SPECIFICATIONS FOR SUPERSTRUCTURE CONCRETE

1.0 DESCRIPTION

The Work shall consist of:

1. Supplying of materials, mixing and placing of superstructure concrete as shown and described on the Drawings and in this Specification, including placing, vibrating/compacting, finishing and curing;

2. Supplying, fabricating, constructing, maintaining and removing all temporary works, including falsework and formwork;

3. Supplying, fabricating, constructing, maintaining and removing a movable bridge deck enclosure;

4. Heating and hoarding (when applicable);

5. Developing concrete mix design(s) that meets performance requirements, including a test section;

6. Quality control (QC) testing of all materials; and

7. Supplying and installing water seals and joint fillers (when applicable).

Superstructure concrete refers to decks, barriers, curbs, sidewalks, diaphragms, approach slabs, expansion joints and deck overlay concrete. The Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)] shall govern unless otherwise indicated in this Specification.

Ternary concrete refers to concrete that incorporates hydraulic cement, silica fume and fly ash as the cementitious binder.

"Performance" Alternative

Concrete supplied under this Specification will be specified in accordance with the latest version of "Performance" alternative in Table 5 of CSA A23.1, with the exception that the Contractor shall submit the proposed concrete mix design(s) details.

The Contractor shall:

1. Submit the exact mass or volumetric proportions of all constituent materials of the concrete mixture(s) proposed by the Supplier;

2. Work with the Supplier to establish the concrete mix properties to meet the performance criteria for the plastic and hardened concrete, considering the Contractor's criteria for construction and placement as well as the Department's performance criteria;

3. Submit documentation to the satisfaction of the Engineer demonstrating that the proposed mix design(s) will satisfy the fresh, mechanical and, durability performance requirements;

4. Prepare and implement a quality management plan to ensure that the Department's performance criteria will be met and submit documentation demonstrating the Department's performance requirements have been met;

5. Provide certification from a Professional Engineer registered or licensed to practice in Manitoba that the concrete plant, equipment, and truck mixers comply with the requirements of the latest version of CSA A23.1 and this Specification;

6. Certify that all materials to be used in the concrete comply with the requirements of the latest version of CSA A23.1 and this Specification;

7. Certify that the concrete mix design(s) satisfy the requirements of the latest version of CSA A23.1 and this Specification;

8. Certify that the production and delivery of concrete will meet the requirements of the latest version of CSA A23.1 and this Specification;

9. Certify that the concrete complies with the performance criteria specified; and

10. Ensure that the concrete supplier prepares and implements a quality control plan to ensure that the Department's and the Contractor's performance criteria will be met.

Department's Performance Criteria

The Department's basic performance criteria are provided in this Specification and identified on the Drawings. When required, additional site-specific requirements will be described in the Special Provisions of the project.

Contractor's Performance Criteria

The submission shall include the Contractor's performance criteria for each mix design including:

- Placeability (i.e. pumping, buggies, truck chute, etc.);
- Workability;
- Proposed slump, slump retention time and permissible slump loss; and
- Initial and final setting times.

2.0 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related Specifications shall be active or the latest revision at the date of tender advertisement.

2.1 References

- CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete
- CAN/CSA A3001, Cementitious Materials for Use in Concrete
- CSA G30.14, Deformed Steel Wire for Concrete Reinforcement
- CAN/CSA G30.18, Carbon Steel Bars for Concrete Reinforcement
- CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
- CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles
- AASHTO T 176, Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- CSA A23.2-24A, Test method for the resistance of unconfined coarse aggregate to freezing and thawing
- ASTM C29/C29M, Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
- ASTM C40/C40M, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
- ASTM C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- ASTM C70, Standard Test Method for Surface Moisture in Fine Aggregate
- ASTM C88/C88M, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C117, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

- ASTM C127, Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
- ASTM C128, Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
- ASTM C131/C131M, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C136/C136M, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM C138/C138M, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- ASTM C142/C142M, Standard Test Method for Clay Lumps and Friable Particles in Aggregates
- ASTM C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- ASTM C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C295/C295M, Standard Guide for Petrographic Examination of Aggregates for Concrete
- ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- ASTM C457/C457M, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete
- ASTM C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C586, Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
- ASTM C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- ASTM C1084, Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete
- ASTM C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
- ASTM C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
- ASTM C1583/C1583M, 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 C1581/C1581M, Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage
- ASTM C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM D75/D75M, Standard Practice for Sampling Aggregates
- ASTM D516, Standard Test Method for Sulfate Ion in Water
- ASTM D4791, Standard Test Method for Flat Particles, Elongated Particles or Flat and Elongated Particles in Coarse Aggregate
- ASTM D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- ASTM D6928, Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- ASTM D7428, 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 Reinforced Cast-in-Place Concrete
- Specifications for Supplying and Placing Concrete Reinforcement

- Specifications for Temporary Works

3.0 SUBMITTALS

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

1. Concrete mix design in accordance with the Specifications for Reinforced Cast-in-Place Concrete, Section 3.1, that also satisfies the following additional requirements:

   (a) Concrete temperature shall be as follows:
   - 10°C to 25°C for section thickness less than 1 metres;
   - 5°C to 25°C for section thickness greater than or equal to 1 metres and less than 2 metres;
   - 5°C to 20°C for section thickness greater than or equal to 2 metres; and
   - 10°C to 20°C for concrete containing silica fume.

   (b) Slump retention after 45 minutes shall be equal or greater than 75% of initial slump.

   The concrete mix design shall include current analyses of the aggregate and chemical analysis of the cementitious constituents that the Supplier proposes to use for the specified type(s) of concrete. Sampling and testing shall have been done within 30 days of the submission date, unless otherwise approved by the Engineer. Additional analyses of more recent sampling shall be performed periodically and provided to the Engineer upon request.

   Trial batches shall be used to assess the compatibility of the Contractor's proposed constituent materials including adequate workability of the mixes, as well as the temperature, air content and slump retention properties of the proposed mix(es) during placement operations.

   The Contractor shall produce evidence satisfactory to the Engineer that the proportions selected will produce concrete of the quality specified. This shall include the preparation of satisfactory trial mixes; and, at a minimum, shall also include seven-day compressive strength results, before the concrete is approved by the Engineer for placement on-site. The trial mix shall be a minimum of 3 m^3 or 50% of the rated mixer capacity (whichever is greater) and simulate the anticipated placing procedures at site. In preparing the trial mixes, the fresh properties of the concrete mix(es) including but not limited to workability and slump retention characteristics shall be assessed at 30, 45 and 60 minute intervals upon coordination with the Engineer.

   The sequence of batching all materials shall also accompany the proposed mix design for approval by the Engineer.

   All testing of the concrete trial batches and aggregate testing shall be the responsibility of the Contractor and shall be performed by an independent CSA certified testing firm.

   Permeability shall be assessed using the rapid chloride penetrability test method as per ASTM C1202, that shall be done on samples cast from the trial batches at an age of 28 and 56 days. Acceptable chloride permeability for superstructure concrete will be in accordance with CSA A23.1 considering the mix(es) target exposure classes.

   The Contractor shall submit the mix designs and results of the trial batch testing to the Engineer for review. Approval of mix designs must be in place at least 1 week prior to the first concrete pour on-site. The Contractor shall schedule these activities in order to allow the required time for undertaking and completing all of the required testing and test results. The Contractor should note that failure of the trial batches to demonstrate the specified concrete performance will result in delays for which no claims can be made against the Department.

2. Notification of proposed Ready-Mix Supplier in accordance with the Specifications for Reinforced Cast-in-Place Concrete.

3. Detailed design calculations and Shop Drawings for any formwork and falsework in accordance with the Specifications for Reinforced Cast-in-Place Concrete and the Specifications for Temporary Works shall be provided at least two weeks prior to the first concrete pour on-site and approved by the Engineer.

4. Detailed design calculations and Shop Drawings for the movable deck enclosure or winter hoarding enclosure that are sealed, signed and dated by a Professional Engineer registered or licensed to practice in the Province of Manitoba in accordance with the Specifications for Reinforced Cast-in-Place Concrete and the Specifications for Temporary Works.

5. Copies of all material quality control test results.

4.0 MATERIALS

The Contractor shall supply all materials necessary for the production of the superstructure concrete, including the superstructure concrete constituent materials, in accordance with the Specifications for Reinforced Cast-in-Place Concrete, Section 4. In addition, the Contractor shall also complete the following:

Test Section for Deck and Deck Overlay Concrete

For projects that involve construction of a cast-in-place concrete deck or deck overlay, the Contractor shall construct a deck test section. The test section shall be constructed at a location agreed upon with the Engineer. The test section shall demonstrate that the concrete mix design and Contractor's personnel, equipment, and construction methods are capable of providing the specified concrete properties, durability, and rideability. The test section shall use the same construction procedures to be used for the deck or deck overlay concrete including: batching, delivery, pumping, placing, vibrating/compacting, finishing, fogging and curing.

Deck and deck overlay concrete with a specified Category 1 air content shall meet the hardened concrete air-void parameters described below. The air-void spacing factor in the hardened concrete shall be determined in accordance with ASTM C 457 using a magnification factor between 100 and 125.

The concrete will be considered to have a satisfactory air-void system when the average of all tests is a spacing factor not exceeding 230 µm, with no single test greater than 260 µm, and air content greater or equal to 5.0% in the hardened concrete.

The Contractor shall carry out air void system testing on hardened concrete samples from the trial batches and submit the results as specified under "Submittals". Once the deck test section(s) are constructed, the Contractor shall extract a minimum of three core samples from the test section for air voids system testing. The Contractor shall also carry out air void system testing on hardened concrete samples cored from the completed structure.

The Contractor shall extract the number of core samples specified in the Special Provisions or directed by the Engineer from the structure at the locations identified, test the samples, submit a report that documents the results to the Engineer, and repair the core holes using concrete or high-performance material as approved by the Engineer.

The test section shall be constructed, and all related test results shall be submitted at least 14 days prior to the start of deck or deck overlay concrete placement.

Volumetric Stability of the Deck and Deck Overlay Concrete

The following requirements shall be met with respect to the volumetric stability of the concrete mix design:

(i) The maximum *w/cm* shall be according to the specified exposure class as per CSA A23.1;
(ii) The minimum *w/cm* shall be 0.34;
(iii) Curing procedures shall be as per the Specifications herein or the Special Provisions of the project;

(iv) Free shrinkage strain limit of the concrete mix(es) according to ASTM C157 shall be less than 400 microns at 28 days after curing; and
(v) Restrained shrinkage tests such as ASTM C1581 may be required by the Engineer on a case-by-case basis to evaluate the vulnerability of concrete mix(es) to cracking.

The following recommendations shall be considered by the Contractor and Supplier when preparing the concrete mix design for high surface-volume elements (concrete bridge decks/overlays) to reduce their susceptibility to shrinkage cracking:

(i) Binder content between 340 to 450 kg/m^3;
(ii) Aggregate content in the concrete ranges between 60 to 75% of the total volume;
(iii) At least 55% of the total aggregate content by mass may be coarse aggregate;
(iv) Synthetic micro-fibers (less than 12 mm length) and synthetic macro-fibers (greater than 12 mm length) from the MTI's approved products list may be used to control short- and long-term shrinkage cracking; and
(v) Shrinkage-reducing admixtures may be used in the mix(es).

The Contractor shall provide concrete mix(es) that are compliant with the target performance criteria specified, in addition to volume stability. The concrete mix design(s) shall be conditional upon acceptance by the Engineer.

5.0 CONSTRUCTION METHODS

5.1 Supplying Concrete

The Contractor shall supply the superstructure concrete in accordance with the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 5.1.

5.2 Falsework and Formwork

The Contractor shall construct the falsework and formwork for superstructure concrete in accordance with the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 5.2.

Regarding overhang formwork construction loads, the assumed loads and dimensions of the temporary construction loads that have been accounted for in the design of the girder(s) shall be shown on the Drawings or provided by the Engineer.

The Contractor shall confirm as part of their required submissions if the applied overhang construction loading is less than or equal to the supplied loading information for which the girder(s) have been designed for.

If the Contractor's applied loading is greater, the Contractor shall provide a submission for approval by the Engineer to confirm the stability and integrity of the girder(s), with the Contractor's intended applied loads, and the manner in which the girder(s) will be stabilized, which shall be sealed, signed and dated by a Professional Engineer registered or licensed to practice in the Province of Manitoba.

1. Deck Concrete Formwork

Care shall be taken in the design and installation of support brackets to avoid damage to girder flanges and webs. Where such brackets bear against girder webs, the girder webs shall be protected by timber or neoprene softeners. Effects of concentrated loads on thin webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners.

Formwork for decks, barrier walls, curbs, sidewalks, and parapets shall be fabricated so that the lines and grades shown on the Drawings are achieved. Girders shall be erected to normally accepted industry standards of tolerance with reporting variances to the Engineer, if any. Therefore, the

Contractor shall adjust the formwork as necessary to compensate for variances in girder dimensions, positioning, alignment, and camber. Prior to commencing deck formwork, the Contractor shall survey the profile of all the girders and provide this information to the Engineer prior to commencing any deck formwork. The Engineer shall determine the deck concrete thickness values required to achieve the specified grade line at specified stations. In the event that actual girder camber values vary significantly from the estimated values indicated on the Drawings, the Engineer will require the Contractor to raise or lower the grade line accordingly. The revised screed heights will be provided to the Contractor by the Engineer.

Continuous span deck sections shall be formed fully from one end of the continuity to the other end prior to the start of concrete placing operations.

5.3 Labour Force

In addition to the requirements specified in the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 5.9, the Contractor's crew shall include workers who are skilled and experienced in placing ternary or silica fume concrete for bridge superstructures.

5.4 Handling and Depositing Superstructure Concrete

The Contractor shall handle and deposit superstructure concrete in accordance with the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 5.10.

Concrete shall be placed to avoid the segregation of materials. The concrete shall be internally compacted using mechanical vibrators with non-metallic heads. For deck concrete, internal vibration shall be completed prior to the screed on the finishing machine.

Concrete placing will not be permitted when the air temperature is below 5°C or above 30°C or when the surface moisture evaporation rate is in excess of 0.75 kg/square metre per hour as determined by CSA A23.1 (latest version), Appendix D, "Guidelines for Curing and Protection" unless a mitigation plan is submitted by the Contractor and approved by the Engineer. Further, concrete placement shall not be permitted in the event of harsh weathering conditions such as rain, snow or excessive wind or dust; or when there are other hazardous conditions judged by the Engineer to be detrimental to the superstructure concrete. At temperatures below 5°C, or when there is a probability that the temperature will fall below 5°C within 24 hours of concrete placement, cold weather concreting precautions such as heating and hoarding shall be implemented in accordance with the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 5.12.

During hot weather conditions, deck and deck overlay concrete placing shall normally be between the hours of 3 am to 11 am to meet the ambient air temperature requirements with extra care given to fogging and curing protocols to control the evaporation rate, and consequently alleviate plastic shrinkage cracking. Night pours shall require proper lighting as reviewed and approved by the Engineer.

The temperature of the ternary concrete (concrete including hydraulic cement, silica fume and fly ash) shall not be less than 10°C, nor more than 20°C, at the time of placing, and shall be maintained below this maximum temperature by the inclusion of ice to the mix as approved by the Engineer, taking care to maintain the design water/cementitious materials ratio.

5.5 Placing Deck and Deck Overlay Concrete

1. General
   The Contractor shall ensure that sufficient personnel are provided for the finishing of the deck slab surfaces. In the event that the depositing, vibrating and screeding operations progress faster than the concrete finishing, the Contractor shall reduce the rate of concrete placement or cease the depositing of concrete until the exposed area of unfinished concrete has been satisfactorily finished. The Engineer's judgement in this matter will be final and binding on the Contractor. All loads of concrete,

including those already delivered to site, that exceed the discharge time limit during the delay while the finishing operations catch up shall be rejected.

Placement of the deck or deck overlay concrete shall be carried out in a continuous operation throughout the pour. In the event that concrete placement is stopped or delayed for a period of 60 minutes or more, further placement shall be discontinued and may resume only after a period of not less than 12 hours has passed. This restriction does not prohibit continuation of the placement of concrete provided an in-fill section is left in the lane or strip. The in-fill section shall be sufficient in length for the screed to clear the previously placed concrete. The in-fill section shall be placed after a period of not less than 12 hours.

The edge of any discontinued deck overlay concrete shall be saw-cut before placing further concrete as shown in the Drawings or directed by the Engineer. All edges of the in-fill section after removal shall be re-grouted as directed by the Engineer prior to the placement of deck overlay concrete.

Deck and deck overlay concrete shall be placed within the tolerances indicated in the section “Surface Defects and Tolerances”.

The Contractor shall arrange to have technical representatives available from the concrete supplier and the admixture supplier during the trial batching and on-site concrete placement.

The Contractor shall conduct a detailed and highly accurate elevation survey of the concrete deck profile after the deck slab and curbs (if applicable) have been placed. The Contractor shall submit the proposed survey layout to the Engineer for review and approval prior to completing the survey.

The Contractor shall clearly identify the survey points, document the survey data, and submit this data to the Engineer within 72 hours of completion of the deck pour(s). Bituminous pavement operations shall not begin prior to review and acceptance of the as-cast bridge deck profile by the Engineer.

The Engineer shall provide the Contractor with bituminous pavement thicknesses for the bridge deck area within seven days of receiving the survey and shall determine if the asphalt thickness will be variable or constant across the bridge deck.

2. Surface Preparation of Girders

   Concrete Girders

   The Contractor shall thoroughly clean the indentations on the top surfaces of the concrete girders immediately prior to the placing of the deck concrete, as well as remove any protruding lumps of concrete. All remaining concrete adhering to the reinforcement shall be removed, along with any other substances that would prevent bonding between the reinforcement and the concrete yet to be placed.

   Any concrete surfaces upon which the superstructure concrete is to be placed shall be cleaned and misted to saturated surface dry immediately prior to the concrete being placed.

   Steel Girders

   The Contractor shall ensure that the portion of the top flange in contact with concrete is clean, dry and free of all deleterious and foreign materials that could weaken the bond between the girder and concrete slab.

3. Placing/Finishing Machine

   For all deck concrete and deck overlay concrete, screeding shall be by a self-propelled concrete placing/finishing machine as follows or acceptable equivalents approved by the Engineer:

   - Bidwell Model RF200 or Model 364
   - Gomaco Model C450

   The placing/finishing machine shall be long enough to span the entire width of the deck slab.

   Concrete deck/deck overlay finishing methods shall be approved by the Engineer. Proposed finishing methods shall preclude the occurrence of local depressions in the surface of the concrete and ensure a surface acceptable either for the application of a waterproofing membrane or as a wearing surface with sufficient roughness for skid resistance.

4. Work Bridges

   The Contractor shall provide two work bridges ready for use, separate from the finishing machine, of adequate length to completely span the width of the pour. The work bridges shall facilitate the operations of concrete finishing and post-finishing operations including placing of curing blankets and shall also be available to the Engineer upon request for straight-edge checking. The work bridges shall be supported essentially parallel to the concrete surface, between 250 mm and 600 mm clear height above the concrete surface and shall be at least 800 mm wide to permit diverse uses concurrently, and be rigid enough that dynamic deflections are insignificant.

   The Contractor shall provide a safe and sturdy walkway with safety railing on each side of the work area to provide access to the work bridges.

5. Screed Guide Rails

   Girders, steel and precast prestressed concrete, have an allowable fabrication tolerance in camber, and it may be necessary to vary the depth of the deck slab over the top flanges, by means of variable depth haunches, in order to maintain a correct finished grade on the deck. After all of the girders have been erected, the Engineer will determine the depth of the variable haunches and provide the Contractor with this information.

   The Contractor shall adjust forms, maintain uniform slab thickness, and adjust screed heights to the elevations shown on the Drawings or to the elevations set by the Engineer in the field. The screed chairs shall be tack welded to the screed plates attached to the top girder surface.

Approved screed guide rails shall be installed to provide the profile of the required surface and to ensure a smooth and continuous surface from end to end of the bridge. The screed guide rails shall be adequately supported and extend to at least 3 metres beyond the ends of the deck pours to permit run on and run off of the finishing machine.

Guide rails shall be installed so that a whole day's pour may be made without resetting the rails. The supports shall be fully adjustable by a screw mechanism. Shims will not be permitted for adjusting of supports. Deflection of the rails between the supports will not be tolerated. The Contractor's proposed method, including the guide rail support system, shall be submitted to the Engineer for review and acceptance prior to the start of concrete placement.

Screed rail elevations and the critical clearance over the top reinforcing steel must be thoroughly checked prior to the concrete pour.

During the concrete placement operations, all screed guide rails and supports shall be removed with minimum disturbance to the concrete. Care shall be taken to ensure that the screed guide rails are seated uniformly on the screed chairs at all times.

6. Dry-Run

To confirm the adjustment of the machine and guide rails, the screed shall be "dry-run" prior to the pour by the Contractor and clearance measurements shall be taken at each controlled point and approved by the Engineer.

The finishing machine and screed guide rails shall be adjusted so that the height of the screed will finish the concrete to the design grade line and crown as shown on the Drawings. The Contractor and Engineer shall measure the screed heights at each of the screed plates or girder tenth points for channel and box girders. The Contractor shall also check the top concrete cover over the deck reinforcement during the dry run. The deck reinforcement shall be adjusted to ensure the specified top cover is provided. Re-setting of the finishing machine and/or screed rails shall be done as necessary, to obtain an acceptable dry-run. Adjustments to the machine or screed rails will not be permitted after an acceptable dry-run has been completed. When the skew angle is greater than 15°, the finishing machine shall be set-up to match the skew angle of the bridge.

The screed rails shall be supported by the girders. Where screed rails are supported on cantilevered formwork that could deflect under the weight of the fresh concrete and the deck finishing machine, the Contractor shall pre-load a section of the cantilevered formwork on each side of the bridge to determine deflections that will occur during concrete placement. The formwork, machine and/or screed rails shall be adjusted to compensate for the expected formwork deflection.

Depressions in the concrete surface, resulting from deficient finishing procedures and allowing water to pond, shall be repaired at the Contractor's expense.

7. Vibrating Concrete

All deck concrete shall be consolidated in accordance with Specification 1030 (I): Reinforced Cast-in-Place Concrete, Section 5.10.2, even when vibratory drum type finishing machines are used.

8. Screeding Concrete

   The finishing machine shall be moved slowly and at a uniform rate, where screeding shall be completed in no more than two passes. In general, the direction of pouring should be from the low end of the bridge to the high end. A roll of concrete shall be maintained along the entire front of the screed at all times to ensure the filling and consolidation of the surface concrete. The Contractor shall also ensure that the required concrete thickness is being placed by randomly probing the concrete behind the finishing machine.

   The screed shall not be allowed to run except when screeding is in progress. The screeded surface shall not be walked on or damaged by any other means.

   Additional vibration and hand finishing may be required, as approved by the Engineer, in areas adjacent to the curbs, barriers and deck drains, which may be inaccessible to the screed.

   Concrete adjacent to deck drains shall be “dished” by hand finishing to provide drainage.

9. Bull Floating

   The concrete surface produced behind the finishing machine shall be magnesium floated the minimum amount necessary to remove high spots and ridges, and ensure that the surface is free from open texturing, plucked aggregate and local projections or depressions. This operation should only slightly embed the coarse aggregate below the concrete surface. It is imperative that competent workers be employed to carry out the bull floating and surface texturing.

10. Finished Profile

    The finished surface of the concrete shall conform to the design grade line profiles as indicated on the Drawings and/or determined by the Engineer.

    The Contractor shall provide two – 3 metre long straight edges: one for the edge-of-slab finisher and one for the Engineer. The straight edges must be rigid and not deflect, but light enough and equipped with handles so that they can be easily used.

    After bull-floating, the Contractor shall check the grade and tolerance of the surface of the concrete with the 3 metre long straight-edges. The entire surface shall be checked and any areas not within the tolerances indicated in Section 5.5.11 “Surface Defects and Tolerances”, shall be corrected. Care shall be taken to preserve the crown and cross-section of the roadway.

11. Surface Defects and Tolerances

    The surface shall be free from open texturing, plucked aggregate and local projections.

    Except across the crown, the surface shall be tested with a 3-metre-long straight edge placed anywhere in any direction on the surface. There shall not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the deck below the straight edge at any location.

    The surface shall be checked by the Contractor, as described above, immediately after final bull floating and prior to the texturing.

    After checking and correcting of screeded surfaces has been completed, the marks in the screeded surfaces caused by the use of the straight edge shall be removed.

    The surface shall again be checked by the Contractor at the end of the curing period in the same manner and to the same tolerance. Areas that do not meet the required surface accuracy shall be clearly marked out and the Contractor shall repair the concrete surface by one of the following methods, at his own expense:

(a) Grind down any areas higher than 3 mm but not higher than 10 mm above the correct surface;

(b) Correct any areas lower than 3 mm but not lower than 10 mm below the correct surface, by grinding down the adjacent high areas; or

(c) When the deviation exceeds 10 mm from the correct surface, the deck slab shall be replaced for a length, width and depth that will allow the formation of a new slab, of the required quality, in no way inferior to the adjacent undisturbed slab.

Grinding shall be carried out by a grinding machine approved by the Engineer, of a type and capacity suitable for the total area of grinding requiring correction, until the surface meets the specified requirements.

All corrective work will require the Contractor to submit a proposal to the Engineer for review, prior to commencement of any work.

If the surface is damaged in any way by construction operations, or if the deck concrete shows signs of distress or scaling prior to the final acceptance, it shall be repaired or replaced by the Contractor at his own expense.

12. Setting Expansion Dams

The Contractor shall adjust all expansion joint units to the required elevations and gap after the variable depth haunches have been set by the Engineer. The adjusting shall be done in accordance with the procedures for adjusting of expansion dams as shown on the Drawings or as directed by the Engineer. Shims, if required, shall be supplied by the Contractor.

13. Construction Joints in Deck Slabs

The locations and details of construction joints shall be as shown on the Drawings and formwork drawings.

Construction joints not indicated on the Drawings and formwork drawings shall be subject to the approval of the Engineer.

Vertical construction joints shall be constructed with shear keys covering approximately one-third of the contact area. The surface of the hardened concrete shall be cleaned of surface laitance, curing compound, and other foreign materials, and shall be misted with water to saturated surface dry immediately before fresh concrete is placed against the joint.

Cementitious bonding grout shall be scrubbed into the face of the hardened concrete immediately prior to concrete placement.

When called for on the Drawings or in the Special Provisions, construction joints shall be coated with an approved epoxy bonding agent in accordance with the Manufacturer's specifications immediately prior to the placing of the fresh concrete.

14. Movable Deck Enclosure

The Contractor shall provide a movable deck enclosure for all deck and deck overlay concrete pours during all weather conditions, except when heating of the deck and deck overlay concrete is required in accordance with Specification 1030 (I): Reinforced Cast-in-Place Concrete, Section 5.12.
The enclosure shall be constructed to meet the following requirements:

(a) Sufficient clearances shall be provided to enable the various stages of concrete placing operations including placing and finishing of concrete to proceed unhindered inside the hoarding.

(b) The minimum length of the enclosure shall be the entire length of the freshly placed concrete plus an additional 3 metres on each end.

(c) The enclosure shall have a clear unsupported span between the outside edges of the deck slab or between the centreline of median and the outer edge of the deck slab.

(d) The roof and sides of the enclosure shall be covered with waterproof material, with all joints overlapping and rendered waterproof. The material shall be strong enough to withstand the force of "driving" rain, and at least 2/3 of the roof and the entire sides shall be opaque. The sides of the enclosure at the joint with the deck forms shall be constructed to prevent the entrance of rain from the sides.

(e) Provisions shall be made for enclosing the ends of the enclosure on short notice in the event that closing of the ends is a necessity during the concrete placing operations.

(f) The entire enclosure shall be checked for any damage before each concrete pour and all repairs shall be made as required before concrete placing will be allowed.

(g) The enclosure shall be constructed on wheels or rollers placed on guided rails for ready mobility.

(h) The rail system for the movable deck enclosure shall be independent of the rail system for the finishing machine and the work bridges.

(i) The enclosure shall not be removed from over top of a newly completed deck slab without the wet curing blankets in place and without obtaining permission from the Engineer.

In cases when "Heating Concrete" is not called for, and the Engineer permits the placing of deck concrete during the periods of spring or fall when there is a possibility of night frost, the Contractor shall provide sufficient heat inside of the movable deck hoarding in order to keep the air temperatures above all concrete surfaces at a minimum of 5°C for seven (7) days following the concrete pour. The heating equipment used for this purpose shall be in accordance with the requirements of Section 5.12 of the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030(I)].

The Contractor shall consider as necessary and submit Engineering design notes sealed by a Professional Engineer registered or licenced to practice in the Province of Manitoba, to ensure the stresses resulting from the moveable deck hoarding structure do not damage the freshly placed concrete.

The Contractor shall consider the concrete strength and maturity time when developing their plan to move the hoarding to the next pour location and shall demonstrate to the satisfaction of the Engineer that their plan allows the time necessary for the fresh concrete to gain sufficient strength to not cause damage to the concrete.

The submission of design notes and any monitoring or additional testing considered necessary by the Engineer to satisfy this requirement will be the responsibility of the Contractor and considered incidental to the work.

15. Application of Evaporation Reducer and Fogging

The Contractor shall undertake the following measures to prevent rapid loss of moisture from the surface of the deck or deck overlay concrete:

(a) Immediately after finishing, the Contractor shall spray evaporation reducer directly onto the surface of the concrete in accordance with the Manufacturer's recommendations. The Contractor shall repeat the application of the evaporation reducer as many times as necessary to ensure the concrete surface maintains this protection prior to wet curing as long as it has no impact on the quality of the finished surface.

(b) High relative humidity shall be maintained above the concrete surface by the application of a fog mist. The fog mist must be applied continuously from the time of screeding until the concrete is covered by wet cure blankets, in such a way as to maintain high relative humidity above the concrete and prevent drying of the concrete surface. Water must not be allowed to drip, flow, or puddle on the concrete surface during fog misting, placing wet cure blankets, or at any time before the concrete has achieved final set.

(c) The fog spray mist device shall not be used to apply water to the concrete surface for finishing purposes. The fog spray mist device shall not be directed towards the concrete surface. Extreme care shall be taken to ensure that accumulation of any water on the concrete surface is prevented. Fog spraying may be a continuous process that requires diligent attention to the balance between drying caused by the environmental conditions and the wetting provided by the spraying process. This is frequently a full-time operation in which one or more spray applicators are required from initial strike off until the final curing methods can be applied.

5.6 Finishing Plastic Concrete

1. Deck and Deck Overlay Concrete

The finishing process shall be in accordance with the requirements of Section 5.15 of the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030(I)].

Deck and deck overlay concrete that is to be protected with a waterproof membrane and an asphaltic riding surface shall be bull floated. Hand trowelling shall be limited to removing surface defects. The final surface shall be finished to a smooth surface, free of mortar ridges and other projections and suitable for application of the waterproofing membrane. No surface texturing or broom finishing is to be applied.

Exposed concrete decks and deck overlays are to be tined in the transverse direction. The tining device shall be approved by the Engineer. The tining grooves shall be 1.5 to 3 mm wide, between 3 and 5 mm deep, and spaced 12 to 16 mm on centres. Tining shall be stopped 300 mm from the curb line. The area adjacent to the curbs or barriers shall be given a smooth float finish.

2. Broomed Surface Finish

A broomed surface finish shall be applied to approach slabs and the top surfaces of curbs, sidewalks and barriers.

Brooming shall be done when the concrete has hardened sufficiently. The broom shall be of an approved type. Each broom stroke shall be continuous for the full width of the slab being finished, and at a right angle to the centreline of roadway. Only one (1) stroke per width of the broom will be acceptable with adjacent strokes slightly overlapped. The broom shall be drawn evenly without tearing of the concrete to produce regular corrugations of 3 mm in depth.

The broom shall be cleaned in water after each stroke.

5.7 Curing

In addition to the requirements for wet curing specified in the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 5.13, the following requirements shall be met.

All deck and deck overlay concrete shall be wet-cured for a period of 7 days, not including the day of concrete placement. Wet-curing shall be accomplished by applying a clean white polyester blanket that has been soaked to the deck concrete, normally within 30 minutes of finishing operations or as soon as the concrete surface will support the blanket without deformation. The blanket shall receive an additional cover of 4 mil white or transparent polyethylene sheet as soon as concrete surface conditions permit such that it will not be damaged. This system shall be continuously saturated for a minimum of 7 days by means of soaker hoses. The length of the wet curing period is dependent on the thoroughness of the Contractor in maintaining a saturated surface and may increase at the discretion of the Engineer should the Contractor fail to satisfy the above requirements. Under no condition is the wet curing cover to be removed until permission is received from the Engineer.

The white polyester blankets must be pre-soaked by immersing them in water for a period of time sufficient for the blankets to be saturated to provide a source of water for the freshly placed concrete without having excessive moisture that could damage the concrete surface. The blankets shall overlap 150 mm and shall be held in place without marring the surface of the concrete.

Airflow in the space between the white polyester blanket and the 4 mil polyethylene sheet shall be prevented.

Regardless of ambient temperature, wet curing as described herein shall be provided at all times.

After 7 days of curing with blankets and water, a white pigmented curing compound shall be applied to exposed concrete surface.

The white-pigmented curing compound shall be agitated by mechanical means to provide a homogenous mixture at the time of application. The curing compound shall be applied within 2 to 4 metres of the removal operation, completely covering the surface of the concrete. A second application of curing compound shall be applied within 1 to 2 hours after the first application. Each application shall be such that the membrane formed is uniform in thickness and colour and free from breaks or pinholes. The surface shall be maintained in this condition for a minimum period of 7 days. The rate of each application must not be less than the rate specified by the Manufacturer of the curing compound.

During the cure period, the Contractor shall take all protective measures necessary to ensure that all ternary concrete is not exposed to thermal gradients greater than 15°C through the cast cross-section for a period of 7 days. The Contractor shall supply and install three thermocouples, in the centre, within 25 mm of the surface and within 5 mm of the surface of the concrete, for every 100 m² of deck, at locations determined by the Engineer. The Contractor shall monitor and record the internal temperatures and ambient air temperature at the concrete surface every four hours for the first 3 days after concrete placement and every 12 hours thereafter during the remaining curing period. Daily temperature records shall be provided to the Engineer.

5.8 Preformed Joint Sealers

The preformed joint sealers shall be installed as shown on the Drawings in accordance with the Manufacturer’s instructions.

5.9 Approach Slab Concrete

After properly placing and consolidating the concrete, it shall be struck off and screeded to conform to the required cross-section and grade as shown on the Drawings. Concrete placing shall be carried out in a manner such that the newly deposited concrete is continually placed against fresh concrete across the entire face of the pour and the formation of cold joints is prevented. A slight excess of concrete shall be kept in front of the screed at all times.

The surface shall then be floated as necessary to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions. The top surface of the concrete shall not vary more than 5 mm from the required grades and shall be checked using a 3-metre-long straightedge.

When the Drawings indicate dowels between the approach slabs and the proposed adjoining concrete pavement, the ends of the dowels protruding from the approach slabs shall be coated with a mastic filler as approved on Department's Approved Products List.

5.10 Concrete Diaphragms

Precast concrete girders are fabricated and erected to normally accepted industry standards for tolerance. Forming of diaphragms shall be designed to accommodate variations in girder dimensions, positioning, alignment, camber, and sweep. During the concrete placing operations, care shall be taken to ensure that the sleeves through the webs of the girders are completely filled with concrete.

For shorter concrete I-girders and steel girders, the end diaphragms shall be poured at least 48 hours prior to the pouring of the deck while the intermediate diaphragms shall be poured at least 24 hours prior to the pouring of the deck. For longer steel girders and NU-girders, the diaphragms shall not be poured until all deck concrete has been placed and cured for 7 days.

5.11 Concrete Strength Requirements

Heavy equipment will not be allowed on the deck, deck overlay or approach slabs until the concrete is a minimum of 14 days old and has reached 85% of design compressive strength.

5.12 Shrinkage Cracking in Deck and Deck Overlay Concrete

After the curing period and before opening to public traffic, the Contractor and the Engineer shall jointly inspect the deck surface to identify all cracks.

The Contractor shall repair the cracks at his/her own expense in accordance with the following table:

Type of Deck	Crack Width Requiring Repair
Exposed concrete deck or exposed concrete overlay	0.3 mm or wider
Cast-in-place concrete deck to be protected with a waterproof membrane and an asphalt wearing surface	0.5 mm or wider

Cracks shall be repaired using the following procedure unless an alternative method is approved by the Engineer:

a) Blow out cracks with a jet of oil-free compressed air. The cracks are to be clean and dry.

b) Seal cracks with a gravity feed epoxy in accordance with the Manufacturer's instructions. The gravity feed epoxy shall maximize the penetration by taking into consideration the ambient temperature, the substrate temperature, the viscosity and pot life of the material being used. Gravity feed epoxy material shall be approved by the Engineer prior to its usage.

c) Epoxy injection will be required when cracks extend the full depth of the deck slab or to the top layer of reinforcement. The epoxy material and injection procedure shall be approved by the Engineer prior to its usage.

5.13 Opening to Traffic

The structure shall not be opened to traffic until the concrete has attained a minimum compressive strength of 100% of the specified design strength.

6.0 QUALITY MANAGEMENT

6.1 Test Section

The Contractor shall provide a test section, at a site as agreed by the Engineer, to demonstrate the ability and experience of his personnel and equipment. This test section will be used to replicate the exact procedures to be used by the Contractor for mixing and placing the concrete including batching, delivery of the concrete to its final location, fishing and curing.

The cementitious materials supplier's technical representative shall be at the concrete batching facility and on site during the batching and placing of ternary concrete pours to provide guidance and to make any minor adjustments to the mix.

6.2 Quality Control

Quality control testing shall be in accordance with the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 6.1.

For ternary concrete, the Contractor will be allowed to adjust only the quantities of superplasticizer and air entraining agent. Addition of water at site to the batch will only be permitted subject to an alternate batching procedure approved by the Engineer. In no case shall approved batch adjustment relieve the Contractor of his/her responsibility for the eventual mechanical, volume stability and durability performance as well as acceptability of the concrete.

6.3 Quality Assurance

Quality assurance testing will be in accordance with the Specifications for Reinforced Cast-in-Place Concrete [Specification 1030 (I)], Section 6.2.

7.0 METHOD OF MEASUREMENT

7.1 Superstructure Concrete

Superstructure concrete will be measured on a volume basis. The volume of the superstructure concrete to be paid for will be the total number of cubic metres computed from the neat lines on the Drawings. Further, the concrete quantity for the bridge deck slab to be paid will be determined by the Engineer based on as-constructed girder profiles and the final roadway profile corrected for anticipated girder deflection.

The only variation in the superstructure concrete volume will be from the change of the deck fillet dimensions that will be calculated once the bridge girders are erected and surveyed to verify actual girder cambers. No deductions will be made for chamfer corners, reinforcing steel, structural steel, or bolts.

7.2 Movable Deck Enclosure

The movable deck enclosure shall be paid for on a Lump Sum Basis and no measurement will be taken.

8.0 BASIS OF PAYMENT

8.1 Superstructure Concrete

Superstructure concrete will be paid for at the Contract Unit Price per cubic metre for “Supplying and Placing Concrete (Superstructure)”, measured as specified herein, which price will be payment in full for performing all operations herein described and other items incidental to the Work.

8.2 Movable Deck Enclosure

Moveable deck enclosure shall be paid for at the Contract Lump Sum Price for “Movable Deck Hoarding”, 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.