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SPECIFICATIONS FOR CONCRETE CURBING

860. 1 SCOPE

These Specifications and drawings govern all operations necessary for and pertaining to the construction of concrete curb and concrete curb and gutter.

860. 2 CLASSIFICATION OF CURBING

Concrete curbing, as detailed on page 3 and page 4, is classified as follows:

Barrier Curb Type "A"
Barrier Curb Type "B"
Barrier Curb and Gutter Type "C"

and,

Semi-mountable Curb Type "A"
Semi-mountable Curb Type "B"
Semi-mountable Curb and Gutter Type "C"

860. 3 MIX DESIGN

3.1 Mix Properties

The mix proportions will be based on the concrete meeting the following physical properties when tested in accordance with the requirements of (CAN/CSA A23.1-00 and CAN/CSA A23.2-00):

Type of Concrete Mix	Minimum Cementitious Material	Air Content	Slump	Min. 28 Day Strength	Max. Water/Cement Ratio
Normal	340 kg/m ³	5 – 8%	30 – 80 mm	35 32 MPa	0.45
Normal with Fly Ash	340 kg/m ³	6 – 8%	30 – 80 mm	35 32 MPa	0.40
Cold Weather or Early Strength	355 kg/m ³	5 – 8%	30 – 80 mm	35 32 MPa	0.45

3.2 Mix Design Provided by the Contractor

The Department will consider a mix design provided by the Contractor. The mix design shall be submitted by the Contractor along with the mix properties, including strength, slump, and air content, as determined by independent qualified laboratory. Other pertinent data shall also be supplied including the mix identification, suppliers and types of cement, fly ash and admixtures used. The mix design and other pertinent data shall be provided to the Department a minimum of 2 weeks prior to concrete production.

If the Contractor is unable to provide an acceptable mix design, the Department will provide a mix design in accordance with this specification.

~~860.~~ 3.3 Mix Design Provided by the Department

If requested by the Contractor, the Department will provide concrete mix designs. Prior to concrete production, the proportions of cement, water, fine and coarse aggregates and admixtures that are to be used in the concrete, will be determined by the Department. The mix design will be based on the samples provided by the Contractor and approved by the Department for use in the concrete.

During aggregate production and a minimum of 4 weeks prior to concrete production, the Contractor shall provide sufficient quantities of fine and coarse aggregate samples for the required concrete mix designs.

3.4 Changes to the Mix Design

Changes to the mix design shall not be made without the Department's approval.

860. 4 EQUIPMENT

Equipment shall be in satisfactory working condition and so maintained for the duration of the work. Equipment shall be on the site and available for inspection and approval before paving operations commence.

The slip form curbing machine shall be self-propelled, automated for line and grade control from a stringline and equipped with an extrusion mould capable of producing the specified curb.

The Contractor shall provide additional equipment and small tools necessary to complete the work in accordance with this Specification.

860. 5 MATERIALS

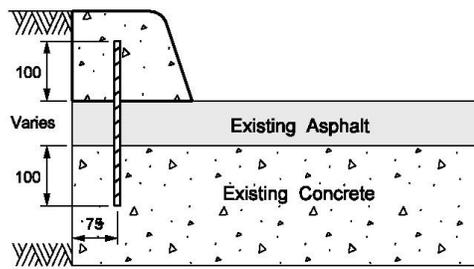
5.1 Testing and Approval

Prior to approval for use, proposed materials will be subject to inspection and/or testing by a testing laboratory designated by the Department. When requested, the samples of materials shall be submitted at least 14 days before their intended use.

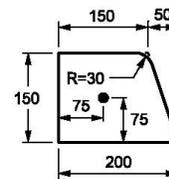
The Department shall not be charged for samples of materials submitted for testing.

The Department will determine the compressive strength of the concrete produced. The compressive strength will be determined from concrete cylinder specimens cast and tested by the Department.

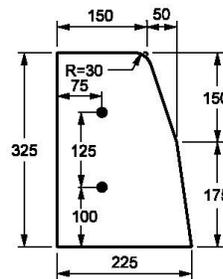
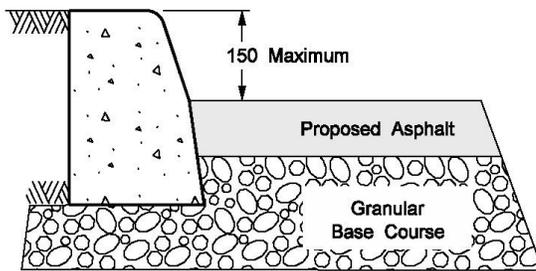
If the cylinder results determine that the concrete did not meet the minimum compressive strength requirement, then the areas represented by the cylinders will not be eligible for full payment. Payment adjustments will be made in accordance with clause 860.8.



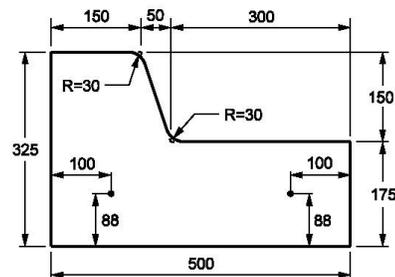
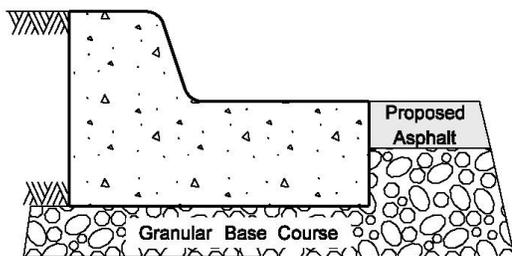
DETAILS OF MOLDS
SHOWING
DOWELS AT CONSTRUCTION JOINTS



BARRIER CURB "TYPE A"



BARRIER CURB "TYPE B"

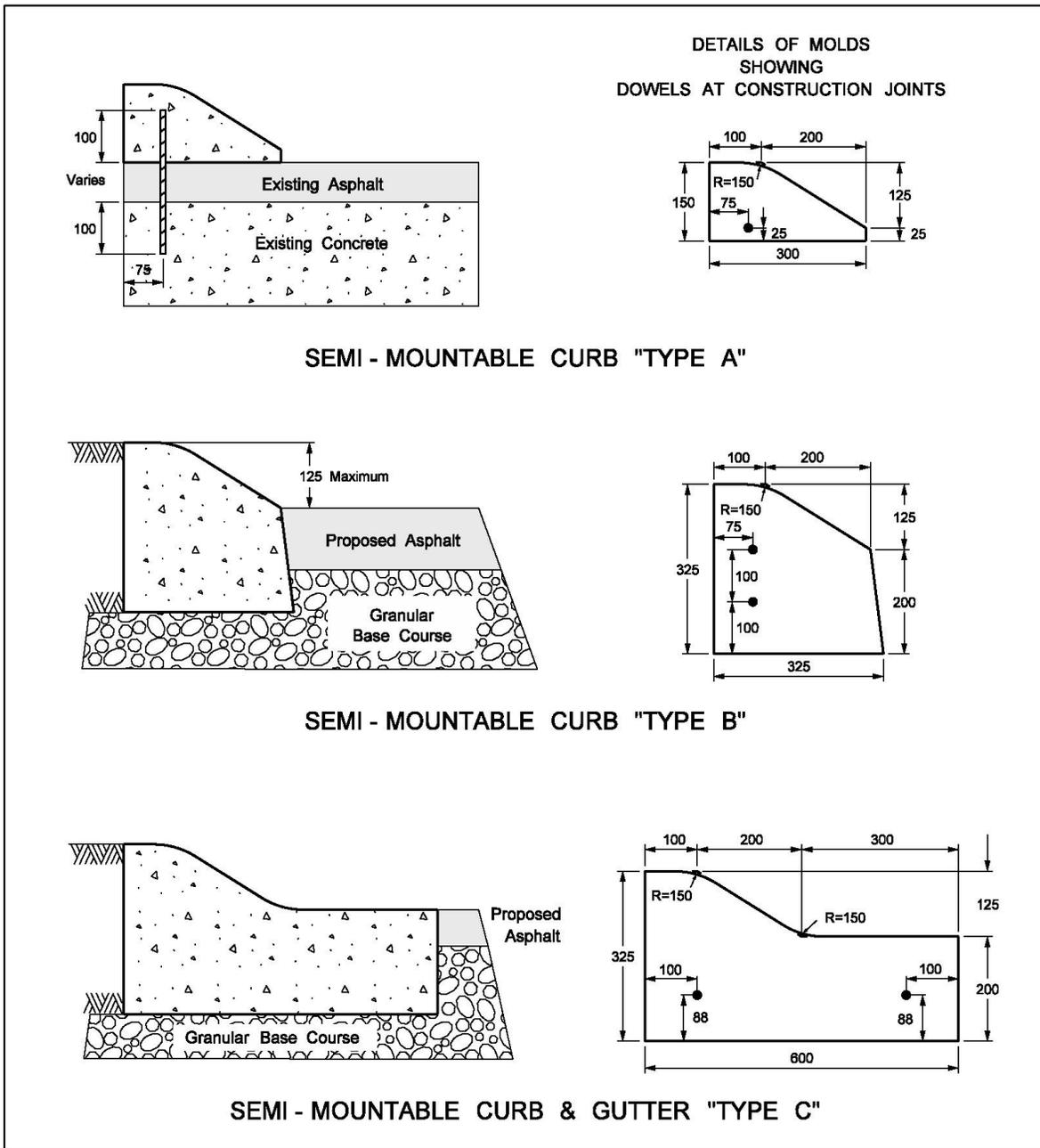


BARRIER CURB & GUTTER "TYPE C"

Notes:
March, 2003, Rev 1
Dimensions are in millimeters.
● Represents construction joint dowels (smooth or deformed) which shall be 15.88 mm in diameter and 300 mm long.
Tolerances for mold dimensions will be ± 5 mm

Standard Cross Sections
for
Barrier Concrete Curbing





Notes:
 March, 2003, Rev 1
 Dimensions are in millimeters.
 ● Represents construction joint dowels (smooth or deformed) which shall be 15.88 mm in diameter and 300 mm long.
 Tolerances for mold dimensions will be ± 5 mm

**Standard Cross Sections
for
Semi-Mountable Concrete Curbing**



~~860~~ 5.2 Supply

Materials supplied by the Contractor will be subject to approval and testing by the Department prior to purchase. A list of materials currently approved for use is available from the Department and all materials to be used must be on this list. All materials shall be applied in strict accordance with the manufacturer's recommendations. Samples shall be provided for testing when requested by the Engineer.

The Contractor shall be responsible for the supply, safe storage and handling of the following materials:

1. Concrete Constituent Materials
 - (i) Type 10 Normal Portland Cement
 - (ii) Aggregates
 - (iii) Water
 - (iv) Air-entraining agent
 - (v) Water reducing agent
 - (vi) Other admixtures
2. Dowels
3. Joint Sealants
4. Liquid, Membrane-Forming, Curing Compound
5. Epoxy Bonding Agents
6. Emulsified Asphalt
7. Reinforcing Steel
8. Fly Ash

5.3 Cement

Cement shall conform to the latest edition of CSA Standard A5.

5.4 Admixtures

All additives or admixtures to concrete, except air entraining and water reducing agents, shall require prior approval by the Engineer.

Air entraining agent shall conform to CSA A 23.1, Can 3-A 266.1 or ASTM C 260. Water Reducing Agent shall conform to CSA A 266.2 or ASTM C 494.

5.5 Fly Ash

The Contractor will have the option of adding fly ash to the concrete mix. If the Contractor elects to use fly ash, a 10 kg sample shall be provided for mix design purposes.

The concrete mixing plant shall have separate bins or compartments for the cement, fly ash and for each type and size of aggregate.

The use of fly ash in the concrete mix will be permitted. The replacement shall not exceed the following limits, by weight of total cementitious materials, depending on the type of cement used in the concrete. The types of cement shall be in accordance with CSA- A-3001-03, as amended.

~~860. 5.5 Fly Ash (Continued)~~

Type of Cement	Maximum Amount of Fly Ash Permitted
GU: General use of Hydraulic Cement	15%
MS or HS: Moderate or High Sulphate-resistant hydraulic cement	15%
HE: High Early strength hydraulic cement	0%
MH or LH: Moderate or Low Heat of hydration cement	0%

The use of Fly ash will not be permitted when the ambient temperature during placing is below 0° C or is expected to be below 0° C within 3 days of placement.

~~Fly ash shall be Type CI conforming to CAN/CSA A 3001-03 "Cementitious Material for use in Concrete", as amended, with the exception that the Loss on Ignition (LOI) shall not exceed 3%.~~

The contractor shall submit the mill certificate including chemical and physical composition and analysis, fly ash source and name of supplier. A new mill certificate shall be provided for each change of source of fly ash or when a new batch of fly ash is delivered. The certificate shall be produced prior to the start of production of concrete and approved by the Engineer.

The mill certificate shall detail the following properties and the fly ash supplied shall meet the following properties:

Property Limits	Ref Table in CSA A 3001-03	Specified Limit or Range
Fineness (% retained on 45µm sieve)	Table 6	Max. 34%
Autoclave Expansion	Table 6	0.8%
CaO %	Table 5	8 to 20%
SiO2 %	Table 5	Min. 50%
SO3 %	Table 2	Max. 3%
Loss on Ignition	Table 2	Max. 3%
Moisture Content		Max. 3%
Pozzolanic Strength	Table A.3	Min. 75% at 28 days

5.6 Aggregates

The Contractor shall supply aggregates in accordance with the "Specifications for Aggregate for Portland Cement Concrete".

860. 6 CONSTRUCTION METHODS

6.1 Curbing Constructed on Roadways

When curbing is to be constructed on a granular base course, other than in a trench, the Contractor shall perform his operation so that:

- the final lift of base course is not constructed until the curbing has been placed and cured.
- granular base course lifts are not less than 50 mm nor more than 100 mm in thickness,
- granular base course under the proposed curb is constructed slightly above the design elevation and fine graded. Should the granular base course lose density, due to a time delay between fine grading and the extrusion operation, the Contractor shall re-compact the granular base course to the specified density.

The design thickness of granular base course may require the Contractor to construct a pad of base course under the proposed curb to meet the above requirements.

6.2 Curbing Constructed in Trenches

Where a trench excavation is required to accommodate a granular base course and concrete curb, material shall be excavated to the specified width and depth. The subgrade shall be compacted to 95% AASHTO Standard Dry Density. In the event of adverse moisture conditions in the subsoil, the Engineer may approve the use of other specialized methods and equipment, including lime supplied by the Department.

The base course shall be constructed to the elevation staked by the Engineer, compacted to 98% AASHTO Standard Dry Density and waterproofed with undiluted emulsion.

The Contractor shall backfill behind the curb to match the level of the existing ground. Excess material shall be disposed of at a location provided by the Contractor and approved by the Engineer.

~~860~~ 6.3 Dowels

Concrete curbing to be constructed on top of or adjacent to existing concrete pavement shall be tied into the pavement using deformed dowels.

Holes drilled for dowels shall have a maximum diameter of 19 mm. Dowels shall be secured in the drill holes using an epoxy cement.

6.4 Hauling Concrete

Mixer and agitator trucks used to transport concrete shall be capable of delivering the concrete thoroughly mixed. The concrete shall meet the requirements for slump, air content and uniformity when it is discharged at the site. Water shall not be added during transportation. Unless otherwise permitted, concrete shall be delivered to the site and discharged within one hour of the time the cement was added to the mix.

A batch ticket showing the volume of the load and time of batching shall be provided with each load of concrete supplied by a Ready Mix Supplier.

When required by the Engineer to verify yield, hauling equipment shall be weighed on a platform scale before and after the discharge of concrete.

6.5 Placing Concrete

An approved slip form curbing machine shall be used to construct curbing except where conditions make the use of the machine impractical.

Placing concrete on an unstable, saturated or frozen base will not be permitted.

If required, the base shall be dampened with water prior to placing concrete.

The supply of concrete to the machine shall be sufficient for uninterrupted placement to the full width and depth of the mould on the curbing machine.

The slip form curbing machine shall be operated using a stringline to maintain profile and alignment. Concrete curbing will be rejected if the profile or alignment deviates in excess of 6 mm in 3 m from the design alignment and gradeline.

Test cylinders will be obtained and slump and air content will be checked by the Engineer at the time of placement. The Contractor shall supply concrete as required for field testing and for test cylinders.

When placing of concrete is suspended for more than 45 minutes a construction joint shall be formed and its location shall be at other than a contraction joint.

Curb openings such as for driveways and paraplegic ramps shall be constructed by the Contractor.

~~860-~~ 6.6 Formwork

Formwork, when required, shall be set to the grade and alignment staked by the Engineer and shall be secured so that no springing or deformation occurs during the placement and consolidation of the concrete.

Forms shall be straight and free from warp, and of sufficient strength to resist springing during the depositing and consolidation of the concrete. The top of any form or the contact face of a straight form shall not vary from a true plane by more than 6 mm in 3 metres. Forms for use on curves shall be capable of installation to within 12 mm of the true curve and if the radius is less than 50 metres, shall be either flexible material or shaped to fit the curve. The forms shall be designed so that they may be securely fastened together in the correct position. The top of the form shall be set to the elevation of the top of the curbing.

Formwork shall be properly cleaned and oiled prior to the placement of concrete. Formwork, in general, shall remain in place for at least twelve hours after concrete placement. Formwork on the curb face shall be removed, as required, to permit texturing.

6.7 Consolidation, Finishing and Curing

Freshly placed concrete shall be consolidated by the use of immersion type vibrators. Two or more vibrators shall be located in the hopper or mould of the slip form curbing machine.

The concrete shall not be finished by hand troweling unless absolutely necessary to produce a smooth level surface. If bleed water is present, troweling shall be delayed until the bleedwater has evaporated or has been removed.

After finishing, exposed surfaces shall be textured by brooming in a direction perpendicular to the curb alignment using a stiff bristle brush.

Exposed surfaces which have been textured shall be sprayed with a membrane curing liquid, except when the ambient air temperature is below 5°C.

6.8 Joints

Construction joints shall be formed at the end of each day's pour and when pouring has been delayed in excess of 45 minutes. Construction joints shall be fixed joints tied together with dowels. Dowels shall be placed at the termination of the pour while the concrete is still plastic or by drilling and grouting with epoxy cement prior to the commencement of the adjacent pour. Both sides of the construction joint shall be edged to produce a smooth uniform joint.

Contraction joints shall be constructed at 3 m intervals or to match existing contraction joints if the curbing is tied to existing concrete pavement. Contraction joints shall be sawn, or troweled and edged, to a width of 6 mm and to a uniform depth determined by the Engineer based on one-quarter of the depth of the concrete. Sawing shall be completed before contraction cracking has occurred. Where curbing is to be covered because of cold weather, the contraction joints shall be trowelled. The gutter portion of contraction joints shall be filled with a hot pour or mastic joint filler.

860. 7 WEATHER RESTRICTIONS

Concrete curbing shall not be constructed at any location where frost exists within 750 mm of the gutter base elevation.

Concrete curbing shall not be constructed when the ambient air temperature is below 0°C.

When the air temperature is between 0°C and 5°C, construction may be approved by the Engineer providing the temperature for the day is forecast to exceed 5°C and wind and precipitation conditions are anticipated to be favourable.

The Contractor shall provide and install sufficient plastic sheeting and straw to maintain a temperature of at least 10°C in the concrete for a minimum of forty-eight hours after it has been poured.

In the event the ambient air temperature drops below 0°C during this 48-hour period, the curbing shall be covered for a further five-day period.

860. 8 PAYMENT REDUCTION AND REJECTION

8.1 Deficient Workmanship

Concrete curbing shall be constructed free of cracking and honeycomb areas. Vertical and horizontal dowels shall be placed in accordance with the Standard Cross Sections for Concrete Curbing. Sections of curbing, not meeting the requirements of this specification, may be rejected by the Engineer.

Concrete with cracking that extends greater than 1/3 of the slab thickness shall be removed and replaced, or at the Department's option, accepted with zero payment. Any rejected

concrete resulting in zero payment shall be sealed by a method approved by the Engineer. All work and material for sealing the concrete will be at the Contractor's expense.

Concrete with cracking that extends less than 1/3 of the slab thickness may be repaired by methods approved by the Engineer. All work to remove and repair cracked concrete will be at the Contractor's expense.

8.2 Deficient Strength

The strength of concrete curbing will be based on cylinders cast by the Department. If the compressive strengths of the cylinders are at least 85% of the specified strength requirement and no single cylinder is less than 75% of the specified strength, the concrete will be deemed to have met the strength requirement. If the compressive strengths of the cylinders are less than 85% of the specified compressive strength, the following will apply:

1. Less than 85% but greater than 80% - Payment for the concrete will be reduced by 25% of the unit price.
2. Less than 80% but greater than 70% - Payment for the concrete will be reduced by 50% of the unit price.
3. Less than 70% - The concrete shall be removed and replaced at the Contractor's expense.

~~860.~~ 8.32 Deficient Materials

Concrete curbing not meeting the material requirements of section 3 or section 5, with the exception of the strength requirements, shall be removed and replaced, or at the Department's option, accepted with zero payment.

~~8.38.4~~ Rejected Work

Any section of curbing that is rejected shall be removed and reconstructed. No payment will be made to the Contractor for curbing which has been rejected.

860. 9 METHOD OF MEASUREMENT

Curbing will be measured on a linear metre basis along the base of the curb face.

Each dowel hole drilled and used will be counted.

860. 10 BASIS OF PAYMENT

The Contract unit price for Concrete Curbing - Barrier Curb, Type "A", Barrier Curb, Type "B", Barrier Curb and Gutter, Type "C", Semi-Mountable Curb, Type "A", Semi-Mountable Curb, Type "B" or Semi-Mountable Curb and Gutter, Type "C" will be payment in full for supplying all materials, for the construction of concrete curbing and for the performance of all operations pertaining or incidental thereto, as herein described.

Granular Base Course used in conjunction with the placement of Concrete Curbing will be measured and paid for at the Contract unit price for the applicable class of Granular Base Course used.

The Contract unit price for "Horizontal Dowels" will be payment in full for drilling horizontal holes into the concrete and for the performance of all operations pertaining or incidental thereto, as herein described.

The Contract unit price for "Vertical Dowels" will be payment in full for drilling vertical holes into the concrete and for the performance of all operations pertaining or incidental thereto, as herein described.

Where no unit price is provided in the Contract for drilling of dowel holes, the work will not be paid for directly but will be considered incidental to the construction of concrete curbing.