
USACE / NAVFAC / AFCEA / NASA UFGS-32 11 34 (August 2008)

Preparing Activity: USACE Superseding
UFGS-32 11 34 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2010

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SECTION 32 11 34

PORTLAND CEMENT-STABILIZED BASE OR SUBBASE COURSE 08/08

NOTE: This guide specification covers the requirements for portland cement-stabilized base or subbase and lean concrete bases or subbases.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: In general, this specification is written for portland cement-stabilized base or subbase courses and is applicable to lean concrete bases or subbases (also popularly known as "Econocrete") since materials and construction procedures are similar. The lean concrete base may or may not require sawcut construction joints depending on the engineer's purpose in using the base and the planned surfacing construction. Generally, all longitudinal construction joints are butt joints without keys, dowels, or tie bars.

Lean concrete base differs from conventional paving concrete primarily due to lower cement contents.

Sometimes a poorer quality aggregate may be used but the durability of this aggregate under the project's freezing and thawing conditions should be investigated. Other considerations such as popouts or easily polished aggregates are of less concern in a base than in a surface pavement. Aggregate quality requirements may be relaxed for these considerations.

The dividing line between a portland cement-stabilized base or subbase and lean concrete base or subbase is not clear. Generally, if the material's compressive strength is less than 10 MPa (1500 psi), the flexural strength is less than 2.5 MPa (350 psi), or the amount of material passing the 0.075 mm (No. 200) sieve is allowed to increase appreciably, it should be treated as a stabilized base or subbase rather than lean concrete base or subbase.

1.1 UNIT PRICES

1.1.1 Measurement

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Method of measurement not applicable to the job conditions will be deleted. If bituminous material is to be paid for separately, select the desired method of measurement. Reference to select material will be deleted when select material is not required from borrow areas.

1.1.1.1 Portland Cement Stabilization

Measurement shall be by the square m yard of work completed and accepted.

1.1.1.2 Cement

Measurement shall be by the number of kg short hundred-weight (cwt) of cement used in the completed and accepted work. No measurement shall be made for wasted cement or cement used in work determined defective.

1.1.1.3 Bituminous Material

Bituminous material to be paid for shall be measured by the number of [L gallons] of the material used in the accepted work, corrected to L at 15 degrees C gallons at 60 degrees F in accordance with [ASTM D 633] [ASTM D 1250]. A coefficient of 0.00045 per degree C 0.00025 per degree F shall be used for asphalt emulsion [metric 2000 pound tons of the material used in the accepted work].

1.1.1.4 Select Material

Select material shall be measured by the [cubic meter yard] [metric 2000

pound ton] of material placed and used in the completed and accepted stabilization. No measurement will be made for select material that is wasted or used in work determined defective.

1.1.2 Payment

NOTE: Paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material. Delete material in the first set of brackets when onsite material is not available.

Reference to select material will be deleted when select material is not required from borrow areas.

The last sentence in brackets will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

Cement stabilization, constructed and accepted, including cement, [bituminous material] [and select material] will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. [Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating.] [No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting will be included in the contract unit price for bituminous material.]

1.1.3 Waybills and Delivery Tickets

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all cement [, bituminous material] [and select material] used in the construction.

1.2 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the

reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 147	(1965; R 2008) Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses
AASHTO M 182	(2005) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
AASHTO M 81	(1992; R 2008) Cut-Back Asphalt (Rapid-Curing Type)
AASHTO M 82	(1975; R 2008) Cut-Back Asphalt (Medium-Curing Type)
AASHTO T 134	(2005) Moisture-Density Relations of Soil-Cement Mixtures
AASHTO T 135	(1997; R 2005) Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
AASHTO T 136	(1997; R 2005) Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150/C 150M	(2009) Standard Specification for Portland Cement
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 595/C 595M	(2008a) Standard Specification for Blended Hydraulic Cements
ASTM D 1241	(2007) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D 1250	(2008) Standard Guide for Use of the Petroleum Measurement Tables

ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D 1632	(2007) Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D 1633	(2000; R 2007) Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2027	(1997; R 2004) Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1997; R 2004) Cutback Asphalt (Rapid-Curing Type)
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 490	(1992; R 2005) Road Tar
ASTM D 558	(2004) Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D 559	(2003) Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D 560	(2003) Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D 633	(1997; R 2005) Volume Correction Table for Road Tar
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 75/D 75M	(2009) Standard Practice for Sampling Aggregates
ASTM D 977	(2005) Emulsified Asphalt
ASTM E 11	(2009) Wire Cloth and Sieves for Testing Purposes

1.3 DEFINITION

Portland cement-stabilized base or subbase course, as used herein, is a mixture of portland cement and in-place, or select borrow, material

uniformly blended and thoroughly compacted to produce a pavement course which meets the criteria set forth in the drawings and specifications.

1.4 SYSTEM DESCRIPTION

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. Provide equipment with the capability of producing the required compaction, meeting grade controls, thickness control and smoothness requirements specified. [Place a test section of at least 2.5 by 30 m 8 by 100 feet, utilizing the equipment and procedures proposed for use by the Contractor, to demonstrate that soil-cement stabilization conforming to this specification can be produced] [A test section is not required].

1.4.1 Central-Plant

Provide a central plant capable of producing a uniform cement-treated mixture at the required cement and moisture contents. Soil and cement shall be dry-mixed sufficiently to prevent cement balls from forming when water is added.

1.4.2 Straightedge

Furnish and maintain at the site, in good condition, one [3.05] [3.66] meter [10] [12] foot straightedge for each bituminous paver, for use in the testing of the finished surface. Make straightedges available for Government use. Construct straightedges of aluminum or other lightweight metal with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.5 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy,
Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force
and NASA projects, or choose the second bracketed
item for Army projects.

Government approval is required for submittals with a "G" designation;
submittals not having a "G" designation are for [Contractor Quality Control
approval.] [information only. When used, a designation following the "G"
designation identifies the office that will review the submittal for the
Government.] Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design[; G][; G, [_____]]

Proposed mix design, prior to start of stabilization work.

Aggregate

Notification of sources from which aggregates are to be
obtained, within 15 days after the award of contract.

Bituminous Material

Notification of sources from which bituminous materials are to
be obtained, within 15 days after the award of the contract.

Waybills and Delivery Tickets

Copies during construction. Copies for all material used,
before final payment.

SD-06 Test Reports

Aggregate

Certified copies of aggregate test results, not less than [30]
[_____] days before the material is required in the work.
Calibration curves and related test results, prior to using the
device or equipment being calibrated.

SD-07 Certificates

Bituminous Material

Certified copies of the manufacturer's test reports indicating
compliance with applicable specified requirements, not less than
[30] [_____] days before the material is required in the work.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not apply cement when the atmospheric temperature is less than 5 degree C
40 degrees F or to soils that are frozen or contain frost, or when the
underlying material is frozen. If the temperature falls below 2 degree C
35 degrees F, protect completed cement-treated areas against detrimental

effects of freezing. Any areas of completed [base] [or] [subbase] that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition in conformance with this specification without additional cost to the Government.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cement

Provide cement conforming to **ASTM C 150/C 150M**, Type I, IA, II, or IIA or **ASTM C 595/C 595M**, Type IS or IS(A).

2.1.2 Bituminous Material

NOTE: Tar or asphalt of one grade or type will be specified.

Bituminous material shall conform to one of the following:

2.1.2.1 Cutback Asphalt

[**AASHTO M 81**] [**AASHTO M 82**] or [**ASTM D 2027**], [**ASTM D 2028**], Grade [MC-70] [MC-250] [RC-70] [RC-250].

2.1.2.2 Emulsified Asphalt

ASTM D 977, Type [RS-1] [RS-2].

2.1.2.3 Tar

ASTM D 490, Grade [RT-7] [RT-8] [RT-9] [RT-10].

2.1.3 Material to be Stabilized

NOTE: For base courses for airfield pavements delete requirements for in-place materials, traveling plant, and in-place mix method. Specify a select material conforming to AASHTO M 147 or ASTM D 1241 and central plant mixing method.

Stabilize material using [in-place material] [select material conforming to **AASHTO M 147** or **ASTM D 1241**, Grading [B] [C] [or] [D]]. Remove stones retained on a **50 mm 2 inch** sieve and deleterious substances such as sticks, debris, and organic matter. When the in-place material consists primarily of soil having high plasticity or otherwise undesirable characteristics, construct the course to produce fully hardened soil cement as determined by **AASHTO T 135** and **AASHTO T 136** or **ASTM D 559** and **ASTM D 560**; not more than 45 percent of the material should be retained on the **4.75 mm No. 4** sieve.

2.1.4 Water

Provide water which is clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious

to the hardening of soil-cement, and subject to approval.

2.1.5 Burlap

Burlap shall conform to AASHTO M 182.

2.1.6 Impervious Sheeting

Sheeting shall conform to ASTM C 171 and shall be white waterproof paper, white opaque polyethylene film or white burlap-polyethylene sheets.

2.2 MIX DESIGN

NOTE: Designer should refer to UFC 3-250-11 and UFC 3-260-01 for further guidance on restrictions to be placed or requirements added to the mix design paragraph, and information on applicability of stabilization with portland cement.

Develop the mix using the aggregate or soil-aggregate material to be stabilized. Mix shall have a minimum compressive strength of [1.75 MPa 250 psi for subbase,] [5 MPa 750 psi for base,] [10 MPa 1500 psi for lean concrete,] a weight loss of 14 percent or less after 12 cycles of the durability test, and "low alkali" cement for alkali reactive aggregate.

2.3 SAMPLING AND TESTING

2.3.1 Testing Facilities

Perform sampling and testing using an approved commercial testing laboratory or by facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government. Cost incurred for any subsequent inspection, required because of failure of the facilities to pass the first inspection, will be charged to the Contractor. Perform tests in sufficient numbers, and as specified, to ensure that materials and compaction meet specified requirements. Furnish copies of the test results to the Contracting Officer within 24 hours of completion of tests.

2.3.2 Test Results

Results shall verify that materials comply with the specification. When a material source is changed, [test the new material for compliance] [_____]. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired to conform to the contract requirements at no additional cost to the Government.

2.3.3 Aggregate

Tests for determining the suitability of aggregate shall include, but not be limited to: sieve analysis in accordance with ASTM C 136, and ASTM D 422 using sieves conforming to ASTM E 11, liquid limits and plasticity index in accordance with ASTM D 4318. Take aggregate samples for laboratory tests in accordance with ASTM D 75/D 75M. Prepare specimens to be used for

unconfined compression tests in accordance with ASTM D 1632 except that a 100 mm 4 inch diameter by 200 mm 8 inch high mold shall be used to prepare specimens when more than 35 percent of the material is retained on the 4.75 mm No. 4 sieve.

2.3.4 Initial Sampling and Testing

2.3.4.1 Laboratory Density

Conduct moisture-density tests in accordance with the procedure contained in AASHTO T 134 or ASTM D 558; however the apparatus and procedures outlined in ASTM D 1557 shall be used to compact the soil-cement mixture.

2.3.4.2 Unconfined Compression Testing

Conduct three unconfined compression tests, in accordance with ASTM D 1633, for each mix design tested. Cure samples at a constant moisture content and temperature for 7 days.

2.3.4.3 Durability Tests

NOTE: Where the soil aggregate mixture is an approved select material conforming to AASHTO M 147 or ASTM D 1241, Grading B, C, or D, the use of the test procedures conforming to AASHTO T 135 and AASHTO T 136 or ASTM D 559 and ASTM D 560 may be waived.

The last sentence in brackets will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

[Conduct wet-dry tests in accordance with AASHTO T 135 or ASTM D 559.]
[Conduct freeze-thaw tests in accordance with AASHTO T 136 or ASTM D 560.]
Three tests shall be conducted for each mix design tested.

2.3.5 Sieve Analysis

NOTE: Delete reference to source of material when select material is not required and edit submittal requirements accordingly.

A minimum of one analysis shall be performed for each [1000] [_____] metric tons tons of material to be stabilized, with a minimum of 3 analyses for each day's run until the course is completed. When [the source of materials is changed] [and] [deficiencies] are found, the analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced at no additional cost to the Government.

2.3.6 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with

ASTM D 4318.

2.3.7 Sampling and Testing During Construction

Perform quality control sampling and testing during construction as required in paragraph FIELD QUALITY CONTROL.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Do not apply cement if the soil moisture content exceeds optimum moisture content specified for the cement-treated mixture. After mixing is completed, the proportions of the mixture shall be in accordance with the approved mix design. When application of water and mixing are completed, on the basis of dry weight, moisture shall not be below the optimum moisture content of the mixture nor shall it be more than 2 percent above the optimum moisture content. When the stabilized course is constructed in more than 1 layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the areas to be stabilized or on pulverized, mixed, or partially mixed material. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF BORROW PITS

**NOTE: Paragraph will be deleted when select
material is not required or when small quantities do
not justify the inclusion of select material.**

[Borrow pits shall be cleared, stripped and excavated to working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Waste strata of unsuitable materials overlying or occurring in the deposit. Methods of operating the pits and the processing and blending of the materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, condition pits to drain readily, and be left in a satisfactory condition.] [Obtain borrow material from approved offsite sources.]

3.3 STOCKPILING MATERIALS

**NOTE: This paragraph will be deleted when select
material is not required or when small quantities do
not justify the inclusion of select material.**

Stockpile select material, including approved material available from excavation and grading, in the manner and at the locations designated. Before stockpiling of material, the storage sites shall be cleared, drained, and leveled. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF AREA TO BE STABILIZED

NOTE: Inapplicable paragraph will be deleted.

Area to be stabilized shall be cleaned of debris; inspected for adequate compaction; and shall be capable of withstanding, without displacement, the compaction specified for the soil-cement mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

3.4.1 In-Place Material to be Stabilized

The entire area to be stabilized shall be graded and shaped to conform to the lines, grades, and cross sections shown in the plans, prior to being processed. Soft or yielding areas shall be made stable before construction is begun.

3.4.2 In-Place Materials to Receive Stabilized Course

NOTE: If this paragraph is retained, inapplicable portions will be deleted.

[Soft, yielding areas and ruts or other irregularities in the surface shall be corrected. Material in the affected areas shall be loosened and unsatisfactory material removed. Add approved select material where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density.] [Subgrade shall conform to Section 31 00 00 EARTHWORK.] [Subbase course shall conform to Section 32 11 16.16 SUBBASE COURSES.]

3.4.3 Select Material

NOTE: Delete if select material is not required.

Sufficient select material shall be utilized to provide the required thickness of the soil-cement layer after compaction and shall be processed to meet the requirements specified before cement stabilization is undertaken.

3.5 INSTALLATION

NOTE: For base courses for airfield pavements delete requirements for in-place materials, traveling plant, and in-place mix method. Specify a select material conforming to AASHTO M 147 or ASTM D 1241 and central plant mixing method.

3.5.1 Edges of Stabilized Course

Placed approved material along the edges of the stabilized course in such quantity as will compact to the thickness of the course being constructed,

or to the thickness of each layer in a multiple-layer course, allowing at least a 300 mm 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course.

3.5.2 Mixed-in-Place Method

3.5.2.1 Scarifying and Pulverizing of Soil

Prior to the application of cement, the soil shall be scarified and pulverized [to the depth shown] [to a depth of [_____] mm inches]. Carefully control scarification so that the layer beneath the layer to be stabilized is not disturbed. Depth of pulverizing shall not exceed the depth of scarification. Unless otherwise permitted, the area scarified and pulverized shall not exceed the area that can be completed in 2 working days.

3.5.2.2 Application of Cement

Approximately shape pulverized material to the cross section indicated. Cement shall be applied so that when uniformly mixed with the soil, the specified cement content is obtained, and a sufficient quantity of cement-treated soil is produced to construct a compacted cement-treated course conforming to the lines, grades, and cross section indicated. Equipment, except that used in spreading and mixing operations, shall not pass over the freshly spread soil cement.

3.5.2.3 Dry Mixing

Immediately after the cement has been distributed, it shall be mixed with the soil. The cement shall not be mixed below the required depth. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied.

3.5.2.4 Water Application and Moist Mixing

Determine moisture content of the mixture immediately after completion of mixing of the soil and cement. Provide water-supply and pressure distributing equipment that will permit the continuous application within 3 hours of all water required on the section being processed. Incorporate water in the mix so that concentration of water near the surface does not occur. After all the mixing water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture, with no portion of the mixture remaining undisturbed during mixing for more than 30 minutes. Any portion of the mixture remaining undisturbed more than 30 minutes during mixing shall be disposed of as specified. Satisfactory moisture distribution shall occur along the edges of the section.

3.5.3 Central-Plant Method

Haul the mixture to the job in trucks equipped with protective covers. Thoroughly moisten the underlying course and deposit the material on the prepared area in a quantity that will produce a compacted base of uniform density to the required grade and cross section. Spreading or spreading-trimming equipment shall be constructed and operated to produce a layer of material which is uniform in thickness and surface contour and free from irregularities in density. Use spreading or spreading-trimming equipment in sufficient numbers and in staggered formation to obtain

full-width spreading in 1 construction operation. Not more than 60 minutes shall elapse between the start of the moist mixing and the start of compaction of the treated layer. Not more than 30 minutes shall elapse between the placement of the cement-treated soil in adjacent lanes on 2-lane structures at any location.

3.5.4 Traveling-Plant Method

Move traveling plant at a uniform rate of speed to accomplish thorough mixing of the materials. Deliver water and cement from supply trucks or bins at a predetermined rate. Windrows of prepared soil-cement mixture shall be of sufficient size to cover a predetermined width to the indicated compacted thickness.

3.5.5 Layer Thickness

Compacted thickness of the stabilized course shall be [as indicated] [[_____] mm inches]. No layer shall be in excess of 200 mm 8 inches nor less than 100 mm 4 inches in compacted thickness.

3.5.6 Compaction

NOTE: Density will be based on the material being stabilized.

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened to the full depth. At the beginning of compaction, at least 80 percent of the soil shall pass a 4.75 mm No. 4 sieve, and 100 percent shall pass the 25 mm 1 inch sieve. Start compaction immediately after mixing is completed. Density of compacted soil-cement mixture shall be at least [_____] percent of the maximum density obtained from the laboratory prepared samples. Loose mixture shall be uniformly and continuously compacted until the entire depth and width of the area are compacted to the density specified. The moisture content at the surface shall be maintained near optimum at all times through the rolling, but shall be less than that quantity which will cause the soil-cement mixture to become unstable during compaction. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Displacement of the mixture shall not occur due to the speed of the roller. Areas inaccessible to rollers shall be compacted with mechanical tampers.

3.6 FINISHING

The surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. Lightly scarify the surface, if necessary, to eliminate any imprints made by the compacting or shaping equipment. The surface shall then be thoroughly compacted to the specified density with rubber-tired rollers and smooth-wheel tandem rollers to the extent necessary to provide a smooth, dense, uniform surface that is free of surface checking, ridges, or loose material, and that conforms to the crown, grade, and line indicated. Complete these finishing operations within 2 hours after completion of mixing operations. In places not accessible to finishing and shaping equipment, the mixtures shall be compacted with mechanical tampers to the density specified and shall be

shaped and finished by hand methods. Correct, as specified below, any portion of the compacted mix that has density less than that specified, that has not properly hardened, or that is improperly finished.

3.7 CONSTRUCTION JOINTS

At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-cement that is mixed, moistened, and compacted as specified.

3.8 CURING AND PROTECTION

NOTE: It may be advantageous to specify only bituminous curing for stabilized base courses which are to receive bituminous surfacing under the contract, in which case, other curing materials and methods will be deleted.

Protect the finished surface against rapid drying for 7 days by one of the methods specified.

3.8.1 Moist Curing

Apply a 50 mm 2 inch covering of soil or not less than 2.2 kg/square meter 4 pounds/square yard of straw. The material shall be moistened initially and kept moistened throughout the curing period. In multiple-layer construction, the soil used in moist curing, if of approved select material, may be used for constructing the succeeding stabilized course.

3.8.2 Burlap

Provide burlap covers consisting of 2 or more layers of burlap having a combined weight of 400 grams 14 ounces or more per square meter yard in a dry condition. Burlap shall be either new or shall have been used only for curing concrete. Burlap strips shall have a length, after shrinkage, at least 300 mm 1 foot greater than necessary to cover the entire width and edges of the finished stabilized area. Mats shall overlap each other at least 150 mm 6 inches. Mats shall be thoroughly wetted before placing and shall be kept continuously wet and in contact with the surface and edges of the finished stabilized area for the entire curing period.

3.8.3 Impervious Sheeting

The surface of the finished stabilized area shall be moistened with a fine spray of water and then covered with impervious sheeting. The burlap of the polyethylene-coated burlap shall be thoroughly saturated with water before placing. Sheeting shall be placed with the light-colored side up. Sheets shall extend over the edges of the stabilized area and shall be held securely in place throughout the curing period. Edges of sheets shall overlap each other at least 300 mm 12 inches and shall be securely cemented or taped to form continuous closed joints. Tears and holes in sheets shall be repaired immediately.

3.9 BITUMINOUS MATERIAL APPLICATION

NOTE: The last sentence will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

The application temperatures will be selected from the following table and inserted in the blanks:

Liquid asphalt:	Degree C	(Degrees F)
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RC-70 or MC-70	50-85	(120-185)
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RC-250 or MC-250	75-110	(165-230)
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Emulsified asphalt:

RS-1	25-55	(75-130)
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RS-2	45-70	(110-160)
------	-------	-----------

Tar:

RT-7	65-105	(150-225)
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RT-8	65-105	(150-225)
------	--------	-----------

RT-9	65-105	(150-225)
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RT-10	80-120	(175-250)
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Apply bituminous material uniformly by means of a bituminous distributor within a temperature range of [_____] to [_____] degrees C F, as directed. Bituminous material for curing shall be uniformly applied at the rate of 0.06 to 0.08 L/square meter 0.2 to 0.25 gallon/square yard. Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Bituminous material shall be applied only to the top layer. At the time the bituminous material is applied, the surface shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, water in sufficient quantity to fill the surface voids shall be applied immediately before the bituminous material is applied. Treated surface shall be sanded or dusted to prevent the bituminous material from being picked up by traffic.

3.10 FIELD QUALITY CONTROL

3.10.1 Grade Control

Underlying material shall be excavated to sufficient depth for the required stabilized-course thickness. The finished stabilized course with the subsequent surface course shall meet the fixed grade. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

3.10.2 Smoothness Test

NOTE: For subgrade and subbase stabilization, paragraph should be deleted.

The surface of a stabilized layer shall show no deviations in excess of 10 mm 3/8 inch when tested with the straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a straightedge. Measurements shall also be taken perpendicular to the road centerline at [15] [] meter [50] [] foot intervals.

3.10.3 Thickness Control

NOTE: Thickness allowance may be modified to 6 mm (1/4 inch) when the course thickness is 150 mm (6 inches) or less. The designer may describe the sampling, testing, and approval considered necessary for a particular project.

The completed thickness of the stabilized course shall be within 13 mm 1/2 inch of the thickness indicated. Where the measured thickness is more than 13 mm 1/2 inch deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompact as directed. Where the measured thickness is more than 13 mm 1/2 inch thicker than indicated, the course shall be considered as conforming with the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm 1/4 inch of the thickness indicated. The thickness of the stabilized course shall be measured at intervals which ensure one measurement for each [400] [] square meters [500] [] square yards of stabilized course. Measurements shall be made in 75 mm 3 inch diameter test holes penetrating the stabilized course.

3.10.4 Testing

Perform field tests in sufficient numbers to assure that the specifications are being met. Testing is be the responsibility of the Contractor and shall be performed by an approved commercial laboratory.

3.10.5 Field Density

Field density tests shall be performed in accordance with ASTM D 1556 or ASTM D 6938. ASTM D 6938 results in a wet unit weight of soil and ASTM D 6938 shall be used to determine the moisture content of the soil. Calibration curves furnished along with the density gauge shall be checked as described in ASTM D 6938. Calibration checks of the density gauge shall be made at the beginning of a job on each type of material encountered. If ASTM D 6938 is used, in-place densities shall be checked by ASTM D 1556 at least once per lift for each [] square meter yard of stabilized material. Calibration curves and calibration test results shall be furnished within 24 hours of conclusion of the tests. At least 1 field density test shall be performed for each [200] [] square meters [250] [] square yards of each layer of base material.

3.10.6 Samples of Bituminous Materials

Obtain under the supervision of the Contracting Officer a sample of the bituminous material used. The sample will be retained by the Government.

3.10.7 Maintenance

Maintain the stabilized area in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be remedied as specified.

3.10.8 Traffic

Completed portions of the cement-treated soil area may be opened immediately to light traffic provided the curing is not impaired. After the curing period has elapsed, completed areas may be opened to all traffic provided that the cement-stabilized course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment will not be permitted on the area during the curing period. Cement and water may be hauled over the area with pneumatic-tired equipment as approved. Finished portions of cement-stabilized soil that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner that prevents equipment from marring or damaging the completed work.

3.11 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials, that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of [as directed] [in disposal area indicated].

-- End of Section --