

PRECAST CONCRETE ROOF PANELS WITH CONCRETE TOPPING

1. GENERAL

1.1 Work Included

- .1 Double-tee and hollow core panels.
- .2 Connecting and supporting devices.
- .3 Formed openings in panels.
- .4 Grouting of hollow core panels.
- .5 Bonded Concrete topping.

1.2 Design, Supply and Installation Requirements

- .1 Design of precast concrete members and connections to conform to CSA A23.4-05, CSA A23.3-04 Clause 16, and Canadian Prestressed Concrete Institute Design Handbook, under direct supervision of a Professional Engineer registered in the Province of Manitoba, fully experienced in the design of precast concrete structural units.
- .2 Design all members and connections to safely support their own weight, superimposed loads and wind loads shown on Drawings, and all other forces and loads to which the structural members may be subjected. Special double-tee stem design may be required for large concentrated loads. Design the precast double-tee panels in composite action with the concrete topping. All precast concrete members shall act as roof in-plane diaphragms, typically bounded by cast-in-place perimeter beams with upstands or similar beams. Design in accordance with CSA A23.3-04, Clause 16.5.2.3. Spacing of connectors shall be determined by the precast concrete Manufacturer.
- .3 Design and provide adjustable double-tee flange connections at the interfaces with structure perimeter beams to accommodate camber of double-tee panels and vertical roof movement with respect to the supporting structure, and to transfer lateral tension/compression forces between perimeter beams and the double-tee flanges.
- .4 Design and provide slide bearings at one end of double-tee panel stems to accommodate movement. Design and provide non-moving bearings at the other end of double-tee panel stems.
- .5 Design and provide all other connecting elements such as panel to panel connectors and panel to support connectors, and all other hardware necessary for a completely installed roof system, including hardware to be installed by others in separate contracts.
- .6 Design precast units for a maximum live load deflection of $1/360$ of the span.
- .7 Design and carry out panel-to-panel, and panel-to-support structure field welding sequences such that the roof panel assembly will be safely supported and secured at all phases of

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installation without moving from its position, and without locking in strains and stresses that might be detrimental to the service performance of the roof panel-support structure system.

- .8 Double-tee flanges shall be 50 mm thick, and the concrete topping nominally 50mm thick.
- .9 Concrete topping shall be minimum 40 mm thick at the apex of the precast member camber. Design members such that the camber for the composite section due to all dead loads is minimized.

1.3 Qualifications

- .1 Manufacturer is to be certified for prestressed precast concrete products under CAN/CSA A251-00.

1.4 Quality Assurance

- .1 Fabricate and install precast concrete roof deck in accordance with requirements of CSA A23.4-05.
- .2 Maximum allowable manufacturing and erection tolerances are not to exceed those given in CSA A23.4-05.

1.5 Inspection and Testing

- .1 In addition to the Contractor's quality control, an independent inspection and testing company may be appointed and paid for the City. Notify Contract Administrator at commencement of shop work so inspection and testing may be scheduled.
- .2 Provide free access to all portions of manufacturing plant and cooperate with appointed firm.
- .3 If requested by Contract Administrator, submit proposed mix design for review prior to commencement of work.
- .4 Testing of cement and aggregates may be required to ensure conformance with requirements stated herein.
- .5 Testing of concrete will be performed in accordance with CSA A23.4-05 and CSA A23.1-04. In addition, make available for inspection and review, records from in-house quality control procedures based upon plant certification requirements.
- .6 Make available certified copies of mill test reports of steel reinforcement supplied, showing physical and chemical analysis.
- .7 Inspect prestressing tendons in accordance with CSA A23.4-05.
- .8 If defects are revealed during testing of concrete and/or inspection of fabricated precast concrete members, Contract Administrator will request additional testing and/or inspection to ascertain full degree of defects.

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- .9 Correct defects and/or irregularities to the satisfaction of the Contract Administrator. Further testing and/or inspection, under similar conditions as earlier, will be performed. The Contractor shall pay all costs for retesting and re-inspection.
- .10 Test results will be issued to Contract Administrator.

1.6 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300 - Submittals.
- .2 Prepare shop drawings and calculations under the seal of a Professional Engineer registered in the Province of Manitoba.
- .3 Provide for Contract Administrator's review, copies of design calculations for reinforcing, hoisting, installation, and connection and anchorage devices, estimated camber, and other items designed by the Manufacturer.
- .4 Clearly indicate layout, product locations, fabrication details, unit identification marks, reinforcement, openings, sleeves, inserts, related reinforcement, connection details, dimensions, erection support points, anchors and relationship to adjacent materials in sufficient detail to cover manufacture, handling and erection.
- .5 Do not proceed with fabrication until shop drawings and design calculations have been reviewed by the Contract Administrator.

1.7 Transportation/Handling/Storage

- .1 Submit method of handling and erection to the Contract Administrator for review prior to installation.
- .2 Handle all precast members in a position consistent with their shape and design. Do all lifting and supporting only from support points indicated on shop drawings. Accept full responsibility for delivery, handling and storage of units.
- .3 Embedded lifting or handling devices are to be capable of supporting members in all positions anticipated during manufacture, storage, transportation and erection. Maintain capacity of lifting devices sufficient to resist forces of minimum 2.5 times weight of member.
- .4 Deliver members to site completely finished. Clearly mark members as indicated on shop drawings, with date of production and final position on structure.
- .5 Block and laterally brace members during transport and while stored on site. Provide lateral bracing sufficient to prevent bowing and warping. Blocking and bracing to be clean, non-staining, and it shall not prevent uniform curing of exposed surfaces.
- .6 Provide edges of members with adequate protection to prevent staining, chipping or spalling of concrete.

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2. PRODUCTS

2.1 General

- .1 Use forms and beds which are rigid, adequate to withstand prestressing forces and constructed of materials that will result in finished products conforming to requirements stated herein and on the Drawings.
- .2 Establish concrete mix design by tests on trial batches to achieve required strengths. Maintain water content as constant as possible during manufacture.
- .3 Reinforcement of the double-tee panel deck shall be centered in the top slab.
- .4 Deposit and vibrate concrete to ensure proper consolidation, elimination of unintentional cold joints, and to minimize entrapped air on surfaces.
- .5 Fabricate all required connecting devices, plates, angles, inserts, bolts and accessories.
- .6 Provide anchors and inserts to support loads as shown on the Drawings.
- .7 Perform shop welding of connecting and supporting devices in accordance with requirements of CSA W59-03.
- .8 Ensure anchors, inserts, plates, angles and other cast-in items are accurately located. Maintain in position while concrete is placed and consolidated.
- .9 Provide 20 mm diameter holes at 1200 mm centre-to-centre through every stem on double-tee panels. Locate holes at approximately mid-height of stem.
- .10 Provide bracing and/or shoring for cast-in-place concrete beams and columns completed under separate contract for any installation loads in excess of the design loads stated on the contract drawings.

2.2 Finish

- .1 Provide heavy broom finish for the double-tee top slab, steel trowel finish for the hollow core slabs. Finish of formed surfaces shall conform to the requirements of CSA A23.4-05, Commercial Grade.
- .2 Provide power steel trowel finish for the concrete topping.

2.3 Concrete Materials

- .1 Cement: normal Portland cement - Type GU, conforming to CAN/CSA A3000-03.
- .2 Fine and Coarse Aggregates: conforming to CSA A23.4-05, from a single source for each type of aggregate for entire job.

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- .3 Water: potable, free of deleterious matter that may interfere with finish, strength and colour of concrete.
- .4 Class of exposure of the precast concrete members shall be F-1 in accordance with CSA A23.1-04, Table 2.

2.4 Reinforcement

- .1 Reinforcing Steel: 400W MPa yield grade, deformed billet steel bars conforming to CSA G30.18-M92 (R2002), galvanized finish.
- .2 Reinforcing Wire: 480 MPa yield grade, deformed steel wire, conforming to CAN/CSA G12-92 (R2003), galvanized finish.
- .3 Welded Steel Wire Fabric: plain type, galvanized finish.
- .4 Prestressing Tendons: uncoated seven-wire strand. Specified tensile strength, f_{pu} = 1860 MPa, conforming to ASTM A416/A416M-05.

2.5 Hardware

- .1 Connections, Supporting Devices: Flange connectors and panel end connectors of double-tee panels, including those to be embedded in the cast-in-place beams opposite to panel ends, shall be Type 304 stainless steel. Embedded item anchors for areas WF, WP and WR shall be Type 304 stainless steel. Other connectors and supporting devices shall be Type W Grade 300 steel, conforming to CSA G40.21-04, all galvanized to CAN/CSA G164-M92 (R2003), 600 g/m² min. zinc coating after fabrication. Provide embedded steel shoe plates at double-tee stem bearing ends. Refer also to Section 2.5.2.b below.
- .2 Bolts, Nuts and Washers: conforming to ASTM A325, cadmium plated.
- .3 Anchors, Inserts: patented, load-tested galvanized steel.
- .4 Sleeves for crane, monorail and lifting eye anchors: ASTM A53, 170 Mpa, Type F galvanized pipe
- .5 Bearings:

Slide Bearings:
 - a. 100% virgin polytetrafluorethylene (PTFE) sliding surfaces between two layers of minimum 5 mm thick reinforced elastomeric pads.
 - b. Upper sliding surface may be mirror finish embedded Type 304 stainless steel shoe plate.
Non-moving Bearings: Elastomeric pads with thickness to match thickness of Slide Bearings.

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- .6 Welding Materials: conforming to CAN/CSA W48-01.

2.6 Prime Paint

- .1 Touch-up Primer on galvanized surfaces: zinc dust/zinc oxide alkyd type, conforming to CAN/CGSB 1.210-2003.

2.7 Fabrication

- .1 Maintain plant records and quality control program during the production of precast structural concrete, as required by CAN/CSA A251-00, Appendix D. Make records available to Contract Administrator upon request.

2.8 Bonded Concrete Topping

- .1 Concrete topping shall comply with CSA A23.1-04, Clause 7.6. The 28-day strength of concrete shall be 30 MPa, class of exposure F-1, except water to cementing materials ratio specified below.
- .2 Concrete materials shall comply with Sections 2.3.1 to 2.3.3 above, except the nominal maximum size of course aggregate shall be 12 mm.
- .3 Cement content shall be optimized to a water to cementing materials ratio of 0.40. Use of flyash is subject to acceptance by the Contract Administrator within 35 days prior to placement of the topping.
- .4 The concrete mix shall contain 80 kg of polypropylene fibres.

3. EXECUTION

3.1 Erection

- .1 Provide temporary bracing of the roof supporting structures for all stresses and induced loads during erection in excess of design loads shown on contract drawings. Maintain temporary bracing in place until all roof panels in that region have been placed and connections complete.
- .2 Provide all hoisting equipment and operate in accordance with all applicable safety regulations.
- .3 Discontinue work and advise Contract Administrator when members require adjustment beyond design criteria. Required modifications shall be performed at the Contractor's cost.
- .4 Erect members without damage to shape or finish. Replace or repair damaged members to approval of Contract Administrator, at the Contractor's cost.
- .5 Coordinate cast-in-place concrete work, installed under separate contract, affecting installation of precast concrete roof panels with Contract Administrator.

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- .6 Erect members without damage to cast-in-place concrete support members installed under separate contract. Repair damage to support members to approval of Contract Administrator, at the Contractor's cost, in accordance with Section 3.2.
- .7 Erect all units level, plumb, square and true within allowable tolerances.
- .8 Differential camber between adjacent precast double tee panels shall not exceed 20 mm. Out-of-tolerance differential cambers will be rejected.
- .9 Where framing members support units from both sides erect panels in a sequence that balances the load on the framing members. Number of unbalanced units on a framing member not to exceed three.
- .10 Securely fasten units in place.
- .11 Perform welding of connecting and supporting devices in accordance with requirements of CSA-W59-03.
- .12 Prime paint field welds and touch up scratched and damaged galvanized surfaces.
- .13 Fill all joints and grout keys between hollow core slabs with 1:3 mixture of cement and sand, trowel smooth.
- .14 Remove all grout from underside of hollow core slabs and walls and floors immediately after grouting.

3.2 Concrete Repair

- .1 Repair concrete surface damage with system that will provide structurally sound surface finish, uniform in appearance or with upgraded finish by other means until acceptable by Contract Administrator.
- .2 Select system, submit for review, and obtain approval from Contract Administrator prior to use.
- .3 For damage to concrete other than concrete surface damage repair as directed by Contract Administrator.

3.3 Bonded Concrete Topping

- .1 Prior to installing topping, clean surfaces of the installed precast panels by high pressure water blast (min. 4000 psi) to remove contaminants and laitance.
- .2 Use a compressor to blow off standing water and loose materials.
- .3 Notify the Contract Administrator when the surfaces are ready for inspection.

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- .4 Keep the substrate continuously moist prior to applying the bonding system. The topping concrete shall be bonded to the precast panels in accordance with CSA A23.1-04, Clause 7.6.4.2.2 (b), except the w/c ratio shall not exceed 0.40. Latex shall be acrylic.
- .5 Install concrete topping such that the finished surface is in a level plane. Refer to design requirements for camber in Sections 1.2.8 and 1.2.9.
- .6 Wet cure and protect topping for seven (7) days in accordance with CSA A23.1-04, Clause 7.4.

END OF SECTION