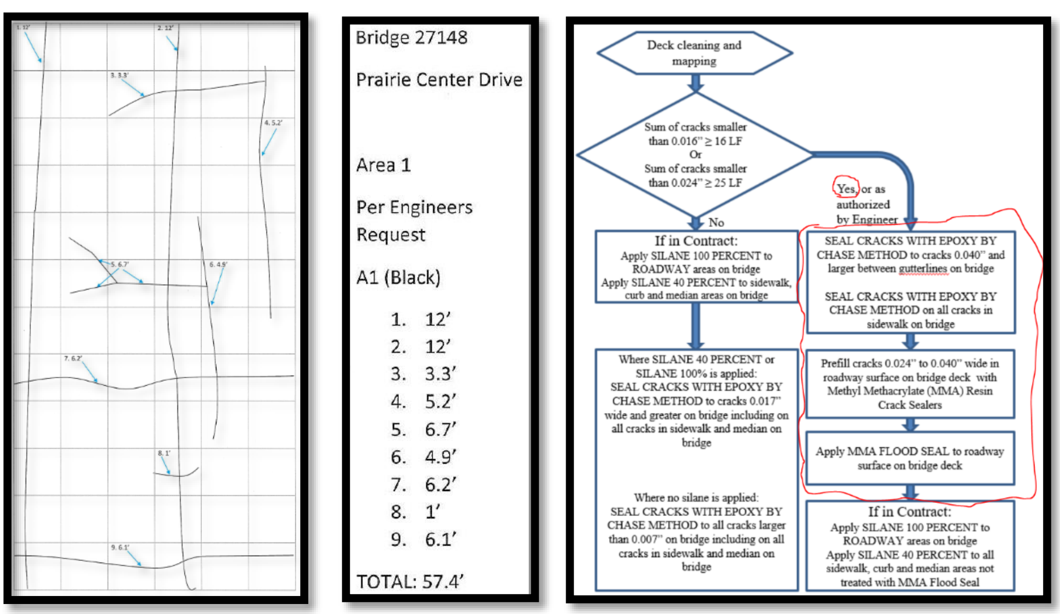


Figure 3: Crack mapping example for one 72-SF area and resultant sealing decision.

D. Crack Sealing Authorization

Compute length of cracks in each crack classification category to the nearest tenth of a foot. Compute cumulative length of crack (e.g., A1, A1+A2, A1+A2+B1, A1+A2+B1+B2). Present crack mapping records and crack lengths to the Engineer at least two business days prior to performing any bridge deck sealing. The Engineer will review the length of cracks based on interpretation of the submitted crack maps. Follow the workflow Figure 1 in for determination of sealing method:

- SB-X.X.2.2 Seal Cracks with Epoxy by Chase Method
- SB-X.X.2.3 MMA Flood Seal

SB-X.X.2.2 Seal Cracks with Epoxy by Chase Method

A. Description of Work

This specification covers crack sealing to:

1. Structural slabs and that will receive a concrete wearing course.
2. Bridge Deck Slabs (Monolithic decks) with low crack density (See Flow Chart – Figure 1).
3. Concrete wearing course with low crack density (See Flow Chart – Figure 1)

The contractor is responsible for sealing all cracks 0.010 inches and larger, at no cost to the Department. Cracks smaller than 0.010 inches, as measured at the crack's widest segment, on finished roadway surfaces and sidewalks will not require sealing.

When applied on finished concrete roadway surfaces, apply epoxy in a width not exceeding 3 inches.

When applied on a structural slab which is to receive a concrete wearing course, apply epoxy in a cured width not exceeding 1 inch.

B. Materials

Furnish only one of the materials listed on the Department's Approved/Qualified Product List for Bridge Products, "Bridge Surface and Crack Sealers," (www.dot.state.mn.us/products/bridge). A product may be selected from either the "High Elongation Epoxy Crack Sealers" or "High Strength Epoxy Crack Sealers" categories. Apply in accordance with the requirements listed on the approved products list, except that when applied under a concrete wearing course only one application pass is required.

C. Surface Preparation and Application

1. When applied on final roadway surface:

Do not apply crack sealants to concrete surfaces less than three (3) weeks old. No greater than three (3) weeks prior to application:

a. Perform a visual inspection of the roadway surface, and sidewalk where applicable. Locate and mark all cracks appearing on the top surface visible from 5 ft above deck surface, and as directed by the Engineer.

b. Within 1½ inches of the cracks, sandblast, shotblast, vapor blast, or waterblast to remove curing compound and other contaminants that would impede the adhesion of the sealant. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations;

c. Air dry a wet deck for a minimum of twenty-four (24) hours before applying the sealer;

d. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft^3 / min., over the cracks to be sealed to remove dust and debris. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic. Use a suitable oil trap between the air supply and nozzle. Use ASTM D4285 "Standard Test Method for Indicating Oil or Water in Compressed Air" to ensure the compressed air is oil and moisture free;

    (1) Have the Engineer approve the prepared surface prior to applying the sealer (Hold Point);

    (2) Seal the entire length of all cracks 0.010 inches or greater in width as measured at its widest segment.

Protect all expansion joints and prevent the crack sealant from contacting the strip seal glands. Protect all striping and traffic markings from marring, sealant application and reduction in reflective properties. Replace any striping and traffic markings that are marred by sealant, at no cost to the Department.

Fill cracks with an approved crack sealer following the manufacturer's recommendations, and as otherwise directed by the Engineer. Where traffic is to be placed on crack sealer before curing is complete, broadcast to refusal oven dried 30 grit or similar sand into wet, uncured resin. If a subsequent treatment will be applied that would be affected by the sand. Cleaning unbonded sand or grit will be not be paid for separately but be considered incidental to surface preparation requirements for the subsequent treatments. Remove excess sand that causes concern for traction or braking from bridge deck including deck joints, as directed by the Engineer.

2. When applied to structural slab prior to placing new wearing course:

Supplement 2404.3.C, "Deck Preparation," with the following:

After shotblasting the surface, perform a visual inspection of the roadway surface. Locate all cracks appearing on the top surface, and as directed by the Engineer. Fill all located cracks with an approved crack sealer following the manufacturer's recommendations, and as otherwise directed by the Engineer. Ensure the sealer is cured prior to preceding pre-wetting of the deck, as required for placement of a low slump concrete wearing course.

Control the application of the crack sealer such that the maximum width of crack sealant does not exceed 1 inch. If exceeding the permitted width of 1 inch, remove excess by means of surface grinding to prevent debonding of concrete wearing course. Air dry a wet deck for a minimum of twenty-four (24) hours before applying the sealer. Have the Engineer accept the prepared surface prior to applying the sealer.

D. Weather Limitations

Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within three (3) hours of the completion of sealer application.

1. Provide a National Weather Service (www.weather.gov) forecast to the Engineer three (3) hours before placement. The Engineer will review the forecast for the following:
   a. No forecasted precipitation two (2) hours prior to the scheduled placement duration, nor up to two (2) hours after the anticipated completion of the placement.
   b. Less than 30% chance of precipitation for the entire placement window.

Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the crack seal at the coolest time of the day within these limitations.

SB-X.X.2.3 Methyl Methacrylate (MMA) Flood Seal

A. Description of Work

This work consists of furnishing and applying a protective MMA sealer, as authorized by the Engineer. Do not apply crack sealants to concrete surfaces less than three (3) weeks old. Where AMS curing compound is present on the roadway surface, shotblasting the areas to be sealed is required as incidental to the work.

B. General

1. Sealing Large Cracks (0.040 inches or greater)

Prior to MMA Flood Seal application, seal cracks greater than 0.040 inches with approved epoxy.

2. Prefill Cracks (0.024 inch to 0.040 inch width)

Ahead of the MMA flood sealant placement, prefill cracks 0.024 inch to 0.040 inches wide with same sealer as used in flood seal or a pre-promoted version of the sealer. Where sealant soaks-in/withdraws from top of crack, place fine grade abrasive sand (20/40 abrasive) in crack and reapply MMA sealant to seal to top of crack. When sealant has not retreated after gel time, the crack is considered prefilled. Do not fill crack with sand beyond top of concrete surface.

3. MMA Application

Apply an approved MMA to bridge deck between gutterlines. At least 14 calendar days before the start of the work, provide the Engineer with the sealer Manufacturer's written instructions for application and use.

C. Materials

1. Epoxy

Furnish only one of the materials listed on the Department's Approved/Qualified Product List for Bridge Products, "Bridge Surface and Crack Sealers," (www.dot.state.mn.us/products/bridge). A product may be selected from either the "High Elongation Epoxy Crack Sealers" or "High Strength Epoxy Crack Sealers" categories (www.dot.state.mn.us/products/bridge). Apply in accordance with the requirements listed on the approved products list, except that when applied under a concrete wearing course only one application pass is required.

2. MMA Sealant

Furnish only one of the materials on the Department's Approved/Qualified Product Lists for Bridge Products, Bridge Surface and Crack Sealers, "Methacrylate Resin Crack Sealers" (www.dot.state.mn.us/products/bridge).

3. Broadcast Sand

Provide a commercial quality dry blast sand meeting the following:

a. 95% passing the No. 8 sieve; and
b. 95% retained on the No. 20 sieve.

4. Fine Grade Sand

Provide fine grade abrasive sand for (20/40 abrasive) prefilling large cracks unable to be prefilled with sealant alone.

Submit sand material data to the Engineer for review and address all written comments. Submit storage and use plan to the Engineer documenting procedures for maintaining dry sand and within gradation requirements above.

D. Surface Preparation

1. Where AMS curing compound is present on the roadway surface, shotblasting the areas to be sealed is required as incidental to the work. Clean all areas to be sealed by removing dirt, dust, oil, grease, curing compounds, laitance, or other contaminants that would prevent adhesion and crack penetration of the sealant;
2. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations;
3. Perform a visual inspection of the roadway surface. Locate and mark all cracks greater than 0.024 inch appearing on the top for prefilling;
4. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft^3 / min., over the entire surface to remove all dust and debris paying special attention to carefully clean all deck cracks. Use a suitable oil trap between the air supply and nozzle. Use ASTM D4285 "Standard Test Method for Indicating Oil or Water in Compressed Air" to ensure the compressed air is oil and moisture free;
5. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic;
6. Air dry a wet deck for a minimum of seventy-two (72) hours before applying the sealer; and
7. Have the Engineer accept the prepared surface prior to applying the sealer (Hold point).

E. Sealant Manufacturer Support

A technical representative from the sealer manufacturer must be present during first application. The need for manufacturer’s representative may be waived if the contractor provides evidence and reference contacts for work involving at least 5 bridges treated with the same products and within the last two years. Contractor experience record in no way relieves the contractor from applying in accordance with this specification and as recommended by the manufacturer.

Prior to application of the sealant, hold a meeting with the Manufacturer's Representative, the Engineer, and the Contractor to discuss all necessary safety precautions and application considerations. The manufacturer’s representative must be available to answer all safety and installation questions.

F. Weather Limitations

Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within twelve (12) hours of the completion of sealer application.

1. Provide a National Weather Service (www.weather.gov) forecast to the Engineer three (3) hours before placement. The Engineer will review the forecast for the following:
   a. No forecasted precipitation two (2) hours prior to the scheduled placement duration, nor up to twelve (12) hours after the anticipated completion of the placement.
   b. Less than 30% chance of precipitation for the entire placement window.

Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the crack seal at the coolest time of the day within these limitations.

G. MMA Flood Seal Application

Do not apply crack sealants to concrete surfaces less than 3 weeks old. Application by spray methods will not be permitted during windy conditions, if the Engineer predicts unsatisfactory results.

Do not thin or alter the MMA crack sealer unless specifically required in the Manufacturer's instructions.

Mix the sealer before and during its use as recommended by the Manufacturer. Distribute the sealant as a flood coat in a gravity-fed process by broom, roller, or with a spray bar near the surface so the spray pattern and coverage rates are reasonably uniform to the satisfaction of the Engineer. Apply the sealant at a minimum rate of 90 ft^2 / gal unless a lower dosage is recommended by the manufacture in writing and accepted by the Engineer.

Protect all expansion joints and prevent the crack sealant from contacting the strip seal glands. Protect all striping and traffic markings from marring, sealant application and reduction in reflective properties. Replace any striping and traffic markings that are marred by sealant, at no cost to the Department.

Prior to completion of gel time of the flood seal (within 15 minutes) and before broadcasting sand, broom uncured sealant in the direction of tining or deck grooves to promote maintenance of the deck texture for traction.

Broadcast sand to refusal into uncured resin to create traction and absorb sealant that is not penetrating into cracks. Broadcast approved sand into the wet, uncured resin no sooner than 20 minutes after applying resin but within gel time of product. Apply approved sand at a minimum rate of 250 lbs. per 1000 square feet.

Allow the sealant to dry/cure according to the Manufacturer's instructions. Do not allow vehicular traffic onto the treated areas until the sealer has dried/cured and the treated surfaces provide safe skid resistance and traction. Remove non-adhered sand from bridge deck and joints by power sweeping the deck and vacuuming the joints. Traffic or equipment will be allowed on the sealed deck after the Engineer has determined:

1. The treated deck surface is tack-free and non-oily;
2. The sand cover adheres and resists brushing by hand;
3. Excess sand and absorbent material has been removed; and
4. No sealant material will be tracked beyond limits of treatment by traffic

H. Method of Measurement

Measurement will be made to the nearest square foot of concrete area sealed as designated by the Engineer.

I. Basis of Payment

The Department will share in the increased cost of flood coat application by executing a Change Order to compensate the Contractor according to the following rates:

1. For full-depth (Monolithic) decks, the amount of $0.50 per square foot of deck area sealed by MMA Flood Seal (methyl methacrylate).
2. For concrete wearing courses, the amount of $0.75 per square foot of deck area sealed by MMA Flood Seal (methyl methacrylate).

The above compensation rates are compensation in full for all costs of furnishing and applying the sealer to the bridge decks, as described above, including surface preparation, traffic control, and all incidentals thereto. Cleanup of excess sand in joints and on bridge deck will not be paid for separately. Restoration of damaged or marred striping will be considered incidental to the above work.

SB- STRUCTURAL CONCRETE – HIGH PERFORMANCE CONCRETE BRIDGE DECKS (CONTRACTOR CONCRETE MIX DESIGN)

SB- Delete the contents of 2401.2.A, "Concrete," and replace with the following:

For Bridge No. ___________, design a **3YLCHPC-M** or **3YLCHPC-S** concrete mixture that will minimize cracking. Perform the work in accordance with the applicable requirements of 2401, "Concrete Bridge Construction," 2461, "Structural Concrete," and the following:

2.A.1 Fine Aggregate Requirements

Provide fine aggregates complying with quality requirements of 3126.2.D, "Deleterious Material," 3126.2.E, "Organic Impurities," and 3126.2.F, "Structural Strength."

2.A.1.a Fine Aggregate Alkali Silica Reactivity (ASR) Requirements

The Department will routinely test fine aggregate sources for alkali silica reactivity (ASR) in accordance with the following:

(1) Multiple sources of certified Portland cement in accordance with ASTM C1260 MnDOT Modified.

The Concrete Engineer, in conjunction with the Engineer, will review the 14-day fine aggregate expansion test results to determine the acceptability of the proposed fine aggregate.

(1) Unmitigated fine aggregate and cement combinations previously tested by the Department must have a 14 day expansion ≤ 0.200.

(2) Alkali silica reactivity (ASR) ASTM C1260 test results are available on the MnDOT Concrete Engineering Unit website.

The Concrete Engineer may reject the fine aggregate if mortar bar specimens exhibit an indication of external or internal distress not represented by the expansion results. The Concrete Engineer will make the final acceptance of the aggregate.

2.A.2 Intermediate Aggregate Requirements

Provide intermediate aggregates complying with the quality requirements of 3137.2.D.2, "Coarse Aggregate for Bridge Superstructure," except as modified in Table HPC-1. If the intermediate aggregate is from the same source as the ¾ inch- fraction, the aggregate quality is determined based upon the composite of the ¾ inch- and intermediate aggregate.

The Concrete Engineer classifies intermediate aggregate in accordance with Table HPC-1.

Table HPC-1
Intermediate Aggregate for Use in Concrete

If the gradation meets the following:	Classify material type as:	Gradation Test Procedures	Quality Test Requirements
100% passing the $^{1}/_{2}$" and ≤90% passing #4	Intermediate Aggregate	Coarse Aggregate (+4 Portion)	Spec. 3137.2.D.2 except 3137.2.D.2(i) modified to maximum 40% carbonate
		Fine Aggregate (-4 Portion)	Shale in Sand (-4 Portion)
100% passing the $^{1}/_{2}$" and >90% passing #4	Intermediate Aggregate	Fine Aggregate (Minimum 1000 g sample)	Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)
			Shale in Sand (-4 Portion)
100% passing the $^{3}/_{8}$" and ≤90% passing #4	Coarse Sand	Fine Aggregate	Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)
			Shale in Sand (-4 Portion)

For any intermediate aggregate size not previously tested by the Department, the Concrete Engineer reserves the right to test for alkali silica reactivity, in accordance with ASTM C1260, prior to allowing incorporation into the concrete mix design.

2.A.3 Coarse Aggregate Requirements

Provide Class A, B or C coarse aggregate meeting the quality requirements in accordance with 3137.2.D.2, "Coarse Aggregate for Bridge Superstructure."

When providing Class B aggregate, the maximum absorption percent by weight is 1.10%.

Coarse aggregate identified as quartzite or gneiss will not be allowed.

2.A.4 Cementitious Materials

Provide only cementitious materials from the MnDOT Approved/Qualified Products List.

2.A.4.a Cement

Use Type I or Type I/II cement complying with 3101, "Portland Cement," or blended cement in accordance with 3103, "Blended Hydraulic Cement."

(1) Total alkalis (Na_2Oe) no greater than 0.60 percent in the Portland cement, and
(2) Total alkalis (Na_2Oe) no greater than 3.0 lb per yd^3 of concrete resulting from the Portland cement.

2.A.5 Additional Ingredients

Combine and blend as required.

2.A.5.a Allowable Admixtures

Use any of the following admixtures on the MnDOT Approved/Qualified Products as listed under "Concrete Admixtures A-S":

(A) Type A, Water Reducing Admixture,
(B) Type B, Retarding Admixture,
(C) Type C, Accelerating Admixture,
(D) Type D, Water Reducing and Retarding Admixture,
(E) Type F, High Range Water Reducing Admixture, and
(F) Type S, Specific Performance Based Admixture

Obtain a written statement from the manufacturer of the admixtures verifying:

(1) Compatibility of the combination of materials, and
(2) Manufacturer recommended sequence of incorporating the admixtures into the concrete.

The manufacturer will further designate a technical representative to dispense the admixture products.

Utilize the technical representative in an advisory capacity and have them report to the Contractor any operations or procedures which are considered as detrimental to the integrity of the placement. Verify with the Engineer whether the Manufacturer's technical representative's presence is required during the concrete placement.

2.A.6 Concrete Mix Design Requirements

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 21 calendar days before the initial concrete placement. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

2.A.6.a Concrete Mix Design Requirements

Design and produce 3YLCHPC-M or 3YLCPHC-S concrete mixes based on an absolute volume of 27.0 ft^3 in accordance with the Table HPC-2 and the following requirements:

Table HPC-2
High Performance Bridge Deck Concrete Mix Design Requirements

Concrete Grade	Mix Number *	Intended Use	w/c ratio	Air Content	Cement Content ‖	Slump Range †, *inches*	Minimum Compressive Strength, f'c (28-day)	3137 Spec.
HPC	3YLCHPC-M	Bridge Deck – Monolithic	0.42-0.45	8.0% ±1.0%	500-535lbs./yd^3	$1^{1}/_{2}$ - 3	4000 psi	2.D.2
	3YLCHPC-S	Bridge – Structural Slab						

* Provide a Job Mix Formula in accordance with 2401.2.A.7 per these special provisions. Use any good standard practice to develop a job mix formula and gradation working range by using procedures such as but not limited to 8-18, 8-20 gradation control, Shilstone process, FHWA 0.45 power chart or any other performance related gradation control to produce a workable and pumpable concrete mixture meeting all the requirements of this contract.
‖ The cement content shall be 100% Portland Cement.
† Keep the consistency of the concrete uniform during entire placement.

2.A.6.b **Required Preliminary Testing**

Prior to placement of any 3YLCHPC-M or 3YLCHPC-S Concrete, the Engineer will require preliminary batching and testing of the concrete mix design.

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 14 calendar days prior to the beginning of preliminary laboratory mixing and testing of the proposed mix designs. Any changes or adjustments to the material or mix design will require a new Contractor mix design submittal. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

Test the concrete for the following hardened concrete properties in accordance with Table HPC-3:

Table HPC-3
Required Hardened Concrete Properties for Mixes 3YHPC-M and 3YHPC-S

Test	Requirement	Test Method
Required Strength (Average of 3 cylinders)	4000 psi at 28 days	ASTM C31
Rapid Chloride Permeability	≤ 2500 coulombs at 28 days (For Preliminary Approval) ≤ 1500 coulombs at 56 days	ASTM C1202
Freeze-Thaw Durability	Greater than 90% at 300 cycles	ASTM C666 Procedure A
Shrinkage	No greater than 0.040 percent at 28 days	ASTM C157
Scaling	Visual rating not greater than 1 at 50 cycles	ASTM C672

The Engineer will allow the maturity method for subsequent strength determination. Perform all maturity testing in accordance with ASTM C1074 and the MnDOT Concrete Manual.

If a mix is approved, the Concrete Engineer will consider the mix design and testing as acceptable for a period of 5 years provided the actual concrete mixed and placed in the field meets the Contract Requirements. The Concrete Engineer will not require new testing within that 5-year period as long as all the constituents (including the aggregates) of the proposed mix design are the same as the original mix design.

The Engineer determines final acceptance of concrete for payment based on satisfactory field placement and performance.

2.A.7 Job Mix Formula

A Job Mix Formula (JMF) contains the following:

(a) Proportions for each aggregate fraction,
(b) Individual gradations for each aggregate fraction; and

(c) Composite gradation of the combined aggregates including working ranges on each sieve in accordance with Table HPC-4.

Table HPC-4 Job Mix Formula Working Range	
Sieve Sizes	**Working Range, %***
1 in and larger	±5
¾ inch	±5
½ inch	±5
⅜ inch	±5
No.4	±5
No.8	±4
No.16	±4
No.30	±4
No.50	±3
No.100	±2
No.200	≤ 1.6
* Working range limits of the composite gradation based on a moving average of 4 tests (N=4).	

2.A.7.a Verification of JMF

Prior to beginning placements of bridge deck concrete, perform gradation testing to ensure current materials comply with the approved JMF. Perform gradation testing in accordance with the Schedule of Materials Control.

(1) Take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work as approved by the Engineer.

(2) Add fill-in sieves as needed during the testing process to prevent overloading.

The Producer and Engineer will test and record the individual gradation results using the Concrete Aggregate Worksheet.

(1) Using the JMF Moving Average Summary Worksheet, calculate the moving average of Producer aggregate gradation test results during production.

(2) The Engineer will randomly verify Producer combined aggregate gradation results as defined in the Schedule of Materials Control.

If, during production, the approved JMF falls outside of the allowable working range immediately sample and test additional gradation and continue production.

2.A.7.b JMF Adjustment

If it is determined that the current aggregates do not meet the approved JMF, submit a new mix design including JMF to the Concrete Engineer in accordance with 2401.2.A.7 in this special provision.

2.A.7.c JMF Acceptance

The Engineer will make monetary adjustments for the quantity of bridge deck concrete represented by the JMF Working Range failure, from the failing test to the next passing test, at a minimum rate of $500.00 or $5.00 per cubic yard, whichever is greater.

2.A.8 Laboratory batching, testing requirements and submittals:

To determine the characteristics of the Contractor proposed mix design, the Concrete Engineer will require the Contractor to prepare test batches and do laboratory testing. Conduct all batching and testing of concrete at a **single** AMRL certified laboratory using the exact materials proposed in the mix design.

Lab testing requirements:

(a) Slump and air content at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing;
(b) Compressive strength (Make cylinders in accordance with AASHTO T126 and tested in accordance with AASHTO T22) at 1, 3, 7, 28, days (sets of 2);
(c) Hardened air content (ASTM C457) at a minimum of 7 days;
(d) Rapid chloride permeability (ASTM C1202) at 28 days and 56 days (2 specimens for 28 day test and 2 test specimens for 56 day test (Take 2 specimens from each batch of a 2 batch mix));
(e) Concrete Durability (ASTM C666, Procedure A) at 300 cycles; and
(f) Concrete Shrinkage (ASTM C157) at 28 days.

The Contractor is required to contact the MnDOT Concrete Engineering Unit a minimum of 2-days prior to any mixing so that a MnDOT representative can observe the process. This same 2-day notification is required prior to any physical testing on hardened concrete samples. Additionally, retain any hardened concrete test specimens for a minimum of 90 days and make available for MnDOT to examine.

All test results are for informational purposes only.

Perform all testing for plastic concrete after all admixtures additions to the concrete mixture.

After completion of the laboratory testing specified herein and, at least, 15 working days prior to the trial placement, submit the laboratory test data to the MnDOT for review and acceptance.

Include the following information in the laboratory reports of the design mixes:
(a) Exact batch weights and properties of all ingredients used and all aggregate gradations;
(b) Slump and air content;
(c) Cylinder identification, including mix designation;
(d) Date and time of cylinder preparation;
(e) Date and time cylinder specimen was tested;
(f) Compressive strength of each cylinder specimen at 1, 3, 7, and , 28, day (sets of s);
(g) A graphic plot of age, from 0 to 28 days, vs. strength for each mix design;
(h) Hardened air content at a minimum of 7 days;
(i) Rapid chloride permeability at 28 days and 56 days;
(j) Concrete Durability at 300 cycles; and
(k) Concrete Shrinkage at 28 days.

2.A.9 Prior to Actual Bridge Deck Placement

2.A.9.a Trial Placement

A minimum of 14 calendar days prior to the actual placement of the bridge deck slab concrete, successfully complete a separate trial placement utilizing a minimum of two (2) - 10 yd^3 loads.

The Engineer may allow the incorporation of the concrete for trial batches into the bridge footings, abutments or end diaphragms. The Contractor may also choose to incorporate the trial batches into residential /commercial construction in the immediate vicinity of the project. In any case, the Engineer will require mixing, transporting, and placing the concrete using the same methods as the actual placement of the bridge deck.

If the concrete is incorporated into the permanent work, the Engineer will test the plastic concrete in accordance with the Schedule of Materials Control. The Engineer may require additional trial batches if the concrete delivered to the project does not comply with the plastic concrete requirements of the Contract.

The Engineer will waive a trial placement at the contractor's request provided the contractor submits a history of at least three successful bridge deck placements in the last 5 years using the same mix design and similar pumping or placement configuration.

The concrete mix design, laboratory batching and mixing, and the trial placement is incidental to the concrete furnished and placed.

Use the same materials, same supplier, and same supplier's manufacturing plant, and proportions in the permanent work as in the trial placement. Strength requirements specified for each mix are applicable to the cylinder tests taken during the production work.

2.A.9.b Slab Placement and Curing Plan

At least 14 calendar days prior to slab placement, provide a slab placement and curing plan for each bridge to the Engineer for approval. Include the following information in the placement and curing plan:

(1) Anticipated concrete delivery rates;
(2) Estimated start and finish time;
(3) Material, labor and equipment proposed for placing, finishing, and curing including placement of wet burlap, soaker hose, or other system to maintain the deck in a moist condition during the curing period;
(4) Number of work bridges proposed for use;
(5) Number of people responsible for the various tasks; and
(6) Bulkheading methods and materials proposed for use if the Contractor cannot maintain the proposed concrete placement rates.

For full depth monolithic decks, the finishing machine will consist of a cylindrical finisher mated with horizontal adjustable augers, both of which are mounted on a transversely moving carriage unless otherwise approved by the State Bridge Construction Engineer.

A 10 ft modified straightedge is required for full-depth decks prior to carpet dragging regardless of whether texture planing is specified for the final ride surface. Float slab in accordance with MnDOT Construction Manual 5-393.358 to ensure the final surface does not vary by greater than ⅛ inch within a 10 ft straightedge laid longitudinally on the final surface. This surface tolerance includes areas near expansion devices and other breaks in the continuity of the bridge slab.

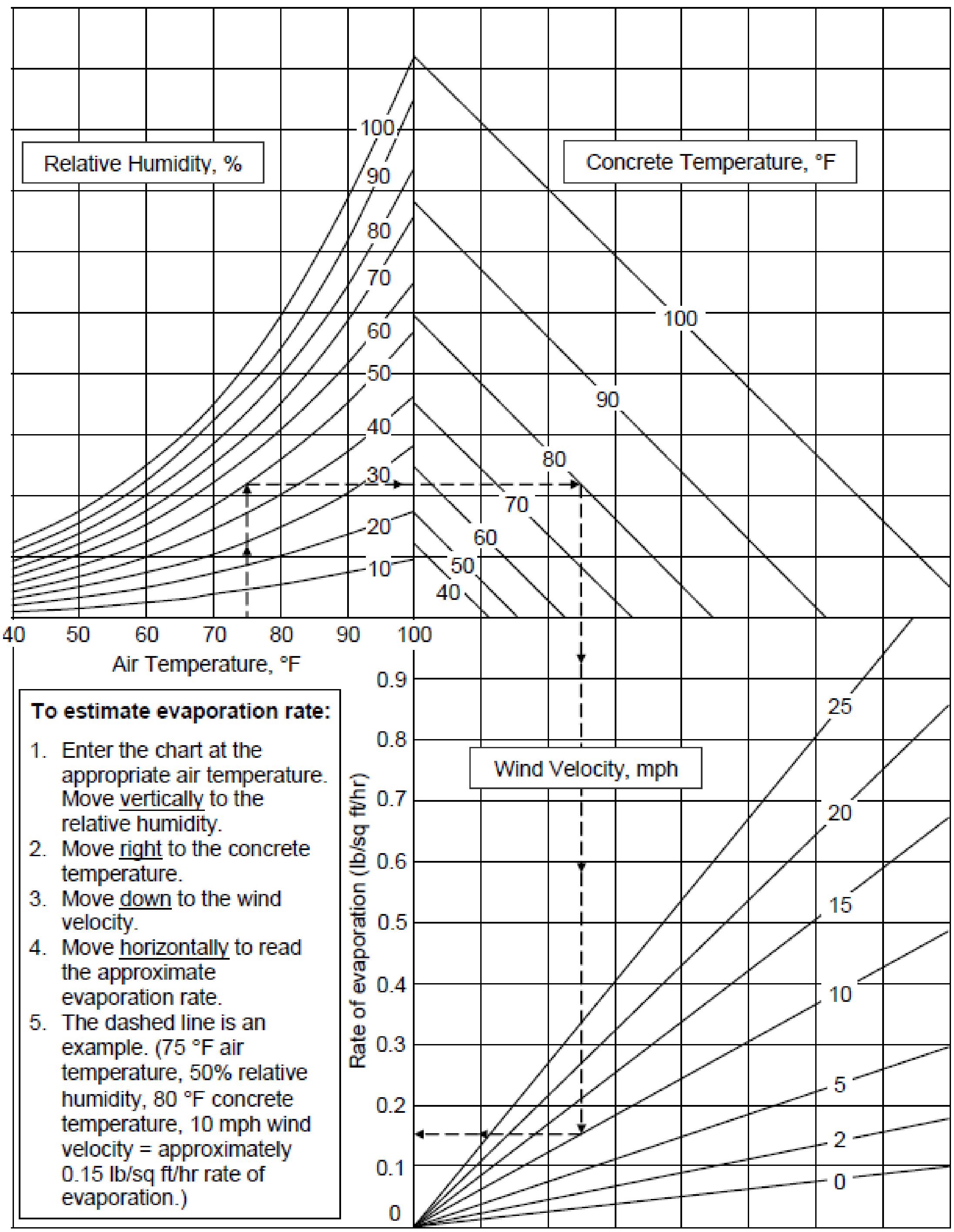
Attend a pre-placement meeting 2 calendar days to 4 calendar days before the slab placement to review the information and details provided in the placement and curing plan. The following project personnel are required to attend the pre-placement meeting:

(1) Contractor;
(2) Engineer;
(3) Concrete supplier; and
(4) If required by the Engineer, the concrete pump supplier.

2.A.9.c Three (3) Hours Prior to Beginning Bridge Deck Concrete Placement

The Engineer requires the Contractor to comply with all of the following conditions prior to allowing the Contractor to begin the bridge deck concrete placement:

(1) Provide a National Weather Service (www.weather.gov) forecast to the Engineer three (3) hours before placement. The Engineer will review the forecast for the following:
    (a) No forecasted precipitation two (2) hours prior to the scheduled placement duration, nor up to two (2) hours after the anticipated completion of the placement.
    (b) Less than 30% chance of precipitation for the entire placement window; and
(2) Only if the combination of air temperature, relative humidity, concrete temperature and wind velocity produces an evaporation rate of less than 0.20 pounds per square foot of surface area per hour, according Figure HPC-1:



[1] Based on ACI 305 R, "Hot Weathering Concreting"

FIGURE HPC-1

SB- ***Delete the 16th paragraph through 18th paragraph of 2401.3.G, "Concrete Curing and Protection," and replaced with the following:***

2.A.9.d Actual Bridge Deck Placement and Curing Requirements

In addition to the requirements set forth in 2461.3.G.4, "Field Adjustments," if any adjustments are necessary on site, comply with the following:

(1) The Engineer will only allow the addition of admixtures originally incorporated into the mix, except Viscosity Modifying Admixture (VMA) is allowed to adjust slump even if they were not used in the original testing;

(2) The Engineer will allow a maximum of 1 gallon of water additions per cubic yard of concrete on site provided additional water is available to add per the Certificate of Compliance, including any water necessary to dilute admixtures;

(3) Mix the load a minimum of 5 minutes or 50 revolutions after any additions; and

(4) Place the concrete at temperature s between 55 to 70 degrees Fahrenheit. If the temperatures exceed 70º F, ice may be added to the mixing water at the location where the temperature is measured.

The Engineer will not allow finishing aids or evaporation retarders for use in finishing of the concrete.

The Contractor is fully responsible for curing methods. Comply with the following curing methods unless other methods are approved by the Engineer in writing.

Table HPC-5
Required Curing Method Based on Final Bridge Deck Surface

Bridge Deck Type	Final Bridge Deck Surface	Required Curing Method ‖
Bridge structural slab curing (3YLCHPC-S)	Low Slump Wearing Course	Conventional wet curing after carpet drag
Bridge deck slab curing for full-depth decks (3YLCHPC-M)	Epoxy Chip Seal Wearing Course or Premixed Polymer Wearing Course	Conventional wet curing after carpet drag
	Bridge Deck Planing	Conventional wet curing after carpet drag.
	Tined Texturing*	Conventional wet curing after tine texturing AMS curing Compound after wet cure period
	Finished Sidewalk or Trail Portion of Deck (without separate pour above)*	Conventional wet curing after applying transverse broom finish AMS curing Compound after wet cure period

‖ Apply conventional wet curing to bridge slabs following the finishing machine or air screed.
* Prevent marring of broomed finish or tined textured surface by careful placement of wet curing.

Use conventional wet curing consisting of pre-wetted burlap covered with white plastic sheeting in accordance with the following:

(1) Place the burlap to cover 100 percent of the deck area without visible openings;

(2) Place the wet curing within 30 min after the finishing machine completes the final strike-off of the concrete surface;

(3) If the Contractor fails to place the wet curing within 30 min, the Department will monetarily deduct $500 for every 5 min period, or any portion thereof, after the initial time period until the Contractor places the wet curing as approved by the Engineer;

(4) The Department may assess the deduction more than once;

(5) Keep the slab surface continuously wet for an initial curing period of at least 7 calendar days;

(6) Use a work bridge to follow the finish machine or air screed; and
(7) Provide an additional center rail on wide bridges, if necessary.

Where marring of the broomed finish or tined texturing surface finish is a concern, the Engineer may authorize curing as follows:

(1) Apply a membrane curing compound meeting the requirements of 3754, "Poly-Alpha Methylsytrene (AMS) Membrane Curing Compound;"
(2) Apply curing compound using approved power-operated spray equipment;
(3) Provide a uniform, solid white, opaque coverage of membrane cure material on exposed concrete surfaces (equal to a white sheet of paper);
(4) Place the membrane cure within 30 minutes of concrete placement unless otherwise directed by the Engineer;
(5) Provide curing compound for moisture retention until the placement of a conventional wet curing;
(6) Apply conventional wet curing when walking on the concrete will not produce imprints deeper than $^{1}/_{16}$ inch;
(7) Keep the deck slab surface continuously wet for an initial curing period of at least 7-calendar days including weekends, holidays, or both if these fall within the 7-calendar-day curing period;
(8) The Engineer will not allow placement of membrane curing compound on any concrete surface that expects future placement of additional concrete on that surface; and
(9) If the Contractor fails to meet these requirements, the Department may reduce the contract unit price for the concrete item in accordance with 1512, "Conformity with Contract Documents."

SB- Delete 2401.3.I.2, "Crack Sealing," and replace with the following:

The Contractor is fully responsible for crack sealing all cracks identified by the Engineer in accordance with Table HPC-6.

Table HPC-6
Required Crack Sealing Requirements Based on Final Bridge Deck Surface

Bridge Deck Type	Final Bridge Deck Surface	Crack Sealing Requirements
Bridge structural slab (3YLCHPC-S) *	Low Slump Wearing Course	Seal cracks in accordance with 2401.3.I.2
Bridge deck slab for full-depth decks (3YLCHPC-M)	Epoxy Chip Seal Wearing Course or Premixed Polymer Wearing Course	See wearing course special provision
	Bridge Deck Texture Planing	Seal cracks in accordance with 2401.3.I.2 after texture planing
	Tined Texturing	Seal cracks in accordance with 2401.3.I.2
	Finished Sidewalk or Trail Portion of Deck (without separate pour above)	Seal cracks in accordance with 2401.3.I.2

* Shotblast the surface in preparation for low slump wearing course. Prior to placing the low slump wearing course, the Engineer will visually inspect the bridge structural slab, and will mark cracks that require sealing appearing on the top surface. Control the application of the crack sealer such that the maximum width of crack sealant does not exceed 1 inch. If exceeding the permitted width of 1 inch, remove excess by means of surface grinding to prevent debonding of concrete wearing course. The Engineer requires the sealer to cure completely prior to pre-wetting of the deck, as required for placement of a low slump concrete wearing course.

1 - DESIGNER NOTE: select the method that is required and remove the other.

SB- Method of Measurement

If measuring bridge slab concrete by area, the Engineer will measure the bridge slab by surface area based on the dimensions shown on the plans. The Engineer will not deduct the surface area of expansion devices or other miscellaneous appurtenances.

If measuring bridge slab concrete by cubic yard, the Engineer will base the measurement on the basis of the dimensions of the structure shown in the plans of the slab.

2 - DESIGNER NOTE: select the payment that is required and remove the others.

SB- Basis of Payment

Payment for Item No. 2401.618 "BRIDGE SLAB CONCRETE (3YLCHPC-M)" will be made at the Contract price per square foot and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to the construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

Payment for Item No. 2401.618 "BRIDGE SLAB CONCRETE (3YLCHPC-S)" will be made at the Contract price per square foot and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to the construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

Payment for Item No. 2401.607 "BRIDGE SLAB CONCRETE (3YLCHPC-M)" will be made at the Contract price per cubic yard and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to the construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

Payment for Item No. 2401.607 "BRIDGE SLAB CONCRETE (3YLCHPC-S)" will be made at the Contract price per cubic yard and shall be compensation in full for all costs of forming, placing, finishing, curing, crack sealing, and all associated incidentals necessary to the construct the bridge deck and diaphragms as detailed in the Plans in accordance with these specifications.

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Use when required per "TABLE MC-1"of this special provision.
Direct any questions to the respective Regional Bridge Construction Engineer.
Include the following note in bridge plans under the schedule of quantities with a bubble note to the affected pay items, "Includes bridge elements with mass concrete requirements. See special provisions."

CREATED 4/22/2015
REVISED 6/6/2018 (4)

SB- MASS CONCRETE

SB-__.1 Description of Work

Assume the responsibility to produce a structure free of cracks, which result from unnecessary heat of hydration during the curing of the mass concrete.

This effort consists of temperature control of mass concrete for the purpose of minimizing potential cracking as a result of excessive temperature differentials due to the heat of hydration in concrete and for limiting the maximum temperature of concrete during the hydration process.

Unless otherwise noted in the plans, Mass Concrete, Concrete Temperature Control and Form Removal requirements for each concrete element must comply with Table MC-1:

Table MC-1
Mass Concrete, Concrete Temperature Control and Form Removal Requirements

Concrete Element	Least Dimension	Mass Concrete Requirements Apply?	Concrete Temperature Control Requirements		Form Removal Requirements Apply? (Section 3.A.3)
			Maximum Temperature Differential Apply? (Section 3.A.1)	Maximum Peak Temperature Apply? (Section 3.A.2)	
Pier Tremie Seal Concrete	Any Dimension	No	No	No	No
Pre-cast Beams	Any Dimension	No	No	No	No
For all other concrete elements					
Concrete Design Strength ≥ 6,000 psi	≤ 48 in	No	No	Yes	No
Post-Tensioned Elements		No	No	Yes	No
All Other Concrete Elements		No	No	No	No
All Concrete Elements*	> 48 in	Yes	Yes	Yes	Yes
Drilled Shafts	> 48 in	Yes	No	Yes	No
Buried Footings	≥ 60 in	Yes	Yes	Yes	Yes
*Except as noted otherwise in table					

Provide temperature control of these elements in accordance with ACI 207.1R-05, "Guide to Mass Concrete," ACI 207.2R-07, "Report on Thermal and Volume Change Effects on Cracking of Mass Concrete," and ACI 207.4R-05, "Cooling and Insulating Systems for Mass Concrete."

The Engineer will allow the Contractor to place successive lifts of concrete over other mass concrete elements if the requirements defined in this special provision are met. Do not alter the mass concrete curing and protection on top of the previous mass concrete elements until the concrete has reached the compressive strengths defined in 2401.3.G, "Concrete Curing and Protection."

SB-__.2 Contractor Concrete Mix Designs

Delete 2401.2.A, "Concrete," and replace with the following:

1 - DESIGNER NOTE: Identify bridge elements that mass concrete requirements apply as shown in Table MC-1 (above) then create a list below.

2.A In accordance with Table MC-1, mass concrete requirements apply to the following elements of Bridge No. __________:

UAR

- Abutment stems
- Abutment footings
- Pier caps
- Pier columns
- Pier struts
- Pier footings

Design all mass concrete mixtures used in the construction of the bridge.   Perform the work in accordance with the applicable requirements of 2401, "Concrete Bridge Construction," 2461, "Structural Concrete," and the following:

2.A.1 Fine Aggregate Requirements

Provide fine aggregates complying with quality requirements of 3126.2.D, "Deleterious Materials," 3126.2.E, "Organic Impurities," and 3126.2.F, "Structural Strength."

2.A.1.a Fine Aggregate Alkali Silica Reactivity (ASR) Requirements

The Department will routinely test fine aggregate sources for alkali silica reactivity (ASR) in accordance with the following:

(1) Multiple sources of certified Portland cement in accordance with ASTM C1260 MnDOT Modified; and

(2) Multiple combinations of certified Portland cement and supplementary cementitious materials in accordance with ASTM C1567 MnDOT Modified.

The Concrete Engineer, in conjunction with the Engineer, will review the 14-day fine aggregate expansion test results to determine the acceptability of the proposed fine aggregate and cement combination in accordance with the following:

(1) For fine aggregate and cement combinations previously tested by the Department, the Concrete Engineer will use the average of all 14-day unmitigated test results for an individual source to determine necessary mitigation in accordance with Table MC-2.

(2) If the previously tested proposed fine aggregate and cement combination requires less mitigation than the average 14-day unmitigated test result, the Concrete Engineer will allow mitigation at the lesser rate in accordance with Table MC-2.

(3) Alkali silica reactivity (ASR) ASTM C1260 and ASTM C1567 test results are available on the MnDOT Concrete Engineering Unit website.

<table>
<tr><th colspan="9">Table MC-2
Fine Aggregate ASR Mitigation Requirements</th></tr>
<tr><th>14-day Fine Aggregate Unmitigated Expansion Limits</th><th>Class F Fly Ash</th><th>Class C Fly Ash</th><th>Slag</th><th>Slag/Class F Fly Ash</th><th>Slag/Class C Fly Ash</th><th>IS(20)/Class F Fly Ash</th><th>IS(20)/Class C Fly Ash</th></tr>
<tr><td>≤ 0.150</td><td colspan="7">No mitigation required</td></tr>
<tr><td>>0.150 - 0.200</td><td>Minimum 20%</td><td>Minimum 20%</td><td>35%</td><td rowspan="2">20% Slag with a minimum of 15% Class F fly ash</td><td rowspan="2">20% Slag and 20% Class C fly ash</td><td rowspan="2">Type IS(20) with a minimum of 15% Class F</td><td rowspan="2">Type IS(20) with a minimum of 15% Class C</td></tr>
<tr><td>> 0.200 – 0.300</td><td>Minimum 20%</td><td>Minimum 30%</td><td>35%</td></tr>
<tr><td>> 0.300</td><td colspan="7">The Department will reject the fine aggregate</td></tr>
</table>

High Early Concrete is not permitted for mass concrete elements.

The Concrete Engineer may reject the fine aggregate if mortar bar specimens exhibit an indication of external or internal distress not represented by the expansion results. The Concrete Engineer will make the final acceptance of the aggregate.

2.A.2 Intermediate Aggregate Requirements

Provide intermediate aggregates complying with the quality requirements of 3137.2.D.1, "Coarse Aggregate for Portland Cement Concrete," except as modified in Table MC-3. If the intermediate aggregate is from the same source as the ¾"- fraction, the aggregate quality is determined based upon the composite of the ¾"- and intermediate aggregate.

The Concrete Engineer classifies intermediate aggregate in accordance with Table MC-3.

Table MC-3 Intermediate Aggregate for Use in Concrete			
If the gradation meets the following:	**Classify material type as:**	**Gradation Test Procedures**	**Quality Test Requirements**
100% passing the 1/2" and ≤90% passing #4	Intermediate Aggregate	Coarse Aggregate (+4 Portion)	Spec. 3137.2.D.2 except 3137.2.D.2(i) modified to maximum 40% carbonate
		Fine Aggregate (-4 Portion)	Shale in Sand (-4 Portion)
100% passing the 1/2" and >90% passing #4	Intermediate Aggregate	Fine Aggregate (Minimum 1000 g sample)	Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)
			Shale in Sand (-4 Portion)
100% passing the 3/8" and ≤90% passing #4	Coarse Sand	Fine Aggregate	Shale Content Test by AASHTO T113 MnDOT Modified (+4 Portion)
			Shale in Sand (-4 Portion)

For any intermediate aggregate size not previously tested by the Department, the Concrete Engineer reserves the right to test for ASR, in accordance with ASTM C1260, prior to allowing incorporation into the concrete mix design.

2.A.3 Coarse Aggregate Requirements

Provide coarse aggregate meeting the quality requirements in accordance with 3137.2.D.1, "Course Aggregate for General Use."

When providing Class B aggregate, the maximum absorption is 1.10%.

2.A.3.a Coarse Aggregate Alkali Silica Reactivity (ASR) Requirements

When using coarse aggregate identified as quartzite or gneiss, the Concrete Engineer will review ASTM C1293 testing to determine the necessary ASR mitigation requirements in accordance with Table MC-4.

ASR ASTM C1293 test results are available on the MnDOT Concrete Engineering Unit website.

Table MC-4 Coarse Aggregate ASR Mitigation Requirements*								
ASTM C1293 Expansion Results	**Class F Fly Ash**	**Class C Fly Ash**	**Slag**	**Slag/Class F Fly Ash**	**Slag/Class C Fly Ash**	**IS(20)/Class F Fly Ash**	**IS(20)/Class C Fly Ash**
≤ 0.040	No mitigation required						
>0.040	Minimum 30%	Not Allowed	35%	20% Slag with a minimum of 15% Class F fly ash	20% Slag and 20% Class C fly ash	Type IS(20) with a minimum of 15% Class F	Type IS(20) with a minimum of 15% Class C
* The Engineer will allow the Contractor to substitute a portion of the minimum required supplementary cementitious material with up to 5% silica fume by weight for mitigation purposes.							

2.A.4 Cementitious Materials

Provide only cementitious materials from the Approved/Qualified Products List.

2.A.4.a Cement

Use Type I or Type I/II cement complying with 3101, "Portland Cement," or blended cement in accordance with 3103, "Blended Hydraulic Cement."

(1) Total alkalis (Na_2Oe) no greater than 0.60 percent in the Portland cement, and

(2) Total alkalis (Na_2Oe) no greater than 3.0 lb per cu. yd. of concrete resulting from the Portland cement.

2.A.4.b Fly Ash

Use fly ash conforming to 3115, "Fly Ash for use in Portland Cement." The Concrete Engineer defines Class F fly ash for the purposes of ASR mitigation as having a maximum CaO content of 18.0%.

2.A.4.c Ground Granulated Blast Furnace Slag

Use ground granulated blast furnace slag conforming to 3102, "Slag Cement."

2.A.4.d Silica Fume

Use silica fume conforming to ASTM C1240.

2.A.4.e Ternary Mixes

Ternary mixes are defined as Portland cement and two other supplementary cementitious materials, or blended cement and one other supplementary cementitious material with a maximum replacement of 40% by weight.

2.A.5 Allowable Admixtures

Use any of the following admixtures as listed on the MnDOT Approved/Qualified Products list:

(1) Type A, Water Reducing Admixture
(2) Type B, Retarding Admixture
(3) Type C, Accelerating Admixture
(4) Type D, Water Reducing and Retarding Admixture
(5) Type F, High Range Water Reducing Admixture
(6) Type S, Specific Performance Based Admixture

Obtain a written statement from the manufacturer of the admixtures verifying:

(1) Compatibility of the combination of materials, and
(2) Manufacturer recommended sequence of incorporating the admixtures into the concrete.

The manufacturer will further designate a technical representative to dispense the admixture products.

The technical representative shall act in an advisory capacity and shall report to the Contractor any operations or procedures which are considered as detrimental to the integrity of the placement. Verify with the Engineer whether the Manufacturer's technical representative's presence is required during the concrete placement.

2.A.6 Concrete Mix Design Requirements

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 21 calendar days before the initial concrete placement. Identify the mix by the MnDOT mix designation (i.e. 3B52, 1A52, etc.). In addition, include "-MC" to the right of the mix designation to identify that the mix will be used on mass concrete elements. See Table MC-5 as an example. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

2.A.6.a Concrete Mix Design Requirements

Design and produce concrete mixes based on an absolute volume of 27.0 cu. ft. in accordance with the Table MC-5 and the following requirements:

Table MC-5
Mass Concrete Bridge Concrete Mix Design Requirements

Concrete Grade	Mix Number *	Intended Use	w/c ratio	Target Air Content	Conventional Concrete Maximum %SCM (FlyAsh/Slag/ Silica Fume/ Ternary) ‖	Mass Concrete Maximum %SCM (FlyAsh/Slag/ Silica Fume/ Ternary) ‖	Slump Range †	Minimum Compressive Strength, f'c (28-day) ǂ	3137 Spec.
B	3B52-MC	Abutments/Piers	0.30-0.45	6.5%	30/35/5/40	30/70/5/70	2-5"	4,000 psi	2D1
G	1G52-MC	Footings	0.30-0.45	-	30/35/5/40	30/70/5/70	2-5"	4,500 psi	2D1

* Provide a Job Mix Formula in accordance with 2401.2.A.7. Use any good standard practice to develop a job mix formula and gradation working range by using procedures such as but not limited to 8-18, 8-20 gradation control, Shilstone process, FHWA 0.45 power chart or any other performance related gradation control to produce a workable and pumpable concrete mixture meeting all the requirements of this contract.
‖ The individual limits of each SCM shall apply to ternary mixtures.
† Keep the consistency of the concrete uniform during entire placement.
ǂ Mass concrete may achieve the specified 28-day strength in 56 days for mix designs including cementitious replacement with the approval of the Engineer.

2.A.6.b Required Preliminary Testing

Prior to placement of any Concrete, the Engineer will require preliminary batching and testing of the concrete mix design.

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 14 calendar days prior to the beginning of preliminary laboratory mixing and testing of the proposed mix designs. Any changes or adjustments to the material or mix design require a new Contractor mix design submittal. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

Test substructure concrete for the following hardened concrete properties in accordance with Table MC-6:

Table MC-6 **Required Hardened Concrete Properties**		
Test	Requirement	Test Method
Required Strength (Average of 3 cylinders)	See Table MC-5	ASTM C31
Hardened air content	At a minimum of 7 days	ASTM C457
Shrinkage	No greater than 0.040 percent at 28 days	ASTM C157

The Engineer will allow the maturity method for subsequent strength determination. Perform all maturity testing in accordance with ASTM C1074 and the MnDOT Concrete Manual.

If a mix is approved, the Concrete Engineer will consider the mix design and testing as acceptable for a period of 5 years provided the actual concrete mixed and placed in the field meets the Contract Requirements. The Concrete Engineer will not require new testing within that 5-year period as long as all the constituents (including the aggregates) of the proposed mix design are the same as the original mix design.

The Engineer determines final acceptance of concrete for payment based on satisfactory field placement and performance.

2.A.7 Job Mix Formula

A Job Mix Formula (JMF) contains the following:

(1) Proportions for each aggregate fraction,
(2) Individual gradations for each aggregate fraction; and
(3) Composite gradation of the combined aggregates including working ranges on each sieve in accordance with Table MC-7.

Table MC-7 Job Mix Formula Working Range	
Sieve Sizes	**Working Range, %***
1 inch and larger	±5
¾ inch	±5
½ inch	±5
⅜ inch	±5
No.4	±5
No.8	±4
No.16	±4
No.30	±4
No.50	±3
No.100	±2
No.200	≤ 1.6
* Working range limits of the composite gradation based on a moving average of 4 tests (N=4).	

2.A.7.a Verification of JMF

Prior to beginning placements of bridge concrete, perform gradation testing to ensure current materials comply with the approved JMF. Perform gradation testing in accordance with the Schedule of Materials Control.

(1) Take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work as approved by the Engineer.

(2) Add fill-in sieves as needed during the testing process to prevent overloading.

The Producer and Engineer will test and record the individual gradation results using the Department's Concrete Aggregate Worksheet.

(1) Using the JMF Moving Average Summary Worksheet, calculate the moving average of Producer aggregate gradation test results during production.

(2) The Engineer will randomly verify Producer combined aggregate gradation results as defined in the Schedule of Materials Control.

If, during production, the approved JMF falls outside of the allowable working range immediately sample and test additional gradation and continue production.

2.A.7.b JMF Adjustment

If it is determined that the current aggregates do not meet the approved JMF, submit a new mix design including JMF to the Concrete Engineer in accordance with 2401.2.A.7.

2.A.7.c JMF Acceptance

The Engineer will make monetary adjustments for the quantity of bridge concrete represented by the JMF Working Range failure, from the failing test to the next passing test, at a minimum rate of $500.00 or $5.00 per cubic yard, whichever is greater.

2.A.8 Laboratory batching, testing requirements and submittals:

To determine the characteristics of the Contractor proposed mix design, the Concrete Engineer will require the Contractor to prepare test batches and do laboratory testing. Conduct all batching and testing of concrete at a **single** AMRL certified laboratory using the exact materials proposed in the mix design.

Lab testing requirements:

a. Slump and air content at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing

b. Compressive strength (Make cylinders in accordance with ASTM C43 and tested in accordance with ASTM C31) at 1, 3, 7, 28, 56 days (sets of 3).

c. Hardened air content (ASTM C457) at a minimum of 7 days.

d. Concrete Shrinkage (ASTM C157) at 28 days.

The Contractor is required to contact the MnDOT Concrete Engineering Unit a minimum of 2-days prior to any mixing so that a MnDOT representative can observe the process. This same 2-day notification is required prior to any physical testing on hardened concrete samples. Additionally, retain any hardened concrete test specimens for a minimum of 90 days and make available for MnDOT to examine.

Perform all testing for plastic concrete after all admixtures additions to the concrete mixture.

After completion of the laboratory testing specified herein and, at least, 15 working days prior to the placement, submit the laboratory test data to the MnDOT for review and approval.

Include the following information in the laboratory reports of the design mixes:

a. Exact batch weights and properties of all ingredients used and all aggregate gradations;
b. Slump and air content;
c. Cylinder identification, including mix designation;
d. Date and time of cylinder preparation;
e. Date and time cylinder specimen was tested;
f. Compressive strength of each cylinder specimen at 1, 3, 7, 28, and 56 day (sets of 3);
g. A graphic plot of age, from 0 to 56 days, vs. strength for each mix design;
h. Hardened air content at a minimum of 7 days;
i. Concrete Shrinkage at 28 days.

SB-__.3 Construction Requirements

A. Temperature Limitations

Maintain temperature control as specified from the time of concrete placement until all interior concrete temperatures are decreasing and requirements in this document are met.

A.1 Maximum Temperature Differential

The temperature differential between the centroid of the placement and a point 2 inches inside the surface along the shortest line from the centroid to the nearest surface of the element at any given time shall not exceed the limits of Table MC-8:

Table MC-8
Maximum Temperature Differential

Time	Maximum Temperature Differential
First 48 Hours	45º F
Next 2 to 7 Calendar Days	50º F
Greater than 8 Calendar Days	60º F

Instead of the limits of Table MC-8, The Contractor may propose, for consideration by the Engineer, differential temperature vs. concrete strength curves based upon the following:

1. A finite element analysis revealing the calculated thermal stresses developed within the concrete will not exceed the tensile strength of the concrete,
2. Use test data from the actual concrete placed in the element to define any specific input properties of the concrete used in the model,
3. Apply a safety factor of at least two (2) to all stress calculations,
4. At least 60 calendar days prior to casting a mass concrete element that utilizes differential temperature vs. concrete strength curves, submit the finite element analysis as part of the Mass Concrete Placement and Temperature Plan,
5. The Engineer reserves the right to allow and discontinue use of the strength curves based on cracking observed on previous concrete elements, and
6. On concrete placements where differential temperature vs. concrete strength curves are allowed for use by the Engineer, the allowable differential temperature referenced in Table MC-11 will be determined from the curves.

A.2 Maximum Peak Temperature

Do not exceed a maximum peak concrete temperature of 160º F for all mass/non-mass concrete elements, except for those elements excluded in table MC-1.

A.3 Temperature Requirements for Form Removal

The Engineer will allow the Contractor to remove the forms from the mass concrete elements provided all of the following requirements are met:

1. Maximum peak temperature is reached and drops by more than 3º F,
2. Maximum temperature differential is reached and drops by more than 3º F,
3. The temperature difference between the ambient and the point 2 inches from the surface has reached its maximum, drops by more than 3º F, and doesn't exceed 35º F,
4. A minimum of 72 hours for bridge substructures and 96 hours for bridge superstructures,
5. The requirements of 2401.3.G, "Concrete Curing and Protection," or a minimum compressive strength of 2000 psi; whichever is greater, based on control cylinders. The Contractor is responsible for making and testing control cylinders at a Qualified Laboratory. Produce sets of 3 cylinders to be used as part of the determination of removal of forms, and
6. Gradually discontinue heating or cooling protection in a manner such that the rate of temperature reduction adjacent to the concrete surface does not exceed 20º F during any 12-hour period until the surface temperature reaches that of the ambient temperature outside any cold weather protection.

B. Temperature Control

Monitor and control the maximum interior and exterior temperature differentials as specified in this document.

B.1 Mass Concrete Placement and Temperature Plan

A registered Professional Engineer licensed in the state of Minnesota is required to develop and complete the analysis for the mass concrete placement and temperature plan in accordance with the following:

1. At least 30 calendar days prior to casting a mass concrete element, submit a Preliminary Mass Concrete Placement and Temperature Plan to the Engineer, and
2. Within 48 hours of actual concrete placement, submit a Final Mass Concrete Placement and Temperature Plan to the Engineer using actual environmental conditions and current construction practices.

Provide the placement and temperature plan for each mass concrete element including, but not limited to the following items:

1. Specific element information, dimensions, and the location of temperature sensors within the element,
2. Mass concrete mix design reviewed and accepted by the Engineer,
3. Expected placement conditions including, but not limited to the following:
   (a) Ambient temperatures,
   (b) Concrete constituent temperatures for mixing,
   (c) Ice or heating requirements,
   (d) Concrete temperature at the point of placement, and
   (e) Options for protection to satisfy temperature control.

4. Comprehensive heat generation and dissipation analysis in accordance with ACI 207.1R-05 "Guide to Mass Concrete," for each mass concrete element. The analysis determines the following:
   (a) Predicted concrete temperature at the centroid,
   (b) Location and temperature of maximum temperature if not at the centroid,
   (c) Temperatures 2 inches inside of the exterior surface exposed to air,
   (d) Complete analyses until all temperatures are decreasing and the mass concrete element reaches maximum temperature differential and begins to decrease, or for the duration of the curing period, whichever is longer, and
   (e) Perform analyses for the anticipated mean weekly ambient air (or enclosure) temperatures for the period of the proposed placement and for temperatures plus and minus 20º F of the mean weekly ambient air (or enclosure) temperature.
5. Anticipated concrete placement temperatures measured at discharge into the forms for the mean weekly ambient air temperatures,
6. The method(s) that are intended for ensuring that required temperature control (maximum temperature differential and maximum peak temperature) for the designated mass concrete elements are not exceeded considering the anticipated mean weekly ambient or enclosure air temperatures in which the element is cast.
   (a) If cooling tubes are selected as a means for controlling the heat of hydration, submit the following:
      i. Summary of design and details for cooling tube system,
      ii. Submit the method of temperature control of cooling water effluent to the Engineer for review and acceptance, and
      iii. Submit a heat transfer analysis, for the cooling tube system, prepared by a registered Professional Engineer licensed in Minnesota.
   (b) If cooling tubes are used and circulating waterway water through the tube system is proposed for temperature control, monitor the spent cooling water temperature to assure that the temperature is in an appropriate range to be discharged back into the waterway water that it originated from.
7. Contractor planned field placement and protection methodologies for varying conditions along with planned mitigation measures should temperature control not follow the Mass Concrete Placement and Temperature Plan.

B.2 Temperature Monitoring

Cast temperature sensors 2 inches below the concrete surfaces for measuring temperature differentials. The Engineer will not permit surface-mounted temperature sensors.

Provide temperature monitoring devices that meet the following requirements:

(a) Automatic sensing and recording instruments that record information at a maximum interval of one hour,
(b) Operate over a range of 0º F to 200º F with an accuracy of plus or minus 2º F,
(c) Use a minimum of two (2) sets of two (2) sensors (or 4 total sensors) for each placement,

Record temperature development at the following locations:

(a) Unless indicated otherwise by the heat generation and dissipation analysis, place the monitoring points at the geometric center (centroid) of the element or placement (interior point) and a point located 2 inches inside the exterior surface along the shortest line from the centroid to the nearest surface of the element (exterior point),
(b) Monitor temperature at a minimum of two independent sets of interior and exterior points for each element to provide redundancy in the event of a monitoring device failure, and
(c) Other locations as accepted by the Engineer.

Monitor temperatures in accordance with the following:

(a) Review temperature readings at intervals not greater than 24 hours or as required by the Mass Concrete Placement and Temperature Plan to ensure that the automatic devices are working properly and that the temperatures are within allowable limits,
(b) Ensure devices begin recording data immediately after casting is complete,
(c) Continue monitoring temperatures for a minimum of 96 hours and until 24 hours after all of the form removal requirements from B.3 above are met, and all formwork, insulation, and other temporary items are removed from the mass concrete element and it is exposed to the environment,
(d) Transmit readings to the Engineer immediately after they are recorded and at least every 24 hours or as required by the Mass Concrete Placement and Temperature Plan,
(e) If monitoring indicates that the maximum temperature differential and/or the maximum peak temperature has or appears to have the potential to exceed specified limits, as determined by the Contractor or the Engineer, take immediate action to retard further growth in the differential or maximum peak temperatures to bring control back within specified limits by adjusting the protection plan in accordance with mitigation measures outlined in the Mass Concrete Placement and Temperature Plan,
(f) Make any necessary revisions to the plan to avoid exceeding temperature limits on any remaining placements and submit to the Engineer for review, and
(g) The Engineer must review and accept all revisions to the plan prior to implementation.

C. Crack Repair

The Engineer will make a visual inspection of the mass concrete elements and will identify all crack widths that are greater than 0.01 inch wide appearing on the concrete surface. Provide lift equipment and other equipment as necessary to allow the Engineer full access to the surfaces of the mass concrete elements for the purpose of inspection.

Seal cracks in mass concrete that exceed 0.01 inch in width as determined by the Engineer in accordance with Table MC-9. Do not repair cracks until at least 24 hours after all of the form removal requirements from B.3 above are met, and all formwork, insulation, and other temporary items are removed from the mass concrete element and it is exposed to the environment.

Table MC-9
Crack Sealing Requirements for Mass Concrete

Crack Width *in*	Crack Sealing Method
0.01 to ≤ 0.03	Approved Epoxy Crack Sealant
0.03 – 0.06	Approved Epoxy Injection Method and Materials #
> 0.06	As determined by the Engineer. The Engineer will evaluate whether these cracks compromise the integrity of the structure or the fitness for use.

#Perform epoxy injection operations in accordance with the material and equipment manufacturer's published recommendations, except where otherwise directed by the Engineer. Upon satisfactory completion and repair, remove all injection ports, excess epoxy and sealing epoxy from the concrete surface.

D. Non-Compliance with Concrete Temperature Limitation

The remedies herein for the Contractor's failure to comply with the requirements of this Document are in addition to, and not in limitation of, those provided elsewhere under the Contract.

The Engineer may deduct the whole, or part, of any payment for concrete identified as Mass Concrete as defined herein or elsewhere in the Contract Documents if, in the Engineer's evaluation and judgment, the Contractor fails to maintain the maximum peak temperature and/or the maximum differential temperature within the limits specified herein.

Tables MC-10 and MC-11 represent the materials that may be accepted by the Engineer even though such materials have received test results that would cause the materials to be considered of "borderline quality" as that term is used in 1503, "Conformity with Contract Documents," and thus subject to the remedies specified in 1512, "Unacceptable and Unauthorized Work". If the Engineer accepts such materials, the Engineer will make the adjustment authorized in the tables below, not as a penalty, but as a pre-agreed adjustment to the Contract Unit Prices approximating a reduction in value of the project due to use of materials of borderline quality.

If, in the judgment of the Engineer, the Contractor fails to maintain concrete temperatures below the maximum peak concrete temperature specified herein, the Engineer will make determinations regarding the disposition, payment or removal. The Engineer will require the following monetary reductions in payment for the subject concrete in accordance with Table MC-10:

Table MC-10
Monetary Reduction for Exceeding Maximum Peak Concrete Temperature

Maximum Concrete Temperature	Monetary Reduction in Bid Price for Concrete
160º F to 165º F	$ 2.00 per cubic yard
> 165º F to 170º F	$ 35.00 per cubic yard
> 170º F to 175º F	$150.00 per cubic yard
> 175º F	Remove and Replace

If, in the judgment of the Engineer, the Contractor fails to maintain concrete temperatures within the maximum temperature differential specified herein, the Engineer will make determinations regarding the disposition, payment or removal. The Engineer will require the following monetary reductions in payment for the subject concrete in accordance with Table MC-11:

Table MC-11
Monetary Reduction for Exceeding Allowable Temperature Differential

Temperature in Excess of Allowable Differential	Monetary Reduction in Bid Price for Concrete
0º F to 5º F	$ 2.00 per cubic yard
5º F to 10º F	$ 15.00 per cubic yard
10º F to 15º F	$45.00 per cubic yard
Over 15º F	Remove and Replace

SB-__.4 Basis of Payment

The Engineer will not make separate payment for the development and testing of mix designs, analysis, plan, materials, protection, labor, equipment and all other incidentals associated with and required for the proper control of the heat generated by the Mass Concrete. No payment for crack measurement and repair or other repairs deemed necessary by the Engineer. The Engineer will consider all such costs incidental to the Structure Concrete of each Grade or Mix as designated in the Contract Documents.

Use when falsework design may be critical, such as with slab spans, box girders, rigid frames, and concrete arches or when recommended by the Region Const. Engineer.

CREATED 4/25/1997

REVISED 7/23/2019 (6)

SB- Falsework and Forms and Bridge Slab Placement

Delete 2401.3.B.2, "Design of Falsework and Forms," and replace with the following:

At least six weeks before starting construction of the (______________ and) superstructure falsework, supply the Engineer with three copies of the detailed plans and Specifications and two copies of the associated calculations of the proposed system for constructing the (_______________ and) superstructure falsework and forms. Design the falsework and forms in accordance with the current AASHTO "Guide Design Specifications for Bridge Temporary Works". Ensure the plans and specifications are prepared by an engineer, thoroughly checked by a second engineer for completeness and accuracy, and certified by one of the aforementioned professional engineers licensed in the State of Minnesota. Include sufficient details so that construction of the proposed system can be completed solely by reference to the plans and Specifications. Show the design criteria on the first sheet of the plans.

As a minimum, falsework plans must contain the following:

- Indicate the size of all load-supporting members and all transverse and longitudinal bracing. Include connection details for load-supporting members. For box girder structures, the drawings must show the falsework members supporting sloping exterior girders, deck overhangs and any attached construction walkways.
- Show all design-controlling dimensions, including beam length and spacing; post location and spacing; overall height of falsework bents; vertical distance between connectors in diagonal bracing; and similar dimensions that are critical to the design.
- Show the location and method by which the falsework will be adjusted to final grade.
- Unless a concrete placing schedule is specified in the contract, the falsework plans must include a superstructure placing diagram showing the proposed concrete placing sequence and/or the direction of pour, whichever one is applicable, and the location of all construction joints. (For relatively simple structures, this requirement may be satisfied by a note on the plans.)

Add the following to 2401.3.B.4:

It is not permitted to place the concrete for the (___________ and) superstructure until (1) plans and Specifications meeting the above requirements have been provided to the Engineer; (2) the engineer who has certified plans and specifications for the falsework and forms has inspected the falsework after erection; and (3) the engineer inspecting the as-constructed falsework certifies in writing that all details are approved.

1 - DESIGNER NOTE: Use the next 2 paragraphs when applicable. For slab spans, recommend 50 cu yds. per hour.

Add the following to 2401.3.F.3.b(1), "General":

At least two weeks in advance of casting Bridge Slab concrete, provide the Engineer with detailed plans for placing the concrete, including the scheme for supporting screed rails for the Bridge Slab and schedules setting forth the rate of concrete delivery. Place the concrete at a rate of _______ cubic yards per hour.

If concrete is cast by means of a pumping operation, maintain a standby pump or crane capable of delivering an uninterrupted flow of concrete in case of a pump breakdown.

<u>SB2018-2401.3 B 2</u>

Use for continuous steel girder structure ONLY when end span lengths are less than 80% of the adjacent span lengths.

CREATED 8/3/1994

REVISED 6/6/2018 (2)

SB- Beam Tie Downs for Slab Construction

The plans indicate that the bridge slab for Bridge No. ____ be placed in one continuous pour. In order to prevent uplift of the beams (during the placement of the concrete in the slab) at the abutment where the slab pour terminates, either counterweight or rigidly tie down the beams at that abutment before the placement of the concrete in the slab is started.

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1 - DESIGNER NOTE: Use a minimum counter weight of 3000 lb or higher if calculated.

Counterweights or tie downs must resist an uplift of at least (3000) (_____) lbs. for each line of beams. Furnish to the Engineer for approval complete details of the proposed methods to use to hold down the beams at the location mentioned above. Do not remove counterweights or release tie downs until at least seventy-five (75) percent of the slab in the span where the devices are used is in place.

SB2018-2401.3 C 1
Use with integral & semi-integral abutments.
CREATED 3/5/2003
REVISED 6/6/2018 (10)

SB- Integral Concrete Diaphragms

Use an approved chemical retarder Type B, D, or G from the "Approved/Qualified Product List for Concrete Products, Concrete Admixtures A-S" (www.dot.state.mn.us/products) in the concrete of the first poured end diaphragm. Adjust the retarder dosage so the initial end diaphragm concrete remains in an unhardened state during placement of the initial full span of the bridge slab. Gradually reduce retarder dosage after the first end diaphragm pour.

SB2018-2401.3 E 1

DO NOT USE for Metro District Bridges.

DO USE for bridge slabs having more than 200 yd^3 of concrete.

CREATED 5/3/1996

REVISED 6/6/2018 (2)

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SB- Bridge Slabs

The plans indicate that (the bridge slab) (each half of the bridge slab) for Bridge No. ____ be placed in one continuous pour. Place not more than (one) (two) transverse construction joint(s) (in the bridge slab) (each half of the bridge slab) to facilitate the placing of the concrete. The location of such transverse construction joints, the sequence of pours, and the direction in which the pours will be placed are subject to the Engineer’s approval.

Replace 2401.3.E.1, "Transverse Construction Joints," provisions with the following:

Immediately prior to placing concrete against a construction joint in the bridge slab, coat the surface of the inplace concrete with an approved bonding agent or grout.

SB2018-2401.3 F 1
Use where Site and Development Unit recommends an Architectural surface finish to the concrete.
CREATED 3/9/2000
REVISED 6/6/2018 (7)

SB- Architectural Concrete Texture

1 - DESIGNER NOTE: Until further notice, the Bridge Office Architectural Specialist (Melissa Schultz, 651-366-4465, melissa.schultz@state.mn.us) will provide all "ARCHITECTURAL SURFACE FINISH" special provision boilerplates.

SB-_.1 Special Surface Finish of Concrete Surfaces

1 - DESIGNER NOTE: The Department's Architectural Specialist (Melissa Schultz, 651.366.4465) will determine the Level of Aesthetic Impact on this particular bridge(s). For the following paragraph, customize as needed and add one of the following three Levels A, B, or C as noted on the preliminary plan.

To preserve and enhance the state's environmental, scenic, historic and cultural values and in response to the National Environmental Policy Act of 1969 (NEPA) the *Cost Participation and Maintenance Responsibilities with Local Units of Government Manual* dictates that the Aesthetic level of bridge(s) [insert bridge number(s) here] is level (insert level here) impact.

2 - DESIGNER NOTE: The following paragraph will only be used if the SSF option is allowed by the MnDOT Regional Br. Const. Engineer.

At the Contractor's option, follow the provisions of SSF II SB _.2 or SSF _.3 as a whole for all elements receiving special surface finish on this project. Use only **one** of the systems per structure.

SB-_.2 Special Surface Finish II (SSF II)

A. Description of Work

Delete the contents of 2401.3.F.2.c, "Special Surface Finish," and substitute the following:

The work consists of the preparation of the concrete surfaces, cleaning the surfaces, furnishing and apply a single component SSF II finish on structure surfaces required by the contract. Follow the approved Quality Control Plan to produce a surface uniform in texture and appearance. Final approval of appearance will be made by the Engineer.

B. Materials

Use only **one** Department-approved product to apply a concrete coating to the entire structure that meets the need for aesthetics and chloride protection as listed on the MnDOT Approved/Qualified Products List for "Special surface finish II coatings," www.dot.state.mn.us/products.

Supply a SSF II product that meets the requirements of 3501, "Basic Requirements for Paints." Per 3501 provide a color draw down sample on a Leneta chart per ASTM D2805, "Standard Test Method for Hiding Power of Paints by Reflectometry" to the Engineer. The Department requires an acceptable initial draw down sample prior to beginning any work because color testing is the initial control for the quality of the product.

The Engineer will randomly take liquid samples of SSF II in the field at the rates and sample sizes that will eventually be shown in the Schedule of Materials Control. Sampling requirements are one quart of liquid taken at a rate of one per 500 gallons of SSF II material, minimum of 1 per each batch/lot. The Engineer will send the samples to the Department's Lab Director for drawdown readings. The Lab will send the testing results back to the Engineer. The Department will sample an entire unopened, manufacturer sealed container if the Engineer determines there is a need.

Non-conforming Material: For any batch/lot that does not test in compliance with 3501, the Engineer will adjust payment based on the table below. Since the contract does not contain a separate contract unit price for SSF II, the Department will reduce payment per the following table.

Table 1 Deviation of sample color from accepted standard	
Deviation	**Adjusted Unit Price**
$\Delta E \leq 3$	No deduction for SSF II materials placed as approved by the Engineer.
$\Delta E > 3$ to 4	The Department will reduce payment by $0.13 per sq. ft. of failing batch/lot material placed.
$\Delta E > 4$ to 5	The Department will reduce payment by $0.25 per sq. ft. of failing batch/lot material placed.
$\Delta E > 5$ to 6	The Department will reduce payment by $0.38 per sq. ft. of failing batch/lot material placed.
$\Delta E > 6$	The Department will not reduce payment. Recoat the failing surface with smooth textured SSF II product in the color specified, at no cost to the Department until $\Delta E \leq 3$.

Deliver SSF II product to the job site in manufacturer sealed containers bearing the manufacturer’s original labels. Assure SSF II containers remain sealed and are maintained at a temperature above 40° F and less than 100° F and not in direct sun light until ready to be mixed and sampled. Do not use product that is older than its shelf-life.

C. Contractor Qualifications and Documentation

At least 20 calendar days before starting SSF II application submit a project specific Quality Control Plan (QCP) meeting the requirements of Table 2, "Concrete Coating Inspection Requirements" to the Engineer for acceptance.

In appendices of the QCP include:

- Training materials and documentation showing that the SSF II manufacturer's technical representative trained the applicators, and Contractor’s Quality Control (QC) personnel to apply the SSF II coating system used on this project;
- Include the method by which the QC person will monitor and document the wet film measurements taken to assure proper coating mils are being maintained utilizing ASTM D4414 "Measurement of Wet Film Thickness by Notch Gauges"; and
- The drawdown sample and the Department Lab Director’s letter accepting the initial color.

The Department’s Quality Assurance Inspector (QAI) will take wet-film readings and review Contractor QCP documentation as necessary to assure the Contractor is in compliance with the specifications. Supply wet film notched gauges to the QAI as needed.

Table 2 Concrete Coating Inspection Requirements	
Requirement	**Frequency/Extent**
General	
Date, time, and location on structure	Beginning of each shift or location
Ambient temperature	Beginning of work and then every 4 hours
Dew point and humidity	Beginning of work and then every 4 hours
Concrete Surface temperature to be coated with SSF II	Beginning of work and then every 4 hours
Wet Film Thickness per ASTM D4414 immediately following the application of the coating (WFT using a wet film thickness gauge provided by the manufacturer of the SSF II product)	Determine and Report the mean and range of the readings every ½ hour of application time or more as defined by the Engineer (if out of compliance take a reading every 10 minutes until in compliance)
Visual inspection	100 percent
Surface Preparation Prior to Coating	
Formed Surfaces (2401.3.F.2.a and/or 2401.3.F.2.b): Pre-clean (grind, sand blast, water blast, vapor blast)	Each component to receive an Ordinary Surface Finish coating. Visually inspect 100 percent of concrete area that will receive SSF II and ensure that all applied release agents, curing compounds, dirt, grease and other deleterious contaminants are completely removed.
Un-Formed Surfaces (2401.3.F.3): Pre-clean (water wash if necessary)	Visually inspect 100 percent for cleanliness
Finish Coat: (Premixed Single Coat System)	
Batch/Lot number	Every container
Verification of surface cleanliness	Examine visually within 1 hour before application
Temperature of mixed product	Just before application
Complete mixing of all components in the shipping container	Examine visually every container (NO residual components left in container)
Coating evaluation and repair	Visual, 100 percent
Recoat time	As recommended by the manufacturer
Coating system final evaluation and repair	Visual, 100 percent

Provide written documentation of the observed and document results of the requirements contained in table 2 to the QAI or to the Engineer within 5 working days from when each SSF II application shift was completed and all testing results in their entirety at the completion of the job. All SSF II QCP results are required to be submitted to the Engineer, **prior to receiving either partial or full payment for SSF II application**. The QAI or the Engineer will reject the coating system or reduce payment if the Contractor did not adhere to the approved QCP or provided inadequate documentation of adherence to the QCP.

D. Application Requirements

Do not start **any** SSF II coating application until the Engineer has written confirmation from the Department's Lab Director that the product complies with initial color requirements.

Cure concrete as required by 2401.3.G and the SSF II manufacturer prior to applying the surface coating. Prepare concrete that is older than 24 hrs. by power washing with potable water using a minimum of 3500 psi. Remove all efflorescence, flaking coatings, oil, curing compounds, release agents and other deleterious contaminants from the concrete surface prior to the application of the coating. Curing compound and release agent must be completely removed and may require additional means beyond 3500 psi pressure washing, grinding, or blasting as approved by the Engineer.

SSF II may be applied to "green" or "damp" concrete surface per the manufacturer's recommendations provided surface does not show liquid water droplets or pooling.

1. Department's preferred method: begin SSF II finishing operations only when it is possible to perform the work continuously from beginning to completion on any one structure element.
2. Department's alternative method: if continuous SSF II application cannot be accomplished then select coverage zones that will not produce an obvious start/stop delineation line.
3. For cooler times of the year concrete surface finishing operations **cannot** start when the temperature of the substrate, coating, or ambient air temperature is outside the manufacturer's recommended range. If no recommendation is given, use a minimum of at least 40° F and rising ambient air temperature. Suspend surface finishing operations if the ambient air temperature falls to 45° F and is dropping. Avoid application in direct sunlight to minimize a premature dry-out condition.

Single-component coatings require the SSF II product to be thoroughly mixed in its original container, then remixed as necessary and as recommended by the manufacturer to keep components in suspension and to incorporate the color pigments. If the SSF II product is shipped in 5 gallon containers, thoroughly mix the contents then completely empty all the contents into a larger container **maintaining** a minimum of 30 gallons of uniformly mixed product at all times. Equip the large container with an agitator during spraying. Provide an agitator or stirring rod capable of reaching within 2 inches of the bottom of the 30 gallon container to keep the product thoroughly mixed during application.

Supply a manufactured SSF II product that doesn't require thinning. Thinning of SSF II product is **not** allowed and the Engineer will reject all thinned SSF II product. Any SSF II product thinned and then applied will be required to be completely removed and replaced, at no cost to the Department.

The Engineer will require the complete removal of all SSF II that is adversely affected by moisture within the first 24 hours after SSF II placement. Once all SSF II is removed, recoat concrete with SSF II to original specified requirements referenced above, at no cost to the Department.

Apply one coat of the SSF II mixture by **spray application only**, using spray equipment as recommended by the manufacturer. Use the minimum coverage rate of wet mils as defined on the MnDOT APL for applying the material. The Engineer will reject, require removal, and recoating of concrete with SSF II if runs, sags, excessive build-up, or overlap of texture causes a non-uniform appearance.

Perform surface finishing that produces a uniform color and texture in the dried surface. To prevent a non-uniform appearance "Tiger-Stripping" of the texture limit the overlap of each spray applied pass of the coating. The final SSF II surface finish will not have laps or breaks in continuity. Perform corrective work on unaccepted finished areas coated with SSF II as directed by the Engineer, at no additional cost to the Department.

Protect non-coated surfaces from overspray. If the Engineer determines that the overspray damage is non-conforming the Engineer will direct that the overspray be removed, at no additional cost to the Department.

1. Exposed Concrete Surfaces receiving a surface finish

Apply a **textured** SSF II (see APL) on the exposed concrete surfaces as designated below for Bridge No.(s). [insert bridge number(s) here]. Apply the SSF II coating at a rate as defined on the APL in a uniform texture and color appearance.

3 - DESIGNER NOTE: Refer to attached "Designer Guide for Surface Finish Requirements," or to the documentation furnished by the Department's Architectural Specialist (Melissa Schultz, 651.366.4465); then create a list of surfaces to be coated.

- Edges of slab;
- Bottom of overhangs;
- Copings;
- Wingwalls;
- Abutments;
- Piers/pier caps;

- Parapets;
- Pilasters; and
- Crash struts.

4 - DESIGNER NOTE: Select a color and color # specified by the Department's Architectural Specialist (Melissa Schultz, 651.366.4465).

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Provide a finish color for all SSF II matching [MnDOT standard color "Gray-Modified" on file in the MnDOT Chemical Laboratory (651-366-5548)] [AMS-STD-595A Color No. 36622 (pearl gray), or (____________________)]. Provide paint free of toxic metals and toxic pigments. Provide a "matte" finish for all colors.

2. Finishing Roadway Faces, Tops of barrier, and Outside surface of barriers

Apply a **smooth** SSF II (see APL) on the exposed concrete surfaces as designated for Bridge No.(s). _________. Apply the SSF II coating at a rate as defined on the APL in a uniform texture and color appearance.

a. Finish conventionally formed roadway faces, tops of barriers, and outside surface of barriers as per 2401.3.F.2.d, "Curb, Sidewalk, and Median Finish," and the following:

(1) Plan and execute concrete placement, form removal, and finishing operations so that the surface finishing can be started immediately after forms are removed. Remove the roadway face forms as soon as the concrete can retain its molded shape. In no case shall the elapsed time between concrete placement and initial surface finishing exceed 12 hours.

5 - DESIGNER NOTE: For the next paragraph, select a color and color # to be specified by the Department's Architectural Specialist (Melissa Schultz, 651.366.4465). This is a "smooth" finish because the broom gives the surface its texture.

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(2) After completion of the proper curing period, begin SSF II application. Provide a finish color for all SSF II matching [MnDOT standard color "Gray-Modified" on file in the MnDOT Chemical Laboratory (651-366-5548)] [AMS-STD-595A Color No. 36622 (pearl gray), or (____________________)]. Provide a "matte" finish for all colors.

b. Finish slipformed barriers, in accordance with the following:

(1) Lightly broom in a texture on the barrier surface immediately after passage of the slipformer.

(2) Coat the surfaces of the barrier as described in paragraph D.2.a(2) of this special provision with SSF II.

6 - DESIGNER NOTE: Use the following section when PCBs are included in the plan.

3. Finishing Precast Concrete Girders

Apply a **smooth** SSF II (see APL) on the exposed concrete surfaces as designated below for Bridge No.(s). _________. Apply the SSF II coating at a rate as defined on the APL in a uniform texture and color appearance.

7 - DESIGNER NOTE: Refer to attached "Designer Guide for Surface Finish Requirements," then create a list of the surfaces to be coated. This is a "smooth" finish.

- Outside face of fascia girders;
- Bottom of bottom flange of fascia girders;
- All faces of all girders; and
- Bottom of bottom flange of all girders.

UAR

Provide a finish color for matching [MnDOT standard color "Gray-Modified" on file in the MnDOT Chemical Laboratory (651-366-5548)] [AMS-STD-595A Color No. 36622 (pearl gray), or (________________)]. Provide a "matte" finish for all colors.

8 - DESIGNER NOTE: The following SB_.3 will only be used if the SSF option is allowed by the MnDOT Regional Br. Const. Engineer.

SB-_.3 Special Surface Finish (SSF)

9 - DESIGNER NOTE: For the following paragraph, modify minimum curing days when needed for short working day contracts.

Cure concrete for a minimum of 28 days or as recommended by the special surface finish (SSF) manufacturer prior to applying SSF or acrylic paint. Thoroughly flush all surfaces that are to receive SSF with potable water not more than 24 hours before commencing with the SSF finishing.

A. Description of Work for SSF

The provisions of 2401.3.F.2.c, "Special Surface Finish," are supplemented as follows:

The work consists of the preparation of the concrete surfaces, cleaning the surfaces, furnishing and applying a two coat SSF finish on structure surfaces required by the contract. Follow the approved Quality Control Plan to produce a surface uniform in texture and appearance. Upon satisfactory completion of surface preparation, the Engineer will approve surfaces ready for SSF application.

B. Materials

Use only **one** Department-approved finish listed on the MnDOT Approved/Qualified Products List for "Special Surface Finish System," www.dot.state.mn.us/products to apply a concrete coating for the entire structure.

Supply a SSF product that meets the requirements of 3501, "Basic Requirements for Paints." Per 3501, provide a color draw down sample on a Leneta chart per ASTM D2805, "Standard Test Method for Hiding Power of Paints by Reflectometry" to the Engineer. The Department requires an acceptable initial draw down sample prior to beginning any work because color testing is the initial control for the quality of the product.

The Engineer will randomly take liquid samples of SSF in the field. Sampling requirements are one quart liquid samples will be taken at a rate of one per 500 gallons of SSF material, minimum of 1 per each SSF batch/lot. The Engineer will send the samples to the Department's Lab Director for drawdown readings. The Lab will send the testing results back to the Engineer.

Non-conforming Material: For any batch/lot that does not test in compliance with 3501, the Engineer will adjust payment based on the table below. Since the contract does not contain a separate contract unit price for SSF, the Engineer will reduce payment per the following table.

Deviation of sample color from accepted standard	
Deviation	**Adjusted Unit Price**
$\Delta E \leq 3$	No deduction for SSF materials placed as approved by the Engineer.
$\Delta E > 3$ to 4	The Department will reduce payment by $0.13 per sq. ft. of failing batch/lot material placed.
$\Delta E > 4$ to 5	The Department will reduce payment by $0.25 per sq. ft. of failing batch/lot material placed.
$\Delta E > 5$ to 6	The Department will reduce payment by $0.38 per sq. ft. of fail batch/lot material placed.
$\Delta E > 6$	Recoat the failed surface with 100% acrylic paint per specification 3584, "Exterior Masonry Acrylic Emulsion Paint," in the color specified, at no cost to the Department and to the satisfaction of the Engineer until the $\Delta E \leq 3$.

Deliver the SSF product to the job site in sealed containers bearing the manufacturer’s original labels. Assure storage containers remain sealed until mixed and sampled, and are maintained at a temperature above 40° F and less than 100° F and not in direct sunlight. Do not use product that is older than its shelf-life.

C. Contractor Qualifications and Documentation

At least 20 calendar days before starting SSF application submit a project specific Quality Control Plan (QCP) meeting the requirements of Table 2, "Concrete Coating Inspection Requirements" to the Engineer for acceptance.

In appendices of the QCP include:

1. Training materials and documentation showing that the SSF manufacturer's technical representative trained the applicators, and Contractor’s Quality Control (QC) personnel to apply the SSF coating system used on this project;
2. Include the method by which the QC person will monitor and document the wet-film measurements taken to assure proper mils are being maintained utilizing ASTM D4414 "Measurement of Wet Film Thickness by Notch Gauges"; and
3. Process for obtaining the drawdown sample and the Department Lab Director’s letter accepting the initial color.

The Department’s Quality Assurance Inspector (QAI) will take wet-film readings and review Contractor QCP documentation as necessary to assure the Contractor is in compliance. Supply wet-film gauges to the QAI as needed.

Table 2 **Concrete Coating Inspection Requirements**	
Requirement	**Frequency/Extent**
General	
Date, time, and location on structure	Beginning of each shift or location
Ambient temperature	Beginning of work and then every 4 hours
Dew point and humidity	Beginning of work and then every 4 hours
Concrete Surface temperature to be surfaced	Beginning of work and then every 4 hours
Two spray applied coats per spec	Every ½ hour of application time or more as defined by the Engineer (if out of compliance document take a reading every 10 minutes until in compliance)
Visual inspection	100 percent
Surface Preparation Prior to Coating	
Formed Surfaces (2401.3.F.2.a and/or 2401.3.F.2.b): Pre-clean (grind, sand blast, water blast, vapor blast)	Each component to receive an Ordinary Surface Finish coating. Visually inspect 100 percent of concrete area that will receive SSF and ensure that all applied release agents and curing compounds are completely removed
Un-Formed Surfaces (2401.3.F.3): Pre-clean (water wash if necessary)	Visually inspect 100 percent (for what)
Finish Coat: (Premixed Single Coat System)	
Batch/Lot number	Every container
Verification of surface cleanliness	Examine visually within 1 hour before application
Temperature of mixed product	Just before application
Complete mixing of all components (document the proportions of each component required)	Examine visually every container (NO residual components left in containers)
Coating evaluation and repair	Visual, 100 percent
Recoat time	As recommended by the manufacturer
Coating system final evaluation and repair	Visual, 100 percent

Provide written documentation of the observed and document results of the requirements contained in table 2 to the QAI or to the Engineer within 5 working days from when each SSF application shift was completed and all testing results in their entirety at the completion of the job. All SSF QCP results are required to be submitted to the Engineer, **prior to receiving either partial or full payment for SSF application**. The QAI or the Engineer will reject the coating system or reduce payment if the Contractor did not adhere to the approved QCP or provided inadequate documentation of adherence to the QCP.

D. Application Requirements

Do not start **any** SSF coating application until the Engineer has written confirmation from the Department's Lab Director that the product complies with initial color requirements.

Cure concrete as required by 2401.3.G and the SSF manufacturer prior to applying the surface coating. Prepare concrete that is older than 24 hours by power washing using a minimum of 3500 psi. Remove all efflorescence, flaking coatings, oil, curing compounds, release agents and other deleterious contaminants from the concrete surface prior to the application of the coating. Curing compound and release agent must be completely removed and may require additional means beyond 3500 psi pressure washing, grinding, or blasting as approved by the Engineer.

SSF may **NOT** be applied over "green" or damp concrete.

1. Department's preferred SSF application method: begin surface finishing operations only when it is possible to perform the work continuously from beginning to completion on any one structure element.
2. Department's alternative SSF application method: if continuous application cannot be accomplished then select coverage zones that will not produce an obvious start/stop delineation line.
3. For cooler times of the year concrete surface finishing operations **cannot** start when the temperature of the substrate, coating, or ambient air temperature is outside the manufacturer's recommended range. If no recommendation is given, use a minimum of at least 40° F and rising ambient air temperature. Suspend surface finishing operations if the ambient air temperature falls to 45° F and is dropping. Avoid application in direct sunlight to minimize premature dry-out condition.

Multi-component coatings require the products to be thoroughly mixed, then remixed as necessary or as recommended by the manufacturer to keep components in suspension. Mix the coating system as required by the manufacturer. When SSF is packaged in containers less than 30 gallons, thoroughly mix all the components. Then completely empty all the contents into a larger container maintaining not less than 30 gallons of uniformly mixed product at all times. Equip the large container with an agitator during spraying. Provide an agitator or stirring rod capable of reaching within 2 inches of the bottom of the 30 gallon container to keep the product thoroughly mixed during application.

Supply a manufactured SSF product that doesn't require thinning. Thinning of SSF product is **not** allowed and the Engineer will reject all thinned SSF product. Any SSF product thinned and then applied will be required to be completely removed and replaced, at no cost to the Department.

The Engineer will require the complete removal of all SSF from concrete that is adversely affected by moisture within the first 24 hours after SSF placement. Once all SSF is removed, recoat concrete with SSF to original specified requirements referenced above, at no cost to the Department.

Apply a minimum of two coats (if sagging is experienced adjust application) of the mixture by **spray application only**, as recommended by the manufacturer. Use manufacturer's coverage rate from the manufacturer's literature. Runs, sags, excessive build-up, or overlap of texture that will cause non-uniform appearance will be removed and replaced following section 3.a, at no cost to the Department.

Perform surface finishing that produces a uniform color and texture in the dried surface, without evidence of laps or breaks in continuity. Perform corrective work on unaccepted finished areas coated with SSF as directed by the Engineer, at no additional cost to the Department.

Apply a top coat (3rd coat) of 100% acrylic paint 3584, "Exterior Masonry Acrylic Emulsion Paint," in the color specified.

Protect non-coated surfaces from overspray. If the Engineer determines that the overspray damage is non-conforming the Engineer will direct that the overspray be removed, at no additional cost to the Department.

1. Exposed Concrete Surfaces receiving a surface finish

Apply a SSF on the exposed areas as defined in the SSF II section above.

2. Finishing Roadway Faces, Tops and Backs of Barriers

Apply an Acrylic paint on the exposed concrete surfaces as designated for Bridge No.(s). __________.

a. Finish conventionally formed roadway faces, tops of barriers, and outside surface of barrier as per 2401.3.F.2.d, "Curb, Sidewalk, and Median Finish," and the following:

(1) Plan and execute concrete placement, form removal, and finishing operations so that the surface finishing can be started immediately after forms are removed. Remove the forms as soon as the concrete can retain its molded shape. In no case shall the elapsed time between concrete placement and initial surface finishing exceed 12 hours.

10 - DESIGNER NOTE: For the next paragraph, select a color and color # to be specified by the Department Architectural Specialist (Melissa Schultz, 651.366.4465). An acrylic paint finish is the standard.

(2) After completion of the required curing period, paint the roadway faces, tops and backs of the barriers with an approved acrylic paint conforming to 3584, "Exterior Masonry Acrylic Emulsion Paint". Supply a color of the acrylic paint shall conform to [MnDOT standard color "Gray-Modified" on file in the MnDOT Chemical Laboratory (651-366-5548)] [AMS-STD-595A Color No. 36622 (pearl gray), or (__________)]. Provide a "matte" finish for all colors. Apply the paint at a rate of 300 ft^2 per gallon or per manufacturer's recommendations. Commence or suspend the painting operation when the air and concrete surface temperature meet or exceed the manufacturer's recommendations.

b. Finish slipformed roadway faces, tops and backs of barriers, in accordance with the following:

(1) Lightly broom in a texture on the barrier surface immediately after passage of the slipformer.

(2) Coat the roadway face, top and back of the barrier as described in D.2.a(2) of this special provision for the conventionally formed barrier.

11 - DESIGNER NOTE: For the following section, use when PCB are included in the plan.

E. Finishing Precast Concrete Girders

Apply two sprayed coats of 100% acrylic paint 3584, "Exterior Masonry Acrylic Emulsion Paint," on the exposed concrete surfaces as designated below for Bridge No.(s). __________.

12 - DESIGNER NOTE: Refer to attached "Designer Guide for Surface Finish Requirements," then create a list of the surfaces to be coated.

- Outside face of fascia girder;
- Bottom of bottom flange of fascia girder;
- All faces of all girders; and
- Bottom of bottom flange of all girders.

Provide a finish color for acrylic paint matching [MnDOT standard color "Gray-Modified" on file in the MnDOT Chemical Laboratory (651-366-5548)] [AMS-STD-595A Color No. 36622 (pearl gray), or (_________)]. Provide a "matte" finish for all colors.

Apply the paint at a rate of 300 ft^2 per gallon or per manufacturer's recommendations. Commence or suspend the painting operation when the air and concrete surface temperature meet or exceed the manufacturer's recommendations.

13 - DESIGNER NOTE: This Basis of Payment is the same for the SSF II and the SSF.

F. Basis of Payment

Finishing of concrete surfaces, except as otherwise provided in these special provisions, are considered an incidental expense to the respective concrete mixes for this construction, and no additional compensation will be made for this work.

DESIGNER GUIDE FOR SURFACE FINISH REQUIREMENTS

BRIDGES OVER		FOR ALL TYPES OF BRIDGES: BARRIER & POSTS (EXCEPT "F")	COPINGS	EDGE OF SLAB	PIERS	ABUTMENTS	MEDIAN "F" BARRIER	INSIDE FACE "F" BARRIER	OUTSIDE FACE "F" BARRIER	WINGWALLS	FOR CONCRETE GIRDERS, BOXES, ETC.: OUTSIDE FACE & BOTTOM OF BOTTOM FLANGE	BOX GIRDERS
INTERSTATE	URBAN	X	X	X	X	X	X	X	X	X	X	X
	RURAL	X	X	X	X	X	X	X	X	X	X	X
TRUNK HIGHWAYS	URBAN	X	X	X	X	X	X	X	X	X	X	X
	RURAL	X	X	X	X	X	X	X	X	X	X	X
SECONDARY ROADS	URBAN	X	X	X	X	X	X	X	X	X	X	X
	RURAL	X					X	X				
CITY STREETS		X	X	X	X	X	X	X	X	X	X	X
STREAMS		X	1	1	1	1	X	X	1	1	1	1
SWAMPS AND MARSHES		X					X	X				
RAILROADS		X					X	X				
RAILROADS OVER TH		X	X	X	X	X	X	X		X	X	X

X = USE SPECIAL SURFACE FINISH ON THESE FACES.

1= ONLY IN SPECIAL CASES, SUCH AS IN RESIDENTIAL AREAS, CAMPING GROUNDS, ETC.

CHECK WITH BRIDGE CONSTRUCTION UNIT
IN THE EVENT OF QUESTIONABLE CONDITIONS OR AREAS.

Use when the roadway faces & tops of barrier railings are the ONLY surfaces to receive special surface finish.

CREATED 5/1/1998
REVISED 6/6/2018 (4)

SB- Finish of Concrete

A. Finishing Roadway Faces and Tops of Barrier

UAR

1. Finish the roadway faces and tops of barriers (and medians), if conventionally formed, in accordance with 2401.3.F.2.d, "Curb, Sidewalk, and Median Finish," except as follows:

a. Plan and execute concrete placement, form removal, and finishing operations so that the surface finishing can be started immediately after forms are removed. The roadway face forms may be removed as soon as the concrete can retain its molded shape. However, in no case shall the elapsed time between concrete placement and initial surface finishing exceed 24 hours.

1 - DESIGNER NOTE: For the following paragraph, modify minimum curing days when needed for short working day contracts.

UAR

b. After completion of the 28 day curing period, paint the roadway faces and tops of the barriers (and median) with an approved acrylic paint conforming to 3584, "Exterior Masonry Acrylic Emulsion Paint". Provide an acrylic paint matching Federal Std. No. 595 C No. 26622 (pearl gray). Apply the paint at an approximate rate of 300 ft^2 per gallon. Commence painting operation when the air and surface temperature is at least 50°F with temperature rising, and suspend when the air and surface temperature is falling and reaches 55°F.

UAR

2. Finish the roadway faces and tops of barriers (and median), if slipformed, in accordance with the following:

a. Lightly broom the barrier immediately after passage of the slipformer creating a uniform texture appearance.

2 - DESIGNER NOTE: For the following paragraph, modify minimum curing days when needed for short working day contracts.

b. After completion of the 28 day curing period, paint the roadway face and top of the barriers with an approved acrylic paint as described above for the conventionally formed railing.

B. Basis of Payment

Everything described above is considered an incidental expense to the concrete mix for this construction.

Use where special surface finish is required on inplace concrete.

CREATED 10/30/1997

REVISED 6/6/2018 (3)

SB- Finish of Inplace Concrete

Provide and apply a Special Surface Finish as described in 2401.3.F.2.c, "Special Surface Finish," on the following exposed concrete surfaces:

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Etch concrete surfaces by sandblasting before applying the special surface finish to them.

1 - DESIGNER NOTE: Select ONE of the two following paragraphs.

Payment for Item No. 2401.618 "SPECIAL SURFACE FINISH (INPLACE)", at the Contract price per square foot shall be compensation in full for performing all work described above complete in place.

Payment for Item No. 2401.604 "SPECIAL SURFACE FINISH (INPLACE)", at the Contract price per square meter shall be compensation in full for performing all work described above complete in place.

Use with bridges having skews 20 degrees or greater, when there is a vertical curve, but only when recommended by the Regional Bridge Engineer.

CREATED 8/3/1994

REVISED 6/6/2018 (3)

SB- Bridge Slab

Operate the finishing machine for Bridge No. _________ so that the longitudinal axis of the machine is generally parallel to the centerline of bearings of the substructure units.

Use when texture planing is required on monolithic bridge deck slab.

Use in the Metro District for speeds over 40 mph. For speeds ≤ 40 mph, consult the Metro Region Construction Engineer.

CREATED 6/5/1996

REVISED 6/6/2018 (14)

SB- Texture Planing of Bridge Deck Slab Surface

Delete the 5th and 6th paragraphs of 2401.3.F.3.b(4), "Final Finish Texture," and substitute the following:

Take special care in finishing roadway surfaces in the vicinity of expansion devices and other locations where breaks in continuity occur to ensure a smooth riding surface.

Upon completion of curing and a minimum of 72 hours prior to performing texture planing, remove all equipment and material from the bridge deck slab and approach panel surface and sweep the surface clean of debris. The Engineer will check surface smoothness of the roadway surface in accordance with 2401.3.F.3.b(7), "Surface Smoothness Check". The final surface must meet the tolerance requirements of 2401.3.F.3.b(4), "Final Finish Texture". Correct surface areas not meeting the specified tolerances by removal and replacement or by grinding using a surface diamond grinding device consisting of multiple diamond blades on the high spots to the extent directed by the Engineer prior to beginning surface texturing operations. Nonconforming areas that are not satisfactorily corrected are subject to 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work".

Notify the Engineer at least 24 hours before beginning texture planing. Do not begin texture planing until the Engineer agrees that work **required to meet surface tolerance has been completed**. Mark the lane lines and crown in the deck and discuss with the texture planing operator prior to beginning the work.

Texture the roadway surface in a longitudinal direction by planing the hardened concrete with diamond saw-blades. Plane the entire surface area of the roadway, except the area within 20 inches of the curb, or gutter to a uniform texture. Ensure the surface has a finished texture with groove width between $^1/_{10}$ inch and $^1/_8$ inch at a distance of between $^5/_{64}$ inch and $^1/_8$ inch apart. Make the grooves no less than $^1/_{32}$ inch or more than $^1/_8$ inch in depth. Ensure the actual textured surface in any selected 1.5 feet by 100 ft longitudinal strip is no less than 95% of the surface area. The Engineer will not include areas directly adjacent to expansion joints if it has been agreed that texture planing of those areas will result in damage to the expansion joint device or plow finger straps.

The Engineer will observe the planing and any damage, including coating damage, to the expansion joint devices, plow finger straps, and deck drains will be corrected or will be removed and replaced as unacceptable work, as directed by the Engineer. If the Engineer does not direct either repair or replace of the unacceptable work, the Contractor may leave the work in-place and the Engineer will adjust the contract unit price of the affected items by 50 percent. Install modular expansion joint devices after texture planing.

Perform planing in a manner that will provide a smooth riding surface at expansion joints and at the ends. After completion of the planing, the permissible surface deviation will be $^1/_8$ inch in 10 ft measured with a straightedge laid longitudinally and $^1/_8$ inch in 3 ft measured transversely at right angles to the centerline of roadway. **In all areas of the exposed deck the Contractor will be required to provide positive drainage (including the 20 inches of unplaned gutter).** A small walk-behind grinder may be required to remove high spots along the gutter.

Perform the slurry management per (1717) AIR, LAND, AND WATER POLLUTION (CONCRETE GRINDING) of the "S" section of this contract.

The Engineer will measure the surface of the finished concrete and all planed areas not meeting the requirements may, at the Engineer’s option, be re-planed, be replaced as unacceptable work, or left as is and accepted for payment subject to a price reduction of 50 cents per sq ft but, in all cases, provide positive surface drainage.

Measurement will be made to the nearest square foot of concrete area planed and textured based on surface area. Areas not texture planed will be deducted from the plan quantity, unless the surface in any selected 1.5 feet by 100 ft longitudinal strip is at least 95% textured. Payment will be made under Item 2401.618 "BRIDGE DECK PLANING" at the Contract bid price per square foot, which shall be compensation in full for all costs relative to the specified texture planing.

SB- Bearing Seat Tolerances

Delete the contents of 2401.3.F.3.b(8), "Preparation of Bridge Seats," and substitute the following:

1. Prior to casting bearing seats:

Construct the bearing seat forms, at time of form setting, within a 0.01-foot accuracy tolerance. The contractor may elect to build bearing seat forms at a higher elevation with subsequent grinding to come back into elevation tolerance provided no ponding areas result on top of the bearing seat. If bearing seats are built to a higher elevation, increase top concrete cover by the same amount.

1 – DESIGNER NOTE: For disc and pot bearings where blockouts are incorporated into the plans, produce X and Y coordinates for individual anchor rods and center of anchor rod groups in advance of the letting and keep with calculations. This will be similar to construction elevations and be used to check the placement of blockouts by MnDOT. Include appropriate plan note to recognize this SP, if blockouts are used.

Where anchor rod blockouts are incorporated within the forms, the blockouts may be tied individually or with a template rigidly joining a blockout group. All anchor rod blockouts at a given bearing seat comprise a blockout group. The location tolerance for individual blockouts is $^{1}/_{16}$ inch within the blockout group. Position the blockout group to enable placement of the bearing assembly within $^{1}/_{4}$ inch of the plan center bearing position. Refer to the Plan and adhere to all requirements of 2472.3.C "Placing, Supporting, and Tying Bar Reinforcement." Survey the center of individual blockouts prior to casting concrete and provide the X and Y coordinate data to the Engineer. Adjust any blockouts that are out of tolerance. Survey final blockout positions and provide the X and Y coordinate data to the Engineer.

2. After meeting the curing requirements as specified for this concrete:

Grind the bridge seats to produce a Level Surface Area that does not vary by greater than $^{1}/_{16}$ inch for steel base plates or by greater than $^{1}/_{8}$ inch for elastomeric bearing pads. The Level Surface Area is defined as an area with a boundary 2 inches outside the bearing contact area on all sides. Grind surfaces outside the Level Surface Area to prevent ponding. Adjust the Level Surface Area if any of the tolerances are exceeded.

After grinding the Level Surface Area, field-survey bearing seats at center of bearing and provide an electronic copy of the X and Y coordinates and elevations to the Engineer.

When anchor rod blockouts are cast into the bearing seat, survey the center of each blockout position and provide the information to the Engineer.

3. Adjustments to leveled bearing seats:

Adjust the Level Surface Area when the differential between adjacent Level Surface Areas deviates by more than:

a. $^{1}/_{8}$ inch for steel framing fabricated by "full assembly" as specified in Spec 2471,"Structural Metals";
b. $^{3}/_{8}$ inch for all other bridges.

The differential between adjacent bearings can be determined as follows:

$\Delta =$ |(Plan Elevation Beam A – Survey Elevation Beam A) – (Plan Elevation Beam B – Survey Elevation Beam B)|

2 - DESIGNER NOTE: Designer should review the following tolerances and adjust as needed for Complex Stiff Structures.

At a given line of bearing or within the same substructure, produce bearing seats within the following accuracy:

a. Seats may be no more than $^3/_4$ inch low from plan elevation for the lowest seat at a given substructure; and
b. Seats may be no more than $^3/_8$ inch high from plan elevation for the highest seat at a given substructure.

Tolerances above are superseded by any plan notes. Plan elevation is defined as the plan bearing seat elevation as adjusted for actual bearing heights which have been approved by the Engineer.

Prior to adjusting any Level Surface Areas or bearing seats, submit the proposed method, material specifications, and required adjustment for each bearing seat to the Engineer. The Engineer must accept the correction proposal in writing prior to proceeding with any bridge seat modifications.

SB2018-2401.3 G 1
Use on all projects where potential prematurely applied loads may be a concern.
CREATED 8/3/1994
REVISED 6/6/2018 (15)

SB- Concrete Curing and Protection

1 - DESIGNER NOTE: Designer is directed to evaluate all potential prematurely applied load scenarios (i.e. pier caps, concrete hinges, falsework, etc.) and if a strength greater than what is defined in Table 2401-1, "Curing Requirements for Concrete Bridge Elements," is required write a SP for it here. Do not use for slab spans, use SB2018-2401.1.

Add the following to 2401.3.G:

The curing requirement for concrete bridge element ________ is ________ percent of the compressive strength prior to applying load to the element from ________.

SB- Concrete Curing and Protection for Slab Span Superstructures

1 – DESIGNER NOTE: Include with slab span bridges to define required concrete strength for form removal and load application in Table 2401-1. Consider the following items during design to establish the required strengths below:

- ***A. Minimum Strength Required to Pull Forms: self-weight of concrete. The minimum value should be greater than or equal to 65% of the design f'c, expressed in psi in the table. The "ǂ" symbol is included after the strength to reference the proper note at the bottom of the table.***
- ***B. Minimum Strength to Apply Loads: Typically use f'c =100% and include the "‖" symbol after the percentage to reference the proper note at the bottom of the table. If a lesser strength is desired, consider construction loads that would be applied after then minimum curing period (e.g. loaded concrete truck and slip-form machine).***

SB-X.X.1 Modify Table 2401-1, "Curing Requirements for Concrete Bridge Elements", as follows:

1. Replace the row labeled "Slab Span Superstructure" with the following:

Bridge Element	Minimum Curing Period	Minimum Period For Form Cure	Minimum Strength Required to Pull Forms, psi	Minimum Strength to Apply Loads, % of Required †	Method Allowed to determine in-place concrete strength
Slab Span Superstructure	7 days	8 days	A ǂ	B‖	Maturity or Control Cylinders

2. Replace the footnote starting with "‖" symbol with the following:

‖ Achieve 100% of minimum strength prior to opening to traffic.

SB-X.X.2 Delete the last sentence of 2401.3.G.6.d, "Protection from premature loading".

Use with high abutments that have vertical construction joints detailed in the plan.
CREATED 8/3/1994
REVISED 6/6/2018 (2)

SB- Placement of Concrete in High Abutments

Delay adjacent concrete pours of abutments with vertical construction joints by 72 hours to reduce the effects of shrinkage.

Use with high abutments that have vertical construction joints detailed in the plan. Use only if recommended by the Regional Bridge Engineer.

CREATED 8/3/1994

REVISED 6/6/2018 (2)

SB- Placement of Concrete in High Abutments

Delay adjacent concrete pours of abutments with vertical construction joints by 72 hours to reduce the effects of shrinkage. When necessary to advance the project schedule, the 72 hour delay may be reduced to a minimum of 24 hours for abutments that are continuously formed. The forms will remain in place on adjacent pours for the full curing period.

SB- Protection of New Concrete Against Vibration

The provisions of 2401.3.G, "Concrete Curing and Protection," are supplemented as follows:

Delete 2401.3.G (5) and replace with the following:

(5) Vibration exceeding a specific limit;

Add the following as 2401.3.G.7, "Protection of New Concrete Against Vibration":

Do not subject freshly placed concrete to excessive vibration and shock waves during the curing period until it has reached a 2,000 psi minimum compressive strength for structural concrete and lower-strength classes of concrete.

After the first 5 hours from the time the concrete has been placed and consolidated, keep all vibration producing operations at a safe horizontal distance from the freshly placed concrete by following either the Primary or Alternate method. Plant cast concrete is not subject to these requirements.

A. Primary Method - Prescriptive Safe Distance Method

After the concrete has been placed and consolidated, keep all vibration producing operations at a safe distance from the freshly placed concrete as follows:

Minimum Compressive Strength, f'c	Safe Horizontal Distance		
	Equipment Class L	Equipment Class M	Equipment Class H
< 1,000 psi	10 feet	75 feet	125 feet
1,000 to < 1,400 psi	10 feet	30 feet	50 feet
1,400 to 2,000 psi	10 feet	15 feet	25 feet

Equipment Class L (Low Vibration) includes small rubber tire construction equipment like backhoes under 50,000 pounds, concrete placing equipment, and legal highway vehicles if such equipment travels at speeds of:

- ≤ 5 mph on relatively smooth roadway surface or
- ≤ 3 mph on rough roadway surface (i.e., with potholes)

Equipment Class M (Medium Vibration) includes tracked dozers under 85,000 pounds, track vehicles, trucks (unless excluded above), hand-operated jack hammers, cranes, auger drill rig, caisson drilling, vibratory compacting rollers under 30,000 pounds, and grab hammers.

Equipment Class H (High Vibration) includes pile drivers, vibratory hammers, machine-operated impact tools, pavement breakers, and other large pieces of equipment.

After the concrete has reached the minimum compressive strength specified above, the safe horizontal distance restrictions would no longer apply.

B. Alternate Method - Monitoring Safe Distance Method

Monitor the vibration producing operations in order to decrease the safe horizontal distance requirements of the Prescriptive Safe Distance Method. Monitor all construction operations that produce vibration or shock waves in the vicinity of freshly placed concrete with monitoring equipment sensitive enough to detect a minimum peak partial velocity (PPV) of 0.01 in/sec. Place monitoring devices on or adjacent to the freshly placed concrete when the measurements are taken. During the time subsequent to the concrete placement, cease all vibration or shock producing operations in the vicinity of the newly placed concrete when monitoring equipment detects excessive vibration and shock waves defined as exceeding the following PPV's:

Minimum Compressive Strength, f'c	Maximum PPV
< 1,000 psi	0.1 in/sec
1,000 to < 1,400 psi	1.0 in/sec
1,400 to 2,000 psi	2.0 in/sec

After the concrete has reached a minimum compressive strength specified above, the safe horizontal distance restrictions would no longer apply.

SB2018-2401.3 H 1

Slipforming is typically allowed but sometimes it is prohibited.

CREATED 11/25/1997

REVISED 3/5/2020 (4)

1 – DESIGNER NOTE: Slipforming is typically allowed so include this first SB, unless it is prohibited.

SB- Slipforming of Bridge Barrier

The provisions of 2401.3.H.1, "Reinforcement Bars," are supplemented as follows:

Add the following to 2401.3.H.1:

For slipform construction, tie 100% of the reinforcement bar intersections in the barrier.

2 – DESIGNER NOTE: Include this second SB when slipforming is PROHIBITED on the job.

UAR

SB- Slipforming of Bridge Barrier Prohibited

Slipforming of ______ barrier is not permitted (on this project) (on Bridge No. ______).

Use when Split Median Barrier Caps are required by the Regional Engineer. (Consider using when the gap between back faces of barriers is ≤ 5 inches).

CREATED 3/15/2017

REVISED 6/6/2018 (2)

SB- Split Median Barrier Cap

A. Description of Work

The work consists of preparing the concrete surface, furnishing new materials, and installing the split median barrier cap in accordance with this provision and plan.

B. Materials

1. Concrete Screw Anchors and Fender Washers

$^{1}/_{4}$ inch diameter Hex Head Type 410 Stainless Steel Concrete Screw Anchors at $1^{3}/_{4}$ inches deep with a Type 316 Stainless Steel Fender washer.

2. Molded Rubber Median Seal

"T" shaped one piece molded rubber section meeting the following characteristics:

- $8^{1}/_{2}$ inches wide $\pm^{1}/_{4}$ inch;
- 2 inch stem height $\pm^{1}/_{16}$ inch;
- $^{1}/_{4}$ inch wall thickness $\pm^{1}/_{32}$ inch;
- EPDM rubber [ethylene propylene diene monomer (M-class) rubber];
- Minimum 10 foot length between spliced sections (make overlap splices 6 inches by removal of the stem portion in the overlap region);
- Assure the molded rubber is dry and free of any release agents, oils, films or residues of any kind;
- Provide the molded rubber in a grey color.

MnDOT Metro Bridge Maintenance has successfully used Utility Sales and Supply, Inc. and AAA-Acme Rubber Co. Another product meeting the material characteristics above may be submitted for acceptance by the Engineer.

3. Butyl Rubber Caulk

Use a high performance Butyl Rubber Caulk or an approved equal Butyl Rubber caulk.

MnDOT Metro Bridge Maintenance has successfully used high performance Butyl Rubber White Lightning® Butyl Rubber Caulk. Another product equal to the Butyl Rubber caulk may be submitted for acceptance by the Project Engineer.

C. Application Requirements for Construction

1 - DESIGNER NOTE: Select one of the following sets of paragraphs depending on if you are developing a SP for a rehabilitation or for new construction.

For Rehabilitation Project use this set of paragraphs

Remove all deleterious materials from the joint in the split median barrier to allow the cap to be installed. Sandblast the top surface of the barrier, providing necessary containment.

Install the molded rubber seal after special surface finish on the concrete split median barrier has cured per supplier's recommendations (if applied).

Apply $^{3}/_{8}$ inch thick bead by $^{1}/_{2}$ inch wide along each longitudinal edge of molded rubber seal as shown in plans. Where sections overlap, completely coat the overlapping contact area with caulk before lapping.

Maximum spacing of anchorages is 2 feet. Fasten overlap splices to one side of split median barrier only. Provide 6 inch minimum overlap splices. At splices, place one anchor within each splice region and one 6 inches from the splice region. Anchor molded rubber seal section with two (2) anchors located 6 inches apart near end of run to median seal and at expansion joints. Locate the end of run anchors and expansion joint anchors within 12 inches of end of seal.

At expansion joints, do not anchor on both sides of expansion joint. Provide at least a 10 foot section of seal and extend an unanchored section of belting over the expansion joint plus a 6 inch lap over the next anchored section of belting.

2 - DESIGNER NOTE: For new barrier construction use this set of paragraphs.

Install the rubber cap after special surface finish II has cured per the manufacturer's instructions.

Apply $^{3}/_{8}$ inch thick bead by $^{1}/_{2}$ inch wide along each longitudinal edge of median seal as shown in plans. Where sections overlap, completely coat the overlapping contact area with caulk before lapping.

Maximum spacing of anchorages is 2 feet. Fasten overlap splices to one side of split median barrier only. Provide 6 inch minimum overlap splices. At splices, place one anchor within each splice region and one 6 inches from the splice region. Anchor molded rubber section with two (2) anchors located 6 inches apart near end of run to median seal and at expansion joints. Locate the end of run anchors and expansion joint anchors within 12 inches of end of seal.

At expansion joints, do not anchor on both sides of expansion joint. Provide at least a 10 foot section of seal and extend an unanchored section of belting over the expansion joint plus a 6 inch lap over the next anchored section of belting.

D. Method of Measurement

Measure sealing of split median barrier gap by length, in linear feet, based on the distance along the centerline of gap of median barriers, from out to out length of sealed split median barrier.

E. Basis of Payment

Payment for Item No. 2401.603, "SPLIT MEDIAN BARRIER CAP", at the Contract price per linear foot shall be compensation in full for performing all work as shown in Plans and described in this provision, inclusive.

SB2018-2402
Use for all bridge projects where 2402 is required.
CREATED 7/29/2015
REVISED 9/1/2017 (3)

SB- (2402) STEEL BRIDGE CONSTRUCTION

The provisions of 2402, "Steel Bridge Construction," are supplemented with the following:

SB2018-2402.1
Use on all steel bridge projects requiring bolts installed in the field.
Include SB2018-3391.1 with this provision.
CREATED 9/1/2017
REVISED 4/2/2018 (1)

SB- Connections

Delete the last paragraph of section 2402.3.B.2, "High Strength Fasteners," and add the following:

Before fasteners are delivered to the bridge site, provide documentation of rotational capacity (ROCAP) testing in accordance with ASTM F3125, Supplementary Requirement S4, "Rotational Capacity Testing". The fasteners must be received in packages that match the fastener assembly combination as tested. If documentation of ROCAP testing is not received; then perform this testing in the field prior to installation.

Before installation, ensure that the fastener condition has not changed due to weathering, mixture of tested assembly lots, or other reasons. In the event that changes have occurred, the Engineer will require re-qualification using ROCAP testing in the field for a minimum of three fastener assemblies of each combination to be used in permanent bolting.

Add the following after the third paragraph of section 2402.3.G.2.c(1), "Bolt Tension":

Perform Pre-Installation Verification (PIV) testing on all bolted connections requiring the use of Direct Tension Indicator (DTI) washers. DTIs will be required as indicated elsewhere in this Proposal. To enable more accurate bolt tensioning, the Contractor **may** propose precision bolting systems. A precision bolting system is defined as the use of tools that have been calibrated to produce repeatable results in conjunction with an installation plan that addresses snugging and tensioning of a connection.

Provide the Engineer with a detailed job-specific fastener installation plan at least four weeks before the start of steel erection. The plan will include PIV testing in accordance with the Research Council on Structural Connections (RCSC), "Specification for Structural Joints Using High-Strength Bolts" (http://www.boltcouncil.org). PIV testing requires the use of a properly calibrated hydraulic load cell (i.e. Skidmore-Wilhelm) in order to verify the following in the field prior to permanent bolting:

1. Ensuring the bolt crew is familiar with tightening procedures;
2. Ensuring tools and equipment are capable of performing adequately;
3. Ensuring structural bolting assemblies (including lubrication) are in suitable condition for proper bolting procedure and achieving needed results; and
4. Expanding a greater range of acceptance criteria [2402.3 G.2.d(3)] when utilized with precision bolting systems for snugging and final tightening, respectively.

For bolts that are too short to utilize a calibrated hydraulic load cell, calibrated DTIs will be used as a load cell. Once the DTIs have been calibrated, test the fastener assembly in a steel plate of similar thickness to that used in the permanent condition. Refer to the previously referenced RCSC Specification for more detail, except only one calibrated DTI needs to be used in the fastener assembly for each PIV test.

Perform PIV testing on at least three complete fastener assemblies of each combinations of diameter, length, grade, and lot to be used in the work. PIV testing must be performed no earlier than two weeks prior to permanent bolting. The fastener installation plan will be updated with the results from the PIV testing. The hydraulic load cell must have been calibrated within one year of the date of use in order to be used for PIV testing.

Add the following to section 2402.3.G.2.c, "Installation":

G.2.c(5) Quality Management for Installation

Develop a Quality Control plan that includes at a minimum the following items:

1. Materials tracking process for components of fastener assemblies (bolts, nuts, washers, etc.);
2. Procedure for tracking when permanent bolts were installed and when final tensioning occurred;
3. Record keeping of final tensioning and DTI readings;
4. Develop a snugging and tensioning sequence for each connection detail;
5. Develop a procedure that ensures the Contractor's Quality Manager Staff will verify the fastener installation plans were followed;
6. Lists the Contractor's staff that will be performing the work using the precision bolting system tools. Include details of relevant training, experience, or both for each individual; and
7. Develop a procedure Pre-Installation Verification (PIV) tests for each lot shipped to the project site prior to installation of the permanent bolt assemblies.

Additional ROCAP and PIV tests are required whenever the condition of the fasteners is in question by the Engineer or the condition changes from when the initial ROCAP or PIV tests were performed. In the event field ROCAP testing is required, follow the procedure described in Annex A2 of ASTM F3125.

Submit Quality Control plan to Engineer at least four weeks before the start of steel erection.

Add the following to the end of section 2402.3.G.2.d(3), "Inspection Procedure for Direct Tension Indicators (DTI)":

Use the following procedure for inspection when bolting operations utilize PIV testing and precision bolting systems:

1. Verify bolting operations were performed in accordance with the job-specific fastener installation plan;
2. An initial visual inspection of the DTIs after the bolts are snug tight. Remove and replace DTIs with more than half of the protrusions completely crushed during snugging operations and recalibrate snugging procedure; and
3. After final tightening, randomly select 10 percent of the DTIs, but not less than 2 DTIs, in each connection to inspect in accordance with the job-specific fastener installation plan. The appropriate feeler gauge should be refused in at least half of the spaces between DTI protrusions.

SB- Fracture Critical Steel Bridge Members

1 - DESIGNER NOTE: For Section A, Plates thicker than 1½ inch are available to a maximum length of 50 ft. See Fabrication Methods and Structural Metals Engineer.

A. General

Furnish flange plates in available mill lengths with a minimum number of splices. Location of splices is subject to the Engineer's approval, but shall be a minimum of _____ - _____ from the midpoint of the beam or girder.

2 - DESIGNER NOTE: For Section B, See Fabrication Methods and Structural Metals Engineer.

B. Definition of Fracture Critical Members

Fracture critical members are defined as __________.

SB- Expansion Joint Devices

Fabricate waterproof expansion devices in accordance with 2402, "Steel Bridge Construction," and the following:

A. Materials

1. Joint Seal

Furnish a single diaphragm unreinforced neoprene seal whose physical and chemical properties conform to ASTM D5973, "Elastomeric Strip Seals with Steel Locking Edge Rails used in Expansion Joint Sealing," except for the following:

a. Substitute Durometer requirement of 60 plus or minus 5;

b. Provide a ¼ inch thick seal, subject to a minimum thickness of $^{7}/_{32}$ inch; and

c. Submit 12 inches of seal material from each lot of material for testing, if required by the Project Engineer. Furnish certified test results from the manufacturer attesting to the physical and chemical properties of the joint seal in accordance with 1603, "Materials: Specifications, Samples, Tests, and Acceptance". Provide copies of the test results for the Project Engineer, the Materials Engineer, and the Structural Metals Engineer.

2. Steel Extrusion

Provide only one of the devices shown on the Department's "Approved/Qualified Product Lists for Bridge Products, Expansion Joint System" (http://www.dot.state.mn.us/products). Unless the seal is shop installed, the Fabricator shall install filler material in the seal groove in the steel rail to protect against entry of dirt and debris. Install filler material at the fabrication shop prior to storage or transportation of completed expansion device.

3. Lubricant Adhesive

Ensure the lubricant adhesive conforms to the requirements of ASTM D4070, "Standard Specification for Adhesive Lubricant for Installation of Preformed Elastomeric Bridge Compression Seals in Concrete Structures". Provide only one of the approved lubricant adhesives shown on the Department's "Approved/Qualified Product Lists for Bridge Products, Expansion Joint Lubricant Adhesive" (http://www.dot.state.mn.us/products).

4. Cover Plates

Ensure expansion joint cover plates on pedestrian bridges and sidewalk areas are raised pattern plate.

B. Construction Requirements

1. General

Perform the work in accordance with the applicable requirements of 1703, "Patented Devices, Materials, and Processes," 2402, "Steel Bridge Construction," 2471, "Structural Metals," the plans, and the following:

Before the start of work, the supplier will be pre-qualified on MnDOT's *Approved Suppliers for Fabricated Structural Metals Products* list as maintained by the Structural Metals Engineer at http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf, or at least 30 calendar days prior to beginning work, the supplier is to submit a Quality Manual (QM) to the Engineer for review. Ensure the QM is written in accordance with the MnDOT Supplier Qualification Standard (SQS). The Engineer will use the SQS as the basis of acceptance for the submitted QM. In addition to routine inspections, the Engineer will audit suppliers with approved QMs on a biannual or annual basis or as otherwise directed by the Engineer to ensure the implementation of the QM.

The Department will invoke its Corrective Action Process if the routine inspections or audits indicate non-conformance. Any corrective actions deemed appropriate by the Engineer, are effective immediately and apply to any work remaining on a current project and future projects. If the Engineer determines that work does not comply with the QM or that fabrication does not follow approved fabrication procedures, the Engineer will deem the materials as non-conforming in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work." If the Engineer finds non-conforming work, direct the supplier to immediately correct the procedure and submit a written non-conformance report, containing data required by the Engineer to ensure compliance with the QM, specifications, and drawings. Perform additional testing as required by the Engineer at no additional cost to the Department. For repeat offences or negligence, the Department will require corrective action of hiring a third party Quality Control Inspector, at no additional cost to the Department. A copy of the Department's Corrective Action Process may be obtained from the Engineer.

2. Field Welding

A Certified Field Welder will be permitted to weld pre-galvanized sections of expansion device steel rail at the crown breaks if the following is met:

a. Individual is qualified in accordance with AWS D1.1 using an approved weld procedure;

b. Provide roadway sections that are not less than 10 ft long;

c. Provide an anchorage within 9 inches of each end of the sections. This may require inclusion of additional anchorages;

d. Bevel abutting ends ¼ inch on 3 edges and de-burr the edges;

e. Prepare the surfaces to be welded as per 2471.3.F.2, "Preparation of Base Metal";

f. Groove weld the sections on 3 sides preventing weld metal from entering the seal groove;

g. Grind the weld smooth on the top of the extrusion; and

h. Repair the welded surface as per 3394, "Galvanized Structural Shapes," prior to encasing in concrete.

3. Seal Installation

a. Remove filler material and clean joint seal to steel contact areas of dirt, oil, grease, or other contaminants before installing the neoprene seal;

b. Lightly sandblast the contact areas so as to roughen but not damage the galvanized surface just before applying the lubricant adhesive;

c. Apply lubricant adhesive on both seal and steel contact areas when installing the seal; and

d. Install the seal only with tools recommended by the manufacturer.

C. Method of Measurement

Delete the contents of 2402.4.B.3, "Expansion Joint Devices," and substitute the following:

The Engineer will measure expansion joint devices of each type by length based on the horizontal distance between the outside edges of the deck measured along the centerline of the joint.

SB- Modular Bridge Joint System

Furnish and install a waterproof modular bridge joint system (MBJS) at the expansion joints on Bridge(s) No. _______________. Perform the work in accordance with 2402, "Steel Bridge Construction," the plans, and the following:

A. General

1 - DESIGNER NOTE: For the following paragraph, use a multiple support bar system if the number of elastomeric seals is 9 or less, or if movement ranges are 27 inches or less. Use a single support bar system for larger movements. Use a swivel joint system if large transverse and/or swivel movements are anticipated at the expansion joints.

Suspend support bars over the joint opening by sliding on bearings contained within steel support boxes attached to the edge beams and cast into the bridge deck (and abutment). A MBJS consists of preformed elastomeric expansion joint seals mechanically held in place by steel edge and center beams. Center beams are supported by solid steel support bars. MBJS can be classified as multiple or single-support bar and swivel joint systems. For Bridge(s) No. __________, provide a ((multiple) (single)-support bar) (swivel joint) system.

B. Acceptable Systems

Only manufacturers who have successfully completed fatigue and performance testing will be permitted to supply the MBJS (see below). Submit final results of required tests to the Engineer for approval prior to manufacture.

Provide only one of the devices shown on the Department's "Approved/Qualified Product Lists for Bridge Products, Modular Bridge Joint System" (http://www.dot.state.mn.us/products).

C. Pre-qualification Testing Requirements

Before a MBJS can be accepted for installation on this project, the design must be pre-qualified by the manufacturer through successful fatigue and performance testing administered by a qualified laboratory. Perform fatigue and performance testing in accordance with Section 19, Appendix A19 of the AASHTO LRFD Bridge Construction Specifications.

Perform testing on a test specimen(s) of a model similar to that required of this project. Successful testing will prequalify that model—with allowable variations—for the project and no further testing will be required.

D. Materials

Meet the following physical and chemical properties:

1. Conform structural steel for the edge beams, center beams and support bars to 3309, "High-Strength Low-Alloy Structural Steel". Conform support boxes and anchorages to either 3306, "Low-Carbon Structural Steel," or 3309, "High-Strength Low-Alloy Structural Steel". (Conform sidewalk and (railing) cover-plates to 3306, "Low-Carbon Structural Steel"). Do not use aluminum components or hardware;

2. Conform stainless steel sheet for the sliding surfaces of support bars to ASTM A240, Type 304, "Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications". Polish the surface to a Number 8 mirror finish;

3. Conform fasteners to the same requirements as those used in the prequalification tests;

4. Conform welded studs for anchorage purposes to ASTM A108, "Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished";

5. Ensure each elastomeric sealing element is a single-diaphragm unreinforced seal. Make sure the basic physical and chemical properties of the elastomer conform to the requirements of ASTM D5973, "Standard Specification for Elastomeric Strip Seals with Steel Locking Edge Rails Used in Expansion Joint Sealing";

   Provide a ¼-inch thick seal, subject to a minimum thickness of $^{7}/_{32}$-inch providing a minimum of 3 inches of movement;

6. Ensure polytetrafluoroethylene (PTFE) is unfilled 100% virgin material, woven fabric or dimpled sheet conforming to the requirements of Section 18.8 of the AASHTO LRFD Bridge Construction Specifications;

7. The same material composition and formulation, manufacturer, fabrication procedure and configuration of bearings and springs must be used as was used in the Pre-qualification tests;

8. Provide only one of the approved lubricant adhesives shown on the Department's "Approved/Qualified Product Lists for Bridge Products, Expansion Joint Lubricant Adhesive" (http://www.dot.state.mn.us/products). For lubricant adhesives not on the Department's prequalified list, provide information as required on the web site. Lubricant/adhesive shall conform to ASTM D4070, "Standard Specification for Adhesive Lubricant for Installation of Preformed Elastomeric Bridge Compression Seals in Concrete Structures"; and

9. Ensure control springs are a urethane foam product that conforms to the requirements of ASTM D3574, "Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams".

E. Design and Detailing Requirements

1. Loading and Movement

Design the MBJS in accordance with Article 14.5 of the AASHTO LRFD Bridge Design Specifications.

2 - DESIGNER NOTE: For the next two paragraphs, fill in the blanks as appropriate per project. Use second paragraph only if needed.

Design the MBJS to accommodate a minimum of ____ inches of thermal movement between the lowest anticipated ambient temperature of ____-30° F and the highest anticipated ambient temperature of + ____120° F. Mean temperature for design shall be 45° F. Do not allow physical contact of any beams at the minimum opening, and the maximum opening between beams shall be 3 inches --measured perpendicular to the edge beams--under any conditions.

To supplement the thermal movement described above, include in the MBJS provisions for an additional movement of ____ inch caused by possible shifting of substructures on unstable soil and/or deflection of piers.

2. Edge Beams

Ensure the edge beam cross-section is the same as the section used for the Seal Push Out Test for the performance testing.

Show in the plans concrete anchorages for the devices, or as modified by the manufacturer to be compatible with the devices furnished.

Design modified anchorages to resist vertical and horizontal forces from traffic, including impact. Anchor horizontal elements of the edge beams to resist the upward-acting impact (rebound) from wheel loads. If the skew is greater than 20 degrees, consider horizontal forces from impact from snowplows in the design of the anchorages.

3. Support Boxes

Make support boxes from steel plate or tubing with a minimum thickness of $^{3}/_{8}$ inch. If the support boxes are greater than 16 inches wide, increase the thickness of the top plate so that the width-to-thickness ratio does not exceed 45 unless stiffening ribs are used. For support boxes composed of nested steel tubes, the diameter or width-to-thickness ratio of each tube shall not exceed 45.

4. Bearings and Springs

Design the MBJS to allow removal and replacement of the support bearings, bearing springs, control springs and elastomeric seal elements. Give a procedure for removal and replacement of these elements on the shop drawings.

Positively lock support bar bearings into the support boxes with a non-metallic dowel or pin. The connection must permit removal and replacement of the bearing components.

Situate control springs for the equidistance control on the MBJS so that the direction of resistance will be parallel to the direction of movement and accommodate the full range of design movement without distress.

Provide for replacement of parts subject to wear in the design. Submit a written maintenance and parts replacement plan prepared by the MBJS manufacturer for the Engineer's acceptance. Include a list of parts and instructions for maintenance inspection, acceptable wear tolerances, methods for determining wear, and procedures for replacing worn parts.

5. Elastomeric Seals

Extend seals beyond the ends of the edge and center beams by at least 2 inches.

6. Field Splices in Edge and Center Beams

Fabricate and ship each MBJS to the project site as a single unit unless any or all of the following conditions apply:

a. The bridge will be constructed in stages with longitudinal construction joints.
b. The full length of a MBJS would make shipping impractical.
c. Other factors unique to the project that would require field splices.

Only field splice details that have been designed in accordance with AASHTO LRFD Bridge Design Specifications can be used for the MBJS. Locate splices away from wheel tracks and in areas of least live load stress. Edge beams may be field-welded with fillet welds covering only part of the beam profile.

Ensure center beam splices are welded connections. The span – between support beams – in which the field splices are located, cannot exceed the maximum length of 3 ft.

If the MBJS contains only a single center beam, a field weld may be used. Fillet or partial-penetration welds are not permitted.

In the design of the MBJS, take into account any different installation procedures required under conditions that require field splices. Clearly indicate such procedures on the shop drawings.

7. Lifting and Preset Opening Devices

Provide lifting devices for the MBJS. Provide other devices to maintain the preset openings at a uniform spacing not greater than 15 ft along its length. Use at least three such devices per fabricated segment.

F. Submittals

1. In accordance with 1603, "Materials: Specifications, Samples, Tests, and Acceptance," furnish Certificates of Compliance to:

   Structural Metals Engineer
   Minnesota Department of Transportation
   Bridge Office
   3485 Hadley Ave N
   Oakdale, MN 55128-3307

   Include the following information in the Certificates of Compliance:

   a. Certification that the control springs are produced by the same manufacturer with the same process and in the same configuration as those used in the OMV Test. Certification that the same lubricant adhesive used for the Seal Push Out Test was also used to assemble the MBJS. These certifications shall include the manufacturer’s name and contact information as well as production date and lot identifiers;

   b. Certification that MBJS sub-assemblies with similar center beam and support bar cross-sections and joints have passed pre-qualification testing requirements described in SB-____C (Pre-qualification Testing Requirements);

   c. Design calculations sealed by a Licensed Professional Engineer;

   d. A written maintenance and part replacement plan prepared by the MBJS manufacturer, including a list of parts and instructions for maintenance inspection, acceptable wear tolerances, methods for determining wear, and procedures for replacing worn parts;

   e. Method of installation including, but not limited to, sequence, installation gap setting for various temperatures, support during placement of the concrete, and installation at curbs;

   f. Any required changes to the blockout reinforcement in order to accommodate the MBJS; and

   g. A temporary bridging plan for any MBJS for which construction (and public) traffic is anticipated following installation.

2. Submit a 12-inch section of elastomeric seal material from each lot of material furnished, and samples of the PTFE sheet, size 2 inches x 3 inches x $^{1}/_{8}$-inch from the production material to the Engineer for testing.

3. Submit shop drawings for the MBJS in accordance with the requirements of 2471.3.B, "Shop Detail Drawings," and include, but do not limit to, the following additional items:

   a. Plans and section views of the MBJS for each movement rating and roadway width showing dimensions and tolerances;

   b. Show all welded center beam-to-support bar joints;

   c. Show all welded shop splices and all welded field splices;

   d. Complete details of all components and sections showing all material incorporated into the MBJS;

   e. All appropriate material designations (MnDOT, ASTM, AASHTO. etc.);

   f. Corrosion protection system;

   g. Lifting locations and lifting mechanisms for installation; and

   h. Opening adjustment devices for temperature variations and opening dimensions relative to temperature.

G. Fabrication Requirements

Perform the work in accordance with the applicable requirements of 1703, "Patented Devices, Materials, and Processes," 2402, "Steel Bridge Construction," 2471, "Structural Metals," the plans, and the following:

Before the start of work, the supplier will be pre-qualified on MnDOT's approved suppliers for fabricated structural metals products list as maintained by the Structural Metals Engineer at http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf, or at least 30 calendar days prior to beginning work, the supplier is to submit a Quality Manual (QM) to the Engineer for review. Ensure the QM is written in accordance with the MnDOT Supplier Qualification Standard (SQS). The Engineer will use the SQS as the basis of acceptance for the submitted QM. In addition to routine inspections, the Engineer will audit suppliers with approved QMs on a biannual or annual basis or as otherwise directed by the Engineer to ensure the implementation of the QM.

The Department will invoke its Corrective Action Process if the routine inspections or audits indicate non-conformance. Any and all corrective actions deemed appropriate by the Engineer, are effective immediately and apply to any work remaining on a current project and all future projects. If the Engineer determines that work does not comply with the QM or that fabrication does not follow approved fabrication procedures, the Engineer will deem the materials as non-conforming in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work." If the Engineer finds non-conforming work, direct the supplier to immediately correct the procedure and submit a written non-conformance report, containing data required by the Engineer to ensure compliance with the QM, specifications, and drawings. Perform additional testing as required by the Engineer at no additional cost to the Department. For repeat offences or negligence, the Department will require corrective action of hiring a third party Quality Control Inspector at no additional cost to the Department. A copy of the Department's Corrective Action Process may be obtained from the Engineer.

The same manufacturer must fabricate all MBJS components.

Galvanize all structural steel surfaces, except those made of stainless steel, after fabrication per 3394, "Galvanized Structural Shapes".

Weld stainless steel sheet at each end to the steel substrate by the tungsten-arc welding process in accordance with the current AWS specification. Clamp down the stainless steel sheet to have full contact with the substrate during welding. Do not allow welds to protrude beyond the sliding surface of the stainless steel. Intermittent fillet welds are not allowed.

Ensure tops of the edge and center beams are in the same plane with a maximum tolerance of $^1/_8$ inch difference in elevation among the tops of the center beams or edge beams.

The support box flatness at bearing and compression spring locations will not be out of flat in excess of $^1/_{32}$ inch.

Ultrasonically inspect the full-penetration weld that connects the center beam to the support bar in accordance with 2471, "Structural Metals," and AWS D1.1. Test twenty-five percent of the center beam-to-support bar welds, or as directed otherwise by the Engineer. If ultrasonic inspection reveals at least one rejectable weld defect, the fabricator shall then ultrasonically inspect another 25% of the center beam-to-support bar welds (25% of the original total of welds.) If rejectable defects are found in the second 25% set of welds (50% of total), all remaining non-inspected welds shall then be inspected. Repair each weld that is rejected by ultrasonic inspection using a welding procedure approved by the Engineer. Retest the repaired welds by ultrasonic inspection in accordance with the original requirements.

All CJP welds will be tested to cyclically loaded criteria.

The fabricator will be permitted to shop-weld pre-galvanized sections of the edge and center beams if the following requirements are met:

1. Provide roadway sections that are not less than 10 ft long;

2. Bevel abutting ends ¼-inch and deburr the edges;

3. Prepare the surfaces to be welded as per 2471.3.F.2, "Preparation of Base Metal";

4. Groove-weld sections with care taken to prevent weld metal from entering the seal groove. Completely remove all galvanizing from the weld area. Grind smooth the weld across the top of the beams. Repair all areas of galvanizing damaged by welding operations in accordance with 2471.3.L.1, "Galvanizing"; and

5. Attach anchorages and support boxes to the edge beam section prior to galvanizing. Provide an anchorage within 9 inches of each end of each pre-galvanized section.

(If field splices will be used, stagger the ends of the edge and center beams so that they are not at the same point on each beam.)

Assemble each MBJS at the fabrication shop. Install all elastomeric seals at the shop. Use continuous seals for the full length of each MBJS. Apply lubricant adhesive to all elastomer-to-steel contact areas for seal installation.

3 - DESIGNER NOTE: For the next paragraph, use when staged construction with a longitudinal joint is required.

(Fabricate each MBJS for shipment in separate sections sized in accordance with the slab construction joints required for the construction stages as shown in the plans. Stagger ends of the edge and center beams so that construction joints are not at the same point on each beam. Installation of seal elements is not required during fabrication since they must be continuous without splices for the full length of the device.)

H. Construction Requirements

To aid in assuring proper installation of the MBJS, the manufacturer shall furnish technical assistance to the Contractor and Engineer through a technical representative who is a full-time employee of the manufacturer. The representative shall be accessible to the Engineer and at the site during the work that involves the setting of all parts of each device. Inform the representative of the date of installation.

Immediately prior to installation, the Engineer will inspect the MBJS and the blockout for:

1. Proper alignment;

2. Complete bond between the seals and the edge/center beams; and

3. Placement and effectiveness of the anchorage devices. Correct any bends, kinks, disconnected seals, and other deficiencies, per the judgment of the Engineer, before installation at no expense to the owner. Perform an audio hammer test on the welded stud anchors. Replace studs that do not emit a ringing sound when struck lightly with a hammer as ordered by the Engineer.

Maintain the clearance shown in the plans and/or shop drawings between the bottoms of the support boxes and the tops of the beams.

Reposition reinforcement bars that are cast into the deck and abutment, if possible, in lieu of cutting to provide a minimum of 2 inches of clearance to the support boxes, anchorage devices and edge beams. Also, maintain a minimum of 2 inches of clearance for reinforcement bars placed during installation of the MBJS. Alter bar spacing shown in the plans to clear the MBJS.

If welded field splices are used for the edge and center beams, prevent weld metal from entering the seal retainer grooves.

Install each MBJS at the joint opening given on the shop drawings for a specific ambient temperature, or as adjusted by the manufacturer's installation technician for the temperature at time of installation. Ensure tops of the edge and center beams are in the same plane with a maximum tolerance of $^{1}/_{8}$ inch difference in elevation among the tops of the center beams or edge beams. Measure this variation vertically from a straight line connecting the top of the deck profile on each side of the MBJS. Ensure there is no more than $^{1}/_{2}$ inch longitudinal difference among gap widths at either end of a seal or among multiple gaps.

Ensure formwork for the blockout concrete prevents entry of concrete into the support boxes, and do not allow concrete to impede free movement of the MBJS.

Fully support the MBJS during placement of the concrete in the blackout. Grout pads under the support boxes are not recommended, but if used, shall terminate beyond the sides of the support boxes.

Do not pour concrete until the MBJS installation and joint opening(s)--at the time of the pour--has (have) been inspected and approved by the Engineer.

If there is a vertical grade on the bridge, place concrete on the down-grade side of the block out first. Thoroughly vibrate the concrete so as to adequately consolidate the concrete underneath the support boxes and against the backside of the edge beams.

Construction loads will not be allowed on the MBJS for at least 72 hours after installation, including concreting, is complete. If necessary to cross the joint during that 72-hour period, bridge over the MBJS in a manner approved by the Engineer.

Ensure the complete MBJS installation is watertight at all points and test it by filling the joint opening or portions thereof, as designated by the Engineer, with water and observe the results over a period of not less than one hour.

I. Method of Measurement

Measure each MBJS by length in linear feet based on the out-to-out installed length of the device.

J. Basis of Payment

Payment for Item No. 2402.603 "MODULAR BRIDGE JOINT SYSTEM TYPE ______" will be made at the Contract unit price per linear foot and shall be compensation in full for all costs of furnishing and installing the MBJS complete inplace as described above, including all incidentals thereto.

This is the standard for Duplex Coating Rails.
Use with metal railings that will be "Duplex Coated" with hot-dipped galvanizing and POWDER COATING (not Mpls rail), except chain link fence railings.
CREATED 12/10/2014
REVISED 7/25/2019 (8)

SB- Metal Railing ("Duplex Coated" using Hot-dipped Galvanizing and Powder Coating)

Furnish, coat, and install metal railing, including all anchorages and fittings, in accordance with the applicable provisions of 2402, "Steel Bridge Construction," 2433, "Structure Renovation," 2471, "Structural Metals," 3321, the plans and the following. The Contractor and the sub-contractors are responsible for communicating all applicable specifications, special provisions, standards, and requirements to all subcontractors.

A. Engineer

Engineer, as used herein, when relating to shop fabrication and coatings, shall mean the Department's Bridge Engineer.

B. Materials

Ensure all materials conform to the plan details. If not specified, ensure all steel complies with 3306, "Low-Carbon Structural Steel," except pipe and pipe sleeves, which complies with 3362, "Structural Steel Pipe". Ensure threaded rods, bolts, nuts, and washers meet 3391, "Fasteners," and galvanize in accordance with 3392, "Galvanized Hardware," or electroplate in accordance with ASTM B633, Type III, SC 4.

1 - DESIGNER NOTE: Fill in the yellow blank with the SB- number for 2402.8 SP.

C. Anchorage Requirements See SB-__________

D. Fabrication and Inspection Requirements

Fabricator shall supply QA/QC documentation verifying that all fabricated railing components are within the necessary tolerances for proper fit up and installation of the railing, including measurements between railing base plates that indicate that the as fabricated base plate hole locations are within $^{1}/_{8}$ inch of the specified plan dimensions, based on the plan specified rail post spacing.

Fabricate all metal railing in accordance with 2471, "Structural Metals," the plan, and the welding code AWS D1.1-Structural Welding Code-Steel. Submit Welding Procedure Specifications (WPSs) to the Engineer for approval prior to the start of fabrication.

Prior to fabrication, submit a Quality Manual (QM) and fabrication drawings that are acceptable to the Engineer. Any work started prior to receiving approved drawings WPSs, and a QCP, is subject to 1512, "Unacceptable and Unauthorized Work". Also give the Engineer at least 5 working days' notice prior to beginning work so that Quality Assurance (QA) inspection may be provided.

2 - DESIGNER NOTE: Only use next paragraph for complex railings with multiple unique pieces. Questions regarding this use may be directed to the Structural Metals Unit.

The fabricator shall tag/piece mark all metal railing prior to final storage, and include the following identification markings, as a minimum: individual piece marks, bridge and/or project number(s), fabricator and applicator job numbers. All markings shall not be visible to the public when the railing is in its installed position. Include the method of identification in the fabricators QCP.

The Department QA shop inspections are not intended to supplement or replace the Fabricator's Quality Control (QC). The Contractor is ultimately responsible for the correction of errors and faulty workmanship or for the replacement of nonconforming materials.

The Fabricator will visually inspect all parts of the fabrication and have the inspections documented by QC personnel. The Fabricator will ensure that the rail meets a straightness tolerance of $^{1}/_{8}$ inch in 10 ft. The Fabricator will perform and document any Nondestructive Testing required by the Contract Documents using an ASNT-TC-1A Level II qualified inspector.

Document parts found to be in nonconformance by using a Nonconformance Report form (NCR), an describe in detail the fabrication error and the proposed repair procedure(s) in accordance with the QCP. Repair(s) performed are subject to the written approval of the Engineer.

E. Galvanizing Requirements performed by the Galvanizing Applicator

Galvanize all railing material in accordance with 3394, "Galvanized Structural Shapes," after fabrication and then powder coat (Duplex Coat) using the methods described in this document.

<u>Pre-Galvanized Procedure(s)</u>:

1. Calibrate dry film thickness gages in accordance with SSPC-PA 2-Measurement of Dry Coating Thickness with Magnetic Gauges.

2. Prepare all fabricated material surfaces by abrasive blast cleaning to a minimum of SSPC-SP 6/NACE No. 3-Commercial Blast Cleaning prior to galvanizing.

3. Purchase Order(s) shall identify which specific items are to be duplex coated and which materials to be galvanized are reactive (e.g. 3309, "High-Strength Low-Alloy Structural Steel," etc.).

<u>Galvanizing Procedure(s)</u>:

Galvanize per 3394, "Galvanized Structural Shapes," and this specification. All products supplied using this specification have higher aesthetic expectations than standard galvanized products. Produce the final product to comply with its intended use as an "architectural" railing with heightened aesthetics and/or visual qualities.

1. Process all metal railing to be galvanized utilizing a "dry" kettle. Preflux the metal railing prior to the galvanizing bath using an aqueous tank of zinc chloride/ammonium chloride. Do not use a "top flux" blanket on the molten zinc bath.

2. Air cool the metal railing to ambient temperature before handling for shipment and/or storage. Do not quench the metal railing or apply any post-galvanizing treatments.

3. Lumps, projections, globules, high spots, drip lines, heavy deposits, black and bare areas, blisters, flux deposits, thin spots, dross inclusions, etc., are considered unacceptable. Repair unacceptable zinc coatings in accordance with the Galvanizer’s approved QCP and powder coating applicator approved method. Zinc, which will interfere with the "intended use of the product", will not be permitted.

4. Repair galvanized material that does not meet the requirements of this specification, ASTM D7803, and/or 3394, "Galvanized Structural Shapes," in accordance with the Galvanizer’s QCP.

5. Store galvanized metal railing in a manner that will prevent the formation of "white-rust" or wet storage staining. "White rust" or staining of the galvanize coating is not acceptable.

6. The Galvanizer shall provide the Engineer with all galvanizing process-related Quality Control documents which demonstrate compliance to this specification and referenced specifications prior to shipment of the galvanized product.

7. The Galvanizer will ensure the metal railings meet a straightness tolerance of $^{1}/_{8}$ inch in 10 ft prior to any subsequent coating applications.

8. It is the Galvanizer's responsibility to provide the Engineer with advanced notification of at least 5 working days of intent to galvanize so that the Engineer can perform a QA audit.

3 - DESIGNER NOTE: Fill in the yellow blank with the SB- number for 2477 SP.

F. Powder Coating Requirements See SB-__________

G. Construction Requirements

SPECIAL ALERT: All hardware, fasteners, anchorage nut, washer, and threaded rod stick out, used to install metal railings in the field will no longer be required to be field coated after installation per 2478.3.H, "Fasteners" or 2479.3.H, "Fasteners". Install and do not apply intermediate and finish coat.

4 - DESIGNER NOTE: Only use the following two paragraphs when a drilled-in anchorage alternate is NOT permitted by the contract (when metal railing(s) are intended to resist crash loads).

Provide the Engineer with a QA/QC plan that will be used to ensure that the cast-in-place anchorages are installed in the correct location using templates or other means ensuring that the exposed threads of the anchorages will not be damaged or contaminated and that the anchorages will not be displaced or allowed to move during concrete placement.

If cast-in-place anchorages have been installed in the forms, but prior to placing the barrier concrete, the Contractor shall provide written documentation verifying that all of the anchorages are within the necessary tolerances to place the tubular railing without modifying the railing base plate configuration.

Adjust the steel posts to obtain the grade and alignment as shown in the plans using the following method:

Shim the steel posts with galvanized steel shims or washers to the proper grade and alignment, not to exceed $^{1}/_{4}$ inch of shim height. Before attaching the nuts, **coat the entire surface between the base plate and concrete rail with an approved "Silicone Joint Sealant," as found on the Department's Approved Products website**. Tighten the anchor rod nuts (as per section "C"-Anchorages) and neatly smooth the caulk around the perimeter of the railpost base plate.

Ground all metal railings. Install all electrical grounding in accordance with the applicable provisions of 2557, "Fencing," and the National Electrical Code. Clamp or braze the ground wires to the grounding device, then practicably route and attach to the nearest rail by clamping, brazing, or any other approved means that will provide a permanent positive connection. If rail has non-continuous sections, use a #6 AWG solid copper wire to connect adjacent railing panels.

If the bridge does not include exposed electrical equipment, then ground the rails at points directly below or adjacent to the railing at all abutment corners. Ensure the grounding system consists of a #6 AWG solid copper wire connected to the railing which in turn is connected to a copper coated steel rod having a nominal diameter of $^{5}/_{8}$ inch or more and a minimum length of 8 ft installed to an elevation approximately flush with the ground surface.

If the bridge includes exposed electrical equipment, such as roadway lighting, traffic signals, variable message signs, surveillance cameras, or ramp metering, then bond the railing grounding system to the exposed electrical equipment grounding system. Refer to the electrical plans and electrical special provisions for details regarding bonding multiple electrical grounding systems.

5 - DESIGNER NOTE: Method of Measurement & Basis of Payment are both covered in the Spec. Book 2402.

6 - DESIGNER NOTE: For the following two sections, ONLY use when you are not able to use an Item No. from MnDOT 2402, 500 series.

H. Method of Measurement

Unless otherwise shown on the plans, the Engineer will measure the length based on the sum of the lengths of the various sections as shown on the plans and as measured at the base of the rail.

I. Basis of Payment

Payment for Item No. 2402.603 "__________________" will be made at the contract price per foot and shall be compensation in full for all costs of fabrication, surface preparation, galvanizing, coating, delivery, and installation, as described above.

*This is **NOT** the standard for Duplex Coated Rails, use only when recommended by the RBCE.*
Use with metal railings that will be "Duplex Coated" with hot-dipped galvanized and wet-paint, except chain link fence railings.
CREATED 3/18/2016
REVISED 7/24/2019 (5)

SB- Metal Railing ("Duplex Coated" using Hot-dipped Galvanizing and Paint Coating)

Furnish, coat, and install metal railing, including all anchorages and fittings, in accordance with the applicable provisions of 2402, "Steel Bridge Construction," 2433, "Structure Renovation," 2471, "Structural Metals," 2478, "Organic Zinc-Rich Paint System," ASTM D6386," the plans and the following. The Contractor and the sub-contractors are responsible for communicating all applicable specifications, special provisions, standards, and requirements to all subcontractors.

A. Engineer

Engineer, as used herein, when relating to shop fabrication and coatings, shall mean the Department's Bridge Engineer.

B. Materials

Ensure all materials conform to the plan details. If not specified, ensure all steel complies with 3306, "Low-Carbon Structural Steel," except pipe and pipe sleeves, which complies with 3362, "Structural Steel Pipe". Ensure nuts and washers meet 3391, "Fasteners," and galvanize in accordance with 3392, "Galvanized Hardware," or electroplate in accordance with ASTM B633, Type III, SC 4.

1 - DESIGNER NOTE: Fill in the yellow blank with the SB- number for 2402.8 SP.

C. Anchorage Requirements See SB-__________

D. Fabrication and Inspection Requirements

Fabricator shall supply QA/QC documentation verifying that all fabricated railing components are within the necessary tolerances for proper fit up and installation of the railing, including measurements between railing base plates that indicate that the as fabricated base plate hole locations are within $^1/_8$ inch of the specified plan dimensions, based on the plan specified rail post spacing.

Fabricate all metal railing in accordance with 2471, "Structural Metals," the plan, and the welding code AWS D1.1-Structural Welding Code-Steel. Submit Welding Procedure Specifications (WPSs) to the Engineer for approval prior to the start of fabrication.

Prior to fabrication, submit a Quality Manual (QM) and fabrication drawings that are acceptable to the Engineer. Any work started prior to receiving approved drawings, WPSs, and a QM, is subject to 1512, "Unacceptable and Unauthorized Work". Give the Engineer at least 5 working days' notice prior to beginning work so that Quality Assurance (QA) inspection may be provided.

Mark all metal railing components during fabrication with individual piece marks. Identify the marking and its location on the Shop Drawings. Identify the proper location on the bridge for all piece marks on an Erection Drawings [with Shop Drawing submittal]. All markings should not be readily visible to the public when the railing is in the installed position. Ensure all piece marks are durable markings which will be readily visible after galvanizing [e.g. welded numbers/letters with 1-1½ inch height]. Ensure markings represent good workmanship as to not degrade the aesthetics of the product. For standard post/rail designs, mark post pieces near the bottom of the post [near the base plate] on the exterior post side and mark railing panels on the bottom side of the bottom rail. For special rail designs, mark railing panels and posts in locations which are underneath or toward the exterior of the bridge in locations which minimize their view. Identify/tag bundled pieces, prior to shipping/storage, with the following identification information: individual piece marks included in bundle, bridge and/or project number(s), fabricator name.

The Department QA shop inspections are not intended to supplement or replace the Fabricator's Quality Control (QC). The Contractor is ultimately responsible for the correction of errors and faulty workmanship or for the replacement of nonconforming materials.

The Fabricator will visually inspect all parts of the fabrication and have the inspections documented by QC personnel. The Fabricator will ensure that the rail meets a straightness tolerance of $^{1}/_{8}$ inch in 10 ft. The Fabricator will perform and document any Nondestructive Testing required by the Contract Documents using an ASNT-TC-1A Level II qualified inspector.

Document parts found to be in nonconformance by using a Nonconformance Report form (NCR), and describe in detail the fabrication error and the proposed repair procedure(s) in accordance with the QM. Repair(s) performed are subject to the written approval of the Engineer.

2 - DESIGNER NOTE: For the following section "E", delete if galvanized coating is not recommended by the Structural Metals and Bridge Inspection Engineer (e.g. Minneapolis rail). If you are not using "E" you will need to renumber your sections as you proceed.

E. Galvanizing Requirements performed by the Galvanizing Applicator

Galvanize all railing material in accordance with 3394, "Galvanized Structural Shapes," after fabrication and then paint (Duplex Coat) using the methods described in this document.

Pre-Galvanized Procedure(s):

1. Calibrate dry film thickness gauges in accordance with SSPC-PA 2-Measurement of Dry Coating Thickness with Magnetic Gauges.

2. Prepare all fabricated material surfaces by abrasive blast cleaning to a minimum of SSPC-SP 6/NACE No. 3-Commercial Blast Cleaning prior to galvanizing.

3. Purchase Order(s) shall identify which specific items are to be duplex coated and which materials to be galvanized are reactive (e.g. 3309, "High-Strength Low-Alloy Structural Steel," etc.).

Galvanizing Procedure(s):

Galvanize per 3394, "Galvanized Structural Shapes," ASTM D6386, and this specification. All products supplied using this specification have higher aesthetic expectations than standard galvanized products. Produce the final product to comply with its intended use as an "architectural" railing with heightened aesthetics and/or visual qualities.

1. Process all metal railing to be galvanized utilizing a "dry" kettle. Preflux the metal railing prior to the galvanizing bath using an aqueous tank of zinc chloride/ammonium chloride. Do not use a "top flux" blanket on the molten zinc bath.

2. Air cool the metal railing to ambient temperature before handling for shipment and/or storage. Do not quench the metal railing or apply any post-galvanizing treatments.

3. Lumps, projections, globules, high spots, drip lines, heavy deposits, blisters, black and bare areas, blisters, flux deposits, thin spots, dross inclusions, etc., are considered unacceptable. Repair unacceptable zinc coatings in accordance with the Galvanizer's approved QM. Zinc, which will interfere with the "intended use of the product", will not be permitted.

4. Repair galvanized material that does not meet the requirements of this specification, ASTM D6386, and/or 3394, "Galvanized Structural Shapes," in accordance with the Galvanizer's QM.

5. Store galvanized metal railing in a manner that will prevent the formation of "white-rust" or wet storage staining. "White rust" or staining of the galvanize coating is not acceptable.

6. The Galvanizer shall provide the Engineer with all galvanizing process-related Quality Control documents which demonstrate compliance to this specification and referenced specifications prior to shipment of the galvanized product.

7. The Galvanizer will ensure the metal railings meet a straightness tolerance of $^1/_8$ inch in 10 ft prior to any subsequent coating applications.

8. It is the Galvanizer's responsibility to provide the Engineer with advanced notification of at least 5 working days of intent to galvanize so that the Engineer can perform a QA audit.

F. Coating Requirements performed by the Paint Coating Applicator

This portion of the specification documents specific criteria that paint coated components must conform to in order to meet the quality and intent of the finished product.

Apply the paint intermediate and top coats using the applicable provisions of 2478, "Organic Zinc-Rich Paint System." Do not use the primer coat on galvanized surfaces unless approved in the QM repair procedure.

1. Perform preparation of galvanized surfaces prior to application of paint in accordance with SSPC SP16 "Brush-off Blast Cleaning of Non-Ferrous Metals," and ASTM D6386, "Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting."

   Inspect brush-off blasted surfaces for fins or tears, or any surface that shows that the galvanized coating has been damaged. Repair damaged areas using approved procedures in accordance with the applicator's QM. Repair surface of insufficient galvanize coating Dry Film Thickness (DFT) readings using the approved painting applicator's QM repair procedure.

   The QAI or Engineer will inspect the surface preparation as it is done, after its completion, or review the QM documentation, or any combination of the three. Notify the QAI or the Engineer at least 5 working days before beginning surface preparation.

3 - DESIGNER NOTE: For the following paragraph, insert color(s) as recommended by the MnDOT Bridge Office Architectural Specialist [(651) 366-4465].

Match the color of the finish coat to Federal Standard 595 C No. (fill in coating color here), with a semi-gloss finish.

1. Coat all sweep blasted galvanized railing with the subsequent coat(s) within the time frame defined in ASTM D6386, Sect. 5.4.1, or within the same 8-hour shift, maintaining manufacturer defined control and environmental conditions. The painting applicator's QC personnel shall document that all parameters were followed.

2. Apply all coating material in accordance with the contract documents and the manufacturer's Product Data Sheet (PDS) and application guides for the material and system specified.

3. Ensure coating material(s) meet the requirements of 3520, "Zinc-Rich Paint Systems" and that the color of the intermediate coat presents a distinct contrast from other applied coatings.

4. Accomplish QC inspections of coated products with an observer with normal color vision in a "well lighted" area during each coating phase and prior to final acceptance.

   Well-lighted: A minimum of 50-foot candles (fc), with 200-foot candles recommended. Use a light meter capable of reading in fc to verify the adequacy of the lighting and ensure a record is kept.

   Handling and Shipping by the Paint Coating Applicator of Duplex Coated Metal Railing:

DO NOT move or handle the coated metal railing until the coating dries as defined in the Product Data Sheet of the manufacturer of the paint coating. The paint Applicator will document the environmental conditions related to the time it takes to define cure, in the QC form. Protect completed metal railing during handling and shipping to eliminate damage to the coating.

Any damaged coated surfaces, identified through either Quality Control or Quality Assurance inspections as being unacceptable, either after the application of the paint coating or during handling of the coated components, is subject to the provisions of 1512, "Unacceptable and Unauthorized Work". Also refer to section H.

Storage of Coated Metal Railings:

Store all completed coated metal railing in accordance with 1606, "Storage of Materials," and the following:

Provide the Engineer with advance notification of at least 5 working days of intent to ship, so that the Engineer can perform a QA audit prior to shipping.

G. Construction Requirements

SPECIAL ALERT: All hardware, fasteners, anchorage nut, washer, and threaded rod stick out, used to install metal railings in the field will no longer be required to be field coated after installation per 2478.3.H, "Fasteners" or 2479.3.H, "Fasteners". Install and do not apply intermediate and finish coat.

4 - DESIGNER NOTE: Only use the following two paragraphs when a drilled-in anchorage alternate is NOT permitted by the contract (when metal railing(s) are intended to resist crash loads).

Provide the Engineer with a QA/QC plan that will be used to ensure that the cast-in-place anchorages are installed in the correct location using templates or other means ensuring that the exposed threads of the anchorages will not be damaged or contaminated and that the anchorages will not be displaced or allowed to move during concrete placement.

If cast-in-place anchorages have been installed in the forms, but prior to placing the barrier concrete, the Contractor shall provide written documentation verifying that all of the anchorages are within the necessary tolerances to place the tubular railing without modifying the railing base plate configuration.

Adjust the steel posts to obtain the grade and alignment as shown in the plans using the following method:

Shim the steel posts with galvanized steel shims or washers to the proper grade and alignment, not to exceed $^1/_4$ inch of shim height. Before attaching the nuts, **coat the entire surface between the base plate and concrete rail with an approved "Silicone Joint Sealant," as found on the Department's Approved Products website**. Tighten the anchor rod nuts (as per section "C"-Anchorages) and neatly smooth the caulk around the perimeter of the railpost base plate.

Ground all metal railings. Install all electrical grounding in accordance with the applicable provisions of 2557, "Fencing," and the National Electrical Code. Clamp or braze the ground wires to the grounding device, then practicably route and attach to the nearest rail by clamping, brazing, or any other approved means that will provide a permanent positive connection. If rail has non-continuous sections, use a #6 AWG solid copper wire to connect adjacent railing panels.

If the bridge does not include exposed electrical equipment, then ground the rails at points directly below or adjacent to the railing at all abutment corners. Ensure the grounding system consists of a #6 AWG solid copper wire connected to the railing which in turn is connected to a copper coated steel rod having a nominal diameter of $^5/_8$ inch or more and a minimum length of 8 ft installed to an elevation approximately flush with the ground surface.

If the bridge includes exposed electrical equipment, such as roadway lighting, traffic signals, variable message signs, surveillance cameras, or ramp metering, then bond the railing grounding system to the exposed electrical equipment grounding system. Refer to the electrical plans and electrical special provisions for details regarding bonding multiple electrical grounding systems.

H. Coating Repairs

H.1 Shop (prior to receiving at job site)

Any damaged coated surfaces, identified by the Engineer as being unacceptable is subject to the provisions of 1512, "Unacceptable and Unauthorized Work", and will be replaced or repaired. Submit a Non-conformance repair plan to the Engineer for acceptance. Once accepted in writing by the Engineer, perform repairs using the accepted methods and procedures authorized by the Engineer.

Coating damage is classified in two extent types:

Type 1 – damage is any type of abrasion that caused a surface imperfection not exposing the galvanized surface or exposes an area of galvanized surface that is smaller than 1 square inch in size. This damage may be repaired in the shop using an accepted Non-conformance repair plan as stated above (i.e. abrade the damaged area and apply an intermediate and finish coat per 2478, "Organic Zinc-Rich Paint System." (**Note: Alkyd Enamels will not be allowed as a repair. Aerosol spray paint is not an acceptable repair procedure.)**

Type 2 – damage is any type of surface imperfection that exposes the galvanized surface larger than 1 square inch and/or exposed base metal in an area larger than $^1/_2$ square inch. Repair this damage in the shop using an accepted Non-conformance repair plan.

H.2 Field (once received at the job site)

Any damaged coated surfaces, identified by the Project Engineer as being unacceptable is subject to the provisions of 1512, "Unacceptable and Unauthorized Work", and will be replaced or repaired. Submit a Non-conformance repair plan to the Project Engineer for acceptance. Once accepted in writing by the Project Engineer, perform repairs using the accepted methods and procedures authorized by the Project Engineer.

Coating damage is classified in two extent types:

Type 1 – damage is any type of abrasion that caused a surface imperfection not exposing the galvanized surface or exposes an area of galvanized surface that is less than 1 square inch in size. This damage may be repaired in the field or the shop using an accepted Non-conformance repair plan as stated above (i.e. abrade the damaged area and apply an intermediate and finish coat per 2478, "Organic Zinc-Rich Paint System." (**Note: Alkyd Enamels will not be allowed as a repair. Aerosol spray paint is not an acceptable repair procedure.)**

Type 2 – damage is any type of surface imperfection that exposes the galvanized surface larger than 1 square inch and/or exposed base metal in an area larger than $^{1}/_{2}$ square inch. Remove sections of damaged rail from the site and repair in the Paint Applicator's application facility. (Repair the damaged area utilizing an accepted NCR.)

5 - DESIGNER NOTE: For the following two sections, ONLY use when you are not able to use an Item No. from MnDOT 2402, 500 series.

I. Method of Measurement

Unless otherwise shown on the plans, the measurement will be the length based on the sum of the lengths of the various sections as shown on the plans and as measured at the base of the rail.

J. Basis of Payment

Duplex Coating

Payment for Item No. 2402.603 "____________________" will be made at the contract price per foot and shall be compensation in full for all costs of fabrication, surface preparation, galvanizing, brush blasting of galvanized surface, painting, delivery, and installation, as described above.

6 - DESIGNER NOTE: For the following paragraph, Delete if galvanized coating is NOT recommended by the RBCE or the Structural Metals Engineer.

Three Coat Paint System

Payment for Item No. 2402.603 "____________________" will be made at the contract price per foot and shall be compensation in full for all costs of fabrication, surface preparation, coating, delivery, and installation, as described above.

SB2018-2402.7
Use for Bridge High-Load Multi-rotational Bearings.
CREATED 3/24/1994
REVISED 10/16/2017 (6)

SB- High-Load Multi-Rotational Bearings

A. Description of Work

Furnish High-Load Multi-Rotational Bearings (HLMR) at ________________. All bearing assemblies on a particular bridge shall be of one style. Provide either Pot or Disc type bearings. Pot bearings in combination with disc bearings are not allowed.

Ensure all materials used in the manufacture of pot and disc bearings are new and unused, with no reclaimed material incorporated into the finished product.

Perform the work in accordance with the applicable requirements of 1703, "Patented Devices, Materials, and Processes," 2402, "Steel Bridge Construction," 2471, "Structural Metals," the plans, and the following:

B. General

Before the start of work, the supplier will be pre-qualified on MnDOT’s approved suppliers for fabricated structural metals products list as maintained by the Structural Metals Engineer at http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf, or at least 30 calendar days prior to beginning work, the supplier is to submit a Quality Manual (QM) to the Engineer for review. Ensure the QM is written in accordance with the MnDOT Supplier Qualification Standard (SQS). The Engineer will use the SQS as the basis of acceptance for the submitted QM. In addition to routine inspections, the Engineer will audit suppliers with approved QMs on a biannual or annual basis or as otherwise directed by the Engineer to ensure the implementation of the QM.

The Department will invoke its Corrective Action Process if the routine inspections or audits indicate non-conformance. Any and all corrective actions deemed appropriate by the Engineer, are effective immediately and apply to any work remaining on a current project and all future projects. If the Engineer determines that work does not comply with the QM or that fabrication does not follow approved fabrication procedures, the Engineer will deem the materials as non-conforming in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work." If the Engineer finds non-conforming work, direct the supplier to immediately correct the procedure and submit a written non-conformance report, containing data required by the Engineer to ensure compliance with the QM, specifications, and drawings. Perform additional testing as required by the Engineer at no additional cost to the Department. For repeat offences or negligence, the Department will require corrective action of hiring a third party Quality Control Inspector at no additional cost to the Department. The Contractor may obtain a copy of the Department’s Corrective Action Process from the Engineer.

1. Bearing Types

Three types of bearings are specified in the plans; fixed, guided, and non-guided bearings, all of varying load capacities. The bearings are defined as follows:

a. Fixed bearings allow rotation in the vertical plane, but no longitudinal or transverse movement in the horizontal plane.

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b. Guided bearings allow rotation in the vertical plane and movement in a horizontal plane in the (longitudinal) (transverse) direction of the bridge. Horizontal movement in a direction (transverse) (longitudinal) to the bridge shall be restricted.

c. Non-guided bearings allow rotation in the vertical plane and horizontal movements in all directions.

2. Shop Drawings

Include the following, but not be limited to, in the shop drawings:

a. Complete details of components and sections showing all materials used in the bearing assemblies;

b. A listing of applicable MnDOT, ASTM and AASHTO specifications;

c. Load capacity for each bearing assembly;

d. Name and address of the manufacturer, and location of the fabrication plant;

e. Name and telephone number of the manufacturer's representative who will be responsible for coordination of production, inspection, sampling and testing;

f. Clear and descriptive welding procedures used by the bearing assembly manufacture; and

g. Table of longitudinal offsets for installation at varying temperatures. Use 45° F as the mean temperature for zero-inch offset.

Supplemental to the shop drawings, furnish design calculations which indicate that the bearings furnished by the manufacturer are adequate for the requirements of the Contract. Include calculations that include rotation and horizontal movement capacity, and compression stresses on all elastomeric and sliding surfaces.

Furnish an erection plan to the Engineer at or before the time of delivery showing the location and orientation of each of the bearings.

3. Bearing Dimension Options

Overall heights of the bearing assemblies, including the sole plates, are given in the plans. The bearing manufacturer shall determine the thickness of the masonry and sole plates through design of the bearing assemblies and set the final height – Dimension "H" – of each of the assemblies.

Horizontal dimensions given for the masonry plates may be changed by the manufacturer in accordance with design. Anchor rod offsets from the CL Pier/CL Bearing shall remain as shown in the plans to avoid causing interference of the anchor rods with the main reinforcement in the bearing seats.

If the final height of the bearing assemblies is different from that given in the plans, the manufacturer shall clearly indicate the revised Dimension "H" and provide new bearing seat elevations to the Engineer.

4. Design and Fabrication Requirements

Design the bearings so that the pot cylinder and piston assembly of pot bearings, and the disc and both mating surfaces of disc bearings, can be removed for replacement or repair.

Provide for all vertical and lateral loads, movements from temperature changes, rotation, camber changes, and the effects of creep/shrinkage of post-tensioned concrete box girders. Service and strength limit state design loads and movement values are given in the plans.

Ensure all materials used in the manufacture of pot and disc bearings are new and unused, with no reclaimed material incorporated into the finished product.

Size stainless steel sliding surfaces to completely cover the PTFE surfaces in all operating positions plus one additional inch in all directions of movement—as given in the plans—except transversely in guided bearings.

Do not start fabrication of the bearing assemblies until the shop drawings have been approved by the Engineer.

C. Pot Bearings

Ensure pot bearings consist of a confined elastomeric element encased in steel, the function of which is to transfer loads and accommodate relative movement, including rotation, between the bridge superstructure and the piers and abutments. All material shown in the plans for a single pot bearing unit shall make up an assembly.

Ensure pot bearings are produced by a firm specializing in the design and manufacture of pot bearings, with a minimum of eight years of successful bearing installations.

Design, fabricate and test in accordance with the requirements of *AASHTO LRFD Bridge Design Specifications, Article 14.7.4 Pot Bearings* and the *AASHTO LRFD Bridge Construction Specifications, Article 18.3, Pot and Disc Bearings*.

Ensure brass sealing rings are rectangular cross-section conforming to Article 14.7.4.5.2 with no less than three rings per bearing assembly.

Provide the Engineer with written notification of bearing testing at least 30 calendar days prior to the start of testing operations.

D. Disc Bearings

Ensure disc bearings consist of an elastomeric structural rotational element (disc) confined by upper and lower steel bearing plates plus masonry and sole plates. The function of the bearings is to transfer loads and accommodate relative movement, including rotation, between the bridge superstructure and the piers.

Ensure disc bearings are produced by a firm specializing in the design and manufacture of disc bearings, with a minimum of eight years of successful bearing installations.

Design, fabricate and test in accordance with the requirements of the *AASHTO LRFD Bridge Design Specifications, Article 14.7.8, Disc Bearings* and the *AASHTO LRFD Bridge Construction Specifications, Article 18.3, Pot and Disc Bearings*.

Provide the Engineer with written notification of bearing testing at least 30 calendar days prior to the start of testing operations.

Ensure fabrication of the disc bearings conforms to the applicable requirements of *AASHTO LRFD Bridge Design Specifications, Article 18.3.3*.

E. Method of Measurement

Measure bearings by each individual unit, which consists of all components shown in the plans or on the approved shop drawings for a single bearing assembly, whether it is a pot or disc bearing.

F. Basis of Payment

Payment for Item No. 2402.602 "HIGH-LOAD MULTI-ROTATIONAL BEARINGS" will be made at the Contract price per each and shall be compensation in full for all costs of furnishing and installing bearing assemblies--whether it be pot or disc bearings--as described above.

SB- Threaded Rod Anchorages

Except when part of a proprietary anchorage assembly, ensure threaded rods and bolts meet the requirements of 3385, "Anchor Rods," and 3391," Fasteners," respectively.

Use cast-in-place type anchors unless otherwise specified in the contract.

Ensure bolt heads and/or nuts are in contact with the adjacent surface and torqued to

- $^{1}/_{2}$ inch diameter = 30 ft pounds
- $^{5}/_{8}$ inch diameter = 60 ft pounds
- $^{3}/_{4}$ inch diameter and larger = 80 ft pounds

unless a different torque is recommended by the manufacturer.

1 - DESIGNER NOTE: For the following section (A. Post-Installed Anchorages), ONLY use this section when a post-installed anchorage alternate is permitted by the contract. (DO NOT include this section for metal railings intended to resist crash loads).

A. Post-Installed Anchorages

Furnish and install a post-installed threaded rod anchorage system of the type, shape and size specified, and its satisfactory placement at the locations indicated in "Table 1 – Anchorage Location and Testing Frequency – Method 1".

Adhesive anchorages consist of a continuously threaded rod secured by an approved adhesive, as per the plan.

Adhesive anchorage installers must hold current ACI Adhesive Anchor Installer Certification credentials. Installers are required to check depth, diameter and condition of the drilled hole, clean the hole, and install the anchorage per the Manufacturer's Printed Installation Instructions (MPII). Record the name(s) of all certified installers on the *RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION* form available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools".

Prior to installation coordinate a Pre-installation meeting. Include the Engineer, Inspectors, and Installers in the meeting to review the installation process and requirements. At the Pre-installation meeting, submit the following to the Engineer:

- RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION form with a copy of each installer's ACI Adhesive Anchor Installer Certification card;
- A copy of the Independent Third Party Inspector's ACI Adhesive Anchor Inspector Certification card;
- Printed copy of the MPII; and
- Verification that the adhesive has an uncracked characteristic bond strength as specified in the plan.

Furnish only one of the systems listed on the Department's "Approved/Qualified Products List for Bridge Products, Concrete Adhesive Anchorages for Structural Applications," (www.dot.state.mn.us/products). Verify that the adhesive has an uncracked characteristic bond strength as specified in the plan. Install all anchors as specified by the MPII. Install in sound concrete to a depth equal to the minimum depth specified in the plan or as specified by the manufacturer, whichever is greater.

Meet the following conditions prior to installation and testing:

- Concrete is greater than 14 days old;
- Concrete surface is free of water prior to drilling;
- The hole is dry, as defined below; and
- Any additional requirements listed in the Manufacturer's Printed Installation Instructions.

A dry hole is defined as: *a hole with no water present within the hole*. If the hole is filled with water, partially filled with water, or water entered the hole during drilling, blow out the water using compressed air and allow a minimum of 24 hours dry-out time before cleaning the hole and installing the anchorage.

It is essential that the adhesive material completely fill the hole in the concrete for proper anchorage performance. Ensure that the hole is completely filled to the top of the concrete surface in which the anchorage is installed. Do not permit the adhesive to overtop the concrete surface in a way that will interfere with the placement of the elements.

A1. Testing of Post-installed Anchorages

Perform all testing by an independent third party testing agency. Testing agent must have current ACI Adhesive Anchor Inspector Certification credentials.

Verify the anchor strength and installation procedures by proof testing anchorages in accordance with this specification. Perform all testing in accordance with ASTM E488*, Standard Test Methods for Strength of Anchors in Concrete Elements*. Set up the tension testing device such that no portion of the device bears on the concrete surface within a distance equal to one and a half times the anchorage embedment depth. Test anchorages to not less than the required proof load as provided in the plan (if no anchor proof load is provided in the plan, contact the Engineer). Failure criteria of an anchorage test is defined in ASTM E488.

Ensure that nothing interferes with the testing apparatus during the proof test. Do not perform any caulk prior to testing.

Verify the anchor strength and installation procedure using one of the two following methods:

1. Demonstrate the anchorage system at the first site of field installation. Five passing demonstrations are required to be able to move to the remaining production anchorage installations. Include a proof test in each demonstration installation. Failure of a proof test will require a modification of installation procedures or use of a different anchorage system and an additional five demonstrations of the modified or substituted system. Demonstration anchorages may be used as production anchorages, however, when using anchorages to attach ornamental metal railing or chain link fencing, no more than one demonstration may occur at any given post location. The Contractor assumes all liability for repairs that may need to be performed as a result of a failed test. Record all demonstration results on the *PRE-PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT* available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools," and furnish the original of the completed form to the Engineer.

In addition to the five demonstrations stated above, test the number of anchorages in each location as indicated in Table 1 (see below) at a later date. The Engineer will randomly select the locations of the additional anchors to be tested. If a failure occurs while testing anchorages, more testing at the location in which the failure occurred will be required at the rate indicated in Table 1, per each failure, at no additional cost to the Department. If the number of anchorages at a given location failing in concrete breakout exceed the maximum number of failures permitted in Table 1, stop testing, notify the Engineer, and provide a non-conformance anchorage replacement plan, to be accepted by the Engineer. Once accepted by the Engineer, remove and replace the remaining untested anchorages according to the approved plan and test anchorages as outlined in this provision. Concrete breakout failure is defined as: *a spall a minimum of two inches in diameter by one inch deep*. Furnish a completed original of the *PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT* available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools," to the Engineer. No Ultrasonic Testing of anchorages need be performed.

2 - DESIGNER NOTE: The highlighted areas in the specification below are numbered to correspond with the following bullet points. Each bridge in a project is considered a separate location. Fill in the blanks as follows:

A- ***Examples of Location would be 'Ornamental Railing (Br No. 12345)'.***

B- ***Insert number equal to 10% of the anchorages in a given location, no less than 10.***

C- ***Insert number equal to 5% of the anchorages in a given location.***

Table 1 – Anchorage Location and Testing Frequency – Method 1

Location	Initial Production Anchorage Test	Additional Tests per Failure	Max Number of Breakout Failures
(A)	(B)	(B)	(C)
(A)	(B)	(B)	(C)

2. Install all production anchorages. Test the number of anchorages in each location as indicated in Table 2 (see below) at a later date. The Engineer will randomly select the locations of the anchors to be tested. If a failure occurs while testing anchorages, more testing at the location in which the failure occurred will be required at the rate indicated in Table 2, per each failure, at no additional cost to the Department. If the number of anchorages at a given location failing in concrete breakout exceed the maximum number of failures permitted in Table 2, stop testing, notify the Engineer, and provide a non-conformance anchorage replacement plan, to be accepted by the Engineer. Once accepted by the Engineer, remove and replace the remaining untested anchorages according to the approved plan and test anchorages as outlined in this provision. Concrete breakout failure is defined as: *a spall a minimum of two inches in diameter by one inch deep*.

   In addition to the proof load testing above, perform Ultrasonic Testing (UT) to verify anchorage embedment on the proof loaded anchorages. Also perform UT on an additional number of anchorages as indicated in Table 2 randomly selected by the Engineer. If any anchorage fails the UT, test an additional number of anchorages as indicated in Table 2. At the Contractors option, remove and replace all anchorages that fail UT or proof load test all anchorages that fail UT. Ultrasonic Testing failure is defined as: an anchorage measured to have an embedment more than ½ inch shorter than the required installation embedment. Furnish a completed original of the *PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT* available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools," to the Engineer.

3 - DESIGNER NOTE: The highlighted areas in the specification below are labeled to correspond with the following bullet points. Each bridge in a project is considered a separate location. Fill in the blanks as follows:

A- ***Examples of Location would be 'Ornamental Railing (Br No. 12345)'.***

B- ***Insert number equal to 10% of the anchorages in a given location plus 5, no less than 15.***

C- ***Insert number equal to 5% of the anchorages in a given location.***

D- ***Insert number equal to 5% of the anchorages in a given location, no less than 3.***

Table 2 – Anchorage Location and Testing Frequency – Method 2

Location	Initial Production Anchorage Test	Additional Tests per Failure	Max Number of Breakout Failures	Number of Ultrasonic Tests
(A)	(B)	(B)	(C)	(D)
(A)	(B)	(B)	(C)	(D)

Notify the Engineer immediately after any failure. Provide a non-conformance anchorage replacement plan, to be accepted by the Engineer. Once accepted by the Engineer:

- Remove all anchorages that fail the field test without damage to the surrounding concrete;
- Redrill holes to remove adhesive bonding material;
- Install replacement anchorages in accordance with the MPII; and,
- Test anchors using one of the two methods listed above.

Perform replacement of failed anchorages to the satisfaction of the Engineer and at no cost to the Department.

B. Basis of Payment

4 - DESIGNER NOTE: Use the following paragraph when anchorages have a separate pay item.

Payment will be made as 2433.502 "ANCHORAGES TYPE ______", at the contract price per each, which shall include all costs of furnishing, testing, and installing the anchorages.

5 - DESIGNER NOTE: Use the following paragraph when anchorages are included in another pay item such as Bearing Assemblies, Metal Railings, or Fencing. Update second paragraph with appropriate pay items.

Payment for all costs of furnishing, testing, and installing the anchorages is included in payment for Metal Railings.

SB- Existing Cover Plate Weld Inspection

A. Description of Work

Inspect the fillet welds located on the top flange at the ends of the cover plates. Perform work in accordance with the following:

B. General

The above-mentioned fillet welds are transverse to the primary direction of stress in the member, therefore making them prone to fatigue cracking. The twofold purpose for the inspection is to determine if fatigue cracking is present and whether the welds have defects that would enhance the likelihood of cracking in the future.

C. Inspection of Cover Plates

After the bridge deck is removed, inspect the ends of the top flange cover plate(s) for defects at (____ locations). Inspect the in-place steel beams or girders using Nondestructive Tested (NDT) by Visual Testing (VT) and by Magnetic Particle Testing (MT) per AASHTO/AWS D1.5 Bridge Welding Code, latest edition. Ensure personnel performing NDT are qualified in conformance with the American Society for Nondestructive Testing's (ASNT) SNT-TC-1A and are NDT Level II operators with two years minimum experience.

Ensure the weld surface and adjacent area to be inspected is free of contaminants such as dirt, loose rust, oil, grease, paint, concrete, welding flux/slag, and weld spatter that may mask defects or restrict magnetic particle movement. Prepare the surface prior to inspection by mechanical means (i.e. wire brush, chipping hammer, etc.) only. Do not heat the members to remove surface contaminants.

Perform VT to ensure the fillet welds are acceptable for profile, undercut, and size in accordance to the workmanship and inspection standards of D1.5. Ensure undercut is no more than 0.01 inch in depth. Perform MT to ensure the fillet welds have no cracks or unacceptable levels of porosity and/or fusion-type discontinuities in accordance with D1.5.

Repair welds that do not meet these standards or have defects $^{1}/_{8}$ inch or less of depth into the flange in accordance with SB-___.3. Immediately bring to the Engineer's attention welds that have cracks or defects greater than $^{1}/_{8}$ inch of depth into the flange, and repair in accordance with SB-___.4 or as directed by the Engineer.

Furnish an NDT report of the VT and MT test results for each location on the bridge, whether defects are found or not, to the Engineer upon completion.

D. Method of Measurement

Inspection of all welds noted above will be measured as a single lump sum.

E. Basis of Payment

Payment for Item No. 2402.601 "INSPECT OF COVER PLATE WELDS" will be made at the Contract price per lump sum and shall be compensation in full for all costs of surface preparation, and VT and MT inspection as described above.

SB- Weld and Minor Defect Repair

Repair minor defects and unacceptable profile of welds and base metal at the end of cover plates. Defects and weld profiles may be repaired by hand grinding. Conduct hand grinding in a manner such that grind marks are parallel to the direction of stress. Any grinding must taper at a minimum of 1 vertical to 10 horizontal. The Engineer shall determine the locations of the repairs based on the VT and MT test results indicated in SB-___. All repaired welds shall be re-inspected as described in SB-___ for final approval.

Report any defects more than 1/8 inch into the flange to the Engineer and repair as described in SB-___.4 or as directed by the Engineer.

Prepare all areas where paint was removed and will not be covered with concrete, and prime coat with an approved zinc-rich primer according to MnDOT 2478.

A. Method of Measurement

Measurement will be by the number of repairs conducted, at locations designated by the Engineer, for weld defect repair and re-inspections.

B. Basis of Payment

Payment for Item No. 2402.602 "WELD REPAIR" at the Contract price per each shall be compensation in full for all costs of repairing and re-inspecting the welds to acceptable conditions.

SB- Splice Plate Repair of Top Flange

Repair beam or girder flanges at the ends of cover plates when inspection of the cover plates reveals defects greater than $^{1}/_{8}$ inch in depth into the top flange. The Engineer will determine locations of the repairs based on the results of the tests indicated in SB-___.2.

Repair by drilling holes through the top flange at the ends of the rack or linear defect and splice plate the area. Drill holes using core type drilling bits. Make holes $^{3}/_{4}$ inch in diameter or as otherwise directed by the Engineer. Test removed core(s) to determine if the defect was removed by the drilling operation. Bolt splice plates to the top and bottom of the top flange as shown in the plan, or as directed by the Engineer.

A. Method of Measurement

Measurement will be by the number of repairs conducted, at locations designated by the Engineer, for top flange arrestor hole drilling and splice plating.

B. Basis of Payment

Payment for Item No. 2402.602 "SPLICE PLATE REPAIR" at the Contract price per each shall be compensation in full for all costs of drilling arrestor holes, and splice plate repairing the flanges as shown in the plans.

SB2018-2402.9A

Include when Regional Bridge Construction Engineer recommends Peening or Ultrasonic Impact Treatment (UIT) of cover plates.

CREATED 1/7/2015

REVISED 2/9/2016 (1)

SB- Ultrasonic Impact Treatment (UIT)

To enhance steel fatigue properties, perform UIT to retrofit the (top and/or bottom) flange welded cover plate and terminations.

Perform the retrofit work by completing the following three Tasks (A, B, C):

A. Preliminary Work and Mobilization Task

Prepare documentation and carry out the retrofit work under this task. Provide final retrofit drawings including details of weld configuration, length of weld treated, area of weld treated (i.e., toe of weld), machine settings and travel speed, along with installation procedures, and an inspection guide. Define the treatment methodology and parameters for successful operations in the final retrofit drawings, installation procedures, and inspection guide. Cover the details of the quality assurance program ensuring that the treatment methodology has been successfully applied as per the instructions within the technical procedure manual of the inspection guide. No field work will be allowed until the Engineer has reviewed the documents for general compliance and signed off in writing. Make arrangements for access equipment, materials, and the UIT equipment, following these submittals. Mobilization and demobilization to get the retrofit equipment to and from the bridge site(s) is included in this task.

B. Retrofit of Cover Plate Weld Terminations Task

Due to the sensitivity of the welded cover plate termination details to fatigue, this condition requires modification to upgrade the condition. On the original bridge structures, the top and bottom flange cover plate details will be retrofitted using the UIT peening equipment. UIT the cover plate terminations for a 6 inch length along the taper on each side and across the entire end of the cover plate. Treat the weld toe adjacent to the girder flange material with a minimum of three passes. Perform the UIT treatment work utilizing trained and certified retrofit engineers and/or technicians. Training and certification is to be provided by the UIT equipment manufacturer. If engineers and technicians previously trained and with a minimum of two years field experience are used, UIT treatment training will not be necessary. Provide documentation of certification within 5 working days, when the Engineer requests it.

Repair any damage to the existing corrosion protection systems in accordance with MnDOT 2478 at no added expense to the Department and to the satisfaction of the Engineer.

C. Letter of Report Task

Prepare a summarization letter at the conclusion of the retrofit work, describing the retrofit work and the field procedures (including photographs of each repair location). Submit three hard copies of this report along with an electronic version (CD) to the Engineer.

1 - DESIGNER NOTE: For the following measurement, quantity is per cover plate treated and not each end.

D. Method of Measurement

Measurement will be by the each cover plate ultrasonic impact treated. This includes all affected areas as described above for each cover plate.

E. Basis of Payment

Payment for Item No. 2402.602 "ULTRASONIC IMPACT TREATMENT", at the Contract price per each shall be compensation in full for all costs of treatment of both ends of cover plate as described above.

SB- Bolted Connections

Prepare and install all bolted field connections for steel bridges using Direct Tension Indicator (DTI) washers. Ensure DTIs conform to the requirements of 3391, "Fasteners," and ASTM F959. All DTIs must have unique markings to indicate the gap locations between the protrusions and to allow the inspector to visibly differentiate them from a standard washer after installation. Mechanically galvanize supplied DTIs in accordance to 3392, "Galvanized Hardware".

Install fasteners in accordance with the DTI manufacturer's recommendations and 2402, "Steel Bridge Construction," as well as the requirements of AASHTO LRFD Bridge Construction Specifications, Third Edition, Article 11.5.6.4.7 Direct Tension Indicator Installation Method. Ensure a DTI manufacturer's representative is on-site at the beginning of the bolting operations to provide training and ensure proper installation.

Use of DTIs, as described above, are an incidental expense to the structural steel and no direct compensation will be made.

SB- (2404) CONCRETE WEARING COURSE FOR BRIDGES

The provisions of 2404, "Concrete Wearing Course for Bridges," are supplemented with the following:

SB- Mix Requirements

Delete 2404.2.A.1, 2404.A.2 and 2404.A.3 and replace with the following:

A.1 Mix Requirements

Provide 3U17A concrete in accordance with Table 2404-1 and the requirements of 2461, "Structural Concrete". Use a MnDOT Approved Type A Water Reducing Admixture at the manufacturer's recommended dosage rate to achieve the specified slump.

Table 2404-1
Concrete Mix Design Requirements for 3U17A

Mix Number	Maximum w/c ratio	Water Content (pounds)	Cement Content (pounds)	Fine Aggregate Calculation (pounds)	Coarse Aggregate Calculation (#Pit Number/ pounds) †	%Air Content	Slump Range	Minimum 28-day Compressive Strength, f'c
3U17A*	0.32	270	836	1415 ‖	#06002 - 1369 #17001 - 1374 #52003 - 1364 #73006 -1411 #87002 - 1385 #94009 - 1540 #94035 - 1530	6.5%	½ – 1"	5600 psi

* Do not provide 3U17A containing fly ash or slag cement.
‖ Includes assumed 3% moisture
† Meeting MnDOT CA-70 gradation as shown in Table 3137-4 and Class A coarse aggregate meeting the requirements of 3137.2.D.2, "Coarse Aggregate for General Use".

SB- Crack Sealing

Delete the 11th paragraph of 2404.3.D, "Concrete Placement and Texturing," and replace with the following:

Place joint sealer material of the type as shown on the plans or special provisions in accordance with 2301.3.N, "Joint Sealing."

SB2018-2404.1
Use for low slump concrete wearing courses on new decks when required.
CREATED 4/4/1997
REVISED 9/1/2017 (7)

SB- Concrete Wearing Course 3U17A

1 - DESIGNER NOTE: For the following paragraph, use as recommended by Regional Construction Engineer.

Unless otherwise authorized, ensure the concrete wearing course placement widths do not exceed______ feet in width for Bridge(s) ______ and______ feet in width for Bridges ______.

SB2018-2404.2
Use for low slump concrete wearing course on deck repair work.
CREATED 4/4/1997
REVISED 7/15/2015 (10)

SB- Concrete Wearing Course 3U17A

1 - DESIGNER NOTE: For the following two paragraphs, use with Limited Service Wearing Course.
Delete the first paragraph of 2404.2, "Materials," delete 2404.2.A, "Low Slump Concrete," in its entirety, and substitute the following:

Ensure the wearing course is composed of a 3 inch minimum depth Low Slump Concrete Course, produced in accordance with the following:

2 - DESIGNER NOTE: For the following four paragraphs, use in all other cases.
Delete the provisions of 2404.1, "Description," and substitute the following:

Construct a Portland cement concrete wearing course to a ___ inch minimum depth on an existing bridge deck slab, and concrete approach panels.

Delete the first paragraph of 2404.2, "Materials," delete 2404.2.A, "Low Slump Concrete," in its entirety, and substitute the following:

Ensure the wearing course monolithic partial depth patches and concrete approach tapers are composed of Low Slump Concrete, produced in accordance with the following:

3 - DESIGNER NOTE: For the following two paragraphs, use as recommended by the Regional Construction Engineer.
Delete the second sentence of the first paragraph of 2404.3.D, "Concrete Placement and Texturing," and substitute the following:

Unless otherwise authorized, ensure concrete wearing course placement widths do not exceed ______ feet in width for Bridge(s) ______ and ______ feet in width for Bridges ______.

Add the following to 2404.5, "Basis of Payment":

If the average thickness of the wearing course exceeds the specified minimum thickness by more than ½ inch, payment will be made at the rate of $165.00 per yd^3 for the excess amount. The wearing course concrete volume will be computed using the plan area of wearing course multiplied by the field measured average thickness. Do not take thickness measurements in areas where Remove and Patch Slab repairs have been identified.

4 - DESIGNER NOTE: Use the following paragraph for payment.
Delete the pay item of 2404.5 and substitute the following:

Payment for concrete wearing course will be made as Item No. 2404.618, "CONCRETE WEARING COURSE (3U17A) ___"", at the Contract price per square foot.

Use when texture planing is required on the low slump wearing course.

Use in the Metro District for speeds over 40 mph. For speeds ≤ 40 mph, consult the Metro Region Construction Engineer.

CREATED 7/24/2001

REVISED 9/13/2016 (12)

SB- Texture Planing of Bridge Wearing Course Surface

Delete the 6th and 7th paragraphs of 2404.3.D, "Concrete Placement and Texturing," and substitute the following:

Take special care in finishing roadway surfaces in the vicinity of expansion devices and other locations where breaks in continuity occur to ensure a smooth riding surface.

Upon completion of curing and a minimum of 72 hours prior to performing texture planing, remove all equipment and material from the bridge slab and approach panel surface and sweep the surface clean of debris. The Engineer will check surface smoothness of the roadway surface in accordance with 2401.3.F.3.b(6), "Surface Smoothness Check". The final surface must meet the tolerance requirements of 2401.3.F.3.b(3), "Final Finish Texture". Correct surface areas not meeting the specified tolerances by removal and replacement or by grinding using a surface diamond grinding device consisting of multiple diamond blades on the high spots to the extent directed by the Engineer prior to beginning surface texturing operations. Nonconforming areas that are not satisfactorily corrected are subject to 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work".

Notify the Engineer at least 24 hours before beginning texture planing. Do not begin texture planing until the Engineer agrees that work **required to meet surface tolerance has been completed**. Mark the lane lines and crown in the deck and discuss with the texture planing operator prior to beginning the work.

Texture the roadway surface in a longitudinal direction by planing the hardened concrete with diamond saw-blades. Plane the entire surface area of the roadway, except the area within 20 inches of the curb, or gutter to a uniform texture. Ensure the surface has a finished texture with groove width between $^{1}/_{10}$ inch and $^{1}/_{8}$ inch at a distance of between $^{5}/_{64}$ inch and $^{1}/_{8}$ inch apart. Make the grooves no less than $^{1}/_{32}$ inch or more than $^{1}/_{8}$ inch in depth. Ensure the actual textured surface in any selected 1.5 feet by 100 ft longitudinal strip is no less than 95% of the surface area. The Engineer will not include areas directly adjacent to expansion joints if it has been agreed that texture planing of those areas will result in damage to the expansion joint device or plow finger straps.

The Engineer will observe the planing and any damage, including coating damage, to the expansion joint devices, plow finger straps, and deck drains will be corrected or will be removed and replaced as unacceptable work, as directed by the Engineer. If the Engineer does not direct either repair or replace of the unacceptable work, the Contractor may leave the work in-place and the Engineer will adjust the contract unit price of the affected items by 50 percent. Install modular expansion joint devices after texture planing.

Perform planing in a manner that will provide a smooth riding surface at expansion joints and at the ends. After completion of the planing, the permissible surface deviation will be $^{1}/_{8}$ inch in 10 ft measured with a straightedge laid longitudinally and $^{1}/_{8}$ inch in 3 ft measured transversely at right angles to the centerline of roadway. **In all areas of the exposed deck, the Contractor will be required to provide positive drainage (including the 20 inches of unplaned gutter).** A small walk-behind grinder may be required to remove high spots along the gutter.

Perform the slurry management per (1717) AIR, LAND, AND WATER POLLUTION (CONCRETE GRINDING) of the "S" section of this contract.

The Engineer will measure the surface of the finished concrete and all planed areas not meeting the requirements may, at the Engineer’s option, be re-planed, be replaced as unacceptable work, or left as is and accepted for payment subject to a price reduction of 50 cents per sq ft but, in all cases, provide positive surface drainage.

Measurement will be made to the nearest square foot of concrete area planed and textured based on surface area. Areas not texture planed will be deducted from the plan quantity, unless the surface in any selected 1.5 feet by 100 ft longitudinal strip is at least 95% textured. Payment will be made under Item 2401.618 "BRIDGE DECK PLANING" at the Contract bid price per square foot, which shall be compensation in full for all costs relative to the specified texture planing.

SB2018-2404.3 E

Use where authorized by the Regional Bridge Construction Engineer for concrete wearing courses.

CREATED 7/16/2019

REVISED 7/16/2019

SB- Concrete Wearing Course Pneumatically Applied Wet Blanket Curing

Replace the fourth paragraph of 2404.3.E.4, "Curing Requirements," with the following:

Wet cure the concrete wearing course for a minimum of four days by means of one of the following options:

Option 1: As soon as the concrete can be walked on without damage, cure the surface in accordance with 2401.3.G, "Concrete Curing and Protection." Per 2401.3G.2.b, "Curing Blanket Method" or per 2401.3G.2.c, "Wet Curing Method." Maintain a moist surface condition for the entire curing period.

Option 2: Within three hours after finish strike off of the concrete surface, apply Pneumatically Applied Wet Blanket (PAWB) in accordance with the following:

a. Apply at a minimum thickness of $^{5}/_{8}$ inch. Measure application thickness at random transverse locations at approximately 25 foot minimum longitudinal intervals along the deck. Reapply to areas with less than the minimum thickness;
b. Place in a manner that does not mar the final concrete finish texture;
c. Cover 100% of the newly placed concrete area with no visible openings;
d. If needed to ensure the concrete finish is not damaged during the placement, use a dedicated work bridge. Provide an additional center rail on wide bridges, if necessary;
e. Apply 6-mil white plastic sheeting within 24 hours of application. Cover all surfaces undergoing curing without damaging or displacing the conventional curing product. If seams are present, overlap the sheets a minimum of 1 foot;
f. Maintain a moist surface condition during the full curing period. Additional water will be applied to the curing medium when either of the conditions are encountered:
    1. If material dryness is encountered within $^{1}/_{8}$ inch of the slab after scraping the slab surface; or
    2. When in-place moisture has been measured to be less than 50% using a Ligno Scanner SDM, or approved equivalent wood moisture meter, using the following settings:
        a. Reference Scale: 0
        b. Measuring Depth: $^{1}/_{4}$ inch.

        Note: Alternate wood fiber moisture meters may be proposed for use with identical capabilities to the Ligno Scanner SDM unit. The measurements should be allowed to stabilize for a minimum of 30 seconds (an alternate moisture reading device can be used provided it can provide similar measurements). The moisture content should be read in multiple locations, representative of the entire deck surface, on a daily basis to ensure that the moisture content is acceptable.
g. Remove all PAWB from bonding surfaces prior to casting subsequent concrete on the bonding surface;
h. Following the completion of the curing period remove the PAWB with a combination of sweeping and use of a pressure-washer. At a minimum, pressure wash all bonding surfaces with at least 3,500 psi pressure wash with a spinning head nozzle held within 1 foot of the concrete surface. Remove the PAWB until there is none visible on the deck.

Where PAWB is selected as the curing method, provide PAWB medium meeting the following requirements:

Composition:

- Minimum 77% Processed Wood Fibers or other cellulose material;
- 100% biodegradable; and
- Contain no dyes or coloring that will discolor the concrete surface

Physical Properties of Applied Material:

Property	Test Method	Unit	Value
Mass/Unit Area	ASTM D 6566	oz/yd^2	30
Thickness (Nominal)	ASTM D 6525	inches	0.625
Thickness (Minimum)	ASTM D 6525	inches	0.375
Water-Holding Capacity (Minimum)	ASTM D 7367	percent	1500

SB2018-2404.4
Use with concrete wearing course when the Regional Engineer recommends 10 degree diagonal tining.
CREATED 7/1/2014
REVISED 9/1/2017 (1)

SB- Modified Transverse Texturing (Tining) on Bridge Slab

Delete the 6th and 7th paragraphs of 2404.3.D, "Concrete Placement and Texturing," and replace with the following:

Immediately following the carpet drag, texture the concrete wearing course surface with a metal-tine pattern. Install the transverse texturing (tining) on a slight diagonal, at an angle of approximately 10 degrees to a line perpendicular to the roadway centerline, produced by using a device meeting the following characteristics and requirements:

1. Equipped with steel tines from 4 inches to 6 inches long and from $^{1}/_{12}$ inch to $^{1}/_{8}$ inch thick,
2. Steel tines arranged to obtain randomized grooves from $^{1}/_{8}$ inch to $^{5}/_{16}$ inch deep, and
3. Variable spacing between tines from $^{5}/_{8}$ inch to 1 inch.

Do not texture or tine within 1 ft of gutterline.

SB- (2405) PRESTRESSED CONCRETE BEAMS

The provisions of 2405, "Prestressed Concrete Beams," are supplemented with the following:

SB- Materials

The provisions of 2405.2, "Materials," are modified and supplemented with the following:

Delete the 2405.2.A, "Concrete," and replace with:

A Concrete 2461

Add the following as 2405.2.K:

K Precast Concrete Manufacturing 3240

SB- Pay Item Numbers

The provisions of 2405, "Prestressed Concrete Beams," are supplemented with the following:

Delete the Pay Item table in 2405.5, "Basis of Payment," and substitute the following:

Item No:	Item:	Unit:
2405.502	Prestressed Concrete Beams Type ______	each
2405.502	Prestressed Concrete Double Tee-Beam Type ______	each
2405.503	Prestressed Concrete Beams ____	linear foot
2405.503	Diaphragms for Type ______ Prest Beams	linear foot

SB2018-2405.2
Use on all Prestressed Beam Jobs with "I" shaped beams.
CREATED 1/18/2013
REVISED 11/1/2019 (15)

SB- Beam Camber and Deflection

Add the following 2405.3.J.1, "Beam Camber and Deflection," after the last paragraph of 2405.3.J, "Marking, Handling, Storage, and Transportation,":

J.1 Beam Camber and Deflection

The Erection Camber dimension shown in the Plans is the computed beam camber at midspan based on a time lapse of 30 to 180 calendar days after release of the prestressing strands. This camber may vary by + 1 inch and is intended to advise the Contractor as to the expected camber at the time of deck forming. A positive (+) dimension indicates upward camber.

To help control camber, schedule fabrication of prestressed concrete beams between 30 and 180 calendar days prior to slab placement on the erected beams. For projects where the slab is placed; a) before the beams are 30 calendar days old, or b) after the beams are 180 calendar days old, the Contractor is responsible for controlling the beam camber and all associated costs, including but not limited to:

- bridge and roadway slab materials,
- form adjustments required to maintain specified steel reinforcing bar clearances and deck profiles,
- beam seat adjustments,
- application of load to the beams, and
- any additional expenses in connection with accommodating insufficient or excess beam camber.

Record the date and camber of each beam at the following times:

1. Initial – Just prior to removal of the beam from the casting bed; and
2. During Storage – At a frequency not to exceed 60 calendar days, and within a time frame of 7 to 21 calendar days prior to shipment.

In addition, record the date and camber of each beam if the support or bunking point (distance from point of support to end of beam) changes by more than 2 ft during storage (except during shipping to the job site).

Record the initial camber on the casting bed, just prior to lifting or removal of the beam from the bed.

Measure beam camber as the vertical dimension between the top of the beam at midspan and a theoretical line at the top of the beam between centerline of bearings.

Perform and record each check at a time when the camber and alignment of the beam is not influenced by temporary differences in surface temperature. Make these records available for the Engineer’s inspection, and include in the "Record of Camber" (see attached sheet) document for each beam. Immediately notify the Materials Engineer and Bridge Construction Unit if any of the recorded cambers (other than initial) are outside a range of + 1 inch of the Erection Camber dimension shown in the Plans. At the time of shipment, provide the "Record of Camber" document for each beam to the Materials Engineer and the Engineer.

To help control camber, place 30MH, 35MH, 40MH, 27M, 36M, and MN45 beam shapes on storage bunks with at least 2 ft and no more than 4 ft of beam end overhang. Place beams with a design height exceeding 45 inches on storage bunks with at least 3 ft and no more than 6 ft of beam end overhang. Place all beams within the same span and for each bridge, on storage bunks with beam end overhangs that differ by no more than 2 ft from one another. Include the location of the bunk or support point from the end of the beam on the "Record of Camber" for each end of each beam.

If it is anticipated that the beams will be older than 180 calendar days at time of slab placement, the Contractor shall submit calculations to the Engineer showing the estimated beam camber and the residual camber at midspan, at the beam age anticipated at time of slab forming and at time of deck placement (if more than 45 calendar days after slab forming). Include in the submittal the Contractor's proposal for accommodating or preventing any excess camber in the construction, including but not limited to; increased frequency of camber measurement, potential changes to beam seat elevations, etc.

Take elevations at top of beams after erection and allow for deflection shown to enable building deck forms to correct grade and specified slab thickness. Take elevations no more than 45 calendar days prior to slab placement.

Record of Camber (V3 -06/18/13)

Fabrication Company: ______________________________

Bridge No.: ______________________________ **Beam Size:** ______________________________

S.P. or S.A.P. No.: ______________________________

Fabrication Date: ______________________________ **Date Shipped:** ______________________________

Unique Beam ID (Per Fabricator)	Beam No. From Framing Plans	Erection Camber Shown in Plans	Beam Length (Feet-Inches) (i.e. 101'-7")	Camber Measurement Date	Beam Age (Days)	Camber at Midspan (Inches)*	Method Used**	Bunking Distance From "X" End (Feet-Inches)	Bunking Distance At Opposite End (Feet-Inches)	Measured By (Initials)
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***Beam camber shall be measured as the vertical dimension between the top of the beam at midspan and a theoretical line at the top of the beam between centerline of bearings. Immediately notify the Materials Engineer and Bridge Construction Unit if any of the recorded cambers (other than initial) are outside a range of ± 1 inch of the Erection Camber dimension shown in the Plan.**

****Indicate the method used to measure the camber, i.e. Stringline, Survey instrument, etc.**

Notes:

SB2018-2405.3
Use with prestressed concrete beams where special surface finish is NOT required.
CREATED 7/29/1983
REVISED 6/2/2015 (1)

SB- Concrete Finish of Exterior Beams

Delete the eighth (8) paragraph of 2405.3.K, "Installation," and substitute the following:

A Special Surface Finish II (SSF II) on the outer surface of the exterior beams is not required on this bridge.

SB- Prestress Transfer of I Shaped Beams

The Fabricator of prestressed concrete beams must closely monitor the ends of the beams during the strand release process. The following sequence of releasing the individual prestressing strands is required if cracks occur in the ends of the beams during the Fabricator's releasing sequence.

Delete the first sentence of the second paragraph of 2405.3.G, "Prestress Transfer," and replace with the following:

Conduct prestress transfer in a sequential and alternating manner symmetrical to the vertical axis of the beam in order to minimize the lateral eccentricity of the prestress forces and diminish cracking of the concrete. Perform the sequence of individual prestressing strand release in accordance with the following criteria, unless different criteria are approved by the Engineer.

1. Beginning with the *straight* strands closest to the vertical axis of the beam and in the second row from the bottom of the beam, release the strands each side of center. Move two columns away from this column in the same row and release the strand on each side of the center. Then proceed to the outermost strands in this row and release the strand on each side of the center. Repeat the sequence for the third and subsequent rows from the bottom upward until approximately one-fourth of the straight strands have been released.

2. Release approximately one-half (+/- one strand) of the *draped* strands alternating about the vertical axis, starting from the bottom.

3. Release the hold-down anchors for the draped strands.

4. Release the remainder of the *draped* strands alternating about the vertical axis.

5. Release the remainder of the *straight* strands beginning with the strand in the bottom row nearest the vertical axis. The strands are released alternating each side of the center. Release all the strands in that column moving upward. Proceed two columns away from this column and release the strands bottom to top alternating each side of the center. Next, move to the outer most column and release strands bottom to top continuing to alternate each side of the center. Release the remainder of the strands bottom to top starting with the innermost column alternating each side of the center.

Once release has started, release all strands of that beam in the sequence described above even if cracking is noticed near the end of the beam. Notify the Engineer immediately of any cracking, and do not fabricate other beams with the same strand pattern until the Engineer has approved a revised release sequence.

SB- Prestress Transfer of Rectangular Beams

Monitor the ends of the rectangular prestressed concrete beam during the strand release process. If during the release of the individual prestressing strands cracks occur in the ends of the beam, the following release sequence will be required.

Delete the first sentence of the second paragraph of 2405.3.G, "Prestress Transfer," and replace with the following:

Conduct prestress transfer in a sequential and alternating manner symmetrical to the vertical axis of the beam in order to minimize the lateral eccentricity of the prestress forces and diminish cracking of the concrete. Release individual prestressing strands in the following sequence:

> Beginning with the bottom row of strands, proceed to the outermost strands in this row and release one strand each side of center. Move up one row, to the outermost strands in this row and release one strand each side of center. Move to the top row at the top of the beam, to the outermost strands and release one strand each side of center. Move to the second row from the top of the beam to the outermost strands and release one strand each side of center. Proceed to the bottom row of strands at the bottom of the beam, 3 columns from the vertical axis, and release one strand each side of center. Move up one row in the same column and release one strand each side of center. Then proceed to the innermost strands in the bottom row and release one strand each side of center. Move up one row and release the same strands. Proceed to the innermost strands in the top row at the top of the beam and release one strand each side of center. Proceed to the bottom row, 1 column in from the outmost strands and release one strand each side of center. Move up one row and release the same strands. Proceed to the bottom row, 2 columns out from the vertical axis of the beam and release one strand each side of center. Move up one row and release the same strands.

Once release has started, release all strands of that beam in the sequence described above even if cracking is noticed near the end of the beam. Notify the Engineer immediately of any cracking, and do not fabricate other beams with the same strand pattern until the Engineer has approved a revised release sequence.

SB2018-2405.6

Use for prestressed I-beam shapes (30MH, 35MH, 40MH, 36M, MN45, MN54, MN63, 82MW, 96MW). This SP is not intended to be used for 27M beams so DO NOT USE THIS SECTION IF 27M is the only size. If there are different beam sizes as stated above and including 27M, then incorporate the paragraph referenced by the designer note below.

CREATED 6/2/2015

REVISED 7/22/2019 (5)

SB- Prestressed Concrete Beam End Zone Crack Repair

Add the following as 2405.3.I.1, "End of Beam Cracking and Repair":

1 - DESIGNER NOTE: Use the next paragraph ONLY when this contract includes size 27M and other sizes that are covered by this SP.

The following is NOT intended for size 27M Prestressed Concrete Beams.

The Fabricator of the Prestressed Concrete Beam (PCB) is responsible for evaluating, supplying the products, and their application per the following:

Use feeler gauges to measure cracking in the beams. Report any cracks that appear to be perpendicular to the draped strands to the Department Precast Inspection Engineer, who will evaluate the cracks perpendicular to the draped strands and give further direction to the Fabricator.

1. Reject PCB with cracks exceeding 0.050 inches.

2. Fill PCB cracks ranging in width from 0.025 inches to 0.050 inches using epoxy injection, approved by the Department Materials Engineer.

   Follow these directions for Epoxy injection:

   a. Within 48 hours of application, clean the crack area of any loose debris such as dirt, dust, curing compounds, waxes, laitance, oil, grease, or other contaminants with an oil free 125 psi compressed air blast leaving only clean sound concrete. No water washing is allowed,
   b. Ensure the epoxy injection is performed by a trained, approved, and certified applier of the manufacturer of the epoxy meeting these specifications. Training curriculum shall consist of the theory behind the causes of cracking, selection of materials, and injection technology including flow rates, operating pressures, and temperature effects,
   c. The applier shall submit for review by the Department Materials Engineer, a written description of the proposed epoxy materials, their acceptable approvals, and the injection procedure, at least 7 calendar days prior to proceeding. Include in the list the repair work proposed for each item,
   d. Utilize an epoxy injection system approved in writing by the Department Materials Engineer,
   e. The certified applier is responsible for crack preparation. Determine the exact location and length of the crack to be injected. Clean the crack and the adjacent surfaces or other areas of application of paint, dirt, dust, grease, oil, efflorescence, or other foreign matter detrimental to bond of epoxy injection surface seal system using a grinding wheel, wire brush, and compressed air. Open crack walls slightly along its length with a small crack chaser blade if the crack walls remain contaminated. Acids and corrosives are not permitted for cleaning, and
   f. Inject the approved system as recommended by the manufacturer.

   Then apply Euclid Dural Prep AC or BASF MasterSeal 630 to the ends and the sides of the PCB (no coating applied to the top of the top flange or bottom of the bottom flange) for the greater of the following lengths, end four feet or from the end of the beam to the end of the furthest crack. Prepare and apply per the manufacturer’s recommendations and as approved by Department Materials Engineer.

3. Fill girder cracks ranging in width from 0.012 inches up to 0.025 inches with Hilti RM 800.

Follow these directions for packing the Repair Mortar:

a. Within 48 hours prior to this application, clean the crack area of any loose debris such as dirt, dust, curing compounds, waxes, laitance, oil, grease or other contaminants with an oil free 125 psi compressed air blast leaving only clean sound concrete. No water washing is allowed and do not apply moisture to crack prior to mortar repair,
b. Pack Hilti RM 800, a Portland cement based repair mortar, along the entire length of each crack, filling the voids of the crack, and
c. Mix and apply the material per the manufacturer's recommendation, and as approved by Department Materials Engineer.

Then apply Euclid Dural Prep AC or BASF MasterSeal 630 to the ends and the sides of the PCB (no coating applied to the top of the top flange or bottom of the bottom flange) for the greater of the following lengths, end four feet or from the end of the beam to the end of the furthest crack. Prepare and apply per the manufacturer's recommendations and as approved by Department Materials Engineer.

4. Do not fill girder cracks less than 0.012 inch width but apply either Euclid Dural Prep AC or BASF MasterSeal 630 to the PCB sides and end (no coating applied to the top of the top flange or bottom of the bottom flange) for the greater of the following lengths, end four feet or from the end of the beam to the end of the furthest crack. Prepare and apply per the manufacturer's recommendations and as approved by Department Materials Engineer.

5. If there are no visible cracks, apply either Euclid Dural Prep AC or BASF MasterSeal 630 to the PCB sides and end (no coating applied to the top of the top flange or bottom of the bottom flange) four feet of the beam. Prepare and apply per the manufacturer's recommendations and as approved by Department Materials Engineer.

Make repairs at least three days after prestress transfer has been made, but no sooner than 3 weeks before shipping to site, unless approved by the Department Precast Inspection Engineer.

Give the Department Materials Engineer the opportunity to monitor all end of beam repair work.

The contract unit price for "PRESTRESSED CONCRETE BEAMS ______" includes the cost for all the above mentioned.

SB2018-2405.10
Primary use is CIP Boxes, use when required.
CREATED 6/15/1998
REVISED 6/6/2018 (4)

SB- POST TENSIONING SYSTEM

A. Description of Work

Prestress the concrete using post-tensioning method. Perform work in accordance with the plans, the applicable provisions of 2401, "Concrete Bridge Construction," and 2405, "Prestressed Concrete Beams," and the following:

This work includes:

a. Design calculations and working drawings.

b. Furnishing and installing the ducts and prestressing strands, including strand positioning devices for the tendons and appurtenant items necessary for the particular system to be used.

c. Furnishing and installing the anchorage system.

d. In-place friction testing.

e. Post-tensioning the system.

f. Grouting the ducts and anchorage blockouts upon completion of the stressing operations.

g. Protection of anchorages, clean-up, and other work necessary for installation of the system.

B. Working Drawings

1. General

Submit working drawings of the proposed prestressed concrete members in accordance with the requirements of 1502, "Plans and Working Drawings," and these special provisions.

Prepare composite drawings in plan, elevation and section which show to scale the relative positions of all items that are to be embedded in the concrete, the concrete cover, and the embedment depth for the portions of the structure that are to be temporarily or permanently prestressed. Such embedded items include the prestressing ducts, vents, anchorage reinforcement and hardware, and reinforcing steel strand. Ensure such drawings are adequate so that there will be no conflict between the planned positions of any embedded items, and that concrete cover will be adequate. If conflicts are discovered during the preparation of such drawings, revise the working drawings for one or more of the embedded items, or propose changes in the dimensions of the work as necessary to eliminate the conflicts or provide proper cover. Any such revisions must be approved by the Engineer before work on an affected item is started.

On the drawings, show the method and procedure of jacking and the type, size, and properties of the strands or bars and the anchorage assemblies. Show the number of strands per tendon. Include details in addition to those shown on the contract plans for any additional reinforcing steel required to resist the concrete bursting stresses in the vicinity of the anchorage assemblies. Show the force or stress diagram on the drawings. Show the sizes, shapes, and dimensions for the ducts. Show lay-out dimensions for locating the ducts along the tendon path at intervals not exceeding one-tenth the span length of the member being prestressed, and at anchorages, low points, high points, and points of inflection. Include vent locations and details of the vents on the drawings.

On the drawings, include complete details of the method, materials, and equipment proposed for use in the prestressing operations. With such details, outline the method and sequence of jacking, show complete details of the prestressing steel, anchoring devices, type of enclosures, block-outs, and show all other data pertaining to the post-tensioning system or operations.

Submit calculations showing, at each stage of erection, the elongation of the strands at the time of jacking, the initial forces in the strands, prestress losses, parameters, and the final working forces. Include the stresses in the anchorages and distribution plates in the calculations.

Final prestress losses and final working forces are not required when the post-tensioning system is fully designed and detailed in the Plans and the Contractor does not propose to change the system.

Submit complete details for grouting prestressing tendons including the materials and proportions for grout, details of equipment for mixing and placing grout and methods of mixing and placing grout.

The Contractor is not required to duplicate in the working drawings any aspect of the system that is fully detailed in the plans unless a change is proposed.

2. Contractor Proposed Options:

The Contractor may propose for consideration by the Engineer certain variations from the prestressing systems shown in the contract document.

3. Restrictions to Contractor Proposed Options:

a. Conform materials and devices used in the prestress system to the requirements in the following Materials Section of this Special Provision.

b. The net compressive stress in the concrete after all losses shall be at least as large as that provided by the system shown on the Plans.

c. Generally conform the distribution of individual tendons at each section to the distribution shown on the Plans.

d. Conform the ultimate strength of the structure with the proposed prestressing system, stresses in the concrete and prestressing steel at all sections and at all stages of construction and all work and materials to meet the requirements of the AASHTO Standard Specifications for Highway Bridges, 16th Edition (referred to hereafter as AASHTO) including all Interim Specifications, the requirements of the Design Criteria noted on the Plans, and the AASHTO Guide Specifications for Design and Construction of Segmental Concrete Bridges as applicable.

e. Fully redesign and detail, as required, the elements where an alternate prestressing system is proposed to be used. When the system is fully designed and detailed in the Plans, the cost for the original designer to review the proposed change will be at the expense of the Contractor.

f. Submit 5 sets of complete shop drawings including the prestressing scheme and system, reinforcing steel, and concrete cover; and design calculations (including short and long term prestress losses) for the Engineer’s approval.

g. Any Contractor proposed option to the prestressing system approved by the Engineer, which results in a change in other quantities from that shown on the plans, shall be paid based on the quantity actually used and accepted or the plan quantity, whichever is less, and at the unit bid price.

C. Materials

1. Prestress Anchorages

Secure all prestressing steel at the ends by means of permanent type anchoring device. Develop in prestress anchorages at least 95 percent of the guaranteed ultimate tensile strength of the prestressing steel.

Testing of anchorage devices shall be performed by an independent testing agency in accordance with the procedures described in Division II Article 10.3.2 of AASHTO. The anchorage device shall meet the acceptance criteria specified in Division II Article 10.3.2.3.10 for a moderately aggressive environment using samples representing the type of prestressing steel and concrete strength to be used on the project. Assemble the test specimen in an unbonded state and, in testing, do not exceed the anticipated anchor set. Supply certified copies of test results for the anchorage system to the Engineer. Arrange the anchorage system so that the prestressing force in the tendon may be verified prior to the removal of the stressing equipment.

The Contractor is responsible for tendon anchorages, the design and furnishing of local zone reinforcement in accordance with AASHTO Division I, Section 9.21 (in addition to the reinforcement shown on the plans).

Ensure prestress anchorage devices effectively distribute prestressing loads to the concrete and conform to the following requirements.

a. The bearing stress in the concrete created by the anchorage plates shall not exceed the values per Division I, Section 9.21.

b. Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material in the anchorage plate when 95 percent of the ultimate strength of the tendon is applied. Nor shall it cause visual distortion of the anchor plate as determined by the Engineer.

2. Ducts

a. General

Ensure all duct material is sufficiently rigid to withstand loads imposed during placing of concrete and internal pressure during grouting while maintaining its shape, remaining in proper alignment and remaining watertight.

Ensure the duct system, including splices and joints, effectively prevents entrance of cement paste or water into the system and effectively contains pressurized grout during grouting of the tendon. Also ensure the duct system is capable of withstanding water pressure during flushing of a duct in the event the grouting operation is aborted.

Ensure the interior diameter of ducts for single strand, bar or wire tendons are at least ½ inch greater than the nominal diameter of the tendon. Ensure the interior diameter of ducts for tendons consisting of more than one strand, bar or wire are such that the interior area is not less than 2.5 times the net area of the prestressing steel.

b. Duct Type Designation

Key to Duct Material: A - Galvanized Rigid Steel Pipe
B - Corrugated Metal
C - Corrugated Plastic

Except as otherwise designated in the plans, use the type of duct material in specific applications as follows:

Number of Strands in Tendon		Tendon Radius (R) ft	Duct Type Material
0.5"	0.6"		
1 to 13	1 to 8	30 or more 10* to 30 2 to 10	A, B, C A, B A
14 to 18	9 to 13	30 or more 12* to 30 2 to 12	A, B, C A, B A
19 to 32	14 to 20	50 or more 25* to 50 3 to 25	A, B, C A, B A

* This radius is the minimum allowed for a tendon unless otherwise approved by the Engineer based on test data.

3. Specific Material Properties

a. Type A - Galvanized Rigid Steel Pipe

Steel pipe duct shall be galvanized steel pipe conforming to the requirements of 3362, "Structural Steel Pipe," Schedule 40. Bend the pipe so as to accurately conform to the alignment of the tendon, taking into consideration the minimum bending radius shown in the working drawings.

b. Type B - Corrugated Metal

Fabricate corrugated metal duct with either welded or interlocked seams and bend without crimping or flattening. Connect sections of duct with heat shrink sleeves having uni-directional circumferential shrinkage manufactured specifically for the size of the duct being coupled, consisting of an irradiated and cross linked high density polyethylene backing for external applications and linear-density polyethylene for internal applications. Adhesive must bond to steel and polyolefin plastic materials.

Ensure the heat shrink sleeves have an adhesive layer that will withstand 150° F operating temperature and meet the requirements of the following table:

Property	**Test Method**	**Minimum Requirements**	
		Internal Application	**External Application**
Minimum Fully Recovered Thickness		92 mils	111 mils
Peel Strength	ASTM D1000	29 psi	46 psi
Softening Point	ASTM E28	162ºF	216ºF
Lap Shear	DIN 30 672M	87 psi	58 psi
Tensile Strength	ASTM D638	2,900 psi	3,480 psi
Hardness	ASTM D2240	46 Shore D	52 Shore D
Water Absorption	ASTM D570	Less than 0.05%	Less than 0.05%
Color		Yellow	Black
Shrinkage		33%	23%

Install heat shrink sleeves using procedures and methods in accordance with the manufacturer's recommendations.

Fabricate duct and metal connectors from galvanized sheet steel meeting the requirements of ASTM 525, Coating Designation G90. Repair areas of zinc coating damaged by welding or in fabricating interlocked seams by painting with a zinc dust-zinc oxide paint conforming to Federal Specifications TT-P-640 or MIL-P-21035.

Joints between sections of duct shall have no sharp edges within contact of the prestressing steel.

The minimum duct thickness for strand and wire tendons is 26 gauge up to 2.6 inches diameter. Ducts larger than 2.6 inches diameter shall be 24 gauge minimum thickness.

c. Type C - Corrugated Plastic Duct

Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts.

Use corrugated duct manufactured from unfilled polypropylene or polyethylene. The polypropylene duct shall meet the requirements of ASTM D4101 "Standard Specification for Polypropylene Plastic Injection and Extrusion Materials" with a cell classification range of PP0340B14542 to PP0340B67884.

The polyethylene duct shall be corrugated high-density material conforming to the requirements of ASTM D3350 "Standard Specification for Polyethylene Plastics Pipe and Fittings" Type III, Class C, Category 5, Grade P33.

(1) Testing Requirements for Corrugated Plastic Duct

Ensure that the duct system components and accessories meet the requirements of Chapter 4, Articles 4.1 through 4.1.8 of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, titled "Corrugated Plastic Duct for Internal Bonded Post-Tensioning" as modified herein.

The requirements in FIB Technical Report, Bulletin 7, are modified as follows: Conduct the lateral load resistance test (FIB 4.1.4), without the use of a duct stiffener plate, using a load of 150 lbs. for all sizes; Wear resistance of duct (FIB 4.1.7) must not be less than 0.06 inch for duct up to 3.35 inches in diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter; Bond length test (FIB 4.1.8) must achieve 40 % GUTS in a maximum length of 16 duct diameters.

4. Minimum Radius of Curvature

Tendons ducts shall be installed with a radius of curvature shown in the Plans.

5. Grout and Grout Storage

a. Use only pre-packaged grouts that meet the specifications of the table below. Select the post-tensioning grout for use by the proper application either repair or horizontal. Mix pre-packaged grout with potable water. Maintain grout fluidity in strict compliance with the grout manufacturer’s recommendations and test with a flow cone.

b. Store grout in a location that is both dry and convenient to the work. Storage in the open must be on a raised platform and with adequate waterproof covering to protect the material. On site storage of grout is limited to a maximum period of one month.

c. All grouting operations shall comply with the requirements of SB-18.3.10.

(1) Grout Properties

Meet or exceed the specified physical properties for the grout stated herein as determined by the following standard and modified ASTM test methods conducted at normal laboratory temperature 65-78˚F and conditions. Conduct all grout tests with grout mixed to produce the minimum time of efflux. Establish the water content to produce the minimum and maximum time of efflux.

Property	Test Value	Test Method
Total Chloride Ions	Max. 0.08% by weight of cementitious material	ASTM C1152
Fine Aggregate (if utilized)	99% passing the No. 50 Sieve (300 micron)	ASTM C136 *
Hardened Height Change @ 24 hours and 28 days	0.0% to + 0.2%	ASTM C090 ‖
Expansion	≤ 2.0% for up to 3 hours	ASTM C940
Wet Density – Laboratory	Report maximum and minimum obtained test value lb/ft^3	ASTM C185
Wet Density – Field	Report maximum and minimum obtained test value lb/ft^3	ASTM C138
Compressive Strength 28 day (Average of 3 cubes)	≥ 7,000 psi	ASTM C942
Initial Set of Grout	Min. 3 hours Max. 12 hours	ASTM C953
Time of Efflux †		
(a) Immediately after mixing	Min. 20 Sec. Max. 30 Sec.	ASTM C939
	Or Min. 9 Sec. Max. 20 Sec.	ASTM C939 †
(b) 30 minutes after mixing with remixing for 30 sec	Max. 30 Sec.	ASTM C939
	Or Max. 30 Sec.	ASTM C939 ǂ
Bleeding @ 3 hours	Max. 0.0 percent	ASTM C940 #
Permeability @ 28 days	Max. 2500 coulombs At 30 V for 6 hours	ASTM C1202

* Use ASTM C117 procedure modified to use a #50 sieve. Determine the percent passing the #50 sieve after washing the sieve.
‖ Modify ASTM C1090 to include verification at both 24 hours and 28 days.
† Adjustments to flow rates will be achieved by strict compliance with the manufacturer's recommendations. The time of efflux is the time to fill a one liter container placed directly under the flow cone.
ǂ Modify the ASTM C939 test by filling the cone to the top instead of to the standard level.
Modify ASTM C940 to conform with the wick induced bleed test as follows:

- Use a wick made of a 20 inch length of ASTM A416 seven wire 0.5 inch diameter strand. Wrap the strand with 2 inch wide duct or electrical tape at each end prior to cuffing to avoid splaying of the wires when it is cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before temperature conditioning.
- Condition the dry ingredients, mixing water, prestressing strand and test apparatus overnight at 65 to 75˚F.
- Mix the conditioned dry ingredients with the conditioned mixing water and place 27 oz. of the resulting grout into the 1 quart graduate cylinder. Measure and record the level of the top of the grout.
- Completely insert the strand into the graduated cylinder. Center and fasten the strand so it remains essentially parallel to the vertical axis of the cylinder. Measure and record the level of the top of the grout.
- Store the mixed grout at the temperature range listed above in (b).
- Measure the level of the bleed water every 15 minutes for the first hour and hourly for two successive readings thereafter.

- Calculate the bleed water, if any, at the end of the three hour test period and the resulting expansion per the procedures outlined in ASTM C940, with the quantity of bleed water expressed as a percent of the initial grout volume. Note if the bleed water remains above or below the top of the original grout height. Note if any bleed water is absorbed into the specimen during the test.

(2) Simulated Field High Temperature Fluidity Test

Perform a conditioned laboratory high temperature grout fluidity test as described below using production grouting equipment utilizing both mixing and storage tanks. Grouts must conform to the requirements of ______________ including initial fluidity test. For the test to be successful, the grout must have an efflux time of not greater than 30 seconds at the end of the one hour test period. Efflux time may be determined by either ASTM C939 or the modified ASTM C939 described herein.

- Perform the test in a temperature conditioned laboratory. Condition the room, grout, water, duct, pump, mixer and all other equipment to be used to a temperature of 90˚F for a minimum of 12 hours prior to the test.
- Use 400 ft ± 10 ft of duct (tube) for the test. Use a duct with a nominal inside diameter of 1 inch.
- Mix the grout to the specified water content. Pump the grout through the duct until the grout discharges from the outlet end of the duct and is returned to the pump.
- Start the one hour test period after the duct is completely filled with grout. Record the time to circulate the grout through the duct. Constantly pump and recirculate the grout into the commercial grout mixer storage tank.
- Pump and recirculate the grout for a minimum of one hour.
- Record at 15 minute intervals throughout the test period, the pumping pressure at the inlet, grout temperature, and fluidity at the discharge outlet.

6. Prestressing Steel

a. Strand: Unless otherwise noted on the plans, use uncoated strand meeting requirements of AASHTO M203, ASTM A416, (Grade 270), low relaxation 7-wire strand meeting the requirements of ASTM A416).

b. Bar: Unless otherwise noted on the plans, uncoated Grade 150, high strength, threaded bar meeting the requirements of ASTM A722, Type II.

7. Inlets, Outlets, Valves and Plugs

a. Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A240 Type 316 stainless steel, nylon or polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be of S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Products made from polyolefin shall contain antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 348 psi. resulting in a minimum failure time of 3 hours.

b. All inlets and outlets will be equipped with pressure rated mechanical shut-off valves or plugs. Inlets, outlets, valves and plugs will be rated for a minimum pressure rating of 150 psi. Use inlets and outlets with a minimum inside diameter of 3/4 inch for strand and 3/8 inch for single bar tendons and four-strand duct.

c. Provide dual mechanical shutoff valves when performing vertical grouting.

d. Temporary items, not part of the permanent structure, shall be specifically designated on the PT System drawings and may be made of any suitable material.

8. Permanent Grout caps

a. Use permanent grout caps made from fiber reinforced polymer or ASTM A240 Type 316L stainless steel. The resins used in the fiber reinforced polymer shall be either nylon, Acrylonitrite Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). For products made from nylon a cell class of S-PA0141 (weathering resistant) is required.

b. Seal the cap with "O" ring seals or precision fitted flat gaskets placed against the bearing plate. Place a grout vent on the top of the cap. Grout caps must be rated for a minimum pressure rating of 150 psi. Use ASTM A240 Type 316L stainless steel bolts to attach the cap to the anchorage. When stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

D. Construction Requirements

1. Protection of Prestressing Steel

Protect prestressing steel against physical damage at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time will be rejected. Any reel that is found to contain broken wires will be rejected and the reel shall be replaced.

Package prestressing steel in containers or shipping forms for protection against physical damage and corrosion during shipping and storage. Place a corrosion inhibitor, which prevents rust or other results or corrosion, in the package or form, incorporated in a corrosion inhibitor carrier type packaging material, or, when permitted by the engineer, applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specifications MIL-P-3420. Immediately replace or restore to original condition packaging or forms damaged from any cause.

Clearly mark the shipping package or form with the heat number and with a statement that the package contains high-strength prestressing steel; use care in handling. Also mark the type and amount of corrosion inhibitor used, the date when placed, safety orders and instructions for use on the package or form.

Store the prestressing steel in a manner which will prevent the packing material from becoming saturated with water and allow a free flow of air around the packages. Immediately rejuvenate or replace the corrosion inhibitor if the useful life of the corrosion inhibitor in the package expires.

Free the prestressing steel from loose rust, loose mill scale, dirt, paint, oil, grease or other deleterious material at the time the prestressing steel is installed in the tendons. Removal of tightly adhering rust or mill scale is not required. Do not use prestressing steel which has experienced rusting to the extent that it exhibits pits visible to the naked eye.

Protect the prestressing steel from corrosion the entire period it is in place but ungrouted as provided below, if the period of time between installation of prestressing steel and grouting of the tendon will exceed 10 calendar days.

When the plans provide for prestressing steel to be installed in one unit with a length of prestressing steel left projecting to be threaded into another unit during erection, protect all of the prestressing from corrosion from immediately after it is installed in the first unit until the tendon is grouted in the second unit as provided below.

When corrosion protection of in-place prestressing steel is required, apply a corrosion inhibitor which prevents rust or other results of corrosion directly to the prestressing steel. Use a water soluble corrosion inhibitor with no deleterious effects on the prestressing steel or grout or bonding of the prestressing steel to the grout. The corrosion inhibitor, the amount and time of initial application, and the frequency of reapplication are subject to the Engineer's approval.

2. Installation of Ducts

Securely tie ducts in position, and carefully inspect and repair before placing the concrete. Exercise care during placement of the concrete to avoid displacing or damaging the ducts. Support internal ducts at intervals of not more than 4 feet. Any additional mild reinforcing required to support post-tensioning ducts shall be supplied by the contractor with no additional compensation. The tolerance on the location of the tendons shall be plus or minus ¼ inch at any point. After installation in the forms, keep the ends of the ducts sealed at all times to prevent entry of water and debris.

All ducts or anchorage assemblies for permanent post-tensioning shall be provided with vent pipes or other suitable connections at each end and at each side of couplers for the injection of grout after post-tensioning. Ducts, except vertical ducts, shall be vented at the high points of the post-tensioning steel profile when there is more than a 6 inch variation in the vertical position of the duct. All low points shall be vented if freezing weather conditions are anticipated prior to grouting. Use ½ inch minimum diameter standard pipe or suitable plastic pipe for vents. Make all connections to ducts with metallic or plastic structural fasteners. Use waterproof tape at all connections including vent and grouting pipes. Plastic components, if selected and approved, shall not react with the concrete or enhance corrosion of the post-tensioning steel, and shall be free of water soluble chlorides. The vents shall be mortar tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing the vents. Remove ends of steel vents at least 1 inch below the concrete surface after the grout has set. Properly grout over the vents with an epoxy grout. After the grout has set, remove the ends of plastic vents to the surface of the concrete.

Fit all grout injection and vent pipes with positive mechanical shut-off valves. Fill vents and injection pipes with valves, caps or other devices capable of withstanding the pumping pressures.

3. Testing of Prestressing Tendons by the Contractor

a. Testing by Contractor

<u>In-Place Friction Test</u>: For the purpose of accurately determining the friction loss in the tendons, test, in place, the first tendon installed or one selected by the Engineer. Use the same equipment to perform the tests as for the tensioning operations.

For the test procedure, stress the tendon at an anchorage assembly with the dead end consisting of a load cell.

Tension the test specimen to 80% of ultimate in 10 increments and then de-tension from 80% of ultimate to 0% in 10 increments. Record the gauge pressure, elongation and load cell force for each increment. Furnish this data to the Engineer. Re-evaluate as necessary the theoretical elongations shown on the post-tensioning working drawings using the results of the tests and correct as necessary. Submit revisions to the theoretical elongations to the Engineer for approval. Propose apparatus and methods used to perform the tests, subject to the review of the Engineer. After the initial testing, two more tests may be requested if difficulty in tensioning operations becomes apparent. Submit the results of the friction tests to the Engineer.

b. Test Data

Provide, in graph form, load extension test data for strand samples taken from each coil to be used in the work. Submit this data to the Engineer at least one week prior to the use in the work of any of the strand from the coil.

Identify all strand coils shipped to the Project by the use of metallic tags or other equally durable means, indicating the heat number and physical properties of the material. The marking system shall remain inplace until the entire coil has been used up. All strand received at the Project that does not have the required identification, as described above, will be rejected.

4. Post-Tensioning Operations

a. Stress in Tendons

The post-tensioning forces shown are theoretical and do not include losses in the system or thermal affects.

Tension all post-tensioning by means of hydraulic jacks so that the force of the prestressing steel shall not be less than the value shown on the approved working drawings. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 81 percent of the guaranteed ultimate tensile strength (GUTS) of the prestressing steel. Anchor the prestressing steel in a way that will result in the ultimate retention of forces not less than those shown on the approved working drawings, but in no case shall the stress, after anchor set, exceed 70 percent of the guaranteed ultimate tensile strength of the prestressing steel at the anchorage nor 75% at the end of the anchorage seating zone.

When friction must be reduced, water soluble oil or graphite with no corrosive agents may be used as a lubricant subject to the approval of the Engineer. Flush lubricants from the duct as soon as possible after stressing is completed by use of water pressure. Flush these ducts again just prior to the grouting operations. Each time the ducts are flushed, immediately blow dry with oil-free air.

b. Stressing Jacks

Equip each jack used to stress tendons with a pressure gauge that has an accurate reading dial at least 6 inch in diameter for determining the jack pressure. The display indicator on the gauge shall be readable by normal vision at a distance of 10 ft. Prior to use for stressing on the project, calibrate each jack and its gauge as a unit by a testing laboratory approved by the Engineer.

Perform calibration with the cylinder extension approximately in the position that it will be when applying the final jacking force and with the jacking assembly in an identical configuration to that which will be used at the job site (i.e. same length hydraulic lines). Furnish certified calibration calculations and a calibration chart, both in Metric units of measure, to the Engineer for each jack.

Perform recalibration of each jack at six month intervals and at other times when requested by the Engineer. Calibrations subsequent to the initial laboratory calibration may be accomplished by the use of a master gauge. Calibrate the master gauge at the same time as the initial calibration of the jacks, as part of the unit for each jack. Furnish the data recorded during the initial calibrations to the Engineer for use in the field. Supply the master gauge in a protective waterproof container capable of protecting the calibration of the master gauge during shipment. Provide a quick-attach coupler next to the permanent gauge in the hydraulic lines which enables the quick and easy installation of the master gauge to verify the permanent gauge readings. The Engineer shall possess the master gauge for the duration of the project. If a jack is repaired or modified, including replacing the seals or changing the length of the hydraulic lines, recalibrate the jack by the approved testing laboratory. No extra compensation will be allowed for the initial or subsequent jack calibrations or for the use and required calibration of a master gauge.

c. Stressing of Tendons

Do not apply post-tensioning forces until the concrete has attained the specified compressive strength as evidenced by tests on representative samples of the concrete. Store these samples under the same conditions as the concrete in order to accurately represent the curing condition of the concrete in place.

Conduct the tensioning process so that tension being applied and the elongation of the post-tensioning steel may be measured at all times. Keep a permanent record of gauge pressures and elongations at all times and submit to the Engineer. The post-tensioning force may be verified as deemed necessary by the Engineer.

For all tendons the elongation coinciding with the tendon force measured by gauge pressure shall agree within five percent of the theoretical calculated elongation for the entire operation. When provisional (unused) ducts are installed to accommodate future additional post-tensioning, the tolerance will be 7%. Check any deviation and determine and remedy the source of error to the satisfaction of the Engineer before proceeding with the work. Measure elongations to the nearest millimeter. In determining why the measured tendon force and the theoretical elongation do not agree within five percent, the Contractor may elect to establish that the apparent modulus of elasticity of the post-tensioning steel varies from the value shown in the general notes to the plans by conducting a bench test on a full size tendon in accordance with a procedure furnished by the Engineer. This test may be performed at a site remote from the project provided that the Contractor pays the cost to the Engineer of sending a representative to witness the test. The manufacturer of the system must furnish equipment for tensioning the tendons. Should agreement between pressure gauge readings and measured elongations fall outside the acceptable tolerances, the Engineer may require without additional compensation to the Contractor, additional in-place friction tests in accordance with these Special Provisions.

In the event that more than two percent of the individual strand wires in a tendon break during the tensioning operation, remove and replace the tendon. Do not allow previously tensioned strands unless approved by the Engineer.

Cut prestressing steel using an abrasive saw within ¾ inch to 1½ inches away from the anchoring device. Do not flame cut prestressing steel, except for pretensioned prestressing steel.

5. Grouting Operations

a. Grouting Operations Plan

Submit a grouting operations plan for approval at least six weeks in advance of any scheduled grouting operations. Written approval of the grouting operations plan by the Engineer is required before any grouting of the permanent structure takes place.

At a minimum, the plan will address and provide procedures for the following items:

(1) Names and proof of training for the grouting crew and the crew supervisor in conformance with this specification;
(2) Type, quantity, and brand of materials used in grouting including all certifications required;
(3) Type of equipment furnished, including capacity in relation to demand and working condition, as well as back-up equipment and spare parts;
(4) General grouting procedure;
(5) Duct pressure test and repair procedures;
(6) Method to be used to control the rate of flow within ducts;
(7) Theoretical grout volume calculations;
(8) Mixing and pumping procedures;
(9) Direction of grouting;
(10) Sequence of use of the inlets and outlet pipes;
(11) Procedures for handling blockages;
(12) Procedures for possible post grouting repair.

b. Before Grouting Operations

Conduct a pre-grouting conference with the grouting crew and the Engineer. At the meeting discuss the grouting operation plan, required testing, corrective procedures and any other relevant issues.

c. Grout Inlets and Outlets

Ensure the connections from the grout pump hose to inlets are free of dirt and are air- tight. Inspect valves to be sure that they can be opened and closed properly.

d. Supplies

Before grouting operations start, provide an adequate supply of water and compressed air for clearing and testing the ducts, mixing and pumping the grout. Where water is not supplied through the public water supply system, provide a water storage tank of sufficient capacity.

e. Equipment

General: Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (holding reservoir) and a pump with all the necessary connecting hoses, valves, and pressure gauge. Provide pumping equipment with sufficient capacity to ensure that the post-tensioning ducts to be grouted can be filled and vented without interruption at the required rate of injection in not more than 30 minutes.

(1) Provide an air compressor and hoses with sufficient output to perform the required functions.
(2) Provide vacuum grouting equipment (volumetric measuring type) prior to the start of grouting operations and retain the equipment on the job during the duration of tendon grouting operations.

Mixer, Storage Hopper: Provide a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and undispersed cement. The colloidal grout machinery will have a charging tank for blending and a holding tank. The blending tank must be equipped with a high shear colloidal mixer. The holding tank must be kept agitated and at least partially full at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct. Add water during the initial mixing by use of a flow meter or calibrated water reservoir with a measuring accuracy equal to one percent of the total water volume.

Grout Pumping Equipment: Provide pumping equipment capable of continuous operation which includes a system for circulating the grout when actual grouting is not in progress. The equipment will be capable of maintaining pressure on completely grouted ducts and will be fitted with a valve that can be closed off without loss of pressure in the duct. Grout pumps will be positive displacement type, and will provide a continuous flow of grout and will be able to maintain a discharge pressure of at least 145 psi. Pumps will be constructed to have seals adequate to prevent oil, air or other foreign substances entering the grout and to prevent loss of grout or water. The capacity will be such that an optimal rate of grouting can be achieved. Place a pressure gauge having a full scale reading of no more than 300 psi at the duct inlet. If long hoses (in excess of 100 ft are used, place two gauges, one at the pump and one at the inlet. The diameter and rated pressure capacity of the grout hoses must be compatible with the pump output.

Vacuum Grouting Equipment: Provide vacuum grouting equipment at the job site, concurrently with all pressure grouting operations, consisting of the following:

- Volumeter for the measurement of void volume
- Vacuum pump with a minimum capacity of 10 cfm and equipped with flow-meter capable of measuring amount of grout being injected
- Manual colloidal mixers and/or dissolvers (manual high speed shear mixers), for voids less than 20 liters in volume
- Standard colloidal mixers, for voids 20 liters and greater in volume

Stand-by Equipment: During grouting operations, provide a stand-by grout mixer and pump.

f. Grouting

(1) General: Perform test to confirm the accuracy of the volume-measuring component of the vacuum grouting equipment each day before performing any grouting operations. Use either water or grout for testing using standard testing devices with volumes of 0.5 gal and 6.5 gal and an accuracy of equal to or less than 4 oz. Perform one test with each device. The results must verify the accuracy of the void volume-measuring component of the vacuum grouting equipment within 1% of the test devise volume and must verify the accuracy of the grout volume component of the vacuum grouting equipment within 5% of the test devise volume. Ensure the Engineer is present when any tests are performed. Grout tendons in accordance with the procedures set forth in the approved grouting operation plan. Grout all empty ducts.

(2) Temperature Considerations: Maximum grout temperature must not exceed 90°F at the grout inlet. Use chilled water and/or pre-cooling of the bagged material to maintain mixed grout temperature below the maximum allowed temperature. Grouting operations are prohibited when the ambient temperature is below 40°F or is 40°F and falling.

(3) Mixing and Pumping: Mix the grout with a metered amount of water. The materials will be mixed to produce a homogeneous grout. Continuously agitate the grout until grouting is complete.

(4) Grout Production Test: During grouting operations the fluidity of the grout must be strictly maintained within the limits established by the grout manufacturer. A target fluidity rate will be established by the manufacturer’s representative, based on ambient weather conditions. Determine grout fluidity by use of either test method found in SB-18.2.04. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious ratio. Do not use grout which tests outside the allowable flow rates.

- Prior to grouting empty ducts, condition the grout materials as required to limit the grout temperature at the inlet end of the grout hose to 90°F. Prior to performing repair grouting operations, condition the grout materials to limit the grout temperature at the inlet end of the grout hose to 85°F. Check the temperature of the grout at the inlet end of the grout hose hourly.

- Perform a wick induced bleed test in accordance with SB-18.2.04 at the beginning of each day’s grouting operation for the initial two cantilevers and spans being precast or erected. Frequency may be reduced to the first and every third day of consecutive grouting operations should zero bleed be consistently achieved.

- If zero bleed is not achieved at the end of the required time period, do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.

(5) Grout Operations: Open all grout outlets before starting the grouting operation. Grout tendons in accordance with the Grouting Operations Plan.

- Unless approved otherwise by the Engineer, pump grout at a rate of 16 ft to 50 ft of duct per minute. Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at the grout inlet. Do not exceed the maximum pumping pressure of 145 psi at the grout inlet.

- Use grout pumping methods which will ensure complete filling of the ducts and complete encasement of the steel. Grout must flow from the first and subsequent outlets until any residual water or entrapped air has been removed prior to closing the outlet.

- Pump grout through the duct and continuously discharge it at the anchorage and grout cap outlets until all free water and air are discharged and the consistency of the grout is equivalent to that of the grout being pumped into the inlet. Close the anchorage outlet and discharge a minimum of 2 gal of grout from the grout cap into a clean receptacle. Close the grout cap outlet.

- For each tendon, immediately after uncontaminated uniform discharge begins, perform a fluidity test using the flow cone on the grout discharged from the anchorage outlet. The measured grout efflux time will not be less than the efflux time measured at the pump or minimum acceptable efflux time as established in SB-18.2.04. Alternately, check the grout fluidity using the Wet Density method contained in SB-18.2.04. The measured density must fall within the values established in SB-18.2.04. The density at the final outlet must not be less than the grout density at the inlet. If the grout fluidity is not acceptable, discharge additional grout from the anchorage outlet and test the grout fluidity. Continue this cycle until an acceptable grout fluidity is achieved. Discard grout used for testing fluidity. After all outlets have been bled and sealed, elevate the grout pressure to ±75 psi, seal the inlet valve and wait two minutes to determine if any leaks exist. If leaks are present, fix the leaks using methods approved by the Engineer. Repeat the above stated process until no leaks are present. If no leaks are present, bleed the pressure to 5 psi and wait a minimum of ten minutes for any entrapped air to flow to the high points. After the minimum ten minutes period has expired, increase the pressure as needed and discharge grout at each high point outlet to eliminate any entrapped air or water. Complete the process by locking a pressure of 30 psi into the tendon.

- If the actual grouting pressure exceeds the maximum allowed, the inlet will be closed and the grout will be pumped at the next outlet, which has just been, or is ready to be closed as long as a one-way flow is maintained. Grout will not be pumped into a succeeding outlet from which grout has not yet flowed. If this procedure is used, the outlet/inlet, which is to be used for pumping, will be fitted with a positive shut-off and pressure gage.

- When complete grouting of the tendon cannot be achieved by the steps stated herein, stop the grouting operation. After waiting 48 hours, fill the tendon with grout in accordance with the procedure outlined in SB-18.3.10.F.8.

(6) Vertical Grouting: For all vertical tendons, provide a standpipe at the upper end of the tendon to store bleed water and grout, maintain the grout level above the level of the prestressing plate and anchorage. This device will be designed and sized to maintain the level of the grout at an elevation which will assure that bleeding will at no time cause the level of the grout to drop below the highest point of the upper anchorage device. Design the standpipe to allow all bleed water to rise into the standpipe, not into the uppermost part of the tendon and anchorage device.

- Discharge grout and check grout fluidity as described above. As grouting is completed, the standpipe will be filled with grout to a level which assures that, as settlement of the grout occurs, the level of the grout will not drop below the highest point in the upper anchorage device. If the level of the grout drops below the highest point in the anchorage device, immediately add grout to the standpipe. After the grout has hardened, the standpipe will be removed. In the presence of the Engineer, visually inspect for voids using an endoscope or probe. Fill all voids found in the duct using volumetric measuring vacuum grouting processes.

- If the grouting pressure exceeds the maximum recommended pumping pressure, then grout will be pumped at increasingly higher outlets which have been or are ready to be closed as long as a one-way flow of grout is maintained. Grout will be allowed to flow from each outlet until all air and water have been purged prior to using that outlet for pumping.

(7) Construction Traffic and Operations Causing Vibrations: During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from sources such as moving vehicles on the partially completed superstructure as well as jackhammers, compressors, generators, pile driving operations and soil compaction operations that are operating within 300 ft down-station and 300 ft up-station of the ends of the span in which grouting is taking place.

(8) Post-Grouting Operations and Inspection: Do not remove or open inlets and outlets until the grout has cured for 24 to 48 hours. Perform inspections within one hour after the removal of the inlet/outlet. After the grout has cured, remove all outlets located at anchorages and high points along the tendon to facilitate inspection. Drill and inspect all high points along the tendon as well as the inlets or outlets located at the anchorages. Depending on the geometry of the grout inlets, drilling may be required to penetrate to the inner surface of the trumpet or duct. Use drilling equipment that will automatically shut-off when steel is encountered. Unless grout caps are determined to have voids by sounding, do not drill into the cap. Perform inspections in the presence of the Engineer using endoscopes or probes. Within four hours of completion of the inspections, fill all duct and anchorage voids using the volumetric measuring vacuum grouting process.

- Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes. Remove the inlet/outlet to a minimum depth of 2 inches. Use an injection tube to extend to the bottom of the drilled holes for backfilling with epoxy.

- Post grouting inspection of tendons having a length of less than 150 ft may utilize the following statistical frequency for inspection:

- Utilize the following statistical frequency for post grouting inspection of the cantilever tendons, or as directed by the Engineer.

    - Inspect the first 9 cantilever tendons at outlets located at anchors and tendon high points by drilling and probing with the MnDOT owned endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), repeat this step (100% inspection) until no defects are detected.

    - When no defects are detected as defined in No. 1 above, then the frequency of inspection may be reduced to inspect every fourth tendon (25%). If a defect is located, inspect 100% of the last three tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

- Utilize the following statistical frequency for post grouting inspection of the continuity tendons (tendons in the bottom of the segments, between the piers, which extend in the longitudinal direction), or as directed by the Engineer.

    - Inspect the first 9 continuity tendons at outlets located at anchors and tendon high points by drilling and probing with the MnDOT owned endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), repeat this step (100% inspection) until no defects are detected.

  - When no defects are detected as defined in No. 1 above, then the frequency of inspection may be reduced to inspect every other tendon (50%). If a defect is located, inspect 100% of the last three tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

- Utilize the following statistical frequency for post grouting inspection of all other tendons, except as noted otherwise or as directed by the Engineer.

  - Inspect the first 2 tendons at outlets located at anchors and tendon high points by drilling and probing with the MnDOT owned endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), repeat this step (100% inspection) until no defects are detected.

  - When no defects are detected as defined in No. 1 above, then the frequency of inspection may be reduced to inspect every twentieth tendon (5%). If a defect is located, inspect 100% of the last three tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

- If tendon grouting operations were prematurely terminated prior to completely filling the tendon, drill into the duct and explore the voided areas with an endoscope. Probing is not allowed. Determine the location and extent of all voided areas. Install grout inlets as needed and fill the voids using volumetric measuring vacuum grouting equipment.

(9) Grouting Report: Provide a grouting report signed by the Contractor and/or the Subcontractor within 72 hours of each grouting operation for review by the Engineer.

- Report the theoretical quantity of grout anticipated as compared to the actual quantity of grout used to fill the duct. Notify the Engineer immediately of shortages or overages.

- Information to be noted in the records must include but not necessarily be limited to the following:

  - Identification of the tendon
  - Date grouted
  - Number of days from tendon installation to grouting
  - Type of grout
  - Injection end and applied grouting pressure, ratio of actual to theoretical grout quantity
  - Summary of any problems encountered and corrective action taken.

E. Protection of Prestress Anchorages

As soon as possible but not to exceed 14 days after tensioning and grouting is completed, clean exposed end anchorages, strands, other metal accessories and concrete in and around blockout by sandblasting or equal of rust, misplaced mortar, grout, and other such materials. The surfaces of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and aggregate exposed. Immediately following the cleaning operations, thoroughly dry the entire surface of the anchorage recess (all metal and concrete) and place permanent grout caps on each anchor head. Apply a heavy unbroken coating of "wet-to-dry" epoxy bonding compound, per AASHTO M235, Class II, to all surfaces against which concrete or grout will be cast.

When blockouts are used, the following shall apply: Place epoxy coated mesh across the anchor head block out and tie to the inplace reinforcement with plastic coated wire ties. Place an approved high strength and low shrinkage grout over the anchor heads. After the grout has cured, place an approved epoxy paint (which does not delaminate) over the concrete block out. Cover the entire block out plus at least 1 ft all around as approved by the Engineer. Apply this epoxy paint in a manner and thickness as recommended by the manufacturer.

F. Final Clean Up

Before Final Acceptance, clean the interior of the concrete box girders of all rubbish, excess materials, loose concrete, grout, dirt, and debris. Sweep out the interior of the box girders. Perform the final clean up after all work on the interior of the box girders, including grouting of all tendons and electric work, has been completed.

G. Method of Measurement

Measurement will be per system. This includes full compensation as described above.

H. Basis of Payment

Payment for Item No. 2405.616 "POST-TENSIONING SYSTEM" will be made at the Contract Price per System and shall be full compensation for furnishing, installing, testing, stressing and grouting all temporary and permanent post-tensioning tendons. Payment includes anchorage assemblies, additional reinforcement for supporting ducts, lubricants, cleaning of ducts, grout and grouting, testing, anchorage protection systems, labor, materials, tools, equipment and incidentals necessary for completing the work in accordance with Contract requirements.

SB2018-2406
Use only when reconstructing an E8 AND when not in the grading plan.
CREATED 9/1/2017
REVISED 12/11/2017 (4)

SB- (2406) BRIDGE APPROACH PANELS

The provisions of 2406.3.I, "E8 Expansion Joint Seal," are substituted with the following:

A. Description of Work

Remove existing joint seal 4 inches wide by the full-depth of the slab. Inspect to ensure the joint is 4 inches wide for the full depth of the slab. Inspect to ensure the inside walls of the joint have been clean, dry, smooth and free of debris and loose particles. If any of the following conditions exist, cut the joint to a 4 inch wide opening full-depth for the full length of joint (Engineer will decide the following):

- The joint is less than 3.5 inches in width;
- The side of the joint is unsuitable for sealing due to rough irregular edge; or
- The concrete is deteriorated and unsuitable for bonding length along the bonding area after sandblasting.

1 - DESIGNER NOTE: The following five paragraphs may be substituted or mixed/matched for/with the above paragraph and bullet list when removing failing compression joint steel protection angles and inserting a preformed E8 Expansion Joint Seal.

Remove the old compression joint steel protection angles. This removal requires partial depth removal of the adjacent concrete slab on each side of the joint. Recast the concrete header (3Y47) and install a Preformed E8 expansion joint seal. These provisions allow for the Contractor to propose an alternate header material such as Wabocrete, or an approved equal, in order to reduce the duration of the required cure time, to be accepted by the Engineer. All concrete surfaces that are in contact with the seal adhesive must be at least 28 calendar days old prior to installation of the expansion joint seal.

Verify the joint opening is uniform and per plan dimensions and that the concrete surface is appropriately prepared per product manufacturer's installation instructions. Supply a joint material that is designed by the manufacturer to fit the field measured joint.

Clean and dry joint faces by sandblasting and air blasting prior to sealing the joint.

Install the seal according to the manufacturer's instructions.

B. Material

Furnish only one of the materials listed on the Department's "Approved/Qualified Product Lists of Bridge, Preformed E8 expansion joint seal" (http://www.dot.state.mn.us/products/index.html). Prepare and install the joint in accordance with manufacturer's instructions.

C. Basis of Payment

Payment for item No. 2406.603 "EXPANSION JOINTS, DESIGN E8 SPECIAL," at the Contract price per linear foot and shall be compensation in full for all related work (except for saw cutting) described in 2406, "Bridge Approach Panels," and above as complete in place.

Saw cutting existing concrete found unsuitable by the Engineer or having inadequate opening will be paid for under Item No. 2301.603 "EXPANSION RELIEF CUT 4" WIDE," at the Contract price per linear foot.

2 - DESIGNER NOTE: Neither item is a plan quantity. Designer should verify a quantity for "EXPANSION RELIEF CUT 4" WIDE" exists in bridge plan, or grading plan if E8 rehabilitation included in grading plan.

SB2018-2407.1

Use when crack pretreatment is recommended by Regional Bridge Construction Engineer in conjunction with an Epoxy Chip Seal.

CREATED 9/1/2017

REVISED 9/1/2017

SB- CRACK PRETREATMENT FOR CHIP SEAL WEARING COURSE

A. Description of Work

This work consists of pretreating cracks through a flood application of crack sealant prior to placing a $^{3}/_{8}$" Epoxy Chip Seal Wearing Course or Epoxy-Urethane Chip Seal Wearing Course. All references within this specification to Epoxy Chip Seal Wearing Course are also applicable to an Epoxy-Urethane Chip Seal Wearing Course. Preparing the concrete surface, furnishing and applying the wearing course system are paid for separately. Flood application of sealant shall occur immediately prior to Epoxy chip seal application within the manufacturer limits for bonding time. Crack sealant used must be from the same manufacturer as the Epoxy Chip Seal placed.

B. Materials

1. General

Furnish materials specifically designed for healing cracks in concrete bridge decks that are from the same manufacturer as the Epoxy Chip Seal binder material to be placed. Prefill all cracks greater than 0.040" wide immediately ahead of the flood seal. After prefilling cracks, flood seal the entire surface to be covered with subsequent wearing course, and fill all existing cracks to a level even with the surrounding surface. Place only areas that will be covered by Epoxy Chip Seal Wearing Course within the recommended timeframe for placing epoxy chip seals over the pretreatment.

Figure 1: Prefilling cracks .040" and larger

Figure 2: Flood seal deck 12 mil minimum

2. Crack Pretreatment Resin

Crack treatment shall be composed of a two part epoxy that is flooded on the deck prior to wearing course to enhance bond. Furnish primer or pretreatment compatible with epoxy urethane in accordance with the manufacturer's recommendations and meeting the following requirements:

Property	Requirements	Test Method
Compressive Strength	Min. 5000 psi	ASTM C109
Tensile Strength	Min 2500 psi	ASTM D638
Tensile Elongation	30% - 70% @ 7 days	ASTM D638
Absorption [A]	1% maximum at 24 hr	ASTM D570
Shore D Hardness	Min. 65-75 at 77º	ASTM D2240
Adhesion to Concrete	100% failure in conc.	ASTM 1583
Viscosity cP	Max. 300	-

[A] Cured, mixed epoxy urethane binder

3. Approval of Bridge Deck Epoxy Urethane Wearing Course System

A minimum of 20 working days prior to application, submit product data sheets and specifications from the manufacturer, product history/reference projects, and a certified test report to the Engineer for approval of the pretreatment materials with corresponding proposed epoxy wearing course system. The engineer may request samples of the pretreatment sealer, prior to application, for the purpose of acceptance testing by the Department.

A certified test report consists of a certification by an independent testing laboratory showing compliance with the requirements of this specification. Include the test results with the certification.

Product data sheets and specifications from the manufacturer consists of literature from the manufacturer showing general instructions, application recommendations and methods, product properties, general instructions, or any other applicable information. Include table showing estimates of the working timeframe for overcoating any pretreatment with the epoxy chip seal wearing course based on environmental influences (Temperature, humidity, wind or other). Include procedures to be implemented if crack pretreatment is fouled by contaminants of dust, water, or chemicals prior to topping with an epoxy chip seal wearing course.

C. Construction

1. General

Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the Engineer a copy of the recommended procedures and apply the pretreatment according to the manufacturer's instructions. The manufacturer's representative familiar with the wearing course system installation procedures, shall inspect all surface preparation prior to placing the epoxy chip seal wearing course and shall be present at all times during wearing course placement to provide quality assurance that the work is being performed properly.

The requirement for manufacturer’s representative may be waived by the Engineer provided:

(1) The contractor presents evidence they are certified applicators by the epoxy manufacturer for the product being applied.

(2) The specific foreman supervising the epoxy placement produces evidence of three successful epoxy chip seal placements in the last two years with references and contact information for the owner of the referenced placements.

(3) The manufacturer representative must be available for consultation at any time during the epoxy chip seal placement and for evaluating preparation of the concrete prior to placing the epoxy chip seal.

Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturer’s recommendations.

2. Deck Preparation (Included in Epoxy Chip Seal Wearing Course provisions and payment)

3. Application of the Crack Pretreatment

Perform the handling and mixing of the epoxy urethane resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer’s instructions. Follow all manufacturer written application instructions.

After the deck has been shotblasted or during the wearing course curing period, only necessary surface preparation and wearing course application equipment will be allowed on the deck. Do not place unauthorized equipment over flood sealed areas that have not fully cured.

Hand mixing of material is not permitted. Use an application machine with positive displacement volumetric metering capable of storing and mixing resins at the proper mix ratio.

Follow the cure times listed under this specification or as prescribed by the manufacturer. Do not allow traffic on the treated area until directed by the Engineer.

In the event Contractors operations damages or mars the wearing course, remove the damaged areas by saw cutting in rectangular sections and replacing the wearing course in accordance with this specification at no additional cost.

Take measures to prevent construction liquids from entering into lanes of traffic on the bridge. All property claims resulting from damaging liquids is the responsibility of the contractor.

4. Application Rates

Achieve a minimum 12 mil pretreatment over the entire surface of the area to receive chip seal wearing course. Fill all cracks even with surrounding concrete after sealants have gelled.

5. Acceptance

Acceptance of the materials will be based on the certified test report received during the approval process, a certification of compliance from the manufacturer, and results of any acceptance tests ordered or performed by the Engineer during construction.

D. Method of Measurement

The Department will measure Crack Pretreatment for Chip Seal Wearing Course in area by square feet of deck or sidewalk and may include approach panel areas.

E. Basis of Payment

Payment will be made under Item 2407.618, "CRACK PRETREATMENT FOR CHIP SEAL WEARING COURSE" for measured quantities at the contract bid price per square foot. Quantity can include roadway deck area or sidewalks or a combination thereof.

SB2018-2407.2

Use when Epoxy Chip Seal (Normal epoxy – not epoxy-urethane binder) is recommended by Regional Bridge Construction Engineer. To date, there have not been significant difference between epoxy and epoxy-urethane performance, although binder material cost is 50% greater.

CREATED 9/1/2017

REVISED 5/1/2018 (1)

SB- POLYMER WEARING COURSE TYPE EPOXY

A. Description of Work

This work consists of preparing deck surface, furnishing and applying a multiple layer epoxy and aggregate wearing course system as shown on the Plans. The wearing course will provide deck protection and increased skid resistance. The total thickness of the wearing course will be $^{3}/_{8}$" minimum.

B. Materials

1. General

Furnish materials specifically designed for use over concrete bridge decks. Pre-qualified polymer liquid binders are as follows:

Product Trade Name	Manufacturer or Supplier	Telephone
Mark-163 Flexogrid	PolyCarb, Inc.	(866) 765-9227
Sikadur 22 Lo Mod FS	Sika Corporation	(800) 933-7452
Sikadur 22 Lo-mod	Sika Corporation	(800) 933-7452
E-Bond 526 Lo-Mod	E-Bond Epoxies, Inc.	(954) 566-6555
Propoxy DOT Type III	Unitex	(816) 231-7700
Sure Level Epoxy (J-57)	Dayton Superior	(888) 977-9600
ICO Flexi-Coat	International Coatings	(800) 624-8919
Flexolith	Euclid Chemical Co.	(800) 321-7628
MASTERSEAL 350 (Formerly Trafficguard EP35)	BASF	(800) 433-9517
EPX50-Overlay	E-Chem, LLC	(505) 217-2121

2. Epoxy Resin

The polymer resin base and hardener shall be composed of two-component, 100% solids, 100% reactive, thermosetting compound with the following properties:

Property	Requirements	Test Method
Gel Time [A]	15 - 45 minutes @ 75° F	ASTM C881
Viscosity [A]	7 - 70 poises	ASTM D2393, Brookfield RVT, Spindle No. 3, 20 rpm
Shore D Hardness [B]	60-75	ASTM D2240
Absorption [B]	1% maximum at 24 hr	ASTM D570
Tensile Elongation [B]	30% - 70% @ 7 days	ASTM D638
Tensile Strength [B]	>2000 psi @ 7 days	ASTM D638
Flexural Strength [B]	>4500 psi @ 7 days	ASTM D790
Chloride Permeability[B]	<100 coulombs @ 28 days	AASHTO T277

[A] Uncured, mixed polymer binder
[B] Cured, mixed polymer binder

3. Aggregates

Furnish natural or synthetic aggregates that have a proven record of performance in applications of this type. Furnish aggregates that are non-polishing, clean, free of surface moisture, fractured or angular in shape; free from silt, clay, asphalt, or other organic materials; and meet the following properties and gradation requirements:

Aggregate Properties:

Property	Requirement	Test Method
Moisture Content	$\leq$0.2%	ASTM C566
Hardness	$\geq$6.5	Mohs Scale
Fractured Faces	100% with at least 1 fractured face & 80% with at least 2 fractured faces of material retained on No. 16	ASTM 5821
Absorption	$\leq$1%	ASTM C128

Gradation for roadway deck:

Sieve Size	% Passing by Weight
No. 4	100
No. 8	30 – 75
No. 16	0 – 5
No. 30	0 – 1

No Dresser Trap Rock is allowed due to excessive dust. The color of the aggregate will be dark unless noted otherwise.

Gradation for sidewalk:

Sieve Size	% Passing by Weight
No. 4	100
No. 8	95-100
No. 16	30-70
No. 30	0-3
No. 100	0-1

The color for sidewalk aggregate will be light unless noted otherwise.

4. Required Properties of Wearing Course System

The required properties of the wearing course system are listed in the table below:

Property	Requirement [A]	Test Method
Minimum Compressive Strength. (psi)	1,000 psi @ 8 hrs 5,000 psi @ 24 hrs	ASTM C579 Method B, Modified [B]
Thermal Compatibility	No Delaminations	ASTM C884
Minimum Pull-off Strength	250 psi @ 24 hrs	ASTM C1583

[A] Based on samples cured or aged and tested at 75°F
[B] Plastic inserts that will provide 2-inch by 2-inch cubes shall be placed in the oversized brass molds.

5. Approval of Bridge Deck Epoxy Wearing Course System

A minimum of 20 working days prior to application, submit product data sheets and specifications from the manufacturer, product history/reference projects, and a certified test report to the Engineer for approval of the wearing course system. The engineer may request samples of the epoxy and/or aggregate, prior to application, for the purpose of acceptance testing by the Department.

A certified test report consists of a certification by an independent testing laboratory showing compliance with the requirements of this specification. Include the test results with the certification.

Product data sheets and specifications from the manufacturer consists of literature from the manufacturer showing general instructions, application recommendations and methods, product properties, general instructions, or any other applicable information.

C. Construction Requirements

1. General

Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the Engineer a copy of the recommended procedures and apply the wearing course system according to the manufacturer's instructions. The manufacturer's representative familiar with the wearing course system installation procedures, shall inspect all surface preparation prior to placing chip seal wearing course and shall be present at all times during wearing course placement to provide quality assurance that the work is being performed properly.

The requirement for manufacturer's representative may be waived by the Engineer provided:

(1) The contractor presents evidence they are certified applicators by the epoxy manufacturer for the product being applied.

(2) The specific foreman supervising the epoxy placement produces evidence of three successful epoxy chip seal placements in the last two years with references and contact information for the owner of the referenced placements.

(3) The manufacturer representative must be available for consultation at any time during the epoxy chip seal placement and for evaluating preparation of the concrete prior to placing the epoxy chip seal.

Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturer's recommendations. Store all aggregates in a dry environment and protect aggregates from contaminants on the job site.

For rehabilitation projects with partial depth bridge removal, contractor shall coordinate final deck profile surface with chip seal wearing course supplier.

2. Deck Preparation

a. Surface Preparation

Determine an acceptable shotblasting machine operation (size of shot, flow of shot, forward speed, and number of passes) that provides a surface profile meeting CSP 5 according to the International Concrete Repair Institute Technical Guideline No. 03732. Continue adjusting the shotblasting machine and necessary testing until the surface is acceptable to the Engineer or a passing test result is obtained.

Prepare the entire deck using the final accepted adjustments to the shotblasting machine as determined above. Thoroughly blast clean with hand-held equipment any areas inaccessible by the shotblasting equipment. Do not perform surface preparation more than 24 hours prior to the application of the wearing course system.

Take special precautions to control and abate the dust generated by the blasting operation in accordance with MPCA Rule 7011.0150 https://www.revisor.leg.state.mn.us/rules/?id=7011.0150. Submit the proposed plan for dust abatement at least 14 days before the start of this work. Include in the abatement plan, but not necessarily limit to, the following operations and procedures:

(1) Thoroughly sweep the bridge and approach slab(s) prior to blasting. Ensure a power sweeper uses the least amount of water necessary to minimize the dust from the sweeping operation.

(2) Enclose the blast wheel or blasting nozzle(s) in a housing or direct into a housing. Ensure the housing has a negative air emission control system that draws the confined air and dust into an adequate filter collection system. Ensure the capacity of the exhaust system is sufficient to readily relieve the pressure generated within the housing by the blasting equipment. Clean the filter collection system as necessary to ensure proper filtration. Ensure the sides and corners of the housing are flexible at the bottom to the extent that the bottom of the housing is in contact with the deck surface during all blasting operations.

(3) Construct, maintain and operate the housing and/or filter collection system so that avoidable dust emissions are eliminated.

(4) After blasting, hand-sweep the prepared surface or sweep with a "Pickup" type power sweeper equipped with adequate dust storage capacity. Completely remove all minor debris remaining after the sweeping operation by airblasting. Construct the air supply system so that a suitable oil trap is placed in the air supply line between the storage tank and the nozzle.

Prior to full application of wearing course three representative areas shall be tested to verify surface preparation is adequate.

Test in accordance with ASTM C1583 "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method)". The failure should be in the concrete substrate and not in the chip seal wearing course or the bond of the wearing course to the substrate. The pullout value should not be less than 250 psi with more than 50 percent of the failure area in the concrete at a depth of ¼" or greater. Repair of the test area shall be incidental to chip seal wearing course.

Just prior to wear course placement, clean all dust, debris, and concrete fines from the deck surface including vertical faces of curbs and barrier walls up to a height of 2 inches above the wearing course with compressed air. When using compressed air, the air stream must be free of oil. Any grease, oil, or other foreign matter that rests on or has absorbed into the concrete shall be removed completely. Brooms shall not be used.

Cover the bridge deck drains and bridge expansion joints to prevent materials from adhering and entering.

If required for rehabilitation projects create a transitional area approaching transverse expansion joints and ends of the deck or approach panel using the shot blasting machine or other approved method. Remove $^{5}/_{16}$"to $^{3}/_{8}$" of concrete adjacent to the joint or end of deck and taper a distance of 3 feet.

Any surface preparation including shotblasting shall be incidental to chip seal wearing course.

The Engineer may consider alternate surface preparation methods per the wear course system manufacturer's recommendations. The Engineer will approve the final surface profile and deck cleanliness prior to the contractor placing the chip seal wearing course.

All deck preparation equipment will be staged at least 50' from deck so as not to get any windblown dust on the bridge prior to placement.

3. Application of the Wearing Course

Perform the handling and mixing of the epoxy resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer's instructions. Do not apply the wearing course system if any of the following exists:

a. Ambient air temperature is below 60ºF;
b. Deck temperature is below 60ºF;
c. Moisture content in the deck exceeds 4.5% when measured by an electronic moisture meter or shows visible moisture after 2 hours when measured in accordance with ASTM D4263.
d. Rain is forecasted within 8 hours after the estimated completion time;
e. Materials component temperatures below 50ºF.
f. Epoxy wearing course shall not be placed until all deck concrete has 28 days of cure. On rehabilitation projects, contractor may propose alternative deck patch material to reduce cure time with written approval from epoxy supplier and approval from Engineer. Moisture content tests will be required as part of submittal by contractor.

After the deck has been shotblasted or during the wearing course curing period, only necessary surface preparation and wearing course application equipment will be allowed on the deck.

Begin wearing course placement as soon as possible after surface preparation operations.

The epoxy wearing course shall consist of a two-course application of epoxy and aggregate. Each of the two courses shall consist of a layer of epoxy covered with a layer of aggregate in sufficient quantity to completely cover the epoxy. Apply the epoxy and aggregate a minimum 2" up from deck on vertical surface of concrete barrier. Apply the epoxy and aggregate according to the manufacturer's requirements. Apply the wearing course using equipment designed for this purpose. Hand mixing of material is not permitted.

The wearing course manufacturer representative will be at the job site during the entire application unless the conditions under SB-XX.2, "General", are met. The application machine shall feature positive displacement volumetric metering and be capable of storing and mixing the epoxy resins at the proper mix ratio. Disperse the aggregate using a standard chip spreader or equivalent machine that can provide a uniform, consistent coverage of aggregate. The dry aggregate shall be applied in such a manner as to cover the epoxy mixture completely within 5 minutes.

Remove and replace first course applications that do not receive enough aggregate before the epoxy gels. A second course applied with insufficient aggregate may be left in place, but will require additional application(s) before opening to traffic.

After completion of each course, cure the wearing course according to the manufacturer's instructions. Follow the minimum cure times listed under this specification or as prescribed by the manufacturer. Remove the excess aggregate from the surface treatment by sweeping, blowing, or vacuuming without tearing or damaging the surface; the material may be re-used if approved by the Engineer and manufacturer. Apply all courses of the wearing course system before opening the area to traffic. Do not allow traffic on the treated area until directed by the Engineer. Do not broom excess aggregate from any layer of the wearing course until the wearing course has cured sufficiently to ensure that the brooming operations will not damage the surface.

In the event Contractors operations damages or mars the wearing course, remove the damaged areas by saw cutting in rectangular sections and replace the wearing course in accordance with this specification at no additional cost to the Department.

After the first layer of coating has cured to the point where the aggregate cannot be pulled out, apply the second layer. Prior to applying the second layer, broom and blow off the first layer with compressed air to remove all loose excess aggregate.

Prior to opening to traffic, clean expansion joints and joint seals of all debris and epoxy.

No traffic is allowed on lanes between first and second application.

If there are small deck panel areas that cannot freely drain water after second chip seal application, isolated areas of a third layer may be required to achieve positive drainage.

If the Engineer requires additional verification of adequate chip seal bonding to the deck, the contractor shall perform one additional tensile bond strength test per ASTM C1583 similar to pre application test. If there is a failure in bond of wearing course to the deck, the contractor shall perform additional test(s) to determine extent of the debonded area. Repair options for debonded areas, include partial and up to total removal of chip seal wearing coarse and reapplication. All testing and repairs are considered incidental.

Take measures to prevent liquid or aggregate entering into lanes of traffic on the bridge. All property claims resulting from liquid or aggregate damage is responsibility of the contractor.

4. Application Rates

Apply the epoxy wearing course in two separate courses in accordance with the manufacturer's instructions, but not less than the following rate of application.

Course	**Minimum Epoxy Rate** [A] **(GAL/100 SF)**	**Aggregate** [B] **(LBS/SY)**
1	2.5	10+
2	5.0	14+

[A] The minimum total applications rate is 7.5 GAL/100 SF.
[B] Application of aggregate shall be of sufficient quantity to completely cover the epoxy.

5. Minimum Curing Periods

As a minimum, cure the coating as follows:

	Average temperature of deck, epoxy and aggregate components in °F					
Course	**60-64**	**65-69**	**70-74**	**75-79**	**80-84**	**85+**
1	4 hrs.	3 hrs.	2.5 hrs	2 hrs	1.5 hrs.	1 hr.
2 *	6.5 hrs.	5 hrs.	4 hrs.	3 hrs.	3 hrs.	3 hrs.

* Cure course 2 for 8 hours if the air temperature drops below 60° F during the curing period.

6. Acceptance

Acceptance of the materials will be based on the certified test report received during the approval process, a certification of compliance from the manufacturer, and results of any acceptance tests ordered or performed by the Engineer during construction.

7. Repair of Polymer Overlay

Repair all areas of unbonded, uncured, or damaged polymer overlay for no additional compensation. Submit repair procedures from the manufacturer to the engineer for approval. Absent a manufacturer's repair procedures and with the approval of the engineer, complete repairs according to the following: Saw cut the limits of the area to the top of the concrete; remove the overlay by scarifying, grinding, or other approved methods; shot blast or sand blast and air blast the concrete prior to placement of polymer overlay; and place the polymer overlay according to section C.

8. Final Clean-Up

After curing and 30 days exposure to traffic, sweep loose aggregate and other materials from areas within the limits of the chip seal application area, including all bridge joints and approach panels. Bridge joint cleaning may require hand-operated equipment such as blowers and power washers to thoroughly clean. Any loose material removed from swept and cleaned areas shall become shall become property of the Contractor and must be disposed of as per MnDOT 2104.3.C.3.

D. Method of Measurement

The Department will measure Chip Seal Wearing Course in area by square feet of deck or sidewalk and may include approach panel areas. Where chip seal meets a curb or concrete barrier the epoxy wearing course layers excluding aggregate shall be carried 2" up the concrete face, but is not measured.

E. Basis of Payment

Payment will be made under Item 2407.618, "POLYMER WEARING COURSE TYPE EPOXY" for measured quantities at the contract bid price per square foot. Quantity can include roadway deck area or sidewalks or a combination thereof. Payment is full compensation for preparing the surface including shotblasting; for tensile bond testing; for providing the wearing course; for cleanup; and for sweeping/vacuuming; and disposing of excess materials. No measurement and payment will be made for vertical face areas and these areas shall be considered incidental to the square foot unit prices. Associated mobilization costs shall be considered incidental to the pay item described above.

Use when Epoxy Chip Seal with improved ductility (Epoxy-urethane binder material composition) is recommended by the Regional Bridge Construction Engineer. To date, there have not been significant difference between Epoxy and Epoxy-Urethane, although binder material cost is 50% greater.

CREATED 9/1/2017
REVISED 9/1/2017

SB- POLYMER WEARING COURSE TYPE EPOXY-URETHANE

A. Description of Work

This work consists of preparing deck surface, furnishing and applying a multiple layer epoxy urethane and aggregate wearing course system as shown on the Plans. The wearing course will provide deck protection and increased skid resistance. The total thickness of the wearing course will be $^3/_8$" minimum.

B. Materials

1. General

Furnish materials specifically designed for use over concrete bridge decks. Pre-qualified polymer liquid binders are as follows:

Product Trade Name	Manufacturer or Supplier	Telephone
Mark-163 Flexogrid	PolyCarb, Inc.	(866) 765-9227
Propoxy DOT Type III	Unitex	(816) 231-7700

2. Epoxy Urethane Resin

The epoxy urethane resin base and hardener shall be composed of two-component, 100% solids, 100% reactive, thermosetting compound free of any fillers or solvents with the following properties:

Property	Requirements	Test Method
Gel Time ^{B}	15 - 45 minutes @ 75° F	ASTM C881
Viscosity ^{B}	7 - 70 poises	ASTM D2393, Brookfield RVT, Spindle No. 3, 20 rpm
Shore D Hardness ^{A}	60-75	ASTM D2240
Absorption ^{A}	1% maximum at 24 hr	ASTM D570
Tensile Elongation ^{A}	30% - 70% @ 7 days	ASTM D638
Tensile Strength ^{A}	>2000 psi @ 7 days	ASTM D638
Flexural Strength ^{A}	>4500 psi @ 7 days	ASTM D790
Chloride Permeability^A	<100 coulombs @ 28 days	AASHTO T277
Load Bearing	At 20% strain, retain minimum 85% load bearing tensile strength	ASTM D638

^{A} Cured, mixed epoxy urethane binder
^{B} Uncured, mixed epoxy urethane binder

3. Aggregates

Furnish natural or synthetic aggregates that have a proven record of performance in applications of this type. Furnish aggregates that are non-polishing, clean, free of surface moisture, fractured or angular in shape; free from silt, clay, asphalt, or other organic materials; and meet the following properties and gradation requirements:

Aggregate Properties:

Property	***Requirement***	***Test Method***
Moisture Content	½ of the measured aggregate absorption, %	ASTM C566
Hardness	≥6.5	Mohs Scale
Fractured Faces	100% with at least 1 fractured face & 80% with at least 2 fractured faces of material retained on No. 16	ASTM 5821
Absorption	≤1%	ASTM C128

Gradation for roadway deck:

Sieve Size	**% Passing by Weight**
No. 4	100
No. 8	30 – 75
No. 16	0 – 5
No. 30	0 – 1

No Dresser Trap Rock is allowed due to excessive dust. The color of the aggregate will be dark unless noted otherwise.

Gradation for sidewalk:

Sieve Size	**% Passing by Weight**
No. 4	100
No. 8	95-100
No. 16	30-70
No. 30	0-3
No. 100	0-1

The color for sidewalk aggregate will be light unless noted otherwise.

4. Required Properties of Wearing Course System

The required properties of the wearing course system are listed in the table below:

Property	**Requirement** [A]	**Test Method**
Minimum Compressive Strength. (psi)	1,000 psi @ 8 hrs 5,000 psi @ 24 hrs	ASTM C579 Method B, Modified [B]
Thermal Compatibility	No Delaminations	ASTM C884
Minimum Pull-off Strength	250 psi @ 24 hrs	ASTM C1583

[A] Based on samples cured or aged and tested at 75°F
[B] Plastic inserts that will provide 2-inch by 2-inch cubes shall be placed in the oversized brass molds.

5. Approval of Bridge Deck Epoxy Urethane Wearing Course System

A minimum of 20 working days prior to application, submit product data sheets and specifications from the manufacturer, product history/reference projects, and a certified test report to the Engineer for approval of the wearing course system. The engineer may request samples of the epoxy urethane and/or aggregate, prior to application, for the purpose of acceptance testing by the Department.

A certified test report consists of a certification by an independent testing laboratory showing compliance with the requirements of this specification. Include the test results with the certification.

Product data sheets and specifications from the manufacturer consists of literature from the manufacturer showing general instructions, application recommendations and methods, product properties, general instructions, or any other applicable information.

C. Construction

1. General

Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the Engineer a copy of the recommended procedures and apply the wearing course system according to the manufacturer’s instructions. The manufacturer's representative familiar with the wearing course system installation procedures, shall inspect all surface preparation prior to placing chip seal wearing course and shall be present at all times during wearing course placement to provide quality assurance that the work is being performed properly.

The requirement for manufacturer’s representative may be waived by the Engineer provided:

a. The contractor presents evidence they are certified applicators by the epoxy manufacturer for the product being applied.
b. The specific foreman supervising the epoxy placement produces evidence of three successful epoxy chip seal placements in the last two years with references and contact information for the owner of the referenced placements.
c. The manufacturer representative must be available for consultation at any time during the epoxy chip seal placement and for evaluating preparation of the concrete prior to placing the epoxy chip seal.

Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturer’s recommendations. Store all aggregates in a dry environment and protect aggregates from contaminants on the job site.

For rehabilitation projects with partial depth bridge removal, contractor shall coordinate final deck profile surface with chip seal wearing course supplier.

2. Deck Preparation

a. Surface Preparation

Determine an acceptable shotblasting machine operation (size of shot, flow of shot, forward speed, and number of passes) that provides a surface profile meeting CSP 5 according to the International Concrete Repair Institute Technical Guideline No. 03732. Continue adjusting the shotblasting machine and necessary testing until the surface is acceptable to the Engineer or a passing test result is obtained.

Prepare the entire deck using the final accepted adjustments to the shotblasting machine as determined above. Thoroughly blast clean with hand-held equipment any areas inaccessible by the shotblasting equipment. Do not perform surface preparation more than 24 hours prior to the application of the wearing course system.

Take special precautions to control and abate the dust generated by the blasting operation in accordance with MPCA Rule 7011.0150 https://www.revisor.leg.state.mn.us/rules/?id=7011.0150. Submit the proposed plan for dust abatement at least 14 days before the start of this work. Include in the abatement plan, but not necessarily limit to, the following operations and procedures:

a. Thoroughly sweep the bridge and approach slab(s) prior to blasting. Ensure a power sweeper uses the least amount of water necessary to minimize the dust from the sweeping operation.
b. Enclose the blast wheel or blasting nozzle(s) in a housing or direct into a housing. Ensure the housing has a negative air emission control system that draws the confined air and dust into an adequate filter collection system. Ensure the capacity of the exhaust system is sufficient to readily relieve the pressure generated within the housing by the blasting equipment. Clean the filter collection system as necessary to ensure proper filtration. Ensure the sides and corners of the housing are flexible at the bottom to the extent that the bottom of the housing is in contact with the deck surface during all blasting operations.
c. Construct, maintain and operate the housing and/or filter collection system so that avoidable dust emissions are eliminated.
d. After blasting, hand-sweep the prepared surface or sweep with a "Pickup" type power sweeper equipped with adequate dust storage capacity. Completely remove all minor debris remaining after the sweeping operation by airblasting. Construct the air supply system so that a suitable oil trap is placed in the air supply line between the storage tank and the nozzle.

Prior to full application of wearing course three representative areas shall be tested to verify surface preparation is adequate.

Test in accordance with ASTM C1583 "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method)". The failure should be in the concrete substrate and not in the chip seal wearing course or the bond of the wearing course to the substrate. The pullout value should not be less than 250 psi with more than 50 percent of the failure area in the concrete at a depth of ¼" or greater. Repair of the test area shall be incidental to chip seal wearing course.

Just prior to wear course placement, clean all dust, debris, and concrete fines from the deck surface including vertical faces of curbs and barrier walls up to a height of 2 inches above the wearing course with compressed air. When using compressed air, the air stream must be free of oil. Any grease, oil, or other foreign matter that rests on or has absorbed into the concrete shall be removed completely. Brooms shall not be used.

Cover the bridge deck drains and bridge expansion joints to prevent materials from adhering and entering.

If required for rehabilitation projects create a transitional area approaching transverse expansion joints and ends of the deck or approach panel using the shot blasting machine or other approved method. Remove $^{5}/_{16}$" to $^{3}/_{8}$" of concrete adjacent to the joint or end of deck and taper a distance of 3 feet.

Any surface preparation including shotblasting shall be incidental to chip seal wearing course.

The Engineer may consider alternate surface preparation methods per the wear course system manufacturer's recommendations. The Engineer will approve the final surface profile and deck cleanliness prior to the contractor placing the chip seal wearing course.

All deck preparation equipment will be staged at least 50' from deck so as not to get any windblown dust on the bridge prior to placement.

3. Application of the Wearing Course

Perform the handling and mixing of the epoxy urethane resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer's instructions. Do not apply the wearing course system if any of the following exists:

a. Ambient air temperature is below 60ºF;
b. Deck temperature is below 60ºF;
c. Moisture content in the deck exceeds 4.5% when measured by an electronic moisture meter or shows visible moisture after 2 hours when measured in accordance with ASTM D4263.
d. Rain is forecasted within 8 hours after the estimated completion time;
e. Materials component temperatures below 50ºF.
f. Epoxy urethane wearing course shall not be placed until all deck concrete has 28 days of cure. On rehabilitation projects, contractor may propose alternative deck patch material to reduce cure time with written approval from epoxy supplier and approval from Engineer. Moisture content tests will be required as part of submittal by contractor.

After the deck has been shotblasted or during the wearing course curing period, only necessary surface preparation and wearing course application equipment will be allowed on the deck.

Begin wearing course placement as soon as possible after surface preparation operations.

The epoxy urethane wearing course shall consist of a two-course application of epoxy urethane and aggregate. Each of the two courses shall consist of a layer of epoxy urethane covered with a layer of aggregate in sufficient quantity to completely cover the epoxy urethane. Apply the epoxy urethane and aggregate a minimum 2" up from deck on vertical surface of rail. Apply the epoxy urethane and aggregate according to the manufacturer's requirements. Apply the wearing course using equipment designed for this purpose. Hand mixing of material is not permitted.

The wearing course manufacturer representative will be at the job site during the entire application unless the conditions under SB-__2, "General", are met. The application machine shall feature positive displacement volumetric metering and be capable of storing and mixing the epoxy urethane resins at the proper mix ratio. Disperse the aggregate using a standard chip spreader or equivalent machine that can provide a uniform, consistent coverage of aggregate. The dry aggregate shall be applied in such a manner as to cover the epoxy urethane mixture completely within 5 minutes.

First course applications that do not receive enough aggregate before the epoxy urethane gels shall be removed and replaced. A second course applied with insufficient aggregate may be left in place, but will require additional applications before opening to traffic.

After completion of each course, cure the wearing course according to the manufacturer's instructions. Follow the minimum cure times listed under this specification or as prescribed by the manufacturer. Remove the excess aggregate from the surface treatment by sweeping, blowing, or vacuuming without tearing or damaging the surface; the material may be re-used if approved by the Engineer and manufacturer. Apply all courses of the wearing course system before opening the area to traffic. Do not allow traffic on the treated area until directed by the Engineer. Brooming the excess aggregate from any layer of the wearing course shall not begin until the wearing course has cured sufficiently to ensure that the brooming operations will not damage the surface.

In the event Contractors operations damages or mars the wearing course, the Contractor shall remove the damaged areas by saw cutting in rectangular sections and replacing the wearing course in accordance with this specification at no additional cost.

After the first layer of coating has cured to the point where the aggregate cannot be pulled out, apply the second layer. Prior to applying the second layer, broom and blow off the first layer with compressed air to remove all loose excess aggregate.

Prior to opening to traffic, clean expansion joints and joint seals of all debris and epoxy urethane.

No traffic is allowed on lanes between first and second application.

If there are small deck panel areas that cannot freely drain water after second chip seal application, isolated areas of a third layer may be required to achieve positive drainage.

If the Engineer requires additional verification of adequate chip seal bonding to the deck, the contractor shall perform one additional tensile bond strength test per ASTM 1583 similar to pre application test. If there is a failure in bond of wearing course to the deck, the contractor shall perform additional test(s) to determine extent of the debonded area. Repair options for debonded areas, include partial and up to total removal of chip seal wearing coarse and reapplication. All testing and repairs are considered incidental.

Take measures to prevent liquid or aggregate entering into lanes of traffic on the bridge. All property claims resulting from liquid or aggregate damage is responsibility of the contractor.

4. Application Rates

Apply the epoxy urethane wearing course in two separate courses in accordance with the manufacturer's instructions, but not less than the following rate of application.

Course	**Minimum Epoxy Urethane Rate [A] (GAL/100 SF)**	**Aggregate [B] (LBS/SY)**
1	2.5	10+
2	5.0	14+

[A] The minimum total applications rate is 7.5 GAL/100 SF.
[B] Application of aggregate shall be of sufficient quantity to completely cover the epoxy urethane.

5. Minimum Curing Periods

As a minimum, cure the coating as follows:

	Average temperature of deck, epoxy-urethane and aggregate components in °F					
Course	**60-64**	**65-69**	**70-74**	**75-79**	**80-84**	**85+**
1	4 hrs.	3 hrs.	2.5 hrs	2 hrs	1.5 hrs.	1 hr.
2 *	6.5 hrs.	5 hrs.	4 hrs.	3 hrs.	3 hrs.	3 hrs.

* Cure course 2 for 8 hours if the air temperature drops below 60° F during the curing period.

6. Acceptance

Acceptance of the materials will be based on the certified test report received during the approval process, a certification of compliance from the manufacturer, and results of any acceptance tests ordered or performed by the Engineer during construction.

7. Repair of Polymer Overlay

Repair all areas of unbonded, uncured, or damaged polymer overlay for no additional compensation. Submit repair procedures from the manufacturer to the engineer for approval. Absent a manufacturer's repair procedures and with the approval of the engineer, complete repairs according to the following: Saw cut the limits of the area to the top of the concrete; remove the overlay by scarifying, grinding, or other approved methods; shot blast or sand blast and air blast the concrete prior to placement of polymer overlay; and place the polymer overlay according to section C.

8. Final Clean-Up

After curing and 30 days exposure to traffic, sweep loose aggregate and other materials from areas within the limits of the chip seal application area, including all bridge joints and approach panels. Bridge joint cleaning may require hand-operated equipment such as blowers and power washers to thoroughly clean. Any loose material removed from swept and cleaned areas shall become shall become property of the Contractor and must be disposed of as per MnDOT 2104.3C3.

D. Method of Measurement

The Department will measure Chip Seal Wearing Course in area by square feet of deck or sidewalk and may include approach panel areas. Where chip seal meets a curb or concrete railing the epoxy urethane wearing course layers excluding aggregate shall be carried 2" up the concrete face, but is not measured.

E. Basis of Payment

1. Chip Seal Wearing Course

Payment will be made under Item 2407.618, "POLYMER WEARING COURSE TYPE EPOXY-URETHANE" for measured quantities at the contract bid price per square foot. Quantity can include roadway deck area or sidewalks or a combination thereof. Payment is full compensation for preparing the surface including shotblasting; for tensile bond testing; for providing the wearing course; for cleanup; and for sweeping/vacuuming; and disposing of excess materials. No measurement and payment will be made for vertical face areas and these areas shall be considered incidental to the square foot unit prices. Associated mobilization costs shall be considered incidental to the pay item described above.

SB2018-2433

Special Provisions within the 2433 series are to be used as required in the Bridge Repair Recommendations or as required by the Regional Bridge Construction Engineer (RBCE). EXCEPTION: Include 2433.8_ for bridge anchorages that are not associated with metal railings or fences.

CREATED 3/28/1994

REVISED 3/20/2018 (3)

SB- (2433) STRUCTURE RENOVATION

The provisions of 2433, "Structure Renovation," are supplemented with the following:

Use only when removals are not shown in the plan or need further detail to explain the removal.

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Structure Removals

Remove and dispose of areas shown in the Plan and ____

____.

SB2018-2433.2 A
Use when removing a minimal depth of the existing roadway surface on the bridge.
CREATED 12/12/1997
REVISED 3/20/2018 (13)

SB- Scarify Bridge Deck

Scarify the bridge roadway slab(s) in accordance with the following:

Ensure scarifying equipment and removal methods are restricted to which, in the Engineer's judgment, will not damage the structure. Perform removal with power equipment which has previously demonstrated satisfactory performance on the type of work for which it is to be used. If permitted by the Engineer, use newly developed power equipment on a performance basis, but discontinue such usage if so directed by the Engineer.

Ensure scarifying of the bridge roadway slab(s) removes at least _____ inch of concrete.

A. Method of Measurement

Measurement will be by the area, in ft^2, based on the bridge roadway dimensions between gutterlines and from end of slab to end of slab.

B. Basis of Payment

Payment for scarifying the bridge deck and disposal of the scarified material will be made as Item No. 2433.618 "SCARIFY BRIDGE DECK" at the contract price per ft^2.

Use when removing a minimal depth of the existing roadway surface on the concrete approach panels to match into existing pavement..

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Scarify Concrete Approaches

Scarify the concrete approaches in accordance with the following:

Ensure scarifying equipment and removal methods are restricted to which, in the Engineer's judgment, will not damage the structure. Perform removal with power equipment which has previously demonstrated satisfactory performance on the type of work for which it is to be used. If permitted by the Engineer, use newly developed power equipment on a performance basis, but discontinue such usage if so directed by the Engineer.

Scarify the area of the approaches, designated for concrete approach tapers, to remove at least ½ inch of concrete. Continue concrete removal below the ½ inch minimum to the extent necessary to place the approach taper concrete to a thickness of not less than 1½ inches.

A. Method of Measurement

Measurement will be by the area, in ft^2, based on the limits of scarification shown in the plans or as directed by the Engineer.

B. Basis of Payment

Payment for scarifying the bridge approaches and disposal of scarified material will be made as Item No. 2433.618 "SCARIFY CONCRETE APPROACHES" at the Contract price per ft^2.

Use when removing a minimal depth of the existing bituminous roadway surface to match into existing pavement..

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Scarify Bituminous Approaches

Scarify designated areas of the bituminous approaches in accordance with the following:

Ensure scarifying equipment and removal methods are restricted to which, in the Engineer's judgment, will not damage the structure. Perform removal with power equipment which has previously demonstrated satisfactory performance on the type of work for which it is to be used. If permitted by the Engineer, use newly developed power equipment on a performance basis, but discontinue such usage if so directed by the Engineer.

Ensure scarifying of the bituminous approach areas designated removes sufficient material to assure that the new bituminous tapers will have a thickness of not less than 1 inch. Make the transverse edge at the end of the scarification nearly vertical.

A. Method of Measurement

Measurement will be by the area, in ft^2, based on the limits of scarification shown in the plans or as directed by the Engineer.

B. Basis of Payment

Payment for scarifying the designated areas of the bituminous approaches and the disposal of the scarified material will be made as Item No. 2433.618 "SCARIFY BITUMINOUS APPROACHES" at the Contract price per ft^2.

This SP is currently being developed by the S.P.E.C.S Committee and Jessica Duncan is the lead author.

SB2018-2433.2 D

Use when removing the concrete wearing course on the bridge and/or approach panels.

CREATED XX/XX/XXXX

REVISED XX/XX/XXXX (X)

SB- Remove Concrete Wearing Course

XXXXXXXXXX

SB- Remove Slab

A. Description of Work

Remove and dispose of delaminated or unsound concrete bridge deck surfaces and other areas of the superstructure identified for partial removal in the plans and by the Engineer, in accordance with the applicable provisions of 2433, "Structure Renovation," the plans and the following:

B. Removal Requirements

After traffic control has been established, the Engineer will sound the deck and identify removal locations by defining the areas for repair. Remove only that portion of the deck that has been defined for repair by the Engineer.

Restrict removal to methods which, in the Engineer's judgment, will not damage the structure.

Restrictions for the power equipment:

1. Perform removal with power equipment which has previously demonstrated satisfactory performance on the type of work for which it is to be used. If permitted by the Engineer, use newly developed power equipment on a performance basis, but discontinue such usage if so directed by the Engineer.

2. Do not use jack-hammers heavier than a nominal 30 pound class for removal above the top layer of reinforcement; except that the Engineer may permit the use of up to a nominal 60 pound hammer by individual operators on a performance basis, but discontinue such usage if the Engineer determines that the heavier hammers are creating additional delamination, or that they are not being used with proper discretion.

3. Pointed bits for jack-hammers are not permitted except in areas where full depth removal is specifically defined by the Engineer.

4. Do not use jack-hammers heavier than a nominal 15 pound class for removal below the top layer of reinforcing bars unless full depth removal is specifically defined by the Engineer.

Ensure that the edges of all removal areas are near vertical and clean immediately before placing the concrete patching mix.

After removal operations are completed, clean the removal area of all remaining loose concrete by sandblasting. Clean exposed reinforcing bars by sandblasting to remove loose rust. Tightly adherent rust and mill scale may remain on the surface. Remove spent sand and debris.

Follow provisions of SB-_____ 1717, "Air, Land, and Water Pollution," as supplemented in these Special Provisions, referring to MPCA Rule 7011.0150 (http://www.pca.state.mn.us) as it relates to sandblasting and or concrete removal operations.

Leave all deck reinforcement steel in place as it was before concrete removal, unless otherwise directed by the Engineer. Repair and/or replace all reinforcement bars damaged by Contractor's operations, as directed by the Engineer. All costs incurred are considered incidental expenses for which no direct compensation will be made.

1 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Augment inplace reinforcement displaying loss of more than _____% of cross sectional area with additional reinforcement as directed by the Engineer.

All damage to other portions of the structure which are to remain inplace which is due to the removal operations will be repaired. All costs incurred are considered incidental expenses for which no direct compensation will be made.

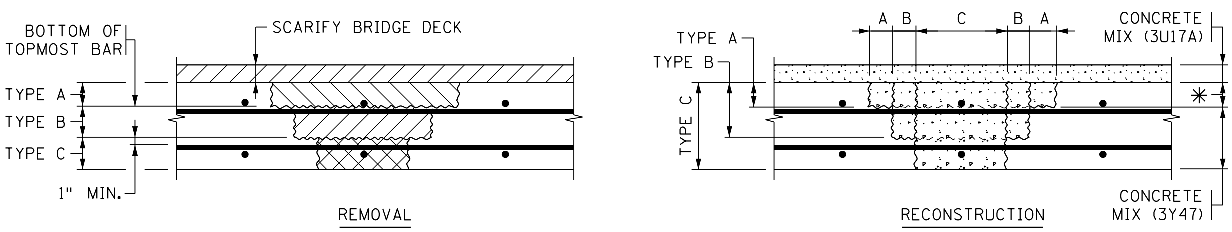
Do not perform removal in any area until the perimeters for removal in that area have been defined by the Engineer for that type of removal.

Dispose of all materials removed in accordance with 2104.3.C, "Removal Operations".

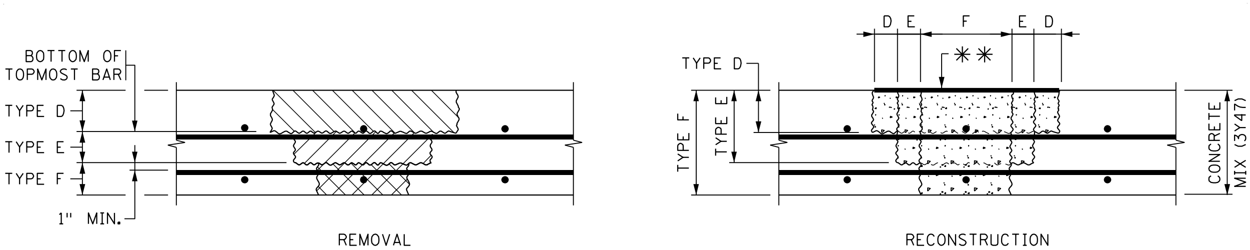
1 - DESIGNER NOTE: Designer may choose to delete either: figure and associated description for Type A, B, & C deck repairs, or figure and description for Type D, E, & F deck repairs according to repair methods used on Project.

SB-__.__ Remove and Patch Monolithic Slab

Repair Type *Materials*



REMOVE AND PATCH WITH NEW CONCRETE WEARING COURSE



REMOVE AND PATCH ON MONOLITHIC DECK

*	Concrete mix 3U17A permitted if depth from top of roadway to bottom of total patch is less than 4 inches. Otherwise use concrete mix 3Y47 from the bottom of patch up to the bottom of the concrete wearing course.
**	Alternatively, overpour the patch and grind the surface to a smoothness tolerance of $^1/_8$ inch in 10 ft after wet cure has been completed.

Figures above demonstrate special provision intent. If there is a discrepancy, all written special provisions below these figures supersede the guidance given within the figure shown.

2 - DESIGNER NOTE: Insert the SB-# for 2433.3, "Remove Slab" in the blank.

Remove slab in accordance with SB-______, "Remove Slab."

SB-__.__ Remove and Patch Slab, Type A (With New Concrete Wearing Course)

3 - DESIGNER NOTE: Use if wearing course is being placed on the Entire Deck

Perform work in accordance with the requirements of SB- _____, "Remove and Patch Monolithic Slab". Remove and dispose of portions of the bridge surface to the depth of the top of the bottom bars in the top mat of reinforcement. (In extensive areas of Type A removal, this removal will be considered to be accomplished when 80% of these bars are exposed in any 100 ft^2 area.) The Engineer may require additional removal of deteriorated concrete below the top of these bars but only to the extent that the additional removal can be performed by sandblasting. (Removal below these limits, if required by the Engineer, will be measured and paid for separately under SB- _____, "Remove and Patch Slab, Type B".)

Patch the area after removals have been completed, damaged reinforcement has been repaired or replaced, and areas inspected. Furnish, place, finish, and cure concrete for partial depth patches. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout". Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

For patches that will be 4 inches or more from the bottom of repair to the top of the deck, use the patching concrete mix 3Y47 to fill up to the bottom of the future wearing course and concrete mix 3U17A for a depth matching the inplace concrete wearing course. For repairs less than 4 inches in depth, fill with concrete mix 3U17A during wearing course placement. Strike off the concrete at the approximate level of the surrounding concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer.

4 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection." to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Derive all strength gain percentages from the strength gain chart in Table 2401-2 or as verified by breaking control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

5 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

6 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix is subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;
2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetrating" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

7 - DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at an offsite area prior to production use. Make the test area (i.e. patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM C1583, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)." At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

8 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process, subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas where the repair does not extend below the bottom bar in the top mat.

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type A*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE A" at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired**.

SB-__.__ Remove and Patch Slab, Type B (With New Concrete Wearing Course)

9 - DESIGNER NOTE: Use if wearing course is being placed on the Entire Deck

Perform work in accordance with the requirements of SB- ______, "Remove and Patch Monolithic Slab." Remove and dispose of portions of the bridge slab which the Engineer specifically designates for Type B removal, after Type A removal has been performed. Type B removal includes all removal which the Engineer designates after the Type A removal is completed but which is not full depth removal. The minimum depth of Type B removal is ¾ inch below the bottom of the bottom bars in the top mat of reinforcement and the maximum depth of Type B removal is to within 1 inch of the top bar of the of the bottom mat. Any removals exposing more than 10% of the bottom mat are Type C Removals.

10 - DESIGNER NOTE: Use the following statement for box girder bridges that are not post-tensioned. Designer to modify limits as required.

Restrict Type B removal on box girder bridges to areas of 10 ft^2 or less in a 2 ft maximum width longitudinal stripe.

After removals have been completed and damaged reinforcement has been repaired or replaced, patch the slab. This work consists of furnishing, placing, finishing and curing concrete for partial depth patches. Perform work in accordance 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) for the portion of the patch below the bottom of the future wearing course. Fill the area to be repaired above the bottom of the future wearing course with concrete mix 3U17A. At Contractors option, if total thickness of repair is less than 4 inches, then repair can be made with a single pour of 3U17A during wearing course replacement. Strike off the concrete at the approximate level of the surrounding concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer.

11 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection." to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

12 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix is subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;
2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetrating" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

13 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection", to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

14 - DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at an offsite area prior to production use. Make the test area (i.e. patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM C1583, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)." At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

15 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process, subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will any curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas where the removal was specifically authorized to extend below the top layer of deck reinforcement and the **removals were made with a 15 pound class hammer.**

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type B,* includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE B" at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired**.

SB-__.__ Remove and Patch Slab, Type C (Full Depth Slab Removal and Patching with New Concrete Wearing Course)

16 - DESIGNER NOTE: Use if wearing course is being placed on the Entire Deck

Perform work in accordance with the requirements of SB-_____, "Remove and Patch MonolithicSlab." Remove and dispose of portions of the bridge slab which the Engineer specifically designates for full depth removal, after Type A and Type B removals have been performed. Provide formwork, furnish, place, cure, and grind concrete for full depth patches in the bridge slab. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) to fill up to the bottom of the future concrete wearing course. Strike off the 3Y47 concrete and internally vibrate. Roughen, groove or serrate the surface of the full depth patches to the extent – and by methods and equipment – approved by the Engineer.

17 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

18 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix is subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;
2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetrating" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

19 - DESIGNER NOTE: Use this paragraph where authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

20 - DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at an offsite area prior to production use. Make the test area (i.e. patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM C1583, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)." At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

21 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will any curing be considered completed in less than 20 hours.

Cure patches made above the top mat of reinforcement in accordance with 2404.3.E.4, "Concrete Wearing Course".

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas specifically designated or authorized for full depth slab patching. Only areas where bottom of patch is formed will be paid for as a Type C repair. Full depth patching of areas of the slab where full depth removal was not designated or authorized by the Engineer will not be measured for payment.

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type C*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for full depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

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Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE C" at the Contract price per ft^2, complete in place, and shall include all necessary slab forming. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired.**

SB-__.__ Remove and Patch Slab, Type D (No New Wearing Course)

Perform work in accordance with the requirements of SB- _____, "Remove and Patch Monolithic Slab." Remove and dispose of portions of the bridge surface to the depth of the top of the bottom bars in the top mat of reinforcement. (In extensive areas of Type D removal, this removal will be considered to be accomplished when 80% of these bars are exposed in any 100 ft^2 area.) The Engineer may require additional removal of deteriorated concrete below the top of these bars but only to the extent that the additional removal can be performed by sandblasting. (Removal below these limits, if approved by the Engineer, will be measured and paid for separately under SB- _____ "Remove and Patch Slab, Type E.")

Patch the area after removals have been completed, damaged reinforcement has been repaired or replaced, and areas inspected. This work shall consist of furnishing, placing, finishing, and curing concrete for partial depth patches. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) to fill the area to be repaired. If the total thickness of repair is 4 inches or greater, then repair must be made in two separate lifts in order for the surface to be a consistent profile. Strike off the concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer. Alternatively, the contractor may overpour the patch and grind the surface to a smoothness tolerance of $^1/_8$ inch in 10 ft (after the concrete has been wet cured).

22 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure patches that extend to top of finished deck in accordance with 2401.3.G, "Concrete Curing and Protection", until concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5.b, "Control Strength Cylinders." For patches that don't extend to the top of deck, wet cure until the concrete has reached 45% of anticipated compressive strength, but no less than 24 hours. Allow a bottom patch to air dry for at least 4 hours before placing a concrete patch above it.

23 - DESIGNER NOTE: Use this section where authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix shall be subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix, ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;
2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetration" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

24 - DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at on offsite area prior to production use. Make the test area (i.e. Patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material shall be between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM 1583. At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

25 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with wet burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas where the repair does not extend below the bottom bar in the top mat.

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type D*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE D" at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired.**

SB-__.__ Remove and Patch Slab, Type E (No New Wearing Course)

Perform work in accordance with the requirements of SB- ______, "Remove and Patch Monolithic Slab." Remove and dispose of that portion of the bridge slab which the Engineer specifically designates for Type E removal after Type D removal has been performed. Type E removal includes all removal which the Engineer designates after the Type D removal is completed but which is not full depth removal. The minimum depth of Type E removal is ¾ inch below the bottom of the bottom bars in the top mat of reinforcement and the maximum depth of Type E removal is to within 1 inch of the top bar of the of the bottom mat. Any removals exposing more than 10% of the bottom mat are Type F Removals.

26 - DESIGNER NOTE: Use the following statement for box girder bridges that are not post-tensioned. Designer to modify limits as required.

Restrict Type E removal on box girder bridges to areas of 10 ft^2 or less in a 2 ft maximum width longitudinal stripe.

After removals have been completed and damaged reinforcement has been repaired or replaced, patch the slab. This work consists of furnishing, placing, finishing, and curing concrete for partial depth patches. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) to fill area to be repaired. If total thickness of repair is 4 inches or greater, then repair in two separate pours, the upper pour being at least 2 inches, but no more than 4 inches thick in order for the final surface to be a consistent profile. Strike off the concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer. As an option, use an over pour patch filled high and then ground (after the concrete has been wet-cured) to a smoothness tolerance of $^1/_8$ inch in 10 ft. with inplace surface.

27 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing a concrete patch above it.

28 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing a concrete patch above it.

29 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

Cure patches extending to top of finished deck in accordance with 2404.3.E.4, "Concrete Wearing Course".

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as marked earlier, and include only those areas where the removal was specifically authorized to extend below the top layer of deck reinforcement **and the removals were made with a 15 pound class hammer.**

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type E*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE E," at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired**.

SB-__.__ Remove and Patch Slab, Type F (No New Concrete Wearing Course)

Perform work in accordance with the requirements of SB-_____, "Remove and Patch Monolithic Slab." Remove and dispose of that portion of the bridge slab which the Engineer specifically designates for full depth removal, after Type D and Type E removals have been performed. Provide formwork, furnish, place, cure, and grind concrete for full depth patches in the bridge slab. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) to fill area to be repaired. If total thickness of repair is 4 inches or greater, then repair in two separate pours, the upper pour being at least 2 inches, but no more than 4 inches thick in order for the final surface to be a consistent profile. Strike off the 3Y42-M concrete, and internally vibrate. Roughen, groove or serrate the surface of the patch to the extent – and by methods and equipment – approved by the Engineer. As an option, use an over pour patch filled high and then ground (after the concrete has been wet-cured) to a smoothness tolerance of $^1/_8$ inch in 10 ft. with inplace surface.

30 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing a concrete patch above it.

31 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix is subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;

2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetrating" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

32 - DESIGNER NOTE: Use this paragraph where authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing a concrete patch above it.

33- DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at an offsite area prior to production use. Make the test area (i.e. patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM C1583, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)." At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

34 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas specifically designated or authorized for full depth slab patching. Only areas where bottom of patch is formed will be paid for as a Type F repair. Full depth patching of areas of the bridge slab where full depth removal was not designated or authorized by the Engineer will not be measured for payment

B. Basis of Payment

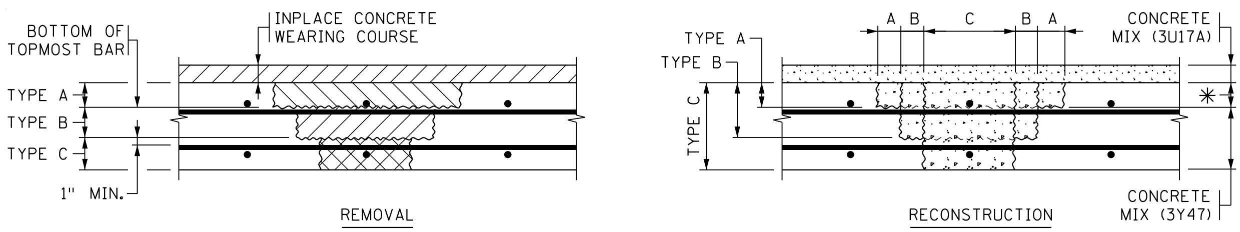
The contract unit price for *Remove and Patch Slab, Type F*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for full depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE F," at the Contract price per ft^2, complete in place, and shall include all necessary slab forming. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired.**

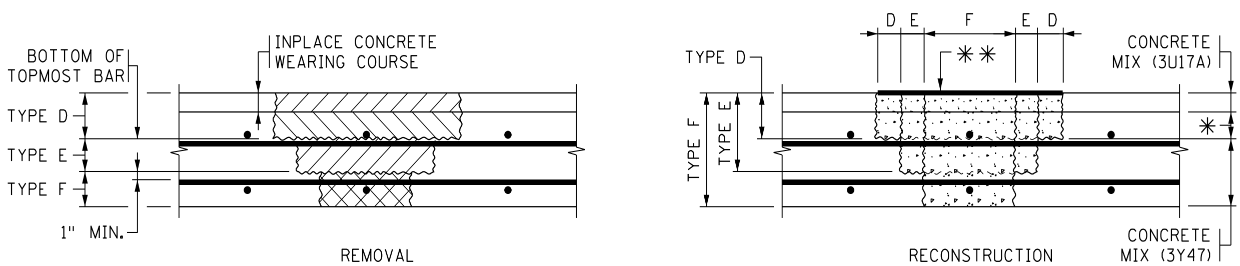
1 - DESIGNER NOTE: Designer may choose to delete either: figure and associated description for Type A, B, & C deck repairs, or figure and description for Type D, E, & F deck repairs according to repair methods used on Project.

SB-__.__ Remove and Patch Structural Slab

Repair Type *Materials*



REMOVE AND PATCH WITH CONCRETE WEARING COURSE REPLACEMENT



REMOVE AND PATCH WITHOUT CONCRETE WEARING COURSE REPLACEMENT

*	Concrete mix 3U17A permitted if depth from top of roadway to bottom of total patch does not exceed 4 inches. Otherwise use concrete mix 3Y47 from the bottom of patch up to a depth between the top of the topmost bar and the bottom of the concrete wearing course.
**	Alternatively, overpour the patch and grind the surface to a smoothness tolerance of $^{1}/_{8}$ inch in 10 ft after wet cure has been completed.

Figures above demonstrate special provision intent. If there is a discrepancy, all written special provisions below these figures supersede the guidance given within the figure shown.

2 - DESIGNER NOTE: Insert the SB-# for 2433.3, "Remove Slab" in the blank.

Remove slab in accordance with SB-______, "Remove Slab."

SB-__.__ Remove and Patch Slab, Type A (Where Wearing Course is being Replaced on the Entire Deck)

3 - DESIGNER NOTE: Use if wearing course is being replaced on the Entire Deck

Perform work in accordance with the requirements of SB- _____, "Remove and Patch Structural Slab." Remove and dispose of portions of the bridge surface to the depth of the top of the bottom bars in the top mat of reinforcement. (In extensive areas of Type A removal, this removal will be considered to be accomplished when 80% of these bars are exposed in any 100 ft^2 area.) The Engineer may require additional removal of deteriorated concrete below the top of these bars but only to the extent that the additional removal can be performed by sandblasting. (Removal below these limits, if required by the Engineer, will be measured and paid for separately under SB- _____, "Remove and Patch Slab, Type B".)

Patch the area after removals have been completed, damaged reinforcement has been repaired or replaced, and areas inspected. Furnish, place, finish, and cure concrete for partial depth patches. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

For patches that will be 4 inches or more from the bottom of repair to the top of the deck use the patching concrete mix 3Y47 to fill up to the bottom of the inplace wearing course and concrete mix 3U17A for a depth matching the inplace concrete wearing course. For repairs less than 4 inches in depth fill with concrete mix 3U17A during wearing course placement.

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout". Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Strike off the concrete at the approximate level of the surrounding concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer.

4 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 24, 72 hours or until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

5 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

6 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix is subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;

2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetrating" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

7 - DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at an offsite area prior to production use. Make the test area (i.e. patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM C1583, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)." At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

8 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process, subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas where the repair does not extend below the bottom bar in the top mat.

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type A*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE A" at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired**.

SB-__.__ Remove and Patch Slab, Type B (Where Wearing Course is being Replaced on the Entire Deck)

9 - DESIGNER NOTE: Use if wearing course is being replaced on the Entire Deck

Perform work in accordance with the requirements of SB- ______, "Remove and Patch Structural Slab." Remove and dispose of portions of the bridge slab which the Engineer specifically designates for Type B removal, after Type A removal has been performed. Type B removal includes all removal which the Engineer designates after the Type A removal is completed but which is not full depth removal. The minimum depth of Type B removal is ¾ inch below the bottom of the bottom bars in the top mat of reinforcement and the maximum depth of Type B removal is to within 1 inch of the top bar of the of the bottom mat. Any removals exposing more than 10% of the bottom mat are Type C Removals.

10 - DESIGNER NOTE: Use the following statement for box girder bridges that are not post-tensioned. Designer to modify limits as required.

Restrict Type B removal on box girder bridges to areas of 10 ft^2 or less in a 2 ft maximum width longitudinal stripe.

After removals have been completed and damaged reinforcement has been repaired or replaced, patch the slab. This work consists of furnishing, placing, finishing and curing concrete for partial depth patches. Perform work in accordance 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) for the portion of the patch below the bottom of the future wearing course. Fill the area to be repaired above the bottom of the future wearing course with concrete mix 3U17A. At Contractors option, if total thickness of repair is less than 4 inches, then repair can be made with a single pour of 3U17A during wearing course replacement. Strike off the concrete at the approximate level of the surrounding concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer.

11 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection." to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

12 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection", to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

13 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process, subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will any curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas where the removal was specifically authorized to extend below the top layer of deck reinforcement and the **removals were made with a 15 pound class hammer.**

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type B*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE B" at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired**.

SB-__.__ Remove and Patch Slab, Type C (Full Depth Slab Removal and Patching)

14 - DESIGNER NOTE: Use if wearing course is being replaced on the Entire Deck

Perform work in accordance with the requirements of SB-_____, "Remove and Patch Structural Slab." Remove and dispose of portions of the bridge slab which the Engineer specifically designates for full depth removal, after Type A and Type B removals have been performed. Provide formwork, furnish, place, cure, and grind concrete for full depth patches in the bridge slab. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) for the portion of the patch below the bottom of the inplace wearing course. Use concrete mix 3U17A for a depth matching the inplace wearing course.

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Strike off the 3Y47 concrete at the approximate lower limit of the inplace wearing course, and internally vibrate. Roughen, groove or serrate the surface of the full depth patches to the extent – and by methods and equipment – approved by the Engineer.

15 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

16 - DESIGNER NOTE: Use this paragraph where authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

17 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will any curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas specifically designated or authorized for full depth slab patching. Full depth patching of areas of the slab where full depth removal was not designated or authorized by the Engineer will not be measured for payment.

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type C*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for full depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

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Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE C" at the Contract price per ft^2, complete in place, and shall include all necessary slab forming. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired.**

SB-__.__ Remove and Patch Slab, Type D (Wearing Course Replacement on Patched Areas Only)

Perform work in accordance with the requirements of SB- _____, "Remove and Patch Structural Slab." Remove and dispose of portions of the bridge surface to the depth of the top of the bottom bars in the top mat of reinforcement. (In extensive areas of Type D removal, this removal will be considered to be accomplished when 80% of these bars are exposed in any 100 ft^2 area.) The Engineer may require additional removal of deteriorated concrete below the top of these bars but only to the extent that the additional removal can be performed by sandblasting. (Removal below these limits, if approved by the Engineer, will be measured and paid for separately under SB- _____ "Remove and Patch Slab, Type E.")

Patch the area after removals have been completed, damaged reinforcement has been repaired or replaced, and areas inspected. This work shall consist of furnishing, placing, finishing, and curing concrete for partial depth patches. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

For patches that will be 4 inches or more from the bottom of repair to the top of the deck use the patching concrete mix 3Y47 to fill up to the bottom of the inplace wearing course and concrete mix 3U17A for a depth matching the inplace concrete wearing course. Alternatively, overpour the patch with 3U17A and grind the surface to a smoothness tolerance of $^1/_8$ inch in 10 ft after wet cure has been completed. For repairs that will be less than 4 inches thick use concrete mix 3U17A.

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Strike off the concrete at the approximate level of the surrounding concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer.

18 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

19 - DESIGNER NOTE: Use this section where authorized by the Regional Construction Engineer.

Where the Plan indicates high early strength concrete, or as otherwise required to meet staging and traffic control requirements, propose a compatible patching mix, subject to the approval of the Engineer. Use of high early strength concrete mix or contractor designed high early strength concrete mix shall be subject to the approval of the Engineer and the proposed area shall not exceed 5% of the bridge deck area. If proposing a patching mix, ensure it is cementitious based and that it closely matches the cement content and aggregate size of the surrounding concrete wearing course. Submit test results of the proposed patching mix that show:

1. Shrinkage, when performed in accordance with ASTM C157 "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete," is not to be greater than .040 percent at 28 calendar days;
2. Relative dynamic modulus of 95% or better when tested for freeze/thaw resistance in accordance with ASTM C666, "Resistance of Concrete to Rapid Freezing and Thawing";
3. Chloride ion permeability test results according to ASTM C1202, "Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetration" and;
4. Predicted strength gain chart for proposed mix. Expected concrete strength prior to opening to traffic is 3000 psi minimum with the anticipated cure time and temperatures.

20 - DESIGNER NOTE: Use this next paragraph when authorized by the Regional Construction Engineer.

Where an Epoxy Chip Seal Wearing Course is to be placed over patches in less than 28 calendar days from time of placement, demonstrate material compatibility at on offsite area prior to production use. Make the test area (i.e. Patch qualification area) a minimum of 4 ft^2 milled area and have a depth between 3 inches and 4 inches, and resultant volume of patch material shall be between 1 and 2 ft^3. Place and cure the patch in a manner equivalent to that proposed for production patching prior to Epoxy Chip Seal Placement. Place the proposed Epoxy Chip Seal Wearing Course over the patch area and demonstrate 250 psi adhesion through a minimum of three pull-off tests per ASTM 1583. At least 90% of pull-off tests must meet the tension test in order to place the Epoxy Chip Seal Wearing Course over patches matching the proposed curing and age. No separate payment will be issued for testing and qualifying contractor-proposed mixes with the Epoxy Chip Seal Wearing Course.

21 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with wet burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas where the repair does not extend below the bottom bar in the top mat.

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type D*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE D" at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired.**

SB-__.__ Remove and Patch Slab, Type E (Wearing Course Replacement on Patched Areas Only)

Perform work in accordance with the requirements of SB- ______, "Remove and Patch Structural Slab." Remove and dispose of that portion of the bridge slab which the Engineer specifically designates for Type E removal after Type D removal has been performed. Type E removal includes all removal which the Engineer designates after the Type D removal is completed but which is not full depth removal. The minimum depth of Type E removal is ¾ inch below the bottom of the bottom bars in the top mat of reinforcement and the maximum depth of Type E removal is to within 1 inch of the top bar of the of the bottom mat. Any removals exposing more than 10% of the bottom mat are Type F Removals.

22 - DESIGNER NOTE: Use the following statement for box girder bridges that are not post-tensioned. Designer to modify limits as required.

Restrict Type E removal on box girder bridges to areas of 10 ft^2 or less in a 2 ft maximum width longitudinal stripe.

After removals have been completed and damaged reinforcement has been repaired or replaced, patch the slab. This work consists of furnishing, placing, finishing, and curing concrete for partial depth patches. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) for the portion of the patch below the bottom of the inplace wearing course. Fill the area to be repaired above the bottom of the inplace wearing course with concrete mix 3U17A. Strike off the concrete at the approximate level of the surrounding concrete and internally vibrate. Roughen, groove or serrate the surface of the patches to the extent – and by methods and equipment – approved by the Engineer. At Contractors option, if total thickness of repair is less than 4 inches, then repair can be made with a single pour of 3U17A.

23 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

24 - DESIGNER NOTE: Use this paragraph when authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

25 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as marked earlier, and include only those areas where the removal was specifically authorized to extend below the top layer of deck reinforcement **and the removals were made with a 15 pound class hammer.**

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type E*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for partial depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE E," at the Contract price per ft^2, complete in place. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired**.

SB-__.__ Remove and Patch Slab, Type F (Wearing Course Replacement on Patched Areas Only)

Perform work in accordance with the requirements of SB-_____, "Remove and Patch Structural Slab." Remove and dispose of that portion of the bridge slab which the Engineer specifically designates for full depth removal, after Type D and Type E removals have been performed. Provide formwork, furnish, place, cure, and grind concrete for full depth patches in the bridge slab. Perform work in accordance with 2401, "Concrete Bridge Construction," and the following:

Bond the patching concrete to the inplace concrete per 2404.2.B, "Bonding Grout." Brush or scrub the grout into the inplace concrete immediately prior to placement of patching concrete.

Use the patching concrete mix 3Y47 (with the maximum dosage of approved water reducer as permitted by the Department's Concrete Manual) for the portion of the patch below the bottom of the inplace wearing course. Use concrete mix 3U17A for a depth matching the inplace wearing course.

Strike off the 3Y47 concrete at the approximate lower limit of the inplace wearing course, and internally vibrate. Roughen, groove or serrate the surface of the full depth patches to the extent – and by methods and equipment – approved by the Engineer.

26 - DESIGNER NOTE: Use the next paragraph for typical applications. Use 72 hours unless 24 hours is recommended by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure until the concrete has reached a minimum strength of 2000 psi but no less than 24, 72 hours. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A

27 - DESIGNER NOTE: Use this paragraph where authorized by the Regional Construction Engineer.

Wet-cure the patches in accordance with 2401.3.G, "Concrete Curing and Protection," to the greatest duration possible (up to 7 calendar days). In all cases, wet cure to the greater of 20 hours or until the concrete has reached a minimum strength of 2000 psi. Control cylinders required for determining strength; in lieu of control cylinders the Contractor may use the maturity method in accordance with 2461.3.G.6, "Estimating Strength by the Concrete Maturity Method". Break control cylinders in accordance with 2461.3.G.5, "Test Methods and Specimens". Allow the bottom patch to air dry for at least 4 hours before placing the concrete wear course, 3U17A.

28 - DESIGNER NOTE: Use this paragraph if allowing less than 72 hours wet cure of patches.

When High Early Strength Concrete or High Early Contractor Mixes are used, immediately after completion of the finishing operations, cover the concrete with pre-wetted burlap and insulated curing blankets (to retain heat and speed hydration) for a minimum curing period of 20 hours. Where a contractor mix is used, propose a curing process subject to the approval of the Engineer. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case will curing be considered completed in less than 20 hours.

A. Method of Measurement

The Engineer will measure the repaired area based on the actual surface dimensions as defined earlier, and include only those areas specifically designated or authorized for full depth slab patching. Full depth patching of areas of the bridge slab where full depth removal was not designated or authorized by the Engineer will not be measured for payment

B. Basis of Payment

The contract unit price for *Remove and Patch Slab, Type F*, includes: removal, furnishing, placing, finishing, grinding, and curing the concrete for full depth patches complete in place, cleaning of reinforcement bars, clean-up & disposal of all materials removed from deck, and all other items needed to complete the patch will be considered incidental to item.

Payment will be made as Item 2433.618 "REMOVE AND PATCH SLAB TYPE F," at the Contract price per ft^2, complete in place, and shall include all necessary slab forming. **Payment will only be made for one type of repair for each ft^2 area satisfactorily repaired.**

SB2018-2433.3 A
Use for deck removal for widening and redeck projects only.
CREATED 3/5/1996
REVISED 12/3/2019 (3)

SB- Remove Concrete Bridge Deck

Remove and dispose of the (railings, barriers, curbs, slab, bituminous wearing course and membrane, end webs and tops of wingwalls) in accordance with 2433, "Structure Renovation," the plan, and the following:

No salvage is required.

A. Submittals

1 - DESIGNER NOTE: For the following, use when steel or prestressed beams will be reused.

Submit a detailed Controlled Demolition Plan (CDP) to the Engineer three weeks prior to demolition for review. Address all requirements for removal of the structure to the limits shown in the Contract documents. Provide the following minimum criteria in the submitted CDP, if applicable:

1. A removal sequence showing gravity loads imposed by Contractor equipment and materials;
2. Proposed methods of demolition, as applicable:
    - A list of all equipment that will be used and the weights of each,
    - Details of methods to brace the existing structure during demo process,
    - Saw cut and/or break point locations,
    - Locations of existing beams, diaphragms, cover plates, studs, etc.,
    - Crane pick locations, loads, positions, charts, and rigging,
    - Location of protective covers or shields.
3. Specific details for removal will be clearly defined, as applicable:
    - Practical environmental conditions that limit the removal,
    - Detailed Pick descriptions (Length, Center of Gravity, weight, etc.),
    - Temporary shoring/falsework details, and
    - Methods for identifying existing elements to remain after demolition.
4. List on the Demolition Plans the name of the person who is responsible for all rigging and handling of all elements requiring removal. This person, referred to as the Demolition Supervisor, will be present at the site during the demolition of all elements requiring removal. All field operations and field changes are under the authority and responsibility of the Contractor's Demolition Supervisor;
5. Traffic control narrative or reference to related traffic control submittal.

Do not suspend/swing any material, equipment, tools or personnel over lanes or pedestrian facilities open to traffic at any time during any stage of the removal procedure.

2 - DESIGNER NOTE: For the following two paragraphs, use when the girder stability during demolition may be a concern (i.e. steel bridges with hinges).

With the CDP, supply the Engineer with the detailed plans and the associated calculations of the proposed demolition plan which ensures stability of the structure during demolition, for review.

Plans and calculations should include the following:

1. Ensure stability of the superstructure elements during removal,
2. Identify any hinged spans and the means and method for removal, and
3. Prepared by an engineer, thoroughly checked by a second engineer for completeness and accuracy, and certified by one of the aforementioned professional engineers licensed in the State of Minnesota.

The Engineer's review will be for compliance with the Contract and will not be technical in nature. Demolition cannot start until the CDP has been accepted by the Engineer, in writing. The Engineer's review shall in no way or manner relieve the Contractor of their sole responsibility to remove the deck in a safe and controlled manner with no adverse effects to the inplace structure.

B. Removal

At the beginning of the work, demonstrate proposed method of removal as defined in the CDP in the presence of the Engineer by removing an area of deck considered appropriate by the Engineer. Use reasonable care so as not to cause damage to the remaining elements of the structure. At any time during demolition, the Engineer determines that use of the demonstrated method results in unreasonable damage to any portion of the remaining structure, change the removal method to one that will preclude such damage. The Engineer may, at their sole discretion, require the use of no larger than a 60 pound jackhammers by individual operators for the area over the beam flanges and up to one foot beyond the top flange edges of the beams (to deliver an uninterrupted removal process the Department suggests that hand operated jackhammers be on site). In no case use wrecking balls, spring-arm hammer machines, gravity-drop hammers, or other similar devices for concrete removal, as determined by the Engineer to cause excessive damage to the remaining structure.

The Engineer will inspect the remaining structure for damage due to the operations of the removal process, then consult with the Regional Bridge Construction Engineer, if there is damage. The determination/engineering of elements requiring repair/replacement will be completed by the Engineer of Record at no cost to the Department, as defined in 1502 of this proposal.

3 - DESIGNER NOTE: For the following paragraph, use only for total deck removal.

C. Method of Measurement

Measurement for payment will be from (out-to-out of coping and end-to-end of slab). (Wingwall removals will not be measured for payment but will be considered included in the costs of "Remove Concrete Bridge Deck.")

D. Basis of Payment

Payment for Item No. 2433.518 "REMOVE CONCRETE BRIDGE DECK" will be made at the Contract price per square foot and shall be compensation in full for all costs of performing described work, mobilization, as described above, including all work incidental thereto.

This work is used to mitigate risk of concrete deck bottom cover spalling onto publicly traveled areas when rebar corrosion creates delamination. Not to be used for concrete box girder superstructure..

CREATED 3/5/1996

REVISED 3/20/2018 (2)

SB- Sound and Remove Loose Concrete

Sound the underside of bridge concrete decks and remove the delaminated concrete in accordance with the applicable provisions of 2433, "Structure Renovation," the Plans, as directed by the Engineer, and the following:

Visually inspect and sound the bottom of the concrete bridge deck in areas [designated in the Plans] [directly above traveled traffic lanes and shoulders from edge of deck to edge of deck, including the vertical edge of deck], in conjunction with the Engineer. Remove areas of delamination or loose concrete to the extent of sound concrete. Provide protection per 1514, "Maintenance During Construction." Address roadway and traveling public in this protection. Removal of the concrete is restricted to methods that, in the Engineer's judgment, will not damage the structure. Do not remove more than 3 inch thickness of concrete without alerting the Engineer.

Dispose of removed materials in accordance with 2104, "Removing Pavement and Miscellaneous Structure."

A. Method of Measurement

Measurement area is the area total to be sounded for delamination designated in the plans. Sounding of vertical edge of deck will not be measured but is included with the measurement of under-deck sounding. No separate measurement will be made for removal and disposal of concrete.

No measurement will be made for sounding where the concrete removals are repaired in the contract. Sounding, removal and repair areas are measured and paid for under other items where repair has been designated in the Plans.

B. Basis of Payment

Payment for Item No. 2433.618 "SOUND AND REMOVE LOOSE CONCRETE" will be made at the Contract price per square foot and shall be compensation in full for all costs of performing described work, mobilization, as described above, including all work incidental thereto.

SB2018-2433.3 C

This work is for cleaning or preparing exposed reinforcement and painting with an approved product. The reinforcement may be exposed during the delaminated concrete removal process through the separate pay item, "Sound and Remove Loose Concrete", or be present prior to contract, or both.

CREATED 3/5/1996

REVISED 3/20/2018 (2)

SB- Clean and Paint Reinforcement (Bridge Nos. _________)

Clean and paint existing exposed reinforcement as designated in the Plans but not otherwise repaired through patching. This work is intended for areas where reinforcing is exposed but all concrete in the area is sound. This work includes previously exposed reinforcement and reinforcement exposed under "Sound and Remove Loose Concrete" pay item. Patching the concrete surface and reinforcement bars exposed after concrete removed is *not* required unless designated for concrete repair by the Engineer or in the plans. Repair of concrete is covered by other bid items as described in the Plans and other Special Provisions.

After delaminated concrete removal operations are completed, sandblast concrete removal areas detaching loose rust and concrete. Remove dust and loose particles by air blasting prior to painting. Follow provisions of SB-_____ 1717, "Air, Land, and Water Pollution," as supplemented in these Special Provisions, referring to MPCA Rule 7011.0150 (www.pca.state.mn.us) as it relates to sandblasting and or concrete removal operations.

Furnish only one of the materials listed on the Department's "Approved/Qualified Product List for Signals, Zinc Rich Paint for Galvanized Pole Repair," (www.dot.state.mn.us/products/paint/galvanizingrepairpaint.html).

Apply the paint coating to all delaminated areas including exposed reinforcement. Provide a finish color matching MnDOT standard color "Gray-Modified" on file in the MnDOT Chemical Laboratory (651-366-5548).

A. Method of Measurement

Measurement for cleaning and painting reinforcing will be by area in square feet of the bottom of the deck surface that has been identified by the Engineer for such work.

Bridge slab areas to be repaired in contract with full depth patches, or through Concrete Surface Repair, will not be measured. Cleaning and coating (where applicable) of reinforcement in concrete repair areas are measured and paid for under other items where repair has been designated in the Plans or by the Engineer.

B. Basis of Payment

Payment for Item No. 2433.618 "CLEAN AND PAINT REINFORCEMENT" will be made at the Contract price per square foot and shall be compensation for all costs of cleaning and painting the exposed area of reinforcement.

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- SD: Remove Concrete (Hydrodemolition)

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- SD: Remove Bridge Slab (Partial-Depth)

SB2018-2433.3 H3
xxxxxxxxxx
CREATED X/X/XXXX
REVISED X/X/XXXX (X)

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- SD: Remove Bridge Slab (Full-Depth)

SB2018-2433.3 H4
xxxxxxxxxx
CREATED X/X/XXXX
REVISED X/X/XXXX (X)

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- SD: Patch Removal

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB-   SD: Hydrodemolition Water Treatment

SB- BRIDGE PENETRATING SEALER (SILANE 100%)

A. Description of Work

1 - DESIGNER NOTE: insert appropriate area(s) in blank below. Clarify areas as needed.

- ***as indicated in the plans,***
- ***roadway surface,***
- ***side and top of median barrier,***
- ***roadway face and top of barrier,***
- ***sidewalk and curb,***
- ***raised median,***
- ***pier column,***
- ***wingwalls,***
- ***abutments***

Furnish and apply a penetrating sealer to the ____________ area of Bridge. Perform this work in accordance with the applicable provisions of 2433, "Structure Renovation," the plans, as directed by the Engineer, and the following:

B. General

Apply a MnDOT approved, penetrating, solvent based 100% silane sealer. Provide the Engineer with the sealer Manufacturer's written instructions for application and use, at least 30 calendar days before the start of the work.

C. Materials

Furnish only one of the materials listed on the Department's "Approved/Qualified Product Lists of Bridge Penetrating Sealers" (http://www.dot.state.mn.us/products/index.html).

The manufacturer of the silane product must directly ship a one quart sample of the sealer to the MnDOT Materials Lab (1400 Gervais Avenue; Maplewood, MN 55109) for quality assurance testing and IR scanning at least 30 days prior to the start of the work.

D. Application Requirements

1. Surface Preparation

Clean all areas to be sealed by removing dirt, dust, oil, grease, curing compounds, laitance, or other contaminants that would impede the penetration of the sealant. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft^3 / min., over the entire surface to remove all dust and debris paying special attention to carefully clean all deck cracks. Use a suitable oil trap between the air supply and nozzle. Use ASTM D4285 "Standard Test Method for Indicating Oil or Water in Compressed Air" to ensure the compressed air is oil and moisture free. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic. Have the Engineer accept the prepared surface prior to applying the sealer.

Air dry a wet deck for a minimum of seventy-two (72) hours before applying the sealer.

Cover all expansion joints in a manner that will prevent the sealer from contacting the strip seals but will allow sealer to penetrate the steel/concrete interface on each side of the joint. Secure the materials used to cover the strip seals with duct tape or another material approved by the Engineer.

2. Weather Limitations

Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within 12 hours of the completion of sealer application. Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the sealant at the coolest time of the day within these limitations. Application by spray methods will not be permitted during windy conditions, if the Engineer predicts unsatisfactory results.

3. Test Section

Prior to each bridge application apply the sealant to a test area, of at least 50 ft^2, on the shoulder of each bridge in project requiring this work. The test section will be used to evaluate the application equipment, coverage rate, drying times, traffic control, etc. Propose the specific location and application time for the test section at least 5 days prior to applying the sealer. A technical representative from the sealer manufacturer must be present during application and drying of the test section. Prior to application of the sealant, hold a meeting with the Manufacturer's Representative and the Engineer to discuss all necessary safety precautions and application considerations. If the coverage rate is increased (less product per area), by the Engineer, the contract unit price will be decreased by that same percentage.

4. Sealer Application

Do not thin or alter the sealer unless specifically required in the Manufacturer's instructions. Mix the sealer before and during its use as recommended by the Manufacturer. Distribute the sealant with a spray bar near the surface so the spray pattern and coverage rates are reasonably uniform to the satisfaction of the Engineer. Do not allow running or puddling of the sealer to occur. Apply the sealant at a coverage rate of 400 ft^2 / gal and apply in two coats if running or puddling cannot be controlled with one coat. (see "Test Section" for clarification on coverage rate)

Allow the sealant to dry according to the Manufacturer's instructions. Do not allow vehicular traffic onto the treated areas until the sealer has dried and the treated surfaces provide safe skid resistance and traction.

E. Method of Measurement

Measurement will be made to the nearest square foot of concrete area sealed based on surface area.

F. Basis of Payment

Payment for Item No. 2433.618 "SILANE 100 PERCENT", will be made at the Contract price per square foot and shall be compensation in full for all costs of furnishing and applying the sealer to the bridge decks, as described above, including surface preparation, and all incidentals thereto.

SB- **BRIDGE PENETRATING SEALER (SILANE 40%)**

A. Description of Work

1 - DESIGNER NOTE: insert appropriate area(s) in blank below. Clarify areas as needed.

- ***as indicated in the plans,***
- ***roadway surface,***
- ***side and top of median barrier,***
- ***roadway face and top of barrier,***
- ***sidewalk and curb,***
- ***raised median,***
- ***pier column,***
- ***wingwalls,***
- ***abutments***

Furnish and apply a penetrating sealer to the _____________ area of Bridge. Perform this work in accordance with the applicable provisions of 2433, "Structure Renovation," the plans, as directed by the Engineer, and the following:

B. General

Apply a MnDOT approved, penetrating, solvent based 40% silane sealer. Provide the Engineer with the sealer Manufacturer's written instructions for application and use, at least 30 calendar days before the start of the work.

C. Materials

Furnish only one of the materials listed on the Department's "Approved/Qualified Product Lists of Bridge Penetrating Sealers" (http://www.dot.state.mn.us/products/index.html).

The manufacturer of the silane product must directly ship a one quart sample of the sealer to the MnDOT Materials Lab (1400 Gervais Avenue; Maplewood, MN 55109) for quality assurance testing and IR scanning at least 30 days prior to the start of the work.

D. Application Requirements

1. Surface Preparation

Clean all areas to be sealed by removing dirt, dust, oil, grease, curing compounds, laitance, or other contaminants that would impede the penetration of the sealant. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft^3 / min., over the entire surface to remove all dust and debris paying special attention to carefully clean all deck cracks. Use a suitable oil trap between the air supply and nozzle. Use ASTM D4285 "Standard Test Method for Indicating Oil or Water in Compressed Air" to ensure the compressed air is oil and moisture free. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic. Have the Engineer accept the prepared surface prior to applying the sealer.

Air dry a wet deck for a minimum of seventy-two (72) hours before applying the sealer.

Cover all expansion joints in a manner that will prevent the sealer from contacting the strip seals but will allow sealer to penetrate the steel/concrete interface on each side of the joint. Secure the materials used to cover the strip seals with duct tape or another material approved by the Engineer.

2. Weather Limitations

Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within 12 hours of the completion of sealer application. Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the sealant at the coolest time of the day within these limitations. Application by spray methods will not be permitted during windy conditions, if the Engineer predicts unsatisfactory results.

3. Test Section

Prior to each bridge application apply the sealant to a test area, of at least 50 ft^2, on the shoulder of each bridge in project requiring this work. The test section will be used to evaluate the application equipment, coverage rate, drying times, traffic control, etc. Propose the specific location and application time for the test section at least 5 days prior to applying the sealer. A technical representative from the sealer manufacturer must be present during application and drying of the test section. Prior to application of the sealant, hold a meeting with the Manufacturer's Representative and the Engineer to discuss all necessary safety precautions and application considerations. If the coverage rate is increased (less product per area), by the Engineer, the contract unit price will be decreased by that same percentage.

4. Sealer Application

Do not thin or alter the sealer unless specifically required in the Manufacturer's instructions. Mix the sealer before and during its use as recommended by the Manufacturer. Distribute the sealant with a spray bar near the surface so the spray pattern and coverage rates are reasonably uniform to the satisfaction of the Engineer. Do not allow running or puddling of the sealer to occur. Apply the sealant at a coverage rate of 125 ft^2 / gal and apply in two coats if running or puddling cannot be controlled with one coat. (see "Test Section" for clarification on coverage rate)

Allow the sealant to dry according to the Manufacturer's instructions. Do not allow vehicular traffic onto the treated areas until the sealer has dried and the treated surfaces provide safe skid resistance and traction.

E. Method of Measurement

Measurement will be made to the nearest square foot of concrete area sealed based on surface area.

F. Basis of Payment

Payment for Item No. 2433.618 "SILANE 40 PERCENT", will be made at the Contract price per square foot and shall be compensation in full for all costs of furnishing and applying the sealer to the bridge decks, as described above, including surface preparation, and all incidentals thereto.

SB2018-2433.5 Chase

Include on existing bridges receiving a new concrete wearing course or when recommended on existing roadway surfaces that are not map cracked or that do not have tightly spaced cracks.

CREATED 10/8/2015

REVISED 3/20/2018 (1)

SB- Seal Cracks with Epoxy by Chase Method

A. Description of Work

This work consists of sealing cracks with narrow band of approved epoxy. This specification covers application to existing structural slabs that will receive a new concrete wearing course or to existing finished concrete surfaces. The Department defines existing structural slabs as bridge slabs that are existing prior to contract initiation, which have been scarified or otherwise prepared to receive a new concrete wearing course.

On finished roadway surfaces and sidewalks, cracks 0.007 inch or smaller, as measured at the crack's widest segment, will not require sealing.

When applied on existing concrete roadway surfaces, apply epoxy in a width not exceeding 3 inches.

When applied on an existing structural slab which is to receive a concrete wearing course, apply epoxy in a cured width not exceeding ¾ inch.

B. Materials

Furnish only one of the materials listed on the Department's "Approved/Qualified Product List for Bridge Products, Bridge Surface and Crack Sealers," (www.dot.state.mn.us/products/bridge). A product may be selected from either the "High Elongation Epoxy Crack Sealers" or "High Strength Epoxy Crack Sealers" categories listed on the Bridge surface and crack sealer approved products list. Apply in accordance with the requirements listed on the approved products list, except that when applied under a concrete wearing course only one application pass is required.

C. Surface Preparation and Application

1. When applied on final roadway surface:

   No greater than three weeks prior to application:

   a. Clean all areas to be sealed by removing dirt, dust, oil, grease, curing compounds, laitance, or other contaminants that would impede the penetration of the sealant;
   b. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations;
   c. Wash deck and sidewalk surfaces with a water pressure of 3,000 psi minimum with the wand held 8-inches or less from the surface and moved parallel to the surface. Use clean, fresh water with pressure adequate to remove all visible dirt, salt, animal waste and similar debris. Direct sediment and dirt off bridge and collect sediment on approach panels. Flush joints free of any sediment, dirt or debris;
   d. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic;
   e. Perform a visual inspection of the roadway surface, and sidewalk where applicable. Locate and mark all cracks appearing on the top surface visible from 5 ft above deck surface, and as directed by the Engineer. Traffic may be run on washed surface and prior to air blasting.
   f. Air dry a wet deck for a minimum of seventy-two (72) hours before applying the sealer;

g. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft^3 / min., over the entire surface to remove all dust and debris paying special attention to carefully clean all deck cracks. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic. Use a suitable oil trap between the air supply and nozzle. Use ASTM D4285 "Standard Test Method for Indicating Oil or Water in Compressed Air" to ensure the compressed air is oil and moisture free;

h. Have the Engineer approve the prepared surface prior to applying the sealer;

i. Seal all cracks 0.007" or greater in width at its widest segment. Chase crack with sealant application to limits of crack, including those portions that are narrower than 0.007" wide.

Where crack spacing is observed closer than an average of 6 ft on center, consult the Engineer for a change order to a MMA FLOOD SEAL.

Protect all expansion joints and prevent the crack sealant from contacting the strip seal glands. Protect all striping and traffic markings from marring, sealant application and reduction in reflective properties. Replace any striping and traffic markings that are marred by sealant.

Fill cracks with an approved crack sealer following the manufacturer's recommendations, and as otherwise directed by the Engineer prior to opening the bridge to vehicular traffic. Where traffic is to be placed on crack sealer before curing is complete, broadcast to refusal oven dried 30 grit or similar sand into wet, uncured resin. If a subsequent treatment will be applied that would be affected by the sand. Cleaning unbonded sand or grit will be not be paid for separately but be considered incidental to surface preparation requirements for the subsequent treatments. Remove excess sand that causes concern for traction or braking from bridge deck including deck joints as directed by the Engineer.

2. When applied to existing structural slab prior to placing new wearing course:

Supplement 2404.3.C, "Deck Preparation," with the following:

After shotblasting the surface, the Engineer will perform a visual inspection of the bridge deck, and locate all cracks appearing on the top surface. Fill all located cracks with an approved crack sealer following the manufacturer's recommendations, and as otherwise directed by the Engineer. Ensure the sealer is cured prior to preceding pre-wetting of the deck, as required for placement of a low slump concrete wearing course.

Control the application of the crack sealer such that the maximum width of crack sealant does not exceed ¾ inch. If exceeding the permitted width of ¾ inch, remove excess by means of surface grinding to prevent debonding of concrete wearing course. Air dry a wet deck for a minimum of twenty-four (24) hours before applying the sealer. Have the Engineer approve the prepared surface prior to applying the sealer.

D. Weather Limitations

Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within 6 hours of the completion of sealer application. Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the crack seal at the coolest time of the day within these limitations.

E. Method of Measurement

1 - DESIGNER NOTE: Select either gallons or linear foot.

Sealing cracks in the deck surface will be measured by (gallons of epoxy sealer applied to the cracks) (linear feet of cracks sealed with epoxy) that have been designated by the Engineer to be sealed. Cracks sealed by the Contractor that have not been designated by the Engineer will not be measured for payment. Additional qualifications on measurement are application-specific as follows.

1. Cracks on Final Roadway Surface:

Cracks sealed with an epoxy width greater than 3 inches on final roadway surface will not be counted for measurement. When the unit of measurement is in gallons, the pay quantity will be established at a rate of 450 linear feet per gallon for any cracks sealed in excess of 3 inch wide and where the gallon measurement is in dispute.

2. Cracks sealed prior to placing concrete wearing course:

Cracks sealed with an epoxy width greater than $^3/_4$ inch on structural deck will be not be counted for measurement and must be ground to $^3/_4$ inch in width. When the unit of measurement is in gallons, the pay quantity will be established at a rate of 1350 linear feet per gallon for any gallon measurement in dispute.

F. Basis of Payment

2 - DESIGNER NOTE: Use when payment will be by the gallon (this will be used the majority of the time).

Payment for Item No. 2433.606 "SEAL CRACKS WITH EPOXY BY CHASE METHOD" will be made at the Contract price per gallon and shall be compensation in full for all costs of cleaning and sealing the cracks in the bridge decks, as described above. No payment will be issued for treating new concrete surfaces placed within contract.

If a contract work on the same area includes "MMA FLOOD SEAL", no payment will be issued for sealing cracks 0.040 inch wide or smaller. These cracks will be prefilled immediately ahead of "MMA FLOOD SEAL" and will be considered included with "MMA FLOOD SEAL".

No payment will be made for replacement of any striping marred as a result of sealing operations.

3 - DESIGNER NOTE: Use when payment will be by the linear foot (this is usually just for District 6).

Payment for Item No. 2433.603 "SEAL CRACKS WITH EPOXY BY CHASE METHOD" will be made at the Contract price per linear foot and shall be compensation in full for all costs of cleaning and sealing the cracks in the bridge decks, as described above. No payment will be issued for treating new concrete surfaces placed within contract.

If a contract work on the same area includes "MMA FLOOD SEAL", no payment will be issued for sealing cracks 0.040 inch wide or smaller. These cracks will be prefilled immediately ahead of "MMA FLOOD SEAL" and will be considered included with "MMA FLOOD SEAL".

No payment will be made for replacement of any striping marred as a result of sealing operations.

SB2018-2433.5 Flood

Use for flood seal treatment of bridge decks with map cracking or cracking spaced at 6 foot on center or closer.

CREATED 10/8/2015

REVISED 3/20/2018 (1)

SB- Methyl Methacrylate (MMA) Flood Seal

A. Description of Work

1 - DESIGNER NOTE: review the Bridge Preservation Recommendations for your needed information.

This work consists of furnishing and applying a protective MMA sealer as shown in plans or as authorized by the Engineer. Perform this work in accordance with the applicable provisions of 2433, "Structure Renovation," the plans, as directed by the Engineer, and the following:

B. General

1. Remove existing crack sealants

Remove existing sealants including epoxy crack sealant prior to MMA Flood Seal. Remove sealants with equipment that does not damage the underlying substrate. Use 7,000 psi power wash with a spin head to remove epoxy, or propose alternate means which do not remove more than $^{1}/_{16}$ inch of concrete.

2. Prefill Large Cracks

Prior to application, prefill cracks greater than 0.025 inch with same sealer as used in flood seal or a pre-promoted version of the sealer. Where sealant soaks-in/withdraws from top of crack, place fine grade abrasive sand (20/40 abrasive) in crack and reapply MMA sealant to seal to top of crack. When sealant has not retreated after gel time, the crack is considered prefilled. Do not fill crack with sand beyond top of concrete surface.

3. MMA Application

Apply an approved MMA to roadway surfaces on bridge deck or on surfaces as directed by the Engineer. At least 30 calendar days before the start of the work, provide the Engineer with the sealer Manufacturer's written instructions for application and use.

C. Materials

1. MMA Sealant

Furnish only one of the materials on the Department's "Approved/Qualified Product Lists for Bridge Products, Bridge Surface and Crack Sealers, Methacrylate Resin Crack Sealers" (www.dot.state.mn.us/products/bridge) at a minimum rate of 90 ft^2 / gal.

2. Broadcast sand

Provide a commercial quality dry blast sand meeting the following:

a. 95% passing the No. 8 sieve; and

b. 95% retained on the No. 20 sieve.

3. Fine grade sand

Provide fine grade abrasive sand for (20/40 abrasive) prefilling large cracks unable to be prefilled with sealant alone.

Submit sand material data to the Engineer for review and address all written comments. Submit storage and use plan to the Engineer documenting procedures for maintaining dry sand and within gradation requirements above.

D. Surface Preparation

1. Clean all areas to be sealed by removing dirt, dust, oil, grease, curing compounds, laitance, or other contaminants that would impede the penetration of the sealant;
2. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations;
3. Perform a visual inspection of the roadway surface, and sidewalk where applicable. Locate and mark all cracks greater than 0.024 inch appearing on the top for prefilling.
4. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft^3 / min., over the entire surface to remove all dust and debris paying special attention to carefully clean all deck cracks. Use a suitable oil trap between the air supply and nozzle. Use ASTM D4285 "Standard Test Method for Indicating Oil or Water in Compressed Air" to ensure the compressed air is oil and moisture free;
5. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic;
6. Air dry a wet deck for a minimum of seventy-two (72) hours before applying the sealer;
7. Have the Engineer approve the prepared surface prior to applying the sealer;

E. Sealant Manufacturer Support

A technical representative from the sealer manufacturer must be present during first application. The need for manufacturer's representative may be waived if the contractor provides evidence and reference contacts for work involving at least 5 bridges treated with the same products and within the last two years. Contractor experience record in no way relieves the contractor from applying in accordance with this specification and as recommended by the manufacturer.

Prior to application of the sealant, hold a meeting with the Manufacturer's Representative, the Engineer, and the Contractor to discuss all necessary safety precautions and application considerations. The manufacturer's representative must be available to answer all safety and installation questions.

F. MMA Flood Seal Application

Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within twelve (12) hours of the completion of sealer application. Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the sealant at the coolest time of the day within these limitations. Application by spray methods will not be permitted during windy conditions, if the Engineer predicts unsatisfactory results.

Do not thin or alter the MMA crack sealer unless specifically required in the Manufacturer's instructions.

Mix the sealer before and during its use as recommended by the Manufacturer. Distribute the sealant as a flood coat in a gravity-fed process by broom, roller, or with a spray bar near the surface so the spray pattern and coverage rates are reasonably uniform to the satisfaction of the Engineer. Apply the sealant at a minimum rate of 90 ft^2 / gal.

Protect all expansion joints and prevent the crack sealant from contacting the strip seal glands. Protect all striping and traffic markings from marring, sealant application and reduction in reflective properties. Replace any striping and traffic markings that are marred by sealant.

Prior to completion of gel time of the flood seal (within 15 minutes) and before broadcasting sand, broom uncured sealant in the direction of tining or deck grooves to promote maintenance of the deck texture for traction.

Broadcast sand to refusal into uncured resin to create traction and absorb sealant that is not penetrating into cracks. Broadcast approved sand into the wet, uncured resin no sooner than 20 minutes after applying resin but within gel time of product. Apply approved sand at a minimum rate of 250 lbs. per 1000 square feet.

Allow the sealant to dry according to the Manufacturer's instructions. Do not allow vehicular traffic onto the treated areas until the sealer has dried and the treated surfaces provide safe skid resistance and traction. Remove non-adhered sand from bridge deck and joints by power sweeping the deck and vacuuming the joints. Traffic or equipment will be allowed on the sealed deck after the Engineer has determined:

1. The treated deck surface is tack-free and non-oily;
2. The sand cover adheres and resists brushing by hand;
3. Excess sand and absorbent material has been removed; and
4. No sealant material will be tracked beyond limits of treatment by traffic

G. Method of Measurement

Measurement will be made to the nearest square foot of concrete area sealed as designated by the Engineer.

H. Basis of Payment

Payment for Item No. 2433.618 "MMA FLOOD SEAL" will be made at the Contract price per square foot and shall be compensation in full for all costs of furnishing and applying the sealer to the bridge decks, as described above, including surface preparation, and all incidentals thereto. Cleanup of excess sand in joints and on bridge deck will not be paid for separately. Restoration of damaged or marred striping will be considered incidental to application requirements of 2433.618 "MMA FLOOD SEAL".

SB- Clean and Seal Deck Joints (Bridge Nos. ________________________________)

A. Description of Work

This work consists of cleaning out and resealing the top of the transverse pourable-type joints located on the bridge deck above the piers as shown and noted in the Plans.

B. General

Perform the work in accordance with the following.

C. Materials

1 - DESIGNER NOTE: Use the following paragraphs that represents what the district wishes to use.
Provide joint sealer compound conforming to 3722, "Silicone Joint Sealant".

Provide joint sealer compound conforming to 3725, "Hot-Poured, Extra Low Modulus, Elastic Type Joint and Crack Sealer".

Provide backer rod material compatible with the sealer. Supply an uncompressed diameter of the rod, at least, one and one-half times greater than the width of the joint.

D. Construction Requirements

Prior to sealing:

1. Remove inplace compressible and sealing material;
2. Clean the concrete substrate by sandblasting to remove oil, grease, dirt and other foreign matter;
3. Remove loose particles with dry oil-free compressed air; and
4. Install appropriate backer rod if needed (see below).

The Engineer will determine, according to crack width, if backer rod is necessary. If used, install the foam backer rod in the joint opening so that the thickness of the sealant will be approximately one-half the width of the joint. Clean the joint after installation with dry oil-free compressed air being careful not to force the backer rod further down into the joint opening.

Prior to application of the sealing material the depth of the backer rod shall be checked at a minimum of three places per 12 feet of joint, and adjusted as necessary to achieve the proper sealant thickness and recess.

E. Method of Measurement

Measurement of cleaning and sealing the deck joint by length, in linear feet, based on the distance along the centerline of the joint opening from face of concrete barrier to face of concrete barrier.

F. Basis of Payment

Payment for Item No. 2433.603 "CLEAN AND SEAL DECK JOINTS", will be made at the Contract price per linear foot and shall be compensation in full for performing all of the work described above, including all incidentals thereto.

SB- Repair Structural Cracks (Epoxy Injection)

A. Description of Work

This work consists of repairing structural cracks in the concrete ______________ by furnishing materials, labor and incidentals necessary for repair of the cracks by means of pressure injection of an epoxy resin material in accordance with these Special Provisions, and as directed by the Engineer.

B. General

1. Scope of Work

Repair cracks as shown in the Plan or as directed by the Engineer.

2. Submittals

a. Three copies of material certification;
b. Safety Data Sheets (SDS) for products used;
c. Manufacturer's published recommendations for products used; and
d. Type and installation procedure for the injection ports.

C. Materials

Epoxy Resin

Deliver products in original factory packaging, bearing identification of product, manufacturer, batch number, and expiration date. Assure the product has not been exposed to any conditions or limits required by the manufacturer.

Provide two component epoxy systems for the purpose of grouting cracked or delaminated, hardened concrete by pressure injection that meets the following:

1. Will bond cracked or delaminated concrete structures into one monolithic form;
2. Cap-Seal Crack Surface Sealer Epoxy sealant gel (paste type) meeting the requirements of ASTM C881 Type I, Grade 3, Class A, B or C;
3. Epoxy Resin Filler (bulk injection resin) meeting the requirements of ASTM C881 Type IV Grade 1, Class A, B or C; and
4. The colors of the components are distinctly different from each other, and when mixed in proper ratio yield a distinctly different third color.

D. Construction Requirements

1. Pre-installation Meeting

Conduct a preinstallation meeting at the project site. Review scope of work expected. Require representatives of each entity directly concerned with the work to attend, including the following:

a. Contractor;
b. Installer;
c. Epoxy manufacturer's representative; and
d. Department's representative.

Review the following, at a minimum:

a. Schedule;
b. Extent of Work;
c. Materials to be installed;
d. Procedures to be used for crack injection;
e. Material storage and staging;
f. Temperature required; and
g. Cleanup and disposal of waste materials.

2. Preparation

a. Inspect surfaces to receive repair material; ensure that substrate is clean, sound, properly cured, free of standing water, coatings, or curing compounds, foreign particles, oil, dust, grease, or laitance, that will adversely affect the bond of repair materials;
b. Remove loose material by hand or mechanically, in accordance manufacturer's instructions;
c. Clean cracks prior to injection using clean, oil-free compressed air (do not use liquid);
d. Clean surfaces adjacent to cracks adequately to allow cap-seal epoxy to form a proper bond; and
e. Ensure that air, material, and substrate surface temperature is at least 40 degrees F and rising prior to beginning application.

E. Application Requirements

Limit application to cracks ranging in width of $^{1}/_{16}$ to ¼ inch. Injection of epoxy into cracks wider than ¼ inch is not permitted until reviewed and accepted by the Engineer.

Follow manufacturer's recommendations and written instructions when applying crack repair materials.

Perform crack injecting when temperatures are high enough to assure proper penetration with the material being supplied for the work. In no case will thinners be permitted.

1. Injection Ports

Install the injection ports at appropriate intervals to accomplish full penetration of the injection resin. Determine the spacing of the injection ports by the size of the crack and the depth of the concrete substrate but in no case can the spacing exceed 20 inches.

Design injection ports for the intended use and to be acceptable to the epoxy manufacturer.

Positively cap and seal ports following the injection work.

2. Injection Port Installation

Install the injection ports using one or more of the following methods:

a. Surface Mounted Injection Ports:

Center the injection port over the crack and secure in place using the epoxy gel.

Completely seal the exposed crack located between the injection ports and other areas as required to prevent leaking of the resin's epoxy gel.

If the crack extends through the member, and if accessible, install telltale injection ports on the opposite side and seal exposed areas using the procedures below in "C, Curing of Cap-Seal Crack Surface Sealer."

b. Drilled Injection Ports:

Drill proper sized holes a minimum of $^{5}/_{8}$ inch deep. Exercise care so as not to drill beyond a crack which may be running at an angle to the surface.

Insert injection ports into the drilled holes, allowing for a small reservoir below the injection port. Secure the injection ports into position using epoxy gel. Seal the exposed crack using the procedures below in "C, Curing of Cap-Seal Crack Surface Sealer."

c. Injection Ports Mounted Against a Head of Water:

For cracks that have water running from or through them, use a hydraulic cement (fast setting) to set in the injection ports. After the hydraulic cement has cured, seal the cracks and injection ports by overlapping the hydraulic cement one inch on either side using epoxy gel.

3. Curing of Cap-Seal Crack Surface Sealer:

Allow all bonded ports and sealed cracks to cure overnight at temperatures of 50° F or above. Should temperatures below 50° F exist, additional cure time may be provided per the manufacturer’s recommendations. Commence pressure injection operations after the epoxy gel has adequately cured and is capable of sustaining pressures of the injection process.

4. Epoxy Resin Filler (bulk injection resin) - Automated Pressure Injection:

a. Before and During Injection

(1) Set up, calibrate, and test automated pressure injection equipment as directed by the manufacturer of automated injection equipment;
(2) Start by inserting mix head into lowest elevation port to begin injection and assist in venting trapped air and moisture through higher ports;
(3) As pressurized epoxy appears at the next valve close the pumping valve, move to the next valve and commence pumping at the next valve Cap or tie-off completed ports;
(4) Continue procedure until the last valve is reached and the crack is essentially fully injected with epoxy; and
(5) Avoid delays in the pumping operation.

b. After Crack Injection

(1) After crack injection epoxy is cured (approximately 24 hours), remove cap-seal epoxy and injection ports by mechanical means to a surface level that is uniform and matching in with the original surface.

F. Method of Measurement

Seal structural cracks will be measured by the linear foot of accepted crack repair.

G. Basis of Payment

Payment for Item No. 2433.603 "REPAIR STRUCTURAL CRACKS", will be made at the Contract price per linear foot and shall be compensation in full for all labor, materials and equipment costs and incidentals associated with a complete crack repair.

SB2018-2433.5 C

Use when recommended by the Regional Bridge Construction Engineer. Used in high salt exposure areas but must be cognizant that coating should go to a high enough elevation to not let moisture in from coating boundary, and that the color will not match concrete SSF and is glossy sheen. See BR 27982.

CREATED 10/1/2019

REVISED 10/1/2019

SB- High Build Protective Coating

This work consists of the following for field applied high build epoxy coating systems to provide a protective, and abrasion-resistance coating on concrete.

A. Definitions

Whenever the following terms are used in this section, they will have the following meaning:

1. Field Coating: The outdoor on-site coating of new concrete.
2. Quality Assurance (QA): The process and person(s) responsible for verification of the conformance of materials and methods of application to the governing specification, in order to achieve a desired result.
3. Quality Control (QC): The process and person(s) responsible for administrative and production procedures employed to attain the desired product outcome and quality. The job foreman or production painter cannot be this person.
4. Quality Manual (QM): The formal written document prepared by the contractor that describes the policies and procedures that ensure and verify that the coated structural steel component will satisfy the contract requirements.
5. Quality Assurance Inspector (QAI): The Department's representative responsible for duties specified in the Quality Assurance Plan, with the authority to accept work that meets Contract requirements.
6. Prime Coat: The first coat applied following surface preparation work.
7. Coating thickness: The Dry-Film Paint Thickness (DFT) above the peaks of the blast profile.
8. Qualified: Holding appropriate documentation and officially on record as competent and experienced to perform a specified function or practice of a specific skill.
9. Coating System: The surface preparation and application of approved coating products to provide a film forming a unified whole for the purpose of corrosion protection, and/or aesthetics.

B. Materials

Materials must consist of 2-component, 100% solids, moisture-tolerant epoxies that produce a high-build, protective, vapor-barrier system. Use one of the High Build Protective Coating Systems listed as follows, or an approved equal:

1. Simpson Strong-Tie FX-70-9
2. Sikagard 62
3. Fife Tyfo® U with Tyfo S or manufacturer recommended primer

Apply the above products in a minimum of two coats. Apply a coverage rate not exceeding 200 square feet per gallon. Produce an applied coating with a total dry film thickness not less than 16 mils with no bubbles or pinholes penetrating the first coat.

1 - DESIGNER NOTE: Include the following paragraph if there is also dampproofing on job:

As an equivalent alternative, the contractor may apply dampproofing as covered under the "Dampproofing" special provision. No compensation will be made for the substitution unless otherwise authorized by the Engineer.

The finished color of the coating shall be gray, as close matching to AMS-STD-595A No. 26622 (pearl gray), on file in the MnDOT Chemical Laboratory (651-366 5548) as the coating manufacturer produces.

Deliver the coating to the site and package multi-component coatings in clearly marked separate containers or kits.

Provide the Engineer with the following for each coating shipment:

1. The manufacturer's safety data sheets (SDS),
2. Material certifications, and
3. Written instructions for mixing, handling, and application of the coatings.

Ensure a manufacturer's technical representative with knowledge of this coating system is available to assist during coating application.

C. Contractor Qualifications and Documentation

At least 30 calendar days before starting work submit a Quality Manual (QM) meeting the requirements of this section to the Engineer for approval.

For the preparation and application of field applied coatings, Contractors must perform work with staff meeting the requirements of The Society of Protective Coatings Certified Application Specialist (SSPS CAS) Level 2. One CAS Level 2 is required on site overseeing the work in each work area up to a crew of 10 workers. Multiple work areas will require an additional CAS for each area.

At least 30 calendar days before starting work, submit to the Quality Assurance Inspector (QAI) or the Engineer documentation showing that the protective coating manufacturer's technical representative trained the protective coating painters, applicators, and Quality Control (QC) personnel to apply the coating system on the project. Make training materials available to the Engineer upon request.

D. General

Protect the environment and property as required by federal, state, and MnDOT regulations.

Protect areas not scheduled for coatings that are adjacent to the coated surfaces from overspray, unless otherwise shown on the plans or in the special provisions. The Engineer will allow up to 2 inches of overspray and may require the excessive over sprayed protective coating be removed, or wire wheeled from the adjacent surface(s).

Provide a system for inspection that will allow the inspector to safely access the coated areas. For safety systems that require temporary fastening to support the system, use fastening hardware that will not damage the protective coating or attached structure. Repair damages as approved by the Engineer at no additional cost to the Department.

E. Surface Preparation

Concrete should be a minimum of 28 days old being cured at 73°F minimum or substantially cured to the equivalent design strength prior to coating application. Remove all form release agents, curing compounds, salts, efflorescence, laitance, and other foreign matter from surface by abrasive blasting or other mechanical means per SSPC-SP13 / NACE 6, ICRI Guideline 310.2R CSP3-5.

Where surface is previously coated with another system, remove all surface contaminants and mechanically abrade substrate to achieve the equivalent of a 100-grit sandpaper profile. For application to areas with Fiber Reinforced Polymers (FRP), prepare surfaces with sandpaper to a roughness equivalent of a 100-grit sandpaper profile or as recommended by the FRP supplier. Roughen FRP surfaces by means approved by the manufacturer of the FRP system in writing. Submit written letter from FRP supplier approving contractor's surface preparation technique to the Engineer.

F. Application Requirements

Apply the High Build Protective Coating system on the exposed concrete surfaces as defined in the Plan.

Apply in two coats minimum creating a total of not less than 16 mils Dry Film Thickness (DFT), and apply in accordance with manufacturer's application recommendations. Apply a coverage rate not exceeding 200 square feet per gallon. Produce an applied coating system with no bubbles or pinholes penetrating the first coat.

Protect coating from dust and airborne dirt during each coat curing.

Apply in conditions meeting manufacturer's environmental constraints concerning temperature, humidity, and dew point.

G. Quality Control

The Department will appoint a Quality Assurance Inspector (QAI) as a Department representative to accept work meeting the Contract requirements.

1. Quality Manual (QM) Requirements

Provide the minimum requirements and frequencies in the QM as shown in Table 2478-1:

Table 2478-1
Coating Inspection Requirements

	Requirement	Frequency/Extent
General	Ambient temperature	Every 4 (field) hours
	Dew point and relative humidity	Every 4 (field) hours
	Surface temperature	Every 4 (field) hours
	Date and time	Every 4 (field) hours
	Piece mark or bundle	Every 4 (field) hours
	Compressed Air Test ASTM D4285	Daily – when abrasive blasting or blow down operations are occurring
	DFT (each coat of paint)	SSPC PA 2
	Visual inspection (each coat of paint)	100 percent
Surface Preparation	Pre-clean per SSPC-SP 1 – Solvent Cleaning	Each component to be prime coated. Visually inspect 100%
	Abrasive blast clean per SSPC-SP 10 – Near-White Blast Cleaning	Each component to be prime coated
	Visually inspect per VIS-1 – Standard for Blast Comparisons	100 percent
	Soluble Salt Test	See Special Provisions
	Blast profile inspection per ASTM D4417 (Method B for the field)	Steel Girders – minimum of three locations per each blasted. Diaphragms – three locations minimum per each blasted. Sole Plates – three locations minimum per each blasted. Pedestrian Bridges – minimum of three locations on each truss and a minimum of three locations on the floor beam. Railing – ten locations minimum for each 100 lineal feet of rail. Bridge Truss – three locations minimum for each 1000 square feet or the amount of truss blasted by each blasting nozzle in an eight hour shift (whichever is less). Items not covered by this list shall have three documented profile locations for every 1000 square feet blasted.

	Requirement	Frequency/Extent
Prime, Intermediate and Finish Coat	Batch number	Every paint kit
	Verification of surface cleanliness	Examine visually within 1 hour before prime painting For field applications include a white cloth test (nothing is transferred on to the cloth surface)
	Temperature of mixed product	When mixing components
	Proper mixing and straining	Every pot mix
	Induction time and reaction time	Every pot mix
	Pot life	Every pot mix
	Cure time	Each lot of work
	Cure Verification	Prior to the next coat application
	Proper use of stripe coats (prime coat only)	Visual, 100 percent of applicable areas
	Coating evaluation and repair	Visual, 100 percent of each element
	Recoat time	Each lot of work and as recommended by the manufacturer
	Adhesion (Final Coating system)	Three locations minimum, and then 1 additional for each 500 sq. ft.
	Coating system final evaluation and repair	Visual, 100 percent of each element

Provide written documentation of the measurements to the QAI or to the Engineer during the work and in its entirety at the completion of the job. The QAI or the Engineer may reject the coating system or reduce payment if the Contractor did not adhere to the approved QM or provided inadequate documentation of adherence to the QM. Conduct subsequent testing with the QAI or the Engineer’s approval, at no additional cost to the Department, to determine compliance.

H. Coating Repair

The Contractor may use a "Tooke Gauge" to perform a destructive test to measure the DFT, at no additional cost to the Department, if it is not possible to satisfactorily determine the coating thickness of any paint coat after application. Repair the destructively tested area as approved by the Engineer and at no additional cost to the Department. Do not perform mechanical grinding to reduce paint thickness. Where coating system DFT thicknesses are deficient either completely remove and recoat with a new paint system, as defined in this section, or prime and topcoat if full build thickness will be within manufacturer’s limits.

Submit paint repair procedures to the Engineer in writing for approval.

I. Method of Measurement

The Engineer will measure high build protective coating by the square foot based on the area of acceptable coating coverage on surfaces which are properly prepared and are approved for coating.

J. Basis of Payment

The contract square foot price in Item No. 2433.618 "HIGH BUILD PROTECTIVE COAT" includes all labor, materials and equipment required for all surface cleaning, surface preparation, and applying the coating product, including all incidentals, adhesion tests, curing, and final cleanup, in accordance with these Special Provisions.

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.5 D
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- SD: Crack Monitoring Gauge

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.5 E
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB-   Seal Existing Concrete Beam End

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- SD: Caulk Beam Ends

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- SD: Seal Substructure Joints

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- Remove Surface Finish

XXXXXXXXXX

<u>SB2018-2433.6 A</u>
Use when existing deck drains will remain inplace during and after construction.
CREATED 12/12/1997
REVISED 3/20/2018 (13)

SB- Deck Drain Protection

Keep the inplace deck drains in place in the completed work and protect from damage during repair operations.

1 - DESIGNER NOTE: For the following paragraph, Use As Required.
Raise the drain grates on Bridge No. _______ as necessary to fit the roadway surface of the completed wearing course. Galvanize new bolts per 3392, "Galvanized Hardware". Galvanize new plates or shims per 3394, "Galvanized Structural Shapes".

2 - DESIGNER NOTE: For the following paragraph, Use As Required.
Support the grate in the raised position using a device or method that is satisfactory to the Engineer.

3 - DESIGNER NOTE: For the following paragraph, Use As Required.
Block the deck drain openings above the drain while the wearing course is being placed.

Slope the wearing course to drain for all drains.

Protecting the drain, (raising the drain grates,) (blocking out the drain,) and sloping the wearing course as necessary to drain will be considered to be incidental expense for which no direct compensation will be made.

Use when existing deck drains will be lengthened. See Bridge Maintenance Manual for examples.

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Drain Extensions

A. General

Furnish all materials and labor required to extend the deck drains as shown in the plans and perform in accordance with 2402, "Steel Bridge Construction," and the following:

B. Materials

All structural steel must meet the requirements of 3306, "Low-Carbon Structural Steel". Bolts must meet the requirements of 3391.2.A, "Requirements".

If the drains are welded, bevel the contact edge of the extensions 45 degrees. Repair galvanizing after welding per 2471.3.L.1, "Galvanizing". (In addition, use electrodes with high nickel content, ENiFeCI (55% Ni), or approved equal to ensure an adequate weld to cast iron.)

Galvanize all materials per 3392, "Galvanized Hardware," or 3394, "Galvanized Structural Shapes, whichever is applicable.

See SB-______ for approved bolt anchorages for attaching (the drains) (or) (the bent plates) to the girder web. The detailed locations of the bolt anchors are approximate. The Engineer will determine final anchorage locations to ensure that inplace reinforcement will not be damaged by these operations.

C. Method of Measurement

Measurement will be made by the number of drain extensions placed.

D. Basis of Payment

Payment will be made as Item No. 2433.602 "EXTEND FLOOR DRAIN ______", at the Contract price per each.

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski & Jeff Southward are the lead authors.

SB2018-2433.6 C
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- SD: Reconstruct Drainage Pipe

XXXXXXXXXX

SB- Replace Waterproof Gland in Expansion Joint Device

This work consists of removing and disposing of inplace elastomeric gland(s), removing and reinstalling existing sidewalk steel protection plate(s) and furnishing and installing new gland(s) in the strip seal type expansion joint device(s) of Bridge No(s). ____________.

1 - DESIGNER NOTE: Modify depending on inplace gland/extrusion.

A. Material

Furnish a single diaphragm (Type 4 Type 5) gland of the same shape gland that is being removed and consisting of an unreinforced neoprene whose physical and chemical properties conform to ASTM D5973, *Elastomeric Strip Seals with Steel Locking Edge Rails used in Expansion Joint Sealing*, and to the following:

1. Furnish a single diaphragm unreinforced neoprene gland except:

   a. Do not use the requirements and test methods for the Compression-Deflection Characteristics and the Recovery Under Deflection specified in 3721.2A, "Composition and Manufacture", and

   b. Substitute Durometer requirement to 60 plus or minus 5.

2. Make the gland ¼ inch thick, subject to a minimum thickness of $^{7}/_{32}$ inch.

3. Submit 12 inches of seal material from each lot of material for testing if required by the Project Engineer.

4. Furnish certified test results from the manufacturer attesting to the physical and chemical properties of the expansion joint devices in accordance with 1603, "Materials: Specifications, Samples, Tests, and Acceptance".. Provide copies of the test results for the Project Engineer, the Materials Engineer, and the Structural Metals Engineer.

B. Installation

Remove and dispose of the inplace gland in each expansion joint device. The glands may be removed in sections if necessary to comply with traffic staging. During removal of the glands, the Contractor must use caution to avoid damaging the inplace extrusions as replacement extrusions are not available.

Clean all neoprene-to-steel contact areas of all contaminants before installing the new glands. Provide only one of the approved lubricant adhesives shown on the Department's "Approved/Qualified Product Lists for Bridge Products, Expansion Joint Lubricant Adhesive" (http://www.dot.state.mn.us/products). For lubricant adhesives not on the Department's prequalified list, provide information as required on the web site. Lubricant/adhesive must conform to ASTM D4070, *Standard Specification for Adhesive Lubricant for Installation of Preformed Elastomeric Bridge Compression Seals in Concrete Structures*.

Extend neoprene gland 4 inches past end of steel extrusion; then cut gland horizontally assuring the bottom "V" of gland is at the same elevation as the top of the gland lugs.

C. Method of Measurement

Measurement will be by the length, based on the horizontal distance between the outside edges of the deck measured along the centerline of the joint.

D. Basis of Payment

Payment for Item No. 2433,603, "REPLACE WATERPROOF GLAND", at the contract price per linear foot shall be compensation in full for performing all work described above, including all slab forming (and reinforcement bars) required.

Use when the expansion joint device will be replaced. Include pay item for new expansion device.

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Reconstruct Expansion Joints

Provide all labor, materials, and equipment required to reconstruct the expansion joint openings as indicated in the plans and in accordance with 2401, "Concrete Bridge Construction," and the following:

1 - DESIGNER NOTE: Insert the SB-# for 2433.3 in the blank.

Remove slab in accordance with SB-______, "Remove Slab."

Completely remove all inplace joint material or joint forming materials, and all other incompressible materials that would impede the subsequent expansion device from performing throughout the full anticipated range of movement.

2 - DESIGNER NOTE: On the plan sheet, use 3YHPC-M or 3YHPC-S; in this SP, leave 3Y42-M-as 3Y42-S, just for the sake of some out-state concrete companies that may not have an HPC mix on file.

For new concrete use Mix No. 3Y42-M, or 3Y42-S, or 3YHPC-M, or 3YHPC-S.

Bond the new concrete to the inplace concrete with the same bonding grout used for placement of the concrete wearing course.

Brush or scrub the grout into the inplace concrete immediately prior to placement of new concrete.

Wet-cure new concrete in accordance with 2401.3.G, "Concrete Curing and Protection."

Measurement will be by the length, based on the horizontal distance between the outside edges of the deck measured along the centerline of the joint.

Payment for Item No. 2433.603, "RECONSTRUCT EXPANSION JOINT TYPE ______", at the contract price per linear foot shall be compensation in full for performing all work described above, including all slab forming (and reinforcement bars) required.

SB- Reconstruct Fixed Joints

Provide all labor, materials, and equipment required to (reconstruct) (eliminate) the fixed joints as indicated in the plans and in accordance with 2401, "Concrete Bridge Construction," and the following:

1 - DESIGNER NOTE: Insert the SB-# for 2433.1 in the blank.

Remove slab in accordance with SB-______, "Remove Slab."

2 - DESIGNER NOTE: On the plan sheet, use 3YHPC-M or 3YHPC-S; in this SP, leave 3Y42-M-as 3Y42-S, just for the sake of some out-state concrete companies that may not have an HPC mix on file.

For new concrete use Mix No. 3Y42-M, or 3Y42-S, or 3YHPC-M, or 3YHPC-S.

Bond the new concrete to the inplace concrete with the same bonding grout used for placement of the concrete wearing course.

Brush or scrub the grout into the inplace concrete immediately prior to placement of new concrete.

Wet-cure new concrete in accordance with 2401.3.G, "Concrete Curing and Protection."

A. Method of Measurement

Measurement will be by the length, based on the distance along the centerline of the joint from (gutterline to gutterline) (face of rail to face of rail) (edge of slab to edge of slab).

B. Basis of Payment

Payment for Item No. 2433.603, "RECONSTRUCT FIXED JOINT TYPE ______", at the contract price per linear foot shall be compensation in full for performing all work described above, including any slab forming and reinforcement bars required.

SB- Reconstruct Pavement Joints

Provide all labor, materials, and equipment required to reconstruct the pavement joints as indicated in the plans and in accordance with 2401, "Concrete Bridge Construction," and the following:

1 - DESIGNER NOTE: Insert the SB-# for 2433.3 in the blank.

Remove slab in accordance with SB-______, "Remove Slab."

2 - DESIGNER NOTE: For the following paragraph, Use As Required.

For preformed joint filler material for the 4 inch relief joints, use Preformed E8 Expansion Joint Sealers.

3 - DESIGNER NOTE: For the following paragraph, Use As Required.

Perform installation of joint filler material in the 4 inch relief joint in accordance with the manufacturer's recommendations, a copy of which must be supplied with the joint material. At completion of the work, securely bond or compress the relief joint material in the joint cavity so as to resist entrance of moisture and foreign material, and so as to resist ejection from or depression into the joint recess. If the joint filler material does not bottom on the pavement base, adjust the height by inserting a rigid polystyrene or polyurethane foam spacer. Spacer material must be readily compressible.

4 - DESIGNER NOTE: On the plan sheet, use 3YHPC-M or 3YHPC-S; in this SP, leave 3Y42-M-as 3Y42-S, just for the sake of some out-state concrete companies that may not have an HPC mix on file.

For new concrete use Mix No. 3Y42-M, or 3Y42-S, or 3YHPC-M, or 3YHPC-S.

For new concrete use Mix No. 3S52, 3Y42 or 3YHPC.

Bond the new concrete to the inplace concrete with the same bonding grout used for placement of the concrete wearing course.

Brush or scrub the grout into the inplace concrete immediately prior to placement of new concrete.

Wet-cure new concrete in accordance with 2401.3.G, "Concrete Curing and Protection."

A. Method of Measurement

Measure pavement joint reconstruction by length, in linear feet, based on the distance along the centerline of the joint opening from (gutterline to gutterline) (_______________________________________).

B. Basis of Payment

Payment for Item No. 2433.603, "RECONSTRUCT PAVEMENT JOINT TYPE______", at the contract price per linear foot shall be compensation in full for performing all work described above, including any forming (and reinforcement bars) required.

SB2018-2433.8 A

Use on projects utilizing TYPE ST anchorages. Refer to TM 18-11-B-01 for appropriate usage.

Standard plan notes and details can be found in the MnDOT Bridge Final Design Cell Library a copy of which can be downloaded at http://www.dot.state.mn.us/bridge/drafting-aids.html.

Do not specify epoxy coated rebar for tension load transfer applications.

CREATED 10/30/2018
REVISED 10/30/2018

SB- TYPE ST Anchorages

1 - DESIGNER NOTE: Include the following section only when TYPE ST anchorages are threaded rods.

A. Description of Work

Furnish and install a post-installed threaded rod anchorage system of the type, shape and size specified, and its satisfactory placement at the locations indicated in the plan and in "Table 1 – Anchorage Location and Testing Frequency – Method 1".

Ensure threaded rods and bolts meet the requirements of 3385, "Anchor Rods," and 3391," Fasteners," respectively.

Adhesive anchorages consist of a continuously threaded rod secured by an approved adhesive, as per the plan.

Adhesive anchorage installers must hold current ACI Adhesive Anchor Installer Certification credentials. Installers are required to check depth, diameter and condition of the drilled hole, clean the hole, and install the anchorage per the Manufacturer's Printed Installation Instructions (MPII). Record the name(s) of all certified installers on the *RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION* form available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools."

Prior to installation coordinate a Pre-installation meeting. Include the Engineer, Inspectors, and Installers in the meeting to review the installation process and requirements. At the Pre-installation meeting, submit the following to the Engineer:

- RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION form with a copy of each installer's ACI Adhesive Anchor Installer Certification card;
- A copy of the independent third party agent's ACI Adhesive Anchor Inspector Certification card;
- Printed copy of the MPII; and
- Verification that the adhesive has an uncracked characteristic bond strength as specified in the plan and is approved for use in sustained tension applications.

Furnish only one of the adhesives listed on the Department's Approved/Qualified Products List for Bridge Products, "Concrete Anchorages – Threaded Rod Applications," (www.dot.state.mn.us/products). Ensure that the adhesive has an uncracked characteristic bond strength as specified in the plan and is approved for use in sustained tension applications. Install all anchors as specified by the MPII. Install to the depth on the plan or as specified by the manufacturer, whichever is greater, in sound concrete.

Meet the following conditions prior to installation and testing:

- Concrete is greater than 14 days old;
- Concrete is not delaminated or otherwise structurally unsound;
- Concrete surface is free of water prior to drilling;
- The hole is dry, as defined below; and
- Any additional requirements listed in the Manufacturer's Printed Installation Instructions.

A dry hole is defined as: *a hole with no water present within the hole*. If the hole is filled with water, partially filled with water, or water entered the hole during drilling, blow out the water using compressed air and allow a minimum of 24 hours dry-out time before cleaning the hole and installing the anchorage.

It is essential that the adhesive material completely fill the hole in the concrete for proper anchorage performance. Ensure that the hole is completely filled in which the anchorage is installed. Do not permit the adhesive to overtop the concrete surface in a way that will interfere with the placement of the elements.

After proof testing, ensure nuts are in contact with the adjacent surface and torqued to:

- $^1/_2$ inch diameter = 30 ft pounds
- $^5/_8$ inch diameter = 60 ft pounds
- $^3/_4$ inch diameter and larger = 80 ft pounds

2 - DESIGNER NOTE: Include the following section only when TYPE ST anchorages are reinforcing bars.

A. Description of Work

Furnish and install a drilled-in reinforcement bar anchorage system of the type, shape and size specified, and its satisfactory placement at the locations indicated in the plan and in "Table 1 – Anchorage Location and Testing Frequency."

Perform all work in accordance with the applicable provisions of 2433, "Structure Renovation," 2472, "Metal Reinforcement," and 3301, "Reinforcement Bars," the requirements of the plans, as directed by the Engineer, and the following:

Adhesive anchorage installers must hold current ACI Adhesive Anchor Installer Certification credentials. Installers are required to check depth, diameter and condition of the drilled hole, clean the hole, and install the anchorage per the Manufacturer's Printed Installation Instructions (MPII). Record the name(s) of all certified installers on the *RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION* form available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools."

Prior to installation coordinate a Pre-installation meeting. Include the Engineer, Inspectors, and Installers in the meeting to review the installation process and requirements. At the Pre-installation meeting, submit the following to the Engineer:

- RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION form with a copy of each installer's ACI Adhesive Anchor Installer Certification card;
- A copy of the Independent Third Party Inspector's ACI Adhesive Anchor Inspector Certification card;
- Printed copy of the MPII; and
- Verification that the adhesive has an uncracked characteristic bond strength as specified in the plan and is approved for use in sustained tension applications.

Furnish only one of the systems listed on the Department's "Approved/Qualified Products List for Bridge Products, Concrete Anchorages – Reinforcing Bar Applications," (www.dot.state.mn.us/products). Ensure that the adhesive has an uncracked characteristic bond strength as specified in the plan and is approved for use in sustained tension applications. Install all anchors as specified by the Manufacturer's Printed Installation Instructions (MPII).

Meet the following conditions prior to installation and testing:

- Concrete is greater than 14 days old;
- Concrete is not delaminated or otherwise structurally unsound;
- Concrete surface is free of water prior to drilling;
- The hole is dry, as defined below; and
- Any additional requirements listed in the Manufacturer's Printed Installation Instructions.

A dry hole is defined as: *a hole with no water present within the hole*. If the hole is filled with water, partially filled with water, or water entered the hole during drilling, blow out the water using compressed air and allow a minimum of 24 hours dry-out time before cleaning the hole and installing the anchorage.

It is essential that the adhesive material completely fill the hole in the concrete for proper anchorage performance. Ensure that the hole is completely filled in which the anchorage is installed. Do not permit the adhesive to overtop the concrete surface in a way that will interfere with the placement of the elements.

B. Testing of Post-installed Anchorages

Perform all testing by an independent third party testing agency. Testing agent must have current ACI Adhesive Anchor Inspector Certification credentials.

Provide the testing agent with a copy of the plan and these provisions. Instruct the testing agent to do the following:

- Verify that the adhesive used is on the APL and is approved for use in sustained tension applications;
- Check that the anchorage size and type matches the requirements of the contract documents;
- Perform all anchorage proof testing in accordance with the contract documents; and
- Record all test results on the required report form.

Ensure that the testing agent initials the *PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT* form available on the www.dot.state.mn.us/bridge/construction.html under "Construction forms and tools" as evidence that the adhesive is on the APL.

Verify the anchor strength and installation procedure as follows:

Proof test anchorages in accordance with this specification. Perform all testing in accordance with ASTM E 488, *Standard Test Methods for Strength of Anchors in Concrete Elements*. Set up the tension testing device such that no portion of the device bears on the concrete surface within a distance equal to one and a half times the anchorage embedment depth. Test anchorages to not less than the required proof load as provided in the plan (if no anchor proof load is provided in the plan, contact the Engineer). Failure criteria of an anchorage test is defined in ASTM E 488.

3 - DESIGNER NOTE: If caulking is not required as part of attachment of an element to the anchorage, remove the highlighted text.

Ensure that nothing interferes with the testing apparatus during the proof test. Do not perform any caulking prior to testing.

Install all production anchorages. Test the number of the anchorages in each location indicated in Table 1 (see below) at a later date. If a failure occurs while testing anchorages, more testing at the location in which the failure occurred will be required at the rate indicated in Table 1, per each failure at no additional cost to the department. If the number of anchorages at a given location failing in concrete breakout exceed the maximum number of failures permitted in Table 1, provide an anchorage replacement plan to the Project Engineer and remove the remaining anchorages in that location without testing. Concrete breakout failure is defined as a spall a minimum of 2 inches in diameter by 1 inch deep. Record all results on the *PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT* and submit to the Project Engineer within 5 working days of the completion of testing.

4 - DESIGNER NOTE: Include the following paragraph only when using threaded rod anchorages. Update paragraph by inserting the number equal to 5% of the anchorages for the installation, no less than 20.

In addition to the proof load testing above, perform Ultrasonic Testing to verify anchorage embedment on the proof loaded anchorages. Also perform Ultrasonic Testing on an additional ____ anchorages as randomly selected by the Engineer. Record Ultrasonic Testing results on the *PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT*.

5 - DESIGNER NOTE: The highlighted areas in Table 1 below are labeled to correspond with the following bullet points. Fill in the blanks as follows:

> ***A - Examples of Location include 'Traffic Face of Barrier – S502', 'Non-traffic Face of Barrier – S610', 'Crash Strut', 'End Post', and 'Paving Bracket'. Provide a bridge number (e.g. 'Crash Strut (Br No. 12345)') when multiple bridge repairs are part of one contract.***
>
> ***B – For rebar anchorages, insert number equal to 3% of the anchorages at a given location plus 5, no less than 20. For threaded rod anchorages, insert number equal to 15% of the anchorages at a given location plus 5, no less than 20.***
>
> ***C - Insert number equal to 5% of the anchorages in a given location, no less than 1.***

Table 1 – Anchorage Location and Testing Frequency			
Location	**Initial Production Anchorage Test**	**Additional Tests per Failure**	**Max Number of Breakout Failures**
(A)	(B)	(B)	(C)
(A)	(B)	(B)	(C)

Notify the Project Engineer immediately after any failure. Remove all anchors that fail the field test without damage to the surrounding concrete. Redrill holes to remove adhesive bonding material. Replace and test anchors using the method listed above, at no cost to the Department.

6 - DESIGNER NOTE: Include the following 'Method of Measurement' and 'Basis of Payment' when anchorages have a separate pay item. Update 'Basis of Payment' by adding REINF BARS or THREADED RODS depending on anchorage dowel.

C. Method of Measurement

The Department will measure by the single unit of each for furnishing and installing acceptable sustained tension anchorages complete in place. The Department will not measure for payment anchorages installed that are not shown in the plan or ordered by the Engineer.

D. Basis of Payment

The Department will make payment as Item 2433.502 "ANCH TYPE ________ (TYPE ST)," at the contract price per each, which includes all costs of furnishing, testing, and installing anchorages.

7 - DESIGNER NOTE: Use the following paragraph when anchorages are included in another pay item. Update paragraph with appropriate pay items.

C. Basis of Payment

The Department will consider all costs for furnishing, testing, and installing anchorages included in payment for ___________.

SB2018-2433.8 C

Use on all jobs requiring drilled-in reinforcement bar adhesive anchorages.

Engineer shall ensure that there is enough concrete to prevent the structural member from spalling out below or beyond the embedment depth (2" min. is recommended);

Refer to Memo to Designers 2017-02 found on the web at http://www.dot.state.mn.us/bridge/lrfd.html to determine the appropriate rebar type (i.e. stainless, uncoated, epoxy coated) and testing type (i.e. Type H or Type L);

Do not specify epoxy coated rebar for tension load transfer applications; and

Adhesive anchorages are not permitted in sustained tensile-load applications.

CREATED 4/28/2008
REVISED 3/20/2018 (2)

SB- Reinforcement Bar Anchorages (Post-installed)

A. Description of Work

Furnish and install a drilled-in reinforcement bar anchorage system of the type, shape and size specified, and its satisfactory placement at the locations indicated in “Table 1 – Anchorage Location and Testing Frequency”.

Perform all work in accordance with the applicable provisions of 2433, "Structure Renovation," 2472, "Metal Reinforcement," and 3301, "Reinforcement Bars," the requirements of the plans, as directed by the Engineer, and the following:

Furnish only one of the systems listed on the Department’s "Approved/Qualified Products List for Bridge Products, Concrete Anchorages – Reinforcing Bar Applications," (www.dot.state.mn.us/products). Verify that the adhesive has an uncracked characteristic bond strength as specified in the plan. Install all anchors as specified by the Manufacturer’s Printed Installation Instructions (MPII). Furnish a copy of the MPII that the installer will use to the Project Engineer. Install in sound concrete to a depth equal to the minimum depth specified in the plan or as specified by the supplier/manufacturer, whichever is greater.

B. Construction Requirements

Adhesive anchorages consist of a deformed rebar dowel secured by an adhesive. Adhesive anchorage installers must hold current ACI-CRSI Adhesive Anchor Installer Certification credentials. Installers are required to check depth, diameter and condition of the drilled hole, clean the hole, and install the anchorage per the MPII. Record the name(s) of all certified installers on the *RECORD OF CONTRACTOR/INSTALLER ACI-CRSI CERTIFICATION FORM* provided in this specification. Prior to installation of anchorages on the project, meet with the Project Engineer, Inspectors, and Installers to review the installation process and requirements. At the Pre-installation meeting, submit the *RECORD OF CONTRACTOR/INSTALLER ACI-CRSI CERTIFICATION FORM* with a copy of each installer’s ACI-CRSI Adhesive Anchor Installer Certification card and a copy of the MPII to the Project Engineer.

C. Pullout Tests

1 - Designer note: For anchorages that are intended to transfer tension loads (Type H testing level), provide a proof load in the bridge plan equal to the factored design capacity of a single anchorage in tension, no greater than 80% of the yield strength of the anchorage steel.

For anchorages not intended to transfer tension loads (Type L testing level) that have an edge distance of at least 4" and an anchor effective embedment of at least 4" provide a proof load in the bridge plan equal to 2.2 kips. Otherwise, provide a proof load equal to the factored design capacity of a single anchorage in tension.

Verify the anchor strength and installation procedures by proof testing anchorages in accordance with this specification. Perform all testing in accordance with ASTM E488, "Standard Test Methods for Strength of Anchors in Concrete Elements". Set up the testing device such that no portion of the device bears on the concrete surface within a distance equal to one and a half times the anchorage embedment depth. Test anchorages to not less than the required proof load as provided in the plan. If no anchor proof load is provided in the plan, contact the Project Engineer. Failure of an anchorage test is defined in ASTM E488, "Standard Test Methods for Strength of Anchors in Concrete Elements".

All damage to the concrete will be repaired at no cost to the Department. The repair must first be approved by the Project Engineer.

Perform all testing by an independent third party testing agency. Testing agent must have current ACI-CRSI Adhesive Anchor Installer Certification credentials.

Meet the following conditions prior to installation and testing:

- Allow concrete to set at least 14 days after pour;
- Ensure concrete surface is free of water prior to drilling;
- Ensure the hole is dry; and
- Install anchorages per Manufacturer's Printed Installation Instructions.

A dry hole is defined as a hole with no water present within the hole. If the hole is filled with water, partially filled with water, or water entered the hole during drilling, blow out the water using compressed air and allow 24 hours before cleaning the hole and installing the anchorage.

Verify the anchor strength and installation procedure as follows:

Install all production anchorages. Test the number of the anchorages in each location indicated in Table 1 (see below) at a later date. If a failure occurs while testing anchorages, more testing at the location in which the failure occurred will be required at the rate indicated in Table 1, per each failure at no additional cost to the department. If the number of anchorages at a given location failing in concrete breakout exceed the maximum number of failures permitted in Table 1, provide an anchorage replacement plan to the Project Engineer and remove the remaining anchorages in that location without testing. Concrete breakout failure is defined as a spall a minimum of 2 inches in diameter by 1 inch deep. Record all results on the *PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT* provided in these specifications and submit to the Project Engineer within 5 working days of the completion of testing.

2 - Designer note: The highlighted areas in Table 1 below are labeled to correspond with the following bullet points. Fill in the blanks as follows:

> ***A - Examples of Location include 'Traffic Face of Barrier', 'Non-traffic Face of Barrier', 'Crash Strut', 'End Post', and 'Paving Bracket'. Provide a bridge number (e.g. 'Crash Strut (Br No. 12345)') when multiple bridge repairs are part of one contract.***
>
> ***B - For anchorages that require Type H testing, insert number equal to 2% of the anchorages at a given location plus 5, no less than 15. For anchorages that require Type L testing, insert number equal to 1% of the anchorages at a given location plus 2, no less than 7.***
>
> ***C - Insert number equal to 5% of the anchorages in a given location.***

Table 1 – Anchorage Location and Testing Frequency

Location	**Initial Production Anchorage Test**	**Additional Tests per Failure**	**Max Number of Breakout Failures**
(A)	(B)	(B)	(C)
(A)	(B)	(B)	(C)

Notify the Project Engineer immediately after any failure. Remove all anchors that fail the field test without damage to the surrounding concrete. Redrill holes to remove adhesive bonding material. Replace and test anchors using the method listed above, at no cost to the Department.

Perform installation of anchorages in accordance with the manufacturer's recommendations and as specified in the plan.

Fill with approved caulk any voids occurring between the top of the anchorages and the concrete in which it is embedded, as approved by the Project Engineer.

D. Method of Measurement

Measurement will be by the single unit of each for furnishing and installing acceptable reinforcement bar anchorages complete in place. Anchorages installed that are not shown in the plans or ordered by the Engineer will not be measured for payment.

E. Basis of Payment

3 - Designer note: Use when specifying Type H testing on bars that are not stainless.

Payment will be made as Item 2433.502, "ANCH TYPE REINF BARS (TYPE H)", at the Contract price per each and shall be compensation in full for all costs of furnishing, placing, and testing the reinforcement bar anchorages complete inplace.

4 - Designer note: Use when specifying Type H testing on stainless steel bars.

Payment will be made as Item 2433.502, "ANCH TYPE REINF BARS (STAINLESS TYPE H)", at the Contract price per each and shall be compensation in full for all costs of furnishing, placing, and testing the reinforcement bar anchorages complete inplace.

5 - Designer note: Use when specifying Type L testing.

Payment will be made as Item 2433.502, "ANCH TYPE REINF BARS (TYPE L)", at the Contract price per each and shall be compensation in full for all costs of furnishing, placing, and testing the reinforcement bar anchorages complete inplace.

RECORD OF CONTRACTOR/INSTALLER ACI-CRSI CERTIFICATION

PROJECT #: ______________________________ PRIME CONTRACTOR: ______________________________

BRIDGE #: ______________________________ INSTALLER: ______________________________

DATE: ______________________________

NAME OF EMPLOYEE	COMPANY	DATE TRAINING WAS TAKEN	CERT. EXPIRATION DATE	CERTIFICATION ID NUMBER

Attach a photo copy of each certified installer's ACI – CRSI Adhesive Anchor Installer Certification ID showing the ID number, the expiration date, and the name of the installer. All certified installers must carry their certification on their person while installing anchors. Certification to be produced upon request.

PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT

PROJECT #: ______________________ PRIME CONTRACTOR: ______________________

BRIDGE #: ______________________ INSTALLER: ______________________

DATE: ______________________ MANUFACTURER: ______________________

TESTING FIRM: ______________________

ANCHORAGE DIAMETER: ______________ PRODUCT NAME: ______________________

PROOF LOAD (KIPS): AMBIENT TEMP. (°F): WEATHER:

TEST #	LOCATION	TIME @ START	TIME @ END	MAX LOADING (KIPS)	PASS/ FAIL

SIGNATURE OF
TESTING AGENT: ________________________________ DATE: ____________

DATE RECEIVED BY PROJECT ENGINEER: ____________

CC: STATE PROJECTS ONLY:
Copy: Bridge Const. Unit (MS 610)
FOR ALL PROJECTS:
Original: Project Engineer
Copy: Railroad

SB2018-2433.8 D
Use on all jobs requiring Standard Plate B920.
CREATED 3/29/2018
REVISED 3/29/2018

SB- Temporary Portable Precast Concrete Barrier Anchorage Installation and Removal

Furnish, install, and remove the temporary portable precast concrete barrier anchorage in accordance with the applicable requirements of 2433, "Structure Renovation," the plans, and the following:

1 - DESIGNER NOTE: For the following, use only when 'Option 1' as defined in the B920 detail is required.
1.1 - DESIGNER NOTE: If repair to holes in deck is required then add the section entitled "Remove Anchorages" below.

A. Remove Anchorages

Remove and dispose of anchorages between the bridge deck and temporary barriers and repair damage to deck.

Initially prepare the hole by removing all dust and debris. Fill the hole with a grout from the Approved/Qualified Products List for Bridge Products, "Packaged, Dry, Rapid-Hardening Cementitious Material for Concrete Repairs," (www.dot.state.mn.us/products). Follow manufacturer's procedures for mixing, hole preparation, placement and curing.

Repair all damage, due to Contractor's operations, to other portions of the structure which are to remain in place, at the Contractor's expense.

B. Basis of Measurement and Payment

1.2 - DESIGNER NOTE: If repair to deck is not required then remove it from the paragraph.

Payment to furnish, install, and remove the temporary portable precast concrete barrier anchorages and repair damage to deck, as otherwise provided in these special provisions, are considered an incidental expense to 2533.503 "PORTABLE PREC CONC BAR DES 8337-ANCHORED", and no additional compensation will be made for this work.

2 - DESIGNER NOTE: For the following, use only when 'Option 2' as defined on the B920 detail is required. Per B920 designer note instructions, the Regional Bridge Construction Engineer will determine the use of 'Option 2'.

A. Materials

Adhesive anchorages are required in the locations indicated in the plan.

Adhesive anchorages consist of a continuously threaded rod (per MnDOT Bridge Standard Detail B920) secured by an approved adhesive. Adhesive anchorage installers must hold up-to-date ACI Adhesive Anchor Installer Certification credentials. Installers are required to check depth, diameter, and condition of the drilled hole, clean the hole, and install the anchorage per the Manufacturer's Printed Installation Instructions (MPII). Record the name(s) of all certified installers on the RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION form provided in this specification.

Prior to installation coordinate a Pre-installation meeting. Include the Engineer, Inspectors, and Installers in the meeting to review the installation process and requirements. At the Pre-installation meeting, submit the following to the Engineer:

- RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION form with a copy of each installer's ACI Adhesive Anchor Installer Certification card;
- Printed copy of the MPII; and

- Verification that the adhesive has an uncracked characteristic bond strength as specified in the plan.

Furnish only one of the systems listed on the Department's Approved/Qualified Products List for Bridge Products, "Concrete Anchorages – Threaded Rod Applications," (www.dot.state.mn.us/products). Install all anchors as specified by the MPII. Install to the greater depth that is found on the plan or as specified by the manufacturer in sound concrete (1½ inch minimum from bottom of deck).

B. Testing of Post-Installed Anchorages

Perform all testing by using an Independent Third Party testing agency not affiliated with the Contractor. Testing Inspector must provide a copy of their up-to-date ACI Adhesive Anchor Inspector Certification credentials to the Engineer.

Verify the anchor strength and installation procedures by proof testing anchorages in accordance with this specification. Perform all tension testing in accordance with ASTM E488, *Standard Test Methods for Strength of Anchors in Concrete Elements*. Set up the tension testing device such that no portion of the device bears on the concrete surface within a distance equal to one and a half times the anchorage embedment depth. Test anchorages to not less than the required proof load as provided in the plan (if no anchor proof load is provided in the plan, contact the Engineer prior to any testing). Failure criteria of an anchorage test is defined in ASTM E488.

Meet the following conditions prior to installation:

- Concrete is greater than 14 days old;
- Concrete surface is free of water prior to drilling;
- The hole is dry, as defined below; and
- Any additional requirements listed in the Manufacturer's Printed Installation Instructions (MPII).

A dry hole is defined as: *a hole with no water present within the hole*. If the hole is filled with water, partially filled with water, or water entered the hole during drilling, blow out the water using compressed air and allow a minimum of 24 hours dry-out time before cleaning the hole and installing the anchorage.

Verify the anchor strength and installation procedure by testing one anchorage in every set of nine anchorages installed. If an odd set contains less than nine anchorages test at least one. If a failure occurs while testing the anchorages, more testing will be required at the rate of an additional test within the set of nine anchorages that failed, at no additional cost to the Department. If two of the anchorages in a set of nine anchorages fail in concrete breakout, stop testing, notify the Engineer, and provide a non-conformance anchorage replacement plan, to be accepted by the Engineer. Once accepted by the Engineer, remove and replace the remaining untested anchorages on the bridge according to the approved plan and test anchorages as outlined in this provision. Concrete breakout failure is defined as: *a spall a minimum of two inches in diameter by one inch deep*. Compensation for costs of testing is incidental to the payment for the Portable Precast Concrete Barrier Design 8337 - Anchored.

Notify the Engineer immediately after any failure. Remove all anchors that fail the field test without damage to the surrounding concrete. Remove any remaining adhesive bonding material in the hole. Replace and test anchors using the method listed above, at no cost to the Department.

All damage to the concrete will be repaired at no cost to the Department. The repair procedure must first be approved by the Engineer.

2.1 - DESIGNER NOTE: Include the following paragraph when installing in an existing deck.

If an anchorage test fails due to delaminated or poor concrete, contact the Engineer. Once the Engineer has concurred with the cause of failure, core-drill through the deck and attach the barrier at the location of failure using *Option 1* as defined in MnDOT Bridge Standard Detail B920. Test anchorages adjacent to the failed anchorage to ensure these anchorages are not also affected by the concrete condition. Test an additional anchorage within the set of nine anchorages to verify installation. Do not include concrete failures that occur due to poor concrete in the number of concrete failures permitted during testing.

Perform installation of anchorages in accordance with the MPII and as specified in the plan.

2.2 - DESIGNER NOTE: If removal of anchorages and repair to deck is required then include this section.

C. Remove Anchorages

Remove and dispose of anchorages between the bridge deck and temporary barriers and repair damage to deck. Utilize accepted procedure to remove anchorages.

Drill each anchor location with a core barrel at least two times the diameter of the original drill hole. Core to a depth equal to the anchor's installed depth and remove the core without damaging the lower part of the deck. Prepare the hole by removing all dust, debris, and adhesive. Fill the hole with a grout from the "Approved/Qualified Products List for Bridge Products, Packaged, Dry, Rapid-Hardening Cementitious Material for Concrete Repairs," (www.dot.state.mn.us/products) Follow manufacturer's procedures for mixing, hole preparation, placement and curing.

Repair all damage, due to Contractor's operations, to other portions of the structure which are to remain in place at no cost to the Department.

D. Basis of Payment

2.3 - DESIGNER NOTE: If repair to deck is not required then remove it from the paragraph.

Payment to furnish, install, test, and remove the temporary portable precast concrete barrier anchorages and repair damage to deck, as otherwise provided in these special provisions, are considered an incidental expense to 2533.503 "PORTABLE PREC CONC BAR DES 8337-ANCHORED", and no additional compensation will be made for this work.

RECORD OF CONTRACTOR/INSTALLER ACI CERTIFICATION

PROJECT #: ______________________ PRIME CONTRACTOR: ______________________

BRIDGE #: ______________________ INSTALLER: ______________________

DATE: ______________________

NAME OF EMPLOYEE	COMPANY	DATE TRAINING WAS TAKEN	CERT. EXPIRATION DATE	CERTIFICATION ID NUMBER

Attach a photo copy of each certified installer's ACI Adhesive Anchor Installer Certification ID showing the ID number, the expiration date, and the name of the installer. All certified installers must carry their certification on their person while installing anchors. Certification to be produced upon request.

PRODUCTION ANCHORAGES QUALIFICATION TEST REPORT

PROJECT #: ______________________ PRIME CONTRACTOR: ______________________

BRIDGE #: ______________________ INSTALLER: ______________________

DATE: ______________________ MANUFACTURER: ______________________

TESTING FIRM: ______________________

ANCHORAGE DIAMETER: ______________________ PRODUCT NAME: ______________________

PROOF LOAD (KIPS): AMBIENT TEMP. (°F): WEATHER:

TEST #	LOCATION	HOLE DEPTH (INCHES)	TIME @ START	TIME @ END	MAX LOADING (KIPS)	PASS/ FAIL

SIGNATURE OF TESTING AGENT: ______________________ DATE: ______________________

DATE RECEIVED BY ENGINEER: ______________________

CC: STATE PROJECTS ONLY:
Copy: Bridge Const. Unit (MS 610)
FOR ALL PROJECTS:
Original: Engineer
Copy: Railroad

SB- Repair Paving Bracket

Repair portions of the paving bracket(s) in accordance with 2401, "Concrete Bridge Construction," 2433, "Structure Renovation," the plan, and the following:

A. Concrete Removals

After exposure of the paving bracket by other work, remove deteriorated concrete on the paving bracket, as shown on the plan and as designated by the Engineer. Remove any damaged or loose concrete to sound concrete prior to proceeding.

1. Removals

a. Avoid damage to sound concrete that is to remain in place;

b. Unless otherwise approved by the Engineer, use only hand tools or power-driven chipping hammers (15-lb. class maximum) to remove concrete;

c. Square the patch perimeters to eliminate feathered edges and to ensure that the repair material will be applied in depths no greater than $^{1}/_{2}$ inch;
   - Handheld grinders or saws may be used to square the patch perimeters.
   - Do not over-cut the patch perimeters at the corners of the repair areas.
   - When practical, undercut the patch perimeter at an approximate angle of 30 degrees such that the profile will help hold the patch material in place.

d. Roughen the substrate to ensure that there will be a mechanical bond between the patch material and the parent concrete. Attain a minimum surface roughness profile of $^{1}/_{8}$ inch or CSP 6 (Concrete Surface Profile 6) per International Concrete Repair Institute (ICRI) 310.2R-2013, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair."

e. Use abrasive blasting or other approved technique to remove rust from exposed steel surfaces and to clean remaining loose concrete. Clean and straighten inplace reinforcement or dowels. If epoxy coated reinforcement is present, repair damaged epoxy coating within paving bracket with approved 2-component epoxy coating repair material per 2472, "Metal Reinforcement."

2. Anchorages

a. Where existing reinforcement is not exposed to provide clearance around the bar periphery:
   - Install $^{1}/_{4}$ inch diameter anchor bolts on an approximate 1 ft by 1 ft grid spacing. For individual areas of 1 sq. ft. or less, install at least one anchor, although mesh will not be required. Use L-bar or T-bar ¼ inch minimum diameter galvanized anchorages capable of 750 pounds pullout minimum. Where chemical anchorages are used, no pull-out testing is required if installation is performed by personnel with ACI-CRSI Adhesive Anchor Installer Certification.

b. If more than $^{1}/_{2}$ the perimeter of any mild reinforcement is exposed or if the exposed bar exhibits significant corrosion:
   - Remove the concrete from around the entire bar. Provide ¾ inch clearance or 1.5 times the largest sized aggregate in the repair material, whichever is greater, between the steel and surrounding concrete to permit adequate flow of the repair material. If any individual open spaces between bars is 1.5 sq. ft. area or larger provide additional anchorages. For this situation, install $^{1}/_{4}$ inch diameter anchor bolts at the rate of one anchor bolt per each 1.5 square feet of area within each open space.

c. Where patch exceeds 3 inch in depth and 24 inch in length:

- Provide #4 epoxy coated reinforcement for length of patch that is secured to hooked or T-shaped anchors. Spacing is not to exceed 12 inches between existing longitudinal reinforcement and supplemental reinforcement.

B. Construction Requirements

Supplement exposed reinforcement where $^1/_4$ inch or greater bar diameter reduction has occurred, as determined by the Engineer, with a new bar of the same size. Where loss is the result of corrosion, not removal damage, additional reinforcement will be paid as extra work.

Sandblast exposed reinforcing bars clean of all rust and concrete providing a clean surface but not necessarily to white metal, as directed by the Engineer.

Apply a bonding grout consisting of Portland cement mixed with water to form a slurry with the consistency of paint to bond the new concrete to the remaining concrete surface unless otherwise directed by the manufacturer. Coat the in-place concrete immediately before placing the new concrete against it.

Reconstruct areas of removed paving bracket by forming and using an approved mix.

Place and consolidate concrete with an internal vibrator of appropriate size as approved by the Engineer.

Cure newly placed repair concrete per Table 2401-1 or if using an alternate prepackaged mix cure per the manufacturer’s requirements.

C. Materials

1. Use concrete mix 3B52 to repair formed paving bracket.

2. As an alternative to mix 3B52, propose a prepackaged repair mortar mix in conformance with the following requirements:

Compressive Strength (ASTM C109 Modified, 2-inch cubes)
1 DAY...1500 psi
7 DAY...3000 psi
28 DAY..5000 psi
Length Change (ASTM C157) at 1, 3, 14 and 28 days
Max %...+ 0.3
Min. %... 0.0
Bond Strength (ASTM C882 modified*)
28 DAY... 1500 psi
*Mortar scrubbed into substrate or as recommended by the manufacturer.

Where a prepackaged repair mortar is proposed, it is to be prequalified prior to use. Submit to the Department’s Materials Laboratory, from a Qualified Laboratory, test data showing that the material, when mixed and applied according to the manufacturer’s recommendations, meets all of the requirements of this specification.

In addition to the certified test data, submit the following items:

a. Manufacturer’s technical data sheet;
b. Material safety data sheet; and
c. Mixing instructions.

After approval by the Department’s Materials Office, further performance testing by the manufacturer will not be required unless the formulation or manufacturing process has been changed, in which case new certified test results will be required. Acceptance variances shall be established by the Qualified Laboratory.

Furnish the Engineer with a copy of the manufacturer's comprehensive job specific preparation, mixing and application instructions. Any significant changes to these instructions which are recommended by the manufacturer's representative for an unanticipated situation shall be approved by the Engineer prior to the adoption of repair mix. Manufacturer will specify whether the product is designed for horizontal, vertical, or overhead patching. Only prepackaged materials stored in accordance with the manufacturer's requirements may be incorporated in the work.

Provide a manufacturer's representative at the job site until the Engineer and the manufacturer's representative have determined that the Contractor is qualified in all aspects of patching concrete structures with the proposed materials. The Contractor may demonstrate proficiency in the application and curing of the repair material on a mock-up repair in the presence of the Engineer and Manufacturer's representative.

D. Excavation and Backfill

All excavation and backfill necessary to complete repairs as shown in the plans will be incidental unless paid for elsewhere in the contract plans.

Backfill to restore grade and approach panel support in accordance with 2105, "Excavation and Embankment."

E. Method of Measurement

Measure paving bracket repair by length, in linear feet, distance along the centerline of the bracket of repaired paving bracket.

F. Basis of Payment

The contract unit price for Repair Paving Bracket includes the cost of deteriorated concrete removals to paving bracket and repairing the bridge paving bracket complete in place. Excavation and backfill associated with paving bracket repair is incidental to "REPAIR PAVING BRACKET."

Payment for Item No. 2433.603, "REPAIR PAVING BRACKET," will be made at the Contract price for the linear feet of paving bracket repaired, which shall be compensation in full for all work described above and to perform the repair described, complete inplace. Reinforcement bar anchorages will be not be paid for separately. Supplemental reinforcement added due to corrosion or excess unreinforced area of patch per above will be paid as extra work at $2.00 per pound.

Use when the approach panel is being replaced and reconstruction of the existing paving bracket is anticipated due to condition of the end block or settlement in the approach panel.. Include associated repair detail in plans.

CREATED 7/1/2014

REVISED 3/20/2018 (3)

SB- Reconstruct Paving Bracket

Reconstruct portions of the paving bracket(s) in accordance with 2401, "Concrete Bridge Construction," 2433, "Structure Renovation," the plan, and the following:

A. Concrete Removals

After exposure of the paving bracket by other work, remove deteriorated concrete on the paving bracket(s) using equipment and methods approved by the Engineer. Removals are to extend along the length of the abutments as designated by the Engineer for reconstruction.

Remove concrete to the back face of the abutment. Additional removal depth may be required until sound concrete is encountered, as directed by the Engineer. Excavate only as required for reconstruction.

After removal operations are complete attain a minimum surface roughness profile of 1/8 inch or CSP 6 (Concrete Surface Profile 6) per International Concrete Repair Institute (ICRI) 310.2R-2013, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair."

B. Construction Requirements

1 - DESIGNER NOTE: Special provision section for Reinforcement Bar Anchorage (Post-Installed), SB2018-2433.8 C, is required as a companion spec. Note the maximum embedment as wall thickness minus 2 inches. Do not insert here.

Provide and install anchorages in accordance with "Reinforcement Bar Anchorage (Post-Installed)" special provision at embedment, spacing and locations shown on the plan. Work is included in "ANCH TYPE REINF BARS (TYPE L)." Notify the Engineer if inplace geometry of wall does not match the plans. Place anchorages a minimum of 6 inches away from the top of wall or other edge of concrete.

Straighten inplace bars as noted on the plans. Supplement exposed reinforcement where $^{1}/_{8}$ inch or greater bar diameter reduction has occurred, as determined by the Engineer, with a new bar of the same size. Provide and install reinforcement as noted on the plans.

Sandblast exposed reinforcing bars clean of all rust and concrete providing a tight surface but not necessarily to white metal, as directed by the Engineer.

Apply a bonding grout consisting of Portland cement mixed with water to form a slurry with the consistency of paint to bond the new concrete to the remaining concrete surface. Coat the in-place concrete immediately before placing the new concrete against it.

Place and consolidate concrete with an appropriately sized internal vibrator.

Reconstruct areas of removed paving bracket by forming using concrete mix no. 3B52.

Cure newly placed concrete per Table 2401-1.

Backfill to restore grade and approach panel support in accordance with 2104, "Removing Pavement and Miscellaneous Structures."

C. Excavation and Backfill

All excavation and backfill necessary to complete repairs as shown in the plans will be incidental unless paid for elsewhere in the contract plans.

Backfill to restore grade and approach panel support in accordance with 2105, "Excavation and Embankment."

D. Method of Measurement

Measure paving bracket reconstruction by length, in linear feet, distance along the centerline of the bracket of removed and replaced paving bracket.

E. Basis of Payment

The contract unit price for Reconstruct Paving Bracket includes the cost of paving bracket concrete removals and of reconstructing the bridge paving bracket complete in place. Excavation and backfill associated with paving bracket reconstruction is incidental to "RECONSTRUCT PAVING BRACKET."

Payment for Item No. 2433.603, "RECONSTRUCT PAVING BRACKET," will be made at the Contract price for the linear feet of paving bracket reconstructed, which shall be compensation in full for all work described above and needed to perform the repair described, complete inplace except for the anchorages. Anchorages will be included in "ANCH TYPE REINF BARS (TYPE L)."

Use when the approach panel is being replaced and the abutment backwall condition is poor on the front face. Include associated repair detail in plans.

CREATED 7/1/2014

REVISED 3/20/2018 (3)

SB- Reconstruct Paving Bracket and Wall

Reconstruct portions of the paving bracket(s) and parapet wall(s) in accordance with 2401, "Concrete Bridge Construction," 2433, "Structure Renovation," the plan, and the following:

A. Concrete Removals

After exposure of the paving bracket by other work, excavate to dimensions shown in the plan. The plan dimensions are an estimate of the minimum repair area. The Engineer may designate areas for additional excavation to determine actual limits of concrete removal.

Remove concrete using equipment and methods approved by the Engineer, providing at least ½ inch saw cut depth at the limits of concrete removal. Remove concrete to limits directed by the Engineer.

After removal operations are complete attain a minimum surface roughness profile of $^{1}/_{8}$ inch or CSP 6 (Concrete Surface Profile 6) per International Concrete Repair Institute (ICRI) 310.2R-2013, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair."

B. Construction Requirements

1 - DESIGNER NOTE: Special provision section for Reinforcement Bar Anchorage (Post-Installed), SB2018-2433.8 C, is required as a companion spec. Note the maximum embedment as wall thickness minus 2 inches. Do not insert section here.

If shown on the plan or directed by the Engineer, provide and install anchorages in accordance with "Reinforcement Bar Anchorage (Post-Installed)" special provision at embedment, spacing, and locations shown on the plan. Work is included in "ANCH TYPE REINF BARS (TYPE L)."

Straighten inplace bars as noted on the plans. Supplement exposed reinforcement where $^{1}/_{8}$ inch or greater bar diameter reduction has occurred, as determined by the Engineer, with a new bar of the same size. Provide and install reinforcement as noted on the plans.

Sandblast exposed reinforcing bars clean of all rust and concrete providing a clean surface but not necessarily to white metal, as directed by the Engineer.

Apply a bonding grout consisting of Portland cement mixed with water to form a slurry with the consistency of paint to bond the new concrete to the remaining concrete surface. Coat the in-place concrete immediately before placing the new concrete against it.

Reconstruct areas of removed paving bracket and parapet wall by forming using concrete mix no. 3B52. Form wall with paving bracket as shown in the plan.

Place and consolidate concrete with an appropriately sized internal vibrator.

Cure newly placed concrete per Table 2401-1.

Waterproof horizontal joint with membrane waterproofing system per spec. 2481.3.B, "Membrane Waterproofing System."

Backfill to restore grade and approach panel support. Restore Turf as directed by the Engineer and in accordance with 2104, "Removing Pavement and Miscellaneous Structures."

C. Excavation and Backfill

All excavation and backfill necessary to complete repairs as shown in the plans will be incidental unless paid for elsewhere in the contract plans.

Backfill to restore grade and approach panel support in accordance with 2105, "Excavation and Embankment."

D. Method of Measurement

Measure paving bracket and wall reconstruction by square foot, measured along the front face of the abutment back wall.

E. Basis of Payment

The contract unit price for Reconstruct Paving Bracket and Wall includes the cost of concrete removals to paving bracket and back wall, and reconstructing the bridge paving bracket and back wall complete in place.

Payment for Item No. 2433.618, "RECONSTRUCT PAVING BRACKET AND WALL," will be made at the Contract price for the square feet of paving bracket and wall reconstructed, which shall be compensation in full for all work described above and needed to perform the repair described, complete inplace except for the anchorages. Anchorages will be included in "ANCH TYPE REINF BARS (TYPE L)."

SB- Reconstruct Concrete End Post

Reconstruct concrete end post(s) for Bridge No. ________ in accordance with 2401, "Concrete Bridge Construction," 2433, "Structure Renovation," and the following:

A. Removals

Disengage guardrail from end post, excavate, remove and dispose of the inplace end posts.

B. Construction Requirements

1 - DESIGNER NOTE: Special provision section for Reinforcement Bar Anchorage (Post-Installed), SB2018-2433.8 C, is required as a companion spec. Note the maximum embedment as wall thickness minus 2 inches. Do not insert here.

Supply reinforcement bar anchorages that conform to the requirements of SB-____.

C. Restoration of Turf

2 - DESIGNER NOTE: Temporary earth retention for maintenance of traffic (if applicable) will be provided with this work and is included with ________.

Restore the turf within the work area in accordance with the applicable requirements of 2575, "Establishing Turf and Controlling Erosion." Meet the requirements of 2572.2.D, "Sandy Loam Topsoil," for topsoil. Place erosion control blankets per 2575.3.K.2, "Rolled Erosion Control Products," over newly seeded areas. Complete restoration work to the satisfaction of the Engineer.

Approximate quantities of material per end post are as follows: Topsoil – 1 yd^3; Seed mixture – ¼ lbs.; Erosion control blanket – 5 yd^2.

D. Method of Measurement

Measurement of the concrete end post will be by the single unit of each.

E. Basis of Payment

The contract unit price for *Reconstruct Concrete End Post* includes the cost of reconstructing the post, complete in place.

Payment for Item No. 2433.602, "RECONSTRUCT CONCRETE END POST", will be made at the Contract price per each and shall be compensation in full for performing all work described above, including all other work incidental thereto. Reinforcement bar anchorages will be paid for under a separate item.

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski & Jessica Duncan are the lead authors.

SB2018-2433.10 B
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- Reconstruct Concrete Diaphragm

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Jessica Duncan is the lead author.

SB- Reconstruct Concrete Barrier (Type ____)

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Nate Schutte is the lead author.

**SB-	Reconstruct Beam End**

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.10 E
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- Concrete Pedestal Repair

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.10 F
XXXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- Concrete Patching

XXXXXXXXXX

SB- Bearing Keeper

Furnish, galvanize, and install bearing keeper(s), including all anchorages, in accordance with the applicable provisions of 2402, "Steel Bridge Construction," 2433, "Structure Renovation," 2471, "Structural Metals," 3394, "Galvanized Structural Shapes," the plans and the following. The Contractor is responsible for communicating all applicable specifications, special provisions, standards, and requirements to all subcontractors.

A. Materials

Ensure all materials conform to the plan details. If not specified, ensure all steel complies with 3306, "Low-Carbon Structural Steel." Except when part of a proprietary anchorage assembly, ensure threaded rods and hardware meet the requirements of 3385.2.A, "Type A - Carbon Steel Anchor Rods," and 3391,"Fasteners," respectively.

1. Galvanizing Requirements

Galvanize bearing keeper material after fabrication in accordance with 3394, "Galvanized Structural Shapes". Galvanize all fasteners and hardware in accordance with 3392, "Galvanized Hardware," or electroplate in accordance with ASTM B633, Type III, SC 4.

2. Adhesive Anchorages

Adhesive anchorages consist of drilling and affixing a continuously threaded rod secured by an approved adhesive. Ensure anchorages for fastening bearing keepers consist of a Department-approved adhesive listed on the Approved/Qualified Products List for "Concrete Anchorages - Threaded Rod Applications."

Hammer drill anchorage holes into the concrete to diameter and depth shown on plan.

Proceed with installation as specified by the adhesive Manufacturer's Printed Installation Instructions. Supply a set of installation instructions to the Engineer.

Secure bearing keeper to anchorage. Ensure nuts and washers are in contact with the adjacent surface and then torqued as shown in plans or to:

- $^1/_2$ inch diameter = 30 ft pounds
- $^5/_8$ inch diameter = 60 ft pounds
- $^3/_4$ inch diameter and larger = 80 ft pounds

D. Construction Requirements

Provide the Engineer with a written QC/QA plan to ensure that the drilled anchorages are installed in the correct location. For anchorages located at piers locate existing reinforcement bars prior to installation. Only bars within the depth of the pedestal may be drilled through. Do not drill through bars below the top of the pier cap. If reinforcement conflicts with bearing keeper anchorage holes, relocate holes in field; then drill new holes in the bearing keeper plate. Repair of bearing keeper galvanizing is not required for relocated anchorage holes, but filling of an unused hole in the concrete will be filled using one of the materials listed on the Department's "Approved/Qualified Product List for Bridge Products, Bridge Surface and Crack Sealers," (http://www.dot.state.mn.us/products/bridge/index.html), with no additional compensation.

E. Method of Measurement

Measurement will be by the single unit of each for furnishing and installing acceptable bearing keeper complete in place, including anchorages. Anchorages installed that are not shown in the Plans or ordered by the Engineer will not be measured for payment.

F. Basis of Payment

Payment for Item No. 2433.602, "BEARING KEEPER" will be made at the Contract price per each and shall be compensation in full for all costs of furnishing and installing bearing keeper complete in place as described in this special provision, and in the Plans, including all incidentals thereto.

SB2018-2433.11 B

Use when existing bearings will remain and need maintenance in order to function as designed.

CREATED 4/28/2017

REVISED 3/20/2018 (2)

SB- Clean and Grease Expansion Bearing Assemblies

A. Description of Work

Jack the bridge, clean, and grease the lubricated bronze sliding expansion bearings at ____.

This work includes providing a jacking plan and calculations prepared by a registered Engineer in the State of Minnesota. Determine the location of jacking that will not damage structure. Review bridge for utilities or continuous conduits that would inhibit lifting of the girder(s).

Substructure Location	Bearing Location	Unfactored Dead Load (In permanent position)

1 - DESIGNER NOTE: Engineer to coordinate with Project Engineer on traffic closure to remove LL during greasing. If LL not relieved, include the following:

Live loading will not be removed from bridge during jacking. The live load for each bearing is as follows:

Substructure Location	Bearing Location	Unfactored Live Load plus Impact Reaction

The Contractor must provide jacking provisions that are suitable for sustaining live load forces.

B. Construction Requirements

Where painting is within contract, perform greasing after painting unless otherwise authorized by the Engineer.

2 - DESIGNER NOTE: Consider defining "cleaning" refer to Regional Engineer.

1. Jacking and temporary support

Jack the bridge uniformly up to ½ inch to permit the cleaning and greasing of the bearings. Perform jacking to provide access for greasing in a manner that will not damage the structure or any utility conduits crossing the expansion joint openings. Remove the expansion device cover plates as necessary to prevent damage during lift. Submit the proposed jacking scheme to the Engineer for review. Address all written comments to the satisfaction of the Engineer before jacking.

On bearings having grease zerks, jack to relieve pressure on the sliding surfaces.

2. Cleaning

Prior to jacking, remove dirt, debris, and foreign materials from the exterior of the bearing to minimize introduction of foreign materials into the sliding surfaces of the bearing. Perform jacking as defined above. Remove corrosion by-products and contaminated existing grease from sliding surfaces.

Propose methods for acceptance by the Engineer that may include, but are not limited to, cleaning by putty knife, wire brush, wire wheel, needle scalers, metal files, or other methods. Method acceptance does not relieve the contractor from attaining the cleaned condition as defined within this provision. Restore sliding surface flatness within $^{1}/_{32}$-inch by use of metal file or other proposed method. Airblast surfaces prior to greasing.

Do not abrasively blast sliding surfaces unless accepted by the Engineer. When abrasive blasting is used, solvent clean sliding surfaces prior to greasing.

3 - DESIGNER NOTE: Use as directed by RBCE for heavily corroded bearings and remove above 2 sentences:

Sandblasting is required to clean sliding surfaces inaccessible by other cleaning methods. Do not sandblast galvanized surfaces. Remove all sandblast media from bridge bearing and seat after sandblasting. Solvent clean sliding surfaces prior to greasing.

Present cleaned surfaces to the Engineer prior to greasing. Do not grease sliding surfaces until after the Engineer accepts the cleaned and prepared sliding surfaces.

3. Greasing

Use Department-approved grease from the "Approved/Qualified Product List for Bridge Products, Bridge Bearing Lubricant" (http://www.dot.state.mn.us/products). Apply grease uniformly to $^{1}/_{16}$" thickness on lower sliding surface. Lower girder onto permanent bearing at a controlled rate not exceeding $^{1}/_{8}$" per second.

Repair damage resulting from jacking operations to preexisting conditions, at no cost to the Department.

Each bearing greased will be paid for under Item No. 2433.602 "CLEAN AND GREASE EXP BEARING ASSEMBLIES", at the Contract price per each.

C. Method of Measurement

Measurement will be per each bearing serviced by jacking, cleaning, and greasing.

D. Basis of Payment

Each bearing greased will be paid for under Item No. 2433.602 "CLEAN AND GREASE EXP BEARING ASSEMBLIES", at the Contract price per each.

This SP is currently being developed by the S.P.E.C.S Committee and Nate Schutte & Jessica Duncan are the lead authors.

SB2018-2433.11 C
XXXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- Reconstruct Bearing Assembly

XXXXXXXXXX

Use for partial repair of concrete slope paving (i.e., when only select concrete panels are to be removed and replaced due to cracking, settlement, etc.). If complete replacement is required, use 2104 and 2514 pay items and review with RBCE.

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Reconstruct Slope Paving

Remove and dispose of concrete panel, furnish and install granular fill, construct new reinforced concrete panels, and furnish and install joint filler and joint sealer. Perform work in accordance with 2514, "Slope Paving," the plans, and the following:

The Engineer will designate the slope paving areas where the above work is to be performed.

Dispose of excavated materials in accordance with 2104, "Removing Pavement and Miscellaneous Structures".

A. Method of Measurement

The Engineer will separately measure slope paving by area of top surface in ft^2.

B. Basis of Payment

Payment will be made as Item No. 2433.618 "RECONSTRUCT CONCRETE SLOPE PAVING," at the Contract price per square foot and shall be compensation in full for all costs of construction complete in place.

Use for partial repair of aggregate slope paving (i.e., when only small areas are to be removed and replaced due to loss of material, sloughing, etc.). If complete replacement is required, use 2104 and 2514 pay items and review with RBCE.

CREATED 12/12/1997

REVISED 3/20/2018 (13)

SB- Reconstruct Aggregate Slope Paving

Remove and dispose of crushed aggregate and bituminous asphalt, furnish and install granular fill, construct new stabilized aggregate slope paving and bituminous material. Perform work in accordance with 2514, "Slope Paving," the plans, and the following:

The Engineer will designate the slope paving areas where the above work is to be performed.

Dispose of excavated materials in accordance with 2104, "Removing Pavement and Miscellaneous Structures".

A. Method of Measurement

The Engineer will separately measure slope paving by area of top surface in ft^2.

B. Basis of Payment

Payment will be made as Item No. 2433.618 "RECONSTRUCT AGGREGATE SLOPE PAVING," at the Contract price per square foot and shall be compensation in full for all costs of removal and construction complete in place.

This SP is currently being developed by the S.P.E.C.S Committee and Jessica Duncan is the lead author.

SB2018-2433.12 C

Use when the existing flashing at the interface of the abutment and slope *protection has failed and is in need of replacement. Include Detail B* ***from Standard Plan 5-397.301.***

CREATED XX/XX/XXXX

REVISED XX/XX/XXXX (X)

SB- Reseal Slope Paving Joints

XXXXXXXXXX

Use when recommended by the Regional Bridge Construction Engineer. CONCRETE SURFACE REPAIR is typically used on areas of substructures, concrete beams, barriers and overhangs. Dry mix is most suitable for vertical and overhead shallow repairs (≤6-inches), although it can be used for horizontal and sloped repairs.

CREATED 12/3/2019
REVISED 12/3/2019

SB- Concrete Surface Repair by Shotcrete Method

A. Description of Work

This work consists of repairing concrete surface areas using a pre-packaged dry mix as shown in the Plans and as field identified by the Engineer. The dry mix process consists of a Portland cement, silica fume, air-entraining admixture, synthetic fibers and blended aggregates conveyed through a hose and mixed with water at the nozzle as it is pneumatically projected at high velocity onto a prepared substrate.

Provide all labor, materials and equipment to perform the following work:

1 - DESIGNER NOTE: Include the following sentence if a repair sequence is required for a bridge(s) on your plan, such as for pier caps with significant deterioration or low ratings:

Follow the repair sequence in the plans for Bridge Nos. __________.

1. Determine the extent of concrete deterioration—within the areas to be repaired as shown in the Plans and as directed by the Engineer--by tapping the concrete surface to locate all unsound concrete. No removals or repairs will be permitted until the unsound areas have been marked by the Contractor and authorized by the Engineer (hold point). Provide access for the Engineer.

2. Remove and dispose of all damaged or delaminated concrete by methods outlined in Section G, "Surface Preparation for Shotcreting". Where reinforcement corrosion exists, remove concrete damaged by corroding reinforcement to at least 3/4 inch beyond and behind corroded areas of reinforcement.

3. Prepare exposed concrete substrate and reinforcement bar surfaces by sandblasting or high-pressure water (3500 psi) blasting. Contain fugitive dust and debris onsite. Do not allow debris to enter any water bodies. Protect areas outside of work area including areas subject to traffic.

4. Furnish and place new reinforcing steel as necessary, as directed by the Engineer.

5. Supply pre-bagged and pre-blended dry mix selected from the MnDOT Approved/Qualified Product List (APL) for *Shotcrete - Concrete Surface Repair*.

6. Furnish, apply, finish and cure shotcrete, or other approved alternate materials for repair.

7. Provide a field quality control program that meets the requirements of Section F, "Quality Assurance and Quality Control Testing."

2 - DESIGNER NOTE: Remove this item 8 if no FRP on job:

8. Confirm with Engineer areas to receive subsequent FRP (Fiber Reinforcing Polymer) covering (Either Carbon Fiber Reinforcing Polymer (CFRP) or Glass Fiber Reinforcing Polymer (GFRP)). Surface finish quality must meet the FRP manufacturer conditions prior to applying the FRP.

Perform the work in accordance with the applicable provisions of 2401, 2433, 2472, the Plans, as directed by the Engineer, and the requirements described herein. Shotcreting shall conform to all applicable requirements of *ACI 506.2 Specification for Shotcrete* and as referenced herein to *ACI 506R Guide to Shotcrete* contained in the latest edition of the ACI Collection published by the American Concrete Institute (ACI); and the following sections.

B. Materials

1. Water

Provide water conforming to 3906, "Water for Concrete and Mortar".

2. Dry Mix

Provide a fiber-reinforced shotcrete product from the MnDOT Approved/Qualified Product List (APL) for *Shotcrete - Concrete Surface Repair*. Do not batch shotcrete materials on site. Provide dry mix shotcrete material that are a pre-blended, pre-packaged shotcrete product, in which all mix components have been weigh-batched in a quality controlled facility.

3 - DESIGNER NOTE: Use Grading No. 1 when the likely repair areas are 1" thick or less (i.e. prestressed beams). Use Grading No. 2 for most patches expected at greater than 1". Most substructure repairs will be at least 2" in depth. Discuss with Regional Bridge Construction Engineer where more information is needed.

a. Gradation shall comply with Grading No. 2 Grading No. 1, see APL.

4 - DESIGNER NOTE: Use when the RBCE requests a thermal spray coating, also referred to as metalizing, applied over the concrete surface repairs in the contract.

b. Provide shotcrete materials with resistivity < 15,000 Ohm, see APL.

3. Supplemental Reinforcement and Anchors

Supplemental reinforcement is required where unreinforced concrete openings exceed 3 square feet in surface area. Supplemental anchorages are required for overhead and vertical surfaces. See plans for additional requirements. Provide reinforcement and anchorages as follows:

5 - DESIGNER NOTE: Select reinforcement type after reviewing the existing reinforcing steel in areas of patching.

Discussion: There are competing influences for future corrosion. On one hand new uncoated steel has a higher corrosion potential than inplace steel. When electrically connecting the new steel to old steel the new steel will corrode first (becomes the anode). On the other hand, shotcrete repairs institute a high pH environment which passivates the embedded steel and makes it more cathodic. In normal circumstances the high pH environment of the shotcrete will overrule the influence of higher potential of newly placed steel. Therefore the typical behavior is that steel within the patch is protected while the existing steel in native concrete will become the anode and continue to corrode. For this reason, placing uncoated steel within the patch will not control the life of the repair and uncoated steel is recommended for simplicity for #5 bars or less in service life extensions of 30 years or less.

Epoxy-coated steel has the benefit that the new steel surface area will be insulated from interaction with existing steel at the burden of longer lap length requirements. When larger bars are installed in the patch there is higher likelihood of cracking which may introduce more moisture near the bars. Corrosion is highly dependent on concrete moisture levels. There is also greater corrosion influence when splicing new bars with large steel surface area with existing bars. The large surface area creates a larger cathode and may increase the unbalance between anode/cathode regions within the concrete repair boundary, causing increased corrosion activity. For these reasons, it is recommended that patches including #6 bars and larger utilize epoxy-coated reinforcement.

Galvanized bars may be used but the galvanized bars are more expensive and contributed to the steel surface area for future corrosion more than epoxy coated. At this time galvanized bars or mesh are only recommended where epoxy bars might not be available, but are certainly better than uncoated reinforcement. Use galvanized bars only after discussing with RBCE.

a. Provide uncoated [epoxy-coated] [galvanized] steel reinforcement for surface repair conforming to 3301, "Reinforcement Bars" and/or 3303, "Steel Fabric".

b. Provide anchors for steel reinforcement or galvanized steel fabric and of adequate length and strength to resist a minimum pullout strength of 150 pounds per square foot of repaired surface at a spacing not to exceed the greater of:

1. Twice the thickness of the repair
2. Twelve inches

C. Storage, Handling, Supply and Equipment

1. Handling and Storage of Shotcrete Materials

Deliver dry mix shotcrete material in pre-packaged form. Do not add admixtures or other components on site. Handle, transport and store all dry mix material to adequately prevent moisture absorption. Store dry mix materials at ambient temperatures in a temperature range between 40ºF and 85ºF. Protect packaged materials from precipitation, humidity and direct sunlight. Identify each bag with the manufacturer's name, the mix name and identification number, as well as the manufacturing date. Do not use expired materials.

2. Shotcrete Placing Equipment

Supply shotcrete delivery equipment capable of discharging the dry mix shotcrete materials without segregation. Supply mixing and pre-dampening units capable of producing a shotcrete mixture with uniform moisture content, such that the Nozzleman is not required to repeatedly adjust the water content at the nozzle water ring.

Pre-dampen dry-bagged premixed shotcrete materials to provide consistent moisture content in the range of 3% to 5% by mass in a pre-dampener, prior to discharge into the shotcrete gun. Discharge of completely dry materials into the shotcrete gun will not be permitted.

Supply delivery equipment (gun) capable of discharging a continuous, smooth stream of uniformly mixed and pre-dampened material into the delivery hose.

As per *ACI 506R* recommendations, use a hydro-mix nozzle with a nozzle body that is separate from the nozzle tip. Use of a hydro-mix nozzle is optional if pre-dampening. The hydro-mix nozzle body should range from 8 to 10 feet from the nozzle tip. During the pre-trial testing the Engineer will accept a particular distance that is proven to produce material that meets this specification without experiencing blockages during use.

Equip the discharge nozzle with a manually operated perforated water feed ring inside the nozzle capable of adjusting the quantity of water. Position the water feed ring in a location convenient to the Nozzleman.

Ensure the water pressure at the discharge nozzle is sufficiently greater than the operating air pressure so that the water is thoroughly mixed with the pre-dampened shotcrete materials. If the line water pressure is inadequate, make adjustments to provide a steady, non-pulsating water pressure.

Supply a clean, dry air supply, capable of maintaining sufficient nozzle velocity for all parts of the work. Provide a moisture and oil trap in the air supply to prevent contamination of the shotcrete.

D. Submittals

Submit the following written documentation at least 20 business days prior to commencement of shotcreting operations:

1. Pre-bagged mix material data sheets

   Select a pre-blended, prepackaged product from the APL. Submit the supplier name and mix design identification number.

2. Qualifications of Shotcrete Work Crew

   Foreman shall have had at least five years' experience in shotcrete repair work on projects of similar size and character. Provide five references from those responsible for supervision of projects. Include name, address and telephone number of references who will testify to the successful completion of these projects by the shotcrete crew foreman.

   Nozzleman shall pass a test-described in Section E, "Shotcrete Preconstruction Trials", demonstrating their nozzle operation competence. Nozzleman in training, while under direct supervision of an ACI certified shotcrete nozzleman, may place shotcrete on front faces of wingwalls and abutment faces that are at least 3 feet from a bridge bearing. For all other locations, individuals applying shotcrete must be certified as an ACI Shotcrete Nozzleman in the dry mix process as outlined in ACI Certification Program Policy CPP 660.1-17 for the orientation of the proposed work; placed shotcrete must meet the requirements of this provision.

3. A plan that contains the proposed method of application, the mixing process and application equipment.

4. A curing plan that describes the proposed curing procedures and protection to be provided to shotcrete. See Section J, "Shotcrete Curing" requirements.

5. A field quality control testing plan that describes the proposed field quality control testing program. Test shotcrete work in accordance with the requirements of *ACI 506.2.1.6 Quality Assurance*, or as otherwise specified. See also Section F, "Quality Assurance and Quality Control Testing."

6. Submit proposed mechanical anchors to be used as a supplement to bond strength. See above for anchor spacing.

The Engineer will either accept or reject the Contractor’s submittals within 10 business days after receipt of the complete submission. Surface repair work will not be allowed to begin nor materials incorporated into the work until the submittal requirements are satisfied and found acceptable by the Engineer. Resubmit for acceptance any changes or deviations required by the Engineer. No adjustments in Contract time will be allowed due to submittals that are not accepted by the Engineer.

E. Shotcrete Preconstruction Trials

Preconstruction Trials include the preparation of Nozzleman Mock-up panels, Compression Test Panels, and where applicable, a Job Reference Standard and Finish Quality Mock-up Panels by a Nozzleman candidate. Each Nozzleman must demonstrate, using the specified material and the anticipated equipment, acceptable proficiency in applying shotcrete uniformly in the same orientation as the proposed work (Vertical, Overhead or Flat). Overhead is defined as concrete placement on a horizontal surface above the shotcrete nozzle. Flat is defined as a placement below the nozzle on a horizontal or slightly inclined surface not exceeding 30-degrees from horizontal. If changes are made to shotcrete equipment from what was used in the shotcrete preconstruction trials, the trails must be redone with changed shotcrete equipment. Prior to proceeding with work on the Project, the Engineer must accept the preconstruction trial results. Place, handle, cure and store construction mock-up and compression test panels in a manner similar to that proposed for production work in respective work areas.

The Engineer will reject non-performing equipment or require re-qualification of equipment and Nozzleman if placed concrete is out of conformance.

1. Nozzleman Mock-up Panels

Produce mock-up panels according to Figures E.1.1 through E.1.3 for placement quality examination before production shotcrete placement according to requirements in *ACI 506.2* for each mix design, shooting orientation, and Nozzleman. Abutment mock-up panels are only required when other mock-up panels are not produced and work is only at abutments. Construct panel forms of wood and sealed plywood.

Upon completion of panel curing, core five 4-inch nominal diameter core test specimens from each of the Nozzleman qualification mock-up panels. Either submit the cores to the Engineer or to an Independent Testing Agency for core quality examination according to criteria of *ACI 506.6T*. Furnish the Engineer with a complete and current *ACI 506.6T* document. An acceptable mock-up panel will exhibit uniformity in aggregate placement and consolidation without voids around reinforcing based on examination of the core test specimens.

In the event that the prospective Nozzleman fails to achieve the required quality, he/she will be given one additional opportunity to demonstrate acceptable proficiency through additional mock-up panels.

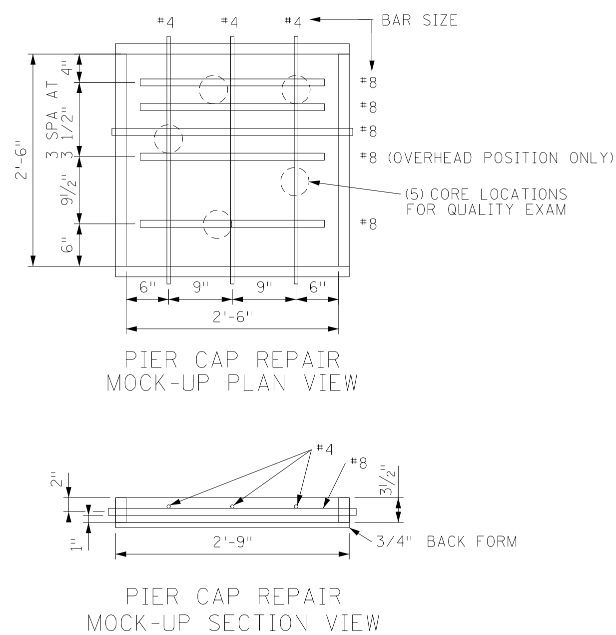

Figure E.1.1: Pier cap repair mock-up panel

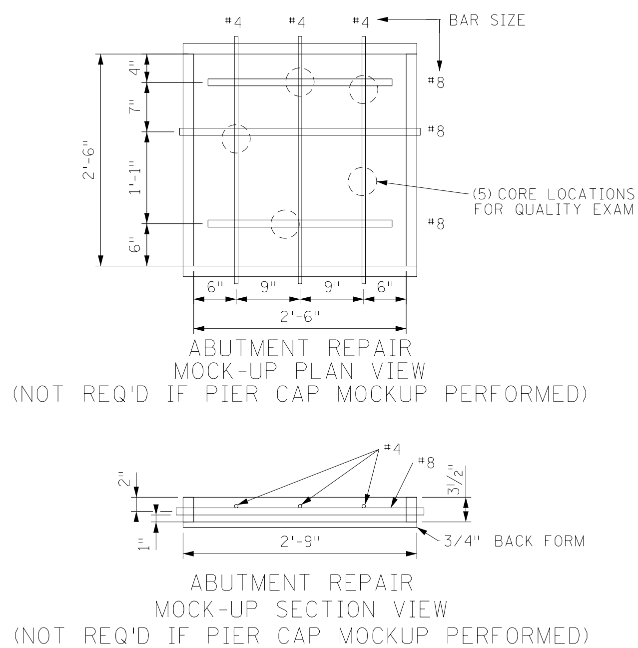

Figure E.1.2: Abutment mock-up panel

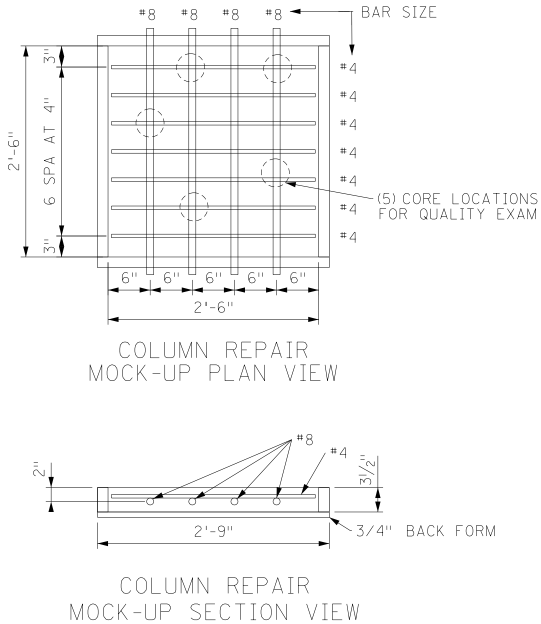

Figure E.1.3: Column repair mock-up panel

2. Compression Test Panels

Produce compression test panels for placement quality and hardened mix testing before production shotcrete placement. Construct panel forms of wood and sealed plywood in accordance with *ASTM C1140 Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels*; with 45º sloping edge forms to permit escape of rebound. Place shotcrete and cure compression test panels according to requirements in *ACI 506.2* as part of the contractor's quality control program for each mix design, shooting orientation, and Nozzleman as relevant to the proposed work areas.

The contractor is responsible for curing and handling compression test panels and hiring an independent testing firm to perform and perform the following:

Core or cut three 3-inch minimum diameter cores from the compression testing panel. Core length/diameter ratios preferably 2:1 and not less than 1:1; or 3-inch cubes.

Conduct compressive strength tests in accordance with *ASTM C1604 Standard Test Method for Obtaining and Testing Drilled Cores of Shotcrete*. The mean compressive strength for a set of two specimens shall equal or exceed f'c. Correct compressive strengths to equivalent 2:1 cores, using the core correction factors in *ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete*. Test one specimen at age 7 days and two at 28 days. Repeat compression testing panels and compressive tests every 50 cubic yards of material placed.

Mix designs shall meet hardened air content requirements. Provide a manufacturer signed letter or independent laboratory testing. The spacing factor of air-void system must not exceed 0.012-inches (300 µm), as determined by the *ASTM C457 Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete* procedure.

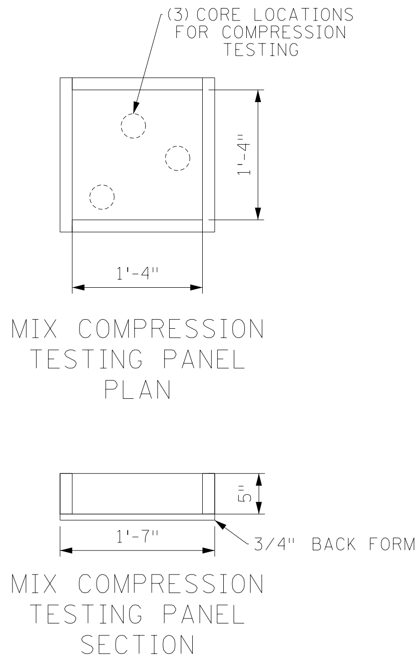

Figure E.2.1: Compression testing panel minimum dimensions

3. Documentation of Preconstruction Mock-up Panels

The Engineer will waive Nozzleman Mock-up Panels if the following conditions are met:\

a. Nozzleman Job Records are submitted with Engineer references and contact information.
b. Mock-up panels were successfully completed on MnDOT jobs made in the past 3 years with the same equipment, mix and orientation.

For each Nozzleman candidate producing mock-up panels, complete and submit a Nozzleman Mock-up Panel Record, Figure E.3.1, documenting each proposed position, equipment and mix design.

Figure E.3.1 is to document Nozzleman mock-up panels successfully completed on the current job. The Engineer's signature is required showing acceptance of mock-up panels prior to proceeding with production work.

Figure E.3.2 is used to compile records of completed job references. Complete, maintain and submit Nozzleman Job Records for each MnDOT job.

Figure E.3.1: Nozzleman Mock-up Record – Excel based version available

Nozzleman Mock-up Panel Record

Nozzleman Name:		SP#:	
ACI Nozzleman Certification # or "in training":		LOCATION:	
Date Certification last renewed or acquired:			
Phone:			
Email:			

Mix name	Mix MFR	Pre-dampen Method
Equipment description:		

Mock-up	Position	Date placed	Date cored	Visual Exam by:	Visual Pass/Fail	Visual Reviewer Signature

MnDOT Engineer Name			
MnDOT Engineer phone			
MnDOT Engineer email			
MnDOT Engineer signature		Date:	

Figure E.3.2: Nozzleman Job Record – Excel based version available

Nozzleman Job Records

Nozzleman Name:		Nozzleman Email:	
ACI Nozzleman Certification #:			
Date acquired:		Definitions: **OH** = horizontal overhead placement with nozzle below **Flat** = horizontal with nozzle above	Mock-up Accepted? (**Y** = Nozzle Operator Mock-up completed on job and accepted, **B.R.** = **By Reference**, Mock-up not performed - prior reference used for nozzleman qualification)
Phone:			

Project References					MnDOT Project Engineer		Abutment		Pier Cap			Column
SP#	Year	Bridge Loc. OR No.	Est. SF	Mix name/mfr	Name	email	Vertical	Flat	OH	Vertical	Flat	Vertical
XXXX-XX	*2019*	*82815*	*210*	*King Shotcrete MS-D1 SY*	*John Doe*	*John.doe@state.mn.us*			*Y*	*Y*	*Y*	*B.R.*

4. Job Reference Standard (Applicable to jobs with multiple substructures and 200 SF or more concrete surface repair area)

A Job Reference Standard is defined as a field trial to demonstrate procedures and demonstrates that adequate shotcrete bond is achieved prior to authorizing production work. It is only required on jobs with concrete repair 200 square feet or more. Implement a trial totaling at least 4 square feet in area to enable the Engineer to evaluate the proposed preparation, materials, shotcrete mixture, equipment and Nozzleman to the Project specifications. Where methods of preparation will vary prepare an additional Job Reference Standard representative of the proposed work. The Engineer will review the following for the Job Reference Standard:

a. Surface Preparation
b. Prewetting
c. Curing methods
d. Bond

Locate the repair area on concrete that is similar in age and strength to the production work. Propose modified procedures to the Engineer in response to failed bond pull-off tests.

The trial repair area may be incorporated into production work if the preparation, curing and bond testing meets contract requirements. Document and photograph the preparation, prewetting procedures, and curing methods prior to proceeding with additional production work. Submit documentation to the Engineer.

Perform three bond tests, also referred to as pull-off tests, on a trial area prepared and shotcreted in accordance with the proposed methods in accordance with the latest version of ASTM C1583 *Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)*. The average of three bond tests must meet or exceed 150 psi bond with the prepared substrate, and no single test may be lower than 100 psi. Where pull-off testing reveals less than 150 psi bond and failure is confirmed at the bond interface or nearer to the surface, propose modifications to meet job specifications, remove nonconforming shotcrete and repeat application until a passing Job Reference Standard is achieved.

Bond failure in the substrate will be subject to Engineer review of the preparation prior to acceptance. The Engineer will determine if preparation was inadequate or if sound concrete is not available.

Repair all pull-off testing with either shotcrete or non-shrink grout.

The Job Reference Standard may be waived if the contractor elects to perform bond testing on production work at a rate of 3 tests per 100 square feet. If bond testing reveals less than 150 psi bond, remove and replace concrete repairs to the nearest passing bond test.

5. Finish Quality Mock-up

Demonstrate finish quality on a mock-up, which may be the same piece of work as the Job Reference Standard. Where multiple finishes are required, the Job Reference Standard may be increased in size and separate finish may be exhibited. Produce finish conforming to Section H, "Shotcrete Application for Surface Repair."

6 - DESIGNER NOTE: Remove the following paragraph if there is no FRP on job:

Produce mock-up panels to illustrate finish quality where FRP is proposed to be applied over shotcrete. Before production shotcrete, construct mock-up panels for each finish required and for each mix design, shooting orientation, and Nozzleman to set quality standards for installation. Two finishes are required on this project: One for areas with subsequent FRP covering, and one for areas not subsequently treated with FRP.

F. Quality Assurance and Quality Control Testing

1. Quality Control Testing

Establish and maintain a quality control program for all shotcrete work. Such a program shall include, but not be limited to the following:

a. Maintenance of test records for all quality control operations
b. Wash-out testing of dry-bagged premix materials to check cementitious content and aggregate gradation
c. Physical testing of the hardened shotcrete

2. Bond Testing

Bond testing according to *ASTM C1583 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)* procedures is required at locations identified by the Engineer. A minimum of 3 bond tests are to be performed on production work and is in addition to any performed on a Job Reference Standard. Perform bond tests for production work at a rate of 3 tests per each 500 square feet of repair area, or any part thereof.

The average of each three bond tests must meet or exceed 150 psi, and no single test may be less than 100 psi bond.

Where bond testing fails the above criteria, perform additional bond tests to determine the limits of low bond strength at no cost to the Department. Remove and replace concrete surface repair in conformance with this special provision without additional compensation. Due to the structural nature of the repair work, the provisions detailed in 1512.1(2), "Unacceptable Work," will not be applicable to shotcrete work.

Bond testing will not be required for overhead repairs that:

a. Incorporate supplemental mechanical anchors in conformance with this specification; and
b. Have had substrate preparation fully hammer sounded and inspected by the Engineer prior to placing shotcrete.

Provide access to the Engineer for all sounding and inspection of prepared surfaces prior to placing concrete.

G. Surface Preparation for Shotcreting

Provide arm’s length access to the Engineer for locating and outlining all loose, spalled and deteriorated concrete to be removed. Exercise care so as to not damage areas of sound concrete or reinforcing steel during concrete removal operations. Unless specifically directed by the Engineer, depth of removal shall not exceed 4 inches.

Accomplish concrete removal using one or more of the following methods:

a. Chipping with hand picks, chisels or light duty jackhammers not to exceed 15 pounds;
b. Scarifiers, scabblers or other suitable mechanical means; and/or

If sound concrete is encountered before existing reinforcing steel is exposed, prepare and repair the surface without further removal of concrete. When corroded reinforcing steel is exposed, continue concrete removal until there is a minimum 3/4-inch clearance around the exposed corroded reinforcing bar. Take care to not damage concrete bond to adjacent non-exposed reinforcing steel during the concrete removal process.

Maintain saturated surface dry condition on all concrete surfaces for at least 12 hours prior to shotcreting surface. Provide and install supplemental #4 reinforcement bars where open spaces between reinforcing bars exceed 3 square feet and depth of repair exceeds 1 1/2 inches. Include mechanical anchors for overhead and vertical surfaces in accordance with Materials Section B.3.

If inplace reinforcement displaying deep pitting or loss of more than 20% of cross-sectional area is encountered, the Engineer will discuss the need for additional reinforcement with the MnDOT Bridge Office. If so directed by the Engineer, remove loose reinforcement and replace with equal size bars. Replacement and new reinforcement minimum lap splice lengths are detailed in the Plans. In the case of lapped splices, do not bundle bars, but place the bars such that the minimum spacing around each bar is three times the maximum aggregate size or 3/4 inch, whichever is larger, to allow for proper encapsulation with shotcrete.

Taper the perimeter of all areas where concrete is removed at an approximate 45º angle, except sawcut the outer edges of all chipped areas to a minimum depth of 3/4 inch to prevent feather edging, unless otherwise approved by the Engineer.

After all deteriorated concrete has been removed; prepare the repair surface to receive shotcrete by sandblasting or high-pressure (14,500 to 40,000 psi) water jetting. The repair surface shall have an adequate surface roughness determined as three peak-to-valley measurements of at least 3/16 inch.

Remove by sandblasting or high-pressure water jetting all fractured surface concrete and all traces of any unsound material or contaminants such as oil, grease, dirt, or any materials which could interfere with the bond of freshly placed shotcrete.

Apply shotcrete to cleaned areas within 48 hours, or re-blasting will be required.

Dispose of all material removed in accordance with the requirements of 2104.3C, "Removal Operations".

H. Shotcrete Application for Surface Repair

1. General

Apply shotcrete in accordance with good practice as detailed in Chapter 8, Section 8.5 of *ACI 506R*. In particular:

a. Operate the nozzle at a distance of 1.5 to 5 feet from the receiving surface and orient at right angles to the receiving surface, except as required to fill corners, cover edges and encase large diameter reinforcement bars.

b. Optimize the combination of air pressure at the nozzle, moisture content of the shotcrete and the distance of the nozzle from the receiving surface to achieve maximum compaction of the shotcrete.

c. Take care while encasing reinforcement and steel fabric to keep the front face of the reinforcement clean during shooting operations so that shotcrete builds up from behind to encase the reinforcement and prevent voids and sand pockets from forming.

d. Continuously remove accumulations of rebound and overspray by the blowpipe operator in advance of the deposition of new shotcrete. Do not reuse rebound material.

2. Surface Repair

All concrete surface areas to be repaired must be inspected and approved by the Engineer prior to application of any shotcrete.

The day before shotcreting, water saturate the concrete substrate within the areas to be repaired and then re-wet prior to shooting. At least one hour prior to application of shotcrete, flush all surfaces to be shotcreted with water. Allow wetted surfaces to dry back to a saturated-surface-dry condition prior to application of shotcrete. If necessary, use a blowpipe to facilitate removal of surface water. Only oil-free compressed air may be used in the blowpipe. In the event a work stoppage longer than two hours takes place on any shotcrete layer prior to the time it has been built up to required thickness, re-wet the surface prior to continuing. Do not apply shotcrete to a dry surface or to a surface with free water.

Bring the shotcrete to an even plane and to well-formed corners by working up to ground wires or other guides, using a lower-than-normal placing velocity.

Do not apply shotcrete during periods of inclement weather, which could interfere with the shotcrete stream unless suitable protective covers, enclosures or wind breaks are installed.

Exercise care to protect adjacent surfaces from build-up of rebound and overspray. Remove hardened rebound and hardened overspray prior to application of additional shotcrete using sandblasting, chipping hammers, high-pressure water blasting or other suitable techniques. Do not allow shotcrete material to fall on natural surfaces within 200’ of the surface waters, or Areas of Environmental Sensitivity (AES), or to fall into surface waters that drain to such areas.

Repair shotcrete surface defects as soon as possible after placement. Remove and replace shotcrete which exhibits segregation, honeycombing, lamination, voids, or sand pockets. In-place shotcrete determined not to meet the specified strength requirement will be subject to remediation as determined by the Engineer. Possible remediation options include placement of additional shotcrete thickness or removal and replacement, at no cost to the Department.

Carefully monitor the water ring in the nozzle for any signs of blockage of individual water spray holes. If non-uniform wetting of discharged shotcrete becomes apparent, stop the shooting and clean the water ring or take other appropriate corrective actions.

Thoroughly clean the delivery equipment at the end of each shift. Remove any build-up of coatings in the delivery hose and nozzle liner.

Protect the shotcrete if it must be placed when the ambient temperature is below 50ºF and falling or when it is likely to be subjected to freezing temperatures before gaining sufficient strength. Maintain cold weather protection until the in-place compressive strength of the shotcrete is greater than 725 psi. Cold weather protection includes blankets, heating under tents, or other means acceptable to the Engineer. Maintain the temperature of the shotcrete mix, when deposited, between 50ºF and 95ºF. Terminate shotcrete application if the ambient temperature rises above 85ºF, unless the Contractor adopts special hot weather shotcreting procedures, approved by the Engineer.

If the prevailing ambient conditions are such that the shotcrete develops plastic shrinkage and/or early drying shrinkage cracking, terminate shotcrete application and take the following action:

1. Reschedule the work to a time when more favorable ambient conditions prevail; and/or

2. Adopt corrective measures, such as installation of sun-screens, windbreaks, surface evaporation retardants or fogging devices to protect the work.

I. Shotcrete Finishing

Build up the surface of the shotcrete slightly and trim to the final surface by cutting with the leading edge of a sharp trowel. Remove any imperfections by floating with a rubber float. Limit work done to the finished surface to correcting imperfections caused by cutting with the trowel. Accomplish final finishing by using a wood float for a preliminary finish, with the final finish using a rubber float. Trim back all shotcrete and overspray from adjacent non-prepared concrete surfaces.

Where not covered by subsequent Fiber Reinforced Polymer (FRP), the final shotcrete surface shall not vary more than 1/4 inch from a straight line in any direction between adjacent inplace surfaces.

7 - DESIGNER NOTE: Remove the following paragraph if there is no FRP on job:

Areas with subsequent FRP covering are required to be free of cracks that would require correction per the FRP manufacturer's surface requirements. The Contractor is required to epoxy inject cracks at boundaries with original concrete or within the shotcrete repair at no cost to the Department to meet conditions suitable to the FRP manufacturer's system. For areas covered by subsequent FRP, the final shotcrete surface shall not vary more than 1/16 inch from a straight line in any direction between adjacent inplace surfaces unless otherwise approved by the FRP manufacturer and the Engineer.

Make transitions on all surfaces smooth and not abrupt. Diamond grinding may be used to bring the hardened surface into tolerance, but the ground surface must not result in an objectionable appearance after final surface finishing, as determined by the Engineer.

J. Shotcrete Curing

On completion of finishing, prevent shotcrete from drying out by keeping it continuously moist for a minimum of 3 calendar days. Accomplish moist curing using one or more of the following procedures:

1. Fogging: Within 1 hour of completing surface finishing, enclose the shotcrete area with 6 mil plastic and provide continuous atomizing or fogging as required to maintain at least 85% humidity within the shotcrete area. Maintain 85% humidity for at least 72 hours. Record humidity level near shotcrete surface every 4 hours for first 8 hours and every 12 hours thereafter. Take at least one reading every 20 feet. Once moist curing period is completed, apply two successive coats of approved curing compounds that conforms to ASTM C309 *Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*.

2. Wet burlap wrapping: Alternatively if fogging is not applicable, wrap the elements in wet burlap, which has been presoaked in water for 24 hours prior to installation. Wrapping the wet burlap in plastic is useful for retarding the rate of drying of the burlap. Keep the wet burlap in place for at least 72 hours, and keep the burlap saturated while in-place to prevent drying of the burlap or shotcrete. The burlap must maintained wet so that it does not draw moisture back from the repaired patch. Once moist curing period is completed, apply two successive coats of approved curing compounds that conforms to ASTM C309 *Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*. When applying successive coats, follow the recommendations of the curing compound manufacturer.

3. Alternatively if wet burlap wrapping is not applicable, install sprinklers, soaker hoses or other devices to keep the shotcrete surface continuously wet for at least 72 hours. The use of intermittent wetting procedures that allow the shotcrete to undergo wetting and drying during the curing period will not be allowed. Once moist curing period is completed, apply two successive coats of approved curing compounds that conforms to ASTM C309 *Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*. When applying successive coats, follow the recommendations of the curing compound manufacturer.

4. Alternatively if wet curing methods listed above are not applicable, apply approved curing compound that conforms to ASTM C309 *Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*. Apply two successive coats of curing compounds immediately after completion of surface finishing. When applying successive coats, follow the recommendations of the curing compound manufacturer.

Notify the Engineer the curing method to be used prior to executing work.

Contain all water and curing compound onsite. Do not allow shotcrete and curing material to fall on natural surfaces within 200 feet of the surface waters or Areas of Environmental Sensitivity (AES), or to fall into surface waters that drain to such areas.

K. Shotcrete Acceptance

Shotcrete that does not conform to these special provisions may be subject to rejection either during the shotcrete application process, or on the basis of tests on the test panels or completed work.

Deficiencies that could lead to rejection of the work, which are observed during the shotcrete application process, such as, but not limited to:

1. Concrete placement prior to submittal compliance;
2. Failure to properly control and remove build-up of overspray and rebound;
3. Incomplete encasement of or incomplete consolidation around reinforcement bars, steel fabric, anchors;
4. Incorporation of sand lenses, excessive voids, delaminations, sags, rebound, and sloughing;
5. Failure to apply shotcrete to the required surface tolerance;
6. Failure to provide cold weather protection to repaired areas;
7. Failure to adhere to the proposed and accepted cure requirements; and/or
8. Failure to meet bond strength requirements.

Whenever possible, perform all remedial work to correct deficiencies while the shotcrete is still plastic.

Repair or remove shotcrete that is determined by the Engineer to be defective or non-conforming to the Project specifications. Replace the shotcrete at no cost to the Department. Repairs of non-conforming shotcrete are subject to the same testing, evaluation and acceptance criteria as the original repair shotcrete.

L. Shotcrete Repair

Remove still plastic shotcrete that is identified as being non-conforming using spades, scrapers or other suitable mechanical devices. High-pressure water jetting may be used, subject to acceptable disposal of the removed shotcrete and water treatment.

Remove hardened shotcrete that is identified as being non-conforming using the same basic procedures used for removal of deteriorated concrete. Take care to avoid damage to reinforcement, steel fabric, anchors or good concrete. Replace any embedment or reinforcement damaged during the shotcrete removal process at no cost to the Department.

Place, finish, cure and protect repair shotcrete in the same manner specified for all shotcrete work. No compensation will be made for the costs of repair and tests for non-conforming shotcrete.

M. Method of Measurement

Measurement will be by area in square feet of concrete surface repaired by the shotcrete method that is shown in the Plans and other areas that have been specifically designated and/or approved by the Engineer for repair by this method. Where finished faces include more than one surface, all surfaces will be included in measurement. Work outside of these designated areas will *not* be measured for payment.

N. Basis of Payment

Payment for Item No. 2433.618 "CONCRETE SURFACE REPAIR" will be made at the Contract price per square foot and shall be compensation in full for all costs of repairing the designated deteriorated concrete surfaces as described herein, including new steel reinforcement.

8 - DESIGNER NOTE: Remove the following paragraph if there is no FRP on job:

Epoxy injection of any cracked concrete surface repairs, as required for FRP installation, will be an included expense to "CONCRETE SURFACE REPAIR" if the area of repair was paid for within this contract.

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.14 A
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB-　　　　Embedded Galvanic Anode 65

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- Embedded Galvanic Anode 100

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB- Embedded Galvanic Anode Special

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

<u>SB2018-2433.14 D</u>
XXXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB-   SD: Distributed Galvanic Anode

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.14 E
XXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- Paint Concrete (Metalizing)

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.14 F
XXXXXXXXXXX.
CREATED XX/XX/XXXX
REVISED XX/XX/XXXX (X)

SB- Metalize Steel

XXXXXXXXXX

This SP is currently being developed by the S.P.E.C.S Committee and Paul Pilarski is the lead author.

SB2018-2433.14 G
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REVISED XX/XX/XXXX (X)

SB- Corrosion Survey

XXXXXXXXXX

SB2018-2442
Use on all jobs requiring "Removal of Existing Bridges".
CREATED 5/14/1997
REVISED 9/4/2019 (13)

SB- (2442) REMOVAL OF EXISTING BRIDGES

The provisions of 2442, "Removal of Existing Bridges," are supplemented as follows:

SB- Removal of Existing Bridges

Add the following to the end of the third paragraph of 2442.3.A, "General":

Completely remove piling and obstructions that interfere with the new structure.

SB- Supplemental Provisions

Dispose of materials in accordance with 1506, "Supervision By Contractor," 2104.3.C, "Removal Operations," MnDOT Managing regulated materials on building and bridge projects per the Office Of Environmental Stewardship and the following:

Furnish written information to the Engineer as to disposal of steel bridge beams and other steel bridge components coated with paint containing hazardous materials (i.e. Lead or PCB). Include method of stabilization and disposal; name, address, and telephone number of disposal site; certification that Contractor has notified disposal site of presence of the hazardous paint; acknowledgment by Contractor of OSHA requirements relating to lead or PCB; and certification that Contractor is familiar with proper handling and disposal of materials with lead or PCB based paint systems. Stabilize all paint that has been identified as peeling by coating with an approved product, as listed on the MnDOT Approved Products website www.dot.state.mn.us/products under "Lead Paint Encasement Product". Prevent the peeling paint from flaking off during demolition, or scrape and contain the peeling paint. If the coating option is used apply 16 mils of the product. Applying more than 16 mils of the product on a bridge over any water will require that the bridge have a diaper apron be attached under the bridge to contain the drips. Complete all work as per the MnDOT Office of Environmental Stewardship. The form supplied in this special provision must include the signature of the authorized Superintendent verifying that the information is correct.

1 - DESIGNER NOTE: For the following section (Salvaged Materials), ONLY use on jobs requiring salvaging materials from bridge removals.

A. Salvaged Materials

Salvage, load, and haul materials specified below, and unload them at the following location(s) in a manner satisfactory to the Engineer:

Bridge No.	Description of Materials	Delivery Location
____________	____________________	____________

Contact (Name________ at (Address _________________, telephone ( ) ___________, prior to hauling the materials to arrange for their delivery.

Replace or repair materials damaged while being salvaged, loaded, or hauled, to the satisfaction of the Engineer and at the Contractor's expense.

2- DESIGNER NOTE: Include all of the above under 2442.501, "SALVAGE AND HAUL MATERIAL (BRIDGE)".

NOTIFICATION FORM OF DISPOSAL OF BRIDGE STEEL WITH LEAD PAINT:

http://www.dot.state.mn.us/environment/regulatedmaterials/ownership.html

SB2018-2442.1

Use where concrete elements from the existing bridge, such as footings, will be left in place. Designer will pre-populate the Bridge, Project, Location, Description, Volume, and Reason Structure was left in-place filled in on the form included at the end of this special provision using the information from the "Bridge Concrete to Remain In-Place" Form (see Designer Notes). Additionally, the approximate location and size of the concrete to remain in place should be included on the soil boring sheets in the plan.

CREATED 09/24/2019
REVISED 9/24/2019

SB- Uncontaminated Concrete Management Record

In accordance with the Minnesota Pollution Control Agency "Strategy for the Management of Uncontaminated Concrete on MnDOT Highway and Maintenance Projects", dated 15 June 2016, MnDOT must document when concrete structures are left in place for engineering, environmental or safety reasons. This document is available on MnDOT's Waste Concrete Management website (http://www.dot.state.mn.us/environment/regulatedmaterials/concrete.html).

A. Description of Work

1. Tasks performed by Contractor:

   a. Perform removals in accordance with the Contract Plan, Provisions, and Standard Specifications.
   b. When concrete element to remain is exposed to view, provide access to Engineer for visual inspection of element prior to burying.
   c. Survey the element to provide XY Coordinates, Elevations, and dimensions. Tabulate data with descriptive labels and submit electronic file to Engineer.
      (1) When the entire element is exposed, collect a sufficient number of survey points to replicate the shape of the element in plan view.
      (2) When the Engineer determines that substantial excavation, additional earth retentions systems, substantial river disturbance, etc. are required to collect all survey data, collect survey data of elements that are exposed.
      (3) For both cases above, a complete description of the survey points is required with the survey data submitted.
   d. Submit 11x17 plan sheet(s) that provides the surveyed location of any elements not removed. In addition to the concrete elements listed in the Plan and this Special Provision, include the following items as applicable:
      (1) Utilities
      (2) Earth retention system components
      (3) Other concrete footings
      (4) Other elements as determined by the Engineer
   e. Alternatively, a legible mark-up of the soil boring sheets from the bridge plan may be submitted if all pertinent information can be included.

2. Tasks performed by Department:

   a. Complete visual assessment (if applicable) of concrete to confirm element is uncontaminated. Sampling must be conducted if there is reason to suspect that the concrete may be coated with lead based paint or asbestos or if contaminated soil is adjacent to the structure in order to determine if the structure is uncontaminated and can be left in-place.
   b. Complete the attached "MnDOT Uncontaminated Concrete Management Record" form for each concrete element to remain in-place.
   c. Attach the Contractor-prepared survey sheets and any photographs collected by the Contractor or Department to the form.
   d. Submit the documentation to:
      (1) BridgeForms.DOT@state.mn.us, or,
      (2) Bridge Office – Attn: Regional Bridge Construction Engineer (MS610)
   e The Bridge Office will upload the form to eDOCS for permanent record.

B. Bridge Concrete First Discovered During Construction

If, during the course of bridge construction or removal, additional bridge concrete other than that noted in the in the Plan or Special Provisions is encountered, notify the Engineer. The Engineer is to follow the guidance provided on MnDOT's Waste Concrete Management website (http://www.dot.state.mn.us/environment/regulatedmaterials/concrete.html) for proper management of this concrete. Contact the MnDOT Office of Environmental Stewardship (http://www.dot.state.mn.us/environment/regulatedmaterials/contacts.html), with any questions.

C. Method of Measurement and Basis of Payment

No measurement will be made. Payment for this work is to be included in Pay Item No. 2442.501, "REMOVE EXISTING BRIDGE".

MnDOT Uncontaminated Concrete Management Record

Bridge: Designer to populate

Project: Designer to populate

Location: Designer to populate

Description of structure(s) and why left in-place:

Designer to populate

Volume or linear feet of structure(s) left in-place:

Designer to populate

GPS coordinates or stationing and offset of where structure(s) was left in-place (as shown in attached as-built plan or red-lined plan sheets"):

The concrete structure(s) is considered uncontaminated because (check all that apply):

☐ The structure(s) did not exhibit any chemical staining and was not coated with lead based paint or a coating suspected of containing asbestos.

☐ Contaminated soil was not observed adjacent to the structure(s).

☐ Sampling was conduct and did not indicate presence of lead based paint or a coating suspected of containing asbestos.

Reason structure(s) was left in-place: *Designer to populate.*

☐ Engineering

☐ Environmental

☐ Safety

Review appendices A and B of the Management of Concrete Pavement, Structures and Debris on MnDOT Projects document to determine if the concrete structure was left in place for engineering, environmental or safety reasons. Consult OES for assistance.

This form was completed by: ____________________

Date: ____________________

Submit the documentation to:

(1) BridgeForms.DOT@state.mn.us, or,
(2) Bridge Office – Attn: Regional Bridge Construction Engineer (MS610)

SB- (2451) STRUCTURE EXCAVATIONS AND BACKFILLS

The provisions of 2451, "Structure Excavations and Backfills," are supplemented as follows:

SB2018-2451.1

Use where excavation is lump sum. Not to be used where rock excavation may be encountered.

CREATED 8/1/1994

REVISED 6/2/2015 (4)

SB- Structure Excavation

Excavate, sheet, shore and/or protect, prepare foundation, and place backfill necessary for construction of Bridge(s) No____________, which are not specifically included in the grading portion of the Contract. Dispose of surplus material.

Do not measure the excavated or backfill material. All work performed as specified above will be considered to be included in a single lump sum for which payment is made under Item No. 2401.601, "STRUCTURE EXCAVATION".

For purposes of partial payments, the portion of the lump sum Structure Excavation at each substructure unit will be defined as follows:

UAR	Bridge ____________	Each Abutment_________%
		Each Pier _______%
	Bridge ____________	Each Abutment _______%
		Each Pier _______%

Use for all spread footings not on rock where plan calls for a subcut.
Aggregate backfill is required in the subcut.
Dewatering is not anticipated at locations where this special provision is used.

1 - DESIGNER NOTE: This pay item should be in bridge plan with a quantity:

ITEM NO.	*ITEM*	*UNIT*
2451.507	*Aggregate Backfill (CV)*	*Cubic Yard*

CREATED 8/28/1986
REVISED 9/1/2017 (2)

SB- Spread Footing Foundation Preparation with Aggregate Backfill

Perform all labor and furnish all materials required to excavate and place the aggregate backfill material under spread footings.

After excavation to the bottom of footing elevation for each unit shown in the plans, excavate (subcut) additional material until acceptable material, as determined by the Engineer, is encountered. Compact the upper 6 inches of this material to not less than 100 percent of Maximum Density in accordance with 2105.1.A.5, "Maximum Density," before placing the backfill material.

Use aggregate backfill material in accordance with 3l49.2.E, "Aggregate Backfill". Compact aggregate backfill to 100 percent of Maximum Density in accordance with 2105.1.A.5, "Maximum Density". Perform sampling and testing on every 3 ft depth of backfill at each footing location.

The Department reserves the right to eliminate all or part of the aggregate backfill. Where aggregate backfill is eliminated, no excavation below the bottom of footing will be required. However, compact the upper 6 inches of the material beneath the footing to not less than 100% of Maximum Density in accordance with 2105.1.A.5, "Maximum Density".

Excavation below the bottom of footing elevation for each unit shown in the plans is incidental to placing the backfill material. Performing the compaction will be considered an incidental expense for which no direct compensation will be made. Where groundwater is encountered that inhibits compaction of backfill prior to concrete placement, dewatering will be considered Extra Work as provided for under 1403, "Notification for Contract Revisions".

Use for all spread footings where the plan does not specify aggregate backfill (with subcut) except:
- Where spread footings are on rock OR
- Where aggregate material may trap and pocket water (Aggregate Bedding is then to be used to facilitate dewatering and a different provision is required).

CREATED 2/16/1990
REVISED 9/1/2017 (1)

SB- Spread Footing Foundation Preparation

Perform foundation excavation in accordance with 2451, "Structure Excavations and Backfills," and the following:

After the Contractor has excavated to the planned footing elevations for each unit shown in the plans, the Engineer will determine if aggregate backfill is necessary based on the soil suitability.

If the Engineer determines that aggregate backfill is not necessary, compact the upper 6 in of the excavation to not less than 100 percent of Maximum Density in accordance with 2105.1.A.5, "Maximum Density".

If the Engineer determines that aggregate backfill is necessary, the Engineer will order additional excavation until acceptable material, as determined by the Engineer, is encountered. Compact the upper 6 in of this material to not less than 100 percent of Maximum Density in accordance with 2105.1.A.5, "Maximum Density," before placing the backfill material.

Use aggregate backfill material in accordance with 3149.2.E, "Aggregate Backfill".

Compact aggregate backfill to 100 percent of Maximum Density in accordance with 2105.1.A.5, "Maximum Density". Perform sampling and testing on every 3 ft depth of backfill at each footing location.

When the proposal does not contain an estimated quantity or a lump sum item for aggregate backfill, any aggregate backfill required for the construction of the footings shall be considered to be Extra Work as provided for under 1403, "Notification for Contract Revisions". Excavation below the bottom of footing elevation for each unit shown in the plans is incidental to placing the backfill material.

Performing the compaction will be considered an incidental expense for which no direct compensation will be made. Where groundwater is encountered that inhibits compaction of backfill prior to concrete placement, dewatering will be considered extra work.

Use when indicated on the Foundation and other Recommendations form. Use when seals are NOT shown in the plan.

CREATED 4/18/1994

REVISED 6/2/2015 (3)

SB- Foundation Preparation (Pier Nos. ____________)

Furnish all material for and perform all work involved in the preparation of the foundation for each of the piers designated. Unless otherwise provided by separate Contract items, each item shall include, but not be limited to temporary work to access pier locations, earth excavation and all other work such as coffer dam construction, concrete seals, pumping, removal of the cofferdam and other temporary works, backfilling the excavation, and disposal of surplus excavated materials as may be necessary. If requested, partial payment for Foundation Preparation items may be made based on the Engineer's estimate of percent of work complete.

UAR

(Rock excavation) (Piling) will be paid for separately.

All costs for the work specified above for each of the piers will be paid for separately as Item No. 2401.601 "FOUNDATION PREPARATION PIER _______", at the contract lump sum price per each pier.

SB- Foundation Preparation (Pier Nos. ____________)

Furnish all material for and perform all work, except for construction of the concrete seals, involved in the preparation of the foundation for each of the piers designated. Unless otherwise provided by separate Contract items, each item shall include, but not be limited to temporary work to access pier locations, earth excavation and all other work such as cofferdam construction, pumping, removal of the cofferdam and other temporary works, backfilling the excavation, and disposal of surplus excavated materials as may be necessary. If requested, partial payment for Foundation Preparation items may be made based on the Engineer's estimate of percent of work complete.

UAR

(Rock excavation) (Piling) will be paid for separately.

UAR

Due to the concern for potential scour at the pier footings, elimination of the concrete seals is not permitted.

After seal courses are poured and before other concreting operations commence, make provisions for flooding of the cofferdams when the water surface elevation exceeds Elev. ________ in order to maintain stability against uplift. Should it become necessary to flood the cofferdams, take every precaution to prevent damage to temporary and permanent construction.

All costs for the work specified above for each of the piers will be paid for separately as Item No. 2401.601 "FOUNDATION PREPARATION PIER _______", at the contract lump sum price per each pier.

Payment for furnishing and placing of the concrete seals is under Item 2401.507 "STRUCTURAL CONCRETE (1X62)" by the yd^{3}.

Use when the Engineer would require Extra Work to provide exploratory drilling or soundings.

CREATED 2/15/1978

REVISED 6/2/2015 (1)

SB- Foundation Exploration

After the Contractor has excavated to the planned footing elevations for ________________________________, the Engineer may perform or require that the Contractor perform certain exploratory operations such as drilling or rod sounding.

After the Contractor has excavated to and exposed ledge rock or to the planned footing elevation, whichever is higher, for ________________________________, the Engineer may perform or require that the Contractor perform certain exploratory operations such as drilling or rod sounding.

The purpose of such exploratory operations will be to assist the Engineer in ascertaining the nature and extent of the underlying materials. The Engineer will then determine if it will be necessary to change the planned size, type, and elevation of the footings.

Any exploratory work that the Engineer orders the Contractor to perform will be paid for as Extra Work per 1403, "Notification for Contract Revisions". No compensation will be made for any delays resulting from the exploration operations or for delays caused by plan changes made because of the results of the exploration, except that extension of contract time may be given in accordance with 1806, "Determination and Extension of Contract Time".

SB2018-2451.7
Use when pile bent piers have concrete encasement walls.
CREATED 11/9/2001
REVISED 6/2/2015 (3)

SB- Foundation Preparation for Pile Bent Pier(s) – Bridge No(s). ___________

1 - DESIGNER NOTE: In the following paragraph, fill in the blank. Elevation to be particularized by the Regional Construction Engineer.

Furnish all material for and perform all work involved in the preparation of the foundation for construction of the pile bent substructures and their encasement walls. The item shall include, but not be limited to, earth excavation and all other work such as pumping, constructing dikes, backfilling the excavation, and disposing of surplus excavated materials as may be necessary to build pier encasement walls in dry conditions above elevation __________. It is anticipated the Contractor will need to provide watertight forms.

Piling will be paid for separately.

All costs for the work specified above for all of the pile bent piers will be paid for as Item No. 2401.601, "FOUNDATION PREP PILE BENT PIERS", at the contract lump sum price.

SB- (2452) PILING

The provisions of 2452, "Piling," are supplemented as follows:

SB2018-2452.1
Use when recommended by the Regional Engineer.
CREATED 6/20/2005
REVISED 2/11/2014 (4)

SB- Commercial Drive Fit Splices for CIP Piling

UAR

Commercial drive fit splices will NOT be permitted (on this project) (on Bridge ____________).

Use on jobs requiring piling to be paid for as furnish and install and when recommended by the Regional Construction Engineer.

CREATED 9/8/2015
REVISED 9/1/2017 (1)

SB- Piling Furnished and Installed

Modify all references to "piling delivered" and "piling driven" under 2452.3, "Construction Requirements," 2452.4," Method of Measurement," and 2452.5, "Basis of Payment," to read "Piling".

Add the following to the end of 2452.3.E.1, "General":

When the conditions of this section have been met for the **test pile,** the resulting pile cut-off becomes the property of the Contractor.

Delete the following sections 2452.3.G, "Disposal of Pile Cut-Offs," 2452.4.C, "Piling Driven," and 2452.5.C, "Piling Driven".

Replace 2452.4.B, "Piling Delivered," with the following:

The Engineer will measure piling for payment by the length of acceptable piling below cut-off.

Replace 2452.5.B, "Piling Delivered," with the following:

All treated timber piles, untreated timber piles, steel pipe piles, steel H-piles, and concrete piles driven will be paid for by the linear foot. Payment will be made only for the actual number of linear feet of acceptable piling complete in place as needed for design or as directed by the Engineer.

Splices will be compensated at the rate of six (6) times the contract unit price for piling furnished and installed, if the splice was made and only after piling is driven to estimated test pile length for that structure and bearing is not achieved. Maximum of one splice will be paid per pile. No additional payment will be made for splices made solely for the Contractor's convenience.

If the quantity of driven piling is less than the estimated plan quantity, the Department will pay 50% of the cost to re-stock unused piling if the Contractor elects to re-stock piling and provides a paid invoice showing the re-stocking fee not to exceed the difference of estimated pile length in the plan and actual driven length. Payment for the Department's portion of the restocking fee will be made as a backsheet item under "Piling, Restock" superseding any claims due from 1907, "Payment for Surplus Material".

The following costs are included in the cost of the piling:

- predrilling pilot holes;
- pile sleeves;
- maintaining open holes during pile driving;
- broken, bent, damaged, or misplaced piles;
- concrete filling or concrete encasement;
- misplaced pile or corrective location or alignment measures;
- modifying or replacing pile driving equipment;
- redriving piles which have heave more than ¼";
- piles which are damaged during handling or if the Engineer determines that the damage was caused by the Contractor's carelessness or negligence while driving;
- piles which were not driven in accordance with these specifications;
- piles driven with the tops lower than the cut-off elevation;
- spudding or jetting of piles;
- cutting and trimming, and coating steel H-pile and steel shell pile;

- providing and attaching driving shoes for pipe piles;
- all labor, equipment, and necessary incidentals; and
- disposal of all pile cut-offs.

A. Method of Measurement

The Engineer will measure piling by the length of acceptable piling below cut-off elevation.

No additional payment will be made if the Contractor elects to furnish and drive thicker wall pipe piles than specified.

The cost of mobilization and demobilization for pile driving operations is included in the cost of mobilization and demobilization in accordance with 2452.5, "Basis of Payment".

The cost to control sediment in water from jetting operations is included in the cost of piling.

B. Basis of Payment

1 - DESIGNER NOTE: select ONE of the two following paragraphs unless both are required by the Regional Construction Engineer.

2 - DESIGNER NOTE: Select ONE of the following Line Items unless more are required by the Regional Construction Engineer. 10", 12", 14", 16", 18", 20", 24" 30", 42".

Payment for Item No. 2452.603 "C-I-P CONCRETE PILING _______" will be made at the Contract unit price per linear foot and shall be compensation in full for furnishing and installing the Piling complete and inplace as described above, including all incidentals thereto.

3 - DESIGNER NOTE: Select ONE of the following Line Items unless more are required by the Regional Construction Engineer. 10", 12", 14", 16".

Payment for Item No. 2452.603 "STEEL H-PILING ________" will be made at the Contract unit price per linear foot and shall be compensation in full for furnishing and installing the Piling complete and inplace as described above, including all incidentals thereto.

SB2018-2452.3

Use on jobs requiring piling to be coated. The Spec Book chapter 2452.3.J includes sections J.1 for "Painting Piles" and J.2 for "Galvanized Piles". Designer will be told by the Regional Construction Engineer or this info will typically be mentioned in the Foundation Rec. of what coating will be required. Include plan note on pier detail sheet.

CREATED 10/5/2017
REVISED 10/5/2017

SB- Pile Coating

1 - DESIGNER NOTE: Include when exposed piles will be galvanized.

The provisions of 2452.3.J, "Coating Steel H Piles and Steel Pile Shells," are modified as follows:

Delete 2452.3.J.1, "Painted Piles."

2 - DESIGNER NOTE: Include when exposed piles will be painted.

The provisions of 2452.3.J, "Coating Steel H Piles and Steel Pile Shells," are modified as follows:

Delete 2452.3.J.2, "Galvanized Piles."

SB2018-2453

Use where drilled shaft foundations are required.

CREATED 9/13/1999

REVISED 9/1/2017 (7)

SB- (2453) DRILLED SHAFT CONSTRUCTION

A. Scope of Work

Furnish all labor, equipment, material and other services necessary for construction of ______ inch and ______ inch diameter reinforced concrete drilled shafts in earth, rock, and water to serve as foundation supports for the piers and abutments as shown in the plans for Bridge No(s). ________ and ________. Perform work in accordance with the applicable provisions of 2401, "Concrete Bridge Construction," 2451, "Structure Excavations and Backfills," the plans, and these special provisions.

The work includes, but is not limited to:

- Obtaining all required Federal, State and local permits
- Exploratory borings as required
- Conformance with environmental regulations
- Dewatering of site as necessary for drilled shaft construction
- Earth and rock excavation for shafts
- Removal of obstructions
- Furnishing and placing temporary or permanent casing
- Disposal of drilling fluids, excavated material, waste concrete and reinforcement
- Roughening of the sides of the rock portion of the shafts
- Furnishing and placing reinforcement and concrete
- Correction to acceptable tolerances

B. Geotechnical Information

1. Geotechnical Data

UAR

Geotechnical borings were taken at this site for design purposes. (copies of the boring logs are included in this document) Cored samples of the rock formations are stored at the Material & Research Lab, 1400 Gervais Ave., Maplewood, MN. It is the responsibility of the drilled shaft contractor to inspect this geotechnical data and core samples, and to visit the job site prior to submitting a proposal for this work. Arrangements for viewing the rock core can be made through the Foundations Engineering Unit, phone (651) 366-5598.

2. Site Geology

(Insert relevant geologic information from Foundation Engineer's report or contact the Foundations Unit.)

C. Definitions

1. Rock

Rock is defined as ... (use geologic definition – rock definition should be site-specific for the project. See Foundations Report or contact Foundations Unit.)

The top of rock will be at the contact of the overlying unconsolidated materials and the underlying bedrock as determined by the Engineer. Rock which has weathered to the degree to be classified as "residual soil" (see MnDOT Geotechnical and Pavement Manual) will not be considered to be bedrock, and top of rock will then be the contact between "residual soil" and weathered bedrock.

Excavation in bedrock will likely require the use of special rock augers, core barrels, air hammers and combination thereof, and/or other methods commonly used for shaft construction in rock. All soft seams, rock fragments, and voids encountered after commencing drilling of rock in a shaft will be included in the quantity of rock excavation.

2. Earth

Earth is defined as all material between the top of the rock (as defined above) and the bottom of footing. It may also contain highly weathered rock ("residual soil").

3 Obstructions

An obstruction will be classified by the Engineer as material and/or objects that cannot be efficiently removed from a shaft during normal excavation operations with the drilling equipment adequate to excavate earth and rock materials found on the project, and which necessitate the use of other methods and/or equipment to remove. Such obstructions may be rock fragments, boulders, waterlogged timbers, or any material, natural or man-made which requires use of special tools or procedures not otherwise required for excavation of rock or earth materials on the project.

For this project the following are *not* classified as obstructions and, if present, must be removed by the Contractor with no additional compensation.

- Material present above rock elevation which is (1) required to be removed by the Contract; or (2) known to the Contractor or readily visible upon site investigation and which can be removed by conventional surface excavation methods.
- Any material below the elevation of the top of the rock.
- Boulders that are one-fourth, or less, of the shaft diameter.

D. Qualifications of Drilled Shaft Contractor

The drilled shaft contractor must have a minimum of five years' experience in drilled shaft installations and have successfully completed construction of shafts with similar site and subsurface conditions, shaft diameter and shaft depths.

The supervisor in charge of this work must have a minimum of three years of experience in the construction of similar types of drilled shafts.

E. Submittals

Submit the following information to the Engineer at the preconstruction conference:

1. Proof that the above-noted drilled shaft contractor qualifications have been met, including a list of similar projects completed within the last three years with names and phone numbers of owner's representatives who can verify the contractor's participation in those projects.

2. Name and experience record of the supervisor in charge of the drilled shaft construction.

3. A preliminary installation plan that contains, but is not limited to, the following data:

- A description of the proposed drilling machine and down-hole tools to be used for the drilled shaft construction
- Procedures for exploratory borings, if required
- Means of access to the drilling site
- Proposed construction methods; include procedures for exploration, excavation, cleaning, inspection, placement of temporary and permanent casings, removal of temporary casings, placement of reinforcement, placement of concrete, filing of voids between permanent casing and earth or rock, and containment and disposal of excavated materials and drilling fluids
- A description of spacers and supports to be used for the reinforcement
- Proposed schedule and sequence of construction operations
- A written contingency plan for containment and clean-up of any spill or discharge of material which might contaminate public waters

4 Status of permits obtained or necessary for the work.

The Engineer will review the plan within 14 calendar days of submittal and provide written instructions if changes are necessary to meet Contract requirements. Submit a final drilling plan which meets all Contract requirements. If revisions in the plan are required to accommodate site conditions, or for other reasons, obtain the Engineer's approval prior to implementation.

The Engineer's approval of the installation plan does not relieve the Contractor of full responsibility for the safe and successful completion of construction of the drilled shafts.

F. Methods and Equipment

1. Drilling and Excavation Equipment

Drilling equipment used to perform the drilled shaft work on this project must have the capability of providing sufficient torque and down-thrust for drilling and excavating shafts in the geologic strata described herein that is 20% greater in diameter than the largest shaft diameter and at least 6.5 feet below the deepest shaft required for this project.

Ensure excavation equipment is capable of excavating the drilled shaft to the dimensions required in the plan with a level bottom. The cutting edges of the excavation tools must be normal to the vertical axis of the equipment within a tolerance of ± 0.42 inches per foot of shaft diameter.

2. Concrete Placement Equipment

Tremie – Use rigid tremie pipe to place concrete underwater that is watertight and of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. The tremie must not contain aluminum parts that will have contact with the concrete. The tremie inside diameter must not be less than 10 inches unless a smaller inside diameter is approved by the Engineer. The inside and outside surfaces of the tremie must be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The discharge end of the tremie must be constructed to permit the free radial flow of concrete. Wall thickness of the tremie must be adequate to prevent crimping or sharp bends that may restrict concrete placement. Use a plug, valve, or bottom plate to separate the concrete from the water until the concrete is flowing through the orifice. Plugs, if left in the shaft concrete, must be of a material approved by the Engineer.

G. Data Reports

Complete the initial data report supplied in this special provision for *each* drilled shaft constructed. Give the report to the Engineer within 24 hours after concreting has been completed for that shaft. Upon the Engineer's completion and acceptance of all shafts, give a final report for each shaft – in the same standard format – containing any additional data to the Engineer. Include the following data in the final report:

- Date and time excavation started
- Shaft location and identification
- Shaft diameter per plans and as constructed
- River pool elevation if appropriate
- Description of soil and rock types encountered while drilling
- Variation of shaft as constructed from plumb and from its plan location
- Location and extent of rock cavities
- Comments on water condition within a shaft, if applicable; i.e. flow volume, hydrostatic head, elevation encountered
- Date and time excavation completed and method of cleaning bottom if applicable
- Date concrete is placed, placement method(s) and Mix No(s)
- Diameter and depth of permanent casings used
- Other comments as deemed necessary for the work including any non-standard methods of construction which may have been required and which affected the shaft configuration and/or construction
- Details of any obstructions encountered and removed including removal methods

H. Materials

1. Permanent casings:

Must conform to the requirements of ASTM A252 or A36, welded and seamless, and may be of unit or sectional construction with welded seams. The casings must be of ample strength to withstand handling stresses, internal pressure of fluid concrete, external pressure of surrounding earth and water, and be watertight. Minimum wall thickness of permanent casing must be $^3/_8$ inch. The outside diameter of the casings must not be less than __________ inches. Casings must be non-corrugated and the surface smooth, clean and free from hardened concrete.

Used material in like-new condition with no section loss may be used for the permanent casings with approval of the Engineer.

2. Temporary casings:

Must conform to the requirements of permanent casings, except that the diameters shall be as required for the particular usage.

3. Concrete:

1 - DESIGNER NOTE: If top of drilled shaft is completely below the frost line use 1X62 mix.

Must conform to the requirements of Mix No. 3X62 unless otherwise specified in the plans. Increase slump to 7-8 inches using MnDOT approved super plasticizers.

4. **Slurry:**

Mineral slurries may be made with sodium bentonite or attapulgite mixed with fresh water and must meet the requirements given in the following table:

MINERAL SLURRY			
Acceptable Range of Values			
Property (Units)	**At Time of Slurry Introduction**	**In Hole at Time of Concreting**	**Test Method**
Density lb/ft^3	64.3-69.1	64.3-75.0	Density Balance
Viscosity seconds/quart	28-45	28-45	Marsh Cone
pH	8-11	8-11	pH Paper or Meter

I. Acceptable Construction Methods

1. Casing or Wet Construction Method

The casing method may be used in earth and rock strata to prevent hole caving and/or excessive deformation of the hole.

Advance the casing through the earth by twisting, driving, or vibrating before cleaning it out. For rock strata, place the casing in a predrilled hole. No extra compensation will be allowed for concrete required to fill an oversized casing, or an oversized excavation required to place the casing.

a. Temporary Casing - All casing is considered temporary (unless the drilled shaft contractor chooses to provide a permanent casing at the top of the shafts as a form). Remove any temporary casing within the excavated shaft during concrete placement operations while the concrete is in a fluid state. If the Contractor elects to remove a casing and substitute a longer and/or larger diameter casing through caving soils, the excavation must be stabilized, as approved by the Engineer, before the new casing is installed.

Temporary casings which become bound or fouled during shaft construction and cannot be practically removed constitute a defect in the drilled shaft. The Contractor is responsible for improving such defective shafts to the satisfaction of the Engineer. Such improvement may consist of, but is not limited to, removing the shaft concrete and extending the shaft deeper to compensate for loss of frictional capacity in the cased zone. The Contractor will perform all corrective measures to the satisfaction of the Engineer. No additional compensation and extension of Contract time will be made for corrective measures, or for casing left in place.

b. Permanent Casing - Permanent steel casing may be used at the Contractor’s option to form the top of the shaft within the earth strata only. The casing may be set in place prior to start of shaft drilling or a temporary casing may be used for drilling and excavation, with the permanent casing placed prior to placement of reinforcement and concrete. Permanent casing may be larger than minimum shaft diameter to allow withdrawal of the temporary casing. Cut off the permanent casing at the top of finished shaft elevation, as given in the plans before or after concrete and reinforcement placement, at the Contractor’s option.

When temporary casings are deemed necessary in conjunction with permanent casings, the drilled shaft contractor must maintain alignment of both casings on the axis of the shaft.

2. Slurry Displacement Construction Method

The slurry displacement method may only be used in earth strata. All slurry must be removed from the excavation prior to beginning rock excavation unless written approval has been obtained from the Engineer. Employ mineral slurries in the drilling process unless other drilling fluids are approved by the Engineer.

During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole at a level not less than 4 ft above the highest expected piezometric pressure head along the depth of the shaft. In the event of a sudden significant loss of slurry such that the slurry level cannot practically be maintained by adding slurry to the hole, or the slurry construction method fails for any other reason, delay construction until an alternate construction procedure has been approved by the Engineer.

Ensure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft.

J. Construction Requirements

1. General

Do not begin construction of drilled shafts until the installation plan has been approved by the Engineer.

Do not place reinforcement or concrete in the drilled shafts without approval of the Engineer.

2. Protection of Existing Structures

If drilled shaft excavation is required within close proximity to inplace structures or utilities, take all reasonable precautions to prevent damage to those utilities and structures. Adverse effects of shaft drilling operations may include loss of ground support, lowering of water table, or vibrations detrimental to utilities and structures. If not otherwise provided in the plans and/or special provisions, the Contractor is solely responsible for evaluating the need for, design of, and installation of all reasonable precautionary features to prevent damage. These measures include, but are not limited to, selecting construction methods and procedures that will prevent damage and monitoring and controlling the vibrations from construction activities. Use vibration monitoring equipment capable of detecting velocities of 0.1 inch/second or less.

3. Excavation of Shafts

Shaft diameter(s) given are the minimum required for this project. The drilled shaft contractor may increase diameters to conform to his equipment or to expedite drilling operations, but no additional compensation will be paid unless the increased diameter is ordered by the Engineer.

2 - DESIGNER NOTE: For the following paragraph, use for shafts in rock designed for side friction.

The permanent steel casing may be set in place prior to start of shaft drilling or a temporary casing may be used for drilling and excavation, with the permanent casing placed prior to placement of reinforcement and concrete. The base of either casing must be in full contact with rock around its perimeter. In order to accomplish this, precore a casing socket into the rock or use the casing as a core barrel to penetrate the rock.

If drilling and excavation operations are performed with permanent casing in place, take care to prevent damage such as dents to the casing.

Excavate shafts occurring in strata subject to caving only after adjacent shafts are filled with concrete and the concrete has reached a minimum strength of 1450 psi.

4. Cleaning and Inspection

Remove loose material from drilled shafts prior to placement of reinforcement. After the shafts have been cleaned, the Engineer will inspect the shafts for conformance to plan dimensions and construction tolerances. If permanent casing is damaged and unacceptable for inclusion in the finished shaft, the casing must be replaced at the Contractor's expense. If a portion of a shaft is underwater, demonstrate that the shaft is clean to the satisfaction of the Engineer. This includes inspection by a diver at no cost to the Department if considered necessary by the Engineer. Dewatering of the drilled shafts for cleaning, inspection and placement of reinforcement and concrete is not required. If the drilled shaft contractor chooses to dewater the shafts for convenience of construction, this work will be done at the contractor's expense.

5. Construction Tolerances

Tops of the finished shafts must be at the elevations given in the plans with a tolerance of plus ½ inch or minus 2 inches. The base elevations given in the plans are estimates only and may be revised by the Engineer.

Do not let rock projections extend inside the plan diameter of the shaft by more than 2 inches.

The maximum permissible variation of the center axis at the top of any finished shaft is 3 inches from its plan location. No finished shaft may be out of plumb by more than 2.0% of its depth. If the center axis of the rock portion of any shaft varies by more than 3 inches from its plan location, ream or re-drill the holes as required to bring them into the proper alignment. In the event that the above-noted tolerances are exceeded, additional reinforcing steel must be added at the direction of the Engineer. All remedial work and materials required to restore or reconstruct a shaft for final acceptance by the Engineer must be provided at no additional cost to the department.

6. Reinforcement

Completely assemble the shaft reinforcement cage and place as a unit in accordance with the installation plan. Do not weld reinforcement.

When lifting the cage for placement in the shaft, provide sufficient pick points to prevent bending of the cage that will cause deformation of the reinforcement bars. Damaged bars must be replaced at the Contractor's expense.

Laterally support the reinforcement cage at the top during placement of the concrete. The support system must be concentric to prevent racking and displacement of the cage. Provide approved spacers at intervals not exceeding 10 ft along the cage to ensure concentric positioning for the entire depth of the cage. Provide a minimum of three perimeter spacers at each spacing interval. Add additional reinforcement to stiffen the cage at the Contractor's option and expense. Extension of the top of the cage above the elevation of the top of each finished shaft must be no less than that given in the plans.

If after placement of the reinforcement the Engineer determines that the condition of the shaft is unsuitable or if concrete placement does not immediately follow the reinforcing steel placement, the Engineer may order the cage removed from the shaft so that the integrity of the excavation, including accumulation of loose material in the bottom of the shaft and the condition of the sides of the shaft, can be determined by inspection. If the reinforcement cage moves up or down from its original position by more than 6 inches, the Engineer may consider the work to be defective and require both reinforcement and concrete to be removed.

7. Concrete

Within 24 hours after placement of the reinforcement, place concrete in the shaft in accordance with the applicable requirements of these special provisions. The minimum placing rate for concrete in the shafts is 40 yd^3 per hour.

Place concrete in water or slurry-filled shafts with a tremie or by pumping. Do not begin concrete placement until the tremie or pump line is placed to within one tremie or line diameter of the shaft base. Remove plugs if not specifically approved to remain in the shaft. Do not raise the discharge end until it becomes immersed at least 5 ft in the concrete. Immersion must remain at a minimum of 5 ft at all times after starting the flow of concrete until the shaft has been filled. If, at any time during concrete placement in water, the discharge end is raised to the top of the fluid concrete and concrete is discharged above the rising concrete level, the Engineer may consider the shaft defective and require removal of both reinforcement and concrete. Maintain a positive pressure differential in the tremie or pump line to prevent water intrusion into the concrete.

Place concrete continuously to the top of the shaft once placement has begun. Continue concrete placement until good quality concrete is evident at the top of the shaft. Vibrate the top 5 ft of concrete to assure compaction at the top of the shaft.

Remove concrete within 6 inches of the top of the shaft and water diluted concrete remaining to the depth ordered by the Engineer and wasted. Only concrete that meets specification requirements must remain as part of the finished shaft.

Place concrete in a dry shaft either by free-fall, by a tremie, or by a concrete pump. Free-fall placement is only permitted for dry construction where the depth of water does not exceed 3 inches immediately prior to commencement of the concrete pour. Let concrete fall directly to the base without contacting the rebar cage or the shaft sidewall. Use a hopper and/or dropchute to direct the concrete. If concrete placement causes the shaft sidewall to cave or slough, or if the concrete strikes the reinforcement cage or sidewall, the drilled shaft contractor must reduce the height of free-fall or reduce the rate of concrete flow into the excavation. If placement cannot be satisfactorily accomplished by free-fall, the Contractor must place the remaining concrete with a tremie or pump.

Before temporary casing is withdrawn, ensure the level of fresh concrete in the casing is at least 3 ft above the bottom of the casing. As the casing is withdrawn, take care to maintain an adequate level of concrete within the casing so that water behind the casing is displaced upward without contaminating or displacing the shaft concrete.

Following concrete placement, thoroughly clean the projecting reinforcing steel to remove accumulations of splashed mortar. Complete this work before the concrete takes its initial set. Take care when cleaning the reinforcing steel to prevent damage to the epoxy coating or breakage of the concrete-steel bond.

K. Method of Measurement

1. Excavation for Drilled Shafts (Earth) will be measured by length in ft along the axis of each shaft from the bottom of footing to the elevation of the top of the rock or tip of the shaft. Portions in water above the ground surface are not included as excavation is not required.

2. Excavation for Drilled Shaft (Rock) will be measured by length in ft along the axis of the shaft from the top of rock to the final tip of the shaft.

3. Permanent Casing will be measured by length in ft along the axis of the shaft from top of installed casing to the final approved elevation of the bottom of the casing.

4. Shaft reinforcement, including spirals, will be measured by weight in pounds for the amount of reinforcement bars required for constructing the drilled shafts excluding reinforcement placed to facilitate construction. Additional splices due to shaft lengths exceeding plan lengths will be measured at 40 bar diameters for each splice required.

5. Shaft concrete will be measured by volume in yd^3 for the amount of concrete required for constructing the drilled shafts based on nominal diameters and approved lengths. Concrete placed to facilitate construction or because of over-excavation will not be measured for payment.

6. Obstruction removal will be measured by volume in yd^3 based on nominal shaft diameter and elevation of initial contact with the obstruction to the elevation where the shaft is free from the obstruction and normal drilling operations are resumed.

7. Exploratory boring will be measured by length in ft from the ground surface to the tip of the boring.

L. Basis of Payment

Payment for constructing drilled shafts will be made under separate pay items for 1) shaft excavation in rock and disposal of waste materials, 2) furnishing and placing permanent casing, 3) furnishing and placing reinforcement bars, and 4) furnishing and placing concrete as follows:

UAR

1. Payment for Item No. 2453.603 "(__________) " DIA DRILLED SHAFTS (EARTH)", will be made at the Contract price per ft and shall be compensation in full for all costs of drilling, excavating, cleaning, and inspecting the shafts in earth as described herein including temporary casings.

UAR

2. Payment for Item No. 2453.603 "(__________) " DIA DRILLED SHAFTS (ROCK)", will be made at the Contract price per ft and shall be compensation in full for all costs of drilling, excavating, cleaning, and inspecting the shafts in rock as described herein, including temporary casings.

UAR

3. Payment for Item No. 2453.603 "(__________) " DIA CASED SHAFTS", will be made at the Contract price per ft of shaft depth and shall be compensation in full for furnishing and installing permanent casing as described herein.

UAR

4. Payment for Item No. 2401.608 "SHAFT REINFORCEMENT", will be made at the Contract price per pound and shall be compensation in full for all costs of furnishing and placing vertical reinforcement bars for the drilled shafts.

UAR

5. Payment for Item No. 2401.508 "SPIRAL REINFORCEMENT" will be made at the Contract price per pound and shall be compensation in full for all costs of furnishing and placing spiral reinforcement for the drilled shafts.

UAR

6. Payment for Item No. 2401.507 "STRUCTURAL CONCRETE (________)", will be made at the Contract price per yd^3 and shall be compensation in full for all costs of furnishing and placing concrete for the drilled shafts.

UAR

7. Payment for Item No. 2453.607 "OBSTRUCTION REMOVAL", will be made at the Contract price per yd^3 and shall be compensation in full for all additional costs of excavation and disposal of materials or objects classified by the Engineer as obstructions.

UAR

8. Payment for item 2453.603 "EXPLORATORY BORINGS", will be made at the contract price per ft for each boring authorized by the Engineer and shall be compensation in full for all costs of drilling, sampling, casing, filling and restoration and documenting.

No additional compensation will be paid for increased dimensions of shafts due to Contractor's method of construction, oversized casing, caving of earth or rock, or corrective action necessitated to meet Contract requirements.

MINNESOTA DEPARTMENT OF TRANSPORTATION

DRILLED SHAFT REPORT

Bridge No. ____________ S.P. No. ______________________ Pier No. ________ Shaft No. _______

Prime Contractor ____

Drilled Shaft Contractor ______________________________ MnDOT Inspector ____________________

GENERAL INFORMATION

Date Shaft Construction Started ____________________

Date Shaft Construction Completed ________________

River Pool Elev. ___________ Water Temp. ________

Construction Method: Wet ________ Dry __________

OBSTRUCTIONS

Description of Obstructions Encountered in Earth Shaft

____

____

Removal Methods and Tools Used ________________

____

____

SHAFT INFORMATION

Permanent Casing Dia.: Plan________________ in

As-built ______________ in

Date Permanent Casing Set ______________________

Bottom Elev. of Permanent Casing _________________

Top Elev. of Finished Shaft: Plan ________________

As-built _________________

Elev. of Initial Contact of Rock __________________

Bottom Elev. of Drilled Shaft ____________________

Rock Shaft Dia. Plan ______in, As-built in_______

ROCK SHAFT CLEANOUT PROCEDURE

Method ______________________________________

____

Estimated Thickness of Sediment at Bottom of Shaft at Time of Concreting ______________________________

CONCRETE PLACEMENT OBSERVATIONS

Concrete Mix No. ______________________________

Placement Date ________________________________

Ambient Temperature ___________________________

Placement Method ______________________________

Total Placement Time ____________________________

Water Elev. in Shaft at Time of Conc. Placement ________

DRILLING INFORMATION

Drill Rig Make and Mdl. ________________________

____

Drilling Tools Used: ____________________________

____

____

Excavation Tools Used: _________________________

____

____

Earth Drilling Start Date ________ , Finish Date ________

Rock Drilling Start Date ________ , Finish Date ________

Excavation Finished Date _______________________

Location and Extent of Rock Cavities or Shaft Caving:

____

____

____

____

VARIATION OF SHAFT FROM PLUMB AND PLAN LOCATIONS

Plumb ______________________________________

Lateral _____________________________________

REMARKS/COMMENTS/NOTES

____

____

____

____

____

SB2018-2471
Use on all jobs requiring 2471.
CREATED 9/15/2015
REVISED 09/05/2018 (5)

SB- (2471) STRUCTURAL METALS

SB- ***The section of 2471.3.B.3, "Submittal for Engineer's Review and Approval," is modified with the following:***

1 - DESIGNER NOTE: Select one of the two sentences depending on who is reviewing shop drawings. For almost all TH projects and federally funded projects, all shop drawings go to the MnDOT Fabrication Methods Engineer. For highly specialized projects or locally funded projects, shop drawings go to the MnDOT Fabrication Methods Engineer or Engineer of Record as arranged by the owner. For design build projects the shop drawings are approved by the contractor's consultant and no exceptions taken by MnDOT representative. Insert one of the following below:

Submit shop drawings from Fabricators directly to the MnDOT Bridge Office

MnDOT Bridge Office
Fabrication Methods Engineer
3485 Hadley Ave. North
Oakdale, MN 55128

Submit shop drawings from the Fabricator directly to ________________________

SB- ***The provisions of MnDOT 2471 are modified with the following:***

The section MnDOT 2471.3.A.1.a is replaced with the following:

1. Bridges: Bearing Assemblies, sole plates, expansion devices, shear connectors, ballast plates, diaphragms for bridges (except curved steel bridges), pile and appurtenances, drainage systems, guardrail connections, conduit systems, and protection angles;
2. Metal fabricated railings and fencing (excluding standard chain link fencing);
3. Electric Lighting, traffic signs, and signal systems;
4. Pedestrian Bridges; and
5. Other systems or components designated by the Engineer.

The section MnDOT 2471.3C second paragraph is replaced with the following:

Before the start of work, the supplier will be qualified on MnDOT's Approved Suppliers for Fabricated Structural Metals Products list as maintained by the Structural Metals Engineer at http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf, or become qualified. To become qualified, the supplier is to submit a Quality Manual (QM) to the Engineer for review and acceptance, at least 60 calendar days before beginning work. The QM is to meet the requirements of the MnDOT Supplier Qualification Standard which will be the basis for acceptance by the Engineer. Upon acceptance of the QM, a supplier is qualified and will be listed on the MnDOT Approved Suppliers for Fabricated Structural Metals Products. In addition to routine inspections, the Engineer will audit supplier with approved QM's on a biannual or annual basis or as otherwise directed by the Engineer to ensure the full implementation of the QM.

SB2018-2472
Use on all jobs requiring reinforcement.
CREATED 6/2/2015
REVISED 9/1/2017 (7)

SB- (2472) METAL REINFORCEMENT

The provisions of 2472, "Metal Reinforcement," are supplemented as follows:

SB2018-2472.1
Use on jobs with grade 75 ksi stainless steel deck and barrier reinforcement.
Use on NEW construction project to connect approach panels to back of integral/semi-integral abutment.
CREATED 6/10/2011
REVISED 5/22/2019 (9)

SB- Stainless Steel Reinforcement Bars

1 - DESIGNER NOTE: In this next paragraph define locations where the SS bars are to be incorporated. Add bridge number to section title if not all bridges on the project require this section.

Furnish and place stainless steel reinforcement bars in the concrete deck slab, barriers, *and end blocks on the abutments, etc….* Stainless steel reinforcement bars are marked with the suffix "S" in the bridge plans. (Example: A504S.)

A. Materials

The requirements of 2472.2, "Materials," are modified to include the following:

Grade and Type: The material shall conform to ASTM A955, *Deformed and Plain Stainless Steel Bars for Concrete Reinforcement*, and to one of the following Unified Numbering System (UNS) designations: S24000, S24100, S32205, S32304, S31803, S32101, or S31653.

Supply Grade 75 bars, all of the same UNS designation.

Evaluation of Corrosion Resistance: Prior to fabrication, supply test results from a qualified laboratory certifying that stainless steel reinforcement from the selected UNS designation meets the requirements of Annex A1 of ASTM A955. Corrosion performance for the selected UNS designation shall be re-demonstrated if the processing method is significantly altered. Removal of mill scale or pickling processes used for stainless steel reinforcement supplied under this contract shall be the same as those used to prepare the samples tested per Annex A1 of ASTM A955.

Chemical composition of the material shall conform to that specified in ASTM A276, Table 1, Chemical Requirements, for the given UNS designation.

Heat Treatment: Bars may be furnished in one of the heat treatment conditions listed in ASTM A955, and as needed to meet the requirements of this specification.

Finish: Supply bars that are free of dirt, mill scale, oil and debris by pickling to a bright or uniform light finish. Fabricate and bend bars using equipment that has been thoroughly cleaned or otherwise modified to prohibit contamination of the stainless steel from fragments of carbon steel or other contaminants.

Bending and Cutting: Bend bars in accordance with 2472, "Metal Reinforcement," and ASTM A955. Use fabrication equipment and tools that will not contaminate the stainless steel with black iron particles. To prevent such contamination, equipment and tools used for fabrication, including bending and cutting, shall be solely used for working with stainless steel. Do not use carbon steel tools, chains, slings, etc. when fabricating or handling stainless steel reinforcement bars. For guidance, refer to ANSI/CRSI – IPG4.1 2016 *Standard Practice for Stainless Steel Reinforcing Bar Fabrication Facilities*.

Stainless steel bars must not be "hot" bent or "hot" straightened.

Manufacturers/Suppliers/Fabricators: The following manufacturers/suppliers are capable of providing material meeting this specification. Other suitable manufacturers/suppliers may also exist. Ensure that all materials supplied meet the Contract requirements.

PROVIDERS:	CONTACT	PHONE NO.
Altec Steel, Inc. 5515 Meadow Crest Drive Dallas, TX 75229	Harmon Hardy hh@altecsteel.com	214-987-1197 214-797-1197 Cell
Contractors Materials Co. 10320 S. Medallion Drive Cincinnati, OH 45241	David Friedman dfriedman@cmcmmi.com	513-719-0112
North American Stainless 6870 Highway 42 East Ghent, KY 41045	Jason Wheeler jwheeler@nas.us	815-600-3973
Salit Specialty Rebar 1050 Military Road Buffalo, NY 14217	Kevin Cornell kcornell@stainlessrebar.com Kyle Hayes khayes@stainlessrebar.com Rick Huza rhuza@salitsteel.com	877-299-1700 716-299-1990 514-208-5335
Carpenter Technology Corp. 2120 Centre Avenue Reading, PA 19605	Scott Heilman sheilman@cartech.com	610-208-2954 800-334-8824

Control of Material: All reinforcement bars or bar bundles delivered to the project site shall be clearly identified with tags bearing the identification symbols used in the Plans. The tags shall also include the UNS designation, heat treat condition, heat number, lot number, grade (corresponding to minimum yield strength level), and sufficient identification to track each bar bundle to the appropriate Mill Test Report (MTR).

In accordance with 1603.2, "Sampling and Testing," supply samples to the MnDOT Materials Laboratory for assurance testing. Supply one three (3) foot long sample per lot, per bar size. Each sample shall include one complete set of bar markings. Individually tag each sample with the same information listed above per "Control of Material" and include a copy of the associated MTR. Straighten the sample if it initially comes from a coil.

Provide MTRs for the Project that:

1. Are from the supplying mill verifying that the stainless reinforcement provided has been sampled and tested and the test results meet ASTM A955, ASTM A276, Table 1 and the Contract requirements;

2. Include a copy of the chemical analysis of the steel provided, with the UNS designation, the heat lot identification, the heat treatment method, and the source of the metal if obtained as ingots from another mill;

3. Include a copy of tensile strength, yield strength and elongation tests per ASTM A955 on each of the bar sizes of stainless steel reinforcement provided;

4. Permit positive determination that the reinforcement provided is that which the test results cover;

5. Include a statement certifying that the materials meet 1601, "Source of Supply and Quality," regarding material being *melted and manufactured in the United States*; and

6. Declare that the bars have been pickled to a bright or uniform light finish.

B. Concrete Reinforcing Steel Institute (CRSI) Certification

Facilities supplying stainless steel reinforcement are required to have certification in accordance with the ANSI/CRSI – IPG4.1 2016: *CRSI Standard for Standard Practice for Stainless Steel Reinforcing Bar Fabrication Facilities.*

C. Construction

Conform to the construction methods in 2401, "Concrete Bridge Construction," and 2472, "Metal Reinforcement," except as modified below:

Ship, handle, store, and place the stainless steel reinforcement bars according to the applicable provisions with the following additions and exceptions:

1. Prior to shipping, ensure that all chains and steel bands will not come into direct contact with the stainless steel reinforcement bars. Place wood or other soft materials (i.e., thick cardboard) under the tie-downs. Alternatively, use nylon or polypropylene straps to secure the stainless steel reinforcement bars.

2. When bundles of reinforcement steel and stainless steel reinforcement bars must be shipped one on top of the other, load the stainless steel reinforcement bars on top. Use wooden spacers to separate the two materials.

3. Outside storage of stainless steel reinforcement bars is acceptable. Cover the stainless steel reinforcement bars with tarpaulins.

4. Store stainless steel reinforcement bars off the ground or shop floor on wooden supports.

5. Do not use carbon steel tools, chains, slings, etc. when fabricating or handling stainless steel reinforcement bars. Only use nylon or polypropylene slings. Protect stainless steel from contamination during construction operations including any cutting, grinding, or welding above or in the vicinity of stainless steel.

6. Bars displaying rust/oxidation, questionable blemishes, a dull or mottled finish or lack of a bright or uniform pickled surface as determined by the Engineer are subject to rejection.

7. Alternatively, epoxy coated bars may be substituted for stainless steel bars where the Plans indicate that the bars are immediately adjacent to (touching) galvanized expansion joint device anchorages, but only for the bars that run parallel to the length of the expansion device and that are completely within 12 inches of the device.

8. Place all stainless steel reinforcement on bar chairs that are solid plastic, stainless steel, or epoxy coated steel. Fabricate stainless steel metal chairs and continuous metal stainless steel supports from stainless steel conforming to the same requirements and UNS designations as stainless steel bar reinforcement as listed in section A, "Materials". Use stainless steel chairs with plastic-coated feet above steel beams, as per 2472, "Metal Reinforcement".

Use one of the listed tie wires to tie stainless steel reinforcement:

- 16 gauge or heavier plastic or nylon coated soft iron wire; or
- Fabricated from stainless steel conforming to the same requirements as stainless steel bar reinforcement as listed in section A, "Materials", dead soft annealed, annealed at size. The tie wire does not need to be of the same UNS designation as the bar reinforcement.

Do not tie stainless steel reinforcing to, or allow contact with uncoated reinforcement, bare metal forming hardware, or to galvanized attachments or galvanized conduits. Direct contact with these materials is not acceptable. When stainless steel reinforcing or dowels must be near uncoated steel reinforcing, bare metal forming hardware or galvanized metals, maintain a minimum 1 inch clearance between the two metals. Where insufficient space exists to maintain this minimum, sleeve the bars with a continuous 1/8 inch minimum thickness polyethylene or nylon tube extending at least 1 inch in each direction past the point of closest contact between the two dissimilar bars and bind them with nylon or polypropylene cable ties. Stainless steel reinforcing bars are allowed to be in direct contact with undamaged epoxy coated reinforcing bars. Stainless steel reinforcing is permitted to contact or be tied to shear studs on steel girders.

Splices: Splices shall generally be of the lap type. Stainless steel mechanical splices may be used in certain situations, subject to the approval of the Engineer.

If it is necessary to increase the number of bar laps from those indicated in the Plans, provide copies of plan sheets to the Engineer showing the revised reinforcement layout with length and location of laps. The Engineer must approve the location of new lap splices prior to fabrication. New lap splices must be at least as long as those shown in the plans. No additional compensation or changes in the reinforcement bar quantities will be made for such splices.

Provide mechanical splices for stainless steel reinforcement made of stainless steel conforming to one of the UNS designations listed in section A, "Materials", above.

Approval: Stainless steel reinforcement placed in any member must be inspected and approved by the Engineer before placing concrete. Concrete placed in violation of this specification may be rejected and removal required, as directed by the Engineer.

D. Method of Measurement

Measurement of the stainless steel reinforcement will be by weight in pounds based on Table 5.2.2.1 of the MnDOT LRFD Bridge Design Manual, regardless of the actual unit weight of the material supplied.

E. Basis of Payment

Payment for Item No. 2401.508 "REINFORCEMENT BARS (STAINLESS-75KSI)" will be made at the Contract price per pound and shall be compensation in full for all costs of furnishing and installing the stainless steel reinforcement with all component materials as described above, including fabricating and shipping.

SB- PAINT REMOVAL AND WASTE DISPOSAL OF DRY ABRASIVE BLASTING OF NON-LEAD AND NON-PCB CONTAINING PAINT

The provisions of 1717, "Air, Land, and Water Pollution," are supplemented as follows:

A. Handling and Disposal of Waste Materials

Contain waste materials, which include but are not limited to blasting waste (spent abrasives or paint chips) and disposable Personnel Protective Equipment (PPE) on site and provide for their transportation and disposal in accordance with Federal and State regulations and MnDOT criteria. Waste from blasting operations must be treated as a hazardous unless the Contractor provides proof that the waste is nonhazardous.

Contractor responsibility for proper management of waste storage, transport and disposal and owner responsibility for recording the Contractor's testing, waste transport and disposal processes are described in MnDOT's manual for "MnDOT Steel Structure Paint Removal Program for Contractors" available on the web at http://www.dot.state.mn.us/environment/regulatedmaterials/paintremoval.html.

Disposal of waste material, such as paint pails, rags, clothing, waste oil, spent cleaning solvents, brushes, etc., with the blasting residue is prohibited.

B. Loss of Waste Paint Materials into Public Waters

In the event of accidental loss of waste paint, cleaning materials or debris into public waters, take immediate action to recover the lost materials and report the incident immediately to the Engineer by telephone to the State Duty Officer (800.422.0798).

C. Methods for Paint Removal

As the paint system is removed, follow special procedures to ensure that the material, when removed from the bridge, does not contaminate the surrounding air, water and land.

A method of paint removal which meets the requirements for surface preparation and complies with Contract requirements can be used by the Contractor. All costs of compliance with these specifications are incidental except as may be provided under payment provisions in the proposal. Contact the MnDOT Office of Environmental Stewardship if there are additional questions.

Remove paint by use of dry abrasive blasting, the following material(s) are acceptable:

1. Recyclable steel grit or steel shot abrasives.

Use an appropriately sized recyclable steel grit or steel shot as an abrasive blasting material per 2478.3D.1.b, "Abrasive Blasting". Provide a recovery system that is self-contained for abrasive blasting and recovery. It must be a recovery system which does not allow fugitive emissions from the recovery operation. The recovery equipment must be such that the amount of contaminants in the clean recycle abrasive is less than one percent by weight.

1 - DESIGNER NOTE: #2 (only the #2 line not the paragraph below it) is not to be used unless requested by the Regional Bridge Construction Engineer for short working hour jobs.

2. Mineral aggregate abrasive.

Waste generated will not be removed off site until the Toxicity Characteristic Leaching Procedure (TCLP) for Resource Conservation Recovery Act (RCRA) metals analysis is completed, shown to be non-hazardous, and provided to the Engineer in writing.

D. Containment

2 - DESIGNER NOTE: Fill in the blank with "7025.0290 Class III" if paint removal is further than 100' from water or "7025.0300 Class IV" for all other cases.

Method will meet or exceed the MN Rule _____ Containment.

Prior to the start of surface preparation operations, submit to the Engineer the following:

1. Information required in 2478;

2. Identify the method proposed for paint removal;

3. Composition of the blast medium;

4. Furnish details, calculations showing loads and stresses of the means of attachment of the containment system and painting platform to the bridge. In the event that the system is in contact with the bridge barrier or railing or previously painted structural steel, the submittal must indicate the method of protecting those surfaces from any visible marring. No system which will produce stresses exceeding the allowable stresses on bridge members is allowed. The Engineer's review of the Contractor's submittal does not relieve the Contractor of responsibility for repairing damage to the bridge and for providing containment which prevents contamination of air, water and land;

5. Detailed plans of the proposed containment and blasting waste collection system.
   a. Provide containment that will completely enclose the work area on the bridge.
   b. Provide exhaust ventilation utilizing a dust collector for the enclosure(s). Use exhaust ventilation sufficient to maintain negative air pressure (inside air pressure must be slightly less than outside ambient air pressure) within the enclosures.
   c. Construct enclosures in such a way that will eliminate the escape of blasting waste during adverse weather conditions. Provide tarpaulins composed of canvas, heavy-gauge nylon, or heavy-gauge nylon-reinforced vinyl. The tarpaulins must be free of holes and tears, be suitable for holding blasting waste and be 100% impermeable to blasting waste, as rated by the manufacturer.

In the event of any marring or structural damage, immediately modify the method of suspension and bridge protection system to the Engineer's satisfaction, at no cost to the Department. Additionally, correct any marring or damage as directed by the Engineer, at no cost to the Department.

E. Dust Emissions

The Contractor's operations and containment must be modified if any dust emissions are observed by the Engineer during removal of paints. Suspend abrasive blasting operations if dust emissions are observed and during times when adverse weather conditions prevent the enclosures from effectively containing the blasting waste.

F. Waste Management, Testing and Disposal of Blasting Waste

1. Storage

Provide containers to hold wastes which meet the requirements of USDOT specifications.

The waste must be stored on-site in closed drums or roll-offs until the results of the TCLP testing indicate it is non-hazardous. Temporary off-site storage must be approved by the Engineer. If blasting waste is temporarily stored off-site, it must be stored in closed drums or roll-offs. Waste must be sealed to the weather elements at all times during storage. Use methods for handling of waste during loading, unloading and transport that eliminate dust emissions.

2. Disposal of Blasting Waste

Blasting waste resulting from the use of recyclable abrasives must be treated as hazardous waste until the waste has been tested and determined not to be hazardous. The Engineer will randomly sample the blasting waste once (1) and will deliver samples from each bridge to a laboratory selected by the Contractor. The Contractor shall engage the services of a Qualified Laboratory to have the samples analyzed for the RCRA metals by the TCLP. Manage the waste as hazardous or non-hazardous according to test results. Provide copies of all test results to the Engineer, in writing.

G. Disposal of Waste Materials (hazardous or non-hazardous)

1. Requirements of Hazardous Wastes

Subject to penalty under 1807, "Failure to Complete the Work on Time," no later than 30 calendar days after any hazardous waste is transported off site, the Contractor will provide the following information to the Engineer in writing:

a. Type of waste shipped;
b. Quantity of waste shipped;
c. Date of waste shipment;
d. Name and address of transporter;
e. Name and location of disposal site;
f. Final (3rd-signature) signed copies of the hazardous waste manifest and Land Disposal Restriction (LDR) form for all hazardous waste.

2. Requirements of Non-hazardous Waste

Notify the Engineer of waste disposal site(s). Subject to penalty under MnDOT 1807, "Failure to Complete the Work on Time," within 30 calendar days of transportation of waste off site, the Contractor will provide the following information to the Engineer in writing:

a. Type of waste shipped;
b. Quantity of waste shipped;
c. Date of waste shipment;
d. Name and address of transporter;
Name and location of disposal site;
e. Scale tickets;
Invoices;
f. Final (three signature) signed copies of the waste manifest for all waste.

Unless otherwise required in these special provisions or by the Office of Environmental Stewardship, disposal of non-hazardous waste in a MnDOT approved landfill is acceptable.

Blasting waste must be covered during transportation to the disposal facility.

H. Method of measurement

Containment, collection and disposal of blasting waste and other waste material will be measured by a single lump sum.

TCLP test will be measured by each test performed.

3 – Designer Note: Per section F2 of this special provision include one (1) TCLP Test per bridge as a plan quantity.

I. Basis of Payment

1. Payment for Item No. 2476.601 "WASTE COLLECTION AND DISPOSAL", will be made at the Contract price per lump sum and shall be compensation in full for all costs of containing, collecting, transporting and disposing of the abrasive blasting waste, as described above, including all work incidental thereto.

2. Payment for Item No. 2013.602 "TCLP TEST", will be made at the Contract price per each and shall be compensation in full for all costs of collecting, transporting and testing the blast waste samples as described above.

3. Except for payment for "WASTE COLLECTION AND DISPOSAL", compliance with all of the requirements of 1717 and those described herein shall be considered an incidental expense for which no direct compensation will be made.

SB- PAINT REMOVAL AND WASTE DISPOSAL OF DRY ABRASIVE BLASTING OF HAZARDOUS WASTE INVOLVING LEAD AND/OR PCB CONTAINING PAINT

The provisions of 1717, "Air, Land, and Water Pollution," are supplemented as follows:

A. Handling and Disposal of Waste Materials

Contain waste materials, which include but are not limited to blasting waste (spent abrasives or paint chips) and disposable Personnel Protective Equipment (PPE) on site and provide for their transportation and disposal in accordance with Federal and State regulations and MnDOT criteria. Waste from blasting operations will be treated as a hazardous waste only. No testing of the waste is required by the Department.

Contractor responsibility for proper management of waste storage, transport and disposal and owner responsibility for recording the Contractor's testing, waste transport and disposal processes are described in MnDOT's manual for "MnDOT Steel Structure Paint Removal Program for Contractors" available on the web at http://www.dot.state.mn.us/environment/regulatedmaterials/paintremoval.html.

Disposal of waste material, such as paint pails, rags, clothing, waste oil, spent cleaning solvents, brushes, etc., with the blasting residue is prohibited.

B. Loss of Waste Paint Materials into Public Waters

In the event of accidental loss of waste paint, cleaning materials or debris into public waters, take immediate action to recover the lost materials and report the incident immediately by telephone to the State Duty Officer (800.422.0798).

C. Lead and/or PCB-Containing Paint Removal

The original paint system on Bridge No. ________ contains lead and/or PCB-containing paint. Precautions to protect worker health and safety are necessary since operations will result in removal or detachment of paint from metal surfaces.

1. Exposure Plan

OSHA rules and regulations pertaining to Lead or PCB Exposure in Construction – 29 CFR 1926.62 – require a written plan to minimize worker exposure to lead or PCBs. Furnish two copies of this plan to the Engineer. Employers are responsible for developing and implementing a worker protection program. At a minimum, the employer's worker protection program for employees exposed to lead or PCBs above the Permissible Exposure Limit (PEL) should include:

a. Hazard determination, including exposure assessment;
b. Medical surveillance and provisions for medical removal;
c. Job-specific compliance programs;
d. Engineering and work practice controls;
e. Respiratory protection;
f. Protective clothing and equipment;
g. Housekeeping;
h. Hygiene facilities and practices;
i. Signs;

j. Employee information and training; and
k. Recordkeeping.

Compliance with provisions of MPCA Rule 7025.0230-7025.0380, which are applicable to abrasive blasting and lead or PCB paint removal, is required on this project.

2. Safety Equipment for Department Paint System Inspectors

Provide the following items, services and information for use by each of the Department inspectors assigned to the project.

a. Protective clothing to be worn within the enclosure(s) during abrasive blasting operations. This clothing must be available at the job site and daily laundering or disposal provided for by the Contractor.

b. Unrestricted use of cleaning and washing facilities, including vacuums, showers, sinks, lockers, soaps or cleansers that are available for use by the Contractor's personnel.

c. A copy of all information supplied to workers about hazards and safe working practices in lead or PCB removal areas, including all information on lead or PCB concentrations measured by the Contractor for the duration of lead removal and clean-up operations.

d. Invitation to all meetings involving safety and health.

3. Notification to Owner/Occupants of Nearby Buildings

Provide written notice to the residents of each dwelling unit and the owner or administrator of each occupied building within 200 ft. of the bridge with lead paint removal exceeding 500 ft^2. State in the notice that lead or PCB paint removal will occur, and specify the days and hours during which removal and clean-up is anticipated. The notice must advise that children under the age of ten (10) are not permitted to enter the outdoor area within 100 ft. of the bridge during the daily paint removal and clean-up operations (http://www.dot.state.mn.us/environment/regulatedmaterials/pdf/paint/102a-notificationrequirements.pdf).

In addition, for buildings within 100 ft. of the bridge, the building owner or administrator and residents must be advised in the notice that during lead removal and clean-up (a) all doors, windows, and storm windows should be closed on the walls facing the bridge and the adjoining walls; and (b) all air conditioning units on walls facing the bridge and the adjoining walls should be turned off; and (c) take inside or remove from the exterior property all pets, pet houses, pet food and water bowls, children's toys and play equipment within 100 ft. of the bridge should be removed or tightly covered with an impermeable material.

Give all required notices a minimum of 10 working days prior to beginning paint removal. If beginning of removal is delayed by more than five working days from the date stated in the notices, provide revised written notices prior to the original starting date for paint removal.

Restrict access to work areas during paint removal and provide warning signs at logical access points sufficiently remote from the work area to minimize possibility of accidental exposure to lead.

D. Methods for Paint Removal

As the paint system is removed, follow special procedures to ensure that the material, when removed from the bridge, does not contaminate the surrounding air, water and land.

A method of paint removal which meets the requirements for surface preparation and complies with Contract requirements can be used by the Contractor. All costs of compliance with these specifications are incidental except as may be provided under payment provisions in the proposal. Contact the MnDOT Office of Environmental Stewardship if there are additional questions.

Remove paint by use of dry abrasive blasting, the following material(s) are acceptable:

1. Recyclable steel grit or steel shot abrasives.

Use an appropriately sized recyclable steel grit or steel shot as an abrasive blasting material per 2478.3D.1.b, "Abrasive Blasting". Provide a recovery system that is self-contained for abrasive blasting and recovery. It must be a recovery system which does not allow fugitive emissions from the recovery operation. The recovery equipment must be such that the amount of contaminants in the clean recycle abrasive is less than one percent by weight. No TCLP testing is permitted, manage the abrasive waste as hazardous waste.

1 - DESIGNER NOTE: #2 (only the #2 line not the paragraph below it) is not to be used unless requested by the Regional Bridge Construction Engineer for short working hour jobs.

2. Mineral aggregate abrasive (use only when approved by the Engineer in conjunction with the Bridge Engineer).

Use an appropriately sized abrasive blasting material per 2478.3D.1.b, "Abrasive Blasting". Provide a recovery system that is self-contained for abrasive blasting and recovery. It must be a recovery system which does not allow fugitive emissions from the recovery operation. No TCLP testing is permitted, manage the abrasive waste as hazardous waste.

E. Containment

2 - DESIGNER NOTE: Fill in the blank with "7025.0290 Class III" if paint removal is further than 100' from water or "7025.0300 Class IV" for all other cases.

Method will meet or exceed the MN Rule ____ Containment.

Prior to the start of surface preparation operations, submit to the Engineer the following:

1. Information required in 2478;

2. Identify the method proposed for paint removal;

3. Composition of the blast medium;

4. Furnish details, calculations showing loads and stresses of the means of attachment of the containment system and painting platform to the bridge. In the event that the system is in contact with the bridge barrier or railing or previously painted structural steel, the submittal must indicate the method of protecting those surfaces from any visible marring. No system which will produce stresses exceeding the allowable stresses on bridge members is allowed. The Engineer's review of the Contractor's submittal does not relieve the Contractor of responsibility for repairing damage to the bridge and for providing containment which prevents contamination of air, water and land;

5. Detailed plans of the proposed containment and blasting waste collection system.
   a. Provide containment that will completely enclose the work area on the bridge.
   b. Provide exhaust ventilation utilizing a dust collector for the enclosure(s). Use exhaust ventilation sufficient to maintain negative air pressure (inside air pressure must be slightly less than outside ambient air pressure) within the enclosures.
   c. Construct enclosures in such a way that will eliminate the escape of blasting waste during adverse weather conditions. Provide tarpaulins composed of canvas, heavy-gauge nylon, or heavy-gauge nylon-reinforced vinyl. The tarpaulins must be free of holes and tears, be suitable for holding blasting waste and be 100% impermeable to blasting waste, as rated by the manufacturer.

In the event of any marring or structural damage, immediately modify the method of suspension and bridge protection system to the Engineer's satisfaction, at no cost to the Department. Additionally, correct any marring or damage as directed by the Engineer, at no cost to the Department.

F. Dust Emissions

The Contractor's operations and containment must be modified if any dust emissions are observed by the Engineer during removal of paints. Suspend abrasive blasting operations if dust emissions are observed and during times when adverse weather conditions prevent the enclosures from effectively containing the blasting waste.

G. Management and Disposal of Blasting Waste

1. Storage

Provide containers to hold hazardous wastes which meet the requirements in CFR 49, subp. 178.502. The containers must meet the requirements of the identification codes 1A2 (steel drum with removable head) or 1H2 (plastic drum with removable head.) The Contractor has the option to store blasting waste for transportation in roll-offs supplied by the MnDOT hazardous waste contractor.

If blasting waste is stored on site, it must be stored in closed drums or roll-offs. Waste must be sealed to the weather elements at all times during storage. Use methods for handling of materials during loading, unloading and transport that minimize dust emissions.

2. Disposal of Hazardous Wastes

Classify blasting waste as a hazardous waste, and transport and dispose of through the MnDOT hazardous waste contractor. See http://www.dot.state.mn.us/environment/regulatedmaterials/pdf/waste-contractors.pdf for current hazardous waste contractors.

Subject to penalty under MnDOT 1807, "Failure to Complete the Work on Time," no later than 30 calendar days after any waste is transported off site; the Contractor will provide the following information to the Engineer, in writing:

a. Type of waste shipped;
b. Quantity of waste shipped;
c. Date of waste shipment;
d. Name and address of transporter;
e. Name and location of disposal site;
f. Final signed copies (3^{rd}-signature) of the hazardous waste manifest and Land Disposal Restriction (LDR) form.

TCLP testing of blasting waste is NOT allowed.

H. Method of Measurement

Containment, collection and disposal of blasting waste and other waste material will be measured by a single lump sum.

I. Basis of Payment

Payment for Item No. 2476.601 "LEAD SUBSTANCES COLLECTION & DISPOSAL", will be made at the Contract price per lump sum and shall be compensation in full for all costs of containing, collecting, transporting and disposing of the abrasive blasting waste whether hazardous or non-hazardous, as described above, including all work incidental thereto.

Except for payment for "LEAD SUBSTANCES COLLECTION & DISPOSAL", compliance with all of the requirements described herein shall be considered an incidental expense for which no direct compensation will be made.

SB- (2477) POWDER COATING SYSTEM

2477.1 Description

This work consists of the following for shop applications of powder coating systems for new construction:

1. Qualification of Powder Applicator;
2. Quality Manual acceptance;
3. Surface Preparation;
4. Application of Powder;
5. Coating Thicknesses;
6. Handling, Storage, and Shipping of components;
7. Coating Repairs;
8. All work include with these operations.

A. Definitions

Whenever the following terms are used in this section (2477), the terms shall have the following meaning:

1. Engineer: Is defined for this section as the State Bridge Engineer, unless otherwise indicated.
2. Contractor: Shall mean the fabricator, coating contractor, applicator, or other entity that prepares the surfaces and applies the coatings.
3. Shop (in shop coating): The indoor facility where structural metals are prepared and coated.
4. Quality Assurance (QA): The process and person(s) responsible for verification of the conformance of materials and methods of application to the governing specification, in order to achieve a desired result.
5. Quality Control (QC): The process and person(s) responsible for administrative and production procedures employed to attain the desired product outcome and quality. Production personnel cannot be the person responsible for quality control.
6. Quality Manual (QM): The formal written document prepared by the contractor that describes the policies and procedures that ensure and verify that the coated structural steel component will satisfy the contract requirements.
7. Quality Assurance Inspector (QAI): The Department’s representative responsible for duties associated with Quality Assurance, with the authority to accept or reject work.
8. Contact surfaces: Those surfaces in the completed structure that touch other surfaces.
9. Corner: The intersection of two surfaces.
10. Edge: An exposed, through-thickness surface of a plate or rolled shape. This may be the as-rolled side face of a beam flange, channel flange or angle leg, or may result from thermal cutting, sawing, or shearing. Edges may be planar or rounded, and either perpendicular or skewed to adjacent faces.
11. Non-contact surfaces: Surfaces that are not in direct contact with other surfaces.
12. Prime Coat: Application of a zinc-rich coating to a bare metal substrate. For duplex coating systems, the hot-dip galvanize coating replaces the zinc-rich prime coat.
13. Coating thickness: The Dry-Film Thickness (DFT) above the peaks of the blast profile.
14. Coating System: The surface preparation and application of specific coating classifications (i.e., Inorganic Zinc-Rich, Organic Zinc-Rich, Polyurethane, Acrylic, Polyurea, Latex, Galvanize, Powder, etc.) of coating products to provide a film forming a unified whole for the purpose of corrosion protection and/or aesthetics.
15. Powder System: A set of interacting film forming powder materials and products which combine to make up a complete coating system.

16. Duplex Coating System: A system whereas hot-dipped galvanizing replaces the zinc-rich primer and subsequently intermediate and top coated in accordance with this specification.
17. Lot: The amount of components that are baked at one time in a curing oven. If a continuous feed oven is used "a lot" shall be defined in the QM.
18. Well-lighted: A minimum of 50-foot candles (fc), with 200-foot candles recommended. Use a light meter capable of reading in fc to verify the adequacy of the lighting and ensure a record is kept.
19. Qualification Testing: Testing of Powders not currently listed on the APL.
20. Verification Testing: Testing of Powders currently listed on the APL by Applicators that did not perform the initial Qualification Testing.

2477.2 Materials

A. Powder Systems

Provide a powder coating system as listed on the Approved/Qualified Products List (A/QPL) for "Powder Coating".

For systems not on the A/QPL, see the "MnDOT Powder Coating Qualification Testing Procedure" as located on the MnDOT Approved/Qualified Products web site www.dot.state.mn.us/products.

1 - DESIGNER NOTE: For the following paragraph, insert color(s) as recommended by the MnDOT Bridge Office Architectural Specialist [(651) 366-4465].

Match the color of the finish coat to Federal Standard RAL K5 Classic No. (fill in coating finish color here), with a semi-matt finish.

Deliver the powder to the applicator in the original unopened containers.

Provide the Engineer with the following for each powder shipment:

1. Safety Data Sheets (SDS),
2. Material certifications, and
3. Technical Data Sheets (TDS).

Ensure a manufacturer's technical representative with knowledge of this powder system is available to assist during coating application.

2477.3 Construction Requirements

A. Qualification for Powder Applicator

Before the start of work, the Powder Applicator will be pre-qualified on MnDOT's *Approved Suppliers for Fabricated Structural Metals Products* list as maintained by the Structural Metals Engineer at http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf, or at least 30 calendar days prior to beginning work, the Applicator is to submit a Quality Manual (QM) to the Engineer for review. Ensure the QM is written in accordance with the MnDOT Supplier Qualification Standard (SQS). The Engineer will use the SQS as the basis of acceptance for the submitted QM. In addition to routine inspections, the Engineer will audit suppliers with approved QMs on a biannual or annual basis or as otherwise directed by the Engineer to ensure the implementation of the QM.

Additionally, Powder Applicators are required to perform either a "MnDOT Powder Coating Qualification or Verification Testing Procedure" located on the MnDOT Approved/Qualified Products web site www.dot.state.mn.us/products and have attained approval status.

The Department will invoke its Corrective Action Process if the routine inspections or audits indicate non-conformance. Corrective actions deemed appropriate by the Engineer, are effective immediately and apply to any work remaining on a current project and future projects. If the Engineer determines that work does not comply with the QM, the Engineer will deem the materials as non-conforming in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work." If the Engineer finds non-conforming work, the supplier will immediately correct the procedure and submit a written non-conformance report, containing data required by the Engineer to ensure compliance with the QM, specifications, and drawings. Perform additional testing as required by the Engineer, at no additional cost to the Department. For repeat offences or negligence, the Department will require corrective action of hiring a Third Party Quality Control Inspector, at no additional cost to the Department. The Contractor may obtain a copy of the Department's Corrective Action Process from the Engineer.

B. General

Preserve or transfer erection markings to ensure legibility when erecting members. Provide removable markings or place markings at locations not visible in the completed structure. Use marking material that will not damage the powder system.

Protect the environment and property as required by Federal, State, and MnDOT regulations.

C. Inspection

Perform QC inspections of the shop coating process in accordance with an approved QM and Table 2477-1.

Perform coating application and QC inspections of coated products by persons with normal color vision, in a "well lighted" area during each coating phase and prior to final acceptance.

The Department will appoint a Quality Assurance Inspector (QAI) as a Department representative to accept work meeting the Contract requirements.

C.1 Quality Manual (QM) Requirements

Provide the minimum requirements and frequencies in the QM as shown in Table 2477-1:

Table 2477-1: Powder Coating Inspection Requirements

Requirement	Criteria	Frequency/Extent
Date and time	Each lot of work	Each lot of work
Compressed air test	ASTM D4285	Daily – When abrasive blasting or blow down operations are occurring
Final Coat Dry Film Thickness (DFT)	As submitted by Manufacturer (listed on the MnDOT APL)	SSPC-PA 2
Surface Preparation		
Abrasive blast clean Duplex System (prior to galv.) Duplex System (prior to powder) Powder Only System (prior to powder) Surface cleanliness (all systems)	SSPC-SP6 SSPC-SP 16/ASTM D7803 SSPC-SP10 SSPC-PA 1	Each component to be powder coated
Pre-Bake for Outgassing (Duplex System)		
Surface cleanliness	SSPC-PA 1	100% Visual examination prior to coating
Pre-bake oven temperature	Same procedure used in qualification/verification	Each lot of work prior to each out-gassing event

Table 2477-1: Powder Coating Inspection Requirements		
Requirement	**Criteria**	**Frequency/Extent**
Baking procedure	ASTM D7803 in conjunction with the same procedure used to pass qualification	Each lot of work
Prime/Intermediate Coat		
Powder product number	Track for each lot	Each batch of powder
Surface cleanliness inspection	SSPC-PA 1	Visual examination prior to coating (within 1 hr of coating)
Prime/Intermediate coat oven temperature	Same procedure used in qualification/verification	Each lot of work
Temperature of component at time of coating	Same procedure used in qualification/verification	Each lot of work
Verification of prime coat coverage	100% Coverage of powder	100% Visual Inspection
Top Coat		
Powder product number	Track for each lot	Each batch of powder
Surface cleanliness inspection	SSPC-PA 1	Visual examination prior to coating
Top coat oven temperature	Same procedure used in qualification/verification	Each lot of work
Final cure temperature of component	Same procedure used in qualification/verification	Each lot of work
Curing time	Per manufacturer Technical Data Sheet	Each lot of work
Coating evaluation / repair	Visual Inspection Coating shall be smooth and uniform free of runs, drips, sags, pinholes, blisters, and other deleterious conditions. (Pinhole density shall not be greater than 5 pin holes per sq. ft. in any given area)	100% Visual Inspection (without the aid of magnification)

Provide written records meeting the *QM Powder Coating Inspection Requirements* in Table 2477-1 to the Engineer upon request on an ongoing basis as the work is being performed. Provide written records meeting the *QM Coating Inspection Requirements* in Table 2477-1, in its entirety, at the completion of the job, prior to receiving final payment. The QAI or the Engineer may reject the coating system or reduce payment per 1512 if the Contractor did not adhere to the approved QM or provided inadequate documentation of adherence to the QM. Conduct subsequent testing with the QAI or the Engineer's approval, at no additional cost to the Department, to determine compliance.

D. Surface Preparation

The QAI or Engineer will inspect the surface preparation as it is done, after its completion, review the QM documentation, or any combination of the three. Notify the QAI or the Engineer at least 5 working days before beginning surface preparation.

D.1 Cleaning

D.1.a Solvent Cleaning

Clean areas containing organic and synthetic and other visible contaminants with solvent meeting the requirements of SSPC-SP 1, "Solvent Cleaning." Protect the adjacent environment and property while solvent cleaning.

D.1.b Abrasive Blasting

D.1.b(1) Duplex Coating System

Perform preparation of galvanized surfaces prior to application of powder in accordance with SSPC SP16 "Brush-off Blast Cleaning of Non-Ferrous Metals," and ASTM D7803, "Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating."

Inspect brush-off blasted surfaces for fins, tears, reduced DFT’s that fall below the required minimum, or any other damage. Submit to the Engineer, an NCR documenting all damage prior to repairing the surface.

D.1.b(2) Powder Only System

Perform preparation of bare steel surfaces prior to the application of powder in accordance with SSPC SP10 "Near-white Blast Cleaning."

D.1.c Post Blasting

After blast cleaning, remove blasting debris from surfaces using procedures that leave the surfaces free of moisture and contaminants. Remove the blasting residue from the containment area, specifically the floor area, to prevent dust from being airborne once coating process starts.

E. Application of Powder

E.1 General

Prior to application of powder, submit documentation to the Quality Assurance Inspector (QAI) showing that the powder manufacturer's technical representative trained, all directly involved shop personnel (including QC) on the proper storage, handling, and application of the coatings system for the project. Make training curriculum available to the Engineer upon request.

Do not start applying powder until the QAI or the Engineer accepts the surface preparation. Before applying powder, clean the surface of oxidation, dust, dirt, grease, oil, moisture, overspray, and other deleterious contaminants that will prevent the powder from adhering. Apply powder to produce a smooth and uniform film free of runs, drips, sags, pinholes, blisters, and other deleterious conditions. Apply powder in accordance with manufacturer’s printed instructions except as stated in this document.

Do not apply powder to metal surfaces when weather conditions that the manufacturer’s literature defines as unsatisfactory are present, and when:

1. The air temperature falls below 40° F;
2. Metal surface temperatures are less than 5° F above the dew point;
3. Water mist is in the air; and
4. Metal surfaces are damp or frosted.

Do not apply powder if other work operations or wind causes the air to carry dust, dirt, or sand onto the prepared or newly coated metal surfaces. The QAI or Engineer will suspend coating operations if the applicator does not properly control coating application.

Powder coat all sweep blasted galvanized railing with the subsequent coat(s) within the time frame defined in ASTM D7803, or within the same 8-hour shift, maintaining manufacturer defined control and environmental conditions. The powder coating applicator’s QC personnel shall document that all parameters were followed.

Remove surface contamination, if any exist. Repair or replace defective previously applied coats as required by the Engineer, at no additional cost to the Department.

Submit coating repair procedures to the QAI or the Engineer for approval.

Ensure the color of the first coat presents a distinct contrast from other coat(s).

E.2 Applying Powder

Apply and cure powder per the same procedure used in qualification/verification. Apply powder in a neat and workman like manner to evenly coat all surfaces.

F. Powder Coats

F.1 Measurement of Coating Thickness

The Department refers to "Dry Film Thickness" (DFT) when using the term "thickness" in this section. Use a properly calibrated thickness gage to measure the coating thickness and average thickness meeting, at a minimum, the requirements of SSPC-PA 2, "Measurement of Dry Coating Thickness with Magnetic Gages." Measure coating thickness from the top of the peaks of the blast profile.

For Duplex coated systems use a DFT measurement thickness tool capable of differentiating the individual thicknesses of both powder coating system and galvanizing layer.

Perform coating operations as recommended by the manufacturer's literature, unless otherwise specified in this section.

F.2 Prime Coat

For powder only systems, apply a zinc-rich primer powder. Remain within the minimum and maximum DFT limits as submitted by the manufacturer.

For duplex coating systems, the hot-dip galvanize coating replaces the zinc-rich primer powder coat.

F.3 Intermediate Coat

Remain within the minimum and maximum DFT limits as submitted by the manufacturer. Ensure the color of the intermediate coat has sufficient contrast with the prime and finish coat.

F.4 Finish Coat

Remain within the minimum and maximum DFT limits as submitted by the manufacturer. Ensure the finish coat color matches the color standard required by the contract.

Ensure the finished surface is uniform in color and free of visible lap marks and other blemishes.

F.5 Total Coating Thickness

Ensure the total coating thickness of the entire system remains within the minimum and maximum thickness limits submitted by the manufacturer of the coating system. If the Engineer finds total coating thickness deficient or excessive over any part of a structure and if the Engineer does not require additional applications or removal of coating, the Department will reduce payment for the appropriate item of work.

G. Handling, Storage, and Shipping of Powder Coated Components

Do not damage the coated steel in the shop or field during shipping, erection, and construction of the project. Do not move or handle the coated steel items until the coating cures and cools in accordance with the applicators approved procedure. Use nylon straps, padded hooks, slings, or other non-metallic lifting devices to protect coated components or products during handling and loading. Use softeners and edge protection devices to protect the steel from binding chains. Use padded hooks and slings to hoist the coated components.

Store completed items in accordance with 1606, "Storage of Materials," and the following:

1. Tag or permanently mark items before final storage. Include individual piece marks, bridge number, project number, manufacturer number, and the applicator job number in the identification markings.

2. Locate the final storage area out of any traffic lanes and in an area capable of bearing the full weight of the members or items and stable enough to maintain bundles, members or items within the supporting substrate. Inspect and store bundles, members, or items in one general location before final acceptance unless otherwise approved by the QAI or the Engineer.

Support individual items or bundles of coated products in transit in a manner that will prevent damage to the coating. Do not drop or drag individual items or bundles of coated products. Pad when shipping, bundling, or banding materials to protect the components from direct contact with packaging materials that may damage the coated products finish. Use softeners and edge protection devices in conjunction with high-density foam or other acceptable packaging materials at all points of contact.

Any damaged coated surfaces, identified through either Quality Control or Quality Assurance inspections as being unacceptable, either after the application of the powder coating or during handling of the powder coated components, is subject to the provisions of 1512, "Unacceptable and Unauthorized Work". Also refer to section H.

H. Coating Repairs

H.1 Shop (prior to receiving at job site)

Any damaged coated surfaces, identified by the Engineer as being unacceptable is subject to the provisions of 1512, "Unacceptable and Unauthorized Work", and will be replaced or repaired. Submit a Non-conformance repair plan to the Engineer for acceptance. Once accepted in writing by the Engineer, perform repairs using the accepted methods and procedures authorized by the Engineer.

Coating damage is classified in two extent types:

Type 1 – damage is any type of abrasion that caused a surface imperfection not exposing the galvanized surface or exposes an area of galvanized surface that is smaller than 1 square inch in size. This damage may be repaired in the shop using an accepted Non-conformance repair plan as stated above (i.e. abrade the damaged area and apply an intermediate and finish coat per 2478, "Organic Zinc-Rich Paint System." (**Note: Alkyd Enamels will not be allowed as a repair. Aerosol spray paint is not an acceptable repair procedure.)**

Type 2 – damage is any type of surface imperfection that exposes the galvanized surface larger than 1 square inch and/or exposed base metal in an area larger than $^1/_2$ square inch. Repair this damage in the shop using an accepted Non-conformance repair plan.

H.2 Field (once received at the job site)

Any damaged coated surfaces, identified by the Project Engineer as being unacceptable is subject to the provisions of 1512, "Unacceptable and Unauthorized Work", and will be replaced or repaired. Submit a Non-conformance repair plan to the Project Engineer for acceptance. Once accepted in writing by the Project Engineer, perform repairs using the accepted methods and procedures authorized by the Project Engineer.

Coating damage is classified in two extent types:

Type 1 – damage is any type of abrasion that caused a surface imperfection not exposing the galvanized surface or exposes an area of galvanized surface that is less than 1 square inch in size. This damage may be repaired in the field or the shop using an accepted Non-conformance repair plan as stated above (i.e. abrade the damaged area and apply an intermediate and finish coat per 2478, "Organic Zinc-Rich Paint System." (**Note: Alkyd Enamels will not be allowed as a repair. Aerosol spray paint is not an acceptable repair procedure.)**

Type 2 – damage is any type of surface imperfection that exposes the galvanized surface larger than 1 square inch and/or exposed base metal in an area larger than $^1/_2$ square inch. Remove sections of damaged rail from the site and repair in the Powder Applicator's powder application facility. (Repair the damaged area utilizing an accepted NCR.)

2477.4 Method of Measurement

Unless otherwise shown on the plans, the Engineer will measure the length based on the sum of the lengths of the various sections as shown on the plans and as measured at the base of the rail.

2477.5 Basis of Payment

The contract unit price for metal railings includes the cost of powder coating.

SB- (2478) ORGANIC ZINC-RICH PAINT SYSTEM

Delete 2478.1.A (20) and substitute the following:

Hold Point (for Field Application of Paints ONLY): Puts a hold on any further activities until an inspection is passed. Do not proceed without the written approval of the Engineer. The Department and the Contractor will use the "Start-up Checklist" and the "Daily Quality Assurance Check List" located on the www.dot.state.mn.us/bridge/construction.html site so that quality is assured.

Modify Table 2478-1, "Coating Inspection Requirements," Sublevel, "Prime, Intermediate, and Finish Coat:" changing the table to read as follows:

Verification of surface cleanliness – Examine visually within 1 h before prime painting and for Field applications include a white cloth wipe test (nothing is transferred on to the cloth surface).

Add the following to the second paragraph of 2478.3.C.1:

(10) Identify the following hold points for Department inspection and verification: Abrasive blast profile and cleanliness, stripe coat, prime coat, intermediate coat, finish coat.

Delete the third paragraph of 2478.3.C.1 and substitute the following:

Provide written records meeting all Coating Inspection Requirements to the Engineer upon request on an ongoing basis as the work is being performed. For field applications, also provide complete written records within 5 working days from when the shift was completed to receive partial payment. Provide written records meeting all Coating Inspection Requirements, in its entirety, at the completion of the job, prior to receiving final payment. The QAI or the Engineer will reject the coating system or reduce payment per 1512, "Unacceptable and Unauthorized Work," if the Contractor did not adhere to the approved QM or provided inadequate documentation of adherence to the QM. Conduct subsequent testing with the QAI for the Engineer's approval, at no additional cost to the Department, to determine compliance.

Delete the third and fourth paragraph of 2478.3.E.1 and substitute the following:

Do not start painting until the QAI or the Engineer approves the surface preparation and paint. Before applying paint, clean the surface of flash rust, dust, dirt, grease, oil, moisture, overspray, and other deleterious contaminants that will prevent the paint from adhering (hold point). For field painting applications, provide a white cloth material to the QAI for cleanliness testing.

Apply paint to produce a smooth and uniform film free of runs, drips, sags, pinholes, blisters, mudcracking, and other deleterious conditions. Apply paint in accordance with manufacturer's printed instructions except as stated in this document.

For field applications:

1. Apply paint by spray application ONLY, unless a different application method is allowed in the contract, and
2. Rollers, daubers, brushes are not allowed to be used to apply paint, unless approved by the Engineer in writing.

Delete 2478.3.E.3 in its entirety and replace with the following:

For field application, this entire section may only be used with written permission from the Engineer.

The Contractor may apply paint by rolling, brushing, or daubers in areas unsuitable for spray painting, such as small surface areas where over-spray would be excessive, and small areas requiring paint repair.

If using brushes, manipulate the paint under the brush to provide a smooth, uniform coating over the entire surface, including corners and crevices. Perform final brush strokes horizontal and parallel to each other. Remove brush hairs on the paint surface.

The Contractor may use sheepskin or other approved daubers to paint surfaces inaccessible by spray or brush.

Delete the second paragraph of 2478.3.I and substitute the following:

Do not damage the painted steel in the shop and field during shipping, erection, and construction of the bridge and components. Do not move or handle the painted steel items until the coating dries in accordance with the manufacturer's data sheet. Use nylon straps, padded hooks, slings, or other non-metallic lifting devices to protect coated components or products during handling and loading. Use softeners and edge protection devices to protect the steel from binding chains. Provide padded hooks and slings to hoist the painted components.

1 - DESIGNER NOTE: For the following paragraph, use where beams are 3309, "High-Strength Low-Alloy Structural Steel," steel and are partially painted at bridge joints (this is typical).

Paint in accordance with the provisions of 2478 all structural steel and steel bearing assemblies for Br. No. __________ that are within 7 ft of the end of the beams or girders as measured along the centerline of the beams or girders. In addition, paint the fascia beams their full length from end to end of bridge on the following designated surfaces: the outboard surfaces of the bottom of the top flange, the web, the top of bottom flange, and the edge of the bottom flange; the bottom of the bottom flange; and the inboard edge of the bottom flange.

2 - DESIGNER NOTE: For the following paragraph, use where beams are 3310, "High-Strength Low-Alloy Collumbium-Vanadium Steel," steel or when the District requires that a full paint system be applied.

Paint all structural steel members __________ of Bridge No. ___________________.

3 - DESIGNER NOTE: For the following paragraph, specify color.

Add the following to 2478.3.F.5, "Finish Coats":

The color must match AMS-STD-595A No. __________ and have a semi-gloss finish.

SB2018-2478.1

Use when required for Historic Bridges or a higher level of aesthetics where overspray is NOT acceptable.

CREATED 6/2/2015

REVISED 6/2/2015

SB- Protection of Non-Painted Surfaces

Delete the sixth paragraph of 2478.3.B, "General," and substitute the following:

1 - DESIGNER NOTE: Fill in the blank with the reason for this aesthetic sensitivity. (Historic, high visibility to the public, etc.)

The structure is aesthetically sensitive because of __________. Protect non-painted surfaces that are adjacent to the painted surfaces from overspray. The Engineer will not allow overspray. The Engineer will visually inspect the non-painted surfaces. If the Engineer determines that there is overspray on the non-painted surfaces, then the Engineer will deem the materials as non-conforming in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work". The Engineer will direct the contractor to immediately correct the oversprayed surface and submit a written non-conformance report, containing data required by the Engineer to ensure compliance with the contract. Perform additional work as required by the Engineer at no additional cost to the Department.

SB- Removal of Soluble Salts

A. Description of Work

Remove soluble salts and test for soluble salt contamination prior to painting as detailed in this provision. Test surfaces for soluble salt contamination (e.g. chlorides and nitrates) using a prescribed procedure outlined in part A.

1. Procedure for Testing for Soluble Salt Contamination

a. Perform the tests for soluble salt contamination after the steel surfaces have been blasted to SSPC - SP 10/NACE No. 2 "Near-White Blast Cleaning".

b. Perform tests of the prepared surfaces at intervals defined, and in the presence of the Engineer.
   (1) When requested by the Engineer, provide evidence that personnel who perform tests for soluble salts have been trained by the manufacturer's technical representative in the use of soluble salt test kits. They must also be able to interpret the results.
   (2) Defined intervals consist of testing all surfaces at a rate of one test for each 3000 ft^2, or any part thereof. Testing must be concentrated in areas where there was coating failure, corrosion, pitting, and/or loss of section. All areas to be tested must be approved by the Engineer.

c. Test methods and equipment used in the procedure must be selected at the contractor's discretion. All equipment and materials chosen must be reviewed and approved by the Engineer.

d. Evaluate approval of test methods and equipment on the following basis. The method used should:

- be a completely self-contained test kit with all materials, supplies, tools and instructions to take tests and identify results. The contractor may purchase the following test kits or an approved equal:
  CHLOR-RID - "Chlor*Test"
- use identifiable, consistent, factory pre-measures test extract solution.
- be dated, or otherwise marked to provide evidence of a 1 year/12 month verifiable shelf-life of the measurement components.
- provide for any steel surfaces, regardless of orientation.
- provide for testing on smooth, pitted, and rough surfaces.
- provide for taking measurements of the chloride ion in micrograms per square centimeter without using conversion charts or tables.
- be environmentally friendly and not contain any form of mercury.
- provide all new forms for extraction and titration for each test.
- provide an encapsulated environment while extracting chlorides.
- provide a factory sealed titration device for each test.
- use the extract sampling container as the titration container.
- allow the test results to be presented in readings in ppm and ug/cm^2. A ratio of 1:1 would provide a direct correlation (eg: 7ppm = $7ug/cm^2$)

e. Readings greater than 7 parts per million (ppm) and/or micrograms per centimeter squared (ug/cm^2) of chlorides, and 7 parts per million (ppm) and/or micrograms per centimeter squared (ug/cm^2) of nitrates, per test area, require that the contaminated surfaces represented by the test be cleaned. Repeat the cleaning and retesting as necessary until satisfactory test results are obtained. All tests are to be properly labeled and sent to the MnDOT Bridge Office:

Bridge Office
% Bridge Construction Unit
3485 Hadley Avenue North
Oakdale, MN 55138

2. Procedure for Cleaning the Contaminated Surface

Surfaces, which have unacceptable levels of soluble salts may be cleaned by the use of sand blasting, high-pressure water washing with a soluble salt remover product (if acceptable by the Office of Environmental Stewardship), or another method acceptable to the Engineer.

B. Basis of Payment

Payment for removal of soluble salts and testing shall be considered an incidental expense to Item No. 2478.______ for which no direct compensation will be made.

SB2018-2478.3

Use when required by the Regional Bridge Engineer and when preexisting steel beam structures are in need of their top of top flange painted. IF this is the ONLY painting being performed, do not include 2476.1 or 2476.2.

CREATED 9/30/2015

REVISED 9/4/2019 (3)

SB- Clean and Prime Top Flange

A. Description of Work

Provide all labor, equipment, and materials to remove corrosion and non-tightly adhered paint and to protect the top and vertical faces of the top steel flange with an epoxy paint.

B. General

After the concrete deck is removed, the top and vertical faces of the top steel flange (that were cast against the existing deck), along with the bottom inch of any channels or angles welded to the top flange for shear connectors (Nelson studs are exempt) shall be mechanically cleaned using vacuum assisted power tools in accordance with SSPC-SP3, "Power Tool Cleaning". Remove loose rust, loose paint and other surface contaminants to prepare surface. Any tightly adhered coatings may remain. Collect and dispose of paint chips and debris in accordance with:

http://www.dot.state.mn.us/environment/regulatedmaterials/mndot.html.

The Department anticipates that vacuum assisted power tools will be utilized to clean the top steel flanges such that a supplemental containment system is not required. An alternate removal method may be proposed, prior to the start of the surface preparation operations. Submit to the Engineer detailed plans of the proposed method to remove and collect the non-tightly adhered paint residue, for acceptance.

C. Materials and Application Requirements

The top and vertical faces of the top flange are to be coated with an approved intermediate coat paint to achieve a dry film thickness of 5.0 - 7.0 mils. Apply the coating in accordance with the paint manufacturer's product data sheet to achieve uniform coverage. Use only paint products identified as intermediate coat as listed on the Department's "Approved/Qualified Product List for Bridge Products," "Bridge Structural Steel Coating, Three Coat Systems - Organic" (www.dot.state.mn.us/products).

D. Method of Measurement

Measurement will be made to the nearest square foot based on plan measurements of top flange area prepped and coated.

E. Basis of Payment

Payment for Item No. 2478.618 "CLEAN AND PAINT STEEL," at the contract price per square foot and shall be compensation for all costs of removal, collection and disposal of paint chips and debris and for applying paint coat on designated areas of top flange.

SB2018-2478.4

Use when required by the Regional Bridge Engineer and when preexisting steel beam structures are in need of Mitigation of Pack Rust.

CREATED 5/3/2016

REVISED 5/3/2016

SB- Mitigation of Pack Rust

A. Description of Work

Provide all labor, equipment, and materials to remove pack rust corrosion, prime, apply a compatible penetrating sealant with corrosion inhibitors as listed on the Department's "Approved/Qualified Product List for Bridge Products, Bridge Structural Steel Coating, Three Coat Systems - Organic" (www.dot.state.mn.us/products), apply intermediate and finish coats, and caulk per 2478.3.F.5, "Finish Coats,". The Engineer will visually inspect and identify the areas of pack rust.

B. Construction Requirements

1. Remove pack rust as practical from identified crevices using manually operated or power operated descaling tools;
2. Remove rust scale from plane surfaces (hold point);
3. Notify Engineer when pack rust mitigation is considered completed and ask for approval by the Engineer to proceed to step 4, additional removal may be necessary after review;
4. Clean/prepare the surface per 2478.3.D, "Surface Preparation" (hold point);
5. Apply the zinc-rich primer stripe coat and full coat per 2478.3.E, "Application of Paint", and 2478.3.F, "Paint Coats";
6. Allow primer to cure to a point when the compatible penetrating sealant can be applied per the manufacturer (hold point);
7. Engineer will identify areas to receive the penetrating sealant;
8. Use an appropriate brush to flood apply an approved compatible penetrating sealant per the manufacturer’s directions so the product flows and wicks into the crevice, more than one application may be required per the Engineer;
9. Remove/wipe excess product from the surface after flood application (hold point);
10. Apply the intermediate coat per 2478.3.E, "Application of Paint", and 2478.3.F, "Paint Coats" (hold point);
11. Apply the finish coat per 2478.3.E, "Application of Paint", and 2478.3.F, "Paint Coats" (hold point);
12. Apply an approved caulk to all faying surfaces previously identified by the Engineer preventing moisture intrusion per 2478.3.F.5, "Finish Coats."

Provide the manufacturer’s literature for the approved penetrating sealer and caulk in advance of the work being done.

C. Basis of Payment

Payment for materials and labor required to mitigate pack rust and apply penetrating sealer shall be considered an incidental expense to Item No. 2478.518, "Organic Zinc-Rich Paint System (Old) for which no direct compensation will be made.

SB- (2479) INORGANIC ZINC-RICH PAINT SYSTEM

The provisions of 2479, "Inorganic Zinc-Rich Paint System," are supplemented as follows:

Delete 2479.1.A (20) and substitute the following:

Hold Point (for Field Application of Paints ONLY): Puts a hold on any further activities until an inspection is passed. Do not proceed without the written approval of the Engineer. The Department and the Contractor will use the "Start-up Checklist" and the "Daily Quality Assurance Check List" located on the www.dot.state.mn.us/bridge/construction.html site so that quality is assured.

Modify Table 2479-1, "Coating Inspection Requirements," Sublevel, "Prime, Intermediate, and Finish Coat:" changing the table to read as follows:

Verification of surface cleanliness – Examine visually within 1 h before prime painting and for Field applications include a white cloth wipe test (nothing is transferred on to the cloth surface).

Add the following to the second paragraph of 2479.3.C.1:

(10) Identify the following hold points for Department inspection and verification: Abrasive blast profile and cleanliness, stripe coat, prime coat, intermediate coat, finish coat.

Delete the third paragraph of 2479.3.C.1 and substitute the following:

Provide written records meeting all Coating Inspection Requirements to the Engineer upon request on an ongoing basis as the work is being performed. For field applications, also provide complete written records within 5 working days from when the shift was completed to receive partial payment. Provide written records meeting all Coating Inspection Requirements, in its entirety, at the completion of the job, prior to receiving final payment. The QAI or the Engineer will reject the coating system or reduce payment per 1512, "Unacceptable and Unauthorized Work," if the Contractor did not adhere to the approved QM or provided inadequate documentation of adherence to the QM. Conduct subsequent testing with the QAI for the Engineer's approval, at no additional cost to the Department, to determine compliance.

Delete the third and fourth paragraph of 2479.3.E.1 and substitute the following:

Do not start painting until the QAI or the Engineer approves the surface preparation and paint. Before applying paint, clean the surface of flash rust, dust, dirt, grease, oil, moisture, overspray, and other deleterious contaminants that will prevent the paint from adhering (hold point). For field painting applications, provide a white cloth material to the QAI for cleanliness testing.

Apply paint to produce a smooth and uniform film free of runs, drips, sags, pinholes, blisters, mudcracking, and other deleterious conditions. Apply paint in accordance with manufacturer's printed instructions except as stated in this document.

For field applications:

1. Apply paint by spray application ONLY, unless a different application method is allowed in the contract, and
2. Rollers, daubers, brushes are not allowed to be used to apply paint, unless approved by the Engineer in writing.

Delete 2479.3.E.3 in its entirety and replace with the following:

For field application, this entire section may only be used with written permission from the Engineer.

The Contractor may apply paint by rolling, brushing, or daubers in areas unsuitable for spray painting, such as small surface areas where over-spray would be excessive, and small areas requiring paint repair.

If using brushes, manipulate the paint under the brush to provide a smooth, uniform coating over the entire surface, including corners and crevices. Perform final brush strokes horizontal and parallel to each other. Remove brush hairs on the paint surface.

The Contractor may use sheepskin or other approved daubers to paint surfaces inaccessible by spray or brush.

Delete the second paragraph of 2479.3.I and substitute the following:

Do not damage the painted steel in the shop and field during shipping, erection, and construction of the bridge and components. Do not move or handle the painted steel items until the coating dries in accordance with the manufacturer's data sheet. Use nylon straps, padded hooks, slings, or other non-metallic lifting devices to protect coated components or products during handling and loading. Use softeners and edge protection devices to protect the steel from binding chains. Provide padded hooks and slings to hoist the painted components.

1 - DESIGNER NOTE: Use when required

2 - DESIGNER NOTE: For the following paragraph, use where beams are 3309, "High-Strength Low-Alloy Structural Steel," steel and are partially painted at bridge joints.

Paint in accordance with the provisions of 2479, "Inorganic Zinc-Rich Paint System," all structural steel and steel bearing assemblies for Br. No. __________ that are within 7 ft of the end of the beams or girders as measured along the centerline of the beams or girders. The fascia beams must be painted for their full length from end to end of bridge on the following designated surfaces:

- the outboard surfaces of the bottom of the top flange,
- the web,
- the top of bottom flange,
- the edge of the bottom flange,
- the bottom of the bottom flange,
- the inboard edge of the bottom flange.

3 - DESIGNER NOTE: For the following paragraph, use only when the District requires that all structural steel receive a full paint system (typical for 3309 steel is a partial paint system -- see memo by Gary Peterson dated 5/1/2006)

The work to be performed under this contract consists of painting all structural steel members, __________________ of Bridge No. ___________.

4 - DESIGNER NOTE: For the following TWO paragraphs, specify color.

Add the following to the first paragraph of 2479.3.F.5, "Finish Coats":

The color must match AMS-STD-595A No. ___________ and have a semi-gloss finish.

SB2018-2479.1

Use when required for Historic Bridges or a higher level of aesthetics where overspray is NOT acceptable.

CREATED 6/2/2015

REVISED 6/2/2015

SB- Protection of Non-Painted Surfaces

Delete the sixth paragraph of 2479.3.B, "General," and substitute the following:

1 - DESIGNER NOTE: Fill in the blank with the reason for this aesthetic sensitivity. (Historic, high visibility to the public, etc.)

The structure is aesthetically sensitive because of __________. Protect non-painted surfaces that are adjacent to the painted surfaces from overspray. The Engineer will not allow overspray. The Engineer will visually inspect the non-painted surfaces. If the Engineer determines that there is overspray on the non-painted surfaces, then the Engineer will deem the materials as non-conforming in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work". The Engineer will direct the contractor to immediately correct the oversprayed surface and submit a written non-conformance report, containing data required by the Engineer to ensure compliance with the contract. Perform additional work as required by the Engineer at no additional cost to the Department.

SB2018-2511

Use where Hydraulics Unit recommends Matrix Riprap in the Hydraulic Letter and/or specified in Bridge Preliminary Plan.

CREATED 7/15/2015

REVISED 7/22/2019

SB- Random Riprap (Matrix)

1 - DESIGNER NOTE: Until further notice, the Bridge Office Waterway Unit (Solomon Woldeamlak, 651-366-4476, solomon.woldeamlak@state.mn.us) will provide all "MATRIX RIPRAP" special provision boilerplates.

SB2018-2545
Use on jobs where conduit systems are required.
CREATED 7/25/1991
REVISED 9/1/2017 (2)

SB- CONDUIT SYSTEMS

Furnish and install each Conduit System in accordance with the plans, approved erection drawing, the applicable requirements of 2545, "Electrical Lighting Systems," 2550, "Traffic Management System," 2565, "Traffic Control Systems," and the following:

All conduit runs must be straight and true and all offsets and bends uniform and symmetrical. Adjust the elevations of the conduit assembly, for its full length, to approximately the same gradient as the finished roadway, and furnish and install in the approaches such suitable spacers and framing as may be necessary to maintain the correct grade and alignment.

Provide conduit hangers, clamps, straps, U-bolts, strut and bar supports, threaded rod, inserts and miscellaneous hardware in accordance with the NEC and 3805.2.C, "Hangers and Supports for PVC Coated Hot Dipped Galvanized Rigid Steel Conduit" for hanging and surface mounted conduit.

Install the conduit hangers, clamps, straps, U-bolts, strut and bar supports, threaded rod, inserts and miscellaneous hardware as shown in the Plans and as approved by the Engineer. Ensure the installation allows for conduit expansion, contraction, and deflection. At time of installation, adjacent conduit sections to be coupled by fittings must be in true alignment.

Ensure fabrication and inspection of structural metals used for each Conduit System are in accordance with the applicable requirements of 2471, "Structural Metals".

Identify the ends of conduits as lighting, signals, telephone, telegraph, power, etc. by the use of embossed metallic tags or other equally durable identification.

Conform non-metallic conduit and fittings to the requirements of the NEMA Standards Publication No. TC 14, titled "Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings."

Furnish three sets of erection drawings of each Conduit System to the Engineer for preliminary review. Two sets will be forwarded to the Bridge Construction and Maintenance Engineer for review and one set will be returned to the Contractor showing any necessary corrections.

The drawings must be to a scale of not less than $^{1}/_{4}$" = 1'-0" and show the locations of the diaphragms and inserts, a conduit placement scheme, and detailed views of the placement of the sleeves through the parapets, end webs, and diaphragms. Define the locations of the sleeves from established reference points or lines and elevations, such as working points or centerlines and bridge seat elevations. Show the locations and manufacturer of expansion fittings in the drawings.

Space concrete inserts for hanger assemblies in such a manner that the assemblies will not interfere with conduit couplings. Hanger spacing must not exceed 10 ft. Conduit must be installed in 10 ft lengths where practicable.

1 - DESIGNER NOTE: For the following paragraph, use with suspended systems where linear expansion is greater than 4 inches and vertical movement would not be detrimental to the systems.

Each expansion fitting must be in accordance with 3839, "Conduit Expansion Fittings," and the plan, except that the fitting must provide for greater than 4 inches linear movement when required by the plans.

2 - DESIGNER NOTE: For the following paragraph, use with concrete encased systems where movement will not exceed $^3/_4$" in any direction.

Each expansion/deflection fitting must be an approved watertight unit which can accommodate $^3/_4$ inch of linear expansion or contraction of conduit, $^3/_4$ inch of parallel misalignment of adjacent conduit sections, and up to 30° of angular misalignment of the axes of adjacent conduit sections. To prevent damage to internal bonding jumper, fittings should not be twisted during installation.

3 - DESIGNER NOTE: For the following paragraph, use where expansion and expansion-deflection fittings are joined together to provide for expansion greater than $^3/_4$" in the longitudinal direction and for misalignment.

A combination expansion/deflection fitting must consist of an expansion fitting and an expansion/deflection fitting connected by a nipple. The expansion fitting must be in accordance with 3839, "Conduit Expansion Fittings," except that the fitting must provide for greater than 4 inches linear movement when required by the plans. Each expansion/deflection fitting must be an approved watertight unit which can accommodate $^3/_4$ inch of linear expansion or contraction of conduit, $^3/_4$ inch of parallel misalignment of adjacent conduit sections, and up to 30° of angular misalignment of the axes of adjacent conduit sections. To prevent damage to internal bonding jumper, do not twist fittings during installation.

Furnish and seal any remaining conduit opening at the back face of each abutment with one of the materials listed on the Department's "Approved/Qualified Product Lists of Bridge Silicone Joint Sealants" www.dot.state.mn.us/products/Bridge, after the conduit is in place.

All sidewalk or flush mounted junction boxes must be removable flange (NEMA 5) galvanized cast iron with checkered cast iron covers. Equip these junction boxes with $^1/_2$ inch diameter pipe drains. Each conduit entrance and the pipe drain entrance must be bossed and threaded to provide five full threads. Fasten the cover and flange with stainless steel screws. Equip the cover with pry bar slots and a neoprene gasket.

Include in each junction box conduit entrance an insulating bushing of the appropriate size.

SB- (2557) FENCING

Furnish and install the complete wire fence (including its frame work, anchorages, and electrical grounds) on the bridge in accordance with the applicable provisions of 2471, "Structural Metals," 2557, "Fencing," and the following:

A. Materials

1. All pipe for posts, rails, and braces must be Standard Weight (ANSI B36.10, Schedule 40) and a grade of steel pipe per ASTM A53 Grade B and meet all the following requirements:

   a. Tensile Properties: Tensile strength, min., 60,000 psi; Yield point, min., 35,000 psi.;

   b. Bending Properties: The pipe must withstand being cold bent through 90 degrees to the radius specified in the plans, without developing cracks and without opening the weld;

   c. Welding Properties: All pipe used for members which require welding must be a grade of steel pipe which is easily welded; and

   d. Coating Properties: Galvanized per 3394, "Galvanized Structural Shapes," after all welding and bending are completed.

   Inspect pipe to ensure compliance with the above requirements according to 2471.3.M, "Fabricator Inspection".

2. Chain link fabric must be 9 gauge wire, 2 inch mesh, Type II fabric complying with 3376, "Fence Wire," except that the fabric must be Type IV when vinyl coating is specified.

3. Hardware, including bolts, nuts, washers and lock washers, must be galvanized per 3392, "Galvanized Hardware". Galvanize all other material per 3394, "Galvanized Structural Shapes".

4. All standard hardware (clamps, caps, and couplings) must be size and type which are compatible with the members and which result in a detail with a workman-like appearance.

1 - DESIGNER NOTE: For the following paragraph, INSERT COLOR.

5. After being galvanized, all fence fabric, pipes, posts, fittings, and hardware must be _______ vinyl coated. The minimum thickness of vinyl coating for pipes, posts, fittings, and hardware is 10 mils.

2 - DESIGNER NOTE: Only use the following paragraph when the plan includes 5-397.202.

6. In lieu of the single grooved washer detailed on the plan for the handrail connection, two individual grooved washers may be used.

3 - DESIGNER NOTE: Fill in the yellow blank with the SB- number for 2402.8 SP.

B. Anchorage Requirements See SB-__________

C. Construction Requirements

1. Delete the requirements for shop detail drawings per 2471.3.B, "Shop Detail Drawings". However, supply the Materials Engineer with a complete list of fence components. Include in the list the names of all suppliers and fabricators for the various components. Do not install the fence until the Materials Engineer and the Project Engineer have approved the required information.

2. Ensure all rods or bolts have lock washers.

3. Ensure chain link fabric is continuous between stretcher bars.

4. Ground all metal railings. Install all electrical grounding in accordance with the applicable provisions of 2557, "Fencing," and the National Electrical Code. Clamp or braze the ground wires to the grounding device, then practicably route and attach to the nearest rail by clamping, brazing, or any other approved means that will provide a permanent positive connection. If rail has non-continuous sections, use a #6 AWG solid copper wire to connect adjacent railing panels.

   If the bridge does not include exposed electrical equipment, then ground the rails at points directly below or adjacent to the railing at all abutment corners. The grounding system must consist of a #6 AWG solid copper wire connected to the railing which in turn is connected to a copper coated steel rod having a nominal diameter of $^5/_8$ inch or more and a minimum length of 8 ft installed to an elevation approximately flush with the ground surface.

   If the bridge includes exposed electrical equipment, such as roadway lighting, traffic signals, variable message signs, surveillance cameras, or ramp metering, then bond the railing grounding system to the exposed electrical equipment grounding system. Refer to the electrical plans and electrical special provisions for details regarding bonding multiple electrical grounding systems.

5. Coat pipe surfaces which have the galvanizing removed during field fabrication (cut or drilled edges) with an approved zinc rich coating. Prior to the application of the coating, clean the pipe in accordance with the manufacturer's recommendations.

D. Method of Measurement

The length of wire fence for payment will be the horizontal dimension along the centerline of each fence between the centers of end posts. Suspended lengths at end posts will not be included in the length for payment.

E. Basis of Payment

Furnishing and installing the Wire Fence, as specified above, will be paid for as Item No. 2557.503 "WIRE FENCE DESIGN ___ VINYL COATED", at the Contract price per linear foot.

SB2018-2565
Use on projects where conduit systems and/or loop detectors are required.
CREATED 12/14/2015
REVISED 12/14/2015

SB- (2565) TRAFFIC CONTROL SYSTEMS

The provisions of 2565, "Traffic Control Systems," are supplemented as follows:

SB2018-2565.1
Use when Loop Detectors are required to be installed in a bridge deck.
CREATED 6/2/2015
REVISED 9/1/2017 (3)

SB- Loop Detector

This work consists of furnishing, installing and testing of loop detector(s) to be cast into the bridge deck concrete on Bridge No. __________ for traffic control signals. Perform the work in accordance with the applicable requirements of 2565.3.G "Loop Detectors," the current edition of the National Electrical Code, MnDOT Standard Plate No. 8132B, the Plans, and the following:

A. Construction Requirements

Install rigid PVC loop detectors in accordance with Standard Plate 8132 and as follows:

At the locations shown in the Plans, attach each loop detector assembly, including lead-in, to the bottom of the top reinforcement bar mat with plastic coated tie wires at each intersection of a bar and the loop detector conduit. Connect the conduit for the lead-in cable to the appropriate junction box suspended below the deck as shown on the Conduit System (Signals) Plan sheet. The connection to the junction box shall be made with proper adapters and fittings to form a moisture-proof seal. To prevent intrusion of moisture before the loop conductors are connected to the signal system, tape the free ends of the leads with rubber tape inside of the junction boxes. Installation of loop detectors shall be to the satisfaction of the Engineer.

Loop detector lead-in cables (from the traffic signal controller cabinets to the appropriate junction boxes) and loop detector splice encapsulation kits (for connecting loop detector conductors in the roadway to the loop detector lead-in cables) shall be furnished and installed as part of the pay item for Item No. 2565.516 (TRAFFIC CONTROL SIGNAL SYSTEM A) and Item No. 2565.516 (TRAFFIC CONTROL SIGNAL SYSTEM B), and are thus not included as part of the pay item for Item No. 2565.602 (NMC LOOP DETECTOR 6' x 6'). See Division SS (Traffic Control Signals) for further information.

B. Method of Measurement

Each loop detector assembly will be measured as an integral loop complete inplace and ready for operation.

C. Basis of Payment

Payment for Item No. 2565.602 "RIGID PVC LOOP DETECTOR ______'x______'" will be made at the Contract price per each which shall be compensation in full for all costs incidental thereto. This item includes the following:

1. Rigid PVC conduit and conduit fittings for loop detectors.
2. Rigid PVC conduit from loop detector to junction box including necessary adapters and fittings for junction box.
3. Loop detector conductors extending to junction box
4. Loop detector installation in the bridge deck.
5. Loop detector testing and reporting.

SB2018-3308.1

Use on projects with repairs to steel members that were fabricated prior to toughness requirements to improve fatigue cracking resistance (generally bridges constructed prior to 1975). Many rolled shapes are not readily available with Charpy V notch testing and can greatly increase the cost for projects requiring small quantities (<20000 lbs) of miscellaneous steel shapes. The new steel members will have a longer fatigue life than existing steel. See Structural Metals Engineer for questions.

CREATED 9/1/2017
REVISED 9/1/2017

SB- Impact Testing of Structural Steel Repair Material

Delete the contents of 3308.3.B, "Impact Tests", and substitute the following:

The Department will not require impact testing for structural steel provided for repair or replacement of existing steel member as indicated in the Plan.

1 - DESIGNER NOTE: Add the following note to the plans:

SEE SPECIAL PROVISIONS FOR IMPACT TESTING REQUIREMENTS FOR STRUCTURAL STEEL MEMBERS.

SB2018-3371
Use on all bridges requiring steel shells for piling where the piling is exposed to view.
CREATED 3/5/2001
REVISED 9/28/2015 (5)

SB- (3371) STEEL SHELLS FOR CONCRETE PILING

The provisions of 3371, "Steel Shells for Concrete Piling," are supplemented as follows:

1 - DESIGNER NOTE: Only use the following paragraphs when Bridge Aesthetics require a "Level A or B" attention.

Supplement the fourth paragraph of 3371.2, "Requirements," with the following:

Pipe containing an as described defect must be given one of the following dispositions:

1. Remove the visible welds, "flash" of trimmed welds or other defects by grinding in such a way that the ground area blends in smoothly with the contour of the pipe. Verify complete removal of the defect by visual inspection of the ground area and ensure the wall thickness in the ground area is not adversely affected.
2. Cut off the section of pipe containing the defect.
3. Reject the entire pipe.

2 - DESIGNER NOTE: Only use the following paragraphs when Bridge Aesthetics require a "Level C" attention and after an evaluation of the site or location of the bridge has been made.

Supplement the fourth paragraph of 3371.2, "Requirements," with the following:

Give pipe containing a non-permissible irregularity as described above one of the following dispositions:

1. Remove the non-permissible irregularity by grinding in such a way that the ground area blends in smoothly with the contour of the pipe. Ensure the wall thickness in the ground area is not adversely affected. Smoothly contoured welds with a clean appearance need not be ground flush. The only permissible irregularity will be one caused from the original manufacturing of the pipe (e.g. weld seam of a Double Submerge Arc Weld process), or a field weld that has a clean appearance.
2. Cut off the section of pipe containing the non-permissible irregularity.
3. The entire pipe containing a non-permissible irregularity may be rejected at the Engineer's discretion.

SB2018-3391
Use on all steel bridges with high strength structural bolts.
Include SB2018-2402.1 with this provision.
CREATED 4/2/2018
REVISED 4/2/2018

SB- (3391) FASTENERS

Add the following after the third paragraph of section 3391.2.B, "High Strength Structural Steel Bolts":

For bolts meeting the requirements of ASTM F3125, "Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions," include Supplementary Requirement S4 "Rotational Capacity Testing". Ship required documentation with the fastener assemblies and provided to the Engineer.

SB- (3394) GALVANIZED STRUCTURAL SHAPES

Delete the third paragraph of 3394.2, "Requirements," and replace with the following:

For galvanized surfaces that have handling marks or minor chips that are no greater than ½ inch at the narrowest dimension, repair in accordance with ASTM A780, Annex A1 or Annex A2 (brush applied paint only). Ensure the dry film thickness (DFT) of the coating repair is in accordance with ASTM A123. Perform repairs in accordance with the supplier's quality procedures. Obtain an approved non-conformance report (NCR) for each repair. See 2452.3.J.2, "Galvanized Piles," for hot-dipped galvanized (HDG) pile repair.

SB2018-3520
Use if a two-coat Zinc-Rich Paint system is allowed by the Regional Engineer.
CREATED 8/14/2018
REVISED 8/14/2018

SB- (3520) ZINC-RICH PAINT SYSTEMS

Delete MnDOT 3520.2.B.4 and replace with the following:

B.4 Two Coat Zinc-Rich System

Provide a zinc-rich system consisting of either a moisture-cure zinc-rich primer or an organic zinc-rich primer and a fast-dry polyaspartic urethane finish coat.

SB2018-3741

Use the following paragraph on rehabilitation jobs when a replacement product is needed between steel masonry plate and concrete surface in place of lead sheets (lead is no longer environmentally allowed). Add this paragraph as a "NOTE" on the plan sheet that shows the detail. Reminder: This is not intended to remain in this special provision, but that it be incorporated into the plan.

CREATED 3/22/2002

REVISED 6/2/2015 (14)

SB- (3741) ELASTOMERIC BEARING PADS

Provide $^{1}/_{8}$ in 60 durometer plain elastomeric pad or preformed fabric pad meeting AASHTO *LRFD Bridge Construction Specification Section 18.10*. Waive the sampling and testing requirements under 3741, "Elastomeric Bearing Pads," and AASHTO M 251.