

## SECTION 2910 – CEMENT STABILIZED BASE

### CEMENT STABILIZED BASE

#### PART 1 – GENERAL

##### 1.01 Section Summary

- A. This work consists of removing existing asphalt pavement and mixing the existing aggregate base course with Portland Cement, water and either existing subgrade soil, imported new aggregate, or salvaged base materials to produce a treated base to the specifications described herein and shall conform to the lines, grades, thickness and typical cross sections shown on the Plans.
- B. The reclaimed aggregate base and subgrade material shall be sufficiently mixed, scarified, shaped, compacted, cured and maintained to the existing roadway; to the lines, grades and shape as indicated on the Plans prior to constructing the surface course.

##### 1.02 Related Sections

- A. Section 1800 – Excavation and Embankment
- B. Section 2900 – Aggregate Base Course
- C. Section 2910 – Salvaged Base Course

##### 1.03 References

- A. American Association of State Highway and Transportation Officials (AASHTO)
  - 1. M85 – Standard Specification for Portland Cement.
  - 2. T2 – Sampling of Aggregates
  - 3. T11 – Materials Finer than #200 sieve in Mineral Aggregates by Washing
  - 4. T27 – Sieve Analysis of Fine and Coarse Aggregates
  - 5. T89 – Standard Method of Test for Determining the Liquid Limit of Soils.
  - 6. T90 – Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.
  - 7. T99 – Moisture-Density Relations of Soils

8. T134 – Moisture-Density Relations of Soil-Cement Mixtures
  9. T208 – Standard Method of Test for Unconfined Compressive Strength of Cohesive Soil.
  10. T248 – Reducing Samples of Aggregate to Testing Size
  11. T265 – Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
- B. North Dakota Department of Transportation "Standard Specification for Road and Bridge Construction" 2014 Edition, As Revised.
1. Section 302 – Aggregate Base and Surface Course
  2. Section 306 – Full Depth Reclamation
  3. Section 802 – Portland Cement Concrete
  4. Section 804 – Cement and Lime
  5. Section 816 – Aggregates
  6. Section 817 – Salvaged Base Course
- 1.04 Submittals
- A. Preconstruction Mix Design
1. At least 7 days before stabilization work is to begin, submit mix design(s) for the Portland cement stabilization to the Owner that meet(s) the requirements specified herein. If the Owner does not approve the mix design, revise and submit a revised mix design. Allow for up to 7 additional days for the Owner to review the revised mix design before beginning stabilization work. Approval of the mix design by the Owner is solely for monitoring quality control and in no way releases Contractor from its responsibilities.
  2. The Contractor shall employ an independent testing laboratory to perform a mix design to determine the optimum cement content to stabilize the existing aggregate base and subgrade soil. The mix design should be prepared under the supervision of a registered professional engineer.

3. Contractor shall assist the testing laboratory in obtaining samples of the existing aggregate base and subgrade soil to the specified depth and perform appropriate testing to establish the mix design. Samples must be obtained inclusive of the depth to be stabilized. Sampled materials must be properly processed and prepared to closely simulate field conditions. When in-place materials change significantly, additional mix designs may be performed to establish representative mixes for the entire project.

4. Mix Design: The Contractor's mix design report shall contain the following minimum requirements:

- a. Moisture-density relation to determine maximum dry density and optimum moisture of the prepared blend of existing aggregate base and subgrade soil in accordance with AASHTO T99.
- b. Atterberg limits tests to determine liquid limit, plastic limit, and plasticity index of the prepared blend of existing aggregate base and subgrade soil in accordance with AASHTO T89 and T90.
- c. Particle size analysis of the prepared blend of existing aggregate base and subgrade soil in accordance with AASHTO T11 and T27.
- d. Moisture-density relation for each cement content tested to determine maximum dry density and optimum moisture of the prepared blend of existing aggregate base and subgrade soil with Portland cement in accordance with AASHTO T134.
- e. Specimens of cement treated aggregate base/subgrade soil blend shall be prepared and molded for strength testing. The specimens shall be prepared as described in AASHTO T-134.

The specimens shall be allowed to cure at room temperature for a period of 7 days in an environment that will prevent moisture loss.

After curing, compressive strength of prepared specimens of cement treated aggregate base/subgrade soil blend shall be determined in accordance with AASHTO T208.

A cement content curve shall be generated by plotting compressive strength of cement treated aggregate base/subgrade soil blend versus the cement content used in each sample. Specimens shall be prepared for a minimum of 3 cement contents. Specimens shall be prepared at a range of cement contents sufficient to achieve a minimum compressive strength of 200 psi. The lowest cement content, for each test at various moisture contents, with the unconfined compressive strength greater than 200 psi, but not greater than 400 psi, shall be the design cement content to stabilize that blend of aggregate base and subgrade soil. Specimens shall be molded at varying moisture contents to determine an allowable tolerance of water to maintain the performance of the mix but allows the Contractor to make slight adjustments based on field conditions during the time of application.

- f. Recommendation for the percent of Portland cement to be blended into the existing aggregate base and subgrade soil. A recommendation should also be provided for the tolerance for moisture content.

## PART 2 – PRODUCTS

### 2.01 Cement

- A. Conform to NDDOT Specification Section 804 except as modified herein:
  - 1. Cement shall be either Portland Cement – Type I, IA, or II, or
  - 2. Blended Hydraulic Cement – Type IL(MS).

### 2.02 Aggregate

- A. Conform to Section 2900 – Aggregate Base.

### 2.03 Water

- A. Use only potable water, free of contaminants and substances deleterious to the hardening of the cement treated material.

## PART 3 – EXECUTION

### 3.01 General Requirements

- A. Prior to the start of the work, all utilities and drainage systems shall be protected or relocated as necessary.

- B. Milling, blending and reclamation may be performed with any machine or combination of machines or equipment as approved by the Engineer prior to the start of the Project which will produce a satisfactory product meeting the requirements for pulverization, cement and water application, mixing, compacting, finishing, and curing as provided in this specification.
- C. Prior to the actual reclaiming of the roadway, drop inlets or catch basins that might be affected shall be sufficiently barricaded to prevent reclaimed subbase material, silt or runoff from plugging the drainage system.
- D. Sufficient surface drainage must be provided for each stage of construction so that ponding does not occur on the exposed roadway surface prior to the placement of bituminous concrete.

### 3.02 Pavement Milling

- A. Existing bituminous surface course and existing aggregate base shall be milled to the depth of ½" below the bottom of the existing asphalt pavement layer. Millings are the property of the City and shall be transported and stockpiled at the City Landfill or at another location specified, by the Contractor.
- B. Care shall be taken when milling around structures and adjacent to curb and gutter. Damaged surfaces shall be replaced or repaired to the satisfaction of the Engineer at no cost to the Owner.

### 3.03 Cement Stabilization Preparation

- A. Cement stabilization process shall not commence when the soil aggregate or sub-grade is frozen, or when the air temperature is below 40°F (4°C).
- B. Before cement is applied, initial pulverization or scarification may be required to the full depth of mixing. Scarification or pre-pulverization is a requirement for the following conditions:
  - 1. When the processed material is more than five (5) percent above or below optimum moisture content. When the material is below optimum moisture content, water shall be added. The pre-pulverized material shall be sealed and properly drained at the end of the day or if rain is expected.
  - 2. For slurry application of cement, initial scarification shall be required to provide a method to uniformly distribute the slurry over the processed material without excessive runoff or ponding.

### 3.04 Cement Application

- A. The operation of cement application, mixing, spreading, compacting, and finishing shall be continuous and completed within 2 hours from the start of

mixing. Any processed material that has not been compacted and finished shall not be left undisturbed for longer than 30 minutes.

- B. The specified quantity of cement shall be applied uniformly over the existing base in a manner that minimizes dust and is satisfactory to the Engineer. If cement is applied as a slurry, the time from first contact of cement with water to application on the soil shall not exceed 60 minutes. The time from cement placement on the soil to start of mixing shall not exceed 30 minutes.
- C. Spreading of the Portland cement shall be performed with a spreader truck designed to spread dry particulate such as Portland cement to insure a uniform distribution. Spreaders or distributors used shall be able to demonstrate a consistent and accurate application rate, as well as dust control during application. The mechanical cement spreader shall be capable of dispensing a measured quantity of cement +/- 3 pounds per square yard in advance of the reclaimer/pulverizer just prior to each pass of the stabilizing operation. The blending equipment shall abut or slightly overlap (.5") previous pass to ensure a continuous homogeneous mass of granular material and cement. Cement spreader does not have to abut or overlap previous pass as long as the calculated quantity of cement is dispersed in front of the reclaimer/pulverizer.
- D. Portland cement shall not be spread over puddled water, during rain, or when rain is imminent. Spreading shall not be performed when wind speeds are 15 miles per hour or greater, or any time when excessive drifting occurs.

### 3.05 Blending

- A. Blending shall be accomplished by means of a self-propelled, traveling rotary reclaimer or equivalent machine capable of cutting through existing bituminous concrete pavement, aggregate base, and subgrade soil to depths of up to 16 inches with one pass. The machine shall be equipped with an adjustable grading blade leaving its path generally smooth for initial compaction. Equipment such as road planers or cold milling machines designed to mill or shred the existing bituminous concrete, rather than crush or fracture it, shall not be allowed during the reclaiming process.  
  
Agricultural disks or motor graders are not acceptable blending equipment.
- B. Any existing bituminous concrete pavement that remains after milling must be removed or pulverized and blended with the existing aggregate base and subgrade soil to form a homogenous mass which will bond together when compacted.
- C. Moisture in the blended material shall be monitored during construction. Water shall be added as necessary to adjust the moisture content of the

blended material to within the tolerances defined in the mix design prior to the start of compaction.

- D. Water may be applied through the mixer or with water trucks equipped with pressure-spray bars. If using the spray bar system, road base shall be pre-wet to obtain required moisture content prior to the dispensing of cement.
- E. Mixing shall begin as soon as possible after the cement has been spread and shall continue until a uniform mixture is produced. Cement and water shall be incorporated into the existing base material at the prescribed percentages and mixed to a depth of 12 inches into the existing aggregate base and subgrade soil. The mixed material shall meet the following gradation conditions:
  - 1. The final mixture (bituminous surface, granular base, and sub-grade soil) shall be pulverized such that 100% passes the 1-in. (25 mm) sieve, except for occasional rocks present in the subgrade soil.
  - 2. Blending operations shall be continued until the product is uniform in color, meets gradation requirements, and is at the required moisture content throughout. The entire operation of cement spreading, water application, and mixing shall result in a uniform pulverized asphalt, soil, cement, and water mixture for the full design depth and width.
- F. Reshaping using the reclaimed base material should be minimized in order to ensure that the roadway has a uniform thickness of stabilized aggregate base/subgrade material throughout.
- G. A motor grader shall be used for shaping, fine grading, and finishing the surface of the reclaimed material or any other granular materials placed to form the surface prior to paving.
- H. Any surface irregularities which develop during or after the above described work shall be corrected until it is brought to a firm and uniform surface satisfactory to the Engineer.

### 3.06 Compaction

- A. The processed material shall be compacted with one or a combination of the following: Tamping or grid roller, pneumatic-tire roller, steel-wheel roller, vibratory roller, or vibrating-plate compactor. The blended material shall be rolled with a vibratory pad/tamping foot roller and a vibratory steel drum soil compactor. The pad/tamping foot roller drum shall have a minimum of 112 tamping feet 3" in height, a minimum contact area per foot of 17 in<sup>2</sup>, and a minimum width of 84 in. The vibratory steel drum roller shall have a minimum 84 in width single drum.
- B. The blended material shall be uniformly compacted to a minimum of 98% of maximum density. Field density of compacted material can be determined by nuclear method in the direct transmission mode (AASHTO T 310), sand

cone method (AASHTO T 191), or rubber balloon method (ASTM D 2167). Optimum moisture and maximum density shall be determined for samples of the blended material in the field during construction by a moisture-density relation test (AASHTO T 134).

- C. At the time of compaction, the moisture content shall be maintained within range of moisture determined by the mix design. No section shall be left undisturbed for longer than 30 minutes during compaction operations. All compaction operations shall be completed within 2 hours from start of mixing.

### 3.07 Finishing and Curing

- A. As compaction nears completion, the surface of the stabilized base material shall be shaped to the specified lines, grades, and cross sections. If necessary or as required by the Engineer, the surface shall be lightly scarified or broom-dragged to remove imprints left by equipment or to prevent compaction planes. Compaction shall then be continued until uniform and adequate density is obtained.
- B. During the finishing process the surface shall be kept moist by means of water spray devices that will not erode the surface until paving operations have begun. Compaction and finishing shall be done in such a manner as to produce a dense surface free of compaction planes, cracks, ridges, or loose material. All finishing operations shall be completed within 4 hours from start of mixing.
- C. Finished portions of the stabilized base that are traveled on by equipment used in constructing an adjoining section shall be protected in such a manner as to prevent equipment from marring or damaging completed work.
- D. After completion of final finishing, the surface shall be cured by being kept continuously moist for a period of 7 days, or until surface pavement is placed, with a water spray that will not erode the surface of the cement stabilized base.
- E. Sufficient protection from freezing shall be given to the cement-treated material for 7 days after its construction or as approved by the Engineer. Contractor assumes all materials and costs to keep cement stabilized base moist for the period of protection, or until the surface course is applied.
- F. The stabilized base shall be allowed to cure a minimum of 72 hours before subsequent aggregate or pavement layers can be placed. Cure time may be reduced if approved by the Engineer and provided the stabilized base is sufficiently stable to support the required construction equipment without marring or permanent distortion of the surface.



3.08 Traffic

- A. Completed portions of cement stabilized base may be opened upon approval from the Engineer, provided that traffic is limited to low-speed local traffic and to construction equipment only, further provided the curing material or moist curing operations are not impaired, and provided the stabilized base is sufficiently stable to withstand traffic without marring or permanent deformation.

3.09 Maintenance

- A. The Contractor shall maintain the stabilized material in good condition until all work is completed and accepted. Such maintenance shall be done by the Contractor incidental to the Item of Work to cement stabilize the existing base material.
- B. Maintenance shall include immediate repairs of any defects that may occur. If it is necessary to replace any processed material, the replacement shall be for the full depth, with vertical cuts, using either cement-treated material or concrete. No skin patches will be permitted.

3.10 Field Quality Control

- A. Contractor shall coordinate and schedule a qualified independent testing laboratory to perform geotechnical testing.
- B. Contractor shall assist the testing agency in performing field tests.
- C. If testing agency reports failing tests, Contractor shall correct the deficiencies until specified compaction is obtained.
- D. The minimum amount of testing must be completed as detailed in Section 1000 – Quality Requirements.
- E. Before placement of base material, subgrade will be checked by the Engineer.
  - 1. A tolerance of 0.04 feet above or below the finished subgrade elevation will be allowed.

PART 4 – MEASUREMENT AND PAYMENT

- A. This work will be paid for at the contract unit price per square yard (SY) for Cement Stabilized Base to a depth of 12 inches measured along the centerline of the road for the width of the roadway base being stabilized or as directed by the Engineer. This work shall include all equipment, labor and materials required for testing and sampling, application of cement and water, mixing, pulverizing, shaping and compacting, inspections, curing, protection and all other appurtenances associated for the Item of work.

- B. The quantities for cement shall be based on six (6) percent by dry unit weight of the soils. Adjustment for cement above 6 percent will be included in a change order for materials only and paid for as cement adjustment.
- C. All costs to properly complete the work specified herein and/or shown on the Plans, including mix designs, shall be included in the prices bid for these or other items unless applicable bid items are included on the Bid Form.

END OF SECTION

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