

**SPECIFICATIONS FOR**  
**FABRICATION AND DELIVERY OF PRECAST CONCRETE BARRIERS**

**1.0 DESCRIPTION**

The Work shall consist of:

- .1 The supply of materials and the fabrication of precast concrete barriers as shown and described on the Drawings and in this Specification;
- .2 The supply of all materials embedded in the precast concrete barriers;
- .3 The handling and storage of the precast concrete barriers;
- .4 The loading, transporting, unloading and stockpiling of the precast concrete barriers at a location specified in the Special Provisions; and
- .5 The quality control (QC) testing of all materials.

**2.0 REFERENCES AND RELATED SPECIFICATIONS**

All reference standards and related specifications shall be current issue or the latest revision at the date of tender advertisement.

**2.1 References**

- CSA A23.1, Concrete Materials and Methods of Concrete Construction
- CSA A23.2, Methods of Test and Standard Practices for Concrete
- CSA A3001, Cementitious Materials for Use in Concrete
- CSA G30.18, Billet-Steel Bars for Concrete Reinforcement
- CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles
- ASTM C 260, Standard Specification for Air Entraining Admixtures for Concrete
- ASTM C 494, Standard Specification for Chemical Admixtures for Concrete
- ASTM C 1017, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

**3.0 SUBMITTALS****4.0 MATERIALS****4.1 Concrete**

Concrete shall meet the requirements of CSA A23.1, Exposure Class C-1, Air Content Category 1 for hardened concrete and shall have a minimum compressive strength of 40 MPa at 28 days.

**.1 Coarse Aggregate**

The maximum nominal size of coarse aggregate shall be 20 mm and meet the grading requirements of CSA A23.1, Table 11, Group 1. Coarse aggregate shall be uniformly graded and not more than 1% shall pass a 75 µm sieve. Coarse aggregate shall consist of crushed stone or gravel or a combination thereof, having hard, strong, durable particles free from elongation, dust, shale, earth, vegetable matter or other injurious substances.

Tests of the coarse aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1, Table 12, for concrete exposed to freezing and thawing.

.2 Fine Aggregate

Fine aggregate shall meet the grading requirements of CSA A23.1, Table 10, FA1. Fine aggregate shall be uniformly graded and not more than 3% shall pass a 75  $\mu\text{m}$  sieve. Fine aggregate shall consist of sand, stone, screenings, other inert materials with similar characteristics or a combination thereof, having clean, hard, strong, uncoated grains free from injurious amounts of dust, lumps, shale, alkali, organic matter, loam or other deleterious substances.

Tests of fine aggregate shall not exceed the limits for standard requirements prescribed in CSA A 23.1, Table 12.

.3 Admixtures

Air entraining admixtures shall conform to the requirements of ASTM C 260.

Chemical admixtures shall conform to the requirements of ASTM C 494 or C 1017 for flowing concrete.

.4 Cementitious Materials

Cementitious materials shall conform to the requirements of CSA A3001.

Should the Contractor choose to include silica fume in the concrete mix design, the substitution of silica fume shall not exceed 8% by mass of cement.

Should the Contractor choose to include fly ash in the concrete mix design, the fly ash shall be Class CI and the substitution shall not exceed 25% by mass of cement.

4.2 Reinforcing Steel

The Contractor shall supply the reinforcing steel. The reinforcing steel shall conform to the requirements of CSA G30.18 Grade 400W.

4.3 Embedded Materials

The Contractor shall supply all embedded materials. Embedded materials shall be galvanized and shall conform to the requirements shown on the Drawings and are subject to the approval of the Engineer.

4.4 Replacement of Damaged Materials

All material supplied by the Contractor that in the opinion of the Engineer has been damaged or otherwise rendered unusable by improper storage or handling by the Contractor shall be replaced by the Contractor at his own expense.

**5.0 CONSTRUCTION METHODS**

5.1 General

The Contractor shall ensure that the concrete is properly batched, mixed, placed and cured.

The precast concrete barriers shall be constructed as shown on the Drawings with the following exceptions:

- (a) Optional anchorage blockout will not be required; and

(b) The 45 mm diameter holes through the barriers shall have a 5 mm chamfer around the circumference of the hole on both sides of the barrier.

## 5.2 Tolerances

Cross sectional dimensions throughout the entire length of the barrier shall not vary from those shown on the Drawings by more than 5 mm.

The locations of the reinforcing steel shall not vary from those shown on the Drawings by more than 5 mm.

For the horizontal alignment, the maximum deviation from a straight line parallel to the centreline of a barrier shall be 5 mm.

The bottom surface of barriers at the bearing areas shall be in a true level plane, which does not vary by more than 5 mm from a true straight edge placed in any direction across the bearing area.

## 5.3 Forms

Steel forms shall be used. The faces of the forms shall be smooth so as to impart a good finish to the concrete. Particular care shall be taken to ensure the verticality and rigidity of the form ends that produce surfaces that will be in contact with each other after installation. Forms shall produce precast concrete barriers that conform to the shape, lines and dimensions as shown on the Drawings and within the tolerances described in Section 4.2 of this Specification.

Forms shall be designed for the rate and method of concrete placement.

The faces of the forms shall be treated with a release agent to ensure that stripping may be carried out without damage to the concrete. Care shall be taken to prevent the release agent from coming in contact with any reinforcing steel or embedded materials.

Forms shall include temporary openings to facilitate the removal of all foreign substances prior to placing the concrete.

## 5.4 Installation of Embedded Materials

Embedded materials shall be placed in the positions as indicated on the Drawings and fixed securely to the forms to ensure that there is no displacement during placing or vibrating of the concrete.

## 5.5 Reinforcing Steel

Reinforcing steel shall be placed accurately in the positions shown on the Drawings, and shall be retained in such positions by means of bar accessories and wires so that the bars shall not be moved out of alignment during or after the depositing of concrete. Bar accessories shall be galvanized or shall be made from non rusting material.

Reinforcing steel shall be kept free of all foreign materials in order to ensure a positive bond between the concrete and steel. The Contractor shall remove any material that has been deposited on the reinforcing steel before concrete is placed.

Intersecting bars shall be tied positively at each intersection.

## 5.6 Depositing of Concrete

The temperature of the mixed concrete shall not be less than 15°C and not more than 25°C at the time of placing in the forms. Aggregates may be heated to a temperature of not more than 65°C. The heating

apparatus and housing for the aggregates shall be sufficient to heat the aggregates uniformly without the possibility of the occurrence of hot spots that may burn the materials. The water may be heated to a temperature of not more than 65°C.

Concrete shall be deposited carefully and vibrated so that it fills the forms completely and makes complete contact with all reinforcing bars and embedded materials.

The Contractor shall provide sufficient personnel to deposit and vibrate the concrete and shall ensure that each batch of concrete is vibrated properly into place as it is deposited.

Buckets, chutes and other equipment used to deposit concrete in the forms shall be positioned as close to the top of the forms as possible to minimize the free fall of the concrete.

Depositing of concrete shall be a single continuous complete operation so that each barrier shall be monolithic without joints.

Before any concrete may be deposited, the interior of the forms shall be cleaned of all chips, earth, shavings, sawdust, rubbish or other foreign substances.

#### 5.7 Vibrating Concrete

Vibrators shall be of sturdy construction, adequately powered and capable of transmitting to the concrete not less than 3,600 impulses per minute when operating under load. The vibration shall be sufficiently intense to cause the concrete to flow or settle readily into place and to visibly affect the concrete over a radius of at least 450 mm from the vibrator when used in concrete having a 25 mm slump.

A sufficient number of vibrators shall be employed so that at the required rate of placement, vibration and complete compaction are obtained throughout the entire barrier. At least one extra vibrator shall be on hand for emergency use.

Internal vibrators shall be constantly moving vertically in the concrete and shall be applied at points uniformly spaced that are not farther apart than the radius over which the vibrator is visibly effective. Internal vibrators shall be applied close enough to the forms to vibrate the surface concrete effectively but care shall be taken to avoid displacing or damaging the forms.

The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete but shall not be continued so as to cause segregation or draw a pool of grout from the surrounding area.

#### 5.8 Concrete Finish

Immediately after the removal of the forms, all defects in the concrete shall be repaired as directed by the Engineer, provided the defects are not extensive enough to cause rejection of the barrier. Should the top surface exhibit excessive laitance or "frothing" or any other deleterious effects, the Contractor shall repair the concrete to the satisfaction of the Engineer.

Honeycomb, if any, shall be repaired as soon as the forms are taken off. When approved by the Engineer, repairs shall be accomplished by: removing all aggregate that is loose or that is not bonded thoroughly to the surrounding concrete; washing the sound concrete with clean water; using a wire brush to remove any loose particles; applying an approved epoxy resin to the dried areas; and applying a cementitious mortar. The cementitious mortar shall have the same quality and mix as that used for the concrete. Patched areas shall be rubbed flush with the surrounding surface after the cementitious mortar has hardened.

All objectionable fins, projections, offsets, streaks, and other surface imperfections shall be removed totally to the Engineer's satisfaction by approved means.

Finally, the concrete surface shall be wetted down thoroughly and all air pockets larger than 6 mm in diameter and other surface cavities shall be filled carefully with the approved cementitious mortar. When sufficiently dry, the surface shall be rubbed down to leave a smooth and uniform finish. Cement washes of any kind will not be allowed.

If, in the Engineer's opinion, repairs to the concrete are not satisfactory or will be detrimental to the strength or long term durability of the barrier, the Contractor shall, at this own expense and as directed by the Engineer replace the barrier.

#### 5.9 Curing

Concrete shall be either moist cured for a minimum of 72 hours from the time of casting or steam cured until the concrete has reached a strength of 25 MPa.

If steam curing is used, steam shall not be applied until after the initial set has taken place. Initial set will be considered to have taken place 4 hours after the completion of concrete placing.

During steam curing, the rise in the ambient air temperature shall not exceed 20°C per hour to a maximum temperature of 60°C.

Once curing has been completed, the temperature of the concrete shall not be allowed to fall at a rate exceeding 20°C per hour.

The barriers shall not be subjected to freezing temperatures before reaching the design strength of 40 MPa. The barriers, including any patched areas, shall be properly cured within the plant a minimum of three (3) days before being subjected to freezing conditions. The Contractor shall monitor the rate of cooling and avoid thermal shock from prematurely subjecting the barrier to freezing temperatures.

#### 5.10 Handling and Storage

The Contractor shall be responsible for storage of the barriers from the completion of their fabrication until they are delivered to the location specified in the Special Provisions. The Contractor may have to store, free of charge, all or portions of the fabricated materials past the delivery date specified in the contract documents, for a period of up to one year.

During handling and storage, the barriers shall be maintained in an upright position and shall be supported at the bearings areas. The barriers may be stacked two (2) barriers in height. Care shall be exercised during the handling and storage of the precast concrete barriers to avoid twisting, cracking or other distortion that may result in damage to the barriers.

#### 5.11 Loading, Transporting, Unloading and Stockpiling

During loading, transporting, unloading and stockpiling of the barriers, the Contractor shall be responsible for protecting the barriers at the restraint points. Any damaged corners or surfaces of the barriers are to be regarded as honeycomb and repaired in accordance with Section 5.8 of this Specification.

Care shall be exercised during the loading, transporting, unloading and stockpiling of the precast concrete barriers to avoid twisting, cracking or other distortion that may result in damage to the barrier. The Contractor and the Engineer shall visually inspect the barriers once they have been unloaded and stockpiled at the location specified in the Special Provisions. Extensive cracking of the barriers during these operations will be basis for rejection by the Engineer.

Timber blocking (150 mm x 150 mm) shall be placed under the barriers at two (2) locations along the length as directed by the Engineer.

It is the Contractor's responsibility to ascertain the actual weight of the barriers prior to transporting.

## **6.0 QUALITY MANAGEMENT**

### **6.1 Qualified Testing Personnel**

The Contractor shall be responsible for quality control testing and all testing shall be completed by qualified personnel who are certified at the time of testing as ACI CSA-based Concrete Field Testing Technicians Grade 1.

### **6.2 Test Cylinders**

The Contractor shall cast a sufficient number of cylinders for every 10 m<sup>3</sup> of concrete placed in a barrier in order to establish that the concrete has achieved the minimum compressive strength of 40 MPa. The minimum compressive strength will be deemed to have been obtained when the average compressive strength of three (3) cylinders from an individual batch equals or exceeds 40 MPa.

The compressive strength of the concrete shall be determined from standard 100 mm diameter x 200 mm test cylinders or 15 mm diameter x 300 mm test cylinders that have been moulded, cured and tested in accordance with CSA A23.2.

### **6.3 Concrete Batches**

In addition to moulding of test cylinders, the Contractor shall perform and record the results of the following tests for every 10 m<sup>3</sup> of concrete placed in a barrier:

- (a) Slump;
- (b) Air; and
- (c) Temperature.

The Contractor shall be responsible for maintaining an up-to-date record of all test results on a "Record of Concrete Strength" from approved by the Engineer. A separate "Record of Concrete Strength" form shall be prepared for each barrier and the strengths of the test cylinders as well as the pertinent data shall be listed in the same order as the batches of concrete were placed in the forms. A complete set of test results shall be submitted to the Engineer within 7 days after the date that the final cylinder from the last barrier was tested.

### **6.4 Quality Assurance**

The Engineer, at his discretion and MIT's expense, may complete other tests deemed necessary on: the concrete; the concrete constituent materials; or any finished or partially finished barrier. The Contractor shall allow the Engineer unhindered access to the concrete, concrete constituent materials and barriers and shall assist the Engineer in carrying out any test.

During fabrication of the precast concrete barriers, the Contractor shall weigh completed barriers to verify the mass when requested by the Engineer.

## **7.0 METHOD OF MEASUREMENT**

Fabrication and delivery of precast concrete barriers will be measured on a Contract unit basis and the number to be paid for will be the total number of barriers fabricated and delivered as accepted by the Engineer.

The supply and placement of embedded materials is considered incidental to the work and no separate measurement will be made for this work.

## **8.0 BASIS OF PAYMENT**

Fabrication of precast concrete barriers will be paid for at the Contract Unit Price per barrier for "Supply of Precast Concrete Barriers", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

Delivery of precast concrete barriers will be paid for at the Contract Unit Price per barrier for "Delivery of Precast Concrete Barriers", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.