6500 - SPECIFICATION FOR CONCRETE

6500 - 1 DESCRIPTION

1.01 The work shall consist of concrete composed of portland cement, water, fine and coarse aggregate and air entraining admixture proportioned, mixed, placed, and cured in accordance with this specification.

6500 - 2 MATERIALS

2.01 Samples of water, coarse aggregate, and fine aggregate shall be submitted to the Engineer, for the purpose of testing and preparing a design mix, at least two (2) weeks before work commences.

Cement

2.02 The Department will supply and pay for the portland cement.

Water

2.03 The Contractor shall supply and pay for the water. The water shall be free from injurious quantities of salt, oil, acid, alkali, and organic matter.

2.04 The water will be subject to the approval of the Engineer.

Admixtures

2.05 The Department will select and pay for admixtures. The addition of admixtures, including air entraining agents, will be as specified by the Engineer.

Curing Compounds

2.06 The Contractor shall supply and pay for curing compounds. Curing compounds shall meet the requirements of the latest issue of A.S.T.M. Standard C309 Liquid, Membrane - Forming Compounds for Curing Concrete.

Fine Aggregate

2.07 The fine aggregate shall comply with the following requirements, except that not more than forty-five (45) percent shall be retained between any two consecutive sieve sizes:

Sieve Designation	Percent by Weight Passing Canadian Metric Standard Sieves
	TYPE 200
9.00 mm	100
5.00 mm	95 - 100
2.50 mm	80 - 100
1.25 mm	50 - 85
630 μm	25 - 60
280 μm	5 - 30
160 μm	0 - 10

2.08 The amounts of deleterious substances in the fine aggregate shall not exceed the following:

Substances	Percent by Weight of Total Sample
Clay lumps	1.0
Material finer than 71 μm sieve	3.0
Coal	0.5
Shale	1.5

Coarse Aggregate

2.09 The coarse aggregate shall consist of fragments of durable rock free from undesirable quantities of soft or flaky particles, loam, dust, shale, earth, or organic matter.

2.10 The coarse aggregate shall comply with the following requirements:

Sieve Designation	Percent by Weight Passing Canadian Metric Standard Sieves		
	TYPE		
	205	206	207
50.0 mm	100	-	-
40.0 mm	95 - 100	100	-
25.0 mm	-	95 - 100	100
18.0 mm	35 - 70	-	90 - 100
12.5 mm	-	25 - 60	-
9.00 mm	10 - 30	-	20 - 55
5.00 mm	0 - 5	0 - 10	0 - 10
2.50 mm	-	0 - 5	0 - 5

2.12 The amounts of deleterious substances in the coarse aggregate shall not exceed the following:

Substances	Percent of Weight of Total Sample
Clay lumps	0.25
Soft particles	5.0
Chert which will readily disintegrate	1.0
Material finer than 71 μm Sieve	1.0
Coal	1.0
Total deleterious material not to exceed	5.0

2.13 The coarse aggregate for curb, curb and gutter, sidewalk, driveway, and sewer work shall be Type 207.

Organic Matter

2.14 Coarse and fine aggregates shall be free from injurious amounts of organic impurities.

2.15 Aggregates producing a colour darker than the standard colour when subjected to Test 9825 shall be rejected, except:

(a) if discoloration is caused principally by the presence of small quantities of coal.

(b) if strength tests show the aggregate to be satisfactory.

6500 - 3 CONSTRUCTION

Aggregates

3.01 Aggregates shall be stockpiled in accordance with requirements for Stockpiling Aggregates (Specification 3600).

Storing Cement

3.02 Cement shall be stored in weatherproof buildings to protect the cement from dampness, except that cement in sacks may be stored on a raised platform and protected with a weatherproof covering.

Proportioning Materials

3.03 The materials for the concrete shall be proportioned as directed by the Engineer. This proportioning will be determined by the "water-cement ratio" method of concrete mix design or on the basis of test results of trial mixes made from the same materials which are to be used in the work.

3.04 Air entraining admixture shall be added to all concrete to produce five (5) percent entrained air. Test 9835 will be used to test for percent entrained air.

3.05 The fine and coarse aggregates and cement shall be proportioned by separate weighings or by other methods subject to the approval of the Engineer.

3.06 The proportions of aggregates, cement, and admixtures added to the mix shall not vary by more than one (1) percent of the amount specified for each material. The proportion of water added to the mix shall not vary by more than one-half (1/2) percent of the amount specified. The water shall be measured by weight or by volume.

3.07 If volumetric measurements are approved by the Engineer, a suitable allowance shall be made for variations in the moisture content and bulking effect of the aggregate.

3.08 If sack cement is used, the batch size shall be controlled to prevent the use of fractional sacks of cement.

Mixing

General

3.09 Unless otherwise authorized by the Engineer, concrete shall be machine mixed.

Mixing at job site

3.10 Concrete shall be thoroughly mixed in a batch mixer.

3.11 The mixer shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the amount of water used in each batch.

3.12 The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand, and water to coat the inside of the drum without reducing the required mortar content of the mix.

3.13 The materials composing a batch shall be deposited simultaneously in the mixer.

3.14 Concrete shall be mixed for a period of not less than one and one-half (11/2) minutes after all materials, including water, are in the mixer. During the period of mixing, the mixer shall operate at a speed of not less than fourteen (14), nor more than twenty (20) revolutions per minute.

3.15 The entire contents of the mixer shall be removed from the drum before materials for the next batch are added. The mixers shall be thoroughly cleaned when mixing is stopped for a prolonged period.

Truck Mixing

3.16 Truck mixers, unless otherwise authorized by the Engineer, shall be the revolving drum type, water tight, and constructed so that the concrete can be mixed to ensure a uniform distribution of materials throughout the mass. Solid materials for the concrete shall be accurately proportioned and charged into the drum at the proportioning plant. The accuracy of that proportioning shall be as specified under subsection 6500-3C above.

3.17 Unless the water is added directly to the batch, the truck mixer shall be equipped with a tank for carrying water. The tank shall be equipped with a device by which the quantity of water can be added accurately and readily verified.

3.18 The size of the batch shall not exceed the rated capacity of the mixer. Within thirty (30) minutes after the cement has been added, mixing shall begin and continue for at least fifty (50) revolutions. If high-early strength cement is used or the atmospheric temperature is greater than thirty degrees Celsius (30°C), the above time limitations shall be reduced to fifteen (15) minutes. These time limitations will be waived only if the aggregate is sufficiently free from moisture, as determined by the Engineer.

3.19 The speed of the mixing drum shall be subject to the following limitations:

(a) Minimum speed of four (4) revolutions per minute.

(b) Maximum peripheral velocity of seventy metres per minute (70 m/min).

(c) Not more than one hundred (100) revolutions at a speed greater than six (6) revolutions per minute.

Partial mixing at the central plant

3.20 If a truck with a mixer or an agitator with adequate mixing blades is used for transportation, the mixing time at the stationary machine mixer may be reduced to 30 seconds and the mixing completed in the truck mixer or agitator. The mixing time in the truck mixer or agitator shall be as specified for truck mixing.

Central plant mix

3.21 Mixing at a central plant shall conform to the requirements for mixing at the job site.

Time of hauling and placing mixed concrete

3.22 Concrete transported in a truck mixer, truck agitator, or other transportation device shall be discharged at the job and placed in its final position in the forms within one and one-half (11/2) hours after the cement or water has been added, except that when the atmospheric temperature is more than thirty degrees Celsius (30°C) or high-early strength cement is used, the maximum allowable time may be reduced by the Engineer.

Hand Mixing

3.23 If hand mixing is authorized, it shall be performed on a water tight platform and in such a manner as to ensure a uniform distribution of the materials throughout the mass. Mixing shall be continued until a homogeneous mixture of the required consistency is obtained.

Delivery

3.24 The rate of delivery of concrete shall be such that the interval between batches shall not exceed twenty (20) minutes. The methods of delivering and handling shall permit placing of the concrete with a minimum of re-handling and without damage to the structure of the concrete.

Retempering

3.25 Concrete which has developed initial set before placing shall not be used. Partially hardened concrete shall not be retempered or remixed.

Forming

3.26 Forms shall be of wood or metal.

3.27 Forms shall be straight, free from waves, and of sufficient strength to resist springing, tipping, or other displacing.

3.28 Forms shall have smooth straight upper edges.

3.29 Forms shall have a smooth surface on the side placed next to the concrete. Forms shall be cleaned and oiled with form oil before concrete is placed against them.

3.30 Forms shall be sufficiently tight to prevent leakage of concrete.

3.31 Forms shall be securely staked and braced to line and grade and maintained on a true position during the placing of concrete.

3.32 No concrete shall be placed until the base and forms have been approved by the Engineer. Forms shall be placed and ready for inspection at least one-half (1/2) day in advance of placing concrete.

3.33 Metal ties or anchorages, within the forms, shall be constructed to permit their removal to a depth of at least five centimetres (5 cm) from the face of the concrete. Fittings for metal ties shall be designated so that, upon their removal, the cavities which are left will be of the smallest possible size. If wire ties are used, the wires shall be cut back, with chisels or nippers, at least six millimetres (6 mm) from the face of the concrete. Nippers shall be used for green concrete. The cavities shall be filled with cement mortar and the surface left sound, smooth, even, and uniform in colour.

Handling and Placing Concrete

3.34 Concrete shall be hauled in accordance with the requirements for Haul (Specification 2405).

3.35 Construction debris and extraneous matter shall be removed from the interior of forms. Temporary braces, holding the forms in correct shape and alignment, shall not be buried in the concrete.

3.36 The concrete mix shall be placed without segregation and in layers not exceeding thirty centimetres (30 cm) in depth.

3.37 The concrete mix shall not be dropped more than one and one-half metres (1.5 m) unless special devices, subject to the approval of the Engineer, are used.

3.38 Open troughs shall have metal linings and baffles, if necessary, to prevent segregation.

3.39 Chutes, troughs, and pipes shall be kept free of hardened concrete.

3.40 As soon as the concrete is spread, it shall be thoroughly tamped and spaded. Each layer shall be placed and compacted before the preceding layer has taken initial set. The concrete shall be spaded along form faces to the full depth of the forms. Mechanical vibrators shall be used, subject to the following provisions:

(a) Vibration shall be internal.

(b) The frequency of vibration shall not be less than 4,500 impulses per minute.

(c) The intensity of vibration shall visibly affect an area over a radius of fifty centimetres (50 cm) for twenty-five millimetre (25 mm) slump concrete.

(d) Sufficient vibrators shall be provided to properly compact each batch immediately after it is placed.

(e) The vibrators shall be manipulated to thoroughly work the concrete around corners, reinforcement, and fixtures. The application of vibrators shall not be spaced further than twice the radius of visibly effective vibration. Excess vibration causing segregation will not be permitted.

(f) Vibration shall not be applied to partly set concrete and shall not be used to make concrete flow in the forms.

(g) Vibration shall be supplemented by spading as required.

3.41 The concrete shall be placed continuously throughout each section of the structure or between specified joints. If it is necessary to stop the placing of concrete for a period greater than two (2) hours before the section is completed, a bulkhead shall be placed. The resulting joint shall be at a specified expansion or contraction joint designated by the Engineer. Surplus or waste concrete resulting from this requirement shall be disposed of at no direct expense to the Department.

3.42 Before placing new concrete on concrete that has set, the surface of the set concrete shall be chipped, roughened, and loose and foreign materials removed. The surface shall then be watered and scrubbed with wire brooms and kept wet until the new concrete is placed. Before placing the new concrete, all forms shall be drawn tight against the concrete in place and the old surface thoroughly coated with a very thin coating of neat cement or mortar.

3.43 When placing of concrete is terminated, accumulations of mortar splashed on reinforcing steel or on form surface shall be removed.

Constructing Joints

3.44 Contraction joints shall be constructed at intervals shown on the plans. The grooves shall be three millimetres (3 mm) in width and shall extend at least one-third (1/3) the depth of the structure for curbs, curbs and gutters, and sidewalks.

3.45 Expansion joints shall be constructed with premolded non-extruding filler thirteen millimetres (13 mm) in thickness, at intervals shown on the plans. The distance between expansion joints shall not be greater than twenty metres (20 m).

3.46 If curb or curb and gutter is placed adjacent to a sidewalk, the expansion joints in the curb or curb and gutter shall be located opposite the expansion joints in the sidewalk. The reverse order of description applies if sidewalks are constructed adjacent to curbs.

Removing Forms

3.47 Forms shall be removed as soon as the concrete has set sufficiently to permit finishing.

Cold Weather Requirements

3.48 For the purpose of this specification, cold weather requirements will apply when:

(a) The atmospheric temperature is less than seven degrees Celsius (7°C).

(b) A minimum temperature of less than five degrees Celsius (5°C) is predicted within forty-eight (48) hours.

3.49 During cold weather, the following requirements will apply:

(a) Heating of materials

(i) During the mixing operation, the temperature of the concrete mix shall not exceed thirty degrees Celsius (30°C).

(ii) The temperature of the concrete mix, when placed, shall be not less than fifteen degrees Celsius (15°C).

(iii) The water shall be heated to a temperature not greater than sixty-five degrees Celsius (65°C).

(iv) If the atmospheric temperature is**,** or was at any time during the previous twenty-four (24) hours, at minus one degree Celsius (-1°C) or lower, or if the aggregate stockpiles contain frozen material, the aggregate shall be heated to a temperature not less than twenty (20) and not greater than sixty-five (65) degrees Celsius (65°).

(v) Water heated over thirty degrees Celsius (30°C) shall not be brought in direct contact with the cement, but shall be added into the mixer and mixed with the aggregate before the cement is added.

(vi) The heating system shall provide uniform heat to avoid local overheating.

(b) Placing

(i) Ice and snow shall be removed from formwork, existing concrete, and reinforcing steel against which concrete is to be placed. When the atmospheric temperature is minus one degree Celsius (-1°C) or less, the Contractor shall preheat the area in which the concrete is to be placed to a temperature of not less than fifteen degrees Celsius (15°C) for a period not less than eight (8) hours.

(ii) Concrete shall not be placed on or against frozen subgrade or ground. The Contractor shall protect any of these areas with straw or covers to ensure that frost does not penetrate into the ground.

(iii) The concrete shall be placed rapidly and evenly, as near to its final position as possible, in order to reduce the risk of segregation, flow lines, and cold joints.

(c) Protecting placed concrete

(i) If the atmospheric temperature falls below five degrees Celsius (5°C) during the seven (7) days after the concrete has been placed, the Contractor shall provide suitable protection, and heat if necessary, to ensure that the concrete cures at a temperature of not less than ten degrees Celsius (10°C) for the seven (7) days from the time that the concrete is placed.

(ii) Heating shall be provided by live wet steam or hot air blowers having a fine water spray into the stream of hot air.

(iii) Insulated formwork, as an alternative to housing and heating may be approved by the Engineer. The formwork shall be designed and insulated so that the initial heat of the aggregate and the heat generated during the hydration of the cement is retained to provide the specified curing conditions. The Contractor shall submit details of his proposals for protecting the concrete to the Engineer for approval; such approval shall not relieve the Contractor of responsibility for the adequacy of the protection.

(d) Removing protection

(i) Protection, and heating if used, shall be withdrawn in such a manner as not to introduce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced, at a rate not exceeding fifteen degrees Celsius (15°C) per day, to the temperature of the surrounding air. To achieve this, the heat shall be slowly reduced and then shut off, and the whole housing allowed to cool to atmospheric temperature before the housing itself or the formwork is removed.

Curing Concrete

3.50 As soon as the concrete has set sufficiently, concrete surfaces exposed to conditions which may cause premature drying shall be kept moist by sprinkling with water or covering with moist canvas, straw, burlap, sand, or other satisfactory material.

3.51 Curing shall continue for a period of not less than seven (7) days after placing the concrete. Curing compounds shall be subject to the approval of the Engineer. Curing compounds shall be applied evenly so that all surfaces have adequate coverage.

3.52 The curing compound coverage is inadequate if the surface of the concrete will absorb water. Curing compounds shall not be used on a surface where a bond is required for additional concrete.

3.53 Curing compounds shall be applied by spraying with pressure equipment. To ensure complete coverage, approximately one-half the quantity for a given area shall be applied in one direction and the remainder at right angles to this direction.

Finishing Concrete

3.54 In general, the required surface finish for all exposed concrete surfaces shall be as follows:

(a) Immediately following the removal of forms, fins and irregular projections shall be removed from surfaces which are to be exposed. On all surfaces, cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned. After having been kept saturated with water for a period of not less than three hours, the cavities shall be carefully pointed and trued with a motar of one (1) part cement and three (3) parts fine aggregate. The cement shall consist of one (1) part white portland cement to four (4) parts portland cement. Mortar used in pointing shall be not more than one (1) hour old. The mortar patches shall be cured as specified under Curing.

(b) Contraction and expansion joints in the completed work shall be carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed, for its full length, with clean and true edges.

(c) If forms are lined with plywood, no surface treatment in addition to that specified above should normally be required. However, any surfaces which cannot be repaired to the satisfaction of the Engineer shall be "rubbed" as specified for Rubbed Finish.

3.55 In addition to the general finish, one of the following finishes will be required for certain types of work:

(a) Rubbed finish, for wing walls, retaining walls, and headwalls.

(i) After removal of forms, the concrete shall be rubbed. Rubbing shall not start until the condition of the concrete is suitable. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water for a minimum period of three (3) hours. Before the wetting down, sufficient time shall elapse to allow the mortar used in the pointing of cavities to thoroughly set.

(ii) A medium coarse carborundum stone, with a small amount of mortar on its face, shall be used to rub the concrete surfaces. The mortar shall be composed of one (1) part cement and three (3) parts fine sand. The cement shall consist of one (1) part white portland cement to four (4) parts portland cement. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled, and a uniform surface obtained. The paste produced by this rubbing shall be left in place at this time.

(iii) The final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform colour.

(iv) After the final rubbing has been completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

(b) Floated surface finish, for roadway floors, slabs, sidewalks, and driveways

(i) Immediately after placing the concrete, concrete floors, sidewalks, and driveways shall be screeded with a template or straight edge to provide the surface with the proper shape and elevation.

(ii) Concrete shall be worked until the coarse aggregate is forced into the body of the concrete so that no coarse aggregate is exposed. The surface shall then be floated, with a wooden float,to a smooth and uniform surface. When the concrete has hardened sufficiently, the surface shall be given a broom finish. The type of broom shall be subject to the approval of the Engineer. The broom strokes shall be perpendicular from edge to edge of the sidewalk and driveway. Adjacent strokes shall be lapped and shall produce corrugations not over three millimetres (3 mm) in depth. Brooming shall not tear the surface of the cement. An edge tool shall be used for finishing edges of sidewalks and driveways.

6500 - 4 MEASUREMENT

6500 - 5 PAYMENT

5.01 Payment for concrete will be under other contract items.