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DIVISION 300
STABILIZED SUBGRADE, BASE AND SHOULDERS

SECTION 301

SUBGRADE MODIFICATION

301.1 DESCRIPTION

Modify the subgrade using the materials and methods shown in the Contract Documents.

When the Contract Documents specify, realign the shoulders and clean and reshape the ditches.

BID ITEMS	UNITS
Manipulation for Aggregate Subgrade Modification (*)(**)	Square Yard
Manipulation for In-Place Material Subgrade Modification (**)	Square Yard
Aggregate for Subgrade Modification (*)	Cubic Yard
Calcium Chloride	Ton
Cement	Ton
Fly Ash	Ton
Water (Subgrade Modification) (Set Price)	M Gallon

* Type, typically Rock, Silt or Millings

**Calcium Chloride, Cement or Fly Ash

301.2 MATERIALS

Provide materials that comply with the applicable requirements.

Aggregate for Subgrade Modification…. **DIVISION 1100**
Emulsified Asphalt (SS-1H or CSS-1H) **DIVISION 1200**
Medium Cure Cutback Asphalt (MC-250) **DIVISION 1200**
Calcium Chloride **DIVISION 1700**
Portland Cement / Blended Hydraulic Cement **DIVISION 2000**
Fly Ash **DIVISION 2000**
Water for Subgrade Modification **DIVISION 2400**
Admixtures / Retarders **DIVISION 1400**

Provide silt for subgrade modification that complies with **TABLE 301-1**.

TABLE 301-1: SILT FOR SUBGRADE MODIFICATION

% Retained - Square Mesh Sieve		P.I. (maximum)
No. 4	No. 200	
0-5	0-50	12

In-place material may be existing rock surfacing or milled pavement. When pavement millings are provided, the maximum size shall be 1½ inches.

301.3 CONSTRUCTION REQUIREMENTS

a. Aggregate Subgrade Modification.

(1) General. Perform subgrade modification to the depth shown in the Contract Documents. Spread, mix and compact the materials as specified in the Contract Documents. Do not perform subgrade modification on frozen subgrade. Do not incorporate calcium chloride, cement or fly ash if air temperatures are expected below 32ºF during the first 24 hours after compaction.

(2) Subgrade preparation. Scarify the existing roadbed to the depth and width shown in the Contract Documents to provide the binder material. When the Contract Documents specify, provide binder material from the shoulder slopes, ditches and back slopes.

(3) Aggregate. Pulverize and mix the specified binder material and aggregate for subgrade modification until no more than 5% of the material is retained on a 2-inch sieve.

If silt is the specified aggregate, a maximum of 20% by weight, minus No. 200 sieve material, is allowed in the combined mixture.

(4) Calcium Chloride, Cement or Fly Ash (additive) Modified Subgrade. Before incorporating the additive in the subgrade, blade the roadway to allow uniform distribution of the additive. On projects having more than 20,000 square yards of manipulation, use equipment with a recycling or mixing drum and with an automatic water proportioning system to incorporate the additive and water into the subgrade to the specified depth. This system may be pressurized or mechanical in nature, utilizing vane or augers feeding cement or fly ash through a funnel or hood at a controlled rate.

On projects having less than 20,000 square yards of manipulation, and in irregular areas, submit a plan to the Engineer for approval that includes equipment and procedures that address subgrade preparation and application process to spread the cement or fly ash at the specified rate.

On projects having more than 20,000 square yards of manipulation, and consisting of multi-phased construction, contact the District Office for approval to waive the use of the controlled application system. Consideration will be based on the Contractor's proposed alternate method of applying the cement or fly ash, the square yards of manipulation in each phase, and the size of individual areas within each phase.

The Engineer will conduct laboratory tests on site materials and the specified additive content to establish the optimum moisture content.

Distribute the additive in a manner that minimizes loss of the material. Do not apply the additive if conditions are such that the material is lost due to the wind or rain. Do not use an additive that was not properly handled and stored in weatherproof containers. When specified, apply a uniform coverage of a retarder to the additive, immediately following the spreading of the additive. If the moisture content of the pulverized subgrade will accommodate additional moisture, the retarder may be diluted with water to obtain a uniform application.

Mix the subgrade, additive and water. Continue mixing until a homogeneous, friable mixture that complies with **TABLE 301-2** is obtained.

TABLE 301-2: CALCIUM CHLORIDE, CEMENT OR FLY ASH MODIFIED SUBGRADE	
% Retained - Square Mesh Sieves	
1 ½-inch	**½-inch**
0	50, maximum

Complete the mixing within 30 minutes of adding the water to the additive and the subgrade.

The uniform moisture content of the mixture immediately before being compacted shall be within ±3% of the optimum moisture content. If the moisture content of the mixture exceeds the optimum moisture content, add additional cement or fly ash to lower the moisture content. Distribute the mixture as needed to maintain the optimum moisture content during the compaction operations.

(5) Compaction. Use a vibratory roller having a minimum operating weight of 12 tons, with a minimum centrifugal force of 24 tons for the initial compaction of the mixture. Use a rubber-tired or smooth-wheeled roller to complete the compaction of the surface. Compact the modified subgrade to a minimum of 95% of the combined materials dry density, as determined in Part V. The compacted subgrade shall have uniform density and remain stable under construction traffic. Complete the compaction operations within 2 hours of incorporating the additive into the subgrade. If any of these requirements are not satisfied, reprocess, recompact and refinish the deficient areas.

(6) Trimming. After compacting the modified subgrade, trim the surface to the specified lines and grades. On projects having more than 20,000 square yards of manipulation, use automatic grade controlled equipment to trim the compacted modified subgrade. In irregular areas, trim the subgrade by wetting, blading and rolling. Compact the trimmed surface of the modified subgrade with a smooth-wheel or a pneumatic-tire roller. If necessary during the final rolling, lightly scarify and blade the surface to eliminate equipment imprints.

(a) Option 1 for Cement or Fly Ash Treated Subgrade. After compaction is complete, trim and recompact the subgrade within 2 ½ hours of the time the water and cementing agent is added to the subgrade. Compact the trimmed surface of the treated subgrade with a smooth-wheel or a pneumatic-tire roller. Lightly scarify and blade the surface to eliminate equipment imprints while performing final rolling.

(b) Option 2 for Cement or Fly Ash Treated Subgrade. After compaction is complete, trim the treated subgrade after 2 ½ hours of the time the water and cementing agent is added to the subgrade. Compact the trimmed surface of the treated subgrade with a smooth-wheel or a pneumatic-tire roller. Remove loose trimmed material from any low spots and fill with the next course of material at the Contractor's expense.

Clean and dress the shoulders and shoulder slopes. Remove all excess material and debris.

(7) Curing and Protection. Protect the finished subgrade against drying for 7 days after completion, or until the subgrade is covered with base or surfacing if covered before 7 days. Protect the finished subgrade from drying by spraying with water to maintain a continuous moist condition. The Contractor may apply an asphalt prime coat instead of keeping the finished surface moist with water during the curing period. If this option is chosen, apply SS-1H, CSS-1H or MC-250 at the rate of 0.22 gallons per square yard to achieve a minimum of 0.13 gallons per square yard residue. Multiple light applications may be necessary to obtain the specified rate of application without runoff.

b. In-Place Material Subgrade Modification. Pulverize or process the in-place material as specified in the Contract Documents.

Construct the subgrade modified with in-place materials according to **subsection 301.3a.**, using the specified in-place material for the aggregate.

c. Construction Traffic. Avoid placing construction loads or operating equipment until the treated subgrade has cured and can withstand the loads without damaging the subgrade. If the subgrade deforms under the construction loads and cannot return back to its original condition, or if it deflects more than 1 inch, allow the subgrade additional curing time before operating equipment on the subgrade. Repair any damaged subgrade.

d. Succeeding Course. Cover the finished treated subgrade with the specified lift of HMA or aggregate base before it is subjected to freezing. If the finished treated subgrade is not covered with a lift of HMA or aggregate base and is subjected to freezing, the Engineer will determine when the subgrade needs to be reworked. KDOT will not pay for the replacement and refinishing of the treated subgrade if the material loses the required stability, density or finish before the next course is placed.

301.4 MEASUREMENT AND PAYMENT

The Engineer will measure aggregate for subgrade modification and silt for subgrade modification by the cubic yard by vehicle measurement at the place of unloading. If weight is converted to cubic yards for payment, the moisture in the aggregate is not measured for payment.

The Engineer will measure water used for modified subgrade by the M Gallon using calibrated tanks or water meters. The Engineer will measure water used for subgrade preparation and mixing, compacting and curing the modified subgrade. The Engineer will not measure water used for dust control, water wasted through the Contractor's negligence or water in excess of the quantity required for mixing and compacting the modified subgrade.

If the Contractor opts to use asphalt material to cure the modified subgrade, the Engineer will not measure the asphalt material for payment.

The Engineer will measure calcium chloride, cement and fly ash by the ton. The Engineer will not measure additional cement or fly ash added to the mixture to reduce moisture content.

The Engineer will measure the various types of subgrade manipulation by the square yard.

Payment for "Manipulation for Aggregate Subgrade Modification", "Manipulation for In-Place Material Subgrade Modification", "Aggregate for Subgrade Modification", "Calcium Chloride", "Cement" and "Fly Ash" at the contract unit prices and "Water (Subgrade Modification) (Set Price)" at the contract set unit price is full compensation for the specified work.

SECTION 302

LIME TREATED SUBGRADE

302.1 DESCRIPTION

Mix soil, lime and water either in-place or off-site in a borrow area. Use the mixed materials to construct a uniform lime treated subgrade as shown in the Contract Documents.

BID ITEMS	**UNITS**
Lime	Ton
Manipulation (Lime Treated Subgrade)	Square Yard
Water (Lime Treated Subgrade) (Set Price)	M Gallon

302.2 MATERIALS

Provide materials that comply with the applicable requirements.

Emulsified Asphalt (SS-1 or CSS-1) ..... **DIVISION 1200**
Medium Cure Cutback Asphalt (MC-250) ..... **DIVISION 1200**
Liquid Membrane Forming Compounds ..... **DIVISION 1400**
Lime ..... **DIVISION 2000**
Water for Lime Treated Subgrade ..... **DIVISION 2400**

302.3 CONSTRUCTION REQUIREMENTS

a. Preparation and Maintenance of the Subgrade or Off-Site Borrow Area. Before the application of the lime treatment, use automatic grade controlled equipment to trim the surface of the subgrade or borrow area to the specified lines and grades. In irregular areas, trim the subgrade or borrow area by wetting, blading and rolling. Trim borrow areas to the profile established by the Contractor. Uniformly compact the trimmed subgrade or borrow area.

Maintain the subgrade or borrow area as prepared. Provide proper drainage at all times. Correct defects that develop in the subgrade or borrow area.

b. Application of Lime. When the lime is not applied through a mixing chamber to the prepared in-place subgrade or off-site borrow area, scarify the prepared area to a minimum depth of 4 inches and a maximum depth of approximately 1 inch less than the specified depth of lime treatment. The specified depth of lime treatment for in-place areas is designated in the Contract Documents. The Contractor shall determine the depth of lime treatment for off-site areas.

The application rate of lime is based on the weight of soil being treated and is shown in the Contract Documents. If the application rate is not shown in the Contract Documents, assume a rate of 5% of the weight of soil.

Perform the scarification with positive depth control equipment. Do not use a plow or disc for the scarification. The Engineer may approve the use of a positive depth controlled motor grader scarifier on a performance basis.

When pebble quicklime is used, slake it at the jobsite to manufacture hydrated lime slurry, according to **DIVISION 2000** and the following.

Determine the amount of water needed to make slurry from dry quick lime using the following:

$$W_W = ((A+B)/P_S)-W_{QL}$$

Where:

A = (Quicklime Delivered) * (% purity in decimal form) * 1.32 = $W_{QL} * P_{CaO} * 1.32$
B = (Quicklime Delivered) * (% inert material) * 1.0 = $W_{QL} * P_I$
A + B = Total Hydrated Lime Produced (Pay Quantity)
W_W = Weight of Water Required for Slurry of Given Percent Solids, tons
W_{QL} = Quicklime Weight, tons
P_{CaO} = Percent of CaO in the Quicklime, purity (as a decimal)
P_I = Percent of Inert Material in the Quicklime (as a decimal)

P_S = Percent Solids in the Lime Slurry (as a decimal)
Gallons of Water = W_W * 2000/8.34

Use a percent solids between 20 and 40%. Determine the concentration strength of the hydrated lime slurry and rate of application to obtain the percent of lime specified in the Contract Documents and advise the Engineer accordingly. See **TABLE 302-1**.

Apply hydrated lime to the scarified areas as slurry. Use equipment that can apply lime slurry through a system of spray bars and nozzles. Regulate the amount of lime slurry from each nozzle and the speed of the delivery vehicle so that the specified amount of lime is placed on the soil. The concentration of the hydrated lime slurry shall allow the application of the correct quantity of lime without adding an undue quantity of excess moisture to the mixture. The application and mixing of the hydrated lime slurry shall result in a uniform lime concentration.

Test the concentration of the lime suspension at the minimum rate of 1 per day or 1 per mixed batch, whichever is greater; use **TABLE 302-1** and a volume measuring device and scale. Use KT-62, Percent Solids of Lime to determine water requirements for slaking for a percent solids. During slaking, check the density of the solution periodically to determine the time required for complete slaking. The minimum amount of time for slaking is 20 minutes.

Apply the hydrated lime slurry the same day it is produced. Continuously agitate the hydrated lime after the batch is made. If the liming operation is interrupted, continue agitating the hydrated lime in storage. If the interruption will be lengthy, the Contractor has the option to cease mixing. In either case, prior to resuming liming operations, the Contractor shall re-test the concentration and adjust the rate of application accordingly. The Engineer will verify the results.

Check the lime application, such as pH testing. Other methods, may be used if approved by the Engineer.

c. Adding Water. Add water, as necessary, to facilitate mixing of the hydrated lime slurry and soil. During the initial mixing operation, add water to obtain a minimum moisture content of 8% above the optimum moisture content of the raw soil being treated.

The Engineer will measure the moisture content (KT-11) immediately after the mixing is completed, and before sealing or compacting.

d. Preliminary Mixing. Mix the lime, soil and water to the dimensions specified in the Contract Documents. For off-site borrow areas, the Contractor shall determine the depth and width. For projects containing more than 20,000 square yards of manipulation, positively control the depth of mixing to maintain the specified depth ± ½ inch. Use equipment with positive depth control that can maintain cutting or mixing heads in a fixed position relative to the wheels or tracks of the machine carrying the head.

Perform a minimum of 2 passes with the mixer traveling in the primary direction. Continue mixing until 95% of the mixture passes the 2-inch sieve as determined by the Engineer (KT-42).

While mixing, do not disturb the roadway or borrow area beyond the specified limits of the lime treatment.

e. Aging. Seal the mixture to prevent moisture loss by lightly rolling with a pneumatic-tired roller. Blade the surface to shed water.

(1) Material Mixed In-Place. Maintain the mixture in the sealed condition for a minimum of 24 hours prior to commencing final mixing.

(2) Material Mixed in a Borrow Area. Maintain the mixture in the sealed condition a minimum of 24 hours or until the mixture is ready to be used.

In both (1) and (2) above keep the surface moist by spraying with water. If the final mixing is not performed within 14 days of the preliminary mixing, add 1% lime by weight of raw soil, in the final mixing operation. If the Contractor knows the final mixing will not be performed within 14 days, the Contractor may reduce the rate of lime applied in the initial application by 1%, and add the 1% in the final mixing.

f. Final Mixing. After the initial mixing and aging (24 hours) is completed, re-mix the mixture to the specified depth (± ½ inch) and width, until 95% of the mixture passes the 1½-inch sieve and 40% passes the No. 4 sieve as determined by the Engineer (KT-42). Periodic mixing over an interval of time is allowed to facilitate the breakdown in particle size. Bring the mixture to the moisture content required for compaction with a minimum of 3% above optimum of the proctor density of the lime treated soil.

While mixing, do not disturb the roadway or borrow area beyond the specified limits of the lime treatment.

g. Compaction of the Mixture. When the material is mixed in-place, compact the material after completing the required final mixing.

When the material is mixed off-site, excavate and haul the material to the project site. Place the material on the prepared and trimmed surface, and compact the material.

Compact the mixture to Type B compaction, MR-3-3 moisture control, **SECTION 205**. Blade the mixture to eliminate surface irregularities during the compaction operations. Maintain the moisture content to a minimum of 3% above optimum of the proctor density of the lime treated soil.

h. Finishing and Curing the Lime Treated Subgrade. After the mixture is compacted, use automatic grade controlled equipment to trim the lime treated subgrade to the specified lines and grades. In irregular areas, trim the lime treated subgrade by wetting, blading and rolling. Compact the trimmed surface with a smooth-wheel or a pneumatic-tire roller.

After the compacted mixture is finished, cure the lime treated subgrade for 7 days, by keeping the finished surface moist with water. Do not allow vehicles or equipment (other than watering equipment) on the finished lime treated subgrade during the curing period.

At the Contractor's option, apply an asphalt prime coat instead of keeping the finished surface moist with water. If asphalt prime coat is used, apply SS-1, CSS-1 or MC-250 at the rate of 0.22 gallons per square yard to achieve a minimum of 0.13 gallons per square yard residue. The use of a liquid membrane forming compound is also an acceptable curing medium. Multiple light applications may be necessary to obtain the specified rate of application without run-off.

When a base course or subbase is to be constructed upon the lime treated subgrade, the Engineer may reduce the curing period to when the lime treated subgrade gains sufficient strength to support the construction and hauling equipment. Repair any damage to the lime treated subgrade due to construction of the base course or subbase.

i. Seasonal Limitations. Do not perform lime treatment operations if the ambient air temperature is below 40°F, or the soil is frozen.

(1) Projects with Rigid Pavement. Cover the finished lime treated subgrade with base or pavement before it is subjected to freezing. If the lime treated subgrade is not covered by base or pavement and is subjected to freezing, re-compact the lime treated subgrade before placing any pavement. The Engineer will determine the extent of the re-compaction.

(2) Projects with Flexible Pavement. Cover the finished lime treated subgrade with the specified lift of HMA or aggregate base before it is subjected to freezing. If lime treated subgrade is not covered with a lift of HMA or aggregate base and is subjected to freezing, add additional lime and re-compact the lime treated subgrade before placing any pavement. The Engineer will determine (by laboratory or field tests) the additional quantity of lime to add, if any, and the extent of the re-compaction.

302.4 MEASUREMENT AND PAYMENT

The Engineer will measure lime by the ton. If bagged lime is used, the Engineer will use the net weight marked on the bag by the manufacturer for the measurement. If certified railroad car or certified truck quantities are used, the Engineer will use the net weight of the lime for the measurement.

Using the relationship for Pure Quicklime (CaO) x 1.32 = Hydrated Lime ($Ca(OH)_2$), determine the basis of pay for jobsite slaked hydrated lime (A+B) according to **subsection 302.3b.** using the certified lime purity for each load.

Calculate the pay quantity for carbide lime as follows:

Pay Quantity = (Weight of material delivered) (% solids)

The percent moisture will not be credited toward water for pay.

The Engineer will measure the manipulation of the lime treated subgrade by the square yard. Material placed beyond the neat lines indicated in the Contract Documents is not measured for payment without approval by the Engineer.

The Engineer will measure water used for lime treated subgrade by the M Gallon using calibrated tanks or water meters. The Engineer will measure water used for subgrade preparation, mixing subgrade and lime, compacting and curing the lime treated subgrade. The Engineer will not measure water used for slaking the lime,

dust control, water wasted through the Contractor's negligence or water in excess of the quantity required for mixing and compacting the lime treated subgrade.

If the Contractor opts to use asphalt prime coat or liquid membrane forming compound to cure the lime treated subgrade, the Engineer will not measure the asphalt prime coat for payment or liquid membrane forming compound.

The Engineer will not measure for payment, the lime, manipulation or water used for adding additional lime or re-compaction if:

- The off-site borrow area mixture is not used with 14 days of the preliminary mixing.
- The lime treated subgrade is not covered with pavement before it is exposed to freezing temperatures.

Payment for "Lime" and "Manipulation (Lime Treated Subgrade)" at the contract unit prices and "Water (Lime Treated Subgrade) (Set Price)" at the contract set unit price is full compensation for the specified work.

TABLE 302-1: STRENGTH OF HYDRATED LIME SLURRY	
Lb. per gal. of suspension	**Lb. Ca $(OH)_2$ per gallon, suspension**
8.41	.135
8.50	.272
8.58	.412
8.66	.546
8.75	.691
8.83	.830
8.91	.962
8.99	1.106
9.08	1.244
9.16	1.392
9.25	1.517
9.33	1.679
9.41	1.816
9.50	1.948
9.58	2.09
9.66	2.23
9.75	2.38
9.85	2.52
9.91	2.68
10.00	2.80
10.08	2.94
10.16	3.09
10.24	3.24
10.33	3.39
10.41	3.52
10.49	3.71
10.58	3.86
10.66	4.00
10.74	4.15
10.83	4.29
10.91	4.45
11.00	4.60
11.08	4.73
11.16	4.90
11.25	5.04
11.33	5.18
11.41	5.32
11.50	5.49
11.58	5.62
11.66	5.78
11.75	5.95
11.83	6.09
11.91	6.22
12.00	6.37
12.08	6.51

SECTION 303

CEMENT OR FLY ASH TREATED SUBGRADE

303.1 DESCRIPTION

Mix subgrade soil, cement or fly ash and water to construct a uniform treated subgrade as shown in the Contract Documents.

BID ITEMS	UNITS
Cement	Ton
Fly Ash	Ton
Manipulation for Treated Subgrade (*)	Square Yard
Water (Treated Subgrade) (Set Price)	M Gallon

*Cement or Fly Ash

303.2 MATERIALS

Provide materials that comply with the applicable requirements.

Emulsified Asphalt (SS-1 or CSS-1) ..... **DIVISION 1200**
Medium Cure Cutback Asphalt (MC-250) ..... **DIVISION 1200**
Concrete Admixtures & Curing Materials ..... **DIVISION 1400**
Portland Cement & Blended Hydraulic Cement ..... **DIVISION 2000**
Fly Ash ..... **DIVISION 2000**
Water for Treated Subgrade ..... **DIVISION 2400**

303.3 CONSTRUCTION REQUIREMENTS

a. Subgrade Preparation. Prepare the subgrade to the lines and grades shown in the Contract Documents.

Scarify the prepared subgrade to the depth of treatment designated in the Contract Document prior to applying the cement or fly-ash. Perform the scarification with positive depth control equipment. Do not use a plow or disc for the scarification. Based on performance, the Engineer may approve the use of an automatic grade control motor grader scarifier. Bring the scarified subgrade to within the specified moisture content of the previous moisture range before adding cement or fly ash.

b. Application. On projects having more than 20,000 square yards of manipulation, apply cement or fly ash using a controlled application system. This system may be pressurized or mechanical in nature, utilizing vane or augers feeding cement or fly ash through a funnel or hood at a controlled rate.

On projects having less than 20,000 square yards of manipulation, and in irregular areas, submit a plan to the Engineer for approval that includes equipment and procedures that address subgrade preparation and application process to spread the cement or fly ash at the specified rate.

On projects having more than 20,000 square yards of manipulation, and consisting of multi-phased construction, contact the District Office for approval to waive the use of the controlled application system. Consideration will be based on the Contractors proposed alternate method of applying the cement or fly ash, the square yards of manipulation in each phase, and the size of individual areas within each phase.

Do not apply the cement or fly ash when conditions are such that the material is lost due to the wind. Do not use cement or fly ash that was not properly handled and not stored in weatherproof containers.

The Engineer will check the application rate of cement or fly ash by having the Contractor blade a flat area in the path of the cement or fly ash application, place a planar surface with a minimum surface area of 1 square foot (e.g. a straight-sided pan) and of sufficient height to contain the admixture on the prepared area and allow the train to pass over the surface. Weigh the test surface before and after the cement or fly ash application and calculate the application rate. Other methods to check the application rate may be used.

c. Mixing. Mix the scarified subgrade and cement or fly ash. Continue mixing and adding water until a homogeneous, friable mixture that complies with **TABLE 303-1** is obtained. Use equipment with a recycling or mixing drum, and with an automatic water proportioning system to pulverize the subgrade to the specified depth.

Do not perform treated subgrade operations when the ambient air temperature is below 40°F, or the soil is frozen.

TABLE 303-1: PERCENT RETAINED - SQUARE MESH SIEVES*	
1½-inch	**½-inch**
0	50 maximum

*The Engineer will determine the percent retained on the specified sieves according to KT-42.

Complete the mixing within 30 minutes of adding the cement or fly ash to the pulverized subgrade.

The uniform moisture content of the mixture immediately before being compacted shall be ±3 percentage points of the optimum moisture content. If the moisture content of the mixture exceeds the specified moisture content, add additional cement or fly ash to lower the moisture content. Spray the mixture with water, as necessary, to maintain the specified moisture content during the compaction operations.

d. Compaction. For the initial compaction of the mixture, use a vibratory roller having a minimum operating weight of 12 tons, with a minimum centrifugal force of 24 tons. Use a rubber-tired or smooth-wheeled roller to complete the compaction of the surface. When the thickness is greater than 6 inches, compact multiple lifts of equal thickness with a maximum lift thickness of 6 inches. Compact the treated subgrade to a minimum of 95% of the combined materials dry density. Complete the compaction operations within 2 hours of incorporating the cement or fly ash into the subgrade. If any of these requirements are not satisfied, reprocess, recompact and refinish the deficient areas.

e. Trimming. After compaction of the treated subgrade, trim and recompact the treated subgrade to the specified lines and grades. On projects having more than 20,000 square yards of manipulation, use automatic grade controlled equipment to trim the subgrade. In irregular areas, trim the subgrade by wetting, blading and rolling.

(1) Option 1. After compaction is complete, trim and recompact the subgrade within 2 ½ hours of the time the water and cementing agent is added to the subgrade. Recompact the trimmed surface of the treated subgrade with a smooth-wheel or a pneumatic-tire roller. Lightly scarify and blade the surface to eliminate equipment imprints while performing final rolling.

(2) Option 2. After compaction is complete, trim the treated subgrade after 2 ½ hours of the time the water and cementing agent is added to the subgrade. After curing according to **subsection 303.3f.**, recompact the trimmed surface of the treated subgrade with a smooth-wheel or a pneumatic-tire roller. Remove loose trimmed material from any low spots and fill with the next course of material at the Contractor's expense.

f. Curing. Protect the finished subgrade against drying for 7 days after completion (Option 1-after compaction, Option 2-after trimming), or until the subgrade is covered with a base or surfacing if covered before 7 days. Protect the finished subgrade from drying by spraying with water to maintain a continuous moist condition. The Contractor may apply an asphalt prime coat instead of keeping the finished surface moist with water during the curing period. If this option is chosen, apply SS-1, CSS-1 or MC-250 at the rate of 0.22 gallons per square yard to achieve a minimum of 0.13 gallons per square yard residue. Multiple light applications may be necessary to obtain the specified rate of application without runoff.

g. Construction Traffic. Avoid placing construction loads or operating equipment until the treated subgrade has cured and can withstand the loads without damaging the subgrade. If the subgrade deforms under the construction loads and cannot return back to its original condition, or if it deflects more than 1 inch, allow the subgrade additional curing time before operating equipment on the subgrade. Repair any damaged subgrade.

h. Succeeding Course. Cover the finished treated subgrade with the specified lift of HMA or aggregate base before it is subjected to freezing. If the finished treated subgrade is not covered with a lift of HMA or aggregate base and is subjected to freezing, the Engineer will determine when the subgrade needs to be reworked. KDOT will not pay for the replacement and refinishing of the treated subgrade if the material loses the required stability, density or finish before the next course is placed.

303.4 MEASUREMENT AND PAYMENT

The Engineer will measure cement or fly ash used in the mixture by the ton. The Engineer will not measure additional cement or fly ash added to the mixture to reduce the moisture content.

The Engineer will measure the manipulation for treated subgrade by the square yard.

The Engineer will measure water used for cement treated subgrade by the M Gallon using calibrated tanks or water meters. The Engineer will measure water used for preparation of the subgrade, mixing subgrade and cement or fly ash, and the 7-day protection from drying period. The Engineer will not measure water used for dust control, water wasted through the Contractor's negligence or water in excess of the quantity required for mixing and compacting the cement subgrade.

If the Contractor opts to use asphalt material to cure the treated subgrade, the Engineer will not measure the asphalt material for payment.

Payment for "Cement", "Fly Ash" and "Manipulation for Treated Subgrade" at the contract unit prices and "Water (Treated Subgrade) (Set Price)" at the contract set unit price is full compensation for the specified work.

SECTION 304

CRUSHED STONE SUBGRADE

304.1 DESCRIPTION

Construct a uniform crushed stone subgrade as backfill in cut sections or as topping of fill sections as shown in the Contract Documents.

BID ITEMS	**UNITS**
Crushed Stone Subgrade (*)	Square Yard
Water (Crushed Stone Subgrade) (Set Price)	M Gallon

*Thickness

304.2 MATERIALS

Provide materials that comply with the applicable requirements.

Aggregates for Backfill ..... **DIVISION 1100**
Water for Crushed Stone Subgrade ..... **DIVISION 2400**

304.3 CONSTRUCTION REQUIREMENTS

Prepare the cut or fill section for the crushed stone subgrade by scarifying, watering, blading and compacting to the specified lines and grades. Do not place crushed stone subgrade on frozen subgrade.

The Engineer will obtain a sample of the crushed stone for backfill from materials stockpiled at the project site, and submit to MRC where the relative density will be determined using KT-69. Allow 48 hours for testing by the MRC.

Uniformly mix the crushed stone with a sufficient quantity of water to provide satisfactory compaction. The mixing methods are:

- Central Plant Method. Use a stationary mechanical mixing plant to mix the water and aggregate.
- Road Mix Method. After the aggregate is placed in a uniform windrow, use a motor grader, or other equipment approved by the Engineer, to mix the water and the aggregate.

Spread and compact the crushed stone subgrade as specified in the Contract Documents. If the thickness is greater than 6 inches, spread and compact the crushed stone subgrade in multiple lifts of equal thickness with a maximum lift thickness of 6 inches. Compact the crushed stone subgrade to a uniform density, a minimum of 70% of the relative density. The Engineer will verify the relative density using a nuclear gauge (KT-41).

If during production, the gradation changes ±10% from the single point designation on any single sieve, cease spreading and compaction operations. The Engineer will obtain a new sample for relative density, submit sample to the MRC and a new relative density value will be established.

304.4 MEASUREMENT AND PAYMENT

The Engineer will measure crushed stone subgrade by the square yard.

The Engineer will measure water used for crushed stone subgrade by the M Gallon using calibrated tanks or water meters. The Engineer will measure water used for subgrade preparation, mixing and compacting the crushed stone subgrade. The Engineer will not measure water used for dust control, water wasted through the Contractor’s negligence or water in excess of the quantity required for mixing and compacting the crushed stone subgrade.

Payment for "Crushed Stone Subgrade" at the contract unit price and "Water (Crushed Stone Subgrade) (Set Price)" at the contract set unit price is full compensation for the specified work.

SECTION 305

AGGREGATE BASE AND AGGREGATE SHOULDERS

305.1 DESCRIPTION

Construct aggregate base and aggregate shoulders on prepared subgrade as shown in the Contract Documents.

BID ITEMS	UNITS
Aggregate Base (*)(**)	Square Yard
Aggregate Shoulder (*)(**)	Square Yard
Calcium Chloride	Ton
Water (Aggregate Base) (Set Price)	M Gallon
Water (Aggregate Shoulders) (Set Price)	M Gallon

*Type of Aggregate
**Thickness

305.2 MATERIALS

Provide materials that comply with the applicable requirements.

Aggregate for Aggregate Base ..... **DIVISION 1100**
Aggregate for Shoulder ..... **DIVISION 1100**
Calcium Chloride ..... **DIVISION 1700**
Water for Aggregate Base and Aggregate Shoulder ..... **DIVISION 2400**

305.3 CONSTRUCTION REQUIREMENTS

a. Subgrade Preparation. Unless other subgrade preparation is included in the Contract Documents, water, scarify, blade and compact the roadway and shoulder subgrade to obtain the lines and grades shown in the Contract Documents. Remove all vegetation before shaping and rolling. Remove and dispose of any excess material. If additional embankment material is needed, obtain the material from locations shown in the Contract Documents or as directed by the Engineer.

Excavate the subgrade as shown in the Contract Documents. If existing pavements or bridges are encountered, excavate the subgrade at all control points to a depth that will allow placement of the required thickness, flush with the existing surface. Use a transition (from normal to special section) of sufficient length to prevent an abrupt or noticeable change in grade. Remove and dispose of the excavated subgrade. Compact the excavated areas to a depth of 6 inches, according to the Contract Documents. When subgrade compaction is not specified in the Contract Documents, compact the excavated areas to a depth of 6 inches, according to Type B, MR-90, **SECTION 205**.

b. Mixing. The mixing methods are:

- Central Plant Method. Use a stationary mechanical mixing plant to uniformly mix the water and aggregate.
- Road Mix Method. After the aggregate is placed in a uniform windrow, use a motor grader, or other equipment approved by the Engineer, to uniformly mix the water and the aggregate.

Mix the aggregate with sufficient water to allow compaction of the mixture to the specified density. If the aggregate is predominantly limestone, use the central plant. Use a central plant or road mix method to mix types of granular aggregate other than limestone, or to mix any type of aggregate if the original contract quantity is less than 15,000 square yards.

When shown in the Contract Documents, mix calcium chloride with the aggregate at the specified rate. Add the calcium chloride (in solution, flakes, pellets or granular) at the same time the water is mixed with the aggregate.

c. Placing, Compacting and Finishing. Immediately after mixing the aggregate and water, use an aggregate spreader to place the mixture full-lane or full-shoulder width. Do not place the mixed material on the prepared subgrade when conditions are such that the hauling and placing will damage the prepared subgrade. Do not dump or mix the aggregate on any paved surface.

The maximum compacted thickness of any layer of aggregate base or shoulder is 6 inches. If the thickness is greater than 6 inches, spread and compact the aggregate base in multiple lifts of equal thickness with a maximum lift thickness of 6 inches. The maximum compacted thickness of any layer may be increased to 8 inches when vibrating compaction equipment or other compaction equipment is approved by the Engineer. On aggregate course projects without shoulders, construct all lifts, regardless of thickness, with an edge slope of 1:1 or flatter. If the aggregate base or shoulder is constructed in more than 1 layer, allow sufficient time for the initial layer to cure to prevent any rutting or surface distortion from equipment being used to place the succeeding layers.

Spread and compact the aggregate base or shoulders as specified in the Contract Documents. Compact the aggregate base to a minimum uniform density of 95% of the standard density. Compact the aggregate shoulders until no further consolidation is gained by additional blading and rolling. The Engineer will visually verify compaction of the aggregate shoulders.

After compacting the aggregate base, trim the surface to the specified lines and grades. On projects having more than 20,000 square yards of aggregate base, use automatic grade controlled equipment to trim the compacted aggregate base. In irregular areas, trim the aggregate base by wetting, blading and rolling. Compact the trimmed surface of the aggregate base with a smooth-wheel or a pneumatic-tire roller. When necessary, lightly scarify and blade the surface to eliminate equipment imprints while performing final rolling.

d. Curing and Maintenance of Aggregate Base. Cure the compacted layer to develop sufficient stability to resist wheel truck rutting before vehicular hauling or heavy equipment is permitted on the base. When Contract Documents call for a PGAB or cutback asphalt prime coat on the aggregate base, cure the compacted layer to maximum moisture content of 60% of optimum moisture content for AB-1, AB-2, & AB-4 and 70% for AB-3, prior to the construction of the Asphalt Prime Coat. The Engineer will perform testing to determine when the cure of the aggregate base is complete. The Engineer may require that the surface of the aggregate base be kept moist during the curing period to prevent loss of surface material.

Do not apply surfacing until the aggregate base is cured. Maintain the base until the surfacing is applied.

e. Shoulders, Entrances and Side Roads. When shoulder construction is not included in the Contract Documents, re-construct, compact and shape the existing shoulder from the top of the completed aggregate base to the shoulder line. Shape the shoulders to provide a uniform shoulder line.

Raise the grade of entrances and side roads to meet the edge of the completed aggregate base. Construct, compact and shape the entrances and side roads full width with shoulders and shoulder radii adjacent to the shoulders of the roadway.

Obtain additional embankment material for shoulders, entrances and side roads from adjacent slopes and ditches. Dispose of excess material from shoulders, entrances and side roads on adjacent backslopes.

305.4 MEASUREMENT AND PAYMENT

The Engineer will measure aggregate base and aggregate shoulder by the square yard.

The Engineer will measure the water used in the mixture and used on the finished surface during the curing period by the M Gallon using calibrated tanks or distributors. The Engineer will not measure water in the mixture in excess of 5% above the optimum moisture. The Engineer will not measure water used for subgrade preparation or construction of earthen shoulders, entrances and side roads. The Engineer will not measure water used for dust control or water wasted through the Contractor’s negligence.

The Engineer will measure Grade 2 calcium chloride (concentrated calcium chloride or equivalent) used in the mixture by the ton. If Grade 1 calcium chloride (regular) is used, 1.2 tons of Grade 1 is the equivalent of 1 ton of Grade 2. The Engineer will not measure the wedges at the pavement edge.

Payment for "Aggregate Base", "Aggregate Shoulders" and "Calcium Chloride" at the contract unit prices and "Water (Aggregate Base) (Set Price)" and "Water (Aggregate Shoulders) (Set Price)" at the contract set unit prices is full compensation for the specified work.

SECTION 306

CEMENT TREATED BASE

Exception: If the PCCP in the contract is <u>not</u> 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 <u>not</u> 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.

BID ITEMS	**UNITS**
Cement Treated Base	Square Yard
Quality Control Testing (CTB)	Square Yard

306.2 CONTRACTOR QUALITY CONTROL REQUIREMENTS

a. General. Provide qualified personnel and sufficient equipment complying with the requirements listed in Part V to conduct quality control testing that complies with Appendix B, Sampling and Testing Frequency Chart for Concrete Construction Items for Quality Control/Quality Assurance Projects.

Allow the Engineer access to the Contractor's laboratory to observe testing procedures, calculations, test documentation and plotting of test results.

Calibrate and correlate the testing equipment with prescribed procedures, and conduct tests in compliance with specified testing procedures as listed in Part V.

Maintain a Quality Manual in the field laboratory showing the calibrations performed on all test equipment and when the next calibration is due for that equipment. As a minimum, follow the calibration/verification interval established in Table 1: Concrete Materials Test Equipment in Section 5.2.7.8-Cement Treated Base: Contractor's Quality Control Plan (CTB), Part V. See also, Part V Section 5.2.7.8.1-Example of a Laboratory Quality Manual for CTB.

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.

b. Quality Control Plan (QCP). At the pre-construction conference, submit to the Engineer for approval by the DME, a QCP as outlined in Section 5.2.7-Contractor's Quality Control Plan, Part V. Follow 5.2.7.8-Cement Treated Base: Contractor's Quality Control Plan in Part V as a general guideline. Keep a printed copy of the approved QCP in the Contractor's laboratory and make available to the Engineer when requested.

The Contractor's laboratory and equipment will be inspected and approved as outlined in Part V, Section 5.2.7-Contractor's Quality Control Plan.

Include a listing of the names and phone numbers of individuals and alternates responsible for quality control administration and inspection. On the Contractor's organizational chart, show the specified lines of authority relating both to mix design and quality control operations during production. Post the organizational chart in the Contractor's test facility.

Provide a quality control organization or private testing firm having personnel certified according to the Policy and Procedures Manual for The Certified Inspection and Testing (CIT) Training Program. The testing for this type of construction will require personnel certified in ACI Concrete Field Testing Technician (CF), Aggregate Field Tester (AGF), Soils Field Tester (SOF) and Nuclear Moisture Density Gauge Tester (NUC) classifications. Only persons certified in the appropriate classifications covering the specific tests required shall perform such testing. Provide a minimum of 1 employee on the project certified in the QC/QA Concrete/Cement Treated Base Specs (QCS) classification.

Only persons certified in the appropriate classifications covering the specific tests required shall perform such testing. At the beginning of the project, provide the Engineer with the list of certified technicians and

alternates, phone numbers and tests/inspection they will be performing. As personnel changes and certifications may expire, continue to provide the Engineer with an accurate list.

Provide an organizational chart showing the specified lines of authority relating to both mix design and quality control operations during production. Identify the company official acting as liaison with KDOT, and the Certified Technician who will direct inspection and testing. Post the chart in the test facility.

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.

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.

c. Required Duties of Certified Technicians. Be available on the project site whenever cement treated base is being produced and being placed on the project site. Perform and utilize quality control tests and other quality control practices to assure that delivered materials and proportioning meet the requirements of the mix designs, including temperature, slump, air content and strength.

Periodically inspect all equipment utilized in transporting, proportioning, mixing, placing, consolidating, finishing and curing to assure it is operating properly and that placement, consolidation, finishing and curing comply with the mix design and other contract requirements.

d. Contractor's Testing Facilities. Describe the testing facility and its accreditation in the QCP.

Locate the testing facility either at the plant site or at the project. Obtain approval of the testing facilities and location from the DME before the commencement of mixture production.

Provide suitable space for the required testing equipment. Also, equip the testing facility with these items for the exclusive use of the testing facility's quality control personnel and the Engineer:

- A telephone with a private line;
- A copying machine; and
- Broadband internet connection (for 1 computer). If the Engineer determines that broadband internet service is not available, provide a fax machine, at no additional cost.

e. Documentation. Include in the QCP procedures, charts and forms to be used to provide the required documentation.

Record and document all test results and calculations. Record all original documentation in a bound field book or other KDOT approved bound record and turn over to KDOT at the end of the project.

At all times, have complete records of all inspections and tests readily available on site for the Engineer. All records documenting the Contractor's quality control inspections and tests become the property of KDOT upon completion of the work.

Indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and the corrective action taken in the records. Examples of quality control forms and charts are available in Part V, or Contractors may design their own. Documentation procedures are subject to approval by the Engineer before the start of the work and to compliance checks during the progress of the work.

Maintain control charts on an ongoing basis. Plot data according to **SECTION 106**.

Record all test results and calculations on electronic data sheets. Record specific test results on a Daily Quality 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 Summary Sheet.

Provide forms on a computer-acceptable medium, where required. Document batch tickets and gradation data according to KDOT requirements.

Complete testing and charting within 1 working day after sampling.

Keep all quality control charts current. Email or fax the data to the Field Engineer and DME, weekly. 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).

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.

Submit (email or 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.

f. Testing Requirements. In the QCP, identify test methods, procedures and equipment proposed for use. Use standard KDOT test methods and properly calibrated measuring and testing equipment as outlined in Part V. Detail any alternative sampling method, procedure or inspection equipment proposed to be used. Such alternatives are subject to review and approval by the DME.

Take all samples for tests and perform in-place tests at random locations selected according to the Contractor's QC Plan and at the rates specified in the Sampling and Testing Frequency Chart for Cement Treated Base for Quality Control/Quality Assurance Projects in Appendix B, Part V. Retain the latest 10 gradation samples for use by the Engineer.

Retain the second half of the latest 10 gradation samples for use by the Engineer.

g. 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 Part V.

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

h. Corrective Action. In the QCP, identify procedures for notifying the Engineer when corrective measures must be implemented, and for halting production.

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.

Failure to cease operations for the conditions cited above will subject all subsequent material to rejection, or acceptance 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 pavement) may be used to define unacceptable work according to **SECTION 105**. The Engineer will apply appropriate price reductions or initiate corrective action.

If a dispute exists between the Engineer and Contractor about the validity of any test results other than compressive strengths or thickness determination, the KDOT District Materials Laboratory or MRC will perform referee testing. If one of the disputed KDOT test results was generated at the MRC, then an independent laboratory agreeable to both parties will be selected. The AASHTO Accreditation Program shall have approved the selected laboratory for the appropriate test procedure. If referee testing indicates that 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.

i. Non-Conforming Materials. In the QCP, specifically address how non-conforming materials will be controlled and identified.

Establish and maintain an effective and positive system for controlling non-conforming material, including procedures for its identification, isolation and disposition. Reclaim or rework non-conforming materials according to procedures acceptable to the Engineer.

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**

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 contract 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 place CTB on frozen subgrade. Do not deposit any material until the subgrade or base has been checked and approved by the Engineer.

b. Mixing the Materials. Do not place CTB on the project until the Engineer has reviewed and approved the submitted mix design.

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. 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 Part V.

If the mix is stiff (can be slip-formed), determine the standard density by averaging the 3 most recent field molded densities using plant mixed base material. Compact one 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), determine the Standard Dry Density by averaging the 3 most recent consolidated 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 (4)) to be known. Use Equation 1 to determine the standard dry density.

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

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.

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 sublot. Make and cure compression test specimens, and determine the 7-day compressive strength of the CTB according to Part V. Sulfur cap compression test specimens in accordance with AASHTO T 231. 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. Compute the pay adjustment 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 260 psi, then 260 psi shall be used for the sample standard deviation during lot comparison with KDOT's value. When there are 3 or more tests in a lot and when the lot comparison between Contractor and KDOT tests pass, the Contractor's actual standard deviation will be used to calculate the compressive strength pay factor. When requested, KDOT will provide a copy of this program to the Contractor. It is the Contractor's responsibility to obtain the 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 sublot). Determine a random location for sampling within each sublot. 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 sublot to accommodate any minor changes in production, and adjust the random location for sampling based on the size of the sublot. When there is only 1 test in a lot, the pay factor will be automatically calculated by the KDOT spreadsheet using a sample standard deviation of 260 psi and n of 3. When there are 2 tests in a lot, the pay factor will be calculated by the KDOT spreadsheet using a spreadsheet calculated standard deviation and n of 3. When there are 3 or 4 tests, the lot stands on its own. Regardless of the number of Contractor tests in a lot, the lot comparison between Contractor and KDOT tests will apply. When the quantity exceeds 115% of the normal daily quantity, increase the number of sublots and restrict the 4^{th} sublot to a maximum of 100% of the established normal daily quantity. Each sublot added may have a maximum of 25% of the normal daily quantity.

Compute the sample standard deviation as shown in Section 5.2.1-Statistics, Part V.

Calculate the Compressive Strength Quality Indices ($\boldsymbol{Q_L}$) for each lot as shown in Section 5.2.1-Statistics, Part V. Use the following definitions, and round to the nearest hundredth.

Where: $\overline{X}$ 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, 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 in Section 5.2.1-Statistics, 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 ($\overline{X}$ 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 Cement Treated Base Compressive Strength Pay Adjustment. 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.

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

Cement Treated Base Compressive Strength Pay Factor (Failing Comparison Test). When the comparison between Contractor and KDOT tests fails, use KDOT test results 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$_L$***: $\overline{X}$ of KDOT's test result for the lot, ***S*** of 260 psi, ***LSL*** of 650 psi. When selecting the ***PWL$_C$*** value from the ***PWL*** in TABLE 2, use ***n*** of 4.

h. Weather Limitations. Do not place material if the CTB will be exposed to ambient air temperatures below 32ºF during the first 7 days of cure. (See **subsections 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 day cure period is complete, 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 40ºF and rising, and discontinue when the ambient air temperatures reaches 45ºF 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.

If the PCCP in the contract is specified as QC/QA, (Quality Control Testing (CTB) is included as a bid item), compressive strength pay adjustments will apply under the bid item "Cement Treated Base Compressive Strength Pay Adjustment", and will be shown as an added item to the contract.

SECTION 307

GRANULAR BASE

307.1 DESCRIPTION

Construct a granular base on a prepared subgrade as shown in the Contract Documents.

BID ITEMS	UNITS
Granular Base (*)	Square Yard
Water (Granular Base) (Set Price)	M Gallon

*Thickness

307.2 MATERIALS

Provide materials that comply with the applicable requirements.

Aggregate for Granular Base ..... **DIVISION 1100**
Water for Granular Base ..... **DIVISION 2400**

307.3 CONSTRUCTION REQUIREMENTS

Recompact soft and yielding subgrade material. Do not place granular base on frozen subgrade. If the project has more than 20,000 square yards of manipulation, use automatic grade controlled equipment to trim the subgrade. In irregular areas, trim the subgrade by wetting, blading and rolling.

Use a stationary mechanical mixing plant to uniformly mix the water and aggregate. A motor grader with water truck, or rotary cross-shaft mixer with water delivery system may be used to mix aggregate and water when the original contract quantity is less than 15,000 square yards.

Mix the granular aggregate with sufficient water to allow compaction of the mixture to the specified density at ± 3 % of the optimum moisture content.

Immediately after mixing the aggregate and water, haul the mixture to the prepared subgrade, place the mixture full-lane width using an aggregate spreader, and compact the mixture. The Engineer will not allow placing of the base material on the prepared subgrade when conditions are such that the hauling and placing will damage the prepared subgrade. The maximum compacted thickness of any layer of granular base or shoulder is 6 inches. When the thickness is greater than 6 inches, spread and compact the aggregate in multiple lifts of equal thickness with a maximum lift thickness of 6 inches. Spread and compact the granular base as specified in the Contract Documents. Compact the granular base to a minimum of 95% of the standard density. Compact granular base placed more than 2 feet outside the edge of pavement to a minimum of 90% of the standard density.

Trim the compacted granular base to the lines and grades in the Contract Documents. Compact the surface of the granular base with a smooth-wheel or a pneumatic-tire roller. While performing final rolling, lightly scarify and blade the surface to eliminate equipment imprints.

Maintain density until paved. When paving is delayed and the granular base dries out, re-establish the specified dry density just prior to paving.

307.4 MEASUREMENT AND PAYMENT

The Engineer will measure granular base by the square yard.

The Engineer will measure water used for granular base by the M Gallon using calibrated tanks or water meters. The Engineer will measure water used for granular base preparation, mixing and compacting the granular base. The Engineer will not measure water used for dust control, water wasted through the Contractor’s negligence, or water in excess of the quantity required for mixing and compacting the granular base.

Payment for "Granular Base" at the contract unit price and "Water (Granular Base) (Set Price)" at the contract set unit price is full compensation for the specified work.

SECTION 308

GEOSYNTHETIC REINFORCED BASE

308.1 DESCRIPTION

Place geosynthetic reinforcement for the base at the locations designated in the Contract Documents.

BID ITEM	UNITS
Geosynthetic Reinforcement (for Base)	Square Yard

308.2 MATERIALS

Provide geosynthetic for base course reinforcement that complies with **DIVISION 1700**.

308.3 CONSTRUCTION REQUIREMENTS

Store and handle the geosynthetic according to the manufacturer's recommendations. Do not expose the geosynthetic to direct sunlight, ultraviolet rays, and temperatures greater than 140°F, mud, dirt, dust, and debris.

Place the geosynthetic on the prepared surface to the limits shown in the Contract Documents. Overlap parallel strips or roll ends a minimum of 12 to 36 inches as designated on the Contract Documents.

Limit placement of geosynthetic to that which can be covered with base material within 72 hours.

When placing the base lift over the geosynthetic, do not allow construction traffic directly on the geosynthetic.

308.4 MEASUREMENT AND PAYMENT

The Engineer will measure the geosynthetic reinforcement by the square yard to the neat lines shown in the Contract Documents.

Payment for "Geosynthetic Reinforcement (for Base)" at the contract unit price is full compensation for the specified work.