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3.9 CEMENT STABILIZED BASE COURSE**3.9.1 GENERAL****3.9.1.1 Description**

Cement stabilized base course shall consist of a uniform mixture of sand or crushed aggregate, Portland Cement and water, combined as hereinafter specified, placed, compacted, and finished on the prepared surfaces.

Cement stabilized base course material as defined herein shall be mixed through a central mixing plant in accordance with the requirements of the specifications.

3.9.2 MATERIALS**3.9.2.1 Portland Cement**

The Contractor shall supply Portland Cement in accordance with Specification 5.11, Supply of Portland Cement. Unless otherwise directed or approved by the Consultant Normal Type 10 Portland Cement shall be used.

3.9.2.2 Aggregates

The Contractor shall produce aggregate in accordance with Specification 3.2, Aggregate Production and Stockpiling, for the designation and class of material specified. The Contractor shall supply aggregate in accordance with Specification 5.2, Supply of Aggregate and haul aggregate in accordance with Specification 4.5, Hauling.

3.9.2.3 Water

The Contractor shall supply all water required in the construction of cement stabilized base course.

Water shall conform to the requirements of the latest version of CSA Standard CAN 3-A23.1, Concrete Materials and Methods of Concrete Construction. Water used in Portland Cement Concrete construction shall be subject to the prior approval of the Consultant.

3.9.2.4 Asphalt

The Contractor shall supply all required asphalt materials in accordance with Specification 5.7, Supply of Asphalt.

3.9.2.5 Test Methods

Unless otherwise specified, the following standard test methods will be used to determine material characteristics.

When requested by the Contractor, the most recent edition of the following test methods will be used for verification purposes, the results of which shall govern:

	Test Description	Method No.
(i)	Sampling Stone, Slag, Gravel, Sand and Stone Block for Use as Highway Materials	AASHTO Designation T 2
(ii)	Sieve Analysis of Fine and Coarse Aggregates (1), and (a) Amount of Material Finer than 0.075 mm sieve in Aggregate (1)	AASHTO Designation T 27 AASHTO Designation T 11
(iii)	Determining the Liquid Limit of Soils (1)	AASHTO Designation T 89
(iv)	Determining the Plastic Limit and Plasticity Index of Soils	AASHTO Designation T 90
(v)	Classification of Soils for Engineering Purposes (for definition of Coefficient of Uniformity, Cu)	ASTM Designation D 2487
(vi)	Determination of Cement Content in Cement-Treated Aggregate by the Method of Titration (1)	AASHTO Designation T 211
(vii)	Cement Content of Soil-Cement Mixture (hardened)	AASHTO Designation T 144
(viii)	Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester	AASHTO Designation T 217
(ix)	Laboratory Determination of Moisture Content of Soil	ASTM Designation D 2216
(x)	Moisture Density Relations of Soil-Cement Mixtures (1) (hereinafter referred to in Section 3.9 as the Standard Proctor Test)	AASHTO Designation T 134
(xi)	Compressive Strength of Molded Soil-Cement Cylinders	ASTM Designation D 1633
(xii)	Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory	ASTM Designation D 1632
(xiii)	Capping Cylindrical Concrete Specimens	AASHTO Designation T 231
(xiv)	Density of Soils In-Place by Block, Chunk or Core	AASHTO Designation T 233
(xv)	Density of Soil In-Place by the Rubber Balloon Method	AASHTO Designation T 205
(xvi)	Density of Soil In-Place by the Sand Cone Method	AASHTO Designation T 191
(xvii)	Density of Soil and Soil-Aggregate In-Place by Nuclear Method (shallow depth)	AASHTO Designation T 238
(xviii)	Sampling Bituminous Materials	AASHTO Designation T 40

NOTES:

- (1) In all Test Methods used as reference in this specification, metric sieves as specified in Canadian General Standards Board specification 8-GP-2M shall be substituted for any other specified wire cloth sieves in accordance with Specification 3.2, Aggregate Production and Stockpiling.

3.9.3 EQUIPMENT**3.9.3.1 General**

The Contractor shall provide sufficient equipment to produce and place cement stabilized mixture at a rate of not less than 200 t per hour.

3.9.3.2 Mixing Plants - General

Mixing plants shall be of approved batch or continuous mix type, capable of producing a uniform mixture. All mixers shall be equipped with adjustable metering devices of a type which will introduce the cement and water into the mixer in the designated proportions. The cement metering devices and feeder shall be interlocked and synchronized to maintain a constant ratio of cement to the sand or gravel material, and the water metering control shall be adjustable to maintain the designated moisture content.

The mixing unit shall be capable of adjustment, either by reduction in volume of material or other means, to correct occurrence of dead areas in the mixer in which material does not move or is not sufficiently agitated to produce the necessary uniform dispersal of the ingredients of the mixture, as may be required by changes in the mixing properties of the material being mixed.

3.9.3.3 Batch Type Mixers

If a batch type mixer is used, the material shall be proportioned by batch weights.

3.9.3.4 Continuous Type Mixers

If a continuous type of mixer is used, the materials shall be proportioned by volume. The sand or gravel materials shall be drawn from the storage bin or bins by an approved continuous feeder through adjustable calibrated gates, or by an approved fixed gate continuous feeder with adjustable speed control, which will supply the correct amount of sand or gravel materials in proportion to the cement and water. The plant shall be equipped with facilities satisfactory to the Consultant for sampling materials and calibrating gate openings or rate of feed by weighing check samples.

3.9.3.5 Spreading Equipment

Spreading equipment shall be readily adjustable to various depths and widths, and shall be constructed and operated to produce a layer of material of uniform thickness, true to grade and cross-section and of uniform consistency.

3.9.3.6 Compaction Equipment

Compaction equipment shall be capable of producing the specified degree of compaction and surface finish within the time limits specified.

3.9.3.7 Sampling and Sampling Stand

Samples of the various components of the mixture and the mixture itself will be taken as often as considered necessary by the Consultant for the purpose of verifying quality control, adherence to specification, or other test purposes. The Contractor shall cooperate with the Consultant and/or his representatives in obtaining the samples required, including the provision by the Contractor of suitable sampling devices. The Contractor shall provide access to all parts of the plant as required by the Consultant. The Contractor shall at his own expense provide, install and maintain a suitable sampling stand for the purpose of sampling from loaded trucks. The stand shall be of solid construction, safe, firmly anchored, and of a convenient height to enable easy acquisition of samples from haul vehicles. The stand shall have a minimum platform area of 3 m in length and 1 m in width, shall be equipped with stairs, and be completely enclosed with guard and hand rails. The stand shall be placed in an approved location.

3.9.3.8 Plant Calibration

Prior to production of any material, the plant shall be calibrated to produce a mix containing the proper proportion of all components of the mixture. Calibration of the plant shall be performed at each new plant setting and at any other time as directed by the Consultant.

All plants shall contain devices capable of diverting each component of the mixture into separate receptacles or trucks for the purpose of weighing check samples.

3.9.4 CONSTRUCTION

3.9.4.1 **Cement Stabilized Base Course - General**

Cement stabilized base course shall not be mixed or placed when the atmospheric temperature is at or below 5°C, or when conditions indicate that the temperature may fall below 5°C within 24 hours, unless adequate means satisfactory to the Consultant are employed for the protection of the work. In no case shall cement stabilized base course be placed on frozen subgrade.

All cement stabilized base course shall be effectively protected from frost action, and any material which has become damaged by the frost action shall be replaced by the Contractor at his own expense.

3.9.4.2 **Cement Addition**

The measurement of cement content for addition to the sand or gravel shall be by weight, whether proportioned by batch weight or by volume.

Cement to be mixed with the sand or gravel material shall be uniformly distributed throughout the material during the mixing operation.

3.9.4.3 **Mixing Cement Stabilized Base Course**

Blending of the sand or gravel material shall be performed prior to the mixing operations to meet the requirements as specified herein.

Sand or gravel, cement and water shall be mixed such that an homogeneous mixture, uniform in gradation, cement content, moisture content and appearance is attained.

The proportions of water and cement to be added to the mixture will be designated by the Consultant, and the rates of addition shall be under strict control at all times.

Cement content of the mixture shall not vary by more than plus or minus 0.3% by weight from the designated cement content. The moisture content shall not vary by more than plus or minus 2% by weight, and shall be such that the designated moisture content is achieved at the compaction stage.

In the event the moisture content of the gravel or sand is above the optimum moisture content designated for the mixture, the material shall be dried by aerating or piling and allowing to drain, or by dewatering with pumps or other such methods prior to plant mixing, such that the optimum moisture of the cement stabilized mixture is realized.

3.9.4.4 **Placing Cement Stabilized Mixture**

Immediately prior to placing of the cement stabilized mixture, the surface of the prepared subgrade shall be moistened and kept moist until covered by the mixture. Care shall be exercised to prevent softening of the subgrade by the addition of excess amounts of water. Ponding of water will not be permitted.

Materials shall be transported by means of approved vehicles equipped with protective covers if required, and deposited and spread by approved spreading equipment. Dumping of mixture in piles or windrows upon the subgrade and subsequent spreading by motor graders or other equipment will not be permitted unless approved by the Consultant for irregular, restrictive areas.

The mix shall be spread and compacted to conform to grade and cross-section, be uniform in gradation, density, moisture and cement content, at the values designated, and the finished surface shall be smooth and tight.

The spreading operation will not be permitted in widths of less than 3 m, excepting as permitted by the Consultant for irregular, restrictive areas.

Where the final compacted thickness of the cement stabilized base is 225 mm or less, sufficient material is to be placed in one operation to obtain this thickness.

Where the thickness designated is greater than 225 mm, the spreading operation shall be carried out in two layers of equal thickness unless otherwise directed by the Consultant. Unless otherwise permitted, placing and spreading of base course materials shall be performed in contiguous sections.

Unless otherwise directed by the Consultant, the mixed materials shall be spread for part width of the subgrade under construction. Care shall be taken to prevent damage to the exposed edge, or edges, by the compacting equipment where part width construction is undertaken. Care shall also be taken to prevent damage to the exposed edge, or edges, by the compacting equipment and/or traffic and weather.

Where the Consultant directs that the mixed materials shall be spread for the full width of the subgrade under construction, either one spreader or several spreaders may be operated in a staggered position across the subgrade. Where more than one spreader is used to distribute the mixed material in adjacent spreads, or where one spreader is used alternately on two adjacent spreads, joint construction as hereinafter specified will not be required when less than thirty minutes elapses between the time of spreading the mix in adjacent spreads at any location. When more than thirty minutes elapses between the placing of adjacent or successive spreads, joint construction as hereinafter specified will be required.

After a part width section has been completed, the longitudinal joint against which additional mixed material is to be placed shall be trimmed to a neat line parallel to the roadbed alignment and with a vertical edge. Material cut away from the edge or material previously placed to protect the edge shall be spread uniformly over the adjacent subgrade, or otherwise disposed of as directed the Consultant.

Contamination of the cement stabilized mixture with subgrade materials will not be permitted.

The spreading operations shall be performed in a manner to prevent excessive drying or loss of moisture, and shall reserve sufficient time to permit complete compaction within the time limits specified or as required by the Consultant.

3.9.4.5 **Compacting the Cement Stabilized Mixture**

Immediately upon completion of the spreading of each lift, the material shall be thoroughly compacted in a manner to avoid the formation of irregularities, and the finished base shall be true to the required grade and cross-section and be of uniform thickness.

The intensity of rolling shall be such that the specified density is obtained to a uniform degree throughout the depth of the mixture and within the time limits. A minimum density of ninety-seven percent of the Standard Proctor Maximum Dry Density shall be attained throughout.

The surface of the uncompacted, partially compacted or completely compacted cement stabilized base shall be kept moist at all times until an asphaltic fog coat seal is applied. Care shall be taken to ensure that excessive water is not applied which subsequently damages the mix or subgrade. The water is to be applied as a fine spray, such that segregation of the cement from the sand or gravel material does not occur.

During the course of compaction, care shall be taken to prevent or eliminate all compaction planes in a manner satisfactory to the Consultant.

Following compaction, before setting of the mixture, high spots on the cement stabilized base shall be removed by means of cutting blades or other equipment, in a manner to cause as little disturbance as possible to the compacted material. The excess material shall be removed to the shoulder or adjacent subgrade as directed by the Consultant. Loose material shall not be left on the cement stabilized base surface. Filling low spots with cement stabilized material following compaction will not be permitted.

The Contractor shall take all precautions necessary to protect the base course from damage by public traffic or construction equipment.

3.9.4.6 Time Limits

Unless otherwise specified, not more than two hours shall elapse between the time cement is added to the sand or gravel material and the time of completion of the final compaction. In no case shall the time interval exceed the initial hydration period for the cement as determined by the Consultant.

If the base course operation is being performed in two layers, the two hour time limit will be measured from the time water and cement are added to the sand or gravel of the first layer to the time of completion of final compaction of the uppermost lift. If the Contractor cannot meet this time limit, he will be required to wait the normal five days curing period before applying the next layer.

3.9.4.7 Joint Construction

All joints shall be vertical and uniform in alignment.

Longitudinal joints shall be formed or cut in a vertical plane to the subgrade surface, shall expose a face of thoroughly compacted material, and new material shall be spread and compacted against this face when constructing the adjacent lane or base section.

Unless otherwise directed by the Consultant, transverse construction joints shall be made by trimming the end of the compacted material to a straight line normal to the centreline of the roadbed and with a vertical edge in well compacted material. No mixture shall be placed until the construction joint has been prepared in a manner satisfactory to the Consultant.

3.9.4.8 Curing Seal

A curing fog coat seal of liquid asphalt shall be applied immediately following the final compaction and trimming of the cement stabilized base course. If the base is being constructed in two layers, the application of a curing seal between layers will not be necessary if the second layer is to be placed within the two hour time limit as described in Section 3.9.4.6. If the second layer is to be constructed after the five day cure period of the first layer, curing seal will be required on both layers after their respective final compaction.

This fog coat shall be constructed according to Specification 3.19, Prime, Tack and Fog Coats.

3.9.4.9 Temporary Crossings

Temporary crossings across the cement stabilized base shall be constructed only at locations approved by the Consultant. The material placed over the cement stabilized base shall be free from rocks or particles which may cause damage to the surface. The material shall be placed to a width of not less than 3.5 m for single lane or 7 m wide for double lane traffic. The depth of the material shall not be less than 0.3 m. The crossing fill shall extend beyond the width of the cement stabilized base by at least 1.5 m on either side.

Where such crossings are required to accommodate the general public, the Contractor shall maintain suitable signs, barricades, and the necessary flag-persons to direct traffic and to prevent damage to the adjacent cement stabilized base. Such crossings will not be permitted prior to the application of the asphaltic fog coat seal unless authorized by the Consultant.

3.9.4.10 Opening to Traffic

In general, completed sections of cement stabilized base course shall be allowed to cure for a minimum of five days before opening to normal traffic and provided the cement stabilized base has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. If the temperature drops below 5°C during the five day curing period, the curing period may be extended if so directed by the Consultant. Light local traffic and the Contractor's construction equipment only shall be permitted on the cement stabilized base during the curing period provided damage to the work is prevented and other accommodation of the local traffic is not possible. Where partial widths are constructed, traffic and the Contractor's hauling equipment shall be accommodated on the untreated portion of the subgrade. Such traffic which must travel over the cement stabilized base during the curing shall have speeds restricted sufficiently to prevent surface damage. The Contractor shall reconstruct any portion damaged by traffic at his own expense.

If required by the Consultant, the curing seal shall be protected from traffic by spreading a layer of fine sand over the completed cement stabilized base course.

3.9.4.11 Tack Coat

Prior to the application of the surface course, a tack coat shall be applied to the finished cement stabilized base course surface at the locations and to the dimensions designated by the Consultant and according to Specification 3.19, "Prime, Tack and Fog Coats".

3.9.4.12 Application of Asphalt Stabilized Base Course

The time interval between the finishing and compacting of the cement stabilized base course and the placing of the asphalt stabilized base course or asphalt concrete pavement as specified, shall be not less than ten days.

All cement stabilized base course placed during the construction season shall be covered with asphalt stabilized base course or asphalt concrete pavement as specified, prior to seasonal shutdown.

3.9.5 MEASUREMENT AND PAYMENT**3.9.5.1 Cement Stabilized Base Course**

Measurement of cement stabilized base course will be in tonnes.

Payment will be made at the unit price bid per tonne for "Cement Stabilized Base Course". This payment will be full compensation for supplying water; moistening the subgrade surface; producing, hauling and placing the cement stabilized base course material; supply and application of curing seal and tack coats; protecting the surface; accommodation of traffic; and all other operations and incidentals necessary to complete the Work, including producing, hauling and placing of fines for protection of curing seal coat.

Payment will not be made for any material used to repair failures which may occur in the base course due to the Contractor's faulty workmanship. Any expense incurred in the production, hauling, and placement of such material shall be borne by the Contractor.

3.9.5.2 Supply of Portland Cement

Payment for the supply of Portland Cement will be made at the unit price bid per tonne for "Portland Cement".

3.9.5.3 Supply of Aggregate

Aggregate materials incorporated into the Work will be paid for in accordance with Specification 5.2, Supply of Aggregate.

3.9.5.4 Curing and Tack Coats

No separate payment will be made for the supply and application of asphalt materials for curing seal coat and fog coat. All costs will be considered incidental to the Work.

3.9.5.5 Temporary Crossings

Costs for producing, hauling, placing and subsequent removal and disposal of material for temporary crossings will not be paid for separately, but will be considered to be incidental to the Work.