

306 – CEMENT TREATED BASE

SECTION 306

CEMENT TREATED BASE

Exception: If the PCCP in the contract is not specified as QC/QA, (Bid item Quality Control Testing (CTB) is not included as a bid item) subsections 306.2 (entire subsection), 306.4d. and 306.4g. of this SECTION are not applicable to the contract.

306.1 DESCRIPTION

Design a cement treated base (CTB) mixture meeting the requirements of the Contract Documents. Construct 1 or more courses of the CTB on a prepared roadway as shown in the Contract Documents.

| <u>BID ITEMS</u> | <u>UNITS</u> |
|-------------------------------|--------------|
| Cement Treated Base | Square Yard |
| Quality Control Testing (CTB) | Square Yard |

306.2 CONTRACTOR QUALITY CONTROL REQUIREMENTS

Provide personnel and equipment to conduct quality control testing that complies with the Contract Documents. Provide certified technicians to perform process control testing. Use equipment that complies with, and is calibrated according to the specified test methods.

a. Quality Control Plan. Prepare a written Quality Control Plan (QCP) that details the type and frequency of sampling, testing and inspection necessary to measure and control the various properties of materials and construction governed by the Contract Documents. Submit the QCP for the Engineer's approval at least 2 weeks before beginning work.

Minimum requirements in the QCP:

(1) Submit an organizational chart (with names and telephone numbers) that shows the lines of authority and responsibility relating both to the mix design and the quality control operations during production. Identify the Contractor's representative that shall serve as the liaison to KDOT personnel. Identify the certified technicians that shall perform process control testing.

Provide individuals certified as ACI Concrete Field Technician, ACI Aggregate Field Tester and Nuclear Moisture Density Gauge Tester.

(2) Submit the mix design for the CTB. If an existing mix design is used, provide the mix design number. Include all the elements of the mix design specified in the Contract Documents.

(3) Submit the proposed methods and procedures to control the elements identified as necessary for the quality of the CTB. These elements include, but are not limited to: producing the aggregate, managing the aggregate stockpiles, proportioning the individual materials for the mixture, mixing and transporting the mixture, placing and consolidating the mixture, and finishing and curing the mixture.

(4) Submit a plan for sampling and testing at random locations at the frequency specified in KDOT's Sampling and Testing Frequency Chart for Cement Treated Base for Quality Control/Quality Assurance Projects, Part V.

Include a plan for controlling non-conforming materials. In the plan, identify the methods and procedures for recognizing the non-conforming materials, isolating the non-conforming materials, determining the disposition of the non-conforming materials and the reclaiming or re-working of the non-conforming materials if approved by the Engineer.

(5) Submit a documentation plan to maintain adequate electronic records of all inspections and tests. Design the documentation plan to indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected and the nature of corrective action to be taken. Design electronic data sheets to record test results and calculations, daily quality control summary sheets, quality control charts and other forms as necessary to provide complete documentation.

Include a plan to document the quality control requirements considered to be normal activities necessary to control the production and placing of a given product or material at an acceptable quality level.

(6) Submit for the DME's approval any alternative sampling and testing methods, inspection procedures or equipment requirements.

b. Production Requirements.

(1) Certified technicians shall be present when material is produced for or placed on the project. Certified technicians shall perform and use quality control tests and other quality control practices to assure that delivered materials and proportioning comply with the requirements of the mix designs. Certified technicians shall periodically inspect equipment used in proportioning, mixing, transporting, placing, consolidating, finishing and curing the CTB to assure compliance with the specified requirements.

(2) Locate the testing facility at the plant site or at the project site. Any other location for the testing facility must be approved by the DME.

Equip the Contractor's testing facility with a telephone, a copying machine and a facsimile machine for the exclusive use of the Contractor's quality control personnel and the Engineer. Post a copy of the Contractor's quality control organizational chart in the Contractor's testing facility.

Allow KDOT access to the testing facility and use of testing equipment to perform verification tests (KT-37).

(3) Perform all sampling and testing according to the QCP. Retain the second half of the latest 10 gradation samples for use by the Engineer.

(4) Record all test results and calculations on electronic data sheets. Record specific test results on a daily summary sheet to facilitate the computation of moving test averages. Base the moving averages on 4 consecutive test results. Include a description of quality control actions taken (adjustment of aggregate or additive proportions in the mix, moisture adjustments, etc.) in the daily quality control summary sheet.

Post and keep current quality control charts; show both individual test results and moving average values. As a minimum, plot the single test values and the 4-test moving average values for gradation of combined aggregates, in-place CTB moisture and dry density, and compressive strength (requires a separate graph for PWL, but no moving average plot). Plot data according to **subsection 106.4d.(2)**.

Complete the charting within 1 working day after the sampling or testing, respective to each type of test.

Make all test results and control charts available to the Engineer at the project site. The Engineer will periodically make compliance checks on the documentation during the progress of the work.

Fax copies of all failing test results (based on a moving average of 4 tests, if appropriate) and a summary sheet to the Field Engineer on a daily basis.

File all reports, records, charts and diaries developed during the progress of construction activities. Upon completion of the contract, all documentation becomes the property of KDOT.

(5) Notify the Engineer when the moving average test result trend line for any property approaches the specification limits. Cease operations when 2 consecutive moving average points fall outside the specification limits, or 2 consecutive single compressive strength tests exceed the specification limits. Ceasing operations is the Contractor's responsibility. Quality control tests for this determination include aggregate gradation, compliance with the mix design band and in-place density of CTB.

When operations for the conditions cited above are not stopped, the Engineer may reject all subsequent material, or accept the material at a reduced price, as determined by the Engineer.

The Engineer may examine materials represented by individual test results which lie beyond the Contractor's normal quality control testing variation. The investigation may be based on either Contractor or KDOT test results. The information from additional testing (including testing of in-place CTB) may be used to define unacceptable work according to **subsection 105.5d**. The Engineer will apply appropriate price reductions or initiate corrective action as determined by the Engineer.

If a dispute exists between the Engineer and Contractor about the validity of any test results, the MRC will perform referee testing. If 1 of the disputed KDOT test results was generated at the MRC, an Independent Laboratory agreeable to both parties shall be selected. The Independent Laboratory shall be approved by the AASHTO Accreditation Program for the tests being refereed. If referee testing indicates that the KDOT test results are correct, the Contractor is responsible for the cost of additional testing, including referee testing performed at the MRC. If the referee testing indicates that the Contractor test results are correct, KDOT is responsible for the cost of additional testing.

(6) Identify all non-conforming materials and products to prevent use, shipment and intermingling with conforming materials and products. Provide holding areas, mutually agreeable to the Engineer and Contractor.

The Engineer will determine if reclaiming or reworking of non-conforming materials is allowed.

306.3 MATERIALS

Provide materials that comply with the applicable requirements.

| | |
|---|----------------------|
| Concrete Admixtures & Curing Material | DIVISION 1400 |
| Portland Cement and Fly Ash | DIVISION 2000 |
| Water for CTB | DIVISION 2400 |
| Aggregates for CTB | DIVISION 1100 |

Mix Design. Design a mixture of aggregate and portland cement or fly ash, or both. If fly ash is used in the mixture, address the set time and strength gain as a function of the ambient temperature. Design the mixture according to the following requirements:

- (1) The compressive strength shall be between 650 and 1600 psi. Any test correlating to the maximum value or higher requires scoring or sawing joints in the base that fall within the failing test section (from previous to next passing test sections). Determine compressive strength at 7 days, according to **DIVISION 2500**.
- (2) Submit a single point gradation for the combined aggregates along with a plus/minus tolerance for each sieve to the Engineer. The plus/minus tolerances shall be used by the Contractor to perform quality control checks and by the Engineer to perform aggregate gradation verification testing. Perform tests on the combined materials.
- (3) Submit the mix batch weights in an acceptable manner to the DME. Address the initial set times (specified in AASHTO T 154) and placement times (with regards to the set times) in the proposed mix design.
- (4) Submit laboratory compressive strength test results on a minimum of 1 set of 3 plugs, produced from the proposed mix design and utilizing the actual materials proposed for use on the contract.
- (5) Submit the test results 2 weeks prior to the anticipated date for using the design on the contract. The Engineer will review the design within 5 working days of receipt. The Engineer may perform any testing necessary to verify the adequacy of the Contractor's design. If the Engineer calls for verification tests, supply the Engineer with the necessary materials to enable the Engineer to test the mix properties within 5 working days of notification.
- (6) Do not place CTB on the project until the Engineer has reviewed and approved the submitted mix design.

Submit any proposed changes to the approved mix design to the DME for approval before implementing the proposed changes.

306.4 CONSTRUCTION REQUIREMENTS

a. Preparation and Maintenance of the Subgrade. Before placing any CTB material on any section, complete the ditches and drains along that section to effectively drain the highway. Use automatic grade control equipment to trim the surface of the subgrade to the line, grade and cross-section as shown in the Contract Documents. Maintain the subgrade to the as-constructed condition under other bid items, repairing any encountered defects to the specifications of the previous bid items. Maintain the subgrade surface to readily drain at all times. Protect the subgrade from damage when handling materials, tools and equipment. Do not store or stockpile materials on the subgrade. Do not place material or lay CTB on a frozen or muddy subgrade.

Lightly spray the subgrade with water to obtain a thoroughly moistened condition before the CTB is placed. Do not puddle water on the grade.

Do not deposit any material until the subgrade or base has been checked and approved by the Engineer.

b. Mixing the Materials. Plant mix the aggregate, cementing agent and water according to the approved mix design.

Control the charge in a batch mixer, or the rate of feed to a continuous mixer (pugmill), to allow complete mixing of all the materials. Mix the materials to produce a homogeneous mixture. Do not use frozen aggregate.

Take all compressive strength samples at the plant site. Compact the samples prior to the CTB reaching its initial set.

c. Spreading and Compacting the CTB. Do not place CTB on frozen subgrade. Moisten the surface of the compacted subgrade before spreading the CTB.

The maximum compacted thickness of a single lift is 6 inches. If the thickness is greater than 6 inches, spread and compact the subgrade in multiple lifts of equal thickness with a maximum lift thickness of 6 inches. If the base is spread in multiple lifts, offset the longitudinal joints by at least 6 inches.

If multiple lifts are placed, keep the surface of each lift moist until the succeeding lift is spread. Cover the exposed lower lift with the final lift the same day the lower lift is placed.

Compact each lift of CTB to a minimum of 95% of the standard density.

Compact the CTB within 2 hours from the time the water and cementing agent is added to the aggregate, or before the mixture reaches the initial set, whichever is the shorter timeframe.

d. Compaction Determination. Determine dry density and moisture content according to **DIVISION 2500**.

If the mix is stiff (can be slip-formed), then determine the standard density by averaging the 3 most recent field molded densities using plant mixed base material. Compact 1 standard mold (using plant mixed material with the proper moisture content) for each day's operation as specified in KT-37.

If the mix is fluid (requires forming), then determine the Standard Dry Density by averaging the 3 most recent vibrated unit weight test results (KT-20). It will be necessary to convert the unit weight (wet density) into a standard dry density which also requires the percent of moisture (KT-11 d.) to be known. Use Equation 1 to determine the standard dry density.

$$\text{Equation 1:} \quad \text{Standard Dry Density} = \frac{\text{Wet Density}}{(1 + [\% \text{Moisture} / 100])}$$

Determine the density of the CTB within 1 day of the compaction operations. The Engineer may verify the Contractor's density test results by conducting density tests at random. If the comparison is not favorable, the DME will investigate to determine the cause and may suspend production until corrective action is taken.

e. Trimming and Finishing the CTB. Trim and recompact the CTB within 2½ hours of the time the water and cementing agent is added to the aggregate.

Trim and compact the CTB to the grades, lines and typical cross sections shown in the Contract Documents. Dress the edge slopes and joints between sections.

Use automatic grade control equipment to trim the surface of the CTB to line grade and cross section.

Keep the surface of the CTB moist during all finishing operations.

Perform the finishing and compacting operations to produce a smooth, dense surface, free of surface compaction planes, cracks, ridges or loose material.

If required, lightly scarify the surface of the CTB to loosen any imprints left by the trimming and compacting equipment. Recompact the surface of the CTB.

At the end of each day's operations, construct a straight transverse construction joint by cutting back into the completed work to form a vertical face. Place a protective covering of earth on the newly constructed CTB a distance back of the joint for turning of equipment used on the following day's work.

Upon satisfactory performance the Engineer may approve the use of equipment that combines the placing, compacting and finishing operations.

f. Protection and Curing. Keep the surface of the CTB moist until the curing material is applied. Apply the curing material immediately after completing the trimming and finishing. Protect the CTB against the loss of moisture for a curing period of 7 days (unless the Contractor's mix design test results justify a different curing period). Protect the CTB against freezing during the curing period.

Apply a wax-based liquid membrane-forming compound for the curing material. The minimum application rate for wax-based liquid membrane-forming compound is 0.12 gallons per square yard. Use an enclosed spray system that minimizes wind influence and obtains the proper application rate. Keep all traffic and construction equipment off the CTB. The only exception is the equipment used to apply the curing material. Cover the surface and edges of the CTB with a complete, uniform coverage. Use a hand sprayer in inaccessible areas.

If the wax-based liquid membrane-forming compound will be in place for more than 30 days, reapply a single coat at the single application rate within 7 days of placing the pavement.

At locations where it is necessary to carry traffic across the CTB, place a layer (8 inches or greater, compacted depth) of stable earth (sand-clay) over the CTB.

The Contractor may place portland cement concrete pavement (PCCP) on the CTB after a minimum of 24 hours, provided all traffic and construction equipment is kept off the CTB.

The Contractor assumes the risk of 7-day compressive strength requirements when PCCP is placed early.

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To promote cracking through the full depth of the base, score or cut the finished CTB surface to coincide with the pavement joint locations, in a parallel manner and within 1 foot:

- if the 7-day compressive strength exceeds 1600 psi. (Note: This does not apply if the CTB has developed cracks at regular intervals prior to placing the PCCP.)
- if the Contractor opts to place the PCCP over the CTB before the 7-day compressive strength is determined. The Engineer may waive this requirement when the Contractor's control charts for CTB shows a history that the 7-day compressive strength is below 1600 psi.

g. Compressive Strength Determination. Using random numbers, select and obtain sampled material at the plant. Make and cure compression test specimens to represent each subplot. Determine the 7-day compressive strength of the CTB according to **DIVISION 2500**. When additional test specimens are taken for early determination of the compressive strength, the specimens are for information only. Perform the 7-day compressive strength testing. Maintain records of all sampling and testing. The Engineer will witness all compressive strength tests and initial the Contractor's documentation.

A percent within limits (**PWL**) analysis shall be made on a lot-by-lot basis and shall be based on Contractor quality control test results on all quality control samples representing the lot of the completed CTB. The **PWL** result shall be determined as specified under Computation of Pay Factor. The pay adjustment shall be computed as shown in Equation 2. It shall be based on the compressive strength values within each lot and the lower specification limits (**LSL**).

KDOT will use a spreadsheet program to calculate pay adjustments for compressive strength and to compare the Contractor's QC and KDOT's verification test results. If the comparison fails, KDOT's value will be used to calculate the pay adjustment for that lot. The lot comparison is based on KDOT's verification result falling within the Contractor's mean, plus or minus 2 times the Contractor's sample standard deviation. When the Contractor's sample standard deviation is less than 145 psi, then 145 psi shall be used for the sample standard deviation. When requested, KDOT will provide a copy of this program to the Contractor. It is the Contractor's responsibility to obtain the Microsoft Excel software required to run this program.

Values computed using equations referenced in this specification may vary slightly from the spreadsheet values due to the rounding of numbers. In such cases, the numbers computed by the spreadsheet shall take precedence.

A typical lot is defined as a normal day's placement. At the beginning of the project, estimate the quantity to be placed during a normal day and submit to the Engineer for approval. Once approved, break the quantity into 4 equal parts (each part represents a subplot). Determine a random location for sampling within each subplot. When the total quantity for the day deviates from expectations, adjust the number of sublots based on **TABLE 306-1**.

| TABLE 306-1: SUBLOT BREAKDOWN OF A NORMAL DAY'S PRODUCTION | |
|--|---------------------|
| Number of Sublots | % of Daily Quantity |
| 4 | 75-115 |
| 3 | 50-74 |
| 2 | 25-49 |
| 1 | 1-24 |

Adjust the quantity of the last subplot to accommodate any minor changes in production, and adjust the random location for sampling based on the size of the subplot. When there is only 1 or 2 tests in a lot, combine the tests with the next lot to create a 5 or 6 test lot. When there are 3 or 4 tests, the lot stands on its own. When the quantity exceeds 115% of the normal daily quantity, increase the number of sublots and restrict the 4th subplot to a maximum of 100% of the established normal daily quantity. Each subplot added may have a maximum of 25% of the normal daily quantity.

The sample standard deviation shall be computed as shown in Section 5.17.09, Part V.

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Calculate the Compressive Strength Quality Indices (Q_L) for each lot as shown in Section 5.17.09, Part V. Use the following definitions, and round to the nearest hundredth.

Where: \bar{X} is the average measured compressive strength of all QC samples representing a lot, rounded to 1.0 psi.

LSL is the lower specification limit for compressive strength and is defined as 650 psi.

S is the sample standard deviation of the compressive strength of all QC samples representing a lot, rounded to 0.1 psi.

Determination of the percent within limits (PWL) values. Use the computed Q value to determine the compressive strength percent within limits value (PWL_C) by locating the Q_L values in the left column of the PWL Table 5.17.09-2 in Section 5.17.09, Part V. Select the appropriate PWL_C by moving across the selected Q_L to the column representing the number of samples in the lot.

When the computed Q_L is a negative value (\bar{X} lies below the LSL), the Engineer will determine if the material in the lot may remain in place. If the material is left in place, and there were no individual plugs found to be less than 600 psi, then 50.00 is assigned as the PWL value. For results exceeding these limits and permitted to remain in place, use the calculated PWL value.

When the computed Q_L is greater than the largest Q_L value shown in the table, a value of 100.00 is assigned as the PWL value for the designated PWL_C .

Computation of Pay Factor. Compute the pay factor for compressive strength using Equation 2 and round to nearest thousandth (0.001). Multiply the pay factor times the square yards, times \$5.00 per square yard to determine the pay adjustment.

$$\text{Equation 2: } P = \frac{(PWL_C \times 0.15)}{100} - 0.135$$

Compressive Strength Pay Factor (Failing Comparison Test). When the comparison between Contractor and KDOT tests fails, KDOT test results shall be used to calculate the compressive strength pay factor for the lot. Follow the procedures as stated above to determine the pay factor or disposition of the lot. Use the following values to determine Q_L : The value of \bar{X} shall be KDOT's test result for the lot, the value of S shall be 145 psi, the value of LSL shall be 650 psi. When selecting the PWL_C value from the PWL Table in 5.17.09 the value of n shall be 4.

h. Weather Limitations. Do not place material if the CTB will be exposed to ambient air temperatures below 32°F during the first 7 days of cure. (See subsection 306.4b., c. and f.). Remove and replace all CTB that is permitted to freeze within the first 24 hours, whether frozen on the surface or full depth. When materials are exposed to freezing ambient air temperatures after the first 24 hours but before the 7 cure period is complete, the Contractor shall demonstrate that the 7 day design strength has been achieved. Failure to demonstrate the 7 day design strength has been achieved shall require removal and replacement at Contractor's expense.

As directed by the Engineer and at the Contractor's expense, repair or replace cured materials exposed to ambient air temperatures below freezing or repeated freeze/thaw cycles that result in loosening or fluffing of the surface.

A lift of pavement placed prior to exposure to freezing ambient air temperatures constitutes curing of the CTB.

Do not place material on frozen subgrade. Mixing and placing may proceed when the ambient air temperature is 40°F and rising, and discontinue when the ambient air temperatures reaches 45°F and falling.

306.5 MEASUREMENT AND PAYMENT

The Engineer will measure the CTB and quality control testing of CTB by the square yard. Material placed beyond the neat lines indicated in the Contract Documents is not measured for payment unless authorized by the Engineer.

Payment for "Cement Treated Base" and "Quality Control Testing (CTB)" at the contract unit prices is full compensation for the specified work.

No adjustment of the contract unit price for "Quality Control Testing (CTB)" is made for overruns or underruns in the contract quantity.