

DEPARTMENT of INFRASTRUCTURE, ENERGY and RESOURCES, TASMANIA
BRIDGEWORKS SPECIFICATION

B11 – REINFORCED, PRESTRESSED AND MASS CONCRETE OCTOBER 2006

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B11.1 SCOPE

This Specification sets out the requirements for the construction of reinforced, prestressed or mass concrete structures, including false work, formwork, reinforcement, concrete placement, curing and finishing to specified surface finishes.

B11.2 OBJECTIVE

To ensure that concrete product is durable and is constructed to the specified standards.

B11.3 REFERENCES

The following Australian and British Standards apply:

A.S. 1391	Methods for tensile testing of metals
A.S. 1554	Structural steel welding Part 3 Reinforcing steel
A.S. 1554	Structural steel welding Part 6 Stainless steel for structural purposes
A.S. 1720	Timber structures code
A.S. 2082	Visually stress graded hardwood for structural purposes
A.S. 2271	Plywood and block board for external use
A.S. 3600	Concrete structures
A.S. 3610	Formwork for concrete
A.S. 3799	Liquid membrane forming curing compounds for concrete
A.S. 4671	Steel reinforcing materials
H.B. 77	Australian Bridge Design Code (formerly Austroads Bridge Design Specification)
B.S. EN 10088-1	Stainless steels. Part 1 List of stainless steels
B.S. 6744	Austenitic stainless steel bars for the reinforcement and use in concrete

B11.4 DEFINITIONS

<i>Curing</i>	The care of fresh concrete to ensure completion of the chemical reactions within the concrete.
<i>Finish</i>	The surface finish as defined in AS 3610.
<i>Laitance</i>	The weak surface cement film which develops on overworked hardened concrete.
<i>Release Agent</i>	An oil or other liquid applied to formwork to assist in the release of the forms from the hardened concrete.
<i>Retarder</i>	An admixture which slows the set of concrete.
<i>Tremie</i>	A pipe which allows concrete to be placed under water without segregation.
<i>Degree hours</i>	A measure of the maturity of the concrete obtained by multiplying the ambient or curing temperature by the time of exposure.

B11.5 MATERIALS

Concrete materials shall comply with the requirements of Specification B10.

Steel reinforcement shall comply with the relevant Australian Standards.

Stainless Steel shall comply with the relevant British Standards.

B11.6 FALSE WORK AND FORMWORK

B11.6.1 General

The Contractor shall design, fabricate and erect all false work and formwork required for the construction of the permanent works, and after the completion of these works shall dismantle all false work and formwork and remove it from the site.

B11.6.2 Design

The design of false work and formwork shall be in accordance with HB 77 requirements and in all other aspects shall conform to A.S. 3610.

- The false work and formwork design shall be certified by an Engineer experienced in structural design, who has qualifications admitting to corporate membership of the Institution of Engineers, Australia.
- The design of formwork shall be such that it shall not be necessary to drop concrete freely from a greater height than 2 m or to move concrete along the formwork after deposition.
- The foundations of false work shall be designed to prevent settlement, (including relative settlement between adjacent supports), and rotation of supports.
- The design shall allow removal of the false work without damage to the finished work. Formwork shall be designed so that the side formwork of members may be removed without disturbing the soffit formwork or its supports.
- The design shall ensure that the hardened concrete conforms to the specified lines and levels shown on the Drawings.
- Forms for edges of concrete and for re-entrant angles and fillets shall provide chamfers as shown on the Drawings, or if not shown, of 20 mm each side with equal angles.
- Temporary openings shall be provided where necessary for cleaning of formwork and inspection before concreting.
- The use of profiled steel sheet soffit formwork shall not be permitted

B11.6.3 Erection

- The foundations of false work shall be safe from scour.
- The material and position of any ties passing through the concrete, and subsequent repair and filling material, shall not compromise the durability of the structure and shall be detailed in the Contractor's Contract Management Plan.

The use of wires or bolts extending to the surface of the concrete will not be permitted. Any embedded ties shall be terminated not less than the specified reinforcement cover from the formed surface

- Narrow spaces between concrete faces may be formed by the use of suitable rigid foamed plastic material. This material shall have sufficient rigidity to prevent appreciable deformation during concreting, but shall not present significant resistance to the expected relative movement of the adjacent concrete faces. The foamed plastic material may be left in the finished work if it is not a visible detail.
- Joints in formwork shall ensure no loss of mortar .
- All rubbish, chippings, shavings, sawdust and dirt shall be removed from the interior of the formwork before concrete is placed. The formwork to be in contact with the concrete shall be cleaned and treated with a suitable release agent to ensure non-adhesion of the mortar and general uniformity of colour of the concrete surface. Care shall be taken that release agent does not contact the reinforcement or concrete at any construction joints.
- Retarding agents shall be used at construction joints so that laitance can be removed by water jetting prior to the next placement.
- Formwork shall be thoroughly cleaned after each use. Damaged or distorted formwork shall not be used.

B11.7 STEEL REINFORCEMENT**B11.7.1 General**

Reinforcing bars between 12 mm and 36 mm diameter inclusive shall be Grade 500N deformed bars. All other bars shall be Grade 250N plain bars.

Welded Wire Reinforcing Mesh shall be fabricated from Grade 500L deformed bars.

Stainless Steel Reinforcing shall be Grade 316 or Duplex with a yield stress of at least 500MPa.

Reinforcement shall be free from loose rust or millscale, or thick grease, tar, paint, oil, mud, mortar or any other coating which may reduce the concrete bond to the reinforcement, but shall not be brought to a smooth polished condition.

Stainless steel reinforcing shall be bent, handled and protected such that it is not contaminated by black steel or other contaminants

B11.7.2 Compliance

The Manufacturer or Supplier shall supply Test Certificates for all steel reinforcement to demonstrate compliance with this Specification.

B11.7.3 Bending

Reinforcement shall be carefully cut and bent to the dimensions and shapes in the steel schedules and within the tolerances specified in A.S. 3600. Bars shall be bent cold, and shall not be bent or straightened in a manner that will damage the material.

All hooks and bends shall be formed in accordance with Section 5 of Australian Bridge Design Code, "Reinforcement Standard Hooks and Bends".

Stainless steel reinforcing shall be formed around stainless steel pins.

B11.7.4 Splicing

- All reinforcement shall be supplied in the lengths indicated on the Drawings. Splice locations shall be as shown on the Drawings.
- Laps in reinforcing bars, wire or fabric shall be as shown on the Drawings.
- The bars shall be placed in contact and wired together in such a manner as to maintain concrete cover of not less than the minimum specified.
- Welding shall conform to the requirements of A.S. 1554 Part 3 or Part 6.
- The Contractor shall detail the equipment and methods for welding reinforcement in his Contract Management Plan, and shall make, without charge, any test or proof tests required by the Superintendent.
- Welded and mechanical splices shall meet requirements of tensile and bend tests specified for the parent metal.

B11.7.5 Storage and Protection

The Contractor shall store all reinforcement off the ground and shall take such steps as are necessary to prevent deterioration of the reinforcement. Exposure to chlorides, urea and other aggressive agents shall be prevented.

Care shall be taken that reinforcement is not damaged, kinked or bent, and any bars so impaired shall not be used.

All costs incurred in storing and protecting reinforcement as specified above shall be borne by the Contractor.

B11.7.6 Placement

- All reinforcement shall be placed in the positions shown on the Drawings to the tolerances specified, and shall be securely held during the depositing and compacting of the concrete by wiring together. Stainless steel reinforcing shall be wired with stainless wire and other steel wired with annealed tie wire of not less than 1.2 mm diameter and by blocking and supporting from the forms with chairs, or by other approved methods, which will ensure that the specified cover is achieved in the hardened concrete. The Contractor shall detail the reinforcement supports to be used in the Contract Management Plan.
- Reinforcement supports shall be made of durable corrosion resistant materials of lower permeability to oxygen, water, carbon dioxide and chloride ions than the cast concrete, have similar mechanical properties including elastic modulus and coefficient of thermal expansion to concrete, and strong enough to withstand the imposed loads without movement of the reinforcement. They shall be positively attached to the reinforcement and of such size as to maintain the specified cover.
- Bars shall be tied at all intersections except where spacing is less than 300 mm in any direction when alternative intersections shall be tied.
- **For non stainless steel reinforcing electrical** continuity for all reinforcement shall be ensured by tack welding bar intersections on at least a 600mm grid. Tack welding of reinforcement shall comply with A.S. 1554.
- Reinforcement in slabs shall be supported at a spacing which will ensure that the specified cover is maintained and at spacing not exceeding 1 metre, both transversely and longitudinally.
- Where shown on the Drawings, steel reinforcement shall be left projecting for the purpose of bonding to subsequent work.
- Care shall be taken to avoid damage to the bars after they have been placed and any damage to the bars or their positioning shall be repaired by the Contractor at his own expense.

B11.8 PLACEMENT AND COMPACTION OF CONCRETE

B11.8.1 General

Concrete shall not be placed:

- (i) while the air temperature is below 3°C or
- (ii) when the air temperature is 5°C on a falling thermometer or
- (iii) while the air shade temperature exceeds 40°C.

In addition, the temperature of the concrete immediately before placement in the work shall not be less than 10°C nor more than 32°C.

A thermometer indicating maximum and minimum ambient air temperature shall be kept on the site and records shall be kept from the day when concreting starts until 7 days after the last concrete has been placed on the Works.

The working surfaces of platforms and conveying equipment shall be cleaned of all foreign material and hardened concrete immediately prior to commencement of each continuous placement.

B11.8.2 Placement of Concrete

- Excavations shall have blinding concrete in accordance with Specification B1 placed prior to reinforcement being placed
- If concrete is placed in other than daylight, an adequate system of lighting over the area of the site shall be provided.
- Any concrete which has developed its initial set, or which does not comply with Specification B10 shall not be used.

- Between the ends of members, or between specified construction joints, concrete shall be placed in one continuous operation such that the face of the finished concrete is in a plastic state when succeeding concrete is placed against it.
- Concrete shall be placed at a rate conforming to the design requirements of the formwork.
- The methods of transport, handling and placement shall be such to prevent the segregation or loss of the ingredients.
- Concrete shall not be dropped through heights greater than 2 metres unless it is placed through suitable pipes or chutes. As far as practicable these pipes shall be kept full of concrete during placement, and their lower ends shall be kept close to the surface of the newly placed concrete.
- Placement methods shall avoid damage to, or displacement of, the formwork or steel reinforcement.
- Gangways may be erected above the reinforcement on supports resting on the formwork or false work and shall be kept back from the working face a distance of at least 2 metres.
- Concrete shall be deposited at, or immediately adjacent, its final position and shall not be deposited at any one point and moved or worked along the forms. Vibrators shall not be used to move concrete.

B11.8.3 Placement of Concrete with Pumping Equipment

Where pumping of concrete is proposed, the mix and the equipment to be used shall be detailed in the Contractor's Contract Management Plan.

Prior to commencement of placement of concrete in the forms, the initial discharge of concrete shall be pumped to waste until a consistent workable mix is discharged. Aluminium pipes shall not be used for the delivery of concrete.

B11.8.4 Placement of Concrete Under Water

When it is required to place concrete under water (fresh or salt) concrete shall only be placed by tremie pipe in water having a temperature above 5°C. Concrete shall not be placed in running water.

Tremies shall be water tight and sufficiently large to permit the free flow of concrete. The tremie shall be fitted with a valve or other device so that at no time shall concrete in the tube come in contact with water when it is being filled. The means of supporting the tremie shall be such as to permit it being lowered rapidly when necessary to prevent or retard the flow of concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall always be filled to a height to overcome the head of water. The tremie shall be operated in such a way as to maintain a uniform flow of concrete.

Concrete placed by tremie shall be placed in one continuous operation keeping the top surface as nearly level as possible until it is brought above the water, or to the required height. The work shall be carried out with sufficient rapidity to prevent any one layer of concrete taking its initial set before the next layer is placed.

B11.8.5 Compaction of Concrete

Concrete shall be thoroughly compacted by means of vibration during and immediately after placement, except for concrete placed under water where no tamping or vibration will be allowed.

The Contractor shall ensure that concrete fills every part of the forms, without air bubbles and voids, and flows under and around the reinforcement without displacing it. Vibration shall not be applied directly to reinforcement or to layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. Placement shall be in uniform horizontal layers, except for slabs, and vibration shall not be used to make concrete flow in the forms.

Care shall be taken during placement and vibration of concrete to avoid damage to, or displacement of forms or steel reinforcement.

B11.8.6 Internal Vibration

Immersion vibrators shall be kept clear of forms and either applied at the point of deposit, or in the area, of freshly deposited concrete.

The vibrators shall be inserted, through the freshly placed concrete into any previously placed underlying concrete, and withdrawn slowly. Vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued to the extent that segregation occurs or localised areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective.

Vibrators shall have a minimum frequency of vibration of 5000 cycles per minute.

The intensity of vibration shall be such as to visibly affect a mass of concrete of 60mm slump over a radius of at least 500 mm.

B11.8.7 External Vibration

Where external vibration is used, the concrete shall be vibrated by the application to the formwork of vibrators operating at a minimum frequency of 80 Hertz.

External vibrators shall be mounted in such a manner as to transmit vibration in the plane of the formwork. If more than one vibrator is attached to the forms, the distance between vibrators shall be large enough to prevent the possibility of one vibrator cancelling out the effect of the other(s). Vibrators of different frequencies shall not be used simultaneously on formwork.

B11.8.8 Vibrating Screeds

On concrete slabs, or other horizontal surfaces, in addition to internal vibrators vibratory screeds shall be used. Screeds shall maintain a frequency of not less than 70 Hertz and travel at a speed not less than 0.5 metres per minute nor greater than 1 metre per minute.

B11.8.9 Number of Vibrators

The number and types of internal and external vibrators to be used shall be detailed in the Contractor's Contract Management Plan.

The Contractor shall provide additional vibrators for immediate use should a breakdown occur.

B11.9 CONCRETE SURFACE FINISH - UNFORMED

B11.9.1 Natspec Tolerance Class C Finish

This finish shall be applied to unformed surfaces that will be permanently covered by fill or other material as in the tops of foundation footings, approach slabs, blinding concrete and culvert roof slabs. Where unformed concrete will later be bonded to future insitu concrete, as in the case of the top surface of the prestressed concrete beams, the concrete surface of the first stage shall be roughened as required by this Specification.

Natspec Tolerance Class C Finish shall also be used on the first stage for finishes Natspec Tolerance Classes B and A.

The concrete shall be compacted, levelled and screeded sufficiently to produce even, uniform surfaces. Surplus concrete shall be removed immediately after compaction by striking off with the sawing motion of a straight edge across the screed guides. Care shall be taken to drain, or otherwise remove, any water that comes to the surface.

A topping of mortar will not be permitted.

B11.9.2 Natspec Tolerance Class B Finish

This finish shall be applied to unformed surfaces that will be permanently covered by a bituminous wearing course or concealed from view but requires a higher degree of finish than that of Natspec Tolerance Class C, as in the tops of abutments, piers, curtain walls, and approach slab seatings and culvert base slabs.

Natspec Tolerance Class B Finish shall also be used as a second stage for finish Natspec Tolerance Class A.

After the concrete surface has been treated as in Natspec Tolerance Class C finish the surface shall be finished with a wood float to provide a uniform even surface free of screed marks. Floating shall be delayed until the screeded surface, produced in Natspec Tolerance Class C, has stiffened sufficiently to prevent formation of laitance.

Slabs to carry pedestrian traffic shall be finished by transverse brooming after the wood float finish.

B11.9.3 Natspec Tolerance Class A Finish

This finish shall be applied to abutment and pier bearing surfaces and prominently exposed surfaces such as tops of wing-walls, mortar pads and kerbs.

Following the preparation as for Natspec Tolerance Class B finish, the surface shall then be finished with a steel float to provide a smooth uniform surface, true to line and level, and free of marks.

B11.10 CONCRETE SURFACE FINISH - FORMED

B11.10.1 AS 3610 Class 3 Finish

This finish shall be applied to formed surfaces exposed in the completed work, but not prominently, such as the barrel walls and roof soffit of culverts and to formed surfaces that will be permanently covered in the completed work, such as the interface between backfill and abutments, wing-walls and footings and both sides of expansion joints.

AS 3610 Class 3 Finish shall also be used as a first stage for AS 3610 Class 2 finish.

As soon as forms are removed mortar fins and irregular projections shall be removed and broken arrises and edges shall be repaired. The surfaces shall be true and even and free from any major surface defects.

Embedded spacers and reinforcement supports which project to the surface shall generally match the colour of the concrete and be of such design that only a minimal area is exposed after formwork removal.

B11.10.2 AS 3610 Class 2 Finish

This finish shall be applied to formed surfaces that will be prominently exposed to view in the completed work such as the beams, abutments, wingwalls, kerbs, cantilever deck faces and piers of bridges and wingwalls, the end of culvert barrels and kerbs.

As soon as the forms are removed, the concrete surface shall be inspected for uniformity of colour and texture and be free from surface defects. Surface defects shall be identified by the Contractor and the proposed method for repair submitted to the Superintendent for approval.

B11.10.3 Colour Variation

If the concrete surface colour varies by more than 2 on the A.S.3610 typical grey scale for AS 3610 Class 1 or 2 finish, then remedial measures shall be taken by the Contractor to produce the required uniformity of surface finish at its own expense.

B11.10.4 Exposed Aggregate Finish on Pylons

Where shown on the Drawings, an exposed aggregate finish shall be provided following a AS 3610 Class 3 finish.

The exposed aggregate finish shall be achieved by methods sufficient to expose the coarse aggregate pattern without pitting or spalling the concrete.

B11.11 CONCRETE SURFACE FINISH - DECK CONCRETE**B11.11.1 Preparation for Insitu Deck Concrete**

No construction equipment or other load shall be placed on precast deck units.

Before any in-situ deck concrete is placed on any portion of the deck, the Contractor shall ensure that:

- (i) All the precast deck panels in that span are in place and have been in place for at least seven days.
- (ii) The top surface of the panels and the tops of beams shall be free of any loose or foreign material.
- (iii) The surface of the panels and beams shall be moistened with water immediately before placing deck concrete. However, ponding of water shall not be permitted.

B11.11.2 Surface Finish for Insitu Deck Concrete

The upper surface of the concrete deck shall be screeded to the shape and levels shown on the Drawings within the tolerances specified.

Immediately screeding has been completed, the temporary screed supports shall be removed and the surface made good with additional concrete, and wood floated to shape. In removing the screed supports cover to reinforcement shall be ensured and the additional concrete shall not compromise the durability of the slab.

Any free surface water shall be removed prior to finishing.

The whole surface shall be a Natspec Tolerance Class B finish roughened with a stiff broom to provide bond for a wearing surface.

Movement of equipment directly on the concrete shall not be permitted within a period of seven days of casting.

Within 15 minutes of the completion of the application of the surface finish of any section of deck, the concrete surface shall be protected from the elements and curing of the concrete commenced.

Deck edges shall be continuous curves or straight lines as shown on the Drawings.

B11.12 ADJUSTMENT OF FINAL KERB LEVELS

The actual hog in the beams may differ from the calculated hog used to define the longitudinal deck and kerb levels shown on the Drawings. Adjustments may have to be made to the design deck and kerb levels.

The abutment kerbs and curtain walls and pier kerbs shall not be constructed until completion of the adjacent deck slab and kerbs.

B11.13 TOLERANCES

Designers shall take tolerances into account in their design

The following tolerances shall be permissible for cast in place concrete:-

- (i) Reinforcement
 - a) Placement of reinforcement, from position shown on Drawings 20 mm
 - b) Concrete cover (measured at reinforcement supports)
 - 1) Prior to concrete placement -0, +15 mm
 - 2) After concrete placement - Insitu elements -10, +25 mm
 - 3) After concrete placement - Precast elements -10,+20 mm

- c) Concrete cover (measured anywhere other than supports)
 - 1) Prior to concrete placement -10, +15 mm
 - 2) After concrete placement - Insitu elements -15, +25 mm
 - 3) After concrete placement - Precast elements -15,+20 mm

(Note that the target tolerance after concrete placement in accordance with Austroads Bridge Design Code and A.S.3600 is) -15, +15 mm

(ii) Footings and Pile Caps

- a) Plan dimensions:-
 - 1) Formed -5, +10mm
 - 2) Unformed -0, +150 mm
- b) Thickness:-
 - 1) Less than 300 mm -5, + 25 mm
 - 2) 300 mm and above -10, + 75 mm
- c) Reduced level of top of footing -25, +25 mm
- d) Departure from plan position in any direction -25, + 25 mm

(iii) Base Slabs

- a) Plan dimensions 15, +15 mm
- b) Thicknesses -5, +25 mm
- c) Reduced level of top of slab -10, + 10 mm
- Water must not pond and must flow in the specified direction
- d) Departure from plan position in any direction 50 mm
- e) Exposed concrete surface and recesses, when measured with a 2.5 metre straight edge 5 mm
- f) Construction joints - width of slot -3, +3 mm

(iv) Columns, crossheads, slabs, walls and similar parts -

- a) Variation in cross section
 - 1) Less than 3 metres -5, + 15 mm
 - 2) Greater than 3 metres -10, + 25 mm
- b) Variation from vertical or specified batter -
 - 1) Unexposed concrete 10 mm in 2.5 m
 - 2) Exposed concrete 5 mm in 2.5 m
- c) Reduced level of tops of walls and crossheads -5, + 5 mm
- d) Difference in level across width of abutment and crosshead shall not exceed 5 mm
- e) Departure from plan position at any level 25 mm
- f) Relative displacement of adjoining components shall not exceed 10 mm
- g) Departure from alignment 10 mm

h) Seatings for prestressed beam bearings

1)	Departure from specified grade	1 in 200
2)	Depth of depressions from true line	1 mm
i)	Reduced level of mortar bearing pads	-2.5, +2.5 mm
(v)	Deck	
a)	Variation in thickness (excluding allowance for correction of camber or hog)	-5, +15 mm
b)	Deck joints - width of slot	-3, +3 mm
c)	Deck surface finish	5 mm in 2.5 m
d)	Deck surface reduced level	-5, +5 mm
(vi)	Kerbs and Arrises	
a)	Variation from grades	2.5 mm in 2.5 m
b)	Section dimensions of kerbs and channels	-5, +5 mm
c)	Departure from plan position shall not exceed	10 mm
(vii)	Exposed concrete surfaces, maximum allowance for irregularities.	
a)	Sections less than 1 metre in dimension when measured with a straight edge across the dimension of the section	2.5 mm
b)	Sections greater than 1 metre in dimensions when measured with a straight edge across the dimension of the section, except that when sections are greater than 2.5 metres in dimension, a 2.5 metre straightedge shall be used	5 mm
(viii)	Bearing pads (refer to B30 Installation clauses)	
a)	Maximum variation from design line and level	1.0 mm

B11.14 REMOVAL OF FALSE WORK AND FORMWORK

- For bridgeworks removal of the false work shall include complete withdrawal of false work piles and footings.
 - Removal of formwork shall not compromise the curing of the concrete.
 - All formwork shall be removed without shock or vibration that may damage the concrete.
 - In no circumstances shall the formwork be removed until the Contractor can demonstrate that the concrete has reached a cylinder strength of at least twice that of the stress to which the concrete may be subjected to at the time of removal.
 - Excluding days when the ambient air temperature is below 4⁰C, the following minimum maturities shall be adopted for the removal of formwork and formwork supports where Type GP cement has been used, without admixtures, provided that the concrete has achieved the necessary strength for structural purposes. The minimum ambient temperature for the day shall be used in this calculation. When days of less than 4⁰C occur the figure in brackets shall apply.
- | | | |
|-----|---|------------------------------|
| (a) | Side formwork of abutment footings, pier footings, pier crossheads, insitu deck, kerbs, wingwalls and retaining wall footings and culvert base slabs. | 120 degree hours
(1 day) |
| (b) | Culvert walls, abutment walls, wingwalls and retaining walls. | 480 degree hours
(2 days) |
| (c) | Pier Columns | 480 degree hours
(2 days) |
| (d) | Soffit formwork of pier crossheads, bridge deck, kerb cantilevers | 1,440 degree hours |

and culvert roofs.

(7 days)

(e) Prestressed Beams, forms and false work.

120 degree hours
(1 day)

Where Type GB cement or supplementary cementitious materials are used the time for removal of formwork, and formwork supports, shall be increased by 120 degree hours or (1 day).

- Immediately upon removal of formwork the concrete surfaces shall be cured in accordance with this Specification.

B11.15 CURING

B11.15.1 General

The durability achieved in concrete is heavily dependent on effective curing. Continuous moist curing is specified. Other methods will only be approved in exceptional circumstances when moist curing cannot be achieved.

The curing of exposed concrete surfaces shall commence within 15 minutes of progressive completion of finishing operations and shall continue uninterrupted for not less than the periods specified.

Where the overnight temperature may drop below 0⁰ C, precautions shall be taken to avoid freezing of the concrete. The Contractor shall bear all associated costs.

The Contractor shall submit full details of his proposed methods of curing, as part of his Contract Management Plan.

Details submitted shall include the following information for the proposed methods of curing.

- (i) Moist Curing - materials, method and duration of cure;
- (ii) Maintenance of Formwork in Place - duration, method of sealing the formwork and curing exposed surfaces;
- (iii) Steam Curing - full details of control methods, duration of proposed curing cycle and subsequent curing.

B11.15.2 Moist Curing



All surfaces of the concrete shall be kept moist for the specified period of curing by continuous spraying, ponding, wet hessian or wet sand blankets. The **Superintendent may request that any water used for the curing of concrete is tested prior to use. Test results shall be provided prior to the concrete pour and the commencement of moist curing.**

B11.15.3 Curing by Maintaining Formwork in Place

When formwork is left in place to satisfy the formwork removal times as specified, or where formwork is left in place for the specified period of curing, or part thereof, the exposed surfaces of the concrete shall be cured and the formwork shall be sealed against evaporative moisture losses for the duration of curing. Water shall be applied to the upper surfaces of the forms to ensure moist formwork as shrinkage of the concrete occurs.

Where formwork is removed prior to the completion of the curing period, curing shall recommence within two hours and continue until the total curing time is not less than the period of curing specified in Table B11.1.

B11.15.4 Steam Curing

The proposed curing cycle to achieve the specified concrete compressive strength and durability shall be submitted as part of the Contract Management Plan. Moist curing will normally be necessary following the steam curing cycle to complete the duration of curing specified in Table B11.1. Under no circumstances shall steam jets be permitted to impinge on the concrete or formwork in such a manner as may cause localised overheating of the concrete.

The maximum allowable temperature in the steam enclosure during steam curing shall be 75°C. The maximum rate of temperature rise of the concrete shall not exceed 24°C per hour. At the end of the cycle the steam covers shall not be removed until the concrete temperature is less than 30°C above the ambient air temperature. The temperature shall be recorded by means of recording thermometers with one placed to record the minimum temperature under the steam covers.

B11.15.5 Duration of Curing ◆

The duration of curing shall be not less than the time given in Table B11.1

TABLE B11.1 Curing Duration

Concrete Grade	Cement Type	Minimum Curing Period			
		Average Temperature During Period			
		10°C – 15°C		Above 15°C	
		Days	Degree-Hours	Days	Degree-Hours
20 to 55	General Purpose Portland (GP)	7	2520	6	2160
20 to 55	General Purpose Blended (GB)	9	3240	8	2880

NOTE

- For concrete decks and slabs, the period of curing shall be extended by two (2) days or 720 degree-hours
- Where the average air temperature during the specified periods falls below 10°C, the period of curing shall be extended by two (2) days or 480 degree-hours (calculated on the 10°C).

The Contractor may elect to calculate degree-hours of curing to reduce the tabulated requirements. The temperature used for the curing duration calculation shall be the temperature of the concrete as determined by a thermocouple cast into the concrete. The thermocouple shall not compromise the cover or durability of the concrete. Calculations shall be based on hourly increments.

The termination of curing shall be a hold point.

B11.15.6 Curing Compounds

Curing compounds shall only be used in exceptional circumstances and shall not be used on concrete decks or base slabs.

If air temperatures exceed 30°C prior to the commencement of moist curing an aliphatic alcohol curing agent shall be applied to reduce moisture loss until moist curing can commence.

Resin and PVA based curing compounds shall not be used.

Curing compounds shall comply with AS 3799. In the event of exceptional circumstances, full details of the curing compound including the time and rate of application, documented evidence of the effectiveness and efficiency of the compound as a curing agent and method of removal, where required, shall be submitted to the Superintendent for acceptance. Such compounds shall be pigmented sufficiently to allow visual inspection to ensure full application on the surface. The pigment shall not be visible fourteen days after application. Curing compounds shall not have a deleterious effect on the concrete nor stain the surface of the concrete.

Curing compounds shall not be applied to construction joints unless the joint is to be roughened or abrasive blasted at a later date.

Curing compounds shall not be applied to surfaces that are to be subsequently coated unless they are compatible with the coating, waterproofing or surfacing system or provision is made for removal of the compound from these surfaces prior to the application of the coating, waterproofing or surfacing system.

Curing membranes shall be maintained intact for not less than the specified period of curing. Any damage to the curing membranes during the period of curing shall be repaired immediately at the original rate of application.

B11.16 MISCELLANEOUS

B11.16.1 Construction Joints

Construction joints shall be provided at the locations shown on the Drawings.

Joints on exposed faces shall be horizontal or vertical and beading shall be fixed inside wall forms on exposed faces to ensure regularity of joints.

Construction joints in deck slabs shall be formed normal to deck grade.

Horizontal joints shall be brushed and washed or jetted with high pressure water after initial set to remove any laitance and expose the coarse aggregate to ensure satisfactory bond between the hardened and fresh concrete.

The surface of vertical or similar joints, which have hardened, shall be roughened in a manner that will not leave loosened particles of aggregate or damaged concrete on the surface. It shall be thoroughly cleaned of foreign matter and laitance, and shall be moistened with water immediately prior to concreting.

Prior to placement of concrete on top of tremie poured concrete, all laitance and weak concrete shall be removed and the surface shall be scabbled.

An exposed aggregate or roughened finish at construction joints may be obtained by using non-staining concrete surface retarders in accordance with the following provisions:-

- At formed construction joints the formed surface shall be coated with a surface retarder in accordance with the manufacturer's instructions.
- At unformed construction joints the concrete surface shall be painted with a surface retarder as soon as the concrete has set sufficiently and while it is still wet.
- The treated surface shall be wire brushed or jetted with high pressure water within four days after casting the concrete to remove the cement matrix to a depth of 5 mm maximum, leaving the larger aggregate exposed.
- On completion of the removal of the cement matrix the concrete surface shall be cleaned and any dust or loose material shall be removed.
- All visible irregularities shall be made good by the Contractor.

B11.16.2 Separation of Concrete Surfaces

Where separation of adjacent concrete surfaces is specified or shown on the drawings, to prevent bonding or binding during differential movements, the contractor shall submit its proposal (which may include the application of a releasing agent or insertion of a separating membrane), to the Superintendent for approval.

B11.16.3 Scuppers

Scuppers shall be formed from durable material such as stainless steel. UPVC is not acceptable. If scupper discharge is not piped the Contractor shall protect areas receiving the discharge from damage.

B11.16.4 Mortar Bearing Pads

Bearings shall be installed on finished concrete or a mortar pad which has been finished to the design line and level. If a gap of 1mm or more is evident under the bearing, prior to placement of the beam, then the bearing pad shall be replaced prior to placement of the beam.

Mortar for bearing pads shall comprise a mixture of sand and cement in the ratio of 3 parts of sand to 1 part of cement.

The water cement ratio shall be as low as possible consistent with achieving thorough mixing and sufficient workability for placement.

The mortar pads shall be continuously moist cured for 7 days.

Proprietary shrinkage compensated polymer modified cementitious mortars that comply with Specification B15 may be used subject to durability for the design life being warranted by the manufacturer.

B11.17 PAYMENT

The rates in the Bill of Quantities for insitu concrete shall include full payment for providing all design, labour, materials, tools, equipment, false work and scaffolding and any other work incidental to completing these reinforced concrete items including bracing, formwork, handling, forming of construction joints, weepholes, joint materials, recesses and identification marks, providing the required concrete and finishing and curing of the concrete. No additional payment will be made for additional cement required to place concrete by pumping.

The net specified finished dimensions of reinforced concrete work as shown on the Drawings have been taken for the purpose of measurement.

The item for deck concrete shall be deemed to cater for variations in hog in beams and shall, in addition to the above inclusions, allow for the cost of any additional labour, plant and temporary materials used including additional work by the Contractor in adjusting the reduced level of the deck, kerbs and curtain wall surfaces.

The rate in the Bill of Quantities for blinding concrete shall include full payment for providing all labour, materials, tools, equipment and any other work incidental to completing this item except where specified in the extra over Items and hereunder.

The rates in the Bill of Quantities for steel reinforcement shall include full payment for supply of, provision for rolling margin and waste, cutting, bending, transport to the site, protection and fixing in the locations shown on the Drawings.

The rate in the Bill of Quantities for anchor bolt assemblies shall include the supply of all plates and commercial hot-dipped galvanised bolts and nuts, the fabrication of assemblies and their subsequent incorporation in the works and cleaning of the top of the bolts and plates after concreting.

B11.18 HOLDPOINTS

The following hold points have been identified in this Specification:

- Certification of formwork and false work design. (B11.6.2)
- Prior to splicing reinforcement at a location not shown on the Drawings. (B11.7.4)
- Prior to welding reinforcement. (B11.7.4)
- Prior to placing concrete. (B11.8.1) (B11.8.2) (B11.8.4)
- Prior to use of set retarder additive. (B11.8.2)
- Prior to repair of surface defects. (B11.10.2)
- Prior to early removal of formwork or false work. (B11.14)

- Prior to using curing methods other than moist curing. (B11.15.1)
- Prior to ceasing curing. (B11.15.5)
- Prior to using proprietary bearing pad grout (B11.16.5)

B11.19 INFORMATION TO BE INCLUDED IN CONTRACT MANAGEMENT PLAN

The following information to be included in the Contract Management Plan has been identified in this Specification:

- False work and formwork designer (B11.6.2)
- Concrete ties (B11.6.3)
- Concrete repair and filling material (B11.6.3)
- Reinforcement welding methods and equipment (B11.7.4)
- Reinforcement supports (B11.7.6)
- Pumped concrete mix and handling equipment (B11.8.3)
- Methods for placement and compacting concrete (B11.8)
- Number and type of vibrating equipment (B11.8.8)
- Method to achieve exposed aggregate finish (B11.10.4)
- Methods and duration of curing (B11.15.1)
- Steam curing details including rate of temperature rise, time and temperature of soak, rate of temperature fall and subsequent curing (B11.15.4)
- Mortar material for bearing pads (B11.16.5)

Nb Bridge number clause has been transferred to General Specification G1