

SECTION 555 - STRUCTURAL CONCRETE

555-1 DESCRIPTION. This work shall consist of furnishing and placing portland cement concrete for structures as indicated on the plans and in accordance with the specifications.

555-2 MATERIALS

555-2.01 General. The materials used for structural concrete shall comply with the material requirements of Section 501, Portland Cement Concrete, General. 5

Additional materials, listed below, required specifically for use in conjunction with structural concrete items shall meet the requirements of the following subsections:

Vertical and Overhead Patching Material	701-08	
Preformed Cork Joint Sealer	705-01	10
Preformed Rubber Joint Filler	705-03	
Caulking Compound for Structures	705-06	
Preformed Elastic Bridge Joint Sealer	705-09	
Polyvinyl Chloride Extruded Shapes and Sheet Material	705-11	15
Lubricant for Preformed Elastic Joint Sealer	705-13	
Portland Cement Mortar Bonding Grout	705-22	
Bar Reinforcement, Grade 420	709-01	
Wire Fabric for Concrete Reinforcement	709-02	
Quilted Covers (for curing)	711-02	20
Plastic Coated Fiber Blankets (for curing)	711-03	
Polyethylene Curing Covers (White Opaque)	711-04	
Membrane Curing Compound	711-05	
Burlap	711-06	
Form Insulating Materials for Winter Concreting	711-07	25
Admixtures	711-08	
Water	712-01	
Asphalt Roofing Felt	712-12	
Epoxy Resin System	721-01	
Epoxy Polysulfide Grout	721-03	30
Copper Flashing	725-01	
Sheet Gasket (treated both sides)	728-06	
Concrete Cylinder Curing Box	735-01	

555-2.02 Concrete for Structures. The class of concrete required for the various structural concrete items will be indicated on the plans. The same source of aggregates shall be used for all faces of a concrete structure exposed to view. 35

555-3 CONSTRUCTION DETAILS

555-3.01 Concrete Manufacturing and Transportation. Unless otherwise specified on the plans or in the proposal, the construction details for manufacturing and transporting concrete shall comply with §501-3, Construction Requirements, under Portland Cement Concrete, General. 40

555-3.02 Falsework. Falsework plans shall be submitted by the Contractor and approved by the Engineer before falsework construction is started. Falsework or centering shall be designed for the dead load of the concrete forms, the dead load of the plastic concrete (based on 2400 kg per cubic meter) and in addition thereto, a live load allowance resulting from a mass of 245 kg per square meter applied to all horizontal surfaces. 45

Falsework which cannot be founded upon a solid footing, shall be supported by falsework piling.

The Engineer may require the Contractor to employ screw jacks or hardwood wedges in connection with the centering or falsework in order to take up any slight settlement in the form work, either before

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or during the placing of concrete.

Falsework shall be set to give the finished structure the specified camber, plus allowance for shrinkage and settlement.

555-3.03 Forms

A. General. All forms shall be well-constructed, carefully aligned, substantial and firm, securely braced and fastened together in their final position. They shall be strong enough to prevent the fresh concrete from bulging the forms between supports and to withstand the action of mechanical vibrators. If required by the Engineer, form work plans shall be submitted by the Contractor and approved by the Engineer before forms shall be used on the work. No work shall be done without the approval of the Engineer. 5
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Forms shall be designed to resist a pressure resulting from a mass of 2400 kg per cubic meter for the plastic concrete and in addition thereto, a live load allowance resulting from a mass of 245 kg per square meter on horizontal surfaces. Forms shall be maintained to eliminate the formation of joints due to shrinkage of the lumber. 15

They shall be sufficiently tight to prevent leakage of mortar. Concrete with surfaces misshapen by bulges or deformations caused by inadequate forms shall be removed or corrected as directed by the Engineer. 20

When concrete is transported by buggies, conveyor belt or other approved methods of conveyance, the forms shall be capable of supporting the distribution equipment and any concentrations of concrete which may occur during transportation and distribution. 25

Buggy runways and other supporting platforms shall be supported directly by the forms. The form and falsework design shall provide for the loads resulting from the conveyance system in addition to the live load allowance resulting from a mass of 245 kg per square meter. Forms for slabs, beams and girders shall be cambered as indicated on the plans. 30

Forms shall be so constructed that those surfaces on which finishing may be required may be stripped without disturbing the remaining forms. 35

Forms shall be filleted 25 mm at all exposed corners unless otherwise shown on the plans.

Forms may be constructed of wood, metal or other approved materials except when a particular material is specified on the plans. When curved, patterned or other special forms are required, the Contractor shall submit details of the form construction to the Engineer for approval prior to constructing the forms. Construction of such forms shall not begin without the approval of the Engineer. 40

The use of fiber forms will be permitted for round columns only if the interior surface of the forms have been treated in such a manner as to prevent helical corrugation marks on the finished concrete surface. 45

Forms shall be adequately braced to resist concrete design loads. If the forms are inadequately braced, the Engineer shall stop concrete placement until adequate bracing has been provided.

Any metal ties or anchorages within the forms shall be so constructed that the embedded portion of the ties can be removed to a depth of at least 50 mm from the surface of the concrete without injury to such surface. Wire ties will not be permitted without written permission of the Engineer. In case wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least 6 mm from the face of the concrete with sharp chisels or nippers (nippers are necessary for green concrete.) All cavities produced by the removal of metal ties shall be filled in conformance with requirements of §555-3.08A, Finishing Surfaces Exposed to View. The surface film on repaired surfaces shall be carefully removed before setting occurs. 50

All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened.

For walls where access to the bottom of the forms is not practicable, the lower form boards or panels shall be left loose so that the inside of the forms can be readily cleaned of all chips, dirt,

sawdust or other extraneous material, immediately prior to the placing of concrete.

Forms to be re-used shall be maintained in good condition as to accuracy of shape, strength, rigidity, water tightness and smoothness of surface. Any warped or bulged forms must be carefully re-sized before being re-used. Forms unsatisfactory in any respect shall not be used. All form surfaces that will be in contact with the concrete shall be thoroughly treated with an approved form coating in the manner, and at the rate specified by the manufacturer. Only those coatings listed on the Approved List published by the Materials Bureau are acceptable. Forms so treated shall be protected against damage or dirt prior to placing concrete.

If metal forms are used, the material shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms, which do not present a smooth surface or line up properly, shall not be used. Special care shall be exercised to keep metal forms free from rust, grease or other foreign matter that would tend to discolor the concrete.

B. Removal of Forms. Forms and their supports shall be removed when ordered by the Engineer and then only in such manner as the Engineer may direct.

Forms shall be removed in such a way as to permit the concrete to take the stresses uniformly and gradually. Any method of form removal likely to cause over stressing of the concrete shall not be used.

The forms for any portion of a structure shall not be removed until the concrete is strong enough to withstand damage.

The following minimum curing periods may be used as a guide for removal of forms and supports from concrete structures:

Arch Centers 8 Curing Days

Centering under Beams 8 Curing Days

A curing day is defined in 555-3.09A.

Forms used for substructure concrete placements shall be removed in accordance with the requirements of Table 555-1.

555-3.04 Handling and Placing Concrete

A. General. No concrete shall be placed when the ambient air temperature is below 7°C, unless the Engineer grants permission under the provisions of §555-3.06. If the ambient air temperature is 7°C, or greater, during the placement and is expected to fall below 0°C, at any time during the curing period, the provisions of §555-3.06 shall apply. If the ambient air temperature is 7°C, or greater, during the placement and is expected to remain at, or above 0°C during the curing period, the provisions of §555-3.09 C. Curing Temperatures - All Placements shall apply. No structural slab or sidewalk placement shall be commenced if the combination of ambient air temperature, relative humidity, wind speed, and plastic concrete temperature, all combine such that a surface moisture evaporation rate is theoretically equal to, or greater than 1.2 kg/m²/hr. of exposed surface. It shall be the contractor's responsibility to determine this rate. (Refer to §555-3.09C, and TABLE 555-3). All foreign matter of every kind shall be removed from the interior of the forms before placing concrete. Temporary studs or braces within the forms shall be removed when the concrete has reached an elevation rendering their further use unnecessary.

Concrete shall be placed so as to avoid segregation of materials and displacement of reinforcement. All equipment used for conveying the concrete mix from the input end to the discharge point shall be capable of meeting the permissible variations given in Table 501-5, Concrete Uniformity. Prior to the actual placement of concrete, the Engineer may require the Contractor to demonstrate the capability of the equipment to convey the concrete mixture. Tests according to Department written instructions will be performed by the Engineer at his discretion. No further verification of the equipment's capability will be required unless evidence on the

TABLE 555-1 MINIMUM TIME REQUIRED FOR STRIPPING FORMS, FORMING NEXT PLACEMENT AND LOADING OF SUBSTRUCTURES

	STRIPPING	FORMING NEXT PLACEMENT	LOADING
All Footings	2 Days	2 Days	4 Days before next placement
Abutment Stems, Backwalls	2 Days if less than 3.0 m (avg.). Add 1 day for each additional 1.5 m up to 5 days, maximum	2 Days	5 Days before placing backwall on stem. 7 Days before backfilling 14 Days before placing superstructure loads. ³
Pier Columns, Pier Plinths	2 Days if less than 3.0 m high (avg.). Add 1 day for each additional 1.5 m	4 Days for Columns 2 Days if forming pedestal	Columns - 7 Days before placing cap beam. Plinth - 2 Days before pedestal placement 21 Days before placing superstructure loads ³
Pier Cap Beams	8 Days (bottom) 3 Days (sides)	2 Days	5 Days before pedestal placement. 21 Days before placing superstructure loads. ³
All Pedestals	2 Days	–	7 Days (Class A) 3 Days (Class F) ⁵
Wingwalls or Retaining Walls	Same as abutment stems	–	14 Days before backfilling ³

NOTES.

1. A "Day" is a curing Day as defined in 555.
2. All concrete shall be cured for a minimum of seven curing days in the manner required by 555.
3. Minimum time requirements for loading may be reduced (or extended) based on test cylinder compressive strength results. The D.C.E.S. will establish requirements for early loading upon request. The Contractor shall notify the Engineer, in writing, at least 10 days prior to placement, that early loading is being requested, so that arrangements for test cylinders can be made. Test cylinders shall be prepared in accordance with Materials Method 9.2 - Field Inspection of Portland Cement Concrete. Two test cylinders shall be prepared for each anticipated testing period. These cylinders shall be cured in the same manner as the substructure element which they represent. After the first compression test, the Engineer shall determine subsequent testing periods based on the results of the first test. No more than three tests for each substructure element shall be allowed.
4. No load shall be applied until the concrete has attained enough strength to resist damage. If the concrete contains set retarding admixture, fly ash or G.G.B.F.S., and is exposed to temperatures below 16°C, test cylinders shall be prepared and used to determine the time to loading according to the procedure described in note 3 above.
5. Minimum time for loading pedestals shall not compromise minimum loading times specified for other placements.
6. Concrete surfaces being cured using covers or blankets from which the covers are removed for any purpose prior to the full cure period shall be sprayed with clear (fugitive dye) curing compound within ten minutes of cover removal. Curing compound material and application requirements are specified in Section 555.

nonuniform concrete is observed by the Engineer during placement. Concrete shall not come in contact with aluminum during conveying and placing operations. When concrete pumps are used, the lines shall have a minimum diameter of 125 mm. The specific pumping equipment which the Contractor proposes to use shall be subject to the approval of the Regional Construction Engineer.

The concrete mixture, prior to placement into the conveying equipment, shall meet the specified requirements for air content and slump given for the various classes and types of placement under Table 501-3, Concrete Mixtures.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the concrete already in place.

Dropping concrete a distance of more than 1.5 m or depositing a large quantity at any point and running or working it along the forms shall not be permitted. 5

Special care shall be taken to fill each part of the form by depositing concrete directly into the form as near to its final position as possible, to work the coarser aggregates back from the face of the concrete and to force the concrete under and around the reinforcement without displacing the reinforcement. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of the projecting reinforcement. 10

Concrete shall be placed in horizontal layers not more than 300 mm thick except as hereinafter provided. 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 layer has taken its initial set to prevent injury to the green concrete and avoid cold joints between batches. Each layer shall be compacted so as to avoid the formation of a joint with a preceding layer which has not taken initial set. 15

When concrete placement is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a depth sufficient to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smooth and level whenever concreting is discontinued. Where a "feather edge" would be produced at a construction joint, as in the sloped top surface of a wing wall, an inset form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than 150 mm in the succeeding layer. Work shall be continuous from the bottom to the top of any face. The surface of all unformed areas, whether permanent or at construction joints, shall be finished by placing an excess of material in the forms and striking off the excess with a suitable screed, forcing the coarse aggregate below the level of the finished surface. 20

Following the discontinuance of placing concrete, all accumulation of mortar splashed upon the reinforcing steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the plastic concrete. 25

Before concrete slabs are placed on steel spans, all permanent field connections shall be completed unless otherwise noted on the contract plans, and all temporary supports and mechanisms used in steel erection shall be removed. 30

When noted on the contract plans, the permanent field connections shall be made after the bridge slab has attained sufficient strength to permit removal of forms and falsework. Permanent field connections shall be made just prior to removal of forms and falsework. 35

The placing of concrete for any bridge slab shall be continuous between joints.

When embedding structural shapes in concrete, the placement of concrete shall be progressed on one side of the shape only until it flushes up over the bottom flange of the shape on the opposite side, after which concrete shall be placed on both sides to completion. 40

B. Vibrating. During and immediately after deposition, concrete shall be thoroughly compacted by vibrating the concrete internally with mechanical vibrating equipment.

Internal mechanical vibrators shall be sturdy and of a type approved by the Engineer. They shall be adequately powered, capable of transmitting vibration to the concrete in frequencies of not less than 3,500 impulses per minute and shall produce a vibration of sufficient intensity to consolidate the concrete into place without separation of the ingredients. 45

The vibratory element shall be inserted into the concrete at the point of deposit and in areas of plastic concrete. The time of vibration shall be of sufficient duration to accomplish thorough consolidation, complete embedment of the reinforcement, produce smooth surfaces free from honeycombing and air bubbles, and to work the concrete into all angles and corners of the forms, 50

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however, over vibration shall be avoided. Vibration shall be continued in one place until the concrete has become uniformly plastic but not to the extent that pools of grout are formed. The duration of vibration will depend upon the frequency of the vibration (impulses per minute), size of vibrators and the slump of the concrete. This length of time must be determined in the field.

The internal vibrators shall be inserted in the concrete at evenly spaced intervals not farther apart than the radius over which the vibration is visibly effective and at a distance close enough to the forms to effectively vibrate the surface concrete. 5

The vibrator shall not be used to push or distribute the concrete laterally. The vibrating element shall be inserted in the concrete mass at a depth sufficient to vibrate the bottom of each layer effectively, in as nearly a vertical position as practicable. It shall be withdrawn completely from the concrete before being advanced to the next point of application. Internal vibrators shall not be placed directly on the forms or the reinforcing steel. 10

To secure even and dense surfaces, free from aggregate pockets or honeycomb, vibration shall be supplemented by working or spading by hand in the corners and angles of forms and along form surfaces while the concrete is plastic. 15

A sufficient number of vibrators shall be employed so that, at the required rate of placement, thorough consolidation is secured throughout the entire volume of each layer of concrete. Extra vibrators shall be on hand for emergency use and when other vibrators are being serviced.

The use of external vibrators will be permitted when satisfactory surfaces cannot be obtained by internal vibration alone or when it is impossible to use internal vibrators. The use of external vibrators shall be subject to the approval of the Engineer. External vibrators shall be attached to, or held on the forms in such a manner as to effectively vibrate the concrete in a horizontal plane. 20

555-3.05 Depositing Structural Concrete Under Water

A. General. Concrete shall not be exposed to the action of water before setting, nor be deposited in water, except when noted on the plans or with the approval of the Engineer. When concrete is so deposited, it shall be Class G concrete with an approved retarder added. 25

B. Placement. Concrete deposited under water shall be carefully placed in its final position by means of a tremie-250 mm minimum diameter or a pipe line - 125 mm minimum diameter. For the purposes of this subsection, the terms tremie, and pipe line are interchangeable.

A tremie shall consist of a watertight tube system constructed in such a manner that it may only be moved vertically. Tremie spacings shall be approximately 10 m on center, or five meters from tremie to form. The support system for the tremie shall permit the tremie to rest on a firm surface, or be held flush with a soft surface, as necessary. No aluminum products shall be used for tremie construction. 30

The tremie shall be clearly marked incrementally to permit visual observation and determination of vertical movements. Increments may be placed at any convenient equal measurement; however, they shall not be less than 100 mm, or greater than 1000 mm (one meter) apart. 35

Actual concrete placement may be accomplished by either of the following methods:

1. An open ended tremie. This method requires the use of a go-devil which is a buoyant object, or material (e.g. sponge ball, hay/ burlap ball, vermiculite, etc.) to separate concrete from water, and prevent the concrete from free falling through the water. 40

The following procedure shall be used to begin the concrete placement:

Insert, into the tremie, a go-devil, acceptable to the Engineer which is not collapsible at the maximum water pressure. Determine the distance necessary to raise the tube sufficiently to permit the go-devil's escape from the tremie's bottom end upon concrete addition. This determination shall be made prior to the placement of concrete into the tremie. Upon determination, the proper distance shall be marked upon the outside of the tremie, using the increments as a guide. 45

If the go-devil is spherical, the permissible distance is limited to the diameter of the tremie.

Prior to placement of any concrete, raise the tremie the distance previously marked. Then place concrete in the tremie at a regular continuous pace which will force the go-devil to the bottom of the tube and out of the tremie thereby expelling the water. If this procedure is done correctly, the concrete column in the tremie should be just less than one-half the water depth upon go-devil discharge. The concrete level inside the tremie will rise as the concrete level outside rises.

2. A dry, closed end tremie. This method requires an easy release end cap, which will release when the fluid concrete pressure exceeds the water pressure.

Determine the distance necessary to permit the opening of the end seal cap and mark this distance on the tremie prior to the insertion of concrete. Generally, this distance should not exceed the tremie diameter. Then raise the tremie and add concrete as noted for Method No. 1.

Regardless of which method is used to place the concrete the following requirements shall apply:

- No concrete shall be placed in running water, nor subjected to the action of running water prior to initial set.
- All form work shall be constructed to properly retain underwater concrete.
- Concrete placement shall begin at the lowest placement elevation.
- The concrete surface shall be kept as nearly horizontal as practicable at all times.
- The discharge end of the tremie shall be kept embedded in fresh concrete until completion of the placement.
- Once begun, the concrete placement shall continue until all of the concrete designated at a specific location has been placed.

C. Dewatering. Unless otherwise noted on the contract plans, dewatering may proceed no less than seven days following the placement of concrete. The Engineer may direct additional waiting time if considered necessary. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, chipping or other means until sound concrete is exposed.

If a leveling course of concrete is required, the concrete shall be as specified in this subsection except that the size of coarse aggregate shall be reduced to suit the conditions of placement using the maximum size of aggregate possible. The concrete leveling course shall be preceded by a layer of portland cement grout well brushed onto the prepared concrete surface.

One or more sumps shall be formed at the top surface of each concrete seal, to provide for the pumping of water leaking through the sheet piling, after the seal has been dewatered. All sumps shall be filled with concrete when it is no longer necessary to maintain the cofferdam in a dry condition.

D. Test Cores. Test cores shall be drilled by the Contractor under the direction of the Engineer to determine the quality of the concrete seal after the cofferdam has been dewatered.

The cores shall be drilled using NX barrels (54 mm). They shall be drilled at the locations shown, and to the depths indicated, on the contract plans. The exact locations shall be as directed by the Engineer. The Contractor shall exercise due care to obtain maximum recovery of cores since less than 100% is presumed to indicate defective concrete.

Should the cores reveal voids, sand pockets, seams, or other defects in the concrete seal, additional cores shall be drilled, at the expense of the Contractor, for further investigation. The number and location of these additional cores shall be as directed by the Engineer. All voids, sand pockets and seams shall be cleaned out and filled by pressure grouting with cement or sand cement grout to the satisfaction of the Engineer. The Engineer shall be present and keep a complete record of the work at the time of grouting each holes. The Contractor's proposed grouting methods and grout mixes shall be subject to the approval of the Engineer.

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Any other defects revealed by the cores shall be repaired in a manner satisfactory to the Engineer.

555-3.06 Provisions for Concreting in Cold Weather

A. General. When permission is granted in writing by the Engineer for cold weather concreting, the curing temperature shall be maintained between 7°C and 30°C for the curing durations stated in §555-3.09, Curing. Curing temperatures shall be maintained by either of the following methods for any placement except bridge slabs: 5

- Provision of external heat.
- Utilization of heat of hydration retained by insulated forms.

Bridge slab placements shall be cured as required by Section 557. 10

Thermometers of the specified type required for determining the temperature under these cold weather concreting provisions shall be supplied by the Contractor. Measurements will be taken by the Engineer and a temperature record will be maintained for the curing period.

The thermometers shall be placed at the following locations:

- Walls: At each corner, both sides of the beam vertically and at the midpoint of both sides horizontally. 15
- Beams: At each corner, both sides of the beam vertically and at the midpoint of both sides horizontally.
- Pier Columns: Two at the top of the column. One shall be placed in the path of the normally prevailing winds, the other diametrically opposite the first. A third thermometer shall be placed halfway up the column, preferably not in the path of the normally prevailing winds. 20
- Footings: One at each corner of the top face, and one each at the midpoint of the longest sides horizontally.
- Other: As established by the Engineer. 25

Thermometers shall consist of the following types:

- Continuously Recording Thermometer: The thermometer shall be capable of continuously recording temperatures within a range of -20°C to 50°C for a minimum of 24 hours.
- Maximum - Minimum Recording Thermometer: For all placements the thermometer shall be capable of recording maximum and minimum temperatures within a range of -20°C to 50°C. 30

When concrete is to be placed in contact with steel members, reinforcing steel or previously placed concrete, the temperature of the steel and concrete shall be raised to approximately 7°C by a method approved by the Engineer before concreting begins.

When concrete is to be placed in contact with earth or rock, the temperature of the earth or rock shall be 2°C or higher. The earth or rock shall not have any snow, frost, or standing water on its surface. 35

B. Provision of External Heat. If the Contractor is required, or elects, to maintain curing temperatures by this method, the Contractor shall furnish sufficient canvas and framework, or other type of housing, to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature between 7°C and 30°C for the specified curing period. At the end of the curing period, the heat shall be gradually reduced at a rate not to exceed 0.5 degree C per hour until the temperature within the enclosure equals the temperature outside the enclosure. 40

Enclosures used for bridge slab pours shall completely enclose the intended slab on all six sides. There shall be sufficient room between the top of the reinforcing steel and the top of the enclosure to allow placement of concrete by any normal means. The bottom of the enclosure shall be below the lowest portion of the superstructure. 45

External heat shall be provided by means of stoves, salamanders, or steam equipment supplied

and operated by the Contractor at his expense. Sufficient equipment shall be supplied to continuously maintain the specified temperature with a reasonable degree of uniformity in all parts of the enclosure. The enclosures shall be properly vented to prevent surface disintegration of fresh concrete due to an accumulation of carbon dioxide gas.

All exposed concrete surfaces within the heated area shall be kept wet during the heating period unless heat is supplied in the form of live steam.

Materials and equipment necessary to erect the enclosure and provided external heat shall be present on the job site and approved by the Engineer before any concrete is placed.

Heating appliances shall not be placed in such a manner as to endanger formwork or centering or expose any area of concrete to drying out or injury due to excessive temperatures.

External heat shall be applied for the required curing period except that structural slabs shall have external heat applied for a minimum of fourteen (14) curing days.

C. Heat Retention by Insulated Forms. If the Contractor elects to maintain curing temperatures by this method, the Contractor shall furnish sufficient insulation and protection to maintain the temperature between the insulation and formwork within the range of 7°C to 30°C for the specified curing period. Discontinuance of protection shall be accomplished in such a manner that the drop in temperature of any portion of the concrete shall be gradual. The surface temperature of concrete sections more than 610 mm in thickness shall not drop faster than 10°C in a 24 hour period. The surface temperature of concrete sections less than 610 mm in thickness shall not drop faster than 20°C in a 24 hour period.

Forms may be removed without restriction providing the temperature difference between the air and the surface of the concrete is not more than 15°C. If possible, forms shall be removed about the middle of the day to take advantage of the generally higher afternoon temperatures.

Form insulating material shall be installed on the forms in such a manner so as to achieve the full benefit of its insulating properties and at the same time provide against the infiltration of wind and water. All portions of steel forms shall be covered by insulating material so that no steel is exposed to the air. Any tears or damaged areas in the insulating material shall be repaired to the satisfaction of the Engineer. Special attention shall be given to ensure that all corners and angles are properly insulated and protected against wind damage.

Where tie rods extend through the form insulating material, a plywood washer (20 mm x 150 mm x 150 mm approx.) shall be placed over the tie rod and against the insulating material. The washer shall be secured in a manner satisfactory to the Engineer.

After placement of the concrete, the exposed concrete surfaces shall be covered with insulating blankets, except for areas where protruding reinforcing bars make the use of blankets impracticable. These areas may be covered with hay or other insulating material approved by the Engineer. Tarpaulins shall be used to protect the insulating material as directed by the Engineer.

The insulating material shall be either insulating blankets, bat insulation, solid foam, or sprayed foam meeting the requirements of Section 711-07, Form Insulating Materials for Winter Concreting. The thickness of standard blankets, or bat insulation, required for varying air temperatures, concrete thicknesses and cement contents of the mix are listed in Table 555-2. The actual thickness of the insulating material used shall be determined by multiplying the equivalency factor for the insulating material by the thickness shown on Table 555-2. The equivalency factors for all approved insulating materials are given on the Approved List.

If the temperature of the concrete surface, or the temperature between the form and the covering, falls below 7°C during any one day of the curing period, that day will not be a curing day. The length of the curing period will be extended until the total required number of curing days are accumulated. If the temperature of the concrete surface, or the temperature between the form and the covering falls below 0°C at any time during the curing period, the concrete will be rejected.

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TABLE 555-2 MINIMUM AIR TEMPERATURE ALLOWABLE FOR INSULATION FOR CONCRETE WALLS, PIERS AND ABUTMENTS ABOVE GROUND (°C)					
Cement Content (kg/m ³)	Wall Thickness (mm)	Thickness of Commercial Blanket or Bat Insulation (mm)			
		13	25	40	50
300	150	7	2	-5	-10
	300	2	-9	-27	-32
	450	-3	-19	-36	-54
	600	-5	-23	-45	
	900	-8	-29		
	1200	-8	-30		
	1500	-9	-32		
360	150	7	0	9	-14
	300	0	-13	-27	-40
	450	-6	-26	-46	-67
	600	-8	-30		
	900	-11	-37		
	1200	-12	-39		
	1500	-12	-40		
415	150	6	-2	-12	-18
	300	-2	-17	-33	-49
	450	-9	-32	-56	
	600	-11	-36		
	900	-14	-44		
	1200	-15			
	1500	-16			

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Notes:

1. This table is based upon the stated thickness of blanket, or bat type insulation, having a thermal conductivity (K value) 0.036 [W/m·K] and concrete placed at 10°C. 10

555-3.07 Concrete Joints

A. Construction Joints. Construction joints for the purpose of these specifications are joints used for the purpose of providing for interruptions in the placement of concrete.

Construction joints shall be designed to transfer shear and moment at the joint. Unless otherwise shown on the plans, a shear key shall be provided at each construction joint by embedding water saturated wooden blocks in the plastic concrete. The shear key thus provided shall be approximately 1/3 of the width of the parts joined. The key depth shall equal the thickness of standard form lumber approximately 1/2 the key width and thickness. Shear keys need not exceed 140 mm in depth regardless of the key width. 15 20

Construction joints shall be placed only where shown on the plans or where permitted by the Deputy Chief Engineer (Structures).

On steel truss or open spandrel concrete arch spans, unless otherwise noted on the plans, the concrete in the floor system shall be placed about the center line of the span, beginning at the center and working simultaneously toward each end; or beginning at the ends, and working simultaneously toward the center. Care shall be taken to prevent the displacement of reinforcement during the placing of concrete. If for any reason it becomes necessary to introduce a construction joint, this shall be formed by means of a vertical bulkhead so constructed as to produce a key joint, placed as 25

shown on the plans or as permitted by the Deputy Chief Engineer (Structures).

When joining fresh concrete to that which has already set, the concrete in place shall have its surface cut over with a suitable tool to remove all loose and foreign materials. This surface shall be scrubbed with wire brooms and kept wet until the new concrete is placed. Immediately before placing the new concrete the forms shall be drawn tightly against the concrete already in place and the old surface shall be thoroughly coated with a thin coating of 1:1 mortar meeting the requirements of §705-22, Portland Cement Mortar Bonding Grout. 5

Forms for female shear keys shall be beveled on four sides to facilitate their removal and shall be securely fastened to the forms to prevent displacement before the concrete has set. Key forms shall be removed in such a manner as to avoid injury to the concrete. 10

B. Contraction Joints. Contraction joints shall be placed at locations shown on the plans and unless otherwise specified, shall be formed the same as construction joints except that reinforcement shall not extend through the joint.

C. Expansion Joints. Expansion joints shall be placed at locations shown on the plans and shall be constructed as detailed thereon. Expansion joints shall provide for expansion, contraction and the transfer of shear at the joint unless otherwise specified. When expansion joints are formed by the insertion and subsequent removal of joint templates, this work shall be done in such a manner that joint edges are not chipped or broken down in the process. 15

When concrete is to be placed against a joint filler, holes or joints in the filler shall be suitably filled with mastic to prevent mortar or concrete from entering the joint and restricting its movement. 20

The face edges of all joints shall be carefully finished or formed true to line and elevation for a minimum distance of 50 mm back from all exposed surfaces.

When caulking compound is used to seal a joint containing premolded bituminous joint filler, a layer of an approved type of pressure-sensitive release tape shall be placed between these materials because of their incompatibility. 25

D. Waterstops. Waterstops shall be installed in joints as shown on the plans. Should the drawings fail to indicate a waterstop in any joint exposed to view, the Contractor shall install a waterstop of polyvinyl chloride or other approved flexible material, copper strip, zinc strip or lead sheet. The waterstop shall extend at least 75 mm into the concrete on each side of the joint, shall be joined to be continuous and watertight and shall be carefully protected from damage until covered by concrete or backfill. 30

Waterstops shall be manufactured, formed and installed so as to provide for expansion and contraction movements at the joint.

555-3.08 Finishing

A. Finishing Surfaces Exposed to View. Immediately after forms have been removed, surfaces exposed to view shall have all projections and irregularities carefully removed and all cavities neatly filled with mortar of the proportion used in the concrete. The same brand of cement and the same kind of aggregate shall be used for filling cavities as was used in the original concrete mix. Plastering of surfaces shall not be allowed. The surface film of all such repaired surfaces shall be carefully removed before setting occurs. 35

All top surfaces of parapets, copings, walls and bridge seats shall be finished by placing an excess of material in the forms and removing or striking off such excess with a suitable screed, forcing the coarse aggregate below the mortar surface. The use of mortar topping for surfaces falling under this classification shall not be permitted. 40

All rust and other stains shall be removed from concrete exposed to view. Removal shall be accomplished using methods and materials approved by the Engineer. Materials used for rust stain removal shall be as listed on the Approved List published by the Department's Materials Bureau. 45

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B. Finishing Bearing Surfaces. The entire surface area of bridge seats or pedestals shall be floated and troweled to true grade or, at the option of the Contractor, left approximately 6 mm high and bush hammered or otherwise finished to the exact elevations indicated on the plans.

C. Sidewalk Finish on Bridges. Sidewalks shall be constructed by placing concrete continuously to an elevation slightly higher than shown on the plans. The concrete shall then be screeded to the correct elevations and worked with a wooden float to give uniform surface. Floating shall be kept to a minimum, consistent with the desired finish, in order to avoid overworking the concrete. Surface scoring will not be permitted.

555-3.09 Curing

A. General. All structural concrete shall be cured for a minimum of seven curing days unless otherwise stated. A curing day is defined as any day, starting with the day of placement, during which the ambient air temperature at the concrete surface is 7°C or higher.

Conditions may occur which prevent an entire day from qualifying as a curing day, but do not prevent portions of that day from reaching temperatures that qualify as curing temperatures. If these conditions occur and with the Engineer's permission, the Contractor may aggregate curing hours. A curing hour is defined as any hour during which the curing temperature remains at, or above 7°C.

An aggregation of 24 curing hours will be credited as one curing day. Aggregations of less than 24 curing hours will not be credited.

Curing hours will be determined with continuous recording thermometers, capable of measuring temperatures in the -1°C to 38°C range, over a 24 hour period. The number and placement of the thermometers will be determined by the Engineer. Provide all equipment, supplies and labor necessary for calibration. Include cost of the calibration in the unit price bid.

Structural concrete may be cured by any one, or a combination of, the following methods unless otherwise noted:

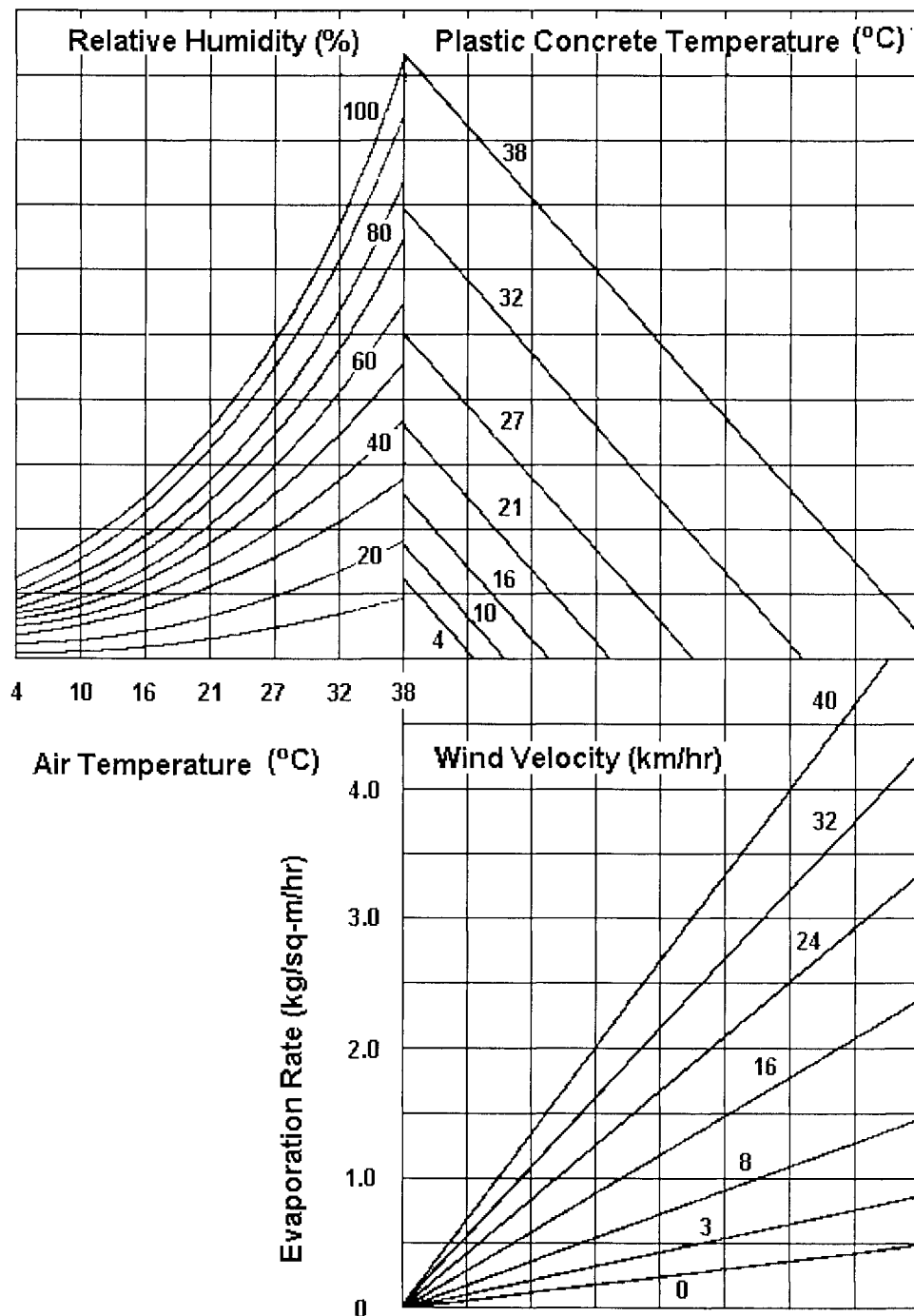
- Curing covers.
- Clear (fugitive dye) membrane curing compound. This method will not be allowed as a curing method for structural slabs, either alone, or in combination with other methods.
- Continuous burlap wetting.
- Wet burlap and curing covers.

Curing covers shall be placed as soon after concrete finishing as the Engineer determines will not cause damage to the concrete surface. However, in no case will the foregoing time period exceed 30 minutes. Curing covers shall be lapped a minimum of 300 mm. All lapped edges shall be sealed with pressure sensitive tape. Covers shall be protected from displacement in a manner approved by the Engineer.

Clear (fugitive dye) membrane curing compound shall be sprayed on the concrete surface immediately following the finishing operation, or form removal, whichever is applicable. The compound shall be applied by means of a pressure spraying system, or by distributing equipment, at the rate directed by the Engineer. Under no circumstances, however, shall the rate be less than 1 L per 3.5 m² of surface. The equipment for applying the compound shall be such that the compound is applied as a fine spray with no surface damage to the concrete. The equipment also provide for adequate agitation of the compound during application, and shall be approved by the Engineer before work is started. Should the application method produce a non-uniform film, or should the spraying equipment fail and duplicate equipment is not immediately available, the application shall cease. Curing shall then be continued by another method acceptable to the Engineer. The Contractor shall provide sufficient approved covers for protection of the concrete surface in the event of rain or equipment breakdown.

No special provisions for curing will be required for surfaces where forms are left in place, except that in extremely hot weather, the Engineer may require the forms to be wetted to reduce

Figure 555-1
STRUCTURAL CONCRETE EVAPORATION RATE



To use this chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to plastic concrete temperature.
3. Move down to wind velocity.
4. Move left to read approximate rate of evaporation.

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surface heat. If forms are removed during the curing period (refer to 555-3.03B), the concrete curing shall be continued using a clear (fugitive dye) membrane curing compound.

B. Exposed Concrete Surfaces. All exposed concrete surface, including fascias, which do not require forms shall be cured using curing covers or a clear (fugitive dye) membrane curing compound.

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1. Curing Covers.

a. *Plastic Coated Fiber Blankets.* These shall meet the requirements of §711-03, they shall be laid dry with the fiber side against the concrete.

b. *Polyethylene Curing Covers (white opaque).* These shall meet the requirements of §711-04.

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2. Clear (fugitive dye) Membrane Curing Compound. This shall meet the requirements of §711-05.

C. Curing Temperatures - All Placements. The curing temperature of concrete is the air temperature at the concrete surface, or the air temperature between the concrete surface and its protective covering. Temperatures at these locations are critical for proper concrete curing. For the purposes of this section the temperatures at the foregoing locations shall be maintained between 7°C and 30°C inclusive. Should the ambient air temperature be out of the 7°C to 30°C range during curing, the following shall apply in addition to the requirements of §555-3.09B .

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1. Temperatures below 7°C. If the ambient air temperature falls, or is expected to fall, below 7°C, but remain above 0°C the Contractor shall propose a suitable method to maintain the curing temperature at, or above, 7°C during the curing period. All proposed methods shall meet the approval of the Engineer.

20

To provide assurance of the methods employed, the Contractor shall supply maximum-minimum thermometers. The number and placement of the thermometers shall be determined by the Engineer. Thermometers shall have a temperature range between -20°C to 50°C inclusive. The Engineer will maintain a temperature record during the curing period.

25

If the curing temperature falls below 7°C, the day during which that occurs will not be a curing day. The Engineer shall notify the Contractor and the Contractor shall modify the existing method employed to maintain the curing temperature. The length of the curing period will be extended until the required number of curing days are accumulated.

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If the method employed by the Contractor to retain heat fails and the curing temperature falls below 7°C, but remains above 0°C, for twenty-four (24) consecutive hours, then the provisions of §555-3.06 shall apply.

If the curing temperature falls below 0°C, at any time during the curing period, the concrete will be rejected.

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2. Temperatures above 30°C. If the ambient air temperature exceeds 30°C, provide seven days of continuous, uniform wetting for curing. Leave all burlap in place for seven (7) curing days.

555-3.10 Weep Holes. The Contractor shall construct weep holes in all retaining walls and abutments at such points as are indicated on the plans or designated by the Engineer.

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555-3.11 Damaged or Defective Concrete. Damaged or defective concrete shall be defined by and repaired in accordance with the requirements of Section 502, Portland Cement Concrete Pavement, and §502-3.14, Damaged or Defective Concrete. Patching material meeting the requirements of §701-08, Vertical and Overhead Patching Material shall be used for patching vertical or overhead surfaces.

555-3.12 Foundation Concrete. The footings of structures shown on the plans shall be considered as approximate only and, when ordered in writing by the Deputy Chief Engineer (Structures) shall be changed to such dimensions as will give a satisfactory foundation.

Concrete shall not be placed in any foundation form without the Engineer's approval. When Footing Concrete, Class A is specified; Class HP may be substituted for all footing placements, and Class H may be substituted when the footing is 1 meter thick or less.

555-4 METHOD OF MEASUREMENT

555-4.01 Concrete for Structures. Payment for each item will be made for the number of cubic meters within the lines of the structure as shown on the plans or as revised by authority of the Engineer. In computing the volume of concrete for payment, no deductions shall be made for the volume of joint material, embedded metal reinforcement, structural shapes, chamfers, tops of piles, or pipe with an end area of less than 0.10 m².

555-5 BASIS OF PAYMENT

555-5.01 General. When the Contractor elects to substitute an optional concrete class as permitted by Table 501-1, Concrete Class Options, payment will be made for the originally specified class of concrete using the originally specified method of measurement.

555-5.02 Concrete for Structures. The unit price bid per cubic meter for each class of concrete, shall include the cost of furnishing all labor, materials and equipment necessary to complete the concrete work as shown on the plans or called for in the specifications, except reinforcement will be paid for separately under its appropriate item. Unless otherwise provided, the unit price bid shall include the cost of furnishing and placing copper flashing or other metal strips, flexible water stops, sheet packing, pipe drains, bituminous material, water for wetting, joint materials, felt, tar paper, joint sealing compounds, joint fillers and concrete curing materials.

No extra compensation for falsework or falsework piling will be paid. This work is included as part of the formwork.

All replacements or corrections to concrete surfaces misshapen by bulges or deformations shall be made at the Contractor's expense.

All additional concrete that may be ordered by the D.C.E.S. for concrete footings that are below or beyond the lines shown on the plans will be paid for at the unit price bid in the contract.

Bridge bearings, expansion joints and anchor bolts will be paid for under their appropriate items.

No payment will be made for concrete replacement or other corrective work which the Contractor is directed to perform in accordance with the requirements of Section 556, Reinforcing Steel for Concrete Structures, §556-3.02E, Placement in Structural Slabs.

Progress payments will be made, after the concrete and curing applications have been properly placed, to the extent that payment will be made at 90% of the computed quantity of each concrete placement, with the balance to be paid after completion of all curing and corrective work thereon.

Payment will be made under:

Item No.	Item	Pay Unit
555.0104 M	Footing Concrete, Class A (No Concrete Class Substitutions Allowed, except as permitted in §555-3.12)	Cubic Meter
555.0105 M	Concrete for Structures, Class A	Cubic Meter
555.05 M	Concrete for Structures, Class F	Cubic Meter
555.06 M	Concrete for Structures, Class G (Deposited Under Water)	Cubic Meter
555.07 M	Concrete for Structures, Class GG (Deposited Under Water)	Cubic Meter
555.08 M	Footing Concrete, Class HP	Cubic Meter
555.09 M	Concrete for Structures, Class HP	Cubic Meter

SECTION 556 - REINFORCING STEEL FOR CONCRETE STRUCTURES

556-1 DESCRIPTION. The work will consist of furnishing and placing reinforcing steel for concrete structures, or stud shear connectors, in accordance with the contract plans, and in a manner satisfactory to the Engineer.

Reinforcing steel for concrete structures may be either epoxy-coated or uncoated. 5

556-2 MATERIALS. Materials for this work shall meet the requirements of the following subsections of Section 700, Materials:

Bar Reinforcement, Grade 420	709-01	
Wire Fabric for Concrete Reinforcement	709-02	
Epoxy Coated Wire Fabric Reinforcement	709-08	10
Epoxy Coated Reinforcement	709-04	
Stud Shear Connectors	709-05	
Mechanical Connectors for Reinforcing Bar Splices	709-10	

556-2.01 Epoxy-Coated Reinforcement. Chairs, tie wires, and other devices used to support, position, or fasten the reinforcement shall be made of or coated with, a dielectric material. The specific hardware that the Contractor proposes to use shall be approved by the Engineer. 15

556-2.02 Uncoated Reinforcement When permanent corrugated metal forms are used, chairs, slab bolsters, and other devices used to support, position, or fasten the reinforcement shall be made of or coated with a dielectric material. Stainless steel chairs without polyethylene tips and meeting the requirements of ASTM A493, AISI Type 430, may also be used. The specific hardware that the Contractor proposes to use shall be subject to approval by the Engineer. 20

When forms are to be removed in their entirety, uncoated steel chairs equipped with snug fitting, high density, polyethylene tips which provide 6 mm clearance between the metal and any exposed surface may be used. Stainless steel chairs meeting the requirements of ASTM A493, AISI Type 430, may be used without polyethylene tips. Chairs that are made of, or coated with, a dielectric material, may also be used. The specific hardware that the Contractor proposes to use shall be subject to approval by the Engineer. 25

556-3 CONSTRUCTION DETAILS

556-3.01 General

A. Storing and Handling Epoxy-Coated Bar Reinforcement Steel. All epoxy-coated bar reinforcement shall be stored above ground on wooden or padded supports. 30

Epoxy-coated bar reinforcement stored on-site shall be protected from sunlight and moisture using opaque waterproof covers. Covers shall be placed in a manner that will permit constant air circulation so as to minimize the formation of condensation on the epoxy-coated bar surface.

All equipment for handling epoxy-coated bars shall have padded contact areas. All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports, or a platform bridge so as to prevent bar-to-bar abrasion from sags in the bar bundle. 35

Bars, or bundles of bars, shall not be dropped or dragged. Care shall be taken at all times to prevent damage to the epoxy coating.

B. Placing and Fastening Bar Reinforcement Steel. Prior to placing bar reinforcement steel all grease, dirt, mortar and any other foreign substances shall be removed. 40

Loose rust and loose millscale on uncoated reinforcement shall be removed by wire brushing.

Steel bar reinforcement shall be placed in the position indicated on the plans and within the allowable tolerances specified. Before concrete is placed, all reinforcement shall be securely

fastened and supported with approved chairs or other approved devices.

C. Inspection. Concrete shall not be placed until the bar reinforcement steel is inspected and permission for placing concrete is granted by the Engineer. All concrete placed in violation of this provision shall be rejected and removed.

556-3.02 Bar Reinforcement

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A. Ordering. Prior to ordering reinforcing steel, the Contractor shall carefully check all bar lists, and assume full responsibility for their accuracy.

No change in the bar list shall be made by the Contractor unless approved by the D.C.E.S.

B. Field Bending

1. Epoxy - Coated Bar Reinforcement. The alternatives of shop bending or field bending of epoxy coated bar reinforcement will be at the option of the Contractor. Field bending shall be done by cold methods only. Direct heating of the bars shall not be permitted.

Field bending operations shall be allowed only when ambient and bar temperatures are 5°C or greater. When lower temperatures prevail the Contractor may supply, for field bending operations, a fully enclosed space that is heated and constructed to the satisfaction of the Engineer. No additional payment will be made for such an enclosure.

Epoxy coated bar reinforcement damaged by field bending work shall be evaluated and repaired, or replaced, in accordance with the requirements of §556-3.02C.

2. Uncoated Bar Reinforcement. When bars are heated for field bending they shall not be heated to a temperature higher than that producing a dark cherry red color. Only competent personnel shall be employed and proper equipment provided for cutting and bending.

The reinforcement shall be bent to the shapes shown on the plans. Unless shown otherwise on the plans, the radii of bends measured to the inside face of the bend bar shall be equal to, or greater than, three times the diameter of the bar. Bends in stirrups shall be equal to, or greater than, the diameter of the bar.

C. Field Repair - Epoxy Coated Bar Reinforcement. The Contractor will be required to field repair damaged areas of the bar coating, and to replace bars exhibiting severely damaged coatings. The material used for field repair shall be that supplied by the coating applicator.

Field repair will be required on all areas of major damage. Major damage is defined as any defect or break in the epoxy coating 6 mm x 6 mm or greater. The total number of all major damaged areas which have been repaired with patching material shall not exceed five (5) in any three meter length of bar.

Field repair will not be required on areas of minor damage. Minor damage is defined as any defect or break in the coating less than 6 mm x 6 mm. The maximum number of unrepaired minor damaged areas shall not exceed an average of six (6) per 300 mm on any individual bar.

Field repair will not be allowed on bars which have severely damaged coatings as determined by the Engineer.

A reinforcing bar having coating damage determined by the Engineer to exceed the above criteria shall not be incorporated in the work, and it shall be removed from the work site. All such bars shall be replaced in kind by the Contractor at no additional cost to the State.

D. Splices. Splices shall be permitted only where shown on the contract plans. Should the Contractor desire to splice bars at locations other than those shown on the contract plans, written permission to do so shall first be obtained from the D.C.E.S. Such permitted splices shall be well distributed, or located, at points of low tensile stress. Splices shall not be permitted unless a minimum of 50 mm can be provided between the spliced bar and the nearest adjacent bar.

Splices for bar sizes No. 36 or smaller, shall be made by means of a mechanical connector or

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by placing the bars in contact and wiring them together for the full length of the splice.

Splices for bars larger than No. 36 shall be made by arc welding, or by use of a mechanical connector.

Mechanical connections shall be used in accordance with the requirements of §709-10 Mechanical Connectors for Reinforcing Bar Splices. Splices made with mechanical connectors shall be installed in accordance with the manufacturer's written requirements. 5

Arc welded splices shall be made and inspected in accordance with the provisions of the SCM, Section 7, Part D. Prior to welding of epoxy coated reinforcing bars, the epoxy coating shall be removed for the length to be welded plus 150 mm on each side of the weld. After welding, the spliced area shall be cleaned in accordance with Steel Structures Painting Council - Surface Preparation Specification No. 6 (SSPC-SP6), Commercial Blast Cleaning. The surface, after cleaning, shall be defined by SSPC-VIC 1-89, Pictorial Standards, BSP6, BSP6, BSP6, as applicable. A compatible epoxy repair material supplied by the coating applicator shall be applied to the spliced area and overlap the original coating by 150 mm. The epoxy repair material shall be applied the same day as the cleaning. 10 15

E. Placement in Structural Slabs. Bar supports shall be spaced no farther apart than 1.2 m center-to-center, nor shall any bar support be closer than 150 mm from the edge of any future concrete surface. Bridge slab bar reinforcement shall be placed in accordance with the following tolerances:

Vertical \pm 6 mm

Horizontal \pm 13 mm 20

The structural slab bar reinforcement mats (top and bottom) shall be securely connected together. This connection may be accomplished by wiring or other means approved by the Engineer. Connections shall be placed no farther apart than 1.2 m on centers. The bar supports may be utilized for this purpose. Connecting devices shall neither deflect the bar reinforcement nor interfere with the smooth flow of concrete. 25

Chairs, tie wires and other similar devices used for epoxy-coated bar reinforcement shall meet the requirements of §556-2.01. Similar hardware used for uncoated bar reinforcement shall meet the requirements of §556-2.01 or §556-2.02.

Immediately prior to placement of concrete, the Engineer shall verify that the reinforcing steel is positioned within the above-stated tolerances. If the allowable tolerances are exceeded, the Engineer shall order that the position of the reinforcing steel be corrected before granting permission for placing concrete. 30

Subsequent to placement of concrete, the Engineer shall verify at random that the vertical clear distance from the top of the structural slab to the top mat of main reinforcing, as shown on the contract plans, is correct within a tolerance of plus or minus 13 mm. If the allowable tolerance is exceeded, the Engineer shall reject the work and so advise the Contractor and the Deputy Chief Engineer (Structures), in writing, stating the deficiencies upon which the rejection is based. The Deputy Chief Engineer (Structures) shall review the nature and extent of the deficiencies and shall designate one or more of the following alternatives: 35

- The affected concrete placement shall be removed and replaced in whole or in part. 40
- The Contractor shall provide special corrective measures as directed by the Deputy Chief Engineer (Structures).
- The concrete placement shall be accepted without corrective action.

The removal of the concrete placement and its subsequent replacement, or other corrective work which the Contractor is directed to perform, shall be accomplished at no additional cost to the State. 45

556-3.03 Stud Shear Connectors for Bridges. Stud shear connectors shall be shop or field welded to the structural steel members at the locations indicated on the plans. This work shall be done in accordance with the provisions of the SCM, Part 7C.

556-4 METHOD OF MEASUREMENT

556-4.01 Steel Fabric Reinforcement. The work will be measured as the number of square meters of fabric reinforcement stated in the Estimate of Quantities. Except to provide for progress payments, no field measurements will be taken. Measurements taken for progress payment purposes will not exceed the Estimate of Quantities figure.

556-4.02 Bar Reinforcement

A. Uncoated Reinforcing Bars. These shall be measured as the number of kilograms of steel bars placed. The mass of bar reinforcing will be computed by the Engineer utilizing the unit mass for each size bar as given in Table 556-1.

TABLE 556-1 UNIT MASS OF DEFORMED BARS											
Bar Number	10 (3)	13 (4)	16 (5)	19 (6)	22 (7)	25 (8)	29 (9)	32 (10)	36 (11)	43 (14)	57 (18)
Mass (kg/m)	0.580	0.994	1.552	2.235	3.041	3.973	5.060	6.404	7.907	11.38	20.24

Note. Numbers in parenthesis are bar sizes in numbers of eighths of inches.

B. Epoxy-Coated Reinforcing Bars. The requirements of §556-4.02A shall apply. No allowance will be made for the mass of the epoxy coating.

556-4.03 Stud Shear Connectors for Bridges. Stud Shear Connectors shall be measured as each connector placed.

556-5 BASIS OF PAYMENT

556-5.01 Steel Fabric Reinforcement. The unit price bid per square meter shall include the cost of all labor, materials and equipment necessary to complete the work.

556-5.02 Bar Reinforcement. The unit price bid per kilogram shall include the cost of all labor, materials and equipment necessary to complete the work. The unit price shall also include the cost of chairs, supports, fastenings, connections, and any splices not specifically shown on the plans. If the Engineer permits the substitution of larger bars than those specified, or the D.C.E.S. permits splices not shown on the plans, payment will be made only for the amount of steel which would have been required if the specified size and length had been used.

556-5.03 Stud Shear Connectors for Bridges. The unit price bid per stud shall include the cost of all labor, materials and equipment necessary to complete the work. If the use of any stud shear connector requires payment of a royalty to the manufacturer, the royalty shall be included in the unit price bid for this work.

Payment will be made under:

Item No.	Item	Pay Unit
556.0101 M	Uncoated Steel Fabric Reinforcement for Structures	Square Meter
556.0102 M	Epoxy Coated Steel Fabric Reinforcement	Square Meter
556.0201 M	Uncoated Bar Reinforcement for Concrete Structures	Kilogram
556.0202 M	Epoxy-Coated Bar Reinforcement for Structures	Kilogram
556.03 M	Stud Shear Connectors for Bridges	Each