

## **FOREWORD**

Highway construction utilizes a wide variety of materials. Control of the quality of these materials and the methods by which they are used is a major concern of the highway practitioner throughout the planning, design, and construction stages of a project.

Requirements are set up in the form of specifications to govern both the quality of materials and their utilization. The Office of Materials has established procedures for determining whether the materials used and the end products meet the specified requirements. To assist the practitioner in making these determinations, this section has prepared a series of manuals as a guide to applying the standard control procedures.

The Supervising Engineers and their Inspectors accomplish the final control of the quality of materials and their use through on-the-job inspection. The ultimate responsibility rests with the Field Personnel to see that materials used meet the requirements of the Specification, the prescribed procedures are followed when so specified, and the required end results are obtained.

This Manual is intended primarily for use in the Field and is prepared from that point of view. We have endeavored to point out the fundamental principles involved in the different types of work and to describe standardized procedures for practical application by the inspection personnel on the job.

Adherence to these procedures will help ensure uniformity of requirements throughout the State on all projects, and will do much to make the inspection more effective in obtaining the best construction possible under the Specification.

The Manual has been revised and brought up-to-date to conform to the 2000 Edition of the Mn/DOT Standard Specifications for Construction.

In addition to this printed copy, we have stored, for your convenience, a copy (pdf format) of the Concrete Manual on the Mn/DOT Concrete Engineering website at [www.mrr.dot.state.mn.us/pavement/concrete/manual.asp](http://www.mrr.dot.state.mn.us/pavement/concrete/manual.asp).



**GENERAL**  
**5-694.000****5-694.001 INTRODUCTION**

This Manual is prepared to familiarize Engineering Personnel, Contractors, and Consultants with the fundamentals, principles, and better practices of concrete construction so that the best possible concrete pavements and structures, consistent with job specifications, are obtained. Particular emphasis is placed on test methods and inspection procedures for the control of concrete production and placement. Manual specifics are addressed to both the Contractor and the Engineer. However, the Engineer or Inspector should never adjust or otherwise operate the Contractor's equipment.

It includes a description of concrete materials, their uses and applications on concrete pavements, bases, bridges, culverts, curb and gutter, and other miscellaneous construction, construction procedures for the various types of work, items of concern to the Inspectors, duties of the Inspectors, typical design, adjustment of concrete mixes, useful tables, and required report forms.

Familiarity with the contents and instructions in this Manual will simplify the work of the Inspector and provide uniformity of control procedures. Where the instructions in this Manual differ from the Specifications and Plans on a project, the Specifications and Plans shall govern.

The Specifications are not repeated in their entirety herein; however, as an aid in locating the related material, a reference number sometimes is given.

**5-694.002 PROCEDURE FOR ROUNDING-OFF NUMBERS**

To “round-off” is to reduce to some predetermined point the number of places to which an observed or calculated figure is recorded. This is accomplished by either retaining the figure in the last place or point based upon the value of figures following this point. The general rules for rounding-off follow:

1. When the figure next beyond the last place retained is less than 5, retain unchanged the figure in the last place retained.
2. When the figure next beyond the last place retained is greater than 5, or a 5 followed by any figures other than zeros, increase by 1 in the figure in the last place retained.
3. When the figure next beyond the last place retained is exactly 5 (a 5 followed only by zeros), the figure in the last place retained shall remain unchanged if that figure is even (0, 2, 4, 6, 8) and increased by 1 if the figure in the last place retained is odd (1, 3, 5, 7, 9). This means: when the figure next beyond the last place retained is 5 and is followed only by zeros, round to nearest even number.
4. The rounded-off value of any number is performed by direct rounding of the most precise observed or calculated value available and not in two or more steps of successive roundings.
5. When it is desired to round-off a figure to the nearest 50, 5, 0.5, etc. proceed by doubling the observed or calculated value and round that value to the nearest 100, 10, 1.0, 0.1, etc. in accordance with the above procedures. Then, halve (divide by 2) the rounded figure to obtain the final rounded product. For example: To round-off the number 7075 to the nearest 50, double the number 7075 (14150) and round that number to the nearest 100 (becomes 14200). When 14200 is divided by 2, the resulting number 7100, is the rounded product of 7075. Some examples of rounding off are:

<u>Observed or Calculated Value</u>	<u>To Be Rounded- Off to Nearest</u>	<u>Becomes Rounded Off Value</u>
1.03497	1/100 or 0.01	1.03
1.03500	1/100 or 0.01	1.04
1.04500	1/100 or 0.01	1.04
1.03502	1/100 or 0.01	1.04
1.34999	1/10 or 0.1	1.3
1.35000	1/10 or 0.1	1.4
1.45000	1/10 or 0.1	1.4
1.35001	1/10 or 0.1	1.4
1.49999	Whole Unit or 1	1
1.50000	Whole Unit or 1	2
2.50000	Whole Unit or 1	2
1.50023	Whole Unit or 1	2
1.24987	1/2 or 0.5	1.0
1.25000	1/2 or 0.5	1.0
2.25000	1/2 or 0.5	2.0
2.25023	1/2 or 0.5	2.5

**5-694.003 Mn/DOT CONCRETE SPECIFICATIONS**

Below is a list of Specifications relating to concrete that are currently found in the Mn/DOT Standard Specifications for Construction, 2000 Edition.

**DIVISION I - GENERAL REQUIREMENTS****DIVISION II - CONSTRUCTION DETAILS**

- 2301 - CONCRETE PAVEMENT
- 2401 - CONCRETE BRIDGE CONSTRUCTION
- 2404 - CONCRETE WEARING COURSE FOR BRIDGES
- 2411 - MINOR CONCRETE STRUCTURES
- 2461 - STRUCTURAL CONCRETE
- 2514 - SLOPE PAVING
- 2521 - WALKS
- 2531 - CONCRETE CURBING
- 2533 - CONCRETE MEDIAN BARRIERS

**DIVISION III - MATERIALS**

- 3101 - PORTLAND CEMENT
- 3102 - GROUND GRANULATED BLAST FURNACE SLAG CEMENT
- 3103 - PORTLAND-POZZOLAN CEMENT
- 3105 - BAGGED PORTLAND CEMENT CONCRETE PATCHING MIX GRADE 3U18
- 3106 - HYDRATED LIME
- 3107 - MASONRY CEMENT
- 3113 - ADMIXTURES FOR CONCRETE
- 3115 - FLYASH FOR USE IN PORTLAND CEMENT CONCRETE
- 3126 - FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE
- 3137 - COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE
- 3301 - REINFORCEMENT BARS
- 3702 - PREFORMED JOINT FILLERS
- 3721 - PREFORMED ELASTOMERIC COMPRESSION JOINT SEALS FOR CONCRETE
- 3723 - JOINT AND CRACK SEALER (HOT POURED ELASTIC TYPE)
- 3725 - JOINT AND CRACK SEALER (HOT POURED, EXTRA LOW MODULUS, ELASTIC TYPE)
- 3751 - BURLAP CURING BLANKETS
- 3754 - MEMBRANE CURING COMPOUND
- 3755 - EXTREME SERVICE MEMBRANE CURING COMPOUND
- 3902 - FORM COATING MATERIALS
- 3906 - WATER FOR CONCRETE AND MORTAR
- 3911 - CALCIUM CHLORIDE
- 3917 - CONCRETE TREATING OIL

## 5-694.004 METRIC EQUIVALENTS

Below is a list of different metric conversion factors commonly dealt with in the concrete industry.

## A. METRIC CONVERSIONS

	MULTIPLY	BY	TO OBTAIN
LENGTH	inches (in.)	25.40	millimeters (mm)
	feet (ft.)	0.3048	meters (m)
	yards (yd.)	0.9144	meters (m)
	miles (mi.)	1.609 344	kilometers (km)
AREA	square inches (in <sup>2</sup> )	645.16	square millimeters (mm <sup>2</sup> )
	square feet (ft <sup>2</sup> )	0.0929	square meters (m <sup>2</sup> )
	square yards (yd <sup>2</sup> )	0.8361	square meters (m <sup>2</sup> )
VOLUME	cubic inches (in <sup>3</sup> )	16387.064	cubic millimeters (mm <sup>3</sup> )
	cubic foot (ft <sup>3</sup> )	0.02832	cubic meters (m <sup>3</sup> )
	cubic yards (yd <sup>3</sup> )	0.76455	cubic meters (m <sup>3</sup> )
MASS (WEIGHT)	ounces (oz.)	28.3495	grams (g)
	pounds (lb.)	0.4536	kilograms (kg)
	kip (k)	0.4536	tonnes (metric ton)
	tons (Tn)	0.9072	tonnes (metric tons)
	tonnes (metric ton)	1000.0	kilograms (kg)
	sack of cement	42.64	kilograms (kg)
STRESS	pounds/square inch (psi)	6.8948	kilopascal (kPa)
	pounds/square inch (psi)	0.006895	megapascal (MPa)
	kip/square inch (ksi)	6.8948	megapascal (MPa)
	kip/square foot (ksf)	47.8803	kilopascal (kPa)
	pascal (Pa)	1.0	N/m <sup>2</sup>
FORCE	poundforce (lbf)	4.4482	newton (N)
	kip (k)	4.4482	kilonewton (kN)
	newton (N)	1.0	kg@m/sec <sup>2</sup>
MASS DENSITY	pounds/cubic foot (pcf)	16.0185	kilogram/cubic meter (kg/m <sup>3</sup> )
	pounds/cubic yard (pcy)	0.5935	kilogram/cubic meter (kg/m <sup>3</sup> )

	MULTIPLY	BY	TO OBTAIN
WATER	gallons (gal)	3.785	liters (L)
	liters (L)	1.0	kilograms (kg)
PROFILOGRAPH OR INERTIAL PROFILER	inches/mile (in/mi)	15.78	millimeters/kilometer (mm/km)
TEMPERATURE	Fahrenheit (°F)	5/9(°F – 32)	Celsius (°C)
ADMIXTURE	ounces/cubic yard (oz./c.y.)	39	milliliters/cubic meter (mL/m <sup>3</sup> )
	fluid ounces/100 lb. cement (fl.oz./cwt)	0.6519	milliliters/kilogram (mL/kg)
	gallons (gal)	0.0037831	cubic meter (m <sup>3</sup> )

**B. PROPERTIES OF CONCRETE**

CONCRETE STRENGTHS (Not Exact Conversions)								
Metric (MPa)	19	23	27	30	32	34	37	39
English (psi)	2700	3400	3900	4300	4700	5000	5300	5600

UNIT WEIGHTS (Not Exact Conversions)		
	Metric	English
Steel	7850 kg/m <sup>3</sup>	490 pcf
Concrete	2400 kg/m <sup>3</sup>	150 pcf

REINFORCING BARS, M31M				
Grade		Tensile and Yield Strengths		
Metric	English	Tensile Strength (MPa)	Min. Yield Strength (MPa)	Min. Yield Strength (ksi)
300	40	500	300	40
400	60	600	400	60

COEFFICIENT OF THERMAL EXPANSION		
	Metric	English
Steel	0.0000117/EC	0.0000065/EF
Concrete	0.0000108/EC	0.000006/EF

**C. SIEVE SIZES**

The sieves used for portland cement concrete are noted below.

<b><u>Metric</u></b>	<b><u>English</u></b>
50 millimeter (mm)	2"
37.5 mm	1 1/2"
31.5 mm	1 1/4"
25.0 mm	1"
19.0 mm	3/4"
16.0 mm	5/8"
12.5 mm	1/2"
9.5 mm	3/8"
4.75 mm	#4
2.36 mm	#8
2.00 mm	#10
1.18 mm	#16
850 micrometer ( $\mu\text{m}$ )	#20
600 $\mu\text{m}$	#30
425 $\mu\text{m}$	#40
300 $\mu\text{m}$	#50
180 $\mu\text{m}$	#80
150 $\mu\text{m}$	#100
75 $\mu\text{m}$	#200



**5-694.005 REINFORCING BARS AND HOOK DETAILS**

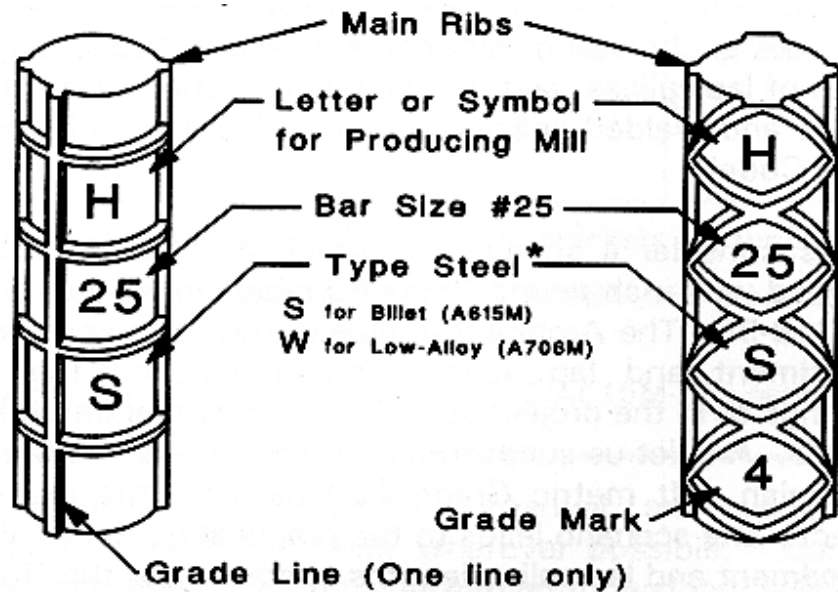
Reproductions of Concrete Reinforcing Steel Institute (CRSI) Reinforcing Bar Specifications and Standard Metric Hook Details are reproduced in Figures A through C 5-694.005.

A 1997 publication from the CRSI indicates that ASTM has approved the soft converted bar sizes and that AASHTO is recommending the use of these revised ASTM specifications. The net result is that the bars are the same physical size as previous, with a new metric size designation.

Figure A 5-694.005 shows the approved standard bar markings for Mn/DOT projects. Soft metric reinforcing bars are identified with the Producer's mill designation, bar size, type of steel, and minimum yield strength or grade as shown in Figure B 5-694.005. Figure C 5-694.005 shows approved hook details.

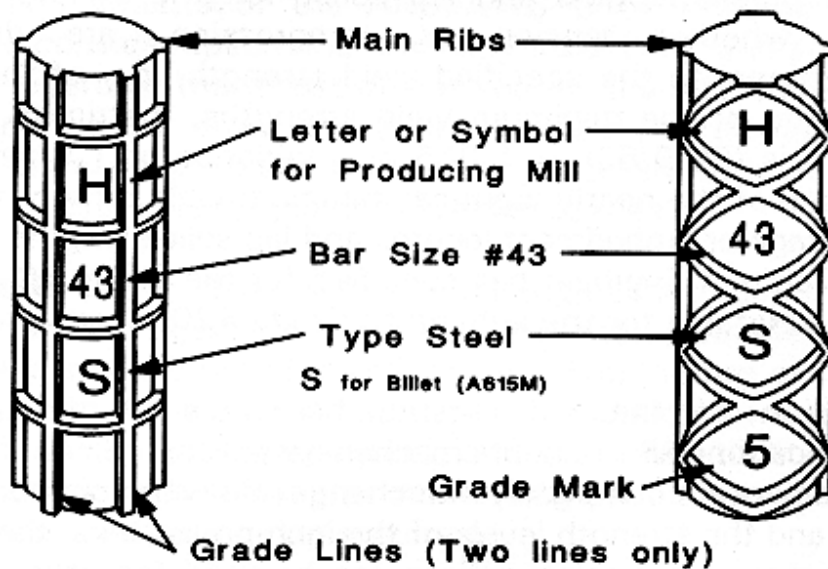
<b>METRIC BAR SIZE</b>	<b>DIAMETER (mm)</b>	<b>DIAMETER (in.)</b>
#10	9.5	0.375
#13	12.7	0.500
#16	15.9	0.625
#19	19.1	0.750
#22	22.2	0.875
#25	25.4	1.000
#29	28.7	1.128
#32	32.3	1.270
#36	35.8	1.410
#43	43.0	1.693
#57	57.3	2.257

**Figure A 5-694.005<sup>1</sup>**



\* Bars marked with a S and W meet both A615M and A706M

### GRADE 420



### GRADE 520

Figure B 5-694.005<sup>2</sup>

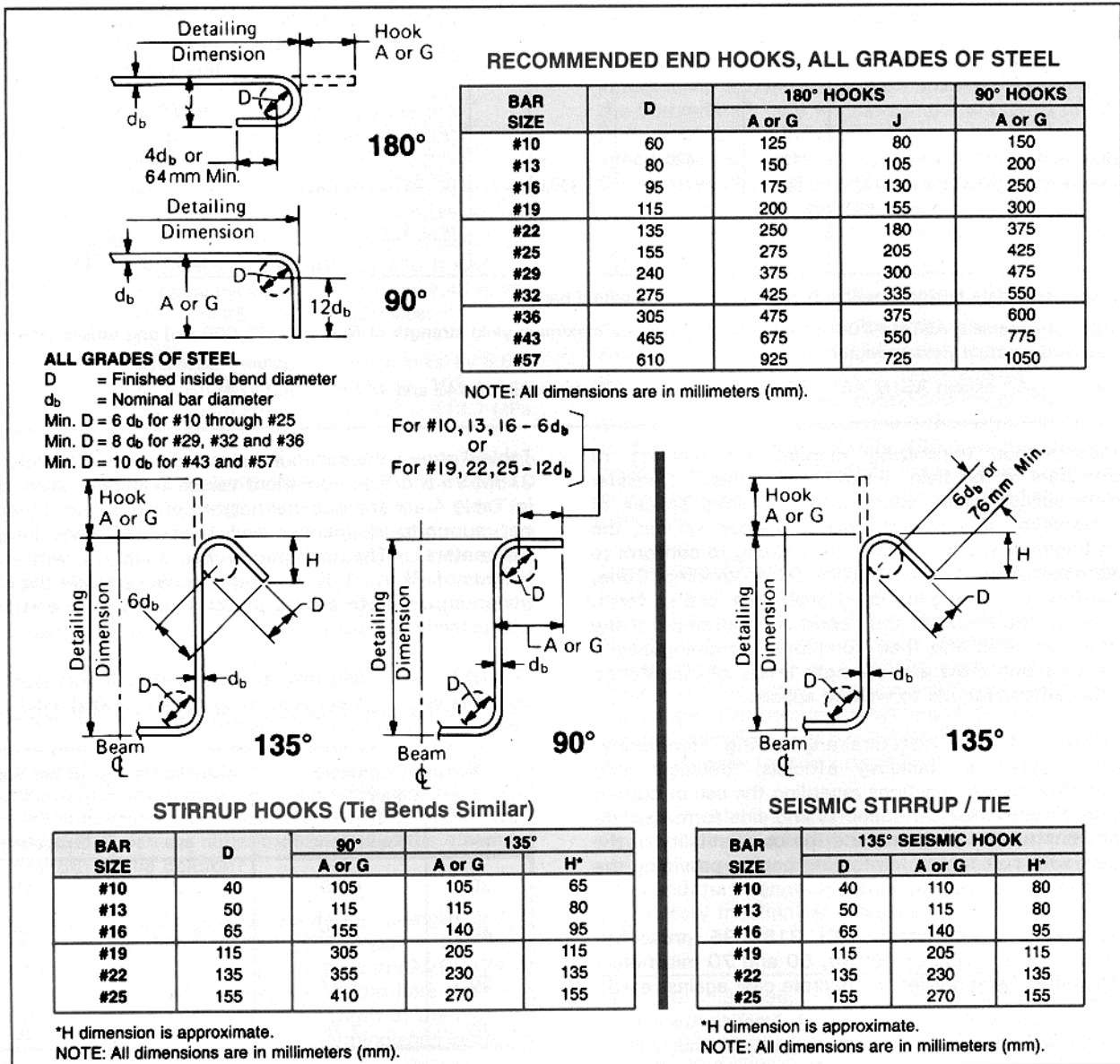


Figure C 5-694.005<sup>3</sup>

5-694.010 INSPECTOR'S CHECKLISTS

These checklists serve as a guide to new Inspectors, or refresh the memory of experienced Inspectors. While they are fairly complete, a good Inspector will modify and add to these checklists to meet the requirements of their particular job, taking into consideration the personnel and equipment used, and changes in the Specifications and the Special Provisions.

**5-694.011 CHECKLIST FOR READY-MIX CONCRETE PLANT MONITOR - AGENCY**

<b>√ LIST FOR READY-MIX CONCRETE PLANT MONITOR</b>	<b><u>Specs.</u></b>	<b><u>Concrete Manual</u></b>
1. Confirm that the ready-mix plant is authorized to produce certified concrete and that a <i>Contact Report</i> (signed by the Agency and Producer) is on file for the current year.	2461.4D7e	5-694.716
2. Become familiar with concrete batching and mixing equipment and the duties of the Producer.	2461.4B 2461.4C	5-694.012 5-694.430
3. Verify scale calibrations are complete and up-to-date.		5-694.401 -.440
4. Verify cement, fly ash, and admixtures are certified and approved. ( <a href="http://www.mrr.dot.state.mn.us/pavement/concrete/products.asp">www.mrr.dot.state.mn.us/pavement/concrete/products.asp</a> )		5-694.114 -.116
5. Obtain cement and fly ash invoices (if available).		5-694.114
6. Verify the sources of the aggregates used in the mix.		
7. Check <i>Certificate of Compliance</i> for completeness and accuracy.	2461.4D7a	5-694.723
8. Verify the proper mix design weights.		5-694.143
9. Verify batch person is using current moisture results.		5-694.718
10. Take appropriate lab samples as required by the Schedule of Materials Control.		5-694.132
11. Fill out lab sample I.D. cards completely and enclose them with lab samples. Promptly submit to lab for testing.		5-694.751
12. Obtain fine and course aggregate verification samples as per Schedule of Materials Control and give a split sample to the Producer. <b>NOTE: Where problems of compliance with the Certified Ready-Mix Program occur, increase plant inspection and testing rates.</b>		5-694.132 -.135
13. Watch Certified Technician obtain and run moisture and gradation tests when possible.		5-694.141 -.148
14. Check to make sure the Producer completed the initial gradation and moisture tests prior to the start of concrete production each day.	2461.4D7c 2461.4D7d	
15. Check to make sure the Producer has run the required amount of gradation and moisture tests. Obtain companion to Producer's QC gradation sample as needed.	Schedule of Materials Control	
16. Review gradation results with respect to project specifications. Compare QC results to verification and companion sample results.	3126 3137	
17. Check Producer's aggregate QC charts for material consistency and verify charts and plant diary are accurate and up-to-date.	2461.4D7b - 2461.4D7d	5-694.735 5-694.736
18. Watch the batchperson weigh at least 1 load each time an audit gradation is collected. This includes observing the removal of wash water from the ready-mix truck by reversing the drum.	2461.4D7d	
19. Validate all water weights on the load watched and compare the total water with the design water. Record the results on the <i>Weekly Certified Ready-Mix Plant Report</i> .	2461.4D7d	5-694.725
20. Maintain daily diary which includes: time arrived and departed from plant, lab sample type and I.D. number, total cubic yards produced (estimate if necessary), materials with appropriate sources, any additional comments, and the signature of the Agency Inspector.	2461.4D7b	5-694.726
21. Submit <i>Weekly Certified Ready-Mix Plant Report</i> to Mn/DOT Concrete Engineering Unit on a weekly basis.	2461.4D7d	5-694.725

## 5-694.012 CHECKLIST FOR READY-MIX CONCRETE PLANT – PRODUCER

<u>√ LIST FOR READY-MIX CONCRETE PLANT - PRODUCER</u>	<u>Specs.</u>	<u>Concrete Manual</u>
1. Sample aggregates for gradation and moisture test. See Certified Ready-Mix Concrete Plant Specifications, Special Provisions, and Schedule of Materials Control.	3137 3126	5-694.127 5-694.128
2. Run fine and coarse aggregate gradations. If aggregates fail to meet Specifications, inform plant superintendent immediately.	2461.4D7d	5-694.141 5-694.144 - .148
3. Perform moisture test on all aggregate fractions and report results to the batch person.	2461.4D7c	5-694.142 - .143
4. If there is a definite indication of moisture change at any time, or prior to a high-early pour, run new moisture tests.		
5. Complete required reports: <ul style="list-style-type: none"> <li>• <i>Concrete Batching Report - Form 2152</i></li> <li>• <i>Chart moisture on Aggregate Moisture Content Chart</i></li> <li>• <i>Concrete Aggregate Worksheet - Form 21763</i></li> <li>• <i>Chart gradations on QC charts</i></li> <li>• <i>Weekly Concrete Aggregate Report - Form 2449</i></li> </ul>		5-694.718 - .722
5. Make periodic checks during the day of the entire plant to see that it is functioning satisfactorily. Spot check the central plant mix timer for accuracy.	2461.4D	5-694.401 - .430
6. Check accuracy of scales and verify scale calibrations are complete and up-to-date.		5-694.431 - .435
7. Check the aggregate bins and piles. Assure that there is no contamination or interblending of the aggregates.		5-694.124
8. Check Certificate of Compliance for completeness and accuracy, or prepare a handwritten <i>Certificate of Compliance –Form 0042</i> if necessary.	2461.4D7a	5-694.723
9. Witness the actual batching of concrete to assure desired batch weights and tolerances are met.	2301.3F	
10. Check ready-mix trucks occasionally to see if revolution counters are working properly and the mixing drums are clean and blades are not worn.	2461.4D5	
11. Detain transit mix trucks on a level area until the minimum specified mixing time is accomplished.	2461.4D5c	
12. Maintain a daily plant diary that must remain at the plant site. The diary will document state project numbers, yards produced each day, tests performed, material problems, breakdowns, weather, etc., all to the approval of the Engineer.	2461.4D7b	5-694.724

## 5-694.013 CHECKLIST FOR MISCELLANEOUS CONCRETE INSPECTION

√ LIST FOR MISC. CONCRETE INSPECTION	<u>Specs.</u>	<u>Concrete Manual</u>
1. Become familiar with applicable specifications for the type of work performed. Check the plan and special provisions for details or changes.		
2. Prior to placement of concrete: <ul style="list-style-type: none"> <li>• Review Contractor's equipment and forms for contract compliance and to ensure plan dimensions are met.</li> <li>• Make sure Contractor has made adequate arrangements for proper curing and protection of the concrete.</li> <li>• Obtain equipment for slump and air tests, cylinders, and temperatures.</li> </ul>	2461.4A5	5-694.511 5-694.521 5-694.531 5-694.541
3. During placement of concrete: <ul style="list-style-type: none"> <li>• Check vertical and horizontal alignment. Make sure forms are complete and adequately braced to correct line and grade.</li> <li>• Inspect grade for slope, adequate compaction, and proper moisture.</li> <li>• Review requirements for reinforcing steel, tie bars, expansion joints, and contraction joints. Check reinforcement to see if it is securely placed in the proper position.</li> <li>• Check location from offset stakes. Confirm handicap ramp and driveway locations.</li> <li>• Verify conduits, brackets or other openings or attachments are securely in place.</li> <li>• Ensure that proper drainage conditions are met.</li> <li>• Review backfilling procedures.</li> </ul>	Standard Plans and Standard Plates	5-694.630 - .632 5-694.642 - .664
4. Check on placement of concrete throughout the pour to see that concrete is placed without segregation, and that vibration and consolidation are adequate. Visually check delivered concrete for load-to-load consistency.	See concrete item specified.	5-694.610 - .622
5. Collect, check and initial <i>Certificate of Compliance</i> : <ul style="list-style-type: none"> <li>• Verify S.P. Number</li> <li>• Verify Mix Number</li> <li>• Verify delivery time is within Specifications</li> <li>• Verify Water – Total Actual Water vs. Mix Design Water</li> <li>• Record any additional water that was added at the jobsite</li> </ul>	2461.4D6 2461.4D7	5-694.723
6. Monitor number and speed of revolutions and document any water added, if applicable.	2461.4D5c	
7. Air and Slump Testing: <ul style="list-style-type: none"> <li>• Perform air content and slump tests at the point of placement. Check the Schedule of Materials Control for sampling rates. If testing is not possible at point of placement, correlation testing must be performed.</li> <li>• If there is any question about the consistency or the quality of the concrete, run additional tests as necessary.</li> <li>• Notify Contractor if air content or slump results are outside of Specifications.</li> </ul>	2461.4A4a 2461.4A4b	5-694.530 - .541

8. Compressive Strength Testing (Cylinders): <ul style="list-style-type: none"> <li>• Make and store cylinders where they are protected from vibration or disturbance until placed in the curing tank.</li> <li>• Provide protection from extreme variations in temperature from the time of casting cylinder until it is transported to the lab.</li> </ul>	2461.4A5	5-694.510 - .511
9. Finishing: <ul style="list-style-type: none"> <li>• Check allowable tolerances and review finishing procedures.</li> <li>• Check surfaces with straight edges for correct line and grade prior to initial set so that corrections are made while concrete is still workable.</li> </ul>	See concrete item specified.	5-694.630 5-694.670
10. Curing: <ul style="list-style-type: none"> <li>• Verify curing compound is approved. Take samples as required by the Schedule of Materials Control.</li> <li>• Check application rate of curing compound for uniformity, yield, and timely placement.</li> <li>• Check all concrete surfaces for adequate curing, immediately after pour and on subsequent days, until end of curing period.</li> <li>• If required, ensure proper cold weather protection is utilized.</li> </ul>	See concrete item specified.	5-694.680 - .684
11. Maintain a daily diary that documents hours of production, equipment, concrete temperatures, air content, slump reading, cylinder data, location of work, yield, weather, air temperatures, any instructions directed to Contractor, and problems or unique circumstances encountered.		
12. Submit <i>Weekly Concrete Report</i> to Mn/DOT Concrete Engineering Unit on a weekly basis.	2461.4D7	5-694.727

## 5-694.014 CHECKLIST FOR CONCRETE PAVING BATCH PLANT INSPECTOR

√ LIST FOR CONCRETE PAVING BATCH PLANT INSPECTOR	<u>Specs.</u>	<u>Concrete Manual</u>
1. Verify the Contractor's aggregate sources and make sure preliminary testing has been done well in advance of the project start date.	See Special Provisions	
2. Make sure the Contractor submits mix designs to the Concrete Engineering Unit for review and approval a minimum of 21 days prior to the start of paving operations.		5-694.731
1. Complete a <i>Concrete Paving Contact Report</i> : <ul style="list-style-type: none"> <li>• Check that scales and water meter are calibrated.</li> <li>• Verify cementitious materials and admixtures are approved. (<a href="http://www.mrr.dot.state.mn.us/pavement/concrete/products.asp">www.mrr.dot.state.mn.us/pavement/concrete/products.asp</a>)</li> </ul>	2301.3F3	5-694.114 - .116 5-694.160 5-694.430 - .435 5-694.732
2. Batch trucks: <ul style="list-style-type: none"> <li>• Check for mortar tightness</li> <li>• Check for properly operating box vibrators</li> <li>• Inspect box walls to insure they will not trap concrete in dents.</li> <li>• Check for cleanliness</li> <li>• Check for legal load limits</li> </ul>	2301.3D	
3. Monitor stockpiling and loading of delivered aggregates: <ul style="list-style-type: none"> <li>• 0.5 m (1 ft.) cushion</li> <li>• Driving of equipment over washed material</li> <li>• Proper drainage at least 12 hours prior to use in batching operations - observe truck boxes</li> <li>• Notice water at edges of pile</li> </ul>	2461.4A1	5-694.124
4. Aggregate hopper and scales: <ul style="list-style-type: none"> <li>• Check that batch weights are adjusted in accordance with moisture tests</li> <li>• Observe scale operation and loading of trucks at 2 hour intervals throughout the day</li> <li>• Check field hoppers for contamination. If contaminated, have Contractor empty storage and weigh hoppers and re-charge</li> </ul>	2301.3F5 1901.8 2461.4B4	5-694.124 5-694.143
5. Cementitious hopper and scales: <ul style="list-style-type: none"> <li>• Observe weighing operation at intervals throughout day</li> <li>• Collect invoices from foreman and assure that the cementitious materials are from certified sources</li> <li>• Complete <i>Cement Record</i> daily - <i>Form 2157</i></li> <li>• Calculate the cementitious cut-offs appropriate to the volume of concrete produced</li> </ul>	1901.8 2301.3F1-.3F4 2461.4B3 Schedule of Materials Control	5-694.112 5-694.115 5-694.431 - .435 5-694.740
6. Ensure the correct mix design weights are being used.		
7. Ensure compliance with minimum and maximum mixing times.	2301.3F1 2461.C2f	
8. Moisture Tests: <ul style="list-style-type: none"> <li>• See Schedule of Materials Control and/or Special Provisions for testing rates</li> <li>• Run before every high early pour or whenever moisture appearance of delivered aggregate seems to vary</li> <li>• Complete <i>Concrete Batching Report - Form 2152</i></li> <li>• Calculate water/cementitious ratio for compliance with project specifications and verify with microwave oven test</li> </ul>		5-694.142 - .143 5-694.532 5-694.542 5-694.733 - .736



<p>9. Gradations:</p> <ul style="list-style-type: none"> <li>• See Schedule of Materials Control and/or Special Provisions for testing rates</li> <li>• Review <i>Concrete Aggregate Worksheet JMF</i> and verify Contractor's tests for compliance</li> </ul>		<p>5-694.141 5-694.145 5-694.148 5-694.737</p>
<p>10. % Passing 75 <math>\mu</math>m (#200) Sieve:</p> <ul style="list-style-type: none"> <li>• Verify all fine aggregate gradations are washed to determine the mass passing the 75 <math>\mu</math>m (#200) sieve.</li> <li>• Verify the amount passing the 75 <math>\mu</math>m (#200) sieve for the coarse aggregate is run on the first four gradations during production.</li> </ul>	<p>3126.2F 3137.2D1</p>	<p>5-694.146 5-694.148</p>
<p>11. Take samples of cementitious materials, admixtures, etc. as required.</p>	<p>Schedule of Materials Control</p>	<p>5-694.112 5-694.115 5-694.751 - .753</p>
<p>12. Obtain the appropriate number of coarse aggregate QC/QA samples as required per project specifications for Coarse Aggregate Quality testing.</p>	<p>See Special Provisions</p>	<p>5-694.140</p>
<p>13. Review the Contractor's on-site QC records and charts for accuracy and completeness.</p>		<p>5-694.735 - .736 5-694.738</p>
<p>14. Maintain daily plant diary that includes hours of production, equipment, weather, air temperatures, concrete yardage totals, cement records, plant diary, water/cementitious ratio calculation worksheets, and problems or unique circumstances encountered.</p>		<p>5-694.726</p>

**5-694.015A CHECKLIST FOR PAVING INSPECTION – BEFORE START OF PAVING**

√ LIST FOR PAVING INSPECTION – BEFORE START OF PAVING OPERATIONS	<u>Specs.</u>	<u>Concrete Manual</u>
1. Testing Equipment: <ul style="list-style-type: none"> <li>• Obtain slump cones, air test units, rulers, pencils, necessary forms, etc., which are required for the job, and make sure all equipment is in good working order.</li> <li>• Check condition of beam boxes.</li> <li>• Make sure that air testing units, sieves, and scales were calibrated within the previous year.</li> </ul>	2461.4A5	5-694.511 5-694.521 5-694.531 5-694.541
2. Obtain plans and special provisions and study them in detail.		
3. Become familiar with paving sequence and review field controls for line and grade.		5-694.600 Series
4. Paving Equipment: <ul style="list-style-type: none"> <li>• Check paving equipment for proper adjustment and compliance with specifications.</li> <li>• Understand the function of each piece of equipment.</li> </ul>	2301.3A1 2301.3H 2301.3J	5-694.645 - .648
5. Reinforcing Steel: <ul style="list-style-type: none"> <li>• Check size, spacing, and placement of bridge approach panel rebars, and any other special reinforced panels.</li> <li>• Verify proper reinforcement size, grade, lap ties, depth and spacing.</li> <li>• Check size and length of centerline steel. Check if the required mechanical placer is placing it at the proper depth.</li> <li>• Check that the tie bars and supplemental steel set on chairs are properly placed.</li> </ul>	2301.3E Standard Plans and Standard Plates	5-694.632
6. Check vibration equipment and verify vibration monitors are operating correctly. Computerized vibration monitors are required on slipform pavers.	2301.3H1 2301.3J Special Provisions	5-694.646
7. Verify the Contractor is prepared for inclement weather (rain or cold weather conditions).	2301.3M	
8. Verify string line is set sufficiently in advance to avoid delays.	2301.3J	5-694.643 - .644
9. Verify that utility work and conduits are complete. Pre-locate utility fixtures to be incorporated into the pavement.		5-694.630

## 5-694.015B CHECKLIST FOR PAVING INSPECTION – DURING SLIPFORM PAVING

√ LIST FOR PAVING INSPECTION – DURING SLIPFORM PAVING	<u>Specs.</u>	<u>Concrete Manual</u>
1. Base: <ul style="list-style-type: none"> <li>• Check that the base (OGAB) material is maintained in a dampened condition ahead of the concrete placement.</li> <li>• Keep PASB thoroughly whitewashed to minimize its temperature.</li> <li>• Monitor trucks hauling concrete. Trucks hauling concrete should not be allowed on the finished grade.</li> </ul>	2301.3G Special Provisions	5-694.631
2. Dowel Baskets: <ul style="list-style-type: none"> <li>• Check dowel bar assemblies for proper placement to assure that they are parallel with the base and centerline of road, properly supported and staked.</li> <li>• Make sure the assembly ties are completely removed.</li> <li>• Make sure dowel baskets are securely anchored on the bottom rail using the correct number and length of anchors.</li> <li>• Check the placement of dowel assemblies at catch basins and manholes; keep joint at least 1 m (3 ft.) from structure. Refer to the Standard Plates for details.</li> <li>• Make sure form release agent has been applied to dowel bars.</li> <li>• Confirm joint locations are marked at the same location as the dowel baskets.</li> </ul>	2301.3E3 2301.3G 2301.3K 3902  Standard Plans and Standard Plates	5-694.632 5-694.660 - .664
3. Monitor paving operation for continuous placement and consolidation of concrete.	2301.3J	5-694.645 - .649
4. Check if vibrating tubes are operating (indicated by localized open surface). Excessive vibration will cause segregation and bring lightweight aggregate to the surface (shale, etc.). Computerized vibration monitors are required on all slipform pavers.	2301.3J  Special Provisions	5-694.646 - .647
5. Verify pavement width, thickness, crown, superelevation, edge slump, and joint match to ensure it meets plan requirements.	2301.3P	5-694.645
6. Check surface using a 3 m (10 ft.) straightedge to check for tolerance and then have surface dragged to remove straightedge marks.	2301.3P	5-694.645
7. Keyway Placement: <ul style="list-style-type: none"> <li>• Assure location at proper elevation.</li> <li>• Make sure bars are the right size and length, and properly spaced.</li> <li>• Make sure keyway tie steel is not placed at a doweled joint.</li> </ul>	Standard Plans and Standard Plates	5-694.632 5-694.664
8. Air and Slump Testing: <ul style="list-style-type: none"> <li>• Observe Contractor perform air and slump tests. See Schedule of Materials Control Schedule and/or Special Provisions for testing rates.</li> <li>• Agency performs one air and slump test per day, run additional tests as necessary.</li> <li>• Agency performs correlation air tests behind and in front of paver daily and verifies air loss. Sample should be taken from upper half of pavement.</li> </ul>	2461.4A4a 2461.4A4b	5-694.530 - .541

<p>9. Flexural Strength Testing (Beams):</p> <ul style="list-style-type: none"> <li>• Observe Contractor make beams. See Schedule of Materials Control and/or Special Provisions for testing rates.</li> <li>• Contractor removes beams from boxes, cleans boxes, and reassembles boxes.</li> <li>• Agency cures and breaks beams.</li> <li>• Record beam break results on <i>Concrete Test Beam Data - Form 2162</i>.</li> </ul>	<p>2301.3A6 2461.4A5</p> <p>Special Provisions</p>	<p>5-694.520 - .522 5-694.741</p>
<p>10. Collect, check, and initial <i>Certificate of Compliance</i> if used.</p>		<p>5-694.723</p>
<p>11. Make sure concrete is placed within time specification.</p>	<p>2461.4C5 2461.4D6</p>	
<p>12. Monitor number and speed of revolutions and water added while truck is mixing, if applicable.</p>	<p>2461.4D5c</p>	
<p>13. Concrete Appearance:</p> <ul style="list-style-type: none"> <li>• Check that the concrete is maintained at a uniform consistency.</li> <li>• Monitor the edge slump.</li> </ul>	<p>2461.4A4a</p>	<p>5-694.648 - .649</p>
<p>14. Check that no concrete is lost on the haul road or sticks in the truck after it dumps.</p>	<p>2301.3D</p>	
<p>15. Make sure concrete is spread evenly and uniformly.</p>	<p>2301.3G</p>	
<p>16. Make sure there is a uniform strike-off.</p>	<p>2301.3H1a 2301.3J</p>	<p>5-694.648</p>
<p>17. Check concrete placement on dowel bar assemblies to see that dowels are not displaced.</p>	<p>2301.3G</p>	<p>5-694.632</p>
<p>18. Check to see that paver is not over or under loaded, and that concrete is “rolling” not “sliding” in front of the screed.</p>		<p>5-694.648</p>
<p>19. Make sure the tamping bar is properly adjusted so large aggregate is tucked below the surface and not dragged.</p>		<p>5-694.647</p>
<p>20. Finishing:</p> <ul style="list-style-type: none"> <li>• Do not allow sprinkling of water on surface during the finishing operation.</li> <li>• Do not permit short smoothing floats as a constant part of the finishing operation.</li> </ul>	<p>2301.3H1d Special Provisions</p>	<p>5-694.648 5-694.671</p>
<p>21. Texturing:</p> <ul style="list-style-type: none"> <li>• Ensure texturing is properly performed at appropriate time.</li> <li>• Check that the texture marks are uniform and parallel to centerline.</li> <li>• Verify texture by observing Contractor sand patch testing.</li> <li>• Transverse tining is performed as required. Check that protection is provided to prevent tining marks at the transverse joint locations, if required.</li> <li>• Check that tines have proper random spacing, width, and are applied at the proper depth.</li> </ul>	<p>2301.3L Special Provisions</p>	<p>5-694.648</p>
<p>22. Stencil the stationing into the edge of the pavement every 200 m (500 ft.).</p>		<p>5-694.602</p>

<p>23. Headers:</p> <ul style="list-style-type: none"> <li>• Verify placement of construction header.</li> <li>• Be sure wet, sloppy concrete in front of the screed is wasted.</li> <li>• Check for right angles from longitudinal edge.</li> <li>• Check steel placement</li> <li>• Monitor vibration</li> </ul>	<p>2301.3G 2301.3H1b  Standard Plates</p>	<p>5-694.630 5-694.660</p>
<p>24. Curing:</p> <ul style="list-style-type: none"> <li>• Verify an approved curing compound is used.</li> <li>• Check application rate of curing compound for uniformity, yield, and timely placement.</li> <li>• Take samples as required.</li> <li>• Ensure compliance with cold weather protection requirements.</li> </ul>	<p>2301.3M  Schedule of Materials Control</p>	<p>5-694.680 - .683</p>
<p>25. Sawing Joints:</p> <ul style="list-style-type: none"> <li>• Check joint sawing operation. Check joint location adjustments at side streets, inlets, manholes, etc.</li> <li>• Check appearance, depth, and width of sawed joints. No raveling and no random cracking should occur at the time of initial sawing.</li> <li>• Widening of the joints shall not occur until the concrete is at least 24 hours old.</li> </ul>	<p>2301.3K Standard Plan 5-297.221</p>	<p>5-694.630 5-694.660 - .664</p>
<p>26. Sealing Joints:</p> <ul style="list-style-type: none"> <li>• Verify joints are clean and dry before approving.</li> <li>• Do not allow traffic on the slab until the joints are sealed.</li> </ul>	<p>2301.3N 2301.3A7 Standard Plan 5-297.221</p>	<p>5-694.665</p>
<p>27. Thickness Verification:</p> <ul style="list-style-type: none"> <li>• Determine the locations for cores using random numbers.</li> <li>• Observe the Contractor coring operation to verify authenticity.</li> </ul>	<p>2301.3P Special Provisions</p>	<p>5-694.691</p>
<p>28. Ride Quality and Smoothness:</p> <ul style="list-style-type: none"> <li>• Make sure California Profilograph or lightweight inertial profiler (LWP) is certified, calibrated and ready for use.</li> <li>• Check Ride Quality (2301.3P1c) and Smoothness (2301.3P1) of surface for contract compliance.</li> </ul>	<p>2301.3P Special Provisions</p>	<p>5-694.690</p>
<p>29. Maintain daily diary that documents hours of production, equipment, concrete temperatures, air content, slump reading, cylinder and beam data, stations paved, width, depth, yield, weather, air temperatures, and problems or unique circumstances encountered.</p>		
<p>30. Submit <i>Weekly Concrete Report</i> to Mn/DOT Concrete Engineering Unit on a weekly basis.</p>	<p>2461.4D7</p>	<p>5-694.744</p>
<p>31. Submit the following to the Mn/DOT Concrete Engineering Unit:</p> <ul style="list-style-type: none"> <li>• <i>Concrete Test Beam Data – Form 2162</i></li> <li>• <i>Field Core Reports – Form 24327</i></li> <li>• Ride Quality results</li> <li>• Incentive/Disincentive Information</li> <li>• Change Orders and Supplement Agreements</li> </ul>		<p>5-694.701 5-694.739 5-694.741 - .742</p>

**5-694.015C CHECKLIST FOR PAVING INSPECTION – FIXED FORM PAVING**

In addition to this checklist, refer to 5-694.015A and 5-694.015B.

√ LIST FOR PAVING INSPECTION – FORMED PAVING	<u>Specs.</u>	<u>Concrete Manual</u>
1. Form Inspection: <ul style="list-style-type: none"> <li>• Cleanliness</li> <li>• Check form tolerances – 15 mm (5/8”) on face and 5 mm (3/16”) on top.</li> </ul>		
2. Form Placement: <ul style="list-style-type: none"> <li>• Check for vertical face.</li> <li>• Check form locks are secure.</li> <li>• Use tape measure to check for alignment from offset tack line and visually inspect for final alignment.</li> <li>• Use carpenter’s level to check for elevation from blue top to form line and visually inspect for final alignment.</li> <li>• Check forms for form release agent coating.</li> <li>• Recheck any forms removed from line for batch trucks.</li> <li>• Check proper grade to match bridge deck at least 50 mm (160 ft.) from bridge.</li> </ul>		5-694.650 - .654
3. Check the placement of expansion joints to assure they are perpendicular to the subgrade, full width with no gaps at edges or center, and at the proper elevation. No daylight should show under the joint.	2301.3K	5-694.662
4. The first screed should carry a uniform roll of concrete 150-200 mm (6-8 in.) in diameter and leave concrete surface slightly high.		5-694.657
5. Second screed should carry a uniform roll of concrete 75-100 mm (3-4 in.) in diameter on the first board and 25-50 mm (1-2 in.) on the second board, and leave concrete slightly above the top of the forms.		
6. Make sure that the surface is tight with slight ripple marks after the finishing machine has passed.		
7. Check that the forward screed is slightly tilted up on the front face to provide compaction and surge. Never tilt the rear screed.	2301.3H1a	
8. Hand-operated straight edges are used to remove accumulated fine material and water and to correct minor discrepancies in elevation. They are pulled from the center to the forms. If much of this work is continually required, equipment and/or forms are out of adjustment.		5-694.654
9. Check that the longitudinal joint along the edge of the forms is made to the proper radius.		5-694.654
10. Within 24 hours of paving or form removal, check that the shoulders are tapered to provide surface water drainage.		5-694.654

**5-694.015D CHECKLIST FOR PAVING INSPECTION – UNBONDED OVERLAYS**

In addition to this checklist, refer to 5-694.015A and 5-694.015B.

√ LIST FOR PAVING INSPECTION – UNBONDED OVERLAYS	<u>Specs.</u>	<u>Concrete Manual</u>
1. Make sure dowel baskets are securely fastened through the PASSRC layer 25 mm (1”) into the concrete below.		5-694.631
2. Keep the PASSRC thoroughly whitewashed to minimize the temperatures and adequately damp prior to concrete placement.	Special Provisions	5-694.631
3. Mark concrete cores two feet from the outside edge of the pavement.	Special Provisions	5-694.631
4. Verify calculated pavement thickness using Contractor’s grade and line control string lines after pavement grades have been established from survey results and approved by the Engineer.	Special Provisions	5-694.631
5. If trucks are driving on PASSRC, ensure they are using plywood or similar material for turnaround points so the trucks don’t tear up the PASSRC.		5-694.631

## 5-694.016 CHECKLIST FOR CONCRETE PAVEMENT REHABILITATION INSPECTION

√ LIST FOR CONCRETE PAVEMENT REHABILITATION	<u>Specs.</u>	<u>Concrete Manual</u>
1. Review the Concrete Pavement Rehabilitation (CPR) Standards and the Special Provisions in the Plans and Proposal.	Special Provisions	5-694.900 Series
2. Prior to construction contact the Mn/DOT Concrete Engineering Unit to review the CPR video.		
3. Shut down the pavement at least 2 – 3 days in advance and mark sections for removal clearly with paint. Check soundness of concrete with hammer, sand, and/or chain drag.		
4. Ensure the Contractor is prepared for inclement weather.		
5. Verify all materials are approved. ( <a href="http://www.mrr.dot.state.mn.us/pavement/concrete/products.asp">www.mrr.dot.state.mn.us/pavement/concrete/products.asp</a> )		
6. Make sure the Contractor keeps the pavement clean.		
7. Be sure the base is replaced with materials similar to the existing pavement and is level with the bottom of the pavement.		
8. Check for proper steel placement.		
9. Make sure all of the joints are clean – clear of laitance, incompressibles, and oils.		
10. Check the bonding grout, if the grout whitens, sand blast and regrout.		
11. Ensure proper consolidation of the concrete.		
12. Ensure the Contractor finishes patches from the middle to the outside of the patch.		
13. Straightedge the repair as often as necessary to ensure smoothness over the repair.		
14. Ensure concrete is properly cured. If a Hudson sprayer is used to apply curing compound, two applications are required.		
15. Perform air and slump tests as required by the Schedule of Materials Control or as directed by the Project Engineer. Run additional tests as necessary.	2461.4A4a 2461.4A4b	5-694.531 5-694.541
16. Collect, check, and initial <i>Certificate of Compliance</i> . Record any additional water that was added at the jobsite.		5-694.723
17. Be aware of allowable time limits for concrete placement.	2461.4D6	
18. Monitor the number and speed of revolutions and document any water added, if applicable.	2461.4D5c	
19. Prepare test cylinders as required. Make additional cylinders as required for high-early mixes.	2461.4A5	5-694.511
20. For retrofit dowel repairs: <ul style="list-style-type: none"> <li>• Make sure the bottoms of the slots are flat.</li> <li>• Ensure caulking is filled to the edges of the slot so that no grout/cementitious material can fill the crack/joint and cause it to lock up.</li> </ul>		
21. Maintain daily diary that includes hours, equipment, concrete temperatures, air content, slump reading, cylinder data, stations paved, width, depth, yield, weather, air temperatures, and problems or unique circumstances encountered.		
22. Submit <i>Weekly Concrete Report</i> to Mn/DOT Concrete Engineering Unit on a weekly basis.	2461.4D7	5-694.727



**REFERENCES**

1. Figure A 5-694.005, "Using Soft Metric Reinforcing Bars in Non-Metric Construction Projects", Engineering Data Report Number 42, Concrete Steel Reinforcing Institute, 1997.
2. Figure B 5-694.005, "Using Soft Metric Reinforcing Bars in Non-Metric Construction Projects", Engineering Data Report Number 42, Concrete Steel Reinforcing Institute, 1997.
3. Figure C 5-694.005, "Using Soft Metric Reinforcing Bars in Non-Metric Construction Projects", Engineering Data Report Number 42, Concrete Steel Reinforcing Institute, 1997.