
USACE / NAVFAC / AFCEC / NASA UFGS-32 11 33 (August 2008)

Preparing Activity: NAVFAC Superseding
UFGS-32 11 33 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2020

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SECTION 32 11 33

CEMENT STABILIZED [BASE] [SUBBASE] COURSE AT AIRFIELDS AND ROADS 08/08

NOTE: This guide specification covers the requirements for portland cement-stabilized base or subbase for airfields, roads and streets.

Adhere to [UFC 1-300-02](#) Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a [Criteria Change Request \(CCR\)](#).

NOTE: The following information should be shown on the project drawings:

1. Location, type and thickness of base and subbase materials.
2. Location of on-site aggregate sources when applicable.

PART 1 GENERAL

1.1 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 Reference Identifier (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 81	(1992; R 2017) Standard Specification for Cutback Asphalt (Rapid-Curing Type)
AASHTO M 82	(2017) Standard Specification for Cutback Asphalt (Medium-Curing Type)
AASHTO M 140	(2016) Standard Specification for Emulsified Asphalt
AASHTO M 208	(2016) Standard Specification for Cationic Emulsified Asphalt

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2018) Standard Specification for Portland Cement
ASTM C171	(2016) Standard Specification for Sheet Materials for Curing Concrete

ASTM C595/C595M	(2018) Standard Specification for Blended Hydraulic Cements
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D420	(1998; R 2003) Site Characterization for Engineering Design, and Construction Purposes
ASTM D558/D558M	(2019) Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D559	(2003) Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D560	(2003) Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D977	(2019a; E 2019) Standard Specification for Emulsified Asphalt
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D1632	(2007) Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D1633	(2000; R 2007) Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D2027/D2027M	(2019) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2015) Cutback Asphalt (Rapid-Curing Type)
ASTM D2487	(2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D6938

(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 81-123

(1981) Occupational Health Guideline for Chemical Hazards, (Vols. I, II, and III)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS CCC-C-467

(Rev C; Notice 1) Cloth, Burlap, Jute (or Kenaf)

1.2 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.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, 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.

The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. Locate the "S" submittal under the SD number that best describes the submittal item.

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.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

- [Subbase aggregate
-][Base course aggregate
-][Flexible pavement base course
-][Rigid pavement base course
-] Submit duplicate samples of material to be subjected to field testing, as required in paragraph entitled "Field Sampling and Testing." Select the source(s) and provide sample of the aggregate listed above before the materials are required for mix design. [Submit duplicate samples for approval at least 30 days prior to start of work. Do not use aggregate prior to receiving written approval of the samples]. Investigate new sources in accordance with ASTM D420. Take samples from pits, borrow areas, stockpiles or other locations in conformance with ASTM D75/D75M and test. For determining optimum moisture content and maximum density, samples of the blended mixture(s) shall be representative of the processing area before addition of cement.

NOTE: Select the type of base or subbase for the
required construction: airfields, roads, and
streets.

SD-05 Design Data

NOTE: Specify at least 28 days for approval of mix
designs. Identify the type of stabilized course.

NOTE: In wet-dry and freeze-thaw conditions, cement
may be added to the above composite materials to
obtain stability and load-carrying capacity as
measured by the compressive strength, however:

(1) If high quality granular materials are not available, the use of substandard materials fully stabilized with cement is acceptable. For such materials, the amount of cement should be determined by ASTM test methods of wetting-and-drying, and/or freezing-and-thawing. Marginal materials having high plasticity or otherwise undesirable characteristics, should be carefully evaluated based on a percent weight loss not to exceed 14 percent as

determined by ASTM D559 or ASTM D560. Gradations shall be limited to not more than 45 percent of the material should be retained on the 4.75 mm No. 4 sieve, and the maximum size of materials limited to 25 or 19 mm one or 3/4 inch.

(2) If the soil and aggregate mixture meet the requirements of the gradations given, the use of the test procedures in accordance with ASTM D559 and ASTM D560 may be waived and the required amount of cement may be determined on the basis of compressive strength. Maximum size of material for base course is usually limited to 38 mm 1 1/2 inches, with between 30 and 45 percent retained on the 4.75 mm No. 4 sieve. When freezing-and-thawing or wetting-and-drying does not occur in a specific location, the freeze-thaw test is valuable in that the test will indicate the internal structural weakness of the soil-cement-aggregate mixture, which otherwise appears more slowly under natural-occurring temperature or moisture fluctuations above the freezing point. The freeze-thaw and wet-dry tests determine the minimum cement content required to produce a structural material that will resist damage due to volume changes and are not meant to simulate specific climate environments.

(3) NOTE FOR TABLE I: Use Table I and Gradation (1) as a requirement of import materials for airfield or major road or street applications. For non-critical applications, design an applicable gradation [(2)] dependent upon the availability of local materials, or delete Table 1 in its entirety.

Mix design

Job-mix formula

Submit a contractor-furnished mix design [thirty] [_____] days prior to commencement of work. After receiving approval of the mix design, submit a job-mix formula.

SD-06 Test Reports

NOTE: Specify test reports for soil-cement loss if such tests are required at paragraph entitled "Weight Loss of Specimens."

Aggregate plasticity index

Sieve analysis of aggregate

Compressive strength

[Soil-cement weight loss

][Aggregate [percentage of wear](#)
][Existing soil [moisture-density](#)
 [Liquid limit](#) of aggregates
 [Plasticity index](#) of aggregates
 [Sieve analysis of combined material](#)
 [Compressive strength](#) of soil aggregate material
 [Optimum moisture content and maximum density](#)
 Submit results of [ASTM C136/C136M](#) sieve analysis and [ASTM D1633](#)
 compressive strength testing.

 SD-07 Certificates
 Portland [cement](#)
 [Location of aggregate source](#)
 [Method](#) of installation
 [Construction equipment list](#)

1.3 DELIVERY AND STORAGE

1.3.1 Cement

Store cement immediately upon receipt. Store cement in bags on pallets in an airtight and weatherproof structure. Elevate pallets above surface a distance sufficient to prevent the absorption of moisture. Stack bags close together to reduce circulation of air, but do not stack against outside walls. The manner of storage shall permit easy access for inspection and identification of each shipment. Transfer bulk cement to elevated airtight and weatherproof bins. Cement shall be free-flowing and free of lumps. Test cement that has been in storage longer than 6 months by standard mortar tests or loss on ignition test and use such cement only with approval of the Contracting Officer. Show the date of receipt of shipment on each bag of cement.

1.3.2 Aggregates

Store aggregates in a manner to minimize segregation and contamination. To prevent the inclusion of contaminants, store aggregates on surfaces covered with tightly laid wooden planks, sheet metal, or other hard and clean material. Store aggregates of different sizes in separate piles. Form stockpiles of coarse aggregates by spreading the materials in horizontal layers not exceeding [1.5 meters 5 feet](#) in depth. Stockpiling may be the single-core type, cast and spread type or truck-dumped type. Should the coarse aggregates become segregated, re-mix the stockpile to conform to specified grading requirements. Aggregate obtained from below existing watertable shall be drained before use.

1.3.3 Curing Materials

Deliver curing materials in original sealed containers showing trade name, specification number and manufacturer's name. Store in a manner that will prevent damage and contamination.

1.4 ENVIRONMENTAL CONDITIONS

Do not construct [base] [subbase] when weather conditions will detrimentally affect quality of the finished course. Apply cement when the ambient temperature is a minimum of 5 degrees C 40 degrees F and rising. Do not apply cement to aggregate materials that are frozen or contain frost. If ambient temperature falls below 5 degrees C 40 degrees F, protect completed cement-treated areas against freezing. Reprocess, reshape, and recompact damaged material. Provide drainage to prevent water from collecting or standing stabilized areas, and on the pulverized, mixed, or partially mixed materials.

1.5 QUALITY ASSURANCE

1.5.1 Required Data

Submit location of aggregate source in writing. Do not construe Government approval of samples as approval of the source of the samples. Submit a construction equipment list, and method of proportioning, spreading, compacting and curing to be used, [thirty] [_____] days prior to commencement of work.

PART 2 PRODUCTS

2.1 CEMENT

NOTE: Specify the type of cement, as required.
Example: When base materials are in contact with
soils having a moderate sulfate content (exceeding
0.20 percent or 2000 ppm), specify Type II, low
alkali cement.

ASTM C150/C150M, [Type I] [Type I or II] [Type II, low alkali] or
ASTM C595/C595M [Type IP] [Type I PM].

2.2 AGGREGATE MATERIALS

NOTE: Select the type of base or subbase for the
required construction: airfields, roads, and
streets.

[2.2.1 Subbase Aggregate

NOTE: Choose this paragraph or the paragraph and
subparagraphs below, entitled "Base Course
Aggregate."

NOTE: Select gradation requirements and other soil index values appropriate for base course or subbase course materials. Where high quality granular materials are not available, select materials which may be available on, or adjacent to, the project site. Aggregate should be clean and free from vegetable matter and other deleterious substances. Also aggregates may be imported from local or commercial sources. Material should consist of sand-clay mixtures; gravel; crushed stone, slag or gravel; or combinations of the above. Percentage of wear should not exceed 50 percent; dry unit weight of slag should not be less than 1040 kilograms per cubic meter 65 pounds per cubic foot; liquid limits and plasticity indexes for flexible or rigid pavements should be in accordance with second technical "NOTE" in paragraph entitled "SD-05, Design Data."

Select aggregate materials which conform to ASTM D2487, classified as GW, GP, GM, GC, SW, SM, SC, SP or combination(s) thereof except as modified. Sample materials in accordance with ASTM D75/D75M. Plasticity index shall not exceed 12 or liquid limit not more than 21 when tested in accordance with ASTM D4318. [Dry weight of air cooled, blast-furnace slag shall be not less than [1041] [1121] [_____] kilograms per cubic meter [65] [70] [_____] pounds per cubic foot in accordance with ASTM C29/C29M]. Perform sieve analysis in accordance with ASTM C117 AND ASTM C136/C136M. Conform to the following gradation limits:

TABLE I		
Sieve Designation	Percent by Weight Passing	
	(1)	[(2)]
4.75 mm No. 4	55 - 100	[_____]
2.00 mm No. 10	36 - 60	[_____]
150 micrometers No. 100	3 - 20	[_____]

] [2.2.2 Base Course Aggregate

NOTE: Choose this paragraph and subparagraphs or the paragraph above, entitled "Subbase Aggregate."

NOTE: Select gradation requirements and other soil index values appropriate for base course or subbase course materials. Where high quality granular materials are not available, select materials which may be available on, or adjacent to, the project site. Aggregate should be clean and free from

vegetable matter and other deleterious substances. Also aggregates may be imported from local or commercial sources. Material should consist of sand-clay mixtures; gravel; crushed stone, slag or gravel; or combinations of the above. Percentage of wear should not exceed 50 percent; dry unit weight of slag should not be less than 1040 kilograms per cubic meter 65 pounds per cubic foot; liquid limits and plasticity indexes for flexible or rigid pavements should be in accordance with second technical "NOTE" in paragraph entitled "SD-05, Design Data."

[Crushed] [and] [uncrushed] coarse and fine aggregate. Sample materials in accordance with ASTM D75/D75M. Material passing the 425 micrometers No. 40 sieve shall have a maximum liquid limit of [25] [_____] and a maximum plasticity index of 12 in accordance with ASTM D4318. The aggregate sand equivalent is to exceed 18. Perform sieve analysis in accordance with ASTM C117 and ASTM C136/C136M.

[2.2.2.1 Flexible Pavement Base Course

NOTE: Choose this subparagraph or the subparagraph below, entitled "Rigid Pavement Base Course" when using the paragraph above, entitled "Base Course Aggregate."

Plasticity index of less than [6] [_____] and liquid limit less than [25] [_____] in accordance with ASTM D4318. [Percentage of wear less than [50] [_____] percent in accordance with ASTM C131/C131M.]

]2.2.2.2 Rigid Pavement Base Course

Plasticity index of less than [8] [_____] and liquid limit less than [25] [_____] in accordance with ASTM D4318.

]2.2.2.3 Gradation of Aggregate

NOTE: Aggregate for use in Gradation (1) of Table II when mixed with Type II modified portland cement in an amount not to exceed 5 percent by weight of the dry aggregate and compacted at optimum moisture content, the minimum compressive strength of the compacted mixture shall be 5171 kPa 750 psi at 7 days. Aggregate for use in Gradation (2) of Table II cement treated base shall have a compressive strength of 1725 kPa 250 psi before mixing with Type II modified portland cement in an amount not to exceed 2 1/2 percent by weight of the dry aggregate and compacted at optimum moisture content to a minimum compressive strength of 4136 kPa 600 psi at 7 days. For specially designed gradations, [(3)], of Table II, see second technical "NOTE" in paragraph entitled "Cement Content."

Conform to the following:

TABLE I			
Sieve Designation	Percent by Weight Passing		
	(1)	(2)	[(3)]
75 mm		100	[_____]
63 mm		90-100	[_____]
50 mm			[_____]
37.5 mm			[_____]
25.0 mm	100		[_____]
19.0 mm	90-100		[_____]
12.5 mm			[_____]
4.75 mm	55-70	55-70	[_____]
2.00 mm			[_____]
600 micrometers	12-55		[_____]
425 micrometers			[_____]
75 micrometers	3-15	3-20	[_____]

TABLE I			
Sieve Designation	Percent by Weight Passing		
	(1)	(2)	[(3)]
3 inch		100	[_____]
2 1/2 inch		90-100	[_____]
2 inch			[_____]
1 1/2 inch			[_____]
1 inch	100		[_____]
3/4 inch	0-100		[_____]

TABLE I			
Sieve Designation	Percent by Weight Passing		
	(1)	(2)	[(3)]
1/2 inch			[_____]
No. 4	5-70	55-70	[_____]
No. 10			[_____]
No. 30	2-55		[_____]
No. 40			[_____]
No. 200	3-15	3-20	[_____]

2.3 WATER

Provide potable, clean, fresh and free from injurious amounts of oils, acid, salt, alkali, organic matter and other substances deleterious to the hardening of soil-cement.

2.4 CEMENT-TREATED [BASE] [SUBBASE]

NOTE: Select the type of base or subbase for the required construction: airfields, roads, and streets.

Uniformly blend aggregates and cement together, mixed with water. Provide cement treated [base] [subbase] produced with the following characteristics:

2.4.1 Compressive Strength

NOTE: Determine the load capacity requirements of the base. Select method (freeze-thaw method is more critical) for determining cement contents for soil-aggregate mixtures based on the nature of the available soil materials, climate conditions (wet-dry or freeze-thaw), and base requirements. For substandard granular materials, select wet-dry and/or freeze-thaw tests for mix design and the cement contents to determine if the hardened cement-treated materials will remain hard or soften from exposure to severe moisture variations and alternate freezing and thawing conditions. Specify compressive strength tests to evaluate the hardened characteristics of the soil-cement mixtures. Site investigation is necessary to determine the nature of existing on-site materials, and, if necessary, the availability and need of imported select materials. The specifier should insure that the

following information is covered:

- (1) Identify the type of base in the project specification and on the drawings.
- (2) Specify the type or quality of the aggregate or soil-aggregate material before cement is added.
- (3) Specify test methods for determining the exact percentage of cement required for the select materials. Establish criteria for selecting the cement content to produce hard, durable cement stabilized base or subbase course. For substandard materials, specify maximum soil-cement losses for specimens tested that contain two or more different cement contents at 12 cycles of wetting-and-drying test or freezing-and-thawing test. For all types of material, specify compressive strength determinations of soil-cement mixtures for preparation of mix design and for field control tests. (Minimum unconfined compressive strengths: 2064 kPa 300 psi for subbase and 4481 kPa 650 psi for base course. See MIL-HDBK-1021/4).

Unconfined compressive strength at optimum moisture content a minimum of [4481] kPa [650] psi [_____] at 7 days when tested in accordance with ASTM D1633.

2.4.2 Cement Content

NOTE: Select the applicable paragraph(s) from the following:

[When blended with soil aggregates and water, mixture shall meet the indicated compressive strength not to exceed [[_____] percent of cement by weight of drying aggregate for base] [and] [[_____] percent of cement by weight of dry aggregate for subbase].
]

NOTE: Use this paragraph when the cement content is known or can be approximated by verification from local material sources. If such information is not available, substitute with an appropriate basis of bid paragraph or use unit prices. When conditions are favorable cement content may be as low as 1 1/2 percent of weight of dry aggregate. Should design requirements for cement content be higher than 4 percent for subbase and 6 percent for base course, compare and consider other more cost effective means of accomplishment. Alternate or additive treatments with lime, fly ash, filter cloth etc. should also be considered. Compressive strength minima/maxima indicated in second technical "NOTE" in paragraph entitled "SD-05, Design Data."

[When blended with imported aggregates and water, mixture is to meet indicated compressive strength while not exceeding [[6] [_____] percent of cement by weight of aggregate for base] [[3] [_____] percent of cement by weight of aggregate for subbase].

12.4.3 Weight Loss of Specimens

NOTE: Select the applicable paragraph(s) from the following:

NOTE: Select both of these tests together, or use the freeze-thaw test only (it is the more critical).

[Less than 14 percent when subjected to 12 cycles of wet-dry tests in accordance with ASTM D559.

]

NOTE: Select both of these tests together, or use the freeze-thaw test only (it is the more critical).

[Less than 14 percent when subjected to 12 cycles of freeze-thaw tests in accordance with ASTM D560.

12.5 MIX DESIGN

NOTE: Specify 7-day compressive tests when high-quality granular materials are specified. However, if available materials have between 37 and 63 percent retained on the 4.75 mm No. 4 sieve or if materials are substandard in quality (cohesive) or are excessive in fines, specify freezing and thawing (ASTM D560) tests in conjunction with compressive tests.

NOTE: Select the type of base or subbase for the required construction: airfields, roads, and streets.

Provide a mix design and job-mix formula for [plant mix material] [mixed-in-place material] for [subbase] [base] prepared by an approved laboratory. Show amount of cement needed and the moisture-density relations of the composite aggregate mixture in accordance with ASTM D558/D558M. Mix design shall include certified test reports showing results of tests [and results of 7-day compressive tests] [and results of 7-day compressive tests and wetting and drying tests] [and results of 7-day compressive test and the freezing and thawing tests]. Mold a minimum of [two] [three] [four] cylinders of each cement mixture in accordance with ASTM D1632, except that test specimen molds shall be 100 mm 4 inches in diameter by 117 mm 4.6 inches high. Cure and test specimens in accordance with ASTM D1633 with the following exceptions: (1) cure

specimens in moist room at 100 percent relative humidity for 7 days; and (2) after curing, cap specimens and immerse in water at room temperature for a period of 4 hours prior to testing. Before or during construction, if the source of any materials is changed, or if there is any variation in quality of materials furnished, conduct additional tests and adjust amount of cement as required to obtain the specified results.

2.6 CURING MATERIALS

2.6.1 Bituminous Material

NOTE: Cutback and Emulsified Asphalts: Prior to specifying cutback and emulsified asphalts contact the State, County or Local Air Pollution Control District for guidelines as to which asphalt material is allowed in the applicable area.

2.6.1.1 Liquid Asphalt

ASTM D2027/D2027M or AASHTO M 82, Type [MC-70] [MC-250] for medium-curing asphalt; ASTM D2028/D2028M or AASHTO M 81, type [RC-70] [RC-250] for rapid-curing asphalt.

2.6.1.2 Emulsified Asphalt

ASTM D977 or AASHTO M 140, Type [RS-1] [RS-2] or AASHTO M 208[CRS-1] [CRS-2].

2.6.2 Burlap

FS CCC-C-467.

2.6.3 Polyethylene Sheeting

White, opaque, free of defects, uniform in appearance, a minimum 0.10 mm 4 mils thick. Water retention requirements shall be in accordance with ASTM C171.

2.6.4 Polyethylene-Coated Burlap

White, opaque, 0.10 mm 4 mil thick film, impregnated into, extruded on, or permanently affixed to surface of one side of burlap weighing not less than 0.30 kilograms per square meter 9 ounces per square yard prior to coating. Water retention requirements shall be in accordance with ASTM C171.

2.6.5 Waterproof Paper

White topside. Water retention requirements shall be in accordance with ASTM C171.

PART 3 EXECUTION

3.1 SITE PREPARATION

3.1.1 Cleaning and Grading

NOTE: Select the type of base or subbase for the required construction: airfields, roads, and streets.

NOTE: Specify this paragraph where subgrade or subbase preparation is required. Add compaction requirements if Section 31 00 00 EARTHWORK is not utilized.

Clean debris from the area to be stabilized. Inspect [subgrade] [subbase] for capability to withstand without displacement, compaction specified for the aggregate-cement mixture. Correct ruts, soft or yielding areas in [subgrade] [subbase] by removing or adding material or aerating or wetting materials as required. [Clear and grub,] grade [proof roll] and shape the area to be stabilized to conform to lines, grades, and cross sections prior to placing cement-treated course [according to Section 31 00 00 EARTHWORK] [with a minimum compaction of [_____] percent of maximum density in accordance with ASTM D1557.] The surface shall be approved by the Contracting Officer prior to [base] [subbase] course placement. Determine moisture-density relationship of existing soils in accordance with ASTM D1557. Perform laboratory tests on existing materials prior to initial construction.

3.1.2 Grade Control

Maintain lines and grades indicated. When the stabilized course is part of a pavement which is to meet a fixed grade, construct a transition of sufficient length to minimize abrupt or noticeable grade changes.

3.1.3 Operation of Government Borrow Pits

Perform cleaning, stripping, and excavating in opening or operation of pits or quarries. Open pits in a manner that will expose vertical faces of the deposit for suitable working depths. Obtain materials excavated from pits in successive vertical cuts extending through exposed strata. Waste pockets or strata of unsuitable materials overlying or occurring in the deposit. Methods of operating pits and processing and blending of materials may be changed or modified by the Contracting Officer without adjustments in the contract price when such action is necessary to obtain material conforming to specified requirements. Upon completion of work, leave condition of pits in accordance with Section [01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.]

3.2 MIXING AND PLACING

3.2.1 Mixing

NOTE: Specify central mixing plant when

cement-stabilized base is used under rigid airfield pavements which have butt-type construction joints without load transfer devices and for all airfield base course applications under flexible pavement. For soil-cement subgrade or subbase, specify mixed-in-place method if mixing of cement to on-site native materials or to import materials is required at the site of the work. The method may also be used for subbase under rigid airfield pavements when butt-type construction joints are required in contracts. Central-plant mixing is preferred for cement stabilization for finer materials. (See DM 5.4 and MIL-HDBK 1021/4).

Mix cement and aggregate [in a central mixing plant] [in a traveling plant] [in place]. Proportion aggregate by weight or by volume in such quantities that specified gradation, bearing ratio, liquid limit, and plasticity index requirements are met after [base] [subbase] has been placed and compacted. Proportion cement by weight in accordance with job-mix formula. Provide necessary moisture content for specified compaction by addition of water by weight or by volume. Mixing operations shall produce uniform blending and the method of discharging shall not produce segregation.

3.2.2 [Plant Mix Materials]

NOTE: Select the applicable paragraph(s) from the following:

NOTE: Specify central mixing plant when cement-stabilized base is used under rigid airfield pavements which have butt-type construction joints without load transfer devices and for all airfield base course applications under flexible pavement. For soil-cement subgrade or subbase, specify mixed-in-place method if mixing of cement to on-site native materials or to import materials is required at the site of the work. The method may also be used for subbase under rigid airfield pavements when butt-type construction joints are required in contracts. Central-plant mixing is preferred for cement stabilization for finer materials. (See DM 5.4 and MIL-HDBK 1021/4).

Materials from several sources which are blended and mixed or processed in a central mixing plant or in a traveling mixing plant. [Prepare base course materials for airfield portland cement concrete pavement in a central mixing plant.] Add cement in accordance with job-mix formula. Uniformly mix materials with required amount of water. After mixing is completed, transport the materials to, and spread on, prepared underlying course without undue loss of the moisture content.

][Mixed-In-Place Materials]

Materials which are proportioned and mixed or blended in place. Add cement in accordance with the job-mix formula. Apply water uniformly prior to and during the mixing operation, if necessary, to maintain required moisture content.

13.2.3 Placing

NOTE: Specify central mixing plant when cement-stabilized base is used under rigid airfield pavements which have butt-type construction joints without load transfer devices and for all airfield base course applications under flexible pavement. For soil-cement subgrade or subbase, specify mixed-in-place method if mixing of cement to on-site native materials or to import materials is required at the site of the work. The method may also be used for subbase under rigid airfield pavements when butt-type construction joints are required in contracts. Central-plant mixing is preferred for cement stabilization for finer materials. (See DM 5.4 and MIL-HDBK 1021/4).

[Loose] [compacted] thickness of individual layers shall not exceed [200] mm [8] inches [_____]. When stabilized course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used where permitted by the Contracting Officer. Not more than 60 minutes shall elapse between start of moist mixing and start of compaction of treated layer. Not more than 30 minutes shall elapse between placement of cement-treated aggregates in adjacent lanes. If elapsed time exceeds 30 minutes, provide construction joint. Layers are to be uniform in thickness.

3.2.4 Compaction

NOTE: Specify degree of compaction in accordance with DM-5.4 or MIL-HDBK-1021/4 for flexible and rigid pavements. (For example: Specify 100 percent compaction for base course of flexible airfield pavements; see MIL-HDBK-1021/4).

With the exception of materials placed by traveling-plant method, thoroughly loosen blended materials to full depth by disks or scarifiers and determine moisture content of mixture and compare with laboratory optimum moisture content. Begin rolling and compaction when moisture content is within plus or minus 2 percentage points of optimum moisture content. Compact layers of [base] [subbase] course materials. Continue compaction until layer or layers are compacted through full depth of [base] [subbase]. Begin rolling at outside edge of a minimum one half the width of the roller. Subsequent rolled trips shall be slightly different lengths. In places not accessible to rolling equipment, compact the material by mechanical tamping. Continue blading, rolling and tamping until surface is smooth and free from waves and irregularities. Determine in-place density of compacted cement-aggregate mixture in accordance with ASTM D1556/D1556M with minimum compaction of [100] [_____] percent of

maximum density in accordance with ASTM D558/D558M.

3.3 FINISHING

3.3.1 Finishing

After compaction, moisten surface if necessary, and shape to required lines, grades and cross section. Lightly scarify surface to eliminate imprints made by the compacting or shaping equipment. Thoroughly compact surface to specified density with rubber-tired rollers and smooth-wheel tandem rollers to provide a smooth, dense, uniform surface free of surface checking, ridges or loose material and conforming to crown, grade and line indicated. Complete finishing operations within 2 hours after completion of mixing operations. In places not accessible to finishing and shaping equipment, compact mixture with mechanical tampers to density specified; shape and finish by hand methods. Reprocess with additional cement, the portion of the compacted mix with density less than that specified, or that has not properly hardened, or that is improperly finished.

3.3.2 Edges of Stabilized Course

Place material along edges of the stabilized course in a quantity that will compact to thickness of course being constructed. If constructed in two or more layers, place in a quantity that will compact to thickness of each layer. Allow in each operation, a minimum width of 300 mm one foot of the shoulder to be rolled and compacted simultaneously with each layer of the stabilized course.

3.3.3 Thickness Control

Where average measured thickness of stabilized course is more than 13 mm 1/2 inch deficient in thickness, conduct additional tests and correct deficiencies as directed by the Contracting Officer. Correct excesses in thickness if so directed by the Contracting Officer. Average job thickness is the average of the job measurements determined as specified in paragraph entitled "Thickness Test," in this section, but within 13 mm 1/2 inch of the thickness indicated. Replace material removed for test holes or for deficient thickness reconstruction and compact with new soil-cement mixture.

3.3.4 Construction Joints

At the end of each work day, form a straight transverse construction joint by cutting back into completed work to form a true vertical face free of loose or shattered material. Remove improperly compacted material along construction joints and replace with soil-cement that is mixed, moistened, and compacted in accordance with this specification.

3.4 CURING AND PROTECTION

3.4.1 Curing, Protection and Cover

Immediately after completion of finishing operations, but no later than the end of each day's stabilization work, protect the surface against rapid drying for seven days by one of the methods specified. In addition, protect the stabilized area from freezing during the curing period or until hardened, whichever period is longer.

3.4.2 Bituminous Material

NOTE: Cutback and Emulsified Asphalts: Prior to specifying cutback and emulsified asphalts contact the State, County or Local Air Pollution Control District for guidelines as to which asphalt material is allowed in the applicable area.

NOTE: For the specified bituminous materials, the recommended application temperatures may be selected from the following table and inserted in the blanks:

<u>LIQUID ASPHALT</u>	<u>DEGREES C</u> <u>DEGREES F</u>
RC-70 or MC-70	49 - 85 120 - 185
RC-250 or MC-250	74 - 110 165 - 230
<u>EMULSIFIED ASPHALT</u>	<u>DEGREES C</u> <u>DEGREES F</u>
RS-1	24 - 54 75 - 130
RS-2	43 - 71 110 - 160
CRS-1	24 - 54 75 - 130
CRS-2	43 - 85 110 - 185

Immediately after finishing, clean surface of loose and foreign matter. Ensure that surface contains sufficient moisture, by applying water in a fine spray as required, to prevent penetration of bituminous material. Using a distributor, apply bituminous material at a temperature between [_____] and [_____] (degrees C [_____] and [_____] (degrees F and at a rate between [0.90] and [1.13] [_____] liters per square meter [0.20] [_____] and [0.25] [_____] gallons per square yard. Treat areas inaccessible to, or missed by distributor using manually operated hose attachment. Apply sand at [_____] (kilograms per square meter [_____] (pounds per square yard to treated surfaces requiring protection from traffic.

3.4.3 Burlap or Cotton Mats

Burlap covers consisting of two or more layers of burlap having a combined weight of 0.47 kilograms or more per square meter 14 ounces or more per square yard in a dry condition. Burlap may be either new or have been used only for curing concrete. Cotton mats and burlap strips shall have a length, after shrinkage, at least 300 mm one foot greater than required to cover the entire width and edges of finished stabilized area. Mats shall overlap each other at least 150 mm 6 inches. Thoroughly wet mats before placing and keep them continuously wet and in intimate contact with surface and edges of finished stabilized area during entire curing period.

3.4.4 Waterproof Paper, Blankets, or Impermeable Sheets

Moisten surface with a fine spray of water, then cover with waterproof-paper, waterproof-paper blankets, polyethylene-coated burlap blankets, or polyethylene sheeting. Thoroughly saturate polyethylene-coated burlap with water before placing. Place waterproof-paper blankets, polyethylene-coated burlap blankets, or polyethylene sheeting with the light-colored side up. Extend sheets over the edges of stabilized area and secure in place during the curing period. Overlap edges of sheets a minimum of 300 mm one foot and securely cement or tape to form continuous closed joints. Immediately repair tears and holes in sheets. Reject curing material that does not provide a continuous cover.

3.4.5 Moist Curing

Apply a 50 mm 2 inch covering of soil or minimum 2.17 kilograms per square meter 4 pounds per square yard of straw. Moisten material initially and keep moistened throughout curing period.

3.5 MAINTENANCE AND TRAFFIC CONTROL

3.5.1 Maintenance

After stabilization is completed, maintain [base] [subbase] except where succeeding course is under construction. Maintenance shall include drainage and watering as required to maintain course in proper condition. Correct deficiencies in thickness, composition, construction, smoothness or density which develop during maintenance to conform to requirements specified. Maintain surface moisture by lightly sprinkling with water to prevent dust.

3.5.2 Traffic Control

Completed portions of the cement-stabilized area may be opened to light, local traffic provided the curing process is not impaired and to other traffic after curing period has elapsed, provided that the cement-stabilized course has hardened sufficiently to prevent surface marring or distortion by equipment or traffic. Do not permit heavy equipment on the area during protection and curing periods. Necessary cement and water may be hauled over the area with pneumatic-tired equipment on approval of the Contracting Officer. Protect finished portions of cement stabilized [base] [subbase] from traffic of equipment used in constructing adjoining sections in a manner to prevent marring or damaging completed work.

3.6 SAFETY REQUIREMENTS

In addition to Safety Requirements contained within the Contract Clauses; prevent employee respiratory, eye or skin contact with Portland Cement during wet or dry mixing or of cutback asphalts during transport or application. Provide and require employee to use and dispose or clean the following in accordance with the pertinent provisions of NIOSH 81-123:

- a. Impervious: Clothing, boots and gloves.
- b. Splash-proof safety goggles and face shields.
- c. Respiratory protection equipment.

3.6.1 Additional Safety Requirements for Cutback Asphalts

**NOTE: Prior to specifying cutback and emulsified
asphalts contact the State, County or Local Air
Pollution Control District for guidelines as to
which asphalt material is allowed in the applicable
area.**

Application temperatures of asphalt cutbacks specified usually exceed flash point of the material. Take suitable safety precautions to prevent flashing of asphalt. Exercise the following minimum safety precautions:

- a. Do not permit open flames or sparks close to the cutback asphalts. Apply controlled heat in heating kettles, mixers, distributors, or other equipment designed and approved for the purpose.
- b. Do not use open flames to examine drums, tank cars, or other containers or cutback asphalts.
- c. Properly and fully vent vehicles transporting cutback asphalts.
- d. Permit only experienced personnel to supervise the handling of cutback asphalt materials.
- e. Comply with all applicable intrastate and interstate commerce regulations for transporting cutback asphalts.

3.7 FIELD SAMPLING AND TESTING

**NOTE: Specify duplicate samples for large projects
which will require five or more days of continuous
operation in processing and placement of base
materials. In subsequent paragraphs, specify
frequency of sampling according to size of proposed
contract.**

In addition to provisions set forth elsewhere in this contract, specified sampling and testing shall be conducted by an approved laboratory. [Provide duplicate samples to the Contracting Officer on the average of [_____] samples a [week] [month]. Take duplicate samples at the same time and in the same manner as the original.]

3.7.1 Sampling

3.7.1.1 Aggregates at Source

Collect samples by taking three incremental specimens at random from source material to make a composite sample a minimum of 68 kilograms 150 pounds. Thereafter, during the course of the project, take one random sample from each [4000] metric tons [4000] [_____] tons of material or a day's run, whichever is less. Take the samples at random to make a composite sample of not less than 22 kilograms 50 pounds. Repeat the sampling when source of material is changed or when unacceptable deficiencies or variations from specified grading of materials are found

in testing.

3.7.1.2 Cement-Treated Materials

After cement and water have been added to the aggregates, thoroughly blend the mixture. Place a sample in a closed and insulated container, before cement hydration is completed, and promptly transport to the laboratory.

3.7.1.3 Sample Identification

Place each sample in a clean container and securely close. Identify each sample with a tag containing the following information:

Contract No.:

Sample No.: Quantity:

Date of Sample:

Sampler:

Source:

Intended Use:

For Testing:

3.7.2 Testing

3.7.2.1 Aggregate Testing

Perform the following tests on each sample of the specified aggregate and existing soil-aggregate materials:

- a. Sieve analysis of combined material: ASTM C136/C136M and ASTM D1140.
- b. Liquid limit: ASTM D4318.
- c. Plasticity index: ASTM D4318.

Perform other specified tests when there is a change of aggregate source. Material shall conform to approved test results developed for the mix design.

3.7.2.2 Compressive Tests

Test composite sample of cement treated materials for compressive strength. Mold specimens in accordance with ASTM D558/D558M, Method A or B (as appropriate), cure and test according to ASTM D1632 and ASTM D1633. Test specimens for compressive strength at 7 days, and submit results to the Contracting Officer.

3.7.2.3 Smoothness Test

Test compacted surface with a 3 m 10 foot straightedge applied parallel with, and at right angles to center line of paved area, and correct deviations in excess of 13 mm 1/2 inch. When [base] [subbase] course is to be constructed in more than one layer, specified smoothness requirements apply only to the top layer.

3.7.2.4 Thickness Test

Measure thickness of the [base] [subbase] course using 75 mm 3 inch diameter test holes through the full depth for each [420] square meters [500] [_____] square yards of completed course. Refill holes with cement treated material and compact.

3.7.2.5 Field Density Tests

Perform field density tests in accordance with ASTM D1556/D1556M or ASTM D6938. Perform one field density test for each [1675] square meters [2000] [_____] square yards for each layer of [base] [subbase] material placed.

3.7.2.6 Laboratory Test

Determine optimum moisture content and maximum density relationship in accordance with ASTM D558/D558M.

-- End of Section --