SECTION 904

CONCRETE STRUCTURES

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904.11.04 Concrete Acceptance and Reduced Payment Criteria on Concrete Located in Rehabilitated Structures

904.01 SCOPE

The scope of this specification is to cover the supply of materials for concrete structures, production, delivery, placement, sampling, and testing of concrete, curing, and the subsequent protection. All work, plant, equipment and materials shall be in strict accordance with CSA A23.1/CSA A23.2 “Concrete materials and methods of concrete construction/Test methods and standard practices for concrete”.

The plant from which the ready mix concrete is supplied shall be certified in accordance with the requirements for certification as per the Atlantic Concrete Association or equivalent. A copy of the certification of conformance shall be provided to the Owner’s Representative prior to the start of delivery under the proposed contract.

A job meeting shall be held prior to the deck concrete placement to discuss all aspects of the concrete work including production, supply, delivery, placing, curing and any other related items. This meeting is to be called by the Owner’s Representative; the Contractor and all others deemed necessary shall be in attendance.

904.02 MATERIALS

All concrete materials shall be in accordance with CSA-A23.1.

904.02.01 Cement

All cementing materials shall be in accordance with CSA A3000 “Cementitious Materials Compendium”.

Cement for Superstructure, Substructure, MSE Panels, Bridge Arches, Reinforced Wharf Deck Concrete (with the exception of Pile, Levelling, Mass and Tremie Concrete), Cast-in-place Concrete Median Barrier and Precast Concrete Traffic Barriers shall be a blended Portland or Portland Limestone, Silica Fume, Fly Ash or Slag, Type GU(L)b F/SF or GU(L)b S/SF. Contractors are advised that the minimum proportion by mass of the total cementing materials for silica fume shall be 5% and a maximum of 8%. Contractors are advised that the minimum proportion by mass of the total cementing materials for fly ash or slag is 15%. The total mass of Supplementary Cementing Materials (SCM’s) should not exceed 30% of the total weight of cementitious material.

Cement for deck and curb resurfacing in Section 919 shall be Portland cement Type GU or GUL unless otherwise specified.

Cement for all other concrete shall be Portland cement Type GU or GUL, a portion of which may be replaced by fly ash or ground granulated furnace slag up to 25% by mass of the total cementing material. Blending a combination of both fly ash and slag for incorporation into the GU or GUL cement is not permitted.

904.02.02 Aggregate

The source of the aggregate will be determined by the Contractor but all aggregate shall meet the requirements of CSA A23.1. The maximum petrographic number will be 125 in superstructure concrete and a maximum 140 for all other concrete classes.

Concrete aggregate shall consist of natural sands and gravels, crushed rock or other inert materials having clean, uncoated grains of strong and durable minerals.

Fine and coarse aggregate shall be stored in separate stock piles sufficiently removed from each other to prevent the materials at the edges of the piles from becoming intermixed.

The maximum size of stone to be used for the different thickness of concrete shall be 20mm unless otherwise ordered by the Engineer of Record. In no case shall the maximum size of stone used be greater than either 2/3 the clear distance between the reinforcement or 2/3 the clear distance between the exterior bars and the face of the structure except for girders where the latter criteria shall be 0.8 times the clear distance between the exterior bars and the face of the structure.

Stock piles of approved fine and coarse aggregate, in amounts of one quarter to one half of that required for the job, shall be placed on the site of the work at least one month previous to concrete placing operations. The stockpiles shall be protected by tarpaulins or plastic sheeting against formations of ice and accumulation of snow.

The Contractor shall provide with the concrete mix design relevant test data for all aggregate materials indicating conformance to the requirements of CSA A23.1 and this specification. The sources and test results of all aggregate materials shall be clearly identified. The aggregate tests shall be conducted by a laboratory CCIL or CSA Certified in accordance with CSA A283 “Qualification code for concrete testing laboratories” latest edition. The aggregate properties shall be signed and stamped by a Professional Engineer registered to practice in Newfoundland and Labrador. The Professional

Engineer shall attest to the validity of the material test data. The test data required but not be limited to shall include:

- Sieve analysis of fine and coarse aggregate CSA A23.2-2A
- Fineness modulus of fine aggregate CSA A23.2-2A
- Clay lumps in natural aggregate CSA A23.2-3A
- Low-density granular material of aggregate CSA A23.2-4A
- Amount of material finer than 80 µm in aggregate CSA A23.2-5A
- Relative density and absorption in fine aggregate CSA A23.2-6A
- Test for organic impurities in fine aggregate in concrete CSA A23.2-7A
- Soundness of coarse & fine aggregate by use of magnesium sulphate CSA A23.2-9A
- Relative density and absorption of coarse aggregate CSA A23.2-12A
- Flat and elongated particles in coarse aggregates CSA A23.2-13A
- Petrographic Analysis of Coarse Aggregate CSA A23.2-15A
- Resistance to degradation of coarse aggregate by abrasion and impact in the Los Angeles machine CSA A23.2-16A
- Test method for the resistance of fine aggregate to degradation by abrasion in the Micro-Deval apparatus CSA A23.2-23A
- Test method for the resistance of unconfined coarse aggregate to freezing and thawing CSA A23.2-24A
- Test method for detection of alkali-silica reactive aggregate by accelerated expansion of motor bars CSA A23.1-25A
- Test method for detection of alkali-carbonate reactivity of quarried carbonate rocks by chemical composition CSA A23.1-26A
- Potential expansivity of aggregates (procedure for length change due to alkali-aggregate reaction in concrete prisms at 38 °C) CSA A23.1-14A

For a concrete mix with a tendered quantity of more than 50 m^3 the test results are only considered valid for up to two years in advance of the date of the project mix design submission. For a concrete mix with a tendered quantity of 50 m^3 or less the test results are considered valid for up to five years in advance of the date of the project mix design submission.

904.02.03 Water

All water shall be clear and free from injurious substances and shall be potable.

All water used for curing shall be clean and free of any material which would cause

staining or discoloration of the concrete. The Contractor shall not use water from shallow, stagnant or marshy sources.

904.02.04 Air Entraining Agent

All concrete shall be air entrained with the air entraining agent conforming to ASTM C260 “Standard Specification for Air-Entraining Admixtures for Concrete”.

904.02.05 Admixtures

Any other admixture, utilized in the mix design must conform to ASTM C494/C494M “Standard Specification for Chemical Admixtures for Concrete” or ASTM C1017/C1017M “Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete”

904.02.06 Reinforcement

Reinforcement shall be in accordance with Section 905.

904.02.07 Form work and Falsework

Form work and falsework shall be in accordance with Section 907.

904.02.08 Burlap

Burlap shall conform to AASHO M182 "Specification for Burlap Cloth made from Jute or Kenaf and Cotton Mats".

904.02.09 Liquid Membrane-Forming Curing Compounds

Liquid membrane-forming curing compounds shall meet the requirements of ASTM C309, and shall only be used as authorized by the Owner’s Representative.

904.02.10 Concrete Curing Sheet Materials

Sheet materials that conform to ASTM C171, "Standard Specification for Sheet Materials for Curing Concrete", may be used as a cover to inhibit moisture loss during the concrete curing period.

904.02.11 Miscellaneous Materials

The supply and installation of miscellaneous materials shown on the drawings or mentioned in the Supplementary General Conditions but which have not been listed on the Unit Price Table, are considered incidental to the work and no separate payment will be made.

This shall include, but not necessarily limited to, all miscellaneous concrete accessories, evaporation retardant, abutment weep holes, drip grooves and guide rail modified end shoes.

904.03 EQUIPMENT

The Contractor shall supply the Owner's Representative before commencement of the project with adequate details of all equipment to be used. The intention is not to limit the Contractor's operation but to ensure adequate planning is undertaken.

The Contractor shall maintain all equipment used for handling, mixing, transporting, depositing, compacting, curing and finishing the concrete in a clean condition and in proper working order.

Pumping equipment may be utilized by the Contractor. Details of the pumping equipment and operation must be to the satisfaction of the Owner's Representative. The Contractor shall submit to the Owner's Representative, manufacturer's specifications detailing pumping capacity and pressure at the required elevations. Aluminum pipelines shall not be used. The Contractor shall be prepared in the event of a breakdown in pumping operations. These emergency preparations shall be discussed with and to the satisfaction of the Owner's Representative prior to the commencement of concrete placement utilizing pumping equipment.

Compaction equipment shall be capable of giving dense concrete in accordance with specification requirements. Internal vibrators may be utilized and must be capable of consolidating the concrete with a minimum duration of vibration. Care must be taken with superplasticized concrete to avoid segregation.

An approved self-propelled mechanical bridge deck finisher shall be used to strike off and finish concrete decks as per specifications. The approved machine shall travel on guides or rails supported so that they are completely clear of the finished surface. The guide or rail supports that extend through the roadway areas of the deck shall be such that they can be removed to at least 50 mm below the top of concrete. Two work platforms shall be used for finishing and curing operations.

Batch plant and mixing equipment shall be as defined in Section 904.04.03.

The equipment required for heating materials for Cold Weather Concreting shall be of adequate capacity and be accepted, prior to installation, by the Owner's Representative.

It shall be available, installed and tested ready for use before it is proposed to place concrete. Heating equipment shall be ready for use between September 1 and April 30 when so required by the Owner's Representative. Alternative methods of keeping concrete temperatures at acceptable levels may be accepted. Where the heating equipment is to be used for heating the housing as well as the materials at the same time, the term adequate capacity means that the equipment shall have adequate capacity to heat both materials and housing simultaneously to the required temperature.

Boilers used for heating materials or housing shall meet the inspection requirements and operating conditions laid down by Provincial Acts and Regulations.

904.04 CONCRETE PRODUCTION, DELIVERY AND PLACING

904.04.01 Measurement of Materials during Batching

All materials used in the production of concrete shall be measured by weighing. Materials shall be added to produce concrete conforming to the mix design prepared as per Section 904.04.02. The mixing water shall be measured by either volume or by weight. The apparatus provided for weighing the aggregate shall be suitably designed and constructed for this purpose. Each size of aggregate shall be weighed separately with a required accuracy of two per cent. The volume of concrete discharged by the supplier's equipment shall be expressed in cubic metres. All batch weights shall be recorded and shall be available for audit by the Owner's Representative.

Cement in standard bags need not be weighed.

All measuring devices shall be to the satisfaction of the Owner's Representative. Other methods of weighing shall only be used if specifically authorized, in writing, by the Owner's Representative.

904.04.02 Concrete Quality

Concrete mixes shall be designed in accordance with CSA A23.1 latest edition. Note that ACI 211.1 "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete", should be used as a guide for determining mix proportions for normal and mass concrete.

Concrete strength shall be as shown on the drawings unless particular specifications require higher strength.

TABLE ONE

Parameter	Superstructure & Bridge Arches [1]	Substructure, Reinforced Wharf Deck, Cast-in-place Median & Precast Traffic Barrier	Curb, Gutter, Sidewalks, Catch Basins & Weir Baffles	Pile Concrete	Levelling, Mass & Tremie Concrete
Cement Type	GUb	GUb	GU	GU	GU
Compressive Strength Within 28 Days	45 MPa	40 MPa	35 MPa	25 MPa	20 MPa
Maximum Water/ Cementitious Material Ratio	0.35	0.37	0.39	0.45	0.45
Slump [2]	As per approved mix design	As per approved mix design	60 ± 20 mm	100 ± 30 mm	190 ± 40 mm
Air Content	5 – 8 %	5 – 8 %	5 – 8 %	4 – 7 %	4 – 7 %
Rapid Chloride Permeability (ASTM C1202)	<1000 Coulombs	<1000 Coulombs	NA	NA	NA
Air Void Spacing Factor (average)[4]	250 µm MAX	230 µm MAX	230 µm MAX	NA	NA

NOTES:

1. The Cementing materials content for 40 and 45 MPa concrete is 480 kg/m^3 maximum.
2. If superplasticizers are used, the maximum concrete slump in a superplasticized condition shall be limited to 230 mm. The mix design shall state the design slump before and after the addition of superplasticizers along with the appropriate tolerances. Note that the slump in the above table may not be applicable when using superplasticizers.
3. The above mix parameters do not include required adjustments for prestressed girder concrete
4. For concrete with a water-to-cementitious materials ratio of 0.36 or less, the average air void spacing factor shall not exceed 250 µm.

The Contractor will be responsible for the mix design, accompanied by the trial batch mix data and quality control of concrete production.

All concrete mix design proportioning including the mix quality control operations shall be performed by a Laboratory CCIL or CSA Certified in accordance with CSA A283 latest edition. All testing shall be as conducted as stated in CSA-A23.1 and A23.2 latest edition. The proposed mixture design shall be signed and stamped by a Professional Engineer registered to practice in Newfoundland and Labrador. The Professional Engineer shall attest to the validity of the material test data.

For a concrete mix with a tendered quantity of more than 50 cubic metres, the mix designs and test results are only considered valid for up to two years in advance of the date of the project mix design submission. For a concrete mix with a tendered quantity of 50 cubic metres or less the test results are considered valid for up to five years in advance of the date of the project mix design submission.

The Contractor shall provide, with the proposed mix design, the following information based on actual trial mixes at least two weeks (14 days) in advance of concrete placement. The verification of the mix design through trial batching must meet the specified requirements in Table One and be performed by a laboratory certified by CCIL or CSA Standard A283 latest edition:

- Slump CSA A23.2-5C
- Air Content of Plastic Concrete by Pressure Method CSA A23.2-4C
- Mass Density and Yield CSA A23.2-6C
- Compressive Strength Testing CSA A23.2-9C
- Air Void Analysis on Hardened Concrete tested at 7 days ASTM C457
- Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration tested at 56 days ASTM C1202
- Alkali Reactivity Test Results A23.2-25A

Also to be included with each mix design submission is the following necessary information:

- Project number and title description
- Contractor company name with contact information
- Ready mix supplier
- Certifying laboratory with signing engineer

- Type of concrete, intended use, approximate quantity and method of placement
- Mix slump and air entraining agent range plus all admixtures with dosage rates
- Aggregate test information as per requirements of 904.02.02 Aggregates
- Type of Cement and test data showing conformance with CSA A3000
- Proof of current Atlantic Concrete Association (ACA) membership certificate

No adjustments shall be made to the concrete mix design without prior acknowledgement from the Materials Engineer. If material characteristics change from–the original mix design a revised mix design must be resubmitted.

High range water reducing agents (superplasticizers) may be used at the Contractor's request, if so indicated when the mix design is submitted. The Contractor shall state their method of concrete placement when submitting the concrete mix design.

Where 45 MPa concrete is specified on the contract drawings, a trial batch consisting of a minimum of 20 cubic metres of superstructure concrete shall be placed in the substructure, i.e. abutments and footings, at least 28 days prior to the placement of any 45 MPa superstructure concrete, when directed by the Owner's Representative. The purpose of this exercise is to allow for fine tuning of the mix to achieve proper air and slump, and to obtain an early indication of the expected compressive strength. The additional cost of this trial batch and fine tuning of the mix design shall be considered incidental to the works.

904.04.03 Mixing Concrete

904.04.03.01 Batch Plant Requirements

The batching of concrete, unless otherwise authorized by the Owner's Representative, shall be done in an approved batch plant.

All materials shall be stored in a manner that will prevent contamination, segregation, deterioration and intermingling. Cement and SCM's must be stored in a suitable bin that will provide protection against dampness. Aggregates shall be separated into fine and coarse sizes as determined by the Concrete Mix Design.

The water shall be proportioned separately by weight or by volume to an accuracy of ± 1%. Metering devices which measure the volume of water should not be affected by variable pressure in the water supply line.

Scales and other mass-measuring devices must be accurate. The Contractor shall

provide standard certified test weights and/or devices for checking the accuracy of the controls. A certificate of accuracy not older than 180 days old shall be provided at the request of the Owner's Representative for the scales utilized. Checks shall be made just prior to the first concrete placement and at 150 cubic metres intervals thereafter. Recalibration shall be performed if the batching plant is moved or any major alterations performed. The Contractor shall carry out all tests in the presence of the Owner's Representative and shall supply them with results of all tests and make any and all alterations, repairs or replacements required to the equipment before authorization will be given to place concrete.

The equipment for batching shall have the capacity to produce at such a rate as to preclude cold joints in the concrete placement. In any event, the equipment is subject to the approval of the Owner's Representative.

904.04.03.02 Mixing

The mixing of concrete, unless otherwise authorized by the Owner's Representative, shall be done in either a stationary mixer or truck mixer. Small quantities of proprietary concrete mixtures may be mixed on site, as authorized by the Owner's Representative, and must follow all preparation, mixing and placing requirements set forth by the manufacture of the proprietary product.

The stationary plant must conform to the limitations set forth in the Concrete Plant Standards of the Concrete Plant Manufactures Bureau. The truck mixer must conform to the limitations of TMMB 100 (Truck Mixer Manufacturer Bureau). Mixers shall carry the manufacturers rating plate in a prominent place. The mixer shall be equipped with a suitable charging hopper, water storage and water measuring device. It shall be cleaned at frequent intervals when in use and maintained in such a condition that the mixing will be unimpaired.

The mixer must be capable of combining the ingredients of the concrete within a time or number of revolutions recommended by the manufacturer of the mixer to produce a uniform mass.

Concrete transported in a truck mixer, agitator, or other transportation device shall be discharged at the job and placed in its final position in the forms within 120 minutes from the time of initial mixing, except in hot weather or under other conditions contributing to quick stiffening of the concrete. The maximum volume of mixed concrete transported in an agitator shall be in accordance with the specified rating. Time of charging the truck shall be clearly indicated and excess time in the mixer shall be cause for rejection of a

load. Each batch slip shall have the time of batching clearly clock stamped onto each such slip.

All Concrete shall be transported to site by means of a truck agitator conforming to the limitations of TMMB 100 (Truck Mixer Manufacturer Bureau).

904.04.04 Placing Concrete

Concrete shall not be placed until there is an aluminum or magnesium 3 metre straight edge on site. Straight edges shall have an accuracy of 0.5mm per metre. Wooden straight edges shall not be utilized on new construction but may be used on rehabilitation projects provided they are verified straight with a 3 metre aluminum or magnesium straight edge that is on site. See Section 919 of the Department's Specification Book for additional requirements regarding the use of wooden straight edges.

Concrete shall not be placed if the air temperature is less than 5 degrees Celsius or greater than 27 degrees Celsius without the written permission of the Owner's Representative. When the air temperature exceeds 27 degrees Celsius or falls below 5 degrees Celsius, additional placement procedures must be followed in accordance with Sections 904.06 and 904.07 respectively.

Before concrete is placed, forms, reinforcement, foundations, granular bases, placing procedures and materials must comply with the project specifications and CSA A23.1. The Contractor shall give 24 hours notice (not including Saturday, Sundays, or holidays) of their intention to place concrete.

In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of the forms. Struts, stays, and braces shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

Concrete delivered to site must conform to the temperature requirements in Table Two. Concrete to be placed in superstructure elements shall not exceed 25 degrees Celsius.

TABLE TWO

LEAST DIMENSION OF SECTION	CONCRETE TEMPERATURE	
	MINIMUM ^{O}C	MAXIMUM ^{O}C
LESS THAN 0.3 M	10	32
0.3 M TO 1 M	10	30
1 TO 2 M	5	25
MORE THAN 2 M	5	20

Concrete shall be placed so as to avoid segregation, have no adverse effects on concrete properties or displace–the reinforcement. An adequate supply of concrete must be supplied to ensure it is placed in a continuous manner.

The use of long troughs, chutes and pipes for conveying from the mixer to the forms shall be permitted only on written authority of the Owner's Representative. In case an inferior quality of concrete is produced by the use of such conveyers, the Owner's Representative may order discontinuance.

Dewatering will not be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other effective means. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

The pumping of concrete from the delivery vehicle to its place of final deposition will be permitted as authorized by the Owner's Representative.

Concrete shall not be placed with a free fall greater than 1500mm. When placing operations would involve dropping the concrete more than 1500mm, it shall be deposited through sheet metal or other approved pipes. The pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete.

After initial set of the concrete the forms shall not be jarred and no strain shall be placed on the ends of reinforcing bars which project.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material

to a sufficient depth to expose sound concrete.

In the construction of box culverts more than 1200mm in height, the concrete in the walls shall be placed and allowed to set before the top slab is placed. In this case, appropriate keys shall be left in the sidewall for anchoring the cover slab.

Concrete for beams, girders, haunches and slabs shall be deposited uniformity in one continuous monolithic operation for the full length (or between vertical construction joints authorized by the Engineer of Record) and brought up evenly in horizontal layers. Efforts shall be made to eliminate segregation as may be evident by flow lines. In this regard, concrete must be deposited in place and thoroughly consolidated rather than be permitted to flow in place.

During wet weather, concrete must not be placed unless suitable means, approved by the Owner's Representative, have been provided to prevent washing of freshly deposited concrete or marring of the exposed surface.

904.04.04.01 Consolidation

Concrete, during and immediately after depositing, shall be compacted thoroughly and uniformly by hand-tamping tools, mechanical vibration or finishing machines. The structure shall be homogenous and free of cold joints, voids, honeycombing and large surface defects. Concrete must be in full contact with reinforcement, hardware and other embedded items.

The vibration may be internal and the intensity of vibration shall visibly affect concrete over a radius of 500 mm. The Contractor shall provide a sufficient number of vibrators and they shall be manipulated so as to thoroughly work the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, until the air bubbles stop breaking on the surface. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Vibration shall not be used to make concrete flow into place. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which vibration is visible.

Vibration shall not be applied directly or through the reinforcement to concrete which has hardened. Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces. Concrete shall be placed in horizontal layers not more than 300 mm thick except when specified above. When less than a complete layer is placed in one operation it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has set to protect green concrete and avoid surfaces of separation. Vibrators shall project into preceding layer to avoid construction joint formation.

904.04.05 Depositing Concrete Under Water

Concrete shall not be deposited in water except with the authorization of the Owner's Representative and under their immediate supervision. To prevent segregation, it shall be carefully placed in a compact mass, in its final position, by means of a tremie tube or other approved method. Still water shall be maintained at the point of deposit and the forms underwater shall be watertight. Precautions shall be taken to prevent the loss of concrete by washing action of the water.

The tremie tube shall have a minimum diameter eight times the maximum size of aggregate, constructed in sections having flanged couplings fitted with gaskets and must be watertight.

The discharge end shall be closed at the start of the work to prevent water entering. The tremie tube shall be filled to the bottom of the hopper and the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete at least 0.3 m. The flow shall be continuous until the work is completed.

No concrete shall be spread at any greater distance than 3 m from the discharge end of the tremie tube. When large areas are to be covered tremie tubes at maximum 6 m centres shall be used and concrete placed simultaneously.

If the tremie operation is unavoidably interrupted below water level, the surface laitance shall be removed by jetting one day after placing and removed by pumping.

904.04.06 Levelling and Mass Concrete

Levelling concrete shall be used to level excavated areas underneath footings or other structures where indicated on the contract drawings. It may also be used to fill large voids between structures and underlying materials. Where levelling concrete exceeds 300 mm thickness, the Engineer of Record shall be contacted. Levelling concrete shall be placed after all unwatering operations have been made effective in maintaining dry and controlled

conditions as authorized by the Owner's Representative.

If the excavated area/void requires a thickness of 1.0 m or greater of concrete it is considered mass concrete and additional requirements must be satisfied as per CSA A23.1. The Contractor must prepare a thermal control plan in accordance with the CSA A23.1 that shall be reviewed and authorized by the Materials Engineer.

904.04.07 Construction Joints

Construction joints in concrete shall be positioned at the location shown on the drawings or where otherwise approved by the Owner's Representative.

The Contractor shall attach the appropriate horizontal and/or vertical wood strips, or approved alternative, to the face(s) of the formwork where all construction joints are planned or occur for reasons beyond the Contractor's control. The concrete shall be worked such that the finished appearance will resemble narrow, neat and straight horizontal and/or vertical line(s) at all construction and cold joints. Forms shall be kept tight throughout the entire concrete placing operation.

At the bottom of curb - top of deck interface along the longitudinal sides of all decks, construction joints shall be neat, straight and properly formed as a 20 mm Vee groove and shall be straight and true to line and grade.

Where construction or cold joints are planned or occur for reasons beyond the Contractor's control, the concrete interface shall be rough, clean and free of laitance, with a full roughness amplitude of 6 mm or more. One exception to this would be at prestress steel box out locations, see Section 906 for more information.

Prior to butting the new concrete against previously hardened concrete the joint face shall be cleaned of all debris and dirt.

In addition, the surface film of laitance and mortar shall be removed from the joint face to present a clean sound concrete face that has the aggregate particles exposed.

904.04.08 Contraction Joints

A contraction joint is a control joint to control volume change mainly (shrinkage). Bonding of the new and existing concrete is not required but provisions to make the joint watertight are necessary.

Joints in concrete members shall be formed in location as shown on the plans.

Contraction joints shall extend to a depth equal to one-quarter of the member thickness. As soon as feasible the joint shall be thoroughly flushed out with compressed air and an approved flexible joint filler compound utilized to fill the joint. The joint filler compound shall be flexible over the extreme temperature conditions in the local area and must be approved by the Owner's Representative.

904.04.09 Concrete Beam Seats and Bearing Surfaces

Concrete beam seats which will not have a bearing placed directly against them shall be magnesium floated to the levels and slopes as shown on the drawings and to prevent the accumulation of water.

Concrete surfaces which are used as bearing surfaces shall be dead level and finished in accordance with Section 912 and the bearing manufacturer's recommendations.

904.04.10 Tolerances

All tolerances shall conform to CSA A23.1.

904.04.11 Evaporation Retardant

Immediately after the straight edge requirements have been met for the deck and curb concrete and the broom finish applied, the fresh concrete shall be coated with an evaporation retardant to preclude rapid evaporation of the bleed water. The Contractor must submit the material data sheets of the evaporation retardant intended to be utilized on the project prior to its use. Evaporation retardant to be MasterKure ER 50 manufactured by Master Builders Company Ltd, SikaFilm manufactured by Sika, or an equivalent satisfactory to Owner's Representative.

In some cases the film may need to be reapplied prior to the completion of the finishing operations and before the final curing conditions can be implemented. When all bleed water is gone, the concrete shall be cured as per Section 904.05. The supply and application of the evaporation retardant is deemed incidental to the placement of the deck concrete and as such, no separate payment will be made.

904.04.12 Caulking of Joints

Caulking shall be applied to all control and expansion joint locations.

The caulking or sealant and the substrate material must have a temperature greater than 5℃ at the time of application unless otherwise specified by the manufacturer. Under no

circumstances should sealant be applied to any surface which contains moisture, condensation, or frost. Joint surfaces are to be clean, dry and free of foreign matter before application of primer and sealant.

The work shall be performed by an approved caulking applicator. Otherwise, the contractor must designate a person for the caulking operation and that person should receive training acceptable to the Manufacturer and Owner's Representative.

The Contractor shall supply a written guarantee of all workmanship and materials for a period of two years following the date of final completion.

The sealant shall meet the requirements of ASTM C920 "Standard Specification for Elastomeric Joint Sealants" and must be Grade NS, minimum Class 50, use Type T and must pass the accelerated weathering test as per ASTM C793 "Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants."

Joint sealant products shall be one of the following or an approved equal:

- DOWSIL 888 Silicone Joint Sealant
- TREMCO Dymonic 100
- -MasterSeal NP 150

Joint backing shall be a closed-cell non gaseous backer rod, such as Softrod specified by Tremco (Canada) Limited or an approved equal.

All work shall be in strict accordance with the Manufacturer's recommendations.

Payment shall be considered incidental to the works associated with concrete work pay items.

904.05 CURING

Curing shall begin immediately following the placing and finishing operations and provide the temperature and moisture conditions for the period of time necessary for concrete to develop its strength. The Contractor must have all necessary equipment and personal on site ready to commence curing processes prior to the placement of concrete. Concrete temperature must be maintained at no less than 10°C throughout the curing period for a minimum of 7 days and for the time to reach 70% of the specified strength. Proper curing will be considered 15% of the associated unit price bid for concrete payment purposes.

Curing of concrete surface shall start as soon as the concrete has hardened sufficiently to prevent damage. The following methods may be used for curing concrete surfaces:

- Ponding or continuous sprinkling of water
- Applying water and covering with polyethylene sheets as per Section 904.02.10
- Applying water and covering with absorptive burlap as per Section 904.02.08
- Curing compounds as per section 904.02.09
- Forms in contact with concrete surfaces

Curing of Precast Concrete structures shall follow the requirements set forth in CSA A23.4.

Concrete in ~~of~~ all superstructure concrete, including barriers, approach slabs, expansion joint dams, end blocks, curbs and sidewalks must be cured by means of burlap and water.

Additional requirements are as follows:

Burlap

All burlap must be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. Two layers of burlap must be applied to the surface of the concrete. Strips must overlap by 150 mm and must be held in place without marring the surface of the concrete.

Curing with burlap and water must be maintained for a minimum period of seven days. The burlap must be maintained in a continuously wet condition throughout the curing period by means of a soaker hose. The burlap must be covered with a layer of moisture vapour barrier within 12 hours of placing the concrete, in a manner which will prevent deformation of the surface of the concrete.

Air flow in the space between the moisture vapour barrier and the burlap must be prevented.

Regardless of ambient temperature, moist curing with burlap and water must be provided at all times. During cold weather, burlap must be prevented from freezing.

Liquid Membrane Curing

At the discretion of the Owner’s Representative, liquid membrane curing compounds meeting the requirements of Section 904.02.09, may be used in place of moist curing on pier columns only. Liquid membrane curing shall not be permitted on other areas

including bridge decks.

904.05.01 Curing of Bridge Decks

Prior to the commencement of curing operations a fog mist shall be applied to bridge decks. Misting shall be conducted through the use of a pressure washer capable of sustaining a minimum 14 MPa pressure. A continuous fog mist shall commence immediately behind the screeding operation until the concrete has hardened sufficiently to permit covering with burlap. The fog mist will maintain a high relative humidity above the concrete and prevent surface drying prior to curing operations. Water shall not be allowed to drip, flow or puddle on the concrete surface during fog misting at any time before concrete has reached final set.

The curing time required for deck concrete is moist curing for 7 days in accordance with this specification and a further 30 days for air drying. Also, the specified design strength must be obtained. Until the above conditions are satisfied, the application of waterproofing and the opening of the bridge to traffic will not be permitted.

Payment shall be considered incidental to the placement of Superstructure Concrete.

904.05.02 Plastic Shrinkage

Where excessive plastic shrinkage may occur, e.g. in a large expanse of concrete such as a bridge deck, more than one method of curing may be required.

If shrinkage cracks occur the Contractor shall grout any cracks and repair by an approved method at their own expense.

All methods and materials employed in concrete curing must be to the satisfaction of the Owner's Representative.

904.06 HOT WEATHER CONCRETING

When the air temperature is at 27 degrees Celsius or greater or is expected to rise to this limit, according to meteorological forecasts, then special measures shall be taken by the Contractor to protect the concrete. Surface moisture evaporation must not exceed 0.75kg/m^2/hr.

Concrete placed in the forms shall be maintained at or below 27 degrees Celsius and the Contractor shall ensure all measures to achieve the temperature requirement are to the satisfaction of the Owner's Representative.

Curing shall be accomplished by moist-curing with water spray or by using absorptive burlap as specified in sections 904.02.08 and 904.05.

904.07 COLD WEATHER CONCRETING

904.07.01 General

When the air temperature is at or below 5 degrees Celsius or when, according to meteorological forecasts, it is likely to fall below this limit within the next 24 hours, then the Contractor shall take special precautions to protect the concrete placed. The Contractor shall obtain approval from the Owner's Representative for this method of protection.

Concrete for the superstructure (or approach slabs) shall not be placed between November 1 and April 1 unless otherwise approved of by the Owner's Representative.

The following table shall apply for determining degree of protection requested by the Owner's Representative:

TABLE THREE

PROTECTIVE MEASURE	OUTSIDE AIR TEMPERATURE FOR LEAST DIMENSION OF SECTION	
	LESS THAN 1M	MORE THAN 1M
SUITABLE HOUSING PLUS SUPPLEMENTARY HEAT OR ADEQUATE INSULATION	BELOW $0^{O}C$	BELOW $-5^{O}C$
SUITABLE COVERING PLUS ADEQUATE INSULATION	$0^{O}C$ TO $5^{O}C$	$0^{O}C$ TO $-5^{O}C$
NORMAL CURING NO TEMPERATURE PROTECTION REQUIRED	$5^{O}C$ TO $25^{O}C$	$5^{O}C$ TO $20^{O}C$

Any concrete damaged by freezing or by inadequate protection or curing shall be removed and replaced by the Contractor at no cost to the Department.

For additional guidance on Cold Weather Concreting see ACI 306 "Guide to Cold Weather Concreting" and the Portland Cement Association publication "Design and Control of Concrete Mixtures."

904.07.02 Placing

Concrete to be placed during cold weather must be within the temperature limits of Table Two.

This temperature can be obtained by heating the water or the aggregate or both; water and aggregate shall then be combined in the mixer first and the temperature of the mixture shall not exceed 38 degrees Celsius when the cement is added.

At temperature below freezing, aggregates are required to be heated prior to incorporation into the mixture. The aggregates shall be uniformly heated in the stockpiles and/or bins by steam, either injected live or circulated in coils, or by using dry heat before the aggregates are placed in the mixer. Whatever system is used, it shall be designed to give uniform heating that will avoid local overheating which may be injurious to the materials. No frozen lump of aggregate will be allowed in the concrete mix and shall be discarded before batching.

When the air temperature is below 0 degrees Celsius the water shall be heated. It shall not be heated to a temperature greater than 60 degrees Celsius.

The use of salt, calcium chloride or other chemicals to lower the freezing point or accelerate the set is prohibited.

No concrete shall be placed on or against any surface that will lower the temperature of concrete in place below the minimum values in Table Two. The ground, formwork, existing concrete and steel against which concrete is to be placed shall be free from ice and snow have a temperature greater than 0℃ before the Owner's Representative will authorize placing to commence. The Contractor shall preheat the area in which the concrete is to be placed, with live steam or moist hot air, this shall also remove snow and ice and heat the contact material to prevent the formation of a cold joint. Additional heating may be necessary if large quantities of steel elements are present, however care must be taken to avoid heating elements more that 5 degrees Celsius above the temperature of the concrete mixture.

Concrete shall not be placed on a frozen subgrade or against frozen ground. The ground must be thawed by either steaming, spreading hot sand/gravel, removing and replacing with unfrozen material, covering with insulation for a period of time or using heaters under insulated blankets. The Contractor shall protect excavations prepared for footings, etc., with covers prior to opening for placing concrete.

The concrete shall be placed rapidly and evenly, as near to its final position as possible to reduce the risk of segregation, flow lines and cold joints. The concrete shall be covered, as quickly as possible after placing.

904.07.03 Protecting Placed Concrete

Concrete placed should be maintained at a temperature no less than 10 degrees Celsius in accordance with Section 904.05 for the duration of the curing period. Depending on ambient temperatures it can either be protected by insulating materials or enclosed with an additional heat source. The proposed method of curing must be submitted and authorized by the Owner's Representative.

Insulating materials, such as moisture impervious insulating blankets, must have an R-value suitable to ensure thermal resistance. Corners, edges and thin/vulnerable concrete sections may require additional insulation. All insulating materials shall be covered by polyethylene sheeting and a max/min thermometer placed in contact with the concrete. Temperatures shall be monitored and additional insulation placed as necessary.

Protective housing shall be utilized as required in Table Three above and must be wind and weather tight and constructed of suitable materials on a substantial framework. The framework must be such as to permit free circulation of warmed air. The housing must have suitable openings to let the concrete be placed and these openings shall be so designed that they may be fully covered and closed as soon as the concrete is placed. The use of "roll back" sheeting or tarpaulins supported on stools is permitted on horizontal surfaces, such as a bridge deck provided the concrete is covered progressively as soon as placed. The housing must be so constructed as to allow a uniform circulation of heat to all parts of the work. This shall include the underside of the bridge deck and beams unless the Owner's Representative has authorized the protection of these areas by fully insulated formwork.

904.07.04 Heating the Protective Housing

The Contractor shall have available, tested and approved, adequate equipment for the heating of the protective housing. Heating will be used to establish and maintain the required curing conditions.

Unless otherwise permitted by the Owner's Representative, concrete to be placed between September 1 and April 30, the Contractor shall supply a live heated wet steam system, such as a steam jenny, fully operational and fully capable of adequately protecting all concrete to be placed. Hot air blowers and the like may be used to supplement the steam heating as long as fine water or steam spray into the stream of hot

air is provided. The humidity as measured by a wet and dry bulb thermometer shall at no time be less than 95% and the air temperature shall be not less than 13 degrees Celsius.

The Contractor shall on the day prior to placing concrete, conduct a trial run to verify their equipment, methods and workmanship to meet the specifications.

The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat are prohibited. In the event of any fire of the formwork or housing, the Owner's Representative must be immediately notified.

The system of heating and positioning of steam outlets so as to give the most uniform distribution possible of the heat must be satisfactory to the Owner's Representative. The Contractor shall make suitable arrangements to stoke boilers outside normal working hours where required. A breakdown in heating is regarded as very serious especially in the early life of the concrete.

Protection shall be withdrawn in such a manner as not to introduce thermal shock stresses in the concrete.

The temperature of the concrete shall be gradually reduced to the permissible temperature differential as specified in CSA A23.1 to that of the surrounding air. To achieve this in a heated housing, the heat shall be slowly reduced and then shut off and the whole housing allowed to cool to within the permissible temperature differential before the housing itself or the formwork is removed. Where work is to proceed within the same housing on the next stage of the work, the formwork may be removed as soon as the prescribed curing period is over. With fully insulated formwork, the forms themselves maybe slackened and some insulation removed if needed. The forms themselves shall not be removed until the temperature of the concrete has fallen to within 12 degrees Celsius of the outside air temperature.

904.08 SURFACE FINISHING

904.08.01 General

All concrete surfaces that will be visible on completion of the work shall be rubbed finish, with the exception of the deck, approach slabs, curbs and/or sidewalks which shall be a floated finish.

The Contractor shall take special care during the planning, forming, concrete placing, curing and stripping phases to ensure defect-free surfaces. Should remedial measures be required, they shall be carried out by personnel expert in this aspect of concrete work.

The surfaces shall be uniform in colour and texture when viewed from a distance of 15 m and shall be attained as follows.

904.08.02 Rubbed Finish

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycombs spots, broken corners or edges and other defects shall be cut back to sound concrete and thoroughly cleaned. No feather edging is permissible. If reinforcing steel is exposed, concrete shall be cut back for at least 50 mm around the reinforcement.

After having been kept saturated with water for a period of not less than three hours, the cavities shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished or an approved product. Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured as specified under Section 904.05. No mortar shall be placed when the air temperature is forecasted to fall below 5 degrees Celsius within 24 hours. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges. The resulting surfaces shall be true and uniform.

After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. However, before starting this work the concrete shall be kept thoroughly saturated with water for a minimum period of three hours but sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing of rod holes and defects to thoroughly set. Surfaces to the finished shall be rubbed with a medium coarse carborundum stone.

When insufficient cement paste can be drawn from the concrete from rubbing use a small amount of mortar on its face. The mortar shall be composed of extra cement and fine sand mixed in proportions such as to match existing concrete verified by a test patch. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place at this time.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform colour. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove

loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

904.08.03 Floated Surface Finish

The provision of an approved self-propelled Bridge Deck Finishing Machine capable of striking off and providing the required surface finish is mandatory for all horizontal structures not covered by fill.

For new bridge decks and rehabilitated bridge decks where the total deck length is greater than fifteen metres, the deck shall be finished with a GOMACO 450 bridge deck finishing machine with a vibrating screed and movable work bridge or approved equal.

For (a) decks less than fifteen metres in length, (b) thin overlay strips wider that two metres, (c) wharf decks and (d) bridge approach slabs greater than 3 metres in length, finishing shall be achieved with a self-propelled air operated vibrating Allen Screed or approved equal.

Deck repairs by overlay shall also meet the requirements in Section 919.

All finishing equipment, as referenced above, shall be equipped and operated in accordance with the manufacturer's literature for the particular concrete and work being performed.

For thin overlays less than two metres wide refer to Section 919.13.

Screed elevations shall be obtained as detailed in Section 907.

A dry run of the finishing machine covering the entire area requiring finishing shall be made to insure the design deck thicknesses and profiles will be attained. The run shall be completed at least 24 hours prior to commencing the deck concrete placement.

The finishing machine must be accompanied by a working platform with two qualified cement finishers assigned to the platform at all times. The Contractor shall submit letters to the Owner’s Representative stating the qualifications of the finisher. The Contractor shall supply sufficient quantities of double railing to support the finishing machine equal to the overall length of the deck. This will enable the Owner’s Representative to check the adjustment of the railing and the finishing machine prior to any concrete being placed.

Proper allowance shall be made for camber of pre-stressed channels or girders.

Concrete placement shall be at a rate to provide satisfactory progress with the finishing machine or the cement finisher.

After the completion of screeding operations concrete shall be worked with a bull float or darby to remove any high spot, ridges or to fill voids in the concrete surface. Bull floating or darbying shall follow as close as practical behind the screed. If the concrete surface has the required smoothness/texture after screeding than bull floating or darbying may not be necessary.

Concrete shall not be placed until there is an aluminum or magnesium 3 metre straight edge on site. Straight edges shall have an accuracy of 0.5mm per metre. Wooden straight edges shall not be utilized on new construction but may be used on rehabilitation projects provided they are verified straight with a 3 metre aluminum or magnesium straight edge that is on site. See Section 919 of the Department's Specification Book for additional details.

After the deck surface has been floated and any bleed water evaporated, but while the concrete is still plastic, the Contractor shall furnish and use a 3 m straight edge swung from handles half the width of the slab.

The straight edge shall be held in successive positions parallel to the road centre line and in contact with the surface and the whole area gone over from one side of the slab to the other as necessary. Advancement along the deck shall be in successive stages of not more than one-half the length of the straight edge. Any depressions found shall be immediately filled with freshly mixed concrete, stuck off, consolidated and refinished. The straight edge testing and refloating shall continue until the entire surface is found to be free from observable departures from the straight edge and the slab has the required grade and contour, until the deviations are less than 3mm per metre to a maximum of 8 mm under the 3 metre straight edge.

The concrete deck surface, approach slabs, curbs and/or sidewalks shall be given a broom finish when the concrete has hardened sufficiently. Exposed concrete bridge decks shall be given a coarse broom finish. Treated or waterproofed bridge decks shall be given a fine broom finish. The broom shall be of an approved type. The strikes shall be square across the slab, from edge to edge, with adjacent strokes slightly overlapped and shall be made by drawing the broom without tearing the concrete but so as to produce regular corrugations not over 3 mm in depth for the coarse broom finish. The fine broom finish shall have corrugations not exceeding 1 mm in depth. The surface as thus finished shall be free from porous spots, irregularities, depressions and small pockets or rough

spots such as may be caused by accidental disturbance during the final brooming of particles of coarse aggregate embedded near the surface. The Owner's Representative may decide to delete the broom finish requirements but tolerances previously stated will still apply.

904.09 SAMPLING AND TESTING

The Contractor shall co-operate fully with the Owner's Representative in enabling quality assurance tests to be carried out. Samples for quality testing purposes will normally be taken from concrete as delivered to the site (at the point of discharge from the delivery equipment). However, depending on the method of placement, random sampling of the concrete as incorporated into the structure shall also be performed to verify the above specified properties. This process shall entail the sampling of fresh concrete as close to the point of deposit in the structure as is practicable. Coring of the in-place hardened concrete may also be performed to verify the specified air void system. The Department reserves the right to designate the point of acceptance, with prior notice given to the Contractor.

Field quality assurance testing will be carried out by an Owner's Representative in accordance with CSA A23.2.

Quality assurance tests carried out by the Department shall conform to the following guidelines:

SUPERSTRUCTURE

AIR & SLUMP TESTS	Each load until 5 consecutive batches meet the requirements then test every second load thereafter.
STRENGTH & TEMPERATURE TESTS	At least 1 set of Laboratory cylinders per 100 cubic metres, minimum 1 set per day plus 1 set of field cures per category of concrete if required by the Owner's Representative.

SUBSTRUCTURE, REINFORCED WHARF DECK CONCRETE, CAST-IN-PLACE MEDIAN BARRIERS, CURB, GUTTER, SIDEWALKS, CATCH BASINS, WEIR BAFFLES, PILE, LEVELLING, MASS AND TREMIE CONCRETE

AIR & SLUMP TESTS	Each load until 5 consecutive batches meet the requirements then test every third load thereafter.
STRENGTH & TEMPERATURE TESTS	At least 1 set of Laboratory cylinders per 100 cubic metres, minimum 1 set per day plus 1 set of field cures per category of concrete if required by the Owner's Representative.

Additional strength tests will be required when early indications of strength are required such as before prestressing, girder transport, removal of falsework, backfilling structure, etc.

If either the measured slump, air content or temperature fall outside the limits specified, a repeat test shall be made. Failure to meet the contract requirements shall result in rejection of the concrete. Acceptance of the concrete will depend on the results and consistency of all of the above tests results being satisfactory.

904.10 MEASUREMENT FOR PAYMENT

904.10.01 Measurement for Payment for concrete work where the Unit Price Table states the unit to be cubic metres

For those concrete work contract items, except mass, levelling and tremie concrete, where the unit of measurement on the Unit Price Table is stated as cubic metre, then measurement for payment will be by the volume of concrete placed, measured in cubic metres rounded to two decimal places, based on the neat lines called for in the plans.

Measurement for payment purposes for mass concrete shall be based upon cross sections measured in cubic metres to the nearest one decimal place. Prior to concrete placing and forming operations, the Owner's Representative shall establish the lateral and vertical limits for mass concrete.

Measurement for payment purposes for tremie concrete shall be made based upon the number of cubic metres of batched concrete rounded to the nearest one decimal place and incorporated into the works as accepted by the Owner's Representative. Every precaution must be taken to prevent waste of concrete, i.e. carelessness resulting in the escape of concrete from within the confines of the forms or inaccuracy in placing. In the event of such occurrence(s) an estimate of the wastage will be made by the Owner's Representative and an appropriate deduction from the batch quantity will be made. All

additional concrete required to be placed above the estimated quantity, accepted by the Owner's Representative.

No deductions will be made from the volume of concrete for:

a) Volume of reinforcement, prestressing steel or prestressing ducts.
b) Inserts of cross-sectional area of less than 0.1 square metres.

When it is specified that concrete is to be placed against undisturbed soil or set in rock, and where the excavation is made wider than the neat lines of the footings, the excess amount of concrete will not be measured for payment quantities.

Where the concrete footings are placed lower than that authorized by the Owner's Representative, any excess amount of concrete will not be measured for payment quantities.

Unless otherwise defined by the Contract Documents, the following will be the definitions for the structure and Unit Price Table:

Substructure concrete shall be that concrete used for slope paving, footings, abutments, back walls, columns, bearing seats, pedestals, wing walls and piers. Wingwall concrete shall be all concrete behind the back face of the abutment, i.e. including the cleat excluding curb (superstructure) concrete.

Where integral curbs and wing walls exist, a horizontal surface at the bottom of the curb including the bevelled portion thereof if any and the horizontal surface at the top of the vertical portion of the wingwall shall constitute the dividing line between substructure and superstructure concrete.

Retaining wall concrete shall be all concrete used in retaining walls and footings which are not cast integrally with the abutments.

Superstructure concrete will be all concrete used in sidewalks, barriers, expansion joint dams, beams, diaphragms, decks, curbs, end blocks, including curbs and end blocks integral with the wing walls.

All concrete in rigid frames used in deck, curbs, barriers, sidewalks, end blocks, vertical or inclined legs and wing walls shall be classified as superstructure concrete.

All concrete for rigid frame footings shall be classified as substructure concrete. All approach slab concrete shall be classified as superstructure concrete.

Not included are AASHTO or CPCI girders, double tees, and any other superstructure work paid for separately.

Not more than 90% of the units will be certified until such time as the surface finish meets the specifications and is completed to the satisfaction of the Owner's Representative.

904.10.02 Measurement for Payment for concrete work where the Unit Price Table states the unit to be a unit other than cubic metres

For those concrete work contract items where the unit of measurement on the Unit Price Table is stated in some unit other than cubic metre, then the measurement for payment shall be in accordance with that stated in the appropriate specification for the item.

Not more than 90% of the units will be certified until such time as the surface finish meets the specifications and is completed to the satisfaction of the Owner's Representative.

904.11 BASIS OF PAYMENT

904.11.01 Basis of Payment for concrete work where the Unit Price Table states the unit to be cubic metres

For those concrete work items where the unit of measurement in the Unit Price Table is stated as cubic metre, then payment at the contract price shall be full compensation for all materials, labour, equipment, plant and services necessary to complete the concrete work as outlined herein.

In particular no separate payment will be made for:

a) supply of cement, aggregates and other materials, plant and equipment-use required for producing the concrete
b) Mix design, production, mixing, transportation, placing, consolidation, curing and quality control during production
c) Formwork and falsework
d) Precautions to be taken for hot weather
e) Precautions to be taken for cold weather
f) Provisions of shipping crates for concrete test specimens

No payment shall be made for any concrete required for normal testing procedures.

Where excessive camber in girders is permitted by the Owner's Representative, the extra concrete due to the camber in excess of the specifications will not be paid for.

Concrete not placed in accordance with the provisions of Section 904.07 the appropriate weather conditions prevail will not be paid for unless and until it can be established to the satisfaction of the Owner's Representative that there has been no harmful effect to the concrete. The onus for establishing this will belong to the Contractor.

904.11.02 Basis of Payment for concrete work where the Unit Price Table states the unit to be a unit other than cubic metres

For those concrete work contract items where the unit of measurement in the Unit Price Table is stated in some unit other than cubic metre, then the basis of payment shall be in accordance with that stated in the appropriate specification for the item.

Concrete not placed in accordance with the provisions of Section 904.07 when the appropriate weather conditions prevail will not be paid for unless and until it can be established to the satisfaction of the Owner's Representative that there has been no harmful effect to the concrete. The onus and costs for establishing this will belong to the Contractor.

904.11.03 Concrete Acceptance and Reduced Payment Criteria on Concrete Located in New Structures

Concrete on a project of a certain class, as defined by its specified strength at 28 days, must have an average tested strength at 28 days equal to or greater than that specified for payment at the bid price.

Concrete of a certain class having an average strength of less than that specified will be accepted into the job at a reduced payment, provided the difference between specified strength and tested strength is no greater than 5 MPa. If the average of tests in a particular predefined portion of concrete is less than that specified by more than 5 MPa then that concrete shall be rejected.

When concrete is rejected, those provisions outlined in CSA A23.1 shall be followed to determine whether or not the concrete may remain in the work. Such work will be done at the Contractors cost. Notwithstanding the above, should the concrete remain in the work it will be subject to a reduction, as outlined below, for having a strength less than that specified.

Concrete of a specific class and otherwise acceptable but having an average strength

deficiency as tested of less than 5 MPa compared with that specified, will be accepted but the bid price for all concrete in the predefined portion will be reduced according to the following procedure:

For concrete work where the Unit Price Table states the unit to be in cubic metres, the adjusted concrete price shall be calculated as follows:

> $(Adjusted Concrete Unit Price) = Tested Strength / Specified Strength * $(Bid Concrete Unit Price)

Division of the structure into predefined portions will be done by the Owner's Representative when the concrete placement sequence is outlined by the Contractor at the pre-job meeting. A predefined portion shall generally be established as that concrete placed within one operation.

There will be no bonus payment under the contract when the average strength is in excess of the specified strength.

904.11.04 Concrete Acceptance and Reduced Payment Criteria on Concrete Located in Rehabilitated Structures

Concrete on a rehabilitation project, as defined by its specified strength at 28 days, must have an average tested strength at 28 days equal to or greater than that specified for payment at the bid price.

Concrete having an average strength of less than that specified will be accepted into the job at a reduced payment, provided the difference between specified strength and tested strength is no greater than 5 MPa. If the average of tests in a particular predefined portion of concrete is less than that specified by more than 5 MPa then that concrete shall be rejected.

When concrete is rejected, those provisions outlined in CSA A23.1 shall be followed to determine whether or not the concrete may remain in the work. Such work will be done at the Contractors cost. Notwithstanding the above, should the concrete remain in the work it will be subject to a reduction, as outlined below, for having a strength less than that specified.

Concrete of a specific class of repair and otherwise acceptable but having an average strength deficiency as tested of less than 5 MPa compared with that specified, will be accepted but the bid price for all concrete in the predefined portion will be reduced

according to the following procedure:

For concrete work where the Unit Price Table states the unit to be square metres or cubic metres the adjusted price shall be calculated as follows:

> $(Adjusted Concrete Unit Price) = (Tested Strength/Specified Strength) x $(Bid Concrete Unit Price)

Division of the structure into predefined portions will be done by the Owner's Representative when the concrete placement sequence is outlined by the Contractor at the pre-job meeting. A predefined portion shall generally be established as that concrete placed within one operation.

There will be no bonus payment under the contract when the average strength is in excess of the specified strength.