SPECIFICATIONS FOR FABRICATION OF PRECAST CONCRETE PANELS

1.0 DESCRIPTION

The Work shall consist of:

.1 The supply of materials and the fabrication of precast concrete panels as shown and described on the Drawings and in this Specification.

.2 The supply of all materials embedded in the precast concrete panels.

.3 The handling and storage of the precast concrete panels.

.4 The loading onto the General Contractor's hauling equipment.

.5 The quality control (QC) testing of all materials.

2.0 REFERENCES AND RELATED SPECIFICATIONS

2.1 All reference standards shall be current issue or latest revision at the first date of tender advertisement.

- CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete
- CAN/CSA A3001, Cementitious Materials for Use in Concrete
- CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement
- AASHTO T 176, Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test Nineteenth Edition
- ASTM C 29, Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
- ASTM C 40, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
- ASTM C 42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- ASTM C 70, Standard Test Method for Surface Moisture in Fine Aggregate
- ASTM C 88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C 117, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C 127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- ASTM C 128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
- ASTM C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM C 138, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- ASTM C 142, Standard Test Method for Clay Lumps and Friable Particles in Aggregates
- ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C 289, Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
- ASTM C 295, Standard Guide for Petrographic Examination of Aggregates for Concrete
- ASTM C 457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- ASTM C 494, Standard Specification for Chemical Admixtures for Concrete

- ASTM C 535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C 586, Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
- ASTM C 1017, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C 1064, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- ASTM C 1084, Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete
- ASTM C 1202, Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
- ASTM C 1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
- ASTM C 1583, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
- ASTM C 1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM D 75, Standard Practice for Sampling Aggregates
- ASTM D 4791, Standard Test Method for Flat Particles, Elongated Particles or Flat and Elongated Particles in Coarse Aggregate
- ASTM D 5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- ASTM D 6928, Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- ASTM D 7428, Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

2.2 Related Specifications

- Specifications for Aggregate for Portland Cement Concrete
- Specifications for Supplying and Placing Concrete Reinforcement
- Specifications for Supply, Fabrication and Erection of Miscellaneous Metal

3.0 SUBMITTALS

The Contractor shall submit the following to the Engineer, in accordance with the Special Provisions:

.1 Concrete mix design that meets the minimum compressive strength of 45 MPa at 28 days. Any changes to the concrete mix design shall be reviewed by the Engineer prior to the Contractor implementing the change.

The concrete mix design shall specify:

a) Concrete mix design proportions

b) Type of cementitious materials used and source locations

c) Designated size of aggregates, and aggregate gradations

d) Aggregate source locations

e) Maximum water/cement ratio

f) The design slump

g) The limits for air content

h) Type and brand of admixtures

i) Certification that all concrete constituents are compatible

The concrete mix design(s) shall be sealed by a Professional Engineer licensed in the Province of Manitoba.

.2 Copies of all reports, including but not limited to: "Record of Concrete Strength" form and material quality control test results.

The Contractor shall conduct and supply copies of all the following material quality control test results:

a) Aggregate testing specified in CSA A23.1 Clauses 4.2.3.3, 4.2.3.4, 4.2.3.5.1, 4.2.3.6, 4.2.3.7, and Tables 10, 11, and the Standard requirements for concrete exposed to freezing and thawing listed in Table 12.

b) Abrasion and impact testing results for coarse aggregate in accordance with CSA A23.2-16A.

c) Report on alkali-aggregate reactivity testing, CSA A23.2-27A.

d) Report on aggregate petrographic examination, CSA A23.2-15A. Petrographic examination of the aggregate shall be done by an experienced petrographer. The weighted petrographic number shall not exceed 125. The report from the petrographer shall confirm that the aggregate is suitable for the intended use and exposure class.

e) Report on chloride ion penetrability test ASTM C 1202.

f) Report on the water soluble chloride ion content by mass of cementing material in the concrete, CSA A23.2-4B.

g) Report on Air Content of Hardened Concrete ASTM C 457.

All testing of concrete and concrete constituents by the Contractor shall be done by an independent laboratory certified by the Canadian Standards Association except the plastic concrete testing (Slump, Air Content and Cylinders) and concrete cylinder compressive strength testing during casting can be done by the Contractor's Quality Control Technician (ACI Certified Concrete Testing Technician) as approved by the Engineer.

4.0 SUPPLY OF MATERIALS

4.1 Concrete

Concrete shall have a minimum compressive strength of 45 MPa at 28 days with a post-cracking residual strength index (Ri) of 0.15 using synthetic fibres and meet requirements of CSA A23.1, Exposure Class C-1, Air Content Category 1 for hardened concrete.

.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 I. Coarse aggregate shall be uniformly graded and not more than 1% shall pass a 75 um 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, be graded uniformly and not more than 3% shall pass a 75 um sieve. Fine aggregate shall consist of sand, stone, screenings, other inert materials with similar characteristics or a combination thereof, having clean, hard, strong, durable, uncoated grains free from injurious amounts of dust, lumps, shale, alkali, organic matter, loam or other deleterious substances.

Tests of the fine aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1, 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 a silica fume admixture 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 substitution shall not exceed 20% by mass of cement. The fly ash shall meet the following requirements:

Chemical and Physical Parameters	**Specification**
CaO Content	10 - 20%
Loss of Ignition	< 1%
Fineness Retained on the 45 µm Sieve	< 15%
Blaine	300 – 400 m^2/kg
Strength Activity Index	
% Control at 7 Days	≥ 85%
% Control at 28 Days	≥ 95%

.5 Synthetic Fibres

The synthetic fibres for the precast concrete panels shall consist of 100% virgin polypropylene. The dosage shall be designed by the Contractor to meet the requirements for post-cracking residual strength as specified in Clause 4.1.

Synthetic fibres must be approved as identified in MIT's Approved Products List and shall be to the satisfaction of the Engineer. Any synthetic fibre that is not in MIT's Approved Products List will be subject to approval by the Engineer.

4.2 Reinforcing Steel

The Contractor shall supply the reinforcing steel. 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 conform to the requirements shown on the Drawings and described in Specifications for Supply, Fabrication, and Erection of Miscellaneous Metal, 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 expense.

5.0 CONSTRUCTION METHODS

5.1 General

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

5.2 Tolerances

Cross-sectional dimensions throughout the entire length of the panel 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 panel shall be 5 mm.

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. Forms shall produce precast concrete panels that conform to the shape, lines and dimensions as shown on the Drawings and within the tolerances described in Section 5.2 of this Specification.

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.

All foreign substances shall be removed from the forms 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 the placing or vibrating of 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.

The Contractor shall mark the location of all reinforcing steel bars on the edges of the forms used to cast the panels and then shall transfer these marks onto the surface edges of the cast panels. Marking shall be made with broad-tipped permanent marker or other approved method on the unformed surface edges of each panel.

5.6 Depositing of Concrete

The temperature of the mixed concrete shall not be less than 10°C and not more than 20°C at the time of placing in the forms. When heating of aggregates and water is required to provide concrete temperatures within the above noted range, aggregates and water shall 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 which may burn the materials.

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 panel shall be monolithic without joints.

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 panel. 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 panel. 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 panel, the Contractor shall, at his own expense and as directed by the Engineer replace the panel.

5.9 Curing

The panels shall be cured until the concrete has reached a minimum compressive strength of 35 MPa. Concrete can either be moist-cured or steam cured.

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 15°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 panels shall not be subjected to freezing temperatures before reaching a compressive strength of 35 MPa. The panels, 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 panel to freezing temperatures.

5.10 Handling and Storage

The Contractor shall be responsible for storage of the panels from the completion of their fabrication until they are required by the General Contractor. The Contractor may have to store, free of charge, all or portions of the fabricated material past the delivery date specified in the contract documents, for a period of up to one year.

During storage, the panels shall be maintained in a horizontal position and shall be, as a minimum, supported at the corners. Care shall be exercised during the handling and storage of the precast concrete panels to avoid twisting, cracking or other distortion that may result in damage to the panel.

The precast concrete panels shall be marked in accordance with Clause 27.5 of CSA A23.4. The markings shall be made with permanent (stenciling) ink on the unformed face of each panel prior to stripping the forms. Markings shall be located so that the markings are visible during storage.

The General Contractor will give the Contractor 48 hours notice of his intention to pick up the panels. The Contractor shall load the panels onto the General Contractor's hauling equipment and shall co-operate with the General Contractor as to the loading procedures.

6.0 QUALITY MANAGEMENT

6.1 Quality Control

.1 General

Batches of concrete that do not meet the requirements of this Specification will be rejected by the Engineer. The Engineer reserves the right to require immediate removal of any concrete from the rejected batches that may have already been placed in the forms.

The Contractor shall be responsible for all concrete testing, including but not limited to making test cylinders, transporting cylinders to an independent certified testing laboratory of his choice, storage, curing, breaking, and providing written reports of the concrete test results to the Engineer.

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, and shall be conducted at the point of discharge into the forms.

.2 Compressive Strength Tests

A “Strength Test” shall consist of the compression test of four standard test specimens, sampled, cast, cured, and tested in accordance with CSA Standard Specifications as referenced with modifications as indicated. One cylinder shall be tested at seven (7) days. One cylinder shall be tested at fourteen (14) days. The 28 day test result shall be the average of the strengths of the remaining two specimens. Additional cylinders may be cast, at the discretion of the Engineer or Contractor.

Compressive strength tests shall be completed by the Contractor for every 10 m3 of concrete placed in the forms. As a minimum, one compressive strength test shall be completed each day that concrete is placed.

Additional test cylinders shall be made, cured and tested as required by the Contractor to verify that the concrete has reached the minimum strength of 35 MPa identified in Section 5.9 of the Special Provisions

The compressive strength of the concrete shall be determined from standard 100 mm diameter x 200 mm test cylinders or 150 mm x 300 mm test cylinders that have been molded, cured and tested in accordance with CSA A23.2.

.3 Additional Testing Requirements

In addition to the compressive strength tests, the Contractor shall perform and record the results of the following tests for each concrete batch:

.1 Slump tests completed in accordance with CSA A23.2 – 5C.

.2 Air content tests completed in accordance with CSA A23.2 – 4C.

.3 Temperature tests completed in accordance with ASTM C 1064.

The Contractor shall be responsible for maintaining an up-to-date record of all test results on a "Record of Concrete Strength" form approved by the Engineer. A separate "Record of Concrete Strength" form shall be prepared for each panel 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 panel was tested.

6.2 Quality Assurance

Visual inspection and sampling will be done in the fabrication plant by the Engineer to confirm the material supplied and the fabrication has been done as specified on the Drawings, in this Specification and in the Special Provisions. The Contractor shall supply material specimens for concrete testing when requested by the Engineer.

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

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

7.0 METHOD OF MEASUREMENT

Fabrication of precast concrete panels will be measured on a square meter basis and the number to be paid for shall be the total number of square meters fabricated and delivered as accepted by the Engineer.

The supply 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 panels will be paid for at the Contract Unit Price for "Supply of Precast Concrete Panels", 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.