SECTION 270
SOIL-CEMENT BASE

270-1 Description.

Construct a base course composed of a combination of soil, portland cement, and water.

270-2 Materials.

Meet the following requirements:

Cement: Portland Cement, Type I, II, III, or
Type IP or Type IS ..... Section 921

Water: Use water that is free from substances deleterious to hardening of the soil-cement mixture.

Curing Material:.....916-4

Use Emulsified Asphalt Grade SS, RS, or MS as approved by the Engineer. Dilute these as recommended by the manufacturer.

Soil: For base course construction, use either the material existing in the location to be occupied by the base, a suitably friable material furnished by the Contractor, or a combination of these. If the material existing in the location to be occupied by the base does not meet the requirements specified below, remove and replace it with suitable soil.

Obtain approval of the material pits prior to use. Excavate material pits to achieve a uniformly mixed material with reasonably consistent characteristics. Blend strata or differing materials in accordance with a procedure approved by the Engineer. The Department will consider proposed recycled materials on a case by case basis.

Specific Requirements For Soil:

Organic Material (As per FM 1-T267) ..... Maximum 5%
Total Clay and Silt Content (minus No. 200 [75µm sieve) (As per FM 1-T088, no hydrometer test) ..... Maximum 25%
Plastic Index (As per FM 1-T090)..... Maximum 10%
Liquid Limit (As per FM 1-T089) ..... Maximum 25%
Gradation: (As per FM 1-T088)
Passing 2 inch [50 mm] sieve .....Minimum 100%
Passing No. 4 [4.75 mm] sieve .....Minimum 55%
Passing No. 10 [2.00 mm] sieve .....Minimum 37%

As an exception to the above requirements, the Contractor may use any material meeting the requirements for Limerock in Section 911.

270-3 Proportioning of Mix.

270-3.1 General: Proportion the soil-cement mixture in accordance with Strength Design or Brush Loss Criteria as specified below.

Submit for approval a design mix for the soil proposed for use in soil-cement construction prepared by a testing laboratory approved by the Engineer. With the design mix submittal, include the results of tests run to verify that the soil meets the requirements specified in 270-2, results of tests used to establish the cement content, and a final design laboratory sample. Submit the design mix to the Engineer for approval a minimum of 60 calendar days prior to beginning of soil-cement construction for Brush Loss Design Method or 15 calendar days prior to beginning of soil-cement construction for Strength Design Method.

The Engineer will perform laboratory testing for design mix evaluation using water from the same source proposed for use during construction.

Express the cement as a percentage of the dry unit weight of the soil. For mixed-in-place construction, the Engineer will use a rate of application of cement based on the maximum density of the

soil, determined in accordance with AASHTO T 99 and rounded up to the nearest pound per cubic yard [kilogram per cubic meter].

270-3.2 Strength Design: When proportioning the soil-cement mixture in accordance with strength design, the Engineer will determine the minimum cement content using FM 5-520. Achieve the design compressive strength specified in the plans in seven days. Ensure that the cement content is not less than 5% by weight, except as noted in 270-3.4.

270-3.3 Brush Loss Design Criteria: When proportioning the soil-cement mixture in accordance with this criteria, the Engineer will determine the minimum cement content in accordance with AASHTO T 135. Ensure that the soil-cement loss at the completion of 12 cycles of testing conforms to the following limits:

AASHTO Soils Groups A-1, A-2-4, A-2-5, and A-3 .....not over 14%
AASHTO Soils Groups A-2-6, A-2-7, A-4, and A-5 .....not over 10%
AASHTO Soils Groups A-6 and A-7 .....not over 7%

Ensure that the cement content is not less than 5% by weight, except as noted in 270-3.4.

When proportioning of soil-cement mixture by the Brush Loss Design Criteria Method and processing by Central-Plant-Mixing where the requirements of 270-3.4 are met, the Engineer will not require strength testing of field specimens. The Engineer will verify the properties of the parent material during the processing, on a random frequency, to ensure that the final mix has not changed from the original design. Ensure that the producer furnishes a printout to the Engineer of each day's production that shows proportioning of the mixture meets the approved Brush Loss Design, including cement.

270-3.4 Exception for Central Mixed Materials: Do not apply the minimum 5% cement content specified in 270-3.2 and 270-3.3 if obtaining the soil material used in producing a soil-cement mixture from a commercial source (not to exclude recycled materials) where soil properties are consistently uniform, and if processing the mixture in a central mix plant that automatically weighs components and automatically records the weight of each component on a printed ticket, tape, or other digital record.

270-4 Construction Methods.

270-4.1 Equipment: For performing the work specified in this Section, use any machine, combination of machines, or equipment that is in good, safe working condition and that will produce results meeting the requirements for cement application, soil pulverization, mixing water application, compaction, finishing, and curing, as required herein. The Department directs special attention to the necessity for utilizing compaction equipment which will produce the required density in a particular soil-cement blend.

270-4.2 Preparation:

270-4.2.1 Subgrade: Before beginning base construction operations, complete the subgrade. Ensure that the subgrade is firm enough to support the equipment used in the soil-cement base operations without appreciable distortion or displacement. Remove any unsuitable material, and replace it with suitable material.

When constructing the base with central-plant-mixed soil-cement, grade and shape the subgrade to the lines, grades, and typical cross-section shown in the plans. Ensure that the subgrade is moist but not ponded at the time of placing the mixed base course material.

270-4.2.2 Base Soil for Mixed-in-Place Processing: Grade and shape the area over which the base is to be constructed to an elevation which will provide a base in conformance with the grades, lines, thickness, and typical cross-sections shown on the plans. Remove all roots, sticks, and other deleterious matter during processing.

270-4.3 Processing of Soil-Cement Mixture:

270-4.3.1 General: Mix the soil, cement, and water either by mixed-in-place or central-plant-mix methods.

Do not allow the percentage of moisture in the soil at the time of cement application to exceed the quantity that will permit a uniform and intimate mixture of soil and cement during mixing operations. With certain types of soils, the Engineer will designate a moisture range.

During seasons of freezing temperature, do not spread any cement or soil-cement mixture unless the ambient temperature is at least 40ºF [4ºC] in the shade and rising.

At the completion of moist-mixing, pulverize the soil so that 100% passes a 1 1/2 inch [37.5 mm] sieve, 95 to 100% passes the 1 inch [25.0 mm] sieve and a minimum of 80% passes a No. 4 [4.75 mm] sieve, exclusive of gravel, shell, or stone.

Continue the operations specified in 270-4.3, 270-4.4, 270-4.5, and 270-4.6 and complete them within a period of four hours starting from the time mixing commences.

270-4.3.2 Mixed-in-Place Method: Where feasible, process the entire width of the base in a single operation. Uniformly spread the design quantity of cement on the soil at the required rate of application, by means of an approved method. Replace spread cement that becomes displaced before starting mixing. The Engineer will check the uniformity of spread rate by (a) weight of cement spread/square yards [spread/square meters] covered for a short trial section that is between 100 and 300 feet [30 and 90 m] in length or (b) use of a square yard [square meter] cloth/box.

After applying the cement, begin mixing within 60 minutes. Initially mix the soil and cement until the cement has sufficiently blended with the soil to prevent formation of cement balls when applying additional water; then add water if necessary, and re-mix the soil-cement mixture. Do not perform windrow mixing.

The Contractor may process the full depth in one course, provided the Contractor obtains a satisfactory distribution of cement and water and the specified density. If not, construct courses of such thickness to obtain satisfactory results. Make provisions to achieve adequate bonding between courses.

Immediately after mixing of the soil and cement, add any additional water that is necessary. If the moisture content exceeds that specified, manipulate the soil-cement mixture by re-mixing or blading as required to reduce the moisture content to within the specified range. Avoid excessive concentrations of water. Continue mixing during and after applying water until obtaining a uniform and intimate mixture of soil, cement, and water.

As an alternative to the above described procedure, the Contractor may use an approved machine that will blend the cement and the soil and then add and mix-in any additional water that is necessary.

270-4.3.3 Central-Plant-Mixed Method: Mix the soil, cement, and water in a pugmill of either the batch or continuous-flow type. Equip the plant with feeding and metering devices which will accurately proportion the soil, cement, and water in the quantities specified. Mix soil and cement sufficiently to prevent cement balls from forming when adding additional water. Continue mixing until obtaining a uniform and intimate mixture of soil, cement, and water.

Haul the mixture to the roadway in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer with suitable equipment. Do not allow more than 60 minutes to elapse between placing of soil-cement in adjacent passes of the spreader at any location, except at construction joints. Ensure that the layer of soil-cement is uniform in thickness and surface contour, and in such quantity that the completed base will conform to the required grade and cross-section. Do not perform windrow mixing.

270-4.4 Construction Joints: Prior to joining any previously constructed section of base, form a vertical construction joint by cutting back into the completed work to form a true vertical face of acceptable soil-cement to the full depth of the base course. Moisten the vertical face, if directed, prior to placing new material against it.

270-4.5 Shaping and Finishing: Prior to final compaction, shape the surface of the soil-cement to the required lines, grades, and cross-section. In all cases where adding soil-cement mixture to any portion of the surface, lightly scarify the surface with a spring tooth harrow, spike drag, or other approved

device to uniformly loosen the surface prior to adding material and prior to the initial set of the soil-cement mixture. Compact the resulting surface to the specified density. Continue rolling until all rutting ceases and until the base conforms to the density requirements.

Ensure that the surface material is moist but not ponded, and maintained at not less than 2% below its specified optimum moisture content, during finishing operations. Perform surface compaction and finishing in such a manner as to produce a smooth dense surface, free of compaction planes, construction cracks, ridges, and loose material. With certain soils, the Engineer may determine that minor tire marks are acceptable.

If the time limits specified in 270-4.3.1 are exceeded, leave the base undisturbed for a period of seven days, after which, the Engineer will examine it to determine its suitability. If the Engineer determines that it is suitable, the Department will fully compensate the Contractor, providing the base meets all other requirements specified herein. If found unsuitable, remove and replace the base without additional compensation. The Contractor may remove and replace the deficient base rather than wait seven days.

270-4.6 Compaction: Begin compacting the soil-cement mixture immediately after mixing or placing. Do not allow more than 30 minutes to elapse between the last pass of moist-mixing or spreading and the start of compaction of the soil-cement mixture at a particular location.

The Engineer will determine the optimum moisture content and the maximum density in the field by the methods prescribed in AASHTO T 134 on representative samples of the soil-cement mixture obtained immediately after the initial mixing. The Engineer will determine the density for each day's run or change of material.

Uniformly compact the loose material to meet the density requirements specified in 270-5.1. During compaction operations, the Contractor may reshape the material to obtain required grade and cross-section.

270-4.7 Protection Against Drying: While finishing and correcting the surface, keep the surface of the base continuously moist by sprinkling it as necessary until applying the emulsified asphalt curing material. As soon as practicable, protect the base from drying for seven days by applying the emulsified asphalt at the rate of 0.20 to 0.25 gallon [0.9 to 1.1 L] of the diluted mixture per square yard [square meter]. The Engineer will direct the actual rate of application that will provide complete coverage without excessive runoff. While applying the bituminous material, ensure that the soil-cement surface is dense, free of all loose and extraneous material, and contains sufficient moisture to prevent excessive penetration of the bituminous materials.

If it is necessary to allow construction equipment or other traffic to use the completed base before the bituminous material has cured sufficiently to prevent pickup or displacement, sand the bituminous material, using approximately 10 lbs [5 kg] of clean sand per square yard [square meter]. Do not use cover material containing organic acids or other compounds detrimental to the soil-cement base.

Maintain the curing material during the seven day protection period.

270-4.8 Opening to Traffic: Do not allow traffic on the base subsequent to completion of the finishing operations specified in 270-4.5 for a minimum period of 72 hours. As an exception to this requirement, allow equipment necessary for correction of surface irregularities, application of water, and application of curing materials on the base, provided that the tire contact pressures of such equipment do not exceed 45 psi [300 kPa]. Under special conditions (i.e. low speed limit, low traffic volume, urban conditions), the Engineer may waive the 72-hour period.

270-4.9 Maintenance: Maintain the base to a true and satisfactory surface until the wearing surface is constructed. If the Engineer requires any repairing or patching, extend the repair or patch to the full depth of the base, and make them in a manner that will ensure restoration of a uniform base course in accordance with the requirements of these Specifications. Do not repair the base by adding a thin layer of soil-cement or concrete to the completed work. The Contractor may make full depth repairs to small or minor areas, such as at manholes, inlets, or the like, with Class I concrete.

For patching of deficient areas less than 100 ft^2 [9 m^2] and less than 1 inch [25 mm] in depth, correct the areas using Type S-III Asphaltic Concrete. For patching of deficient areas less than 100 ft^2 [9 m^2] and greater than 1 inch [25 mm] in depth, remove the areas to full depth, and replace them using Asphalt Base Course Type 3, Type S Asphaltic Concrete, or soil-cement.

270-4.10 Control of Quality: Produce all Soil-Cement Base in accordance with an approved quality control plan in accordance with the Department's Standard Operating Procedure attached to this Specifications Package. In general, the procedure requires a written quality control plan stating how the Contractor will establish, maintain, and implement an individualized process control system to provide a product meeting the requirements of the applicable specifications.

270-5 Acceptance Requirements.

270-5.1 Density: As soon as possible after completing compaction, the Engineer will perform field density testing to ensure that the required density is 97% of the maximum density as determined by methods prescribed in AASHTO T 134.

For density determination, a LOT is defined as 2,500 yd^2 [2,000 m^2] of base. The Engineer may include any small section of base at the end of a day's operation in the preceding LOT (no LOT shall include more than 3,500 yd^2 [3,000 m^2]) or consider it as a separate LOT.

The Engineer will perform five density tests at locations randomly selected within each LOT and will ensure that a LOT value is the average of the five density tests performed within the LOT.

If a LOT value is less than 97% of the maximum density, the Department will reduce payment for the LOT in accordance with the requirements of 270-7.

If an individual test value within a LOT is less than 94% of the maximum density, the Engineer will determine the extent of this deficiency by performing density tests using a 5 foot [1.5 m] grid pattern until a test value of 95% or greater is located in all directions. Remove the delineated area of base, and replace it with base meeting all requirements of this Section, at no expense to the Department.

As an exception to the foregoing, if three or more of the original five individual test values within a LOT are less than 94% of the maximum density, the Engineer will reject the entire LOT, and the Contractor shall remove all base within the LOT and replace it with base meeting all requirements of this Section, at no expense to the Department.

270-5.2 Surface Finish: After compacting and finishing, and not later than the beginning of the next calendar day after constructing of any section of base, measure the surface with a template cut to the required cross-section and with a 15 foot [4.572 m] straightedge laid parallel to the centerline of the road. Correct all irregularities greater than 1/4 inch [6 mm] to the satisfaction of the Engineer with a blade adjusted to the lightest cut which will ensure a surface that does not contain depressions greater than 1/4 inch [6 mm] under the template or the straightedge. The Engineer may approve other suitable methods for measurement. In the testing of the surface, do not take the measurements in small holes caused by the blades pulling out individual rocks. Waste the material removed.

270-5.3 Thickness: After completing the base, including hard planing if necessary, dig or drill 3 inch [75 mm] minimum diameter test holes. The Engineer will determine the thickness from measurements made in these test holes.

For thickness evaluation, a LOT is defined as 2,500 yd^2 [2,000 m^2] of base. The Engineer may include any small section of base at the end of a day's operation or small irregular areas as part of the preceding LOT. The Engineer will consider an area such as an intersection, crossover, ramp, etc., as a separate LOT. The Engineer may include small irregular areas as part of another LOT. No LOT shall include more than 3,500 yd^2 [3,000 m^2] of base.

The Engineer will perform five thickness measurements at locations randomly selected within each LOT.

The Engineer will determine construction tolerances for thickness as follows:

	Deviation From Plan Thickness
Central-Plant-Mixed Processing	-1 inch [-25 mm]
Mixed-in-Place Processing	±1 inch [±25 mm]

When any thickness measurement is outside the construction tolerance, the Engineer will take additional thickness measurements at 10 foot [3 m] intervals parallel to the centerline in each direction from the measurement which is outside the construction tolerance until a measurement in each direction is within the construction tolerance.

The Engineer will evaluate an area of base found to have a thickness outside the construction tolerance and, if he determines that the service life of the base will be significantly reduced, he will require the Contractor to remove and replace it with acceptable base of the thickness shown in the plans, at no expense to the Department. The Department will pay for areas of deficient thickness that are within the construction tolerance in accordance with 270-7.

270-5.4 Strength Testing of Field Specimens: Meet the following requirements for soil-cement when proportioning the mix by the Strength Design Method.

The Engineer is responsible for the following:

1. Checking the adequacy of cement content and uniformity of distribution of cement within the base by sampling and testing the completed mix.

2. Taking samples at the project site just prior to final compaction and determining a minimum of two Strength Test Values (STV) each day, with at least one STV per each 2,500 yd^2 [2,000 m^2] mixed.

3. Ensuring that each STV is the average strength value of a minimum of three individual specimens, and for discarding any obvious outliers.

4. Taking representative samples of the mixed soil-cement material for determining an STV just prior to final compaction, recording the sample location, and ensuring that the samples are large enough to mold three or more compressive strength test specimens as prescribed in FM 5-520.

5. Molding these test specimens at the field moisture content and casting the individual test specimens as close to identical as possible.

6. Resting the molds, during compaction of strength test specimens, on a 200 pound [90 kg] concrete block, or the equivalent thereto, that the Contractor provides.

7. Gently extruding these test specimens from the compaction mold, and carefully placing them in a moist curing environment (not in direct contact with ponded or moving water) such as a tightly closed container under wet cloth or burlap at locations where they will not be disturbed.

Continue the initial field cure for at least 24 hours, and if after 24 hours the Engineer determines that the specimens have not gained sufficient strength to be moved without probable damage, continue field curing until the Engineer determines that each specimen can be safely moved without probable damage occurring. When the Engineer determines that the specimens can be safely moved, the Engineer will transport them to the laboratory where they will be cured, as described in the design procedure (FM 5-520), to seven days of age. At seven days of age, the Engineer will test the individual specimen for determination of compressive stress and ensure that the loading procedure and rates are the same, as described in FM 5-520.

If an STV is less than 60% of the Laboratory Design Strength, remove and replace the material represented by the STV, at no expense to the Department.

270-6 Method of Measurement.

The quantity to be paid for will be plan quantity, in square yards [square meters], completed and accepted. The Contractor shall provide the Engineer with written documentation so he can perform calculations to confirm that the design quantity of cement for the project was incorporated into the project.

270-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including preparing the soil; preliminary grading; furnishing and adding cement; furnishing and adding water; mixing of soil, cement, and water; compacting the mixture; finishing the surface; furnishing and applying curing material; protecting the completed base from traffic; maintaining the completed base; and removing and replacing base which is deficient in thickness as provided in 270-5.3.

No separate payment will be made for cement or for bituminous material applied as a curing seal.

The completed base will be accepted on a LOT to LOT basis. LOTs that have a density less than 97%, or a thickness less than the plan thickness in excess of 0.5 inch [10 mm], will be paid for at reduced rates in accordance with the following schedules.

Density	
Percent Of Maximum Density, LOT Average	Percent Payment
97 and above	100
95.0 to 96.9	90
94.0 to 94.9	50, or remove and replace at the option of the Engineer

Thickness (Applicable only when processing is by the central-plant-mixed method)	
Deficiency From Plan Thickness LOT Average*	Percent Payment
0.00 - 0.50 inch [0.00 - 13 mm]	100
0.51 - 0.75 inch [13.1 - 19 mm]	90
0.76 - 1.00 inch [19.1 - 25 mm]	80
*When processing is by the central-plant-mixed method, the average of the five thickness measurements will be determined. In calculating the average, thickness measurements which exceed the plan thickness by more than 0.5 inch [10 mm] will be considered to be the plan thickness plus 0.5 inch [10 mm] and measurements which are deficient from the plan thickness by more than 1 inch [25 mm] will not be included in the average. Exploratory measurements for determining the extent of an area in which the thickness is outside the construction tolerance will not be included in the average.	

When the LOT average thickness of soil-cement base is deficient by more than 1 inch [25 mm] and the judgement of the Engineer is that the area of such deficiency should not be removed and replaced, payment for the area retained will be at 50%.

When multiple deficiencies occur, the applicable percent payment schedule will be applied to the LOT of base that is identified with each deficiency. The penalty for each deficiency will be applied separately to the unit price.

Payment will be made under:

Item No. 270- 1- Soil-Cement Base - per square yard.
Item No. 2270- 1- Soil-Cement Base - per square meter.