SECTION 540
CEMENT-TREATED BASE COURSE

540-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, construction and curing a cement-treated base composed of aggregate, furnishing of water and aggregate; the mixing, proportioning, hauling and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 540-3. Compact, shape and cure the base to conform to the lines, grades, depths and typical sections shown on the plans.

When cement-treated base course is called for on the plans, the Contractor has the option of providing a plant mixed cement-treated base course or a road mixed cement-treated base course as specified below.

540-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate	1010-1, 1010-2
Portland Cement, Type I	1024-1
Water	1024-4

540-3 LIMITATIONS

Do not construct cement-treated base when the air temperature is less than 40°F nor when conditions indicate that the temperature may fall below 40°F within 24 hours. Do not incorporate frozen materials into the mixture nor place material on frozen subgrade. Protect the base from freezing for 7 days after completion.

Do not place cement-treated base that will not be covered with pavement by December 1 of the same year. Failure of the Contractor to cover the cement-treated base as required above will result in the Engineer notifying the Contractor in writing to cover the cement-treated base with a sand seal. Apply the sand seal in accordance with Section 660, except Articles 660-3 and 660-12 will not apply. If the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage.

540-4 PREPARATION OF SUBGRADE

Prepare the subgrade in accordance with Section 500. Prepare the subgrade so that it is firm and able to support without displacement the construction equipment and the compaction operations hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds. Moisten the subgrade as needed before spreading the base material.

540-5 CONSTRUCTION METHODS

(A) Composition of Mixture

When the Contractor proposes to use a source of aggregate that is not documented by a currently approved job mix formula, submit to the Department's Materials and Tests Unit, samples of all aggregates proposed for use at least 3 weeks before beginning production. Take the aggregate samples in the presence of the Engineer. Submit in writing the proposed gradation for the cement-treated base material. The Department will then prepare a mix design based upon the samples submitted and the Contractor's stated proposed gradation.

A job mix formula will be established for the cement-treated base material within the design limits in Section 1010. Use the job mix formula unless modified in writing by the Engineer.

Prepare all cement-treated base material mixtures so that they conform to the job mix formula within the tolerance ranges specified in Table 540-1. If the Contractor is unable to maintain the production within the tolerance ranges specified in Table 540-1 for two consecutive lots, production will stop until such time as a new mix design and job mix formula has been established and approved by the Engineer.

TABLE 540-1
TOLERANCES FOR JOB MIX FORMULA
PORTLAND CEMENT-TREATED BASE

Sieve Size	Tolerance for Percent Passing
1 1/2"	0
1"	± 5
1/2"	± 8
No. 4	± 7
No. 10	± 7
No. 40	± 4
No. 200	± 2
Material Passing No. 10 Sieve (Soil Mortar)	
No. 40	± 8
No. 200	± 5

(B) Plant Mixed Cement-Treated Base Course

(1) Mixing

(a) General

Add to the aggregate the quantity of cement specified by the Engineer.

Thoroughly mix the cement, aggregates and water in an approved central mixing plant. Use a batch or continuous-flow type stationary mixer and equip it with feeding and metering devices that will add aggregate, cement and water into the mixer in the specified quantity. Use batch weights or rates of feed of cement that are within 0.3% of the quantity designated by the Engineer. Use batch weights or rates of flow of water that are within a range of optimum to optimum plus 1.5% moisture. Use batch weights or rates of feed of aggregate that are within 5% of the amounts designated by the Engineer.

Mix materials at least 20 seconds to assure a proper blend of materials.

(b) Batch Type Plant

Equip the mixer with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch.

Add water during the mixing operation as required to provide the quantity of moisture specified; however, do not add water to the mixture before the aggregate and cement have been mixed sufficiently to prevent the formation of cement balls.

Equip the mixer with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period.

(c) Continuous Flow Type Plant

Calibrate and mark cement storage silos so that the amount of cement in the silo can be readily determined at any time. Design feeders and/or meters for introducing the cement into the mixer such that the amount of cement can be accurately determined before it is introduced into the mixer. Use a variable speed motor on the cement feeder which is regulated by a control mechanism indicating the speed of the motor in r.p.m. or equivalent measure. Design the indicator so that it can be read in daylight from a point 4 feet from the indicator. Equip the cement holding tank which is used in feeding cement with an air pressure gauge and air pressure regulating control such that air pressure can be regulated to a uniform flow.

Measure the water by a meter which determines flow in gallons per minute and control it with 2 valves. Use a variable flow valve for controlling the rate of flow of the water only on one valve and use an on-off valve connected to the plant controls such that the water is turned on and/or off when the plant is started and stopped for the other valve.

After the material has been processed by the pug mill, store it in a holding bin with the minimum capacity of 3 tons before discharging into trucks. Hold the material in the holding bin for loading purposes only and do not store for loading subsequent trucks. Loading trucks directly from a belt or auger box will not be permitted.

Have available a satisfactory platform for obtaining samples from trucks. Make provisions for calibrating the plant daily and at other times as deemed necessary by the Engineer. On plants that are electronically controlled, manual calibration will be required to verify the electronic calibration and shall be performed at the beginning of a project. If the plant operation is interrupted by more than 4 calendar days during an active project, perform the manual calibration process again. Perform random manual calibrations at the direction of the Engineer.

(2) Hauling and Placing

Haul the mixed base material to the roadway in trucks with protective covers to avoid moisture loss. Do not exceed one hour between the loading of the haul trucks and the beginning of compaction.

Place stringlines for alignment control for placing a layer of base.

Place the base in a uniform layer on the moistened, prepared subgrade to produce the depth required by the plans. To insure homogenous distribution of the base material in each layer, place the material using approved spreaders. Perform the spreading operations to eliminate pockets of material of non-uniform gradation resulting from segregation in the hauling or discharging operations. Spread each layer so that compaction can be started without further shaping.

A single spreader may be used provided it is capable of placing a uniform, full-depth layer of material across the full width of the base in one pass. Otherwise, 2 or more spreaders will be required and operate the spreaders so that the spreading progresses along the full width of the base in a uniform manner.

Base placed on areas inaccessible to mechanical spreading equipment may be spread in one layer by approved methods. After spreading, compact the material thoroughly to the required lines, grades and typical sections by means of pneumatic tampers or with other compaction equipment which will constantly obtain the degree of compaction required.

(C) Road Mixed Cement-Treated Base Course

(1) Equipment

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Use a cement spreader which has an adjustable rate of flow and the capability of spreading the required amount of cement in one pass. Mix cement, aggregate and water with a self-propelled rotary mixer capable of mixing to a depth of 10 inches. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal and blotting sand that does not damage the base and in accordance with Article 107-21.

(2) Spreading and Mixing

Place the required quantity of aggregate on the prepared subgrade in a uniform layer. Spread aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Apply the required quantity of cement in a uniform spread on the aggregate in place and immediately blend the aggregate until the cement is uniformly distributed throughout the aggregate. Maintain the moisture content at or below the optimum moisture at the time of application of the cement. Do not apply cement on excessively windy days and apply only to such an area that all operations shall be completed on the same day during daylight hours.

The Engineer will establish the actual cement content during construction.

Immediately after the aggregate and cement have been thoroughly blended, apply water as needed and incorporate into the mixture. Control the application of the water so that there is no excessive concentration on or near the surface of the mixture. After the necessary water has been applied, continue mixing until a thorough and uniform mixture is obtained.

Maintain the moisture content at the time of final mixing and during compaction within a range of optimum to optimum plus 1.5% as determined. Make sure that the moisture content in the mix does not exceed the quantity that will cause the base course to become unstable during compaction or finishing operations.

540-6 COMPACTION

Begin compaction immediately after the plant mixed base has been placed on the prepared subgrade or immediately after cement and water has been incorporated into the previously placed aggregate. Compact any one layer of base so the thickness is between 4 inches and 8 inches.

After spreading, maintain the moisture content of the material within a range of optimum to optimum plus 1.5% moisture during compaction.

Accomplish compaction by the use of approved self-propelled rollers, except do not use a sheep-foot roller for more than 2 passes. Compact the base by the use of approved self-propelled rollers to a density equal to at least 97% of the maximum density obtained by compacting a sample of the material in accordance with AASHTO T 180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. The Engineer may, at his option, utilize nuclear methods as described in the *NCDOT Nuclear Density Testing Manual – Base Course, FDR and Select Materials* to determine the density of the base instead of the methods required above. Copies of this manual are available upon request from the Materials and Tests Unit.

Complete final compaction, including that necessary due to correction of high or low areas, within 3 hours after water has been added to the mixture. Do not leave any cement-aggregate

mixture undisturbed for more than 30 minutes if it has not been compacted and finished. When rain causes excessive moisture, reconstruct the entire section. When such reconstruction is necessary, perform the work of reconstruction and provide the cement required at no cost to the Department.

540-7 CONSTRUCTION JOINTS

Build the base for large, wide areas in a series of parallel lines of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a vertical face free of loose or shattered materials. Where traffic considerations require that a longitudinal joint be exposed for an excessive length of time, the Engineer may require that it be covered with a curing seal in accordance with Section 543.

540-8 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the thickness of the base so that it is within a tolerance of ± 1/2 inch of the base thickness required by the plans. When the base course will be used under concrete pavement the tolerance will be ± 1/4 inch.

Construct the base so that the maximum differential between the established grade and the base within any 100 foot section is 1/2 inch or 1/4 inch when used as a base course under concrete pavement.

540-9 CURING

After the cement-treated base has been finished as specified herein, cure it in accordance with Section 543.

540-10 AGGREGATE FOR CEMENT-TREATED BASE

Use aggregate for cement-treated base course from an approved source participating in the Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) which has been sampled, tested and approved in accordance with Section 1006.

540-11 TRAFFIC

Completed sections of the base may be opened when necessary to lightweight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface and provided the curing is not impaired. Do not operate construction equipment on the base, except as necessary to discharge into the spreader during paving operations.

540-12 MAINTENANCE

Maintain the base in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage that may occur in any maintenance operation. Perform this maintenance at no cost to the Department and repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of cement-stabilized material to the existing layer of base.

540-13 MEASUREMENT AND PAYMENT

Aggregate for Cement-Treated Base Course will be measured and paid at the contract unit price per ton that has been incorporated into the completed and accepted work. The quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. No deduction will be made for any moisture contained in the aggregate at the time of weighing. Measurement will not be made of any base mixture added or replaced for corrective measures during construction or for repairing damaged areas.

Portland Cement for Cement-Treated Base Course will be measured and paid at the contract unit price per ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. When cement-treated base is produced at a commercial source for more than one project, the Engineer may elect to measure the cement based upon the cement content shown in the approved job mix formula. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt Curing Seal will be paid in accordance with Article 543-5.

Blotting Sand will be paid in accordance with Article 818-4.

The above prices and payments will be full compensation for all work covered by this section including, but not limited to, the furnishing of water and aggregate; the mixing, proportioning, hauling and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 542-3.

If the Contractor fails to provide sand seal as required and the Engineer has the work performed by other forces, the cost of such work will be deducted from monies due or to become due to the Contractor.

Payment will be made under

Pay Item	Pay Unit
Aggregate for Cement-Treated Base Course	Ton
Portland Cement for Cement-Treated Base Course	Ton

SECTION 542
SOIL-CEMENT BASE

542-1 DESCRIPTION

The work covered by this section consists of constructing and curing a soil-cement base by treating the subgrade, existing subbase or existing base, or any combination of these materials, by pulverizing, adding Portland cement, adding aggregate when required, mixing, wetting and compacting the mixture to the required density. Proportion, spread and mix the materials on the roadway; manipulate, compact and finish in accordance with the *Standard Specifications* and the lines, grades, depths and typical sections shown on the plans or established by the Engineer.

542-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate, ABC	Table 1005-1
Portland Cement, Type I	1024-1
Water	1024-4

Use soil material that consists of material existing in the area to be paved, approved borrow material or a combination of these materials proportioned as directed by the Engineer that is free from vegetation, roots or other objectionable matter; and does not contain aggregate or stone larger than 2 inches.

542-3 LIMITATIONS

Do not construct the soil-cement base when the air temperature is below 40°F nor when conditions indicate that the temperature may fall below 40°F within 24 hours. Do not place or mix materials with frozen subgrade. Protect the base from freezing for 7 days after