ITEM P-154 SUBBASE COURSE

DESCRIPTION

154-1.1 This item shall consist of a subbase course composed of granular materials constructed on a prepared subgrade or underlying course in accordance with these specifications, and in conformity with the dimensions and typical cross section(s) shown on the plans and with the lines and grades established by the Engineer.

MATERIALS

154-2.1 MATERIALS. The subbase material shall consist of hard durable particles or fragments of granular aggregates. This material will be mixed or blended with fine sand, clay, stone dust, or other similar binding or filler materials produced from approved sources. This mixture must be uniform and shall comply with the requirements of these specifications as to gradation, soil constants, and shall be capable of being compacted into a dense and stable subbase. The material shall be free from vegetable matter, lumps or excessive amounts of clay, and other objectionable or foreign substances. Pit-run material may be used, provided the material meets the requirements specified.

TABLE 1. GRADATION REQUIREMENTS

Sieve designation (square openings) as per ASTM C 136 and ASTM D 422	Percentage by weight passing sieves
3-inch (75.0 mm)	100
No. 10 (2.0 mm)	20 - 100
No. 40 (0.450 mm)	5 - 60
No. 200 (0.075 mm)	0 - 8

The portion of the material passing the No. 40 (0.450 mm) sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 when tested in accordance with ASTM D 4318.

The maximum amount of material finer than 0.02 mm in diameter shall be less than 3 percent (%).

Of particles retained on a 1/2-inch square sieve, not more than 30 percent by weight shall consist of particles so flat or elongated, or both, that the ratio between the maximum and the minimum dimensions of a circumscribing rectangular prism exceeds 5:1 when tested in accordance with ASTM D 4791.

The magnesium sulphate soundness loss shall not exceed 20 percent, after 4 cycles when tested in accordance with ASTM C 88. The material shall have a lab soaked and remolded CBR value of at least 35 when tested in accordance with ASTM D 1883 using a surcharge load of 10 lbs.

a. Sampling and Testing. Aggregates for preliminary testing shall be furnished by the Contractor prior to the start of production. All tests for initial aggregate submittals necessary to determine compliance with the specification requirements will be made by the Engineer at no expense to the Contractor. All retesting shall be at the expense of the Contractor.

Samples of aggregates shall be furnished by the Contractor at the start of production and at intervals during production. The sampling points and intervals will be designated by the Engineer. The samples will be the basis of approval of specific lots of aggregates from the standpoint of the quality requirements of this section.

In lieu of testing, the Engineer may accept certified DOT test results indicating that the aggregate meets specification requirements.

Sampling shall be in accordance with ASTM D 75. Testing shall be in accordance with ASTM C 136 and C 117. When deemed necessary to the Engineer, the Contractor shall furnish aggregate samples to the Engineer for testing to verify compliance with the requirements specified herein.

b. Gradation Requirements. The gradation of the final mixture shall fall within the range indicated in Table 1, when tested in accordance with ASTM C 117 and C 136. The final gradation shall be continuously well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on an adjacent sieve or vice versa.

SUBMITTALS AND CERTIFICATIONS

154-3.1 SUBMITTALS AND CERTIFICATIONS. Submittals of "Shop and Setting Drawings", "Working Drawings", "Catalogue Data" and "Certifications" for review shall be submitted in accordance with appropriate sections of the General Provisions. Submittals and Certifications required are as follows:

a. Certification that aggregate meets the requirements specified or Certified Test Results.

b. Sieve analysis

c. Aggregate samples when requested by the Engineer prior to the start of production.

d. Certification that the soils provided are not contaminated as defined in P-152 Excavation and Embankment, paragraph 152-1.4, Contaminated Borrow Material.

CONSTRUCTION METHODS

154-~~3.1~~4.1 GENERAL. The subbase course shall be placed where designated on the plans or as directed by the Engineer. The material shall be shaped and thoroughly compacted within the tolerances specified.

Granular subbases which, due to grain sizes or shapes, are not sufficiently stable to support without movement the construction equipment, shall be mechanically stabilized to the depth necessary to provide such stability as directed by the Engineer. The mechanical stabilization shall principally include the addition of a fine-grained medium to bind the particles of the subbase material sufficiently to furnish a bearing strength, so that the course will not deform under the traffic of the construction equipment. The addition of the binding medium to the subbase material shall not increase the soil constants of that material above the limits specified.

154-~~3.2~~4.2 OPERATION IN PITS. All work involved in clearing and stripping pits and handling unsuitable material encountered shall be performed by the Contractor at his/her own expense. The subbase material shall be obtained from pits or sources that have been approved. The material in the pits shall be excavated and handled in such manner that a uniform and satisfactory product can be secured.

154-4.3 EQUIPMENT. All equipment necessary for the proper construction of this work shall be on the project, of appropriate size and type for the materials to be handled and site conditions, in first-class working condition, and shall have been approved by the Engineer before construction is permitted to start.

Provisions shall be made by the Contractor for furnishing water at the site of the work using equipment of ample capacity and design to assure uniform application.

The processing equipment shall be designed, constructed, and operated and shall have sufficient capacity to thoroughly mix all materials and water in the proportions required to produce a subbase course of the gradation and consistency required.

154-~~3.3~~4.4 PREPARING UNDERLYING COURSE. Before any subbase material is placed, the underlying course shall be prepared and conditioned as specified. The course shall be checked and accepted by the Engineer before placing and spreading operations are started.

Grade control between the edges of the pavement shall be by means of grade stakes, steel pins, or forms placed in lanes parallel to the centerline of the pavement and at intervals which will permit string lines or check boards to be placed between the stakes, pins, or forms.

To protect the subgrade and to ensure proper drainage, the spreading of the subbase shall begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.

154-~~3.4~~4.5 MATERIALS ACCEPTANCE IN EXISTING CONDITION. When the entire subbase material is secured in a uniform and satisfactory condition and contains approximately the required moisture, such approved material may be moved directly to the spreading equipment for placing. The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with the proper blending. The materials from these sources shall meet the requirements for gradation, quality, and consistency. It is the intent of this section of the specifications to secure materials that will not require further mixing. The moisture content of the material shall be approximately that required to obtain maximum density. Any minor deficiency or excess of moisture may be corrected by surface sprinkling or by aeration. In such instances, some mixing or manipulation may be required, immediately preceding the rolling to obtain the required moisture content. The final operation shall be blading or dragging, if necessary, to obtain a smooth uniform surface true to line and grade.

154-~~3.5~~4.6 PLANT MIXING. When materials from several sources are to be blended and mixed, the subbase material shall be processed in a central or travel mixing plant. The subbase material, together with any blended material, shall be thoroughly mixed with the required amount of water. After the mixing is complete, the material shall be transported to and spread on the underlying course without undue loss of the moisture content.

154-4.6.1 MIXED IN PLACE. When materials from different sources are to be proportioned and mixed or blended in place, the relative proportions of the components of the mixture shall be as designated by the Engineer.

The subbase material shall be deposited and spread evenly to a uniform thickness and width. Then the binder, filler or other material shall be deposited and spread evenly over the first layer. There shall be as many layers of materials added as the Engineer may direct to obtain the required subbase mixture.

When the required amount of materials have been placed, they shall be thoroughly mixed and blended by means of graders, discs, harrows, rotary tillers, supplemented by other suitable equipment if necessary. The mixing shall continue until the mixture is uniform throughout. Areas of segregated material shall be corrected by the addition of binder or filler material and by thorough remixing. Water in the amount and as directed by the Engineer shall be uniformly applied prior to and during the mixing operations, if necessary, to maintain the material at its required moisture content. When the mixing and blending has been completed, the material shall be spread in a uniform layer which, when compacted, will meet the requirements of thickness and typical cross section.

154-~~3.6~~4.7 GENERAL METHODS FOR PLACING. The subbase course shall be constructed in layers. Any layer shall be not less than 3-inches (75 mm) nor more than 8-inches (200 mm) of compacted thickness. The subbase material shall be deposited and spread evenly to a uniform thickness and width. The material, as spread, shall be of uniform gradation with no pockets of fine or coarse materials. The

subbase, unless otherwise permitted by the Engineer, shall not be spread more than 2,000 square yards (1700 square meters) in advance of the rolling. Any necessary sprinkling shall be kept within this limit. No material shall be placed in snow or on a soft, muddy, or frozen course.

When more than one layer is required, the construction procedure described herein shall apply similarly to each layer.

During the placing and spreading, sufficient caution shall be exercised to prevent the incorporation of subgrade, shoulder, or foreign material in the subbase course mixture.

154-~~3.7~~4.8 FINISHING AND COMPACTING. After spreading or mixing, the subbase material shall be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers shall be furnished to adequately handle the rate of placing and spreading of the subbase course.

~~The field density of the compacted material shall be at least 100 percent of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. The laboratory specimens shall be compacted and tested in accordance with **[ ]**. The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 2922 6938. The moisture content of the material at the start of compaction shall not be below nor more than 2 percentage points above the optimum moisture content.~~

a. Compaction Requirements. The subbase material shall be compacted to a depth of **[12 inches]** and to a density of not less than **[100 percent]** percent of the maximum density as determined by the modified Proctor Compaction Test ASTM **[D1557].** The material to be compacted shall be within +/- 2 percent of optimum moisture content before rolled to obtain the prescribed compaction (except for expansive soils).

The in-place field densities shall be determined in accordance with ASTM ~~D 2922~~ 6938/D 3017 with verification by ASTM D1556. The finished grading operations, conforming to the typical cross section, shall be completed and maintained at least 1,000 feet (300 m) ahead of the paving operations or as directed by the Engineer.

When nuclear density gages are to be used for density determination, testing shall be in accordance with Section 120.

The course shall not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the subbase. When the rolling develops irregularities that exceed 1/2-inch (12 mm) when tested with a 16-foot (4.8 m) straightedge, the irregular surface shall be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required above.

Rolling shall progress gradually from the sides to the center of the lane under construction, or from one side toward previously placed material, by lapping uniformly each preceding track by at least 12-inches. Blading and rolling shall be done alternately, as required or directed, to obtain a smooth, even, and uniformly compacted subbase.

Along places inaccessible to rollers, the subbase material shall be tamped thoroughly with mechanical or hand tampers.

To check the surface for fine grade, the Contractor shall pin and stringline the surface with a 50-foot grid along straight sections of typical grade. In transition areas and curved sections, the Contractor shall pin and stringline the surface with a 25-foot grid. Alternate methods of checking the fine grade may be used only when authorized by the Engineer.

Sprinkling during rolling, if necessary, shall be in the amount and by equipment approved by the Engineer. Water shall not be added in such a manner or quantity that free water will reach the underlying layer and cause it to become soft.

154-4.9 ACCEPTANCE SAMPLING AND TESTING FOR DENSITY. Subbase course shall be accepted for density on a lot basis. A lot will consist of one day's production where it is not expected to exceed 2,400 square yards (2,000 square meters). A lot will consist of one-half day's production where a day's production is expected to consist of between 2,400 and 4,800 square yards (2,000 and 4,000 square meters).

Each lot shall be divided into two equal sublots. One test shall be made for each sublot. Sampling locations will be determined by the Engineer on a random basis in accordance with statistical procedures contained in ASTM D3665.

Each lot will be accepted for density when the field density is at least 100 percent of the maximum density of laboratory specimens prepared from samples of the subbase course material delivered to the job site. The specimens shall be compacted and tested in accordance with ASTM D1557. The in-place field density shall be determined in accordance with ASTM D1556 or D 6938. If the specified density is not attained, the entire lot shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached.

In lieu of the core method of field density determination, acceptance testing may be accomplished using a nuclear gage in accordance with ASTM D 6938. The gage should be field calibrated in accordance with Paragraph 4 of ASTM D 6938. Calibration tests shall be conducted on the first lot of material placed that meets the density requirements.

Use of ASTM D 6938 results in a wet unit weight, and when using this method, ASTM D 3017 shall be used to determine the moisture content of the material. The calibration curve furnished with the moisture gages shall be checked as described in Paragraph 7 of ASTM D 3017. The calibration checks of both the density and moisture gages shall be made at the beginning of a job and at intervals as determined by the Engineer and or materials testing laboratory.

If a nuclear gage is used for density determination, two random readings shall be made for each sublot.

There shall be no less than six density/moisture tests performed for each 4,000 square yards of subbase material. At least one test shall be by the sand cone method and at least five evenly distributed nuclear density/moisture tests will be taken in the area covering the 4,000 square yards of which one nuclear density/moisture test shall be taken at the sand cone test location so that calibration of the nuclear to sand cone test can be verified.

154-~~3.9~~4.10 SURFACE TEST. After the course is completely compacted, and immediately prior to paving the surface shall be tested for smoothness and accuracy of grade and crown; any portion found to lack the required smoothness or to fail in accuracy of grade or crown shall be scarified, reshaped, recompacted, and otherwise manipulated as the Engineer may direct until the required smoothness and accuracy is obtained. The finished surface shall not vary more than 1/2-inch (12 mm) when tested with a 16-foot (4.8 m) straightedge applied parallel with, and at right angles to, the centerline.

154-3.104.11 THICKNESS. The thickness of the completed subbase course shall be determined by depth tests or sample holes taken at intervals so each test shall represent no more than 500 square yards (420 square meters). When the deficiency in thickness is more than 1/2-inch (12 mm), the Contractor shall correct such areas by scarifying, adding satisfactory mixture, rolling, sprinkling, reshaping, and finishing in accordance with these specifications. The Contractor shall replace at his/her expense the subbase material where borings are taken for test purposes.

154-~~3.11~~4.12 PROTECTION. Work on subbase course shall not be conducted during freezing temperature nor when the subgrade is wet. When the subbase material contains frozen material or when the underlying course is frozen, the construction shall be stopped.

154-~~3.12~~4.13 MAINTENANCE. Following the final shaping of the material, the subbase shall be maintained throughout its entire length by the use of standard motor graders and rollers until, in the judgment of the Engineer, the subbase meets all requirements and is acceptable for the construction of the next course.

METHOD OF MEASUREMENT

154-4.~~1~~5.1 The yardage of subbase course to be paid for shall be the number of cubic yards (cubic meters) of subbase course material placed, compacted, and accepted in the completed course. The quantity of subbase course material shall be measured in final position based upon depth tests or cores taken as directed by the Engineer, or at the rate of 1 depth test for each 500 square yards (420 square meters) of subbase course, or by means of average end areas on the complete work computed from elevations to the nearest 0.01-foot (3 mm). On individual depth measurements, thicknesses more than 1/2-inch (12 mm) in excess of that shown on the plans shall be considered as the specified thickness plus 1/2-inch (12 mm) in computing the yardage for payment. Subbase materials shall not be included in any other excavation quantities.

154-5.2 The quantity of stockpiling, placing, rescarify and recompact existing subbase course to be paid for will be determined by measurement of the number of square yards of material actually constructed and accepted by the Engineer and complying with the plans and specifications.

BASIS OF PAYMENT

154-~~5.1~~6.1 Payment shall be made at the contract unit price per cubic yard (cubic meter) for subbase course. This price shall be full compensation for furnishing all materials; for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

154-6.2 Payment shall be made at the contract unit price per square yard for stockpiling, placing, rescarify and recompact existing subbase course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

Payment will be made under:

~~Item P-154-5.1~~	~~Subbase Course -- Per Cubic Yard (Cubic Meter)~~
Item P-154-6.1	Subbase Course -- Per Cubic Yard (Cubic Meter)
~~Item P-154-6.2~~	~~Reinstall and Compact Existing Subbase Course -- Per Square Yard (Square Meter)~~

TESTING REQUIREMENTS

ASTM C 88	Soundness of Aggregates by Use of Sodium Sulfate and Magnesium Sulfate
ASTM C 117	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates

ASTM D 75	Sampling Aggregate
ASTM D 422	Particle Size Analysis of Soils
ASTM D 698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12-in (305 mm) Drop
ASTM D 1556	Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Test for Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D 1883	Test Method for Bearing Ratio of Laboratory Compacted Soils (CBR)
ASTM D 6938	In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 3017	Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods
ASTM D 3665	Random Sampling of Paving Materials
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	Flat or Elongated Particles in Coarse Aggregate

END OF ITEM P-154