(2331) BITUMINOUS STABILIZED FULL DEPTH RECLAMATION - (SFDR)

February 3, 2012

2331.1 DESCRIPTION

Construct a Bituminous Stabilized Full Depth Reclamation (SFDR) layer by pulverizing the in-place bituminous pavement structure, mixing it in-place with the specified liquid bituminous material, shaping, and compacting.

A Definitions

A.1 Pulverized (un-stabilized) Material

Pulverized material is the material that is produced by grinding the bituminous pavement with a portion of the underlying granular material. It is produced by the action of the reclaimer and it may include other additional aggregates, but it does not include bituminous stabilizing agent.

A.2 Bituminous Stabilized Material

Bituminous Stabilized Material is pulverized material that has had a bituminous stabilizing agent, such as emulsion, or foamed asphalt, added to it.

A.3 Bituminous Stabilized Full Depth Reclamation (SFDR) Layer

Bituminous Stabilized Full Depth Reclamation (SFDR) Layer is bituminous stabilized material that has been shaped and compacted; it is the completed layer.

A.4 Lift

Lift is a unit of material within a layer that is placed for compaction.

A.5 Layer

Layer is the total embankment thickness for each material type and may be comprised of a single, or multiple lifts.

2331.2 MATERIALS

A Mix Design

Use the mix design included in the contract documents.

B Bituminous Material for Mixture

Provide the type and grade of Bituminous Material for Mixture (liquid bituminous material) at the rate recommended by the mix design. Use liquid bituminous material conforming to 3151, "Bituminous Material". Engineered Emulsion and Foamed Asphalt must also conform to the following:

1. Engineered Emulsion:

a.	Residue from Distillation (AASHTO T-59),	Minimum	63%
b.	Oil Distillate by Distillation (AASHTO T-59)	Maximum	0.5%
c.	Sieve Test (AASHTO T-59)	Maximum	0.10%

2. Liquid Bituminous Material for Foamed Asphalt:

a.	Production Temperature (supplier/manufacture)	Maximum	385°F
b.	Foaming/Mixing Temperature (In the field)	Minimum	320°F

C Mineral Stabilizing Agent

Provide mineral stabilizing agent at the rate recommended by the mix design. Cement, hydrated lime and fly ash must meet the following:

1. Cement must conform to 3101, "Portland Cement".

2. Hydrated Lime must conform to 3106, “Hydrated Lime”.
3. Class C Fly Ash must conform to 3115, “Fly Ash for Use in Portland Cement Concrete”.
   Note: Fly ash must be approved by the Engineer

D Additional Aggregates

Provide additional aggregates meeting the gradation and quality requirements and at a rate recommended by the mix design.

E Pulverized Material

Produce pulverized material conforming to Table 2331-1:

Table 2331-1	
Sieve Size	**Percent Passing**
75 mm (3.0”)	99 - 100
37.5 mm (1.5")	95-100
25 mm (1.0")	90-100

2331.3 CONSTRUCTION REQUIREMENTS

A General

Failure to remove oversize bituminous pieces and dispose of them outside of the right-of-way will be considered unacceptable work in accordance with 1512, “Unacceptable and Unauthorized Work”.

B Equipment

B.1 Reclaiming Machine

Provide a self-propelled reclaiming machine with the ability to:

1. Pulverize and uniformly blend the in-place bituminous pavement structure to the gradation shown in Table 2331-1.
2. Adjust the cutting depth with the pavement profile to maintain a constant ratio of bituminous pavement to granular material.
3. Thoroughly mix the reclaimed pavement while accurately injecting the liquid bituminous material and automatically metering it with a variation of not more than plus or minus 0.2 percent by weight. Allow asphalt contents up to 6% by total weight.
4. Automatically control cross-slope and control cutting depth to within plus or minus ¼ inch (6 mm) of the depth shown on the Plans.
5. Maintain the designed asphalt content of overlapped mixtures by adjusting the application of bituminous material for the width of pulverized layer.
6. Accurately foam bituminous material and uniformly add specified water (Note 1).
7. Provide samples of the foamed bituminous material through a sampling nozzle (Note 1).

Note 1: Requirements 6 and 7 apply only when foamed asphalt is used.

B.2 Asphalt Supply Tankers

When foamed asphalt is used, supply tankers must be equipped with a visible thermometer that continuously measures the temperature of the liquid bituminous material in the bottom third of the supply tank.

B.3 Vane Feeder

When mineral stabilizing agent is used, provide a vane feeder capable of uniformly spreading it on the road surface prior to reclaiming. Spread mineral stabilizing agent in a manner that:

1. Minimizes dusting (do not spread when the wind is strong enough to coat traffic and/or the environment),
2. Does not disturb the surface, and

3. Mixing operations start as soon as practicable, but no more than ½ hour after spreading.

Alternative methods of spreading mineral stabilizing agent must be approved by the Engineer prior to spreading.

B.5 Rollers

1. Meet 2331.3.E.4, "Compaction" of these special provisions
2. Provide at least one pad foot vibratory roller
3. Provide at least one pneumatic tired roller

B.5.a Pneumatic-Tired Roller

Provide pneumatic-tired roller with the following characteristics:

- Minimum weight of 25 tons (23 metric tons)
- A tire arrangement such that compaction is obtained over the full width of the roller with each pass
- Equipped with a water spray system.

B.5.b Pad Foot Vibratory Roller

Provide a pad foot roller with the following characteristics:

- An 84 inch wide drum
- A weight of at least 12.5 tons (11.3 metric tons)
- A blade for back-dragging

B.5.c Steel-Wheeled Roller

Provide a double drum vibratory steel-wheeled roller with the following characteristics:

- A weight of at least 25 tons (23 metric tons)
- Equipped with a water spray system

B.6 Motor Grader

Provide a self-propelled motor grader with the following characteristics:

- Minimum 12 foot (3.6 m) wide blade
- Self-propelled
- Wheelbase of at least 15 feet (4.5 m)

C Construction Operations

Construct SFDR under the following conditions:

- Atmospheric temperature is 50°F (10°C) and rising,
- There are not foggy or rainy conditions
- Freezing temperatures are not predicted within 48 hours after placement of any portion of the Project.

Compliance with the atmospheric temperature and predicted weather requirements are determined by the Engineer.

C.1 Initial Pulverization (Pre-Grind)

Before beginning pulverization, remove vegetation and topsoil adjacent to the surface. Pulverize (grind) and uniformly blend the in-place bituminous pavement with the underlying granular base to the gradation shown in Table 2331-1 of these special provisions. Adjust the cutting depth of the reclaimer with the pavement profile to maintain a constant ratio of bituminous pavement to granular material.

Uniformly spread additional material across the roadway surface before incorporating it into the reclaim mixture.

Protect and avoid damaging existing drainage or utility structures during pulverization.

Correct reclaim sections represented by a failed gradation.

C.2 Spreading & Compaction of the Pulverized Material

Uniformly mix pulverized material before spreading. Spread and compact the pulverized material to the profile and cross section shown on the plans before placing the next layer.

Place and compact pulverized (un-stabilized) materials in maximum 6-inch [150-millimeter] lifts, greater lift thicknesses will only be allowed if the requirements of 2331.3C.2a, "Test Strip" of these special provisions are satisfied.

Compact the pulverized layer that will not be stabilized to a penetration index value of 0.4 in [10 mm] and a seating value of 1.5 in [40 mm] as measured by the MnDOT standard Dynamic Cone Penetrometer (DCP) device. Compact the pulverized layer that will be stabilized according to 2105.3F2 "Quality Compaction Method". Shape the pre-grind material as shown in the plans.

Blend, add water, spread, compact, and shape pulverized material by the end of the workday.

C.2.a Test Strip

Provide 48 hour written notification to the Engineer prior to constructing the test stip. Construct a test strip one lane (12 feet) wide and 500 feet in length and document the testing and construction.

Compact the test strip at the proposed lift thickness, but no greater than 12 inches thick, to a penetration index value of 0.4 in [10 mm] and a seating value of 1.5 in [40 mm] as measured by the MnDOT standard Dynamic Cone Penetrometer (DCP) device.

The Engineer will verify the DCP results, and sample and test the pulverized material for moisture content immediately after compaction. Use the moisture content of the passing density test as the target moisture content unless another test strip is required by the Engineer.

C.3 Mixing/Injecting

Produce the SFDR layer by mixing and injecting the liquid bituminous material into the pulverized pavement. Use a minimum 6 inch (150 mm) overlap between passes of the reclaimer.

The contractor may add additional water to facilitate uniform mixing and to achieve a stable layer that exceeds the minimum specified compaction. The water may be added prior to, or concurrently with, the bituminous material for mixture. Adding water to facilitate uniform mixing must not adversely affect the performance of the stabilized material (i.e. do not wash bituminous emulsion out).

C.4 Compaction of Bituminous Stabilized Material

Complete the initial compaction of the bituminous stabilized material with a combination of pad foot roller(s), pneumatic tired roller(s) and motor grader until the pad foot roller has "walked out" of the SFDR. "Walking-out" for the pad foot roller is defined as light being clearly evident between all of the pads at the material-padfoot drum interface.

C.5 Shaping

Remove any remaining pad foot marks and spread the material using a motor grader. Cut no deeper than necessary to remove the pad foot marks. Achieve the desired slope and shape. Fine grade the bituminous stabilized material as shown in the plans.

C.6 Intermediate and Final Compaction

Use double drum steel roller(s) and pneumatic tire rollers to compact the bladed material. Use double drum steel roller(s) for final rolling operating in a static mode to eliminate pneumatic tire marks. Use the rolling pattern established in 2331.3.E.4, "Compaction" of these special provisions. Establish a new rolling pattern, if there are significant changes in: existing conditions, gradation, or the liquid bituminous material addition rate is changed by

more than 0.5% (emulsion), or 0.3% (foamed asphalt). Re-check the rolling patterns with a nuclear density gauge every day of production or anytime that the appearance of the SFDR layer changes.

D Quality Control

The Contractor is responsible for Quality Control (QC).

Perform tests following methods found on the Grading and Base website, except for nuclear density tests follow AASHTO T-310.

Calibrate test equipment in accordance with the latest version of the MnDOT Laboratory Manual. Provide calibration certificates to the Engineer.

Provide all test results to the Engineer within 24 hours of test completion.

D.1 Pulverized Bituminous Material Sizing

Perform sieve analysis tests on the pulverized (un-stabilized) material at a rate of one test per fifty stations [1.6 km] for each machine's production width, or a minimum of 2 tests per day, whichever is greater. Perform the tests on material sampled to the depth of the pulverized (un-stabilized) layer. Perform sieve analysis tests within the first 500 feet [160 m] of production, and within 500 feet [160 m] of failing gradations.

D.2 Mineral Stabilizing Agent

Measure the mineral stabilizing agent application rate using the direct method, "Measuring the Field Application Rate" found on the Grading and Base website.

Measure the average mineral stabilizing agent application rate using the indirect method, "Measuring the Field Application Rate". Record and report data for each mineral stabilizing agent transport.

Control the residual mineral stabilizing agent content to within ± 0.2% by weight, of the mix design target.

D.3 Bituminous Material for Mixture

Calibrate the reclaiming machine by a method acceptable to the Engineer. Measure the average bituminous material application rate for each transport using the indirect method, "Measuring the Field Application Rate" and record this data.

For foamed asphalt, maintain the temperature of the liquid bituminous material within ± 20°F (± 11°C) and the foaming (injecting) water within ± 0.5% of the mix design optimum. For foamed asphalt, record and report the expansion ratio and half-life.

Obtain the approval of the Engineer to apply liquid bituminous material greater or less than 0.5% (emulsion), or 0.3% (foamed asphalt) of the mix design optimum.

D.4 Moisture Content Before Bituminous Material Addition

Perform moisture tests at a rate of one per lane-mile on the pulverized (un-stabilized) material, prior to each day's anticipated SFDR production. Perform the tests on material sampled to the depth of the pulverized (un-stabilized) layer using the burner method. Perform an additional moisture test if rain has occurred after the initial testing, or if the moisture content has been adjusted. Adjust the moisture content by moisture addition or aeration if the average moisture content is not within 0.5 percent of the mix design optimum.

D.5 Depth of Pulverization

Measure the depth of cut every 5 stations and record and report.

D.6 Compaction

Unless otherwise specified in the contract special provisions, use D.6.A, "Specified Density".

D.6.A Specified Density

Randomly select four locations and perform one-point Modified Proctor and nuclear density testing representative of the first day's SFDR production. The Engineer may select four additional test locations on subsequent days, if the Engineer determines there are significant changes in: existing conditions, gradation, or the liquid bituminous material addition rate is changed by more than 0.5% (emulsion), or 0.3% (foamed asphalt).

Correlate to dry density by direct moisture measurement (microwave oven or equivalent) of a sample from the nuclear gauge testing location. If the materials and moisture contents do not change significantly, use the modified Proctor reference density, which is the average of the four Proctor density values from the first day.

Perform nuclear gauge moisture and density tests at a rate of two for every lane-mile, or a minimum of one per day, whichever is greater, at random locations determined by the Engineer. Compact the reclaim material to 97 percent of the one-point modified Proctor density taken at the same location, or the one-point modified Proctor reference density, or 95 percent of the gyratory density from the mix design. Remix and re-compact sections of SFDR that do not achieve minimum density criterion.

D.6.B Quality Compaction

Determine a wet density by using a nuclear moisture-density gauge. Establish a rolling pattern based on relative nuclear density values that achieve maximum density with the specified rollers. Do not over-roll the mat based on visual observations of check cracking or shoving. Establish a new rolling pattern when the Engineer determines there are significant changes in: existing conditions, gradation, or the liquid bituminous material addition rate is changed by more than 0.5% (emulsion), or 0.3% (foamed asphalt).

E Agency Verification Testing (VT)

The agency is responsible for Verification Testing (VT).

E.1 Pulverized Bituminous Material Sizing

Perform gradation testing at a rate of at least one per day, on a sample selected from locations that are at risk of not meeting the specification requirements.

E.2 DCP Testing of Pulverized (un-stabilized)

Perform Standard Dynamic Penetration Index testing at a minimum rate of one per 1,000 feet on the pulverized (un-stabilized) material.

E.3 Mineral Stabilizing Agent

Verify the mineral stabilizing agent application rate using the indirect method, "Measuring Field Application Rate" found on the Grading and Base Website.

E.4 Bituminous Material for Mixture

Accept material from certified sources only. Sample the first load, then sample at a rate of one quart per 50,000 gallons [200 tons]. Send samples to the MnDOT laboratory to be tested in accordance with 2331.2C, "Bituminous Material for Mixture" of these special provisions. Verify the average liquid bituminous material application rate using the indirect method, "Measuring Field Application Rate" found on the Grading and Base Website. For foamed asphalt, verify the expansion ratio and half-life.

E.5 Compaction

Unless otherwise specified in the contract special provisions, use E.5.A, "Specified Density".

E.5.A Specified Density

Verify that the equipment has been calibrated, the correct procedure (direct transmission mode) is being utilized and that the measured density is at least 95% of the gyratory mix design or 97% of the Proctor Reference Density. Perform one point modified Proctor tests on companion samples obtained in the field.

E.5.B Quality Compaction

Observe the test strip process and ensure (by observation) that the established rolling pattern is consistently followed during production compaction of the entire project.

E.6 Moisture Content Before Placement of Plant Mixed Asphalt Pavement

Check moisture content in a minimum of 3 randomly selected areas within the estimated daily plant mixed asphalt paving run.

F Thickness and Surface Requirements

Place and compact the SFDR surface so that it shows no variations greater than 1/2 inch (12 mm) within 10 feet (3 meter). Correct all deviations from this tolerance.

Apply a fog seal in accordance with 2355, "Bituminous Fog Seal" at a rate of 0.10 to 0.16 gallons per square yard within 48 hours of completion of the Bituminous Stabilized Base Layer.

Place the plant mixed asphalt pavement when the SFDR has cured. Place the plant mixed asphalt layer a minimum of 3 calendar days and a maximum of 7 calendar days after the SFDR has been placed at a given location and when the moisture content of each test result is below (± 1%) the mix design optimum as determined by 2331.3E.5, "Moisture Content Before HMA Placement" of these special provisions.

Apply a tack coat to the SFDR surface immediately prior to placing the plant mixed asphalt pavement.

G Maintenance

Maintain and repair any damage the finished SFDR surface in a smooth compacted condition, free of ruts, distortions, potholes, loose aggregate, and to the grade and cross-section tolerances stated in the plans, specifications and 2331.3F, "Thickness and Surface Requirements" of these special provisions, until the first lift of plant mixed asphalt pavement is placed. Immediately prior to placement of the first lift of plant mixed asphalt, clean the SFDR surface and remove loose aggregate without damaging the surface.

2331.4 METHOD OF MEASUREMENT

Bituminous Stabilized Full Depth Reclamation (SFDR) is measured by the square yard.

The Bituminous Material for Mixture is measured by the ton.

2331.5 BASIS OF PAYMENT

The Department will pay for the correction of in-situ unstable areas, as directed by the Engineer, per 1403, "Extra Work".

The Engineer may issue a price reduction for failing material after consulting with the MnDOT Grading and Base Engineer.

The contract unit price for the bituminous pavement reclamation material contract item includes the cost of production, testing, placement, occasional variations in the bituminous pavement thickness, removing vegetation and topsoil adjacent to the surface, water, and required and necessary maintenance including cleaning the surface.

Payment for any required mineral stabilizing agent is incidental to the price of the bituminous material for mixture.

Payment for bituminous stabilized full depth reclamation will be made on the basis of the following schedule:

Item No.	Item	Unit
2331.604	Bituminous Pavement Reclamation	Square yard
2331.609	Bituminous Material for Mixture	Ton