NOTICE
This document is a Roads and Maritime Services D&C Specification. It has been developed for use with Design & Construct roadworks and bridgeworks contracts let by Roads and Maritime Services. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

Copyright in this document belongs to Roads and Maritime Services.

REVISION REGISTER

<table>
<thead>
<tr>
<th>Ed/Rev Number</th>
<th>Clause Number</th>
<th>Description of Revision</th>
<th>Authorised By</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed 1/Rev 0</td>
<td></td>
<td>First issue</td>
<td>GM, IC</td>
<td>23.06.11</td>
</tr>
<tr>
<td>Ed 2/Rev 0</td>
<td></td>
<td>Updated to accord with changes to base (non-D&amp;C) Specification B80</td>
<td>GM, IC</td>
<td>12.07.12</td>
</tr>
<tr>
<td>Ed 2/Rev 1</td>
<td></td>
<td>Updated to accord with changes to base (non-D&amp;C) Specification B80</td>
<td>GM, IC</td>
<td>31.08.12</td>
</tr>
<tr>
<td>Ed 2/Rev 5</td>
<td></td>
<td>Updated to accord with base (non-D&amp;C) Specification B80 Ed 6/Rev 6</td>
<td>MCQ</td>
<td>27.10.17</td>
</tr>
<tr>
<td>Ed 2/Rev 6</td>
<td></td>
<td>Updated to accord with base (non-D&amp;C) Specification B80 Ed 6/Rev 7</td>
<td>MCQ</td>
<td>27.11.17</td>
</tr>
<tr>
<td>Ed 2/Rev 7</td>
<td></td>
<td>Updated to accord with base (non-D&amp;C) Specification B80 Ed 6/Rev 8</td>
<td>MCQ</td>
<td>04.10.18</td>
</tr>
</tbody>
</table>
6.1 Quality Management System Requirements........................................29
6.2 Materials .........................................................................................29
6.3 Fabrication, Bending and Welding.....................................................29
6.4 Splicing ..........................................................................................31
6.5 Storage ...........................................................................................32
6.6 Surface Condition ...........................................................................32
6.7 Placing and Fixing of Reinforcement and Embedments ...............32
6.8 Cover ............................................................................................34
6.9 Tolerances .....................................................................................35

7 PLACING, COMPACTING, FINISHING AND CURING OF CONCRETE ........................................36
7.1 General .........................................................................................36
7.2 Concrete Cracking .........................................................................36
7.3 Certification by Contractor ..............................................................37
7.4 Concrete Placement and Compaction - Basic Requirements ..........38
7.5 Temperature and Rain ....................................................................39
7.6 Control of Moisture Loss ................................................................40
7.7 Placing Outside Daylight Hours .....................................................40
7.8 Placing in Water ............................................................................40
7.9 Preparation of Surface of Construction Joints ......................... 42
7.10 Additional Requirements for Voided Slab Construction ......... 42
7.11 Screeding and Finishing of Unformed Surfaces ...................... 42
7.12 Curing .........................................................................................44
7.13 Slipformed Barriers ....................................................................47
7.14 Concreting of Deck Joint Blockouts ........................................47
7.15 Early Trafficking of Bridge Decks .............................................47

8 PROPERTIES OF HARDENED CONCRETE .................................................................48
8.1 General .........................................................................................48
8.2 Compressive Strength ....................................................................48
8.3 Compaction ....................................................................................49
8.4 Cover .............................................................................................49

ANNEXURE B80/A – PROJECT SPECIFIC REQUIREMENTS ..............................................50
A1 Members in Exposure Classification U .........................................50
A2 Bridge Members for Which Self-Compacting Concrete or High Workability Concrete is Permitted (Job Specific) ..........51
A3 Formwork Category C (Job Specific) .............................................51
A4 Surface Finish Requirements (Job Specific) .................................51
A5 Bridge Decks for Which Screeding Using Vibrating Power Screeds and Height Pins is Permitted (Job Specific) ....51

ANNEXURE B80/B – (NOT USED) .........................................................52

ANNEXURE B80/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS ......52
C1 Schedule of Hold Points and Witness Points ................................52
C2 Schedule of Identified Records .......................................................52

ANNEXURE B80/D – PLANNING DOCUMENTS ..................................................53

ANNEXURE B80/E – CURING PROVISION B .................................................54

ANNEXURE B80/F – STAINLESS STEEL REINFORCEMENT ........................................56
F1 General ...............................................................................................56
FOREWORD

RMS COPYRIGHT AND USE OF THIS DOCUMENT

Copyright in this document belongs to Roads and Maritime Services.

When this document forms part of a deed

This document should be read with all the documents forming the Project Deed.

When this document does not form part of a deed

This copy is not a controlled document. Observe the Notice that appears on the first page of the copy controlled by RMS. A full copy of the latest version of the document is available on the RMS Internet website: http://www.rms.nsw.gov.au/business-industry/partners-suppliers/specifications/index.html

BASE SPECIFICATION

This document is based on Specification RMS B80 Edition 6 Revision 8.
RMS SPECIFICATION D&C B80

CONCRETE WORK FOR BRIDGES

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for bridgeworks for:

(a) the supply and delivery of all concrete, cement mortar and grout for cast-in-place and precast concrete members used in the Contractor’s Work;
(b) the design, construction, erection and removal of the formwork;
(c) the supply, fabrication and fixing of the reinforcing steel and other embedded items; and
(d) the placing, compacting, finishing and curing of the concrete, cement mortar and grout.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 Details of Work

Project specific requirements are shown in Annexure B80/A.

1.2.2 (Not Used)

1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure B80/C list the HOLD POINTS and WITNESS POINTS that must be observed. Refer to Specification RMS D&C Q6 for the definitions of HOLD POINTS and WITNESS POINTS.

The records listed in Annexure B80/C are Identified Records for the purposes of RMS D&C Q6 Annexure Q/E.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure B80/D and must be implemented.

1.2.5 Frequency of Testing

The Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item and it must not be less than that specified in Annexure B80/L. Where a minimum frequency is not specified, nominate an appropriate frequency.
1.2.6 Referenced Documents and Abbreviations

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure B80/M.

1.3 DEFINITIONS

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

The following definitions apply to this Specification:

**Cement**
Material conforming to Specification RMS D&C 3211. It comprises General Purpose cements, Blended cements and supplementary cementitious materials (SCMs).

**Concrete**
A thoroughly mixed combination of cement, aggregates and water, with or without the addition of chemical admixtures or other materials, all of which separately and when combined conform to this Specification.

**Cement Mortar**
A mixture of cement, water and fine aggregate, with or without the addition of chemical admixtures or other materials, proportioned to produce a plastic mixture without segregation of the constituents, all of which separately and when combined conform to this Specification, with a compressive strength at 28 days not less than 40 MPa at bearings and expansion joints and 32 MPa elsewhere.

**Grout**
A mixture of cement and water, with or without the addition of fine sand or chemical admixtures or other materials, proportioned to produce a pourable liquid without segregation of the constituents, all of which separately and when combined conform to this Specification with a compressive strength at 28 days not less than 32 MPa when sampled and tested in accordance with RMS T375.

**Exposure Classification**
Refer to Clause 4.3 of AS 5100.5:2004.

**Curing**
The control of temperature and moisture in the concrete until the concrete has developed the required properties.

**Self-Compacting Concrete**
Concrete that is able to flow and consolidate under its own weight, completely fill the formwork even in the presence of dense reinforcement, whilst maintaining homogeneity and without the need for additional compaction. Also called self-consolidating concrete or super-workable concrete.

**Standard Moist-Curing Conditions**
Standard Moist-Curing Conditions in accordance with AS 1012.8.1.

**Wet Curing**
Curing at ambient temperature in which the concrete surface is effectively covered with water or placed in a fog room/chamber with a relative humidity exceeding 98%.

**Sealed Curing**
Curing at ambient temperature in which the concrete surface is sealed by the retention in place of impermeable forms or by applying at least two
coats of a curing compound conforming to this Specification or by using tight, fully sealed plastic wrapping.

**Heat Accelerated Curing**
Curing at mechanically elevated concrete temperatures not exceeding 70°C during which time the concrete surface is protected against immature drying. Steam curing at atmospheric pressure is typical heat accelerated curing. Steam curing at high pressure (autoclaving) is excluded from this definition.

**High workability concrete**
Concrete that is able to flow, consolidate and completely fill the formwork, even in the presence of congested reinforcement, and maintain its homogeneity with minimal compaction.

**Cover**
The distance between the outside of the reinforcement and the nearest permanent surface of the member excluding any surface finishing material.

**Water/Cement Ratio**
The ratio, by mass, of total free water including water contained in admixture solutions, to total cement, including all supplementary cementitious materials, in the concrete mix.

## 2 MATERIALS FOR CONCRETE, CEMENT MORTAR AND GROUT

### 2.1 GENERAL

Materials for concrete, cement mortar and grout must conform to Section 2 of AS 1379 and Clause 2.

### 2.2 CEMENT

Cement used in the Contractor’s Work must be Shrinkage Limited Type SL or General Purpose Blended cement Type GB conforming to this Specification and RMS D&C 3211.

Supplementary cementitious materials (SCMs) and proportions must conform to Specification RMS D&C 3211.

Blending of cement must be at either the cement manufacturer's facilities and/or at the concrete batching plant.

Use only cement and SCMs that have been pre-registered under the Australian Technical Infrastructure Committee (ATIC) Scheme. Confirmation of pre-registration can be obtained from the RMS Southern Laboratory at 21 York Place Russell Vale NSW 2517 (telephone 02 4222 3242).

### 2.3 ADMIXTURES

#### 2.3.1 General

Chemical admixtures, including corrosion inhibitors, and their use must conform to AS 1478.1. Admixtures must not contain calcium chloride. Where two or more admixtures are proposed for incorporation into a concrete mix, their compatibility must be certified by the manufacturers. Submit details of the requirements for storage, preparation and mixing the admixtures.
Add an air entraining agent only when specified on the Design Documentation.

### 2.3.2 Corrosion Inhibitors

Corrosion inhibitors must contain a minimum of 30% of calcium nitrite solids. Where retarders additional to those already present in the corrosion inhibitor admixture are used to further modify the acceleration characteristics of the admixture, they must be added to the concrete before or together with the admixture.

Where corrosion inhibitors are specified, the admixture application rate must be such that the concrete contains a minimum of 9 kg of calcium nitrite solids per cubic metre.

### 2.4 AGGREGATES

#### 2.4.1 General

All aggregates used in the Contractor’s Work must conform to AS 2758.1, and Clauses 2.4 and 2.5 of this Specification.

Provide evidence that concrete made with a particle size distribution outside the specified limits meets all other requirements of this Specification both in the fresh and hardened state. Supply additional evidence of acceptable performance for segregation, bleeding, plastic shrinkage and finishing properties.

For wearing surfaces of all exposure classifications, the durability of the aggregate must conform to the requirements for exposure classification C.

#### 2.4.2 Additional Requirements for Coarse Aggregate

(a) Do not use lightweight coarse aggregate;

(b) Use only graded coarse aggregate with maximum nominal sizes of 20 mm, 14 mm or 10 mm;

(c) Coarse aggregate must conform to the dimensional requirements of AS 2758.1 except that Tables B80.1 and B80.2 must be applied in lieu of Tables 1 and 2 of AS 2758.1, respectively. Where more than one type of coarse aggregate is proposed for use in the mix, the resulting blend must conform to the dimensional requirements corresponding to the maximum size of aggregate in the blended coarse aggregate;

(d) The maximum limit for water absorption is 2.5% except for slag aggregate where the maximum limit is 6%;

(e) Use wet strength and wet/dry strength variation tests for aggregate durability assessment in accordance with AS 2758.1 with ‘duplicate testing’ being carried out in accordance with AS 1141.22.

Durability of slag aggregate need only conform to exposure classification B1 requirements, except for wearing surfaces, which must conform to exposure classification C requirements.

#### 2.4.3 Additional Requirements for Fine Aggregate

(a) Graded fine aggregate must conform to the dimensional requirements of AS 2758.1, but Table B80.3 applies instead of Table 3 of AS 2758.1.
Concrete Work for Bridges  D&C B80

Where more than one type of fine aggregate is proposed for use in the mix, the resulting blend must conform to dimensional requirements of the above paragraph;

(b) Limit water absorption to a maximum of 2.5%.

(c) Any manufactured sand used as a fine aggregate must be crushed from rock from which aggregate is produced, and conforming to Clause 2.4, and must be non-plastic when tested in accordance with AS 1289.3.

Clause 8.2.2 of AS 2758.1 does not apply to manufactured sand. The water absorption of the combined fine aggregate must not exceed 2.5%.

For manufactured sands, when tested for Methylene Blue Value (MBV) in accordance with ISSA 145, the multiple of the MBV and the passing 75 μm sieve value of any sample must not exceed 100.

For manufactured sands, the sodium sulfate loss when tested in accordance with AS 1141.24 must not exceed a weighted average loss of 6% for all exposure classifications.

Table B80.1 - Coarse Aggregate - Particle Size Distribution Requirements

<table>
<thead>
<tr>
<th>Sieve aperture (mm)</th>
<th>Mass of sample passing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>85</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>–</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>25</td>
</tr>
<tr>
<td>6.7 mm</td>
<td>–</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>0</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>0</td>
</tr>
</tbody>
</table>

Table B80.2 - Coarse Aggregate - Limits of Deviation

<table>
<thead>
<tr>
<th>Sieve aperture (mm)</th>
<th>Limits of deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>–</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>± 5</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>± 10</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>± 10</td>
</tr>
<tr>
<td>6.7 mm</td>
<td>± 10</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>± 5</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>–</td>
</tr>
</tbody>
</table>
### Table B80.3 - Fine Aggregate - Particle Size Distribution Requirements and Limits of Deviation

<table>
<thead>
<tr>
<th>Sieve aperture</th>
<th>Mass of sample passing (%)</th>
<th>Maximum deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm</td>
<td>100 –</td>
<td>–</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90 – 100</td>
<td>± 3</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>65 – 95</td>
<td>± 10</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>40 – 85</td>
<td>± 10</td>
</tr>
<tr>
<td>600 µm</td>
<td>24 – 60</td>
<td>± 10</td>
</tr>
<tr>
<td>300 µm</td>
<td>8 – 25</td>
<td>± 5</td>
</tr>
<tr>
<td>150 µm</td>
<td>1 – 8</td>
<td>± 2</td>
</tr>
</tbody>
</table>

2.5 **ALKALI-AGGREGATE REACTION (AAR)**

2.5.1 **Testing**

A representative sample of aggregate from each source to be used in the concrete incorporated into the Contractor’s Work must be:

(a) petrographically examined in accordance with Clause 2.5.2; and

(b) assessed and classified for AAR using the accelerated mortar bar test method RMS T363.

For blended aggregates, aggregates from different sources must be tested alone.

2.5.2 **Petrographic Examination**

Petrographic examination must be in accordance with ASTM C295.

Aggregates containing obviously reactive components may be eliminated without further testing. Obviously reactive components include:

(a) opaline material;

(b) unstable silica minerals such as moderate amounts of tridymite and cristobalite; or

(c) sheared rock containing moderate amounts of strained quartz and microcrystalline quartz.

Petrographic examination must not be used alone to determine that an aggregate is non-reactive. Testing of the aggregate to Test Method RMS T363 is also required.

2.5.3 **Actions Required for Control of AAR**

For aggregates classified as non-reactive by Test Method RMS T363, no action for control of potential AAR is required.

Where any of the aggregates in a mix are classified as slowly reactive or reactive by Test Method RMS T363, actions required for control of potential AAR in the concrete must be in accordance with Table B80.4.
Blended cements used for control of potential AAR must be in accordance with Annexure 3211/A of Specification RMS D&C 3211.

Aggregates classified as reactive by Test Method RMS T364 in a particular concrete mix design must not be used. Use alternative aggregates and/or alternative concrete mix designs that conform to this Specification.

Table B80.4 - Actions Required for Control of Potential AAR Based on RMS T363 Testing

<table>
<thead>
<tr>
<th>Mortar bar expansion (%) in 1M NaOH (80°C)</th>
<th>Actions Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 days</td>
<td>21 days</td>
</tr>
<tr>
<td>&lt; 0.10 *</td>
<td>≥ 0.10 *</td>
</tr>
<tr>
<td>Use blended cement</td>
<td></td>
</tr>
<tr>
<td>≥ 0.10 *</td>
<td>&gt;&gt; 0.10 *</td>
</tr>
<tr>
<td>Use an alternative aggregate; or</td>
<td>Use blended cement and assess aggregate reactivity in the concrete mix using RMS T364</td>
</tr>
<tr>
<td>Use blended cement and assess aggregate reactivity in the concrete mix using RMS T364</td>
<td></td>
</tr>
</tbody>
</table>

* Note: 0.15% for naturally occurring fine aggregates

2.6 SOLUBLE SALTS

2.6.1 Chlorides

Determine the chloride ion content by testing ground samples of hardened concrete in accordance with AS 1012.20.

Take the samples from a minimum 1.2 kg portion of the hardened concrete. Crush and grind the 1.2 kg of hardened concrete to a maximum size of 150 microns and then oven dry at 110°C ± 5°C for a minimum of one hour before taking the samples for analysis.

Analyse five (5) randomly selected samples of 20 ± 0.1 grams of the ground concrete for chloride ion content.

Use the Volhard method calibrated against a concrete with known chloride content for the tests. Modify the procedure of AS 1012.20 and use standard solutions for the analysis that bracket the expected chloride ion concentration.

Report the chloride ion content of each of the five samples and calculate and report the average chloride content and the standard deviation of the five samples.

The average mass of acid-soluble chloride ion per unit volume of concrete as placed must not exceed the values given in Table B80.5.
Table B80.5 - Maximum Values of Acid-Soluble Chloride-Ion Content in Concrete

<table>
<thead>
<tr>
<th>Exposure Classification</th>
<th>Unreinforced concrete</th>
<th>Reinforced concrete</th>
<th>Prestressed concrete</th>
<th>Grout</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.8</td>
<td>0.8</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>B1</td>
<td>0.8</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>B2</td>
<td>0.8</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>C</td>
<td>0.8</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>U</td>
<td>In accordance with Annexure B80/A1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Chloride ion content may be expressed in percentage weight of oven dried concrete. (0.1 kg/m³ ion content is approximately equivalent to 0.0042% by weight of oven dried concrete)

2.6.2 Sulfates

Determine the sulfate content of concrete by calculation, expressed as the percentage by mass of acid-soluble SO₃ to cement, by summing the sulfate content of the individual concrete constituents. The sulfate content must not exceed 3.0% for heat accelerated cured concrete or 5.0% otherwise.

3 DESIGN OF CONCRETE MIXES

3.1 GENERAL

Design the concrete mix in accordance with this Specification. Base the mix design on the anticipated conditions which will prevail on the Construction Site so that under these conditions and after supply, placement, compaction, screeding, finishing and curing the concrete meets all the requirements of this Specification.

3.2 DESIGN FOR DURABILITY

The concrete mix must be designed to achieve a structure service life of at least 100 years in the specified environment without significant maintenance.

For concrete durability, conform to Table B80.6 and the following:

(a) For exposure classifications A and B1, concrete made with blended cement must contain a minimum of 240 kg/m³ of General Purpose or Shrinkage Limited cement conforming to Specification RMS D&C 3211, to limit carbonation.

(b) Use blended cement containing amorphous silica only for precast concrete members. Do not use blended cement containing amorphous silica for cast-in-place concrete members, to limit cracking.
Precast concrete members in exposure classification C must contain a corrosion inhibitor in accordance with Clause 2.3.2, except as provided for in Item (d) of this Clause or in Annexure B80/F, to limit chloride induced reinforcement corrosion.

For precast concrete members requiring durability suitable for exposure classification C but which are not in a chloride aggressive environment, the corrosion inhibitor is not required.

The water/cement ratio must not be less than 0.32 for cast-in-place concrete and 0.28 for precast concrete, to ensure cement hydration, except for cast-in-place concrete bridge decks and slabs where it must not be less than 0.40, to limit cracking.

For cast-in-place concrete bridge decks and slabs the specified minimum 28 day compressive strength, $f_{c,min(s)}$, must not exceed 32 MPa, except for exposure classification B2 where it must not exceed 40 MPa, to limit cracking.

Provide curing equivalent to a minimum of 3 days wet curing or better, to limit cracking.

Self-compacting concrete may only be used for precast concrete members, except where permitted by Clauses 3.6 and 7.8, and Annexure B80/A2.

Alternatively, submit a Concrete Durability Plan specific to the Contractor’s Work that will achieve the intent of this Clause and that will prevent the adverse effects specified in Clause 3.3. Demonstrate in the Concrete Durability Plan a durability performance equivalent to or better than that achieved by conforming to Table B80.6 and the preceding items of this Clause.

The Concrete Durability Plan must:

(i) fully detail and quantify the effect of each factor affecting concrete durability on the Contractor’s Work, using field test results and supporting durability calculations;

(ii) propose the measures to be taken during the Contractor’s Work to achieve the specified structure service life; and

(iii) propose suitable concrete mixes for each structure and/or individual members on the Contractor’s Work together with laboratory test results demonstrating conformity with the Concrete Durability Plan.
## Table B80.6 - Durability Requirements for Concrete

<table>
<thead>
<tr>
<th>Exposure classification</th>
<th>Minimum cement content (kg/m³)</th>
<th>Maximum cement content (kg/m³)</th>
<th>Maximum water/cement ratio (by mass)</th>
<th>Minimum water/cement ratio (by mass)</th>
<th>Maximum chloride test coefficients at 20°C ( \times 10^{-12} \text{ m}^2/\text{sec} )</th>
<th>Minimum strength for durability ( f_{c,min}(d) ) (MPa)</th>
<th>Actions required</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cast-in-place Concrete</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>320</td>
<td>400</td>
<td>0.56</td>
<td>0.4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>B1</td>
<td>320</td>
<td>450</td>
<td>0.50</td>
<td>0.4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>B2</td>
<td>370</td>
<td>500</td>
<td>0.46</td>
<td>0.32</td>
<td>3.5</td>
<td>8.0</td>
<td>40</td>
</tr>
<tr>
<td>C</td>
<td>420</td>
<td>550</td>
<td>0.40</td>
<td>0.32</td>
<td>2.0</td>
<td>4.0</td>
<td>50</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In accordance with Annexure B80/A1</td>
</tr>
<tr>
<td><strong>Precast Concrete</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A, B1</td>
<td>320</td>
<td>600</td>
<td>0.5</td>
<td>0.28</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>B2</td>
<td>370</td>
<td>600</td>
<td>0.46</td>
<td>0.28</td>
<td>3.5</td>
<td>8.0</td>
<td>60</td>
</tr>
<tr>
<td>C</td>
<td>420</td>
<td>600</td>
<td>0.40</td>
<td>0.28</td>
<td>2.0</td>
<td>4.0</td>
<td>60</td>
</tr>
</tbody>
</table>

**Notes:**
1. N/A denotes not applicable for this exposure classification. FA denotes flyash and BFS denotes ground granulated iron blast furnace slag conforming to Specification RMS D&C 3211.
2. \( D_e \) denotes effective diffusion coefficient from Nordtest NT Build 443.
3. \( D_{RMC} \) denotes rapid migration coefficient from Nordtest NT Build 492.
4. Continuously standard moist-cure after demoulding specimens for the Nordtest NT Build 443 and NT Build 492 tests and test at an age of 56 and 28 days respectively.
5. The specified coefficients are based on the minimum concrete covers specified in AS 5100.5:2004 Table 4.10.3 (A). If the specified corrosion inhibitor is included, the minimum cover may be reduced by 10 mm.
6. Modify the specified coefficients if the concrete cover is increased.
7. The specified coefficients are for a test temperature of 20°C. Modify the required coefficients for a given temperature as follows: 
   \( (D_e \text{ or } D_{RMC})_{req} = 4.15 \text{ e}^{-0.0703T_i} \), where \( T_i \) is the specified temperature.
3.3 **PREVENTION OF ADVERSE EFFECTS**

Design the concrete mix for prevention of adverse effects arising from excessive drying shrinkage, alkali-aggregate reactions, soluble salts, inadequate compaction and cracking, and from exposure to acid sulfate soils, chloride ingress and carbonation.

3.3.1 **Drying Shrinkage**

Maximum drying shrinkage must be in accordance with Clause 3.7.

3.3.2 **Alkali-Aggregate Reactions (AAR)**

Control alkali-aggregate reactions in accordance with Clause 2.5.

3.3.3 **Soluble Salts**

Maximum soluble salts must be in accordance with Clause 2.6.

3.3.4 **Compaction**

Concrete compaction must be in accordance with Clauses 7.4.3 and 8.3.

3.3.5 **Cracking**

Maximum crack widths must be in accordance with Clause 7.2.

3.3.5.1 **Plastic Shrinkage Cracking**

Control plastic shrinkage cracking in accordance with Clause 7.6.

3.3.5.2 **Thermal Cracking**

Control thermal cracking by using blended cement containing fly ash or blast furnace slag, or by chilling the mix water or by insulating the concrete member. Thermal cracking is usually aggravated with large volume concrete members.

Model the effects in larger members of temperature increases as a result of cement hydration during production and curing of the concrete member and use measures to prevent thermal cracking.

Limit the temperature of all concrete members following concrete placement to a maximum of 70°C.

3.3.6 **Acid Sulfate Soils (ASS)**

For concrete structures located in exposure classification U due to the presence of acid sulfate soils, design the concrete mix in accordance with Annexure B80/A1.

3.3.7 **Chloride Ingress**

For the exposure classifications specified on the Design Documentation drawings, design the concrete mix against chloride ingress in accordance with Table B80.6. The values of diffusion or migration coefficients for the concrete mix must be verified on a trial mix with samples taken for testing for chloride resistance.
Carry out chloride resistance testing in accordance with Nordtest NT Build 443 at a concrete age of 56 days or Nordtest NT Build 492 at a concrete age of 28 days. Specify which test method to use, depending on the time available to obtain the test results.

### 3.3.8 Carbonation of Concrete

Refer to Item (a) of Clause 3.2.

### 3.4 CURING

The curing of the concrete must conform to either Provision A – (Performance) or Provision B – (Method), as specified in Clauses 3.4.1 and 3.4.2.

#### 3.4.1 Curing Provision A - (Performance)

For the exposure classifications specified on the Design Documentation drawings, the effectiveness of the curing of the concrete used in the Contractor’s Work must be in accordance with Table B80.7.

Test the effectiveness of the curing in accordance with Test Method RMS T362. Carry out sorptivity testing by other than a NATA registered laboratory for this test.

The maximum sorptivity penetration depth must be verified on a trial mix using the method and duration of curing ("curing regime") proposed for use on the Contractor’s Work.

At the trial mix stage, the curing of the sorptivity test specimen must be identical to that proposed for the concrete member. At the construction stage, the curing of the concrete member must be identical to that of the sorptivity test specimen. Provide charts of the curing temperature and humidity versus time to verify that the required curing has been achieved.

<table>
<thead>
<tr>
<th>Exposure classification</th>
<th>Maximum sorptivity penetration depth (mm)</th>
<th>General Purpose cement</th>
<th>Blended cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>35</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>N/A</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>N/A</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>In accordance with Annexure B80/A1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3.4.2 Curing Provision B - (Method)

For the exposure classifications specified on the Design Documentation drawings, the curing of the concrete member must be in accordance with Annexure B80/E using one of the methods of curing specified in Clause 7.12.
3.5 TARGET STRENGTH FOR MIX DESIGN

Design the concrete mix to achieve a target strength $f_{c,\text{md}}$ such that:

\[
\begin{align*}
    f_{c,\text{md}} & \geq f_{c,\text{min}} + M_{\text{control}} \\
    f_{c,\text{max}} & \leq f_{c,\text{min}} + 2.0 M_{\text{control}}
\end{align*}
\]

where:

(a) $f_{c,\text{min}}$ is the greater of $f_{c,\text{min}}(s)$ and $f_{c,\text{min}}(d)$;
(b) $f_{c,\text{min}}(s)$ is the specified minimum 28 day compressive strength as stated on the Design Documentation drawings, or elsewhere in the Specification;
(c) $f_{c,\text{min}}(d)$ is the minimum 28 day compressive strength required for durability obtained from Table B80.6;
(d) $M_{\text{control}}$ is the margin nominated for variations in strength as defined in Clause 4.1; and
(e) $f_{c,\text{max}}$ is the maximum 28 day compressive strength test result permitted for the trial mix.

Unless otherwise specified on the Design Documentation drawings:

(i) the target strength $f_{c,\text{md}}$ for cast-in-place deck concrete must not exceed 42 MPa except for exposure classification B2 where it must not exceed 50 MPa;
(ii) the target strength $f_{c,\text{md}}$ for all other concrete must not exceed 75 MPa; and
(iii) $M_{\text{control}}$ must not exceed 10 MPa.

3.6 LIMITATIONS ON SLUMP

Unless specified otherwise on the Design Documentation drawings, the concrete slump of the nominated mix (nominated slump) must not exceed 180 mm. Where a nominated slump in excess of 180 mm is proposed, demonstrate by way of a Test Member in accordance with Clause 5.3.2, that the concrete may be placed, compacted and finished without deleterious effects.

The above limitations on slump may be waived only for the bridge members specified in Annexure B80/A2 for which self-compacting concrete or high workability concrete may be used in accordance with Annexure B80/G.

3.7 LIMITATIONS ON SHRINKAGE

Prepare concrete specimens from the nominated mix in accordance with AS 1012.13 for the purpose of shrinkage testing. Measure the shrinkage of the specimens in accordance with AS 1012.13.

Shrinkage of the concrete specimen after either of the 3 or 8 weeks’ drying periods must conform to Table B80.8.
### Table B80.8 - Maximum Shrinkage Strain of Concrete Specimens

<table>
<thead>
<tr>
<th>Exposure classification</th>
<th>Maximum shrinkage strain (microstrain)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drying period</td>
</tr>
<tr>
<td></td>
<td>3 Weeks</td>
</tr>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>570</td>
</tr>
<tr>
<td>B1, B2</td>
<td>500 (600\textsuperscript{a}) (650\textsuperscript{b})</td>
</tr>
<tr>
<td>C</td>
<td>430 (530\textsuperscript{a}) (550\textsuperscript{b}) (650*)</td>
</tr>
<tr>
<td>U</td>
<td>In accordance with Annexure B80/A1</td>
</tr>
</tbody>
</table>

Note:  

- \textsuperscript{a} For self-compacting concrete.  
- \textsuperscript{b} For concretes with slag-blended cement.  
- \textsuperscript{c} For precast members where the specified corrosion inhibitor has been included in the mix.  

### 3.8 NOMINATED MIXES

#### 3.8.1 Submission of Nominated Mixes

Submit to the Project Verifier the details of each concrete mix and the proposed curing regime together with a certificate stating that the nominated mix, its constituents, and the proposed curing regime conform to this Specification.


### HOLD POINT

Process Held: Use of each nominated mix.

Submission Details:

- (a) (i) all details in Clause 3.8.2; or  
  (ii) nomination of a mix from the Register of RMS Approved Concrete Mixes; and  
- (b) a statement stating that the mix conforms to this Specification and is suitable for its intended use,

at least 5 working days before the concrete mix is proposed to be used.

Release of Hold Point: The Nominated Authority will consider the submitted documents, and may carry out surveillance and audit, prior to authorising the release of the Hold Point.

Prepare trial mixes in accordance with AS 1012.2 using the proposed materials and mix proportions, including all admixtures.

Batch a trial mix at the highest water/cement ratio conforming to the allowable slump and water content tolerances specified in AS 1379 for the nominated mix. For mixes with a nominated water/cement ratio less than 0.40, batch an additional trial mix at the lowest water/cement ratio.
conforming to the allowable slump and water content tolerances. Allow for batching tolerances and anticipated variations in aggregate moisture content.

Report the test results for the hardened concrete prepared from the trial mixes.

From the trial mix results, nominate the water/cement ratio and slump for production. Include the nominated values on the delivery dockets. AS 1379 Clause 4.2 provides for tolerances on production batch ingredients.

Where an RMS approved concrete mix is nominated for use in the Contractor’s Work, submit identification details of the mix and the concrete mix design to the Project Verifier.

### 3.8.2 New Concrete Mix Design

The submission for a mix not currently approved must include the following details:

- **(a) Material Constituents**
  - For each constituent and any individual components making up the constituent:
    - (i) Source; and
    - (ii) Current test results not more than 12 months old for the characteristics and properties specified in Clause 2.

- **(b) Mix Design**
  - (i) Constituent quantities;
  - (ii) Method of controlling alkali-aggregate reactions as specified in Clause 2.5.
  - (iii) Trial mix water/cement ratio and corresponding nominated water/cement ratio;
  - (iv) Condition of constituents used in the mix design e.g. moisture condition of aggregates;
  - (v) $f_{c,md}$, $f_{c,min}$, $f_{c,min}(s)$, $f_{c,max}$ and $f_{c,min}(d)$ determined in accordance with Clause 3.5;
  - (vi) Applicable exposure classification(s);
  - (vii) Trial mix slump and corresponding nominated slump;
  - (viii) For concrete containing high range water reducers, final slump and reversion time; and
  - (ix) Nominated coarse and fine aggregate particle size distributions.

- **(c) Batching, Mixing and Transport**
  - (i) Methods;
  - (ii) Level of control and accuracy of batching;
  - (iii) Level of control and accuracy of determination of the aggregate moisture content;
  - (iv) $M_{control}$ and method of determination of $M_{control}$; and
  - (v) Minimum mixing time.

- **(d) Curing Regime**
  - (i) Method and duration of curing;
  - (ii) Anticipated minimum and maximum ambient temperatures and relative humidity during the curing period; and
(iii) For curing Provision A only, maximum sorptivity penetration depth together with the applicable curing regime accompanied by temperature and relative humidity versus time graphs.

(e) Other Test Results for Hardened Concrete Characteristics

(i) 28 day compressive strength in accordance with AS 1012.9 (cylinders must be moulded in accordance with AS 1012.8.1 using rodding only);

(ii) Shrinkage in accordance with AS 1012.13;

(iii) Sulfate and chloride ion contents in accordance with Clause 2.6;

(iv) Chloride resistance in accordance with Clause 3.3.7; and

(v) Trial mix report in accordance with AS 1012.2.

3.9 Variations to Nomination Mixes

The quantities of the constituents in a nominated mix may be varied to improve the quality of the concrete. Variations to the quantities of constituents in the nominated mix must not exceed the following:

(a) Cement: 3% by mass of each constituent.

(b) Aggregates: 5% by mass of each constituent.

(c) Water: 3% by volume and/or mass.

(d) Admixture: 20% by volume and/or mass of each admixture and within the manufacturer's recommendations.

Notify the Project Verifier in writing and submit written details of such variations to a nominated mix before commencing production with the varied quantities.

Notwithstanding the above provisions, the varied concrete mix must:

(i) not have a water/cement ratio exceeding that nominated for the concrete mix (refer to Clause 3.8);

(ii) conform to Clause 3.2 for minimum cement content and maximum water/cement ratio; and

(iii) conform to Specification RMS D&C 3211 for the range of SCMs in blended cement.

If you wish to vary the quantities of the constituents in excess of the above amounts, or wish to change the type or source of supply of any constituent, or vary the curing regime, submit a new nominated mix for approval in accordance with Clause 3.8.

4 Supply and Delivery of Concrete

4.1 General

All concrete supplied for use in the Contractor’s Work must conform to the approved nominated concrete mixes.

Produce and deliver concrete to the site of the Contractor’s Work or to the precasting yard in accordance with AS 1379 and this Specification.
Classify all concrete for use in the Contractor’s Work as Special Class designated "S" in accordance with Clause 1.5.4 of AS 1379. Nominate the method of production assessment relevant to the plant in accordance with AS 1379.

Nominate a margin for strength which is consistent with the nominated method of production assessment under which the plant operates. This margin for strength, $M_{\text{control}}$, is the measure of the level of control for the nominated plant producing the nominated mix.

Dispose of water, contaminants, debris, excess concrete and other materials from concrete supply operations in accordance with Specification RMS D&C G36.

### 4.2 MOISTURE CONTENT OF AGGREGATES

Store the fine and coarse aggregates in the saturated surface dry condition or wetter prior to and during batching.

Determine the moisture content of the fine and coarse aggregates prior to concrete production for the day, and whenever conditions change, either by a moisture meter or by other equivalent devices or methods. Make corrections to the mass of all aggregates and the volume of water used in the mix commensurate with the moisture content determined so that the nominated water/cement ratio is achieved for all batches supplied for the Contractor’s Work.

### 4.3 ADDITIONAL REQUIREMENTS FOR MIXING

#### 4.3.1 Equipment

Do not use continuous mixers.

#### 4.3.2 Discharging of Mixer

Discharge the entire contents of the mixer before charging it with a new batch.

#### 4.3.3 Maximum Mixing Time

Where by reason of delay it is necessary to hold a batch in the mixer, mixing may be continued for a maximum of ten minutes, except for split drum mixers where the maximum time that mixing may be continued is five minutes.

For longer delays, the batch may be held in the mixer and turned over at regular intervals, subject to the time limits specified for incorporation of the concrete into the work not being exceeded.

#### 4.3.4 Delivery

Transport concrete produced at a remote central batching plant to the point of discharge by truck-mounted drum mixers conforming to AS 1379 and this Specification. On completion of batching, continuously agitate the concrete until it is thoroughly mixed. On completion of mixing, continuously agitate the concrete until it is fully discharged. The agitation speed and duration to achieve thorough mixing must be as specified by the manufacturer of the equipment.

Before discharging from a truck-mounted drum mixer, agitate the concrete on-site for a minimum of three minutes at the mixer’s rated mixing speed.
All concrete batches must be delivered with a delivery docket / identification certificate containing the following details:

(a) Delivery docket number;
(b) Truck number;
(c) Batch number;
(d) Date and time batched;
(e) Batch quantity;
(f) Project name;
(g) Mix type and identification;
(h) Strength grade;
(i) Nominated slump;
(j) Nominated water/cement ratio;
(k) Volume of free water in the batch;
(l) Volume of all water added after batching;
(m) Total free water in the batch;
(n) Mass of cement in the batch;
(o) Actual water/cement ratio at discharge;
(p) Time at discharge;
(q) Total quantity of the deliveries for the pour; and
(r) Concrete supplier and plant details.

4.3.5 Period for Completion of Discharge, Placement and Compaction

Unless a hydration control admixture is added to the approved mix to delay hydration, place and compact the concrete within 1.5 hours from the addition of the cement to the aggregates.

Where a hydration control admixture is added to the approved mix to delay hydration and extend the setting time beyond 1.5 hours, nominate the extended setting time and conform to the following:

(a) Provide NATA endorsed test reports in accordance with Clause 2.3.1 proving conformity of the admixture to AS 1478.1;
(b) Soluble salt content must conform to Clause 2.6;
(c) Carry out trials with the mix containing the admixture prior to and under the most adverse conditions that would most likely occur at the Construction Site over the range of days of the pours to demonstrate that there will be no adverse effects on the plastic and hardened concrete including shrinkage tests in accordance with Clause 3.7 and additional compression strength cylinders in accordance with Clause 8.2 taken after the addition of the second part of the admixture;
(d) Thoroughly remix the concrete after addition of the second part of the admixture but before discharge for a minimum of three minutes at the mixer’s rated speed.
4.4 **Slump and Water/Cement Ratio Tolerances**

Check and record the slump of the concrete within 45 minutes of adding cement to the aggregate or at discharge. Also check and record the slump immediately prior to discharge when the actual haul time exceeds 45 minutes and/or when water is added to a mixed batch in accordance with Clause 4.5.

Check the slump of the concrete in accordance with AS 1379 except for the frequency of sampling which must be in accordance with Annexure B80/L.

If the measured slump is not within the specified limits, carry out one repeat test immediately from another portion of the same sample. If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample is deemed to conform; otherwise reject it.

Do not incorporate concrete into the Contractor’s Work if its slump or water/cement ratio is outside the specified tolerances of AS 1379.

For batches produced with a high level of process control, a reduced frequency of slump checking compared to Annexure B80/L may be acceptable.

The water/cement ratio of each batch must conform to Item (b) of Clause 4.2.1.2 of AS 1379.

4.5 **Addition of Water to a Mixed Batch**

Provided a hydration control admixture has not been added to the approved mix to delay hydration, water may be added to a mixed batch of concrete prior to the commencement of discharge providing the following conditions are satisfied:

(a) Less than 45 minutes have elapsed since cement was added to the aggregate;

(b) Immediately after the addition of any water, operate the mixing mechanism at mixing speed for at least 3 minutes, and for such additional time as may be necessary to re-establish uniformity of the mix;

(c) The total quantity of water added is not more than 9 kg/m³, and the nominated water/cement ratio plus 10% tolerance and maximum water/cement ratio in Table B80.6 are not exceeded;

(d) The quantity of water added is measured and recorded;

(e) The slump of the concrete is checked after the water has been added, in accordance with Clause 4.4.

Once discharge of a batch has commenced, do not add further water to that batch.

4.6 **Temperature at Point of Delivery**

Do not use concrete if its temperature at the point of discharge is less than 10°C or more than 32°C except for precast concrete members and cast-in-place piles where the minimum and maximum concrete temperatures must be 5°C and 35°C respectively.

4.7 **Presence of Corrosion Inhibitor in Fresh Concrete**

Where the corrosion inhibitor is specified in the nominated mix, determine the presence and quantity of the calcium nitrite within the fresh concrete in accordance with Test Method RMS T371. The frequency of sampling must be in accordance with Annexure B80/L.
5 FORMWORK

5.1 GENERAL

Formwork, including all temporary supporting members, must conform to AS 3610 and this Specification.

With the exception of Clauses 5.1, 5.3, 5.8, 5.9 and 5.10, Clause 5 does not apply to formwork for precast concrete members cast in off-site precasting yards.

Design formwork to account for all load cases in accordance with AS 3610. The design and details must also account for stream flow, traffic impact, flooding, ground conditions, effect of post-tensioning and any other applicable conditions. Where formwork is intended for re-use, allow in the design for the deterioration of the materials following use and handling.

Supplement the foundation investigation for the bridge design with additional foundation information, if necessary, to complete the formwork design.

5.2 FORMWORK DESIGN, DOCUMENTATION AND CERTIFICATION

5.2.1 Quality Management System Requirements

Attention is drawn to Specification RMS D&C Q6 for the design control of temporary structures. These requirements apply to the design of formwork.

5.2.2 Project Documentation

Project documentation must conform to Section 2 of AS 3610.

5.2.3 Formwork Design and Documentation

Note clearly on the formwork drawings all relevant formwork construction requirements including design assumptions, foundation preparation, footing details and precamber diagrams. The formwork drawings must be sufficiently comprehensive and clearly presented so that erection and inspection are carried out without reference to any other documentation.

Design any steel girders used for support and all associated bolted or welded splices in accordance with AS 5100. All welded splices must be full penetration butt welds conforming to Specification RMS D&C B201. All bolts and other fasteners must conform to Specification RMS D&C B201.

5.2.4 Submission of Formwork Documentation and Certification

For the purposes of this clause, the formwork for the various members of the bridge structure is divided into three Risk Categories as detailed in Table B80.9.
Concrete Work for Bridges D&C B80

Table B80.9 - Risk Categories for Formwork

<table>
<thead>
<tr>
<th>Category</th>
<th>Bridge Members</th>
</tr>
</thead>
</table>
| A Low Risk | (a) Abutments, pilecaps, footings, piers, columns and walls, with heights less than 3 metres  
(b) Members not included in either Category B or Category C |
| B Moderate Risk | (a) Abutments, pilecaps, footings, piers, columns and walls, with heights greater than 3 metres and less than 6 metres  
(b) Headstocks more than 3 metres off the ground  
(c) Decks and off-ground slabs with maximum thickness less than 600 mm |
| C High Risk | (a) Abutments, pilecaps, footings, piers, columns and walls, with heights greater than 6 metres  
(b) Parapets  
(c) Decks and off-ground slabs with maximum thickness greater than 600 mm  
(d) Concrete box girders  
(e) Any member for which self-compacting concrete is proposed  
(f) Job specific bridge members listed in Annexure B80/A3 |

The submission of formwork documentation and certification for each Category must be in accordance with Table B80.10.

For bridges over or adjacent to railways and/or roads conveying more than 5000 vehicles/day in any lane, formwork for the members listed under Category B must conform to the submission requirements of Category C of Table B80.10.

The submission for the use of a formwork assembly more than once for members listed under Category C need only conform to the requirements of Category A of Table B80.10 after its initial use.

Table B80.10 - Submission Requirements for Formwork

<table>
<thead>
<tr>
<th>Category</th>
<th>Formwork documentation</th>
<th>Design certification</th>
<th>Erected formwork certification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time of submission</td>
<td>by</td>
<td>Time of submission by</td>
</tr>
<tr>
<td>A Low Risk</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>B Moderate Risk</td>
<td>Prior to placing reinforcement</td>
<td>Engineer</td>
<td>Prior to placing reinforcement (HP)</td>
</tr>
<tr>
<td>C High Risk</td>
<td>Prior to erecting formwork</td>
<td>Engineer</td>
<td>Prior to erecting formwork (HP)</td>
</tr>
</tbody>
</table>

Notes: (HP): Hold Point N/A: Not Applicable
When certification by an Engineer is required by Table B80.10, nominate an Engineer who is a member of Engineers Australia (or equivalent) and who is experienced in the design and erection of formwork of at least similar complexity.

When design certification of formwork is required in Table B80.10, the certification must state that the design of the formwork and the formwork documentation conform to AS 3610 and this Specification. Where multiple systems are combined to create the formwork, the design certification must cover the full extent of formwork used, including any interfaces and any required bracing and stiffeners.

The certification for erected formwork must state that the formwork has been erected in accordance with either the formwork documentation for Category A, or the certified design for Categories B and C, as applicable.

Any changes proposed to the certified design or erected formwork must be accompanied by documentation and certification conforming to this Clause.

<table>
<thead>
<tr>
<th>HOLD POINT</th>
<th>(Does not apply to Category A formwork)</th>
</tr>
</thead>
</table>
| Process Held: | For Category B formwork – Placement of reinforcement.  
For Category C formwork – Erection of formwork. |
| Submission Details: | For Categories B and C, formwork documentation and Engineer's design certification in accordance with Clause 5.2. |
| Release of Hold Point: | The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point. Where the Nominated Authority has concerns about the adequacy of the formwork documentation or certification, the Nominated Authority may order an independent verification of the formwork design at your expense before releasing the Hold Point. |

5.3 SURFACE FINISH

5.3.1 Class of Finish

For the purpose of this Specification, the classes of surface finish are as defined in AS 3610.

Design and construct the formwork to produce concrete with the following Class of finish unless stated otherwise in Annexure B80/A4 or the Design Documentation drawings:

(a) Structures beyond 1 km from coast:
   (i) precast girders and piles - Class 2 in accordance with Clause 3.4.5 of AS 3610. The dimensional tolerances of Specifications RMS D&C B110 and RMS D&C B115 take precedence over this Specification;
   (ii) deck soffit between precast girders - Class 2X;
   (iii) all piers, abutment and retaining wall surfaces exposed to view - Class 2X;
   (iv) all other external surfaces including soffits of precast planks - Class 2; and
   (v) all internal and permanently hidden surfaces - Class 3.
(b) Structures within 1 km from coast:
   (i) as for (a) except that Class 2X becomes Class 2.

The surface finish for Class 2X is the surface finish which conforms to Class 2 except that the
blowholes requirement is relaxed to Class 3 (refer Figure B3 of AS 3610).

5.3.2 Test Members

Test members are not required unless specified in Clause 3.6 or Annexure B80/A4 or the Design
Documentation drawings.

When test members are required they must be designed and constructed in accordance with AS 3610.
The method of constructing the test members must effectively simulate the formwork, reinforcement
layout and concreting operations to be applied in the Contractor’s Work.

### HOLD POINT

(If test members are required)

**Process Held:** Erection or prefabrication of formwork for members specified in
Annexure B80/A4 or on the Design Documentation drawings.

**Submission Details:** Give the Nominated Authority two working days notice in writing of the
proposed placement of concrete in the test member to permit observation of
the process. Thereafter, give the Nominated Authority the opportunity to
inspect the completed member.

**Release of Hold Point:** The Nominated Authority will consider the method of construction and the
finished test member, prior to authorising the release of the Hold Point.

5.4 SITE-RELATED REQUIREMENTS

Formwork for concrete intended for composite action with a member previously constructed must be
designed to be supported only from that member and in such a manner that placing of concrete in the
formwork, or any other construction loads, does not produce separation or differential movement
between the member and the formwork.

Formwork for cross girders may be supported off the substructure.

5.5 CONSTRUCTION JOINTS

Construct the Contractor’s Work with construction joints at the locations shown on the Design
Documentation drawings. If additional construction joints or the relocation of those shown on the
Design Documentation drawings is required, submit details of the proposals with the formwork
documentation. Make any additional construction joints perpendicular to the longitudinal axis of a
member.

Unless shown otherwise on the Design Documentation drawings, do not locate construction joints in
salt or brackish water from 1.0 m below minimum low water to 1.0 m above maximum high water tide
levels.

Locate construction joints at the base of columns or walls at least 100 mm above the tops of the
footings or pilecaps.
Form construction joints on visible faces by using suitably dressed timber beading, or by other means, so that the joints are straight and regular.

At horizontal joints where the formwork for the pour above the joint is anchored to the concrete below the joint, pre-tighten the form anchor bolts against the face of the supporting concrete. The pre-tightening must prevent the formwork from separating from the supporting face under the pressure of fresh concrete to form gaps.

At vertical joints in cast-in-place superstructures, place continuous supports directly under the formwork at the joint location. The method of providing and fixing these supports must prevent the formwork from separating from the hardened concrete of the previous pour when the fresh concrete is placed against it.

### 5.6 MATERIALS FOR FORMWORK SURFACES

The formwork for exposed concrete surfaces must be steel plate conforming to AS/NZS 1594 or plywood conforming to AS/NZS 2271. Make plywood from panels having uniform widths of not less than 1 m and uniform lengths of not less than 2 m, except where the dimensions of the member formed are less than these minimum panel dimensions. Place plywood panels with the grain of the outer plies perpendicular to the studding or joists.

Place all form panels in a neat and symmetrical pattern.

Where shown on the Design Documentation drawings, use dressed timber for exposed concrete surfaces instead of plywood or steel.

Where left in place, do not use expanded metal mesh as formwork, including for the forming of construction joints.

Sealed penetrations through the formwork may be permitted for dowel bars, tie rods and the like.

Forms for surfaces which will be completely enclosed or permanently hidden below the ground may be constructed from dressed or rough sawn timber, steel, fibre reinforced cement sheets or plywood. Do not use particleboard, chip board or masonite.

Where indicated on the Design Documentation drawings, narrow spaces between concrete faces may be formed by the use of suitable rigid foamed plastic material (polystyrene or similar). Unless otherwise noted on the Design Documentation drawings, this material may be left in the finished concrete. The foamed plastic material must have sufficient rigidity to prevent appreciable deformation during concreting, but must not present significant resistance to the expected relative movement of the adjacent concrete faces in the finished structure.

The foamed plastic material may be attached to either the forms or the previously cast concrete surfaces, but any adhesive used must be of a type which will not dissolve or otherwise damage the plastic material. Take care to prevent the foamed plastic being damaged by fire, petroleum products, or any other solvents, before the concrete has hardened.

### 5.7 ERECTION OF FORMWORK

#### 5.7.1 General

Erect the formwork strictly in accordance with the certified formwork documentation and drawings.
Concrete Work for Bridges D&C B80

Treat the interior surface of the formwork and any removable items so that adhesion of the concrete does not occur. Commercial quality form release agents, oil or grease are acceptable, provided that the treatment on formwork against surfaces to be exposed is of a type that will not stain or discolour the concrete surface.

Apply the treatment in accordance with the manufacturer’s instructions. Spread the treatment uniformly in a thin film and remove any surplus prior to placing the concrete. In the case of unlined timber forms, thoroughly wet the timber before treating.

Reinforcement, tendons, and embedments must not be soiled by the treatment used. If any reinforcement is soiled, clean it thoroughly. Do not use treatments where concrete surfaces are to receive an applied finish. Use only treatments compatible with any applied curing compound so that its adhesion to the concrete is not affected.

Before commencing placement of concrete, remove all loose tie wire, dirt, wood chips, hardened concrete or mortar, and all other foreign matter from the forms.

Make joints in formwork mortar-tight to prevent slurry loss and subsequent honeycombing.

5.7.2 Surveying Control

Control all survey activities in accordance with Specification RMS D&C G71.

Fabricate and erect the formwork to achieve the specified dimensions, levels and alignment of the completed Contractor’s Work within the specified tolerances. Make allowance for the deflections of the formwork which may occur before and during concreting.

Carry out all necessary investigations and calculations to ensure that the estimated deflections are reliable for the erected formwork and actual site conditions.

Maintain records for the checking and verification of the following items at each listed location:

As planned
(a) the designed characteristic (level, dimension etc) at that point on the structure as shown on the Design Documentation drawings;
(b) the calculated or estimated deflection/settlement of the formwork prior to and during concreting;
(c) the target characteristic for the formwork (allowing for deflection/settlement); and
(d) the specified tolerance on final location of the structure at that point.

As measured
(e) the characteristic as set out;
(f) the characteristic as verified;
(g) the difference between the verified value and the target value; and
(h) the magnitude of any out of tolerance measurement (i.e. the amount by which the measured difference exceeds the specified tolerances).
5.8 TOLERANCES

Design, document and erect the formwork so that, after it is removed, the formed and unformed surfaces have the dimensions shown on the Design Documentation drawings within the tolerances given in Table B80.11 and conform to the surface finish requirements of Clause 5.3.

Achieve the tolerances in Table B80.11 at Construction Completion for cast-in-place and precast concrete members.

Locate all fitments and embedments with sufficient accuracy to prevent any misfit or misalignment between mating components.

Table B80.11 - Dimensional Tolerances for Formed and Unformed Surfaces

<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance (mm) unless shown otherwise</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Footings:</td>
<td></td>
</tr>
<tr>
<td>Plan dimensions for formed footings and pilecaps</td>
<td>−10 to +50</td>
</tr>
<tr>
<td>Plan dimensions for unformed footings</td>
<td>0 to +150</td>
</tr>
<tr>
<td>Thickness &lt; 300 mm</td>
<td>−5 to +25</td>
</tr>
<tr>
<td>Thickness ≥ 300 mm</td>
<td>−10 to +50</td>
</tr>
<tr>
<td>Top of footing or pilecap reduced level</td>
<td>−25 to +25</td>
</tr>
<tr>
<td>Departure from the plan position in any direction</td>
<td>50</td>
</tr>
<tr>
<td>(ii) Variation in cross section of columns, piers, headstocks, slabs, walls, beams and similar parts (excluding deck slabs and barrier end posts):</td>
<td></td>
</tr>
<tr>
<td>&lt; 3 m</td>
<td>−5 to +15</td>
</tr>
<tr>
<td>≥ 3 m</td>
<td>−10 to +25</td>
</tr>
<tr>
<td>(iii) Variation of cross section of barrier end posts:</td>
<td>−5 to +5</td>
</tr>
<tr>
<td>(iv) Decks:</td>
<td></td>
</tr>
<tr>
<td>Variation in thickness of deck slabs (after allowing for corrections for camber or hog and variations in design loads, forces and load effects).</td>
<td>−5 to +15</td>
</tr>
<tr>
<td>Deviation of top of deck slab reduced level/s from design after allowing for corrections for camber or hog and variations in design loads, forces and load effects.</td>
<td>−10 to +5</td>
</tr>
<tr>
<td>Flatness of top surface of bridge deck in any direction (after allowing for superelevation and vertical curvature or grade)</td>
<td>3 mm in 3 m (1/1000)</td>
</tr>
<tr>
<td>(v) Deck joints:</td>
<td></td>
</tr>
<tr>
<td>Width of slot</td>
<td>−3 to +3</td>
</tr>
<tr>
<td>Item</td>
<td>Tolerance (mm) unless shown otherwise</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>(vi) Variation from vertical of specified batter of columns, piers,</td>
<td></td>
</tr>
<tr>
<td>and barriers:</td>
<td></td>
</tr>
<tr>
<td>Unexposed concrete</td>
<td>12 mm in 3 m (1/250)</td>
</tr>
<tr>
<td>Exposed concrete</td>
<td>6 mm in 3 m (1/500)</td>
</tr>
<tr>
<td>(vii) Kerbs and barriers:</td>
<td></td>
</tr>
<tr>
<td>Variation from grades shown on the Design Documentation drawings</td>
<td>3 mm in 3 m (1/1000)</td>
</tr>
<tr>
<td>Kerb and barrier height above deck slab</td>
<td>-5 to +10</td>
</tr>
<tr>
<td>Variation in plan from straight or curved horizontal alignment</td>
<td>5 mm in 3 m (1/600)</td>
</tr>
<tr>
<td>Steps in plan and elevation</td>
<td>5</td>
</tr>
<tr>
<td>Flatness of front face of kerbs and barriers</td>
<td>3 mm in 3 m (1/1000)</td>
</tr>
<tr>
<td>(viii) Reduced level of tops of headstocks and piers:</td>
<td></td>
</tr>
<tr>
<td>With pedestals</td>
<td>-10 to +10</td>
</tr>
<tr>
<td>Without pedestals</td>
<td>-5 to +5</td>
</tr>
<tr>
<td>Difference in level across width of headstocks</td>
<td>5</td>
</tr>
<tr>
<td>(ix) Bearing pads and pedestals:</td>
<td></td>
</tr>
<tr>
<td>Reduced level</td>
<td>-2.5 to +2.5</td>
</tr>
<tr>
<td>Variation from grade across the width of individual pads and pedestals</td>
<td>1 in 200</td>
</tr>
<tr>
<td>Deviation from flat surface</td>
<td>+1.0 to -1.0</td>
</tr>
<tr>
<td>(x) Departure from plan position at any level:</td>
<td></td>
</tr>
<tr>
<td>Columns, piers, walls, headstocks, beams, slabs, kerbs and barriers</td>
<td>25</td>
</tr>
<tr>
<td>and other similar members</td>
<td></td>
</tr>
<tr>
<td>Relative displacement of adjoining members must not exceed</td>
<td>10</td>
</tr>
<tr>
<td>Centreline of bearings</td>
<td>5</td>
</tr>
<tr>
<td>(xi) Departure from alignment:</td>
<td></td>
</tr>
<tr>
<td>Rows of columns, faces of piers or walls</td>
<td>10</td>
</tr>
<tr>
<td>Handrails, faces of hand rail posts, kerbs and barriers</td>
<td>5</td>
</tr>
</tbody>
</table>
(xii) Maximum allowance for irregularities in exposed concrete surfaces:

<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance (mm) unless shown otherwise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sections less than 1 m in dimension when measured with a straight edge</td>
<td>2.5</td>
</tr>
<tr>
<td>across the dimension of the section</td>
<td></td>
</tr>
<tr>
<td>Sections greater than 1 m in dimension when measured with a straight</td>
<td>5</td>
</tr>
<tr>
<td>edge across the dimension of the section, except that when sections are</td>
<td></td>
</tr>
<tr>
<td>greater than 3 m in dimension, a 3 m straight edge must be used</td>
<td></td>
</tr>
<tr>
<td>Deviation from design kerb and barrier dimensions</td>
<td>-2.5 to +2.5</td>
</tr>
</tbody>
</table>

5.9 **REMOVAL OF FORMWORK**

5.9.1 **General**

Remove formwork in such a way and at such a time as to achieve the specified characteristics, prevent damage to the old or recently placed concrete, and maintain safety at all stages of removal. Unless specified otherwise, do not apply superimposed loads to any part of the structure until the design concrete strength stated on the Design Documentation drawings has been achieved.

5.9.2 **Minimum Stripping Times**

Unless specified otherwise, the minimum stripping time is the longest of the times governed by curing in accordance with Clause 3.4 and the time required to achieve the concrete compressive strength in Table B80.12.

**Table B80.12 - Required Compressive Strength for Stripping of Formwork**

<table>
<thead>
<tr>
<th>Member and Surface</th>
<th>Minimum Concrete Compressive Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast-in-place members:</td>
<td></td>
</tr>
<tr>
<td>Vertical surfaces</td>
<td>7 MPa</td>
</tr>
<tr>
<td>Underside of horizontal surfaces</td>
<td>80% of ( f_{c,min} )</td>
</tr>
<tr>
<td>Other surfaces</td>
<td>A compressive strength as detailed in Design Documentation</td>
</tr>
<tr>
<td>Precast Concrete Members:</td>
<td></td>
</tr>
<tr>
<td>All surfaces</td>
<td>A compressive strength as detailed in Design Documentation</td>
</tr>
</tbody>
</table>

Determine the concrete compressive strength by testing representative test cylinders cured under the same conditions as the concrete in question or by other approved means. Provide charts of the temperature and relative humidity in the concrete in the member and the compression test cylinders to prove that the curing of each is the same.
5.10 REPAIRS TO FORMED SURFACES

The method and materials for repairing minor surface imperfections including porous spots, shallow honeycombing, rough areas, and blowholes not conforming to the specified Class must be approved by the RMS Representative and must be detailed in the PROJECT QUALITY PLAN.

Carry out repairs promptly using the approved method and materials so that a general uniform appearance, texture and colour is achieved.

6 SUPPLY AND FIXING OF STEEL REINFORCEMENT AND EMBEDMENTS

This Clause applies to all steel reinforcement and embedments, except where specified otherwise for stainless steel in Annexure B80/F.

6.1 QUALITY MANAGEMENT SYSTEM REQUIREMENTS

The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing Steels for the supply of reinforcement material.

The reinforcement fabricator must be certified by the Australian Certification Authority for Reinforcing Steels for fabricating reinforcement and implement and maintain a quality management system in accordance with AS/NZS ISO 9001 as a means of ensuring that the product conforms to this Specification.

6.2 MATERIALS

6.2.1 Reinforcement

Reinforcement must be deformed bars or welded wire fabric except that plain bars or wire may be used for fitments (a fitment is a unit of reinforcement commonly known as a tie, stirrup, ligature or helix). All reinforcement must conform to AS/NZS 4671.

6.2.2 Protective Coatings

Unless specified otherwise, reinforcement with protective coatings, including epoxy coating, must not be used.

6.3 FABRICATION, BENDING AND WELDING

6.3.1 Fabrication

Fabricate reinforcement to the shape and dimensions shown on the Design Documentation drawings and within the tolerances given in Clause 6.9.

6.3.2 Bending

Bend reinforcement without impact or damage to the bar either by cold bending around pins or by applying uniform heat not exceeding 450°C, for a period not exceeding two minutes, to and beyond, the portion to be bent. Do not cool heated bars by quenching.
Do not bend again reinforcement already bent and straightened, or bend in reverse again, within 20 bar diameters of the previous bend.

Reinforcement partially embedded in concrete may be field bent provided that the bending conforms to the above requirements and the bond of the embedded portion is not impaired as a result of the bending.

The nominal internal diameter of a reinforcement bend or hook is the external diameter of the pin around which the reinforcement is bent. The diameter of the pin must be not less than the value determined from Table B80.13.

<table>
<thead>
<tr>
<th>Type of Bar</th>
<th>Minimum Internal Diameter of Bend</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Normal bends</td>
<td></td>
</tr>
<tr>
<td>Fitments bar: Grade 250 and wire Grade 450</td>
<td>3(d_b)</td>
</tr>
<tr>
<td>Fitments bar: Grade 500</td>
<td>4(d_b)</td>
</tr>
<tr>
<td>Bars other than in (b) and (c) below</td>
<td>5(d_b)</td>
</tr>
<tr>
<td>(b) Bends designed to be straightened or subsequently re-bent</td>
<td></td>
</tr>
<tr>
<td>(d_b \leq 16 \text{ mm})</td>
<td>4(d_b)</td>
</tr>
<tr>
<td>(d_b = 20, 24 \text{ mm})</td>
<td>5(d_b)</td>
</tr>
<tr>
<td>(d_b \geq 28 \text{ mm})</td>
<td>6(d_b)</td>
</tr>
<tr>
<td>(c) Bends in reinforcement epoxy coated or galvanized either before or after bending</td>
<td></td>
</tr>
<tr>
<td>(d_b \leq 16 \text{ mm})</td>
<td>5(d_b)</td>
</tr>
<tr>
<td>(d_b \geq 20 \text{ mm})</td>
<td>8(d_b)</td>
</tr>
</tbody>
</table>

**Note:** “\(d_b\)” is the nominal diameter of the bar or wire

### 6.3.3 Welding

Tying of reinforcement is preferred over welding.

All welding must conform to Specification RMS D&C B203 and the bar manufacturer’s recommendations.

Do not field weld 500L reinforcement. Where 500L is shop welded, demonstrate that the weld procedure does not result in the loss of ductility.

Welded splices must be tested and must meet the specified tensile strength of the parent metal. Testing must be carried out by a laboratory with appropriate NATA registration.

Welding of reinforcement for prestressed members must not take place after the prestressing tendons have been placed in the reinforcement assemblies or cages being assembled.

Welding includes any welding used to assemble reinforcing cages (refer to Clause 6.7.3) or for temporary attachments.
Concrete Work for Bridges  D&C B80

Load bearing welds for lifting and transport of prefabricated reinforcement cages must be designed by a suitably qualified person with extensive experience in the design, welding and handling of prefabricated cages, taking into account static and dynamic loadings and any stress reversals that may occur during lifting, moving and transport.

6.4 SPLICING

6.4.1 Location of Splices

Splice reinforcement only at the locations shown on the Design Documentation drawings.

Additional splices or splices at other locations constitute a change in design detail.

6.4.2 Lapped Splices

Lapped bar splices not shown on the Design Documentation drawings must have lengths not less than the following:

(a) Deformed and plain bars:
   (i) If the bars to be lapped are not top bars and the lapped bars are in contact with each other, the splice length must be in accordance with Table B80.14.
   (ii) For top bars (defined as horizontal bars with 300 mm or more of concrete cast below the bar), increase the length of lap splices by 30% of the lengths given in the preceding item (i) of this Clause.
   (iii) For bars in lightweight concrete members, increase the length of lap splices by 30%.
   (iv) For galvanised or epoxy-coated bars, increase the length of lap splices by 50%.
   (v) The length of the lap splice is governed by the smaller size bar at the splice.
   (vi) The preceding items of this Clause also apply to lapped bars not in contact. For bars not in contact where the clear distance between the two bars, \( s_{cb} \), is larger than 3 times the bar diameter, increase the lap length by a further 1.5 times \( s_{cb} \).
   (vii) Do not lap splice bars unless the concrete cover to the nearest fitment in beams or bar in slabs exceeds the sizes of the bars to be lapped.

(b) Reinforcing fabric:

A lapped splice for welded wire fabric must be made so that the two outermost transverse wires of one sheet of fabric overlap the two outermost transverse wires of the sheet being lapped.
Table B80.14 - Splice Lengths

<table>
<thead>
<tr>
<th>Bar Type</th>
<th>Bar Diameter (mm)</th>
<th>Splice Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deformed</td>
<td>12</td>
<td>430</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>660</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>910</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>1180</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>1470</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>1770</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>2070</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>2400</td>
</tr>
</tbody>
</table>

Notes:
1. The above lapped bar splice lengths assume concrete cover of $35 \pm 5 \text{ mm}$, and clear bar spacing $\geq 70 \text{ mm}$. Longer splice lengths are required for smaller concrete covers or bar spacings.
2. For concrete strengths less than 32 MPa, multiply the above figures by $\sqrt{32/f_c'}$.
3. The splice lengths for plain bars must be 1.5 times the splice lengths of deformed bars.

6.4.3 Mechanical Splices


Install mechanical splices in accordance with the manufacturer's instructions.

6.5 STORAGE

Support reinforcement above the surface of the ground and protect it from damage and from deterioration due to exposure.

6.6 SURFACE CONDITION

At the time the concrete is placed, the surface condition of the reinforcement must not impair its bond to the concrete or its performance in the member.

6.7 PLACING AND FIXING OF REINFORCEMENT AND EMBEDMENTS

6.7.1 General

The provisions of Clause 6.3 with regard to bending and welding apply to reinforcement being placed or worked on site as well as to bending and fabrication off site.
6.7.2 Support of Reinforcement

Support the reinforcement and hold it clear of the formwork or blinding concrete by using individual concrete spacers (‘aspros’), or by suspension using mild steel fitments that do not encroach into the cover.

The smallest aspro dimension must not be less than the cover. The largest aspro dimension must not exceed 1.8 times the cover. Aspros circular in plan with sharp edges are preferred.

Manufacture concrete aspros from machine mixed concrete conforming to this Specification, with the 28 day compressive strength of the concrete in the aspros being at least the same as the concrete in the member. Make concrete aspros so that the sorptivity of the concrete conforms to this Specification. Do not use aspros made from porous concrete or mortar.

Space aspros sufficiently close together so that the specified cover is maintained during concreting and so that crushing of the aspros or penetration into the formwork does not occur.

Individual plastic bar chairs may be used only for precast and cast-in-place concrete members located in exposure classification A, B1 or B2 and for enclosed internal surfaces not exposed to view.

Cementitious and fibre reinforced cementitious spacers must have sharp corners and a minimum footprint flush on the formed surface and may only be used for precast and cast-in-place concrete members located in exposure classifications A, B1 or B2 where a Class 1, 2 or 2X surface finish is specified, and for enclosed internal surfaces not exposed to view.

Continuous bar chairs must:
(a) not be more than 350 mm in length;
(b) not be placed on a continuous straight line;
(c) only be used where the concrete is self-compacting in conformity with Annexure B80/G; and
(d) have at least 25% voids within the enclosed perimeter of the bar chair side elevation, with a minimum gap between the formwork and the underside of the bar chair in the voids of 1.5 times the maximum nominal size aggregate in the concrete mix.

Any excessive staining of the concrete surface caused by the use of continuous bar chairs must be cleaned.

Do not use wire bar chairs of any type or pieces of timber or coarse aggregate or broken concrete or bricks to support the reinforcement.

Reinforcement for cast-in-place decks over precast girders or planks may be supported on the exposed reinforcement of the girders or planks.

6.7.3 Assembly of Reinforcement

Secure reinforcement in place by tying or tack welding. Tie wire must be annealed steel wire having a diameter of not less than 1.2 mm. Perform tack welding in accordance with Clause 6.3.3.

Tie bars at all intersections except where the spacing is less than 300 mm in any direction, in which case the alternate intersections must be tied.

Wire ties must have a clear cover equal to that shown on the Design Documentation drawings for the bar being tied, less the diameter of the tie wire. Projecting ends of ties must not encroach into the concrete cover.
Securely wire together the ends of bars forming a lapped splice in at least two places, unless the splice is welded.

Stiffen the reinforcement to ensure that the specified surface finish tolerances of Clause 5.8 and the clear cover for the reinforcement are achieved.

Note the design location of lifting and transport support points for prefabricated reinforcement cages on shop drawings, and mark these locations indelibly on the cage during fabrication, and show the lifting requirements on a durable drawing attached to the cage, all prior to lifting. Conform to Clause 6.3.3 for welding of load bearing welds.

Submit to the Project Verifier one copy of all prefabricated reinforcement cage shop drawings showing the size, type and location of load bearing welds, lifting and support points and lifting requirements. The person who designed the load bearing welds must sign the shop drawings.

**WITNESS POINT** For prefabricated reinforcement cages

Process to be Witnessed: Assembly, lifting and transport of cages.

Submission Details: At least two working days’ notice to the Nominated Authority of intention to transport cages to the Works.

Prior to the proposed transport date, submit to the Nominated Authority a Certificate of Conformity in respect of load bearing weld sizes and locations, and conformity of finished welds, together with drawings and checklists.

### 6.7.4 Support of Screeding Guide Rails and Height Pins

Support screeding guide rails and height pins independently of the underlying reinforcement. Attachments to forms must either be of durable sacrificial non-corrosive materials compatible with concrete or be capable of being completely removed from the deck after final screeding.

### 6.7.5 Provision of Embedments

Plan in detail the placement of embedments such as stressing anchorages, bearings or bearing attachment plates, form ties and hole formers in their final locations.

In addition to the tolerance requirements of this Specification, install post-tensioning ducts and void formers in accordance with Specifications RMS D&C B113 and RMS D&C B170 respectively.

### 6.7.6 Inspection of Placed Reinforcement and Embedments

Verify by inspection the placement of the reinforcement, the soundness of any associated welding, and the fixing of embedments prior to the placed reinforcement and/or embedments becoming inaccessible.

### 6.8 COVER

Fabricate, bend and place the reinforcement to provide the cover shown on the Design Documentation drawings, within the tolerances given in Clause 6.9.
6.9 TOLERANCES

Fabrication tolerances are as shown in Table B80.15.

<table>
<thead>
<tr>
<th>Type of Reinforcement</th>
<th>Tolerances (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bars and Fabrics used for reinforcement</td>
<td></td>
</tr>
<tr>
<td>Overall dimension for lengths up to 600 mm</td>
<td>−25  +0</td>
</tr>
<tr>
<td>Overall dimension for lengths over 600 mm</td>
<td>−40  +0</td>
</tr>
<tr>
<td>Overall offset dimension of a cranked column bar</td>
<td>−0  +10</td>
</tr>
<tr>
<td>Bars and Fabrics used for fitments</td>
<td></td>
</tr>
<tr>
<td>Overall dimension for deformed bars and fabrics</td>
<td>−15  +0</td>
</tr>
<tr>
<td>Overall dimension for plain round bars and wire</td>
<td>−10  +0</td>
</tr>
</tbody>
</table>

Cover tolerances are as shown in Table B80.16.

<table>
<thead>
<tr>
<th>Reinforcement location</th>
<th>Tolerances (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formed surfaces</td>
<td>−5  +10</td>
</tr>
<tr>
<td>Unformed finished surfaces</td>
<td>−5  +10</td>
</tr>
<tr>
<td>Slabs cast on ground</td>
<td>−10  +20</td>
</tr>
<tr>
<td>Footings cast against ground</td>
<td>−20  +40</td>
</tr>
<tr>
<td>Cast-in-place piles without permanent steel casing</td>
<td>−20  +40</td>
</tr>
</tbody>
</table>

Notes:
1. A positive value indicates the amount by which the cover may exceed the specified thickness and a negative value indicates the amount by which the cover may be reduced below the specified thickness.
2. Concrete cast against a blinding concrete layer is considered as formed.

Achieve the tolerances for cover irrespective of all other dimensional tolerances in the fabrication and casting of concrete members.

Tolerances for location of reinforcement not controlled by cover are as shown in Table B80.17.

<table>
<thead>
<tr>
<th>Reinforcement location</th>
<th>Tolerances (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ends of reinforcement</td>
<td>50</td>
</tr>
<tr>
<td>Spacing (s) of bars in walls/slabs, and of fitments in beams and columns</td>
<td>15, or 0.1s whichever is the greater</td>
</tr>
</tbody>
</table>
7 PLACING, COMPACTING, FINISHING AND CURING OF CONCRETE

7.1 GENERAL

Concrete must be placed, compacted, finished and cured so as to:
(a) prevent segregation or loss of materials;
(b) prevent premature stiffening;
(c) prevent nonconforming displacement of reinforcement, fitments or embedments;
(d) produce a dense homogeneous product which is monolithic between planned joints and/or the extremities of members, or both;
(e) completely fill the formwork to the intended level, expel entrapped air, and surround all reinforcement, tendons, ducts, anchorages and embedments;
(f) provide the specified finishes;
(g) control cracking, including that caused by plastic and drying shrinkage, concrete slumping, plastic settlement, crusting and thermal gradients.

Dispose of water, contaminants, debris, excess concrete and other materials from concrete placing, compaction, finishing and curing operations in accordance with Specification RMS D&C G36.

The Concrete Supervisor, and at least half of the remaining crew involved in a concreting operation, must hold a RMS Bridgeworks Concreting Grey Card.

<table>
<thead>
<tr>
<th>HOLD POINT</th>
<th>RMS Bridgeworks Concreting Grey Card</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Held:</td>
<td>First concrete pour in the Works</td>
</tr>
<tr>
<td>Submission Details:</td>
<td>At least two weeks prior to the first concrete pour, submit to the Nominated Authority the names of all personnel who will be involved in bridgeworks concreting operations, which of these persons hold a RMS Bridgeworks Concreting Grey Card, and corresponding evidence of this. At least four working hours prior to pouring concrete, submit to the Nominated Authority a statement stating that at least half of the personnel who will be involved in bridgeworks concreting operations hold a RMS Bridgeworks Concreting Grey Card.</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
<td>When evidence is provided that at least half of the personnel who will be involved in the bridgeworks concreting operations hold a RMS Bridgeworks Concreting Grey Card.</td>
</tr>
</tbody>
</table>

7.2 CONCRETE CRACKING

At the completion of the curing period the concrete must have no cracks of width greater than 0.05 mm, measured at the concrete surface. Where such cracks exist, they must be identified as a nonconformity.
Concrete Work for Bridges  
D&C B80

At 28 days after placement or later the concrete must have no cracks of width greater than 0.1 mm, measured at the concrete surface. Where such cracks exist, they must be identified as a nonconformity.

All cracks identified as nonconforming must be measured and mapped. The crack maps must form part of the documentation submitted with the non-conformity report, together with the proposed corrective actions to rectify the non-conformities.

7.3 CERTIFICATION BY CONTRACTOR

<table>
<thead>
<tr>
<th>HOLD POINT</th>
<th>For precast concrete members cast off site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Held:</td>
<td>Commencement of production of precast members for the Contractor’s Work.</td>
</tr>
<tr>
<td>Submission Details:</td>
<td>At least two working days’ notice of intention to commence production of precast members for the Contractor’s Work.</td>
</tr>
</tbody>
</table>

Prior to the proposed commencement of production of precast members, submit to the Nominated Authority checklists for verifying conformity of the nominated concrete mix, formwork, reinforcement, embedments and other relevant details.

Release of Hold Point: The Nominated Authority will consider the submitted documents and may carry out further surveillance and audit, prior to authorising the release of the Hold Point.

For concrete pours other than precast members cast off site, include in the PROJECT QUALITY PLAN the name of the Concrete Supervisor with details of qualifications and experience in concreting work. The Concrete Supervisor must hold a RMS Bridgeworks Concreting Grey Card and have suitable and acceptable TAFE or equivalent qualifications for concrete placement, compaction, screeding, finishing and curing and must be present during all stages of the pour until implementation of the curing regime.
HOLD POINT

Process Held: Each placement of concrete in the Contractor’s Work.

Submission Details: At least two working days prior to each intention to place concrete in the Contractor’s Work, submit to the Nominated Authority a pour specific method statement detailing:

(i) delivery rate;
(ii) placement method and rate; and
(iii) equipment on standby.

At least 4 working hours prior to the proposed commencement of placing concrete, submit to the Nominated Authority a Certificate of Conformity, endorsed by the Concrete Supervisor, in respect of formwork, reinforcement, embedments and screeding guide rails or height pins. This certificate is to be accompanied by verification checklists and other details showing conformity to this Specification.

Release of Hold Point: The Nominated Authority will consider the submitted documents and may carry out further surveillance and audit, prior to authorising the release of the Hold Point.

The Concrete Supervisor must certify that all aspects of the placement, compaction, screeding, finishing and curing have been carried out in accordance with your procedures submitted in accordance with Annexure B80/D.

7.4 CONCRETE PLACEMENT AND COMPACTION - BASIC REQUIREMENTS

7.4.1 General

Where necessary, place and compact concrete in discrete layers.

Carry out continuous monitoring of the placement and compaction of the concrete at each head of pour during concreting. Provide access and lighting as necessary to permit adequate monitoring.

7.4.2 Placement

Do not place concrete in water except as provided for in Clause 7.8.

Carry out concreting in one continuous operation between the ends of members and/or construction joints. Do not place fresh concrete against concrete that has taken its initial set, except at properly formed construction joints.

Supply the concrete at a rate that ensures that all the concrete in the forms is kept plastic until placed in its final position and compacted, and so that no cold joints are formed. Provide adequate equipment and personnel to maintain the adopted rate of concrete placement.

Place concrete only from a height from which segregation cannot occur. Ensure conformity to this requirement through the use of suitable tremie pipes, chutes or other similar equipment.
7.4.3 Compaction

Compact concrete immediately after placing using internal and/or external vibration to expel all entrapped air. Carry out vibration in a regular and systematic manner to ensure that all the concrete is thoroughly compacted. Apply vibration to the full depth of each layer and extend into the top 100 mm of the underlying layer. Do not vibrate concrete to the point where segregation occurs.

Vibrators must be of the rotary out-of-balance type and be checked prior to use to ensure they are in proper working order.

Internal vibrators must have a minimum diameter of 50 mm with an operating frequency between 130 Hz and 200 Hz. Use smaller diameter vibrators for compaction of thin or narrow members or spaces or for compaction around dense reinforcement or as otherwise required.

The number of working internal vibrators and motors in use for compacting concrete during a concrete pour must not be less than one for each 10 cubic metres of concrete placed per hour, with a minimum of two. The number of standby vibrators and motors must be not less than one quarter of the number of vibrators and motors in use, with a minimum of one. Do not count vibrators used for spreading concrete in the number of vibrators used for compaction.

Insert internal vibrators vertically at spacings not exceeding 350 mm to liquefy the concrete so that all entrapped air escapes. Leave the vibrator in place until the air bubbles cease breaking the surface, then withdraw slowly to prevent pockets forming. Do not allow vibrators to rest on the reinforcement.

In regions of closely spaced horizontal reinforcement, full compaction of the concrete must be achieved directly beneath the closely spaced horizontal reinforcement prior to encasing that reinforcement with concrete.

7.5 TEMPERATURE AND RAIN

Continuously measure and record the concrete temperature and air temperature at the point of concrete placement. The concrete temperature prior to placement must conform to Clause 4.6.

All concrete other than for cast-in-place piles must not be placed if the air temperature in the shade is;

(i) below 5°C;
(ii) predicted to be below 5°C in the 24 hours after placement; or
(iii) above 38°C.

On hot days, special precautions to reduce the concrete temperature may include:

(a) watering the aggregate stockpiles;
(b) the use of refrigerated water in the mix;
(c) water mist spraying to cool the air provided that the water does not collect or pond on the exposed concrete surfaces.

On hot days, cool reinforcement by providing covers and wetting down prior to concrete placement to prevent flash setting of concrete coming into contact with the reinforcement.

On cold clear nights, take precautions against cooling of exposed surfaces by loss of heat by radiation that may cause frost damage, such as by providing insulation on the concrete surface.
For cast-in-place concrete piles, do not place concrete if ice exists on pile casings, embedments, steel reinforcement or in pile holes.

Do not place concrete during rain or when rain appears imminent unless a waterproof covering is provided to the exposed surfaces of the concrete.

Any concrete which is exposed to rain or other precipitation within the period from placement to curing is deemed to be nonconforming.

### 7.6 CONTROL OF MOISTURE LOSS

When placing concrete into forms, take appropriate measures to restrict the evaporation of water from the concrete surface and to prevent the incidence of plastic shrinkage cracking. Submit Technical Procedures for the restriction of the evaporation rates to less than 1 kg/m²/hour as part of the requirements of Annexure B80/D.

If an evaporation retarder is used to restrict the evaporation of water, apply it in a fine uniform spray. Any subsequent operations on the concrete must not incorporate the evaporation retarder into the unset concrete.

Figure B80.1 may be used as a guide for assessing the rate of evaporation.

### 7.7 PLACING OUTSIDE DAYLIGHT HOURS

When concrete is placed and finished outside daylight hours or in any other conditions where natural light may be inadequate, provide adequate lighting for the work including finishing and inspection.

### 7.8 PLACING IN WATER

Do not place concrete for the permanent structure, except for footings, pile caps and cast-in-place piles, in water.

Where concrete is placed for footings, pile caps and cast-in-place piles, remove all free water from the area where concrete is to be placed and provide suitable cofferdams or other means to stop any inflow of water so that the concrete is placed in the dry.

For cast-in-place piles, where concrete cannot be placed in the dry, place it in water using the tremie method in accordance with the appropriate piling specifications, using either self-compacting concrete or high workability concrete conforming to Annexure B80/G.

Do not place concrete in water having a temperature below 5°C.
**Figure B80.1 – Evaporation from Concrete Freshly Placed on Site**

The graph shows the effects of air temperature, relative humidity, concrete temperature and wind velocity together on the rate of evaporation of water from freshly placed and unprotected concrete.

Example – with:
- air temperature at 27°C;
- relative humidity at 40%;
- concrete temperature at 27°C; and
- a wind velocity of 26 km/hr;

the rate of evaporation would be 1.2 kg/m²/hr.

To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27°C), and move vertically to intersect the curve for relative humidity encountered - here 40%. From this point, move horizontally to the respective line for concrete temperature - here 27°C. Move vertically down to the respective wind velocity curve - in this case interpolating for 26 km/hr and then horizontally to the left to intersect the scale for the rate of evaporation.

* Source of figure: ACI Committee 305, 1999, “Hot weather concreting (ACI 305R-99)”, American Concrete Institute, Farmington Hills, Michigan, USA, p 5.
7.9 **PREPARATION OF SURFACE OF CONSTRUCTION JOINTS**

Deliberately roughen the surface of concrete at construction joints to a pronounced profile with a surface roughness not less than 3 mm. Remove loose aggregate particles and laitance. Prior to placing the adjoining concrete, clean the surface of the construction joint and the projecting reinforcement and saturate the concrete surface with water conforming to the requirements of AS 1379. Remove all excess water and loose material prior to placing the adjoining concrete.

In marine or aggressive environments, remove salt or other contamination from the joint surface and reinforcement by using water under high pressure. Provide temporary openings in formwork to allow contaminated water to be removed.

7.10 **ADDITIONAL REQUIREMENTS FOR VOIDED SLAB CONSTRUCTION**

Voided slab construction comprises a cast-in-place deck slab having multiple longitudinal voids.

Carry out the placing of concrete in voided slabs in at least three stages as follows:

(a) to the bottom one third of the voids;
(b) to the top of the voids; and
(c) to the finished level.

The percentage of the total area covered by any one stage must be such that no concrete has reached its initial set before the overlying concrete is placed.

7.11 **SCREEDING AND FINISHING OF UNFORMED SURFACES**

7.11.1 **Surfaces other than Deck and Approach Slabs**

Unformed surfaces must be compacted and tamped to bring a layer of fines to the surface. Screed the surface to the specified levels and finish with a wooden or “magnesium” float to an even uniform surface. Leave construction joints rough in accordance with Clause 7.9.

When cracks appear before or during finishing, rework the concrete, using vibrators as required, where initial set has not yet occurred and refinish the surface with a wooden or “magnesium” float.

Do not delay at any location the completion of the finishing operation and the commencement of curing at that location.

7.11.2 **Deck and Approach Slab Surfaces**

7.11.2.1 **Profile**

For all types of deck and approach slab surfaces, whether concrete, asphalt or bitumen-sealed, screed the decks using vibrating screeds set on screeding guide rails.

Alternatively, and only when required by the deck and barrier or kerb layout and when specified in Annexure B80/A5, deck slabs may be screeded by experienced operators using power vibrating screeds and height pins. Use the wet screeding technique provided the concrete strips between height pins that are used to guide the screed are placed and compacted at the same time as the concrete between strips.
Set screeding guide rails entirely above the concrete surface, unless they are removed on completion of screeding and before commencement of finishing. Make screeding guide rails sufficiently rigid to ensure that the correct finished deck surface levels shown on the Design Documentation drawings and concrete cover will be produced on completion of the superstructure.

Supports for screeding guide rails and height pins must conform to Clause 6.7.4.

Screeding guide rails or height pin markings must be at levels to allow for take-up of formwork, deflections on removal of formwork, construction of subsequent stages of superstructure, deflection of girders, prestressing of the superstructure and any other factors which may change the deck levels during the construction of the bridge.

Height pin spacings both longitudinally and laterally must be the length of the vibrating screed or three (3) metres, whichever is the lesser.

7.11.2.2 Technical Procedures

The Technical Procedures for finishing referred to in Annexure B80/D must include:
(a) evidence including survey results that the finishing method produces decks conforming to this Specification, and certification that non-conforming results have been included;
(b) type and rate of proposed evaporation retarders;
(c) details of proposed finishing aids;
(d) method of compaction of concrete adjacent to the guide rails;
(e) details including drawings of screeding guide rails or height pins and method of attachment to forms;
(f) method and timing of repairs at guide rail supports or height pins;
(g) timing for checking of profile using a straight edge; and
(h) type and size of allowances to be made for screeding guide rails or height pin marks for profile adjustments such as those mentioned in Clause 7.11.2.1.

7.11.2.3 Screeding

Place and compact the concrete in accordance with Clause 7.4. If a vibrating or power screed is used, bring the surface to the required level with a vibrating screed operating at a frequency of at least 100 Hz.

The final placement, redistribution and compaction of the top layer of deck concrete prior to or during screeding, must be such that the consolidation process is uniform throughout the deck area including areas adjacent to the screed rails or height pins. Keep sufficient surplus concrete in front of the screed to ensure full and uniform compaction to the deck surface.

Supplementary floating to bring fines to the surface is permissible.

Remove all parts of screeding guide rails or the top parts of height pins after final screeding and compact the disturbed areas to provide the concrete cover shown on the Design Documentation drawings, within the tolerances given in Clause 6.9.
7.11.2.4 Protection of Surfaces

After screeding, protect the surface so that only excess bleed water is removed and no drying out of the surface occurs at any location. Conform to Clause 7.6.

7.11.2.5 Finishing

Do not carry out finishing until after the concrete has become sufficiently hardened to support the finishing operation. Complete all repairs to the concrete at the screeding guide rails and supports or height pin locations prior to the commencement of finishing.

Continue to protect the surface from drying out in accordance with Clause 7.11.2.4 during finishing and texturing.

Do not pour water onto the surface during finishing, but apply water mist sprays or aliphatic alcohols to prevent the concrete from drying out.

Provided they are not deleterious to the concrete surface, approved proprietary finishing aids may be used in adverse conditions when the concrete sheen is about to disappear, in which case apply the finishing aid without working it into the surface to restore the sheen.

Finishing must consist of either:

(a) wood or “magnesium” floating the surface; or

(b) steel trowelling followed by sweeping the surface transversely with a stiff-bristled yard broom, or using a suitable mechanical grooving device, to produce a uniformly roughened surface texture.

When cracks appear before or during finishing, rework the concrete using vibrators as required where initial set has not yet occurred, and refinish the surface with a wooden float.

There must be no delay between the completion of the finishing operation at any location and the commencement of curing at that location.

The texture depth of the surface must not be less than 0.90 mm when measured in accordance with Test Method RMS T240.

7.12 CURING

7.12.1 General

Apply curing in accordance with the approved curing regime nominated in Item (d) of Clause 3.8.2.

For all types of curing regimes, protect the concrete surface from extreme heat or cold and maintain at a temperature not less than 5°C throughout the curing period.

Wet cure all cast-in-place bridge decks and approach slabs for a minimum of 72 hours after finishing operations are completed. Further curing conforming to Annexure B80/E or to the approved curing regime of Item (d) of Clause 3.8.2 may be by either wet or sealed curing methods.

7.12.2 Wet Curing

Concrete surfaces must be wetted and completely covered with canvas, hessian, geofabric with plastic sheeting, or other suitable materials and be kept continuously wet. When used for vertical surfaces,
keep these materials effectively wrapped and in place for the whole curing period. Water used for curing must conform to AS 1379 and be not more than 10°C cooler than the concrete surface.

Apply wet curing:
(a) to unformed surfaces immediately after the completion of all finishing operations;
(b) in such a manner that staining of the formed surfaces does not produce a nonconforming finish;
(c) to formed surfaces immediately after the removal of the forms.

### 7.12.3 Sealed Curing

#### 7.12.3.1 Retention of Formwork

Keep all parts of the formwork used under the sealed curing provision in place for the minimum periods nominated in Item (d) of Clause 3.8.2. Where it is proposed to strip part of or all the formwork before the required curing is completed, apply a curing compound or wet curing to the stripped members for the remainder of the curing period.

#### 7.12.3.2 Curing Compounds

Curing compounds must conform to AS 3799 for the Classes and Types specified in Table B80.18.

No evidence of the curing compound must remain on any concrete surface exposed to view within a period of six (6) months from the date of application of the compound.

<table>
<thead>
<tr>
<th>Description of curing compound</th>
<th>Class to AS 3799</th>
<th>Minimum non-volatile content to AS 1580 Method 301.1</th>
<th>Type to AS 3799</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wax-based (Wax emulsion)</td>
<td>A</td>
<td>30%</td>
<td>1-D</td>
</tr>
<tr>
<td>Resin-based (Hydrocarbon resin)</td>
<td>B</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Waterborne emulsions</td>
<td>Z</td>
<td>30%</td>
<td></td>
</tr>
</tbody>
</table>

The curing compound supplier must implement and maintain a quality management system conforming to AS/NZS ISO 9001 as a means of ensuring that the product conforms to this Specification.

For each curing compound proposed for use in the Contractor’s Work, obtain a Certificate of Conformity from the supplier, supported by test certificates from a laboratory with appropriate NATA registration, certifying that the curing compound conforms to this Specification.

This Certificate of Conformity must relate only to the formulation on which the tests were made and must be valid for not more than three years from the date of issue. The test certificates must report the non-volatile content, the efficiency index and the density and must provide a reference for the infrared spectrum as determined in accordance with Test Method T1005.

For each batch delivered, obtain a Certificate of Uniformity from the supplier, supported by uniformity testing on both non-volatile content and density in accordance with AS 3799.
Clause 3.2, and on viscosity in accordance with AS 3799 Clause 3.1.5. Additionally, provide an infrared spectrum which matches the reference infrared spectrum. The Certificate of Uniformity must state that the same formulation has been used for the batch as is represented by the Certificate of Conformity.

Sample and test at a rate of not less than one test per 3000 litres, or part thereof, supplied.

Do not use wax emulsion on deck surfaces.

Apply the curing compound by a pressurised sprayer to give a uniform cover. The sprayer must incorporate a device for continuous agitation and mixing of the compound in its container during spraying.

Apply the curing compound using a fine spray at the rate stated on the Certificate of Conformity, or at a rate of 0.2 litres/m² per coat, whichever is the greater. Check the application rate by calculating the amount of curing compound falling on felt mats, each approximately 0.25 m² in area, placed on the concrete surface.

Apply the curing compound in two coats at the full rate to form a continuous membrane over the whole concrete surface.

The time between the first and second coat must be in accordance with the manufacturer's recommendation, or on the basis of a trial application.

Apply the curing compound to unformed surfaces immediately after completion of all finishing operations, and to formed surfaces within half an hour of the removal of formwork from the section.

Maintain the curing membrane intact after its initial application, for the period nominated in Item (d) of Clause 3.8.2. Make good any damage to the curing membrane by respraying the affected areas.

7.12.3.3 Plastic Wrapping

As an alternative to curing compounds, carry out sealed curing using tight, fully sealed plastic wrapping to prevent moisture loss from the concrete surface. Make good any damage to the wrapping by repairing the affected areas.

7.12.4 Heat Accelerated Curing

7.12.4.1 General

Heat accelerated curing must conform to the following:

(a) At the end of the presetting period (i.e. the interval between placing the last concrete and commencement of heat application) the concrete maturity or time elapsed must be the greater of 50°C.hrs or two hours respectively, and time elapsed must not be longer than five hours, unless wet curing is applied in the interim period prior to its application;

(b) Keep unformed exposed concrete surfaces wet with a relative humidity exceeding 98% at all times after the presetting period and until the completion of the heat curing. Provide evidence of this to the Project Verifier;

(c) The rate at which the temperature of the concrete increases must not exceed 24°C per hour;
(d) The maximum temperature of the concrete during and after the application of heat must not exceed 70°C for all concrete exposure classifications;

(e) After completion of curing, allow the concrete to cool gradually and evenly. Do not expose the concrete to the surrounding environment or operate on it in any way until the temperature at the surface of the concrete has fallen to within 40°C of the ambient temperature;

(f) Record maximum and minimum temperatures and temperature variations with time using a suitable thermograph taking reading at intervals not exceeding 15 minutes; and

(g) For Durability Provision B only, keep the concrete at a temperature, T (°C) of not less than 50°C, for a period, P (hours), so that the result of the multiplication P times T is not less than 350°C.hours.

7.12.4.2 Steam Curing – Additional requirements

Use distribution pipes to assist in the uniform distribution of heat. Arrange the distribution pipes in such a manner and/or protect the concrete members in such a way that steam will not be blown directly against the concrete, or cause uneven heating of the members at any point.

Keep the enclosing arrangements sufficiently airtight during the whole period of steam curing to prevent the entry of cool air at any time.

Cure the associated concrete test cylinders by placing the cylinders within the enclosure in a position adjacent to the lower face of the structural units they represent. Locate the cylinders midway between steam entry points and at least half the width of the structural unit from these points. Do not place the cylinders on top of the structural units or on the steam jet lines or in line with any steam jets.

7.13 SLIPFORMED BARRIERS

Concrete barriers must not be slipformed.

7.14 CONCRETING OF DECK JOINT BLOCKOUTS

Where concreting of deck joint blockouts occurs after concreting of the bridge deck and the space between the blockout and the joint components is not sufficient to place and compact concrete, fill the blockouts using a flowable mortar with 28 day compressive strength not less than 60 MPa and shrinkage of not more than 500 microstrain at 3 weeks or 700 microstrain at 8 weeks. The mortar must contain aggregate conforming to Clauses 2.4.1 and 2.4.3.

Prepare the blockout for concreting strictly in conformity with Clause 7.9.

7.15 EARLY TRAFFICKING OF BRIDGE DECKS

Strictly control trafficking of bridge decks to prevent damage to new and curing concrete. Non-essential traffic must not access the deck until the specified 28 day compressive strength of the concrete is reached or the curing is completed, whichever occurs later.

Control access by essential traffic as follows:

(a) Equipment not exceeding 0.5 tonnes in weight may access the deck after 50% and before 75% of the specified 28 day compressive strength of the deck concrete is reached;
(b) Other equipment must not access the deck until 75% of the specified 28 day compressive strength of the deck concrete is reached, as follows:

(i) Maximum axle loads: 5.0 tonnes single, 8.0 tonnes tandem, 9.0 tonnes triaxle;

(ii) Tracked vehicles: maximum 15 tonnes/m² pressure over the track area, providing the concrete is protected from surface damage.

Carry out in-place strength assessment in accordance with Clause 8.2 at a frequency to suit your construction program. All concrete placed using the same concrete mix for which the strength versus age relationship has been determined may be assumed to have the same strength versus age relationship providing the placement and air temperatures are similar. Otherwise, adjust the strength for the actual temperatures at the site.

### HOLD POINT

<table>
<thead>
<tr>
<th>Process Held:</th>
<th>Early trafficking of concrete bridge deck.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission Details:</td>
<td>Strength versus age relationship of concrete and evidence of completion of curing, with supporting test results.</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
<td>The Nominated Authority will consider the submitted documents, prior to authorising the release of the Hold Point within 2 working days of receipt of the documents.</td>
</tr>
</tbody>
</table>

Make good any damage arising from early trafficking of the bridge deck.

### 8 PROPERTIES OF HARDENED CONCRETE

#### 8.1 GENERAL

The methods and frequencies of sampling and testing of concrete for compressive strength, compaction, cover and other properties during the progress of the work must be in accordance with Annexure B80/L.

Do not take cores in concrete bridge decks or other bridge members without the RMS Representative’s approval.

Use non-destructive tests to investigate concrete of observed or suspect quality, and take cores only to confirm findings of non-conforming concrete. Select coring locations to avoid reinforcement and wheel paths and where possible take cores in areas that will subsequently be covered with concrete.

Scabble and clean core holes and restore using a 10 mm maximum nominal aggregate size concrete mix of the same quality as the material from which the core was cut. Place, finish and cure the concrete in such a manner so as to produce no visible cracks.

The surface of the restored hole must be similar to the surrounding surface in texture and colour.

#### 8.2 COMpressive STRENGTH

Determine the compressive strength of the concrete in accordance with Annexure B80/L Clause L4.
For the purpose of this Clause, the Representative Concrete Strength (RCS) is defined as either the age adjusted strength of concrete cylinders or, when applicable, the age adjusted strength of cores cut from the Contractor’s Work, in accordance with Annexure B80/L Clauses L3 and L4.

Concrete must be considered nonconforming where the RCS is less than $f_{c,\text{min}}$ determined in accordance with Clause 3.5.

Any concrete with the RCS exceeding 100 MPa must be identified as nonconforming.

### 8.3 Compaction

The relative compaction, determined as the percentage ratio of the unit mass of the sample cores to the unit mass of the representative cylinders for the concrete area from which the cores are cut, must be at least 98%. Any concrete failing to meet this requirement must be identified as nonconforming.

### 8.4 Cover

When required by the RMS Representative or Project Verifier carry out a cover measurement survey of reinforced and precast concrete members in accordance with Clause L6 of Annexure B80/L.

Any concrete members failing to conform to Clause L6.2.3 of Annexure B80/L must be identified as nonconforming and marked and mapped to identify the nonconforming locations.

All individual cover survey results which indicate a cover less than 75% of the specified cover must be identified and reported together with the cover map and the proposed corrective action to rectify each nonconformity.
ANNEXURE B80/A – PROJECT SPECIFIC REQUIREMENTS

Refer to Clause 1.2.1.

A1 MEMBERS IN EXPOSURE CLASSIFICATION U

A1.1 General

Concrete members in exposure classification U must conform to Specification RMS D&C B80 for the “Base Exposure Classification” and the additional requirements contained in this Annexure.

A1.2 Base Exposure Classification

The Base Exposure Classification, nature of exposure and concrete isolation requirements are contained in Table B80/A.1 or as specified in the Design Documentation.

Concrete quality, cover and other durability requirements for the Base Exposure Classification must conform to those specified for the corresponding exposure classification of AS 5100.5.

Where full isolation of concrete surface from the aggressive environment is mandatory, include details of the proposed isolation method with the concrete mix design submission.

<table>
<thead>
<tr>
<th>Table B80/A.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameters</strong></td>
</tr>
<tr>
<td><strong>Base Exposure Classification:</strong></td>
</tr>
<tr>
<td>1 B1</td>
</tr>
<tr>
<td><strong>Nature of Exposure:</strong></td>
</tr>
<tr>
<td>1 Acid sulfate soil</td>
</tr>
<tr>
<td><strong>Full isolation of concrete surface from the aggressive environment:</strong></td>
</tr>
<tr>
<td>1 Not required</td>
</tr>
</tbody>
</table>

A1.3 Additional Requirements

Cement: ..................................................................................................................................

Aggregate: ..................................................................................................................................

Admixtures: ..................................................................................................................................

Mandatory Durability Provision (A, B, either): ..........................................................................

Others: ..................................................................................................................................

Note: For concretes requiring durability suitable for exposure classification C, e.g. for acid sulfate soils, but which are not in a chloride aggressive environment, the corrosion inhibitor is not required.
A2  BRIDGE MEMBERS FOR WHICH SELF-COMPACTING CONCRETE OR HIGH WORKABILITY CONCRETE IS PERMITTED (JOB SPECIFIC)

Piling, precast concrete members manufactured under controlled conditions in off-site precasting yards and, when permitted by the RMS Representative, cast-in-place concrete members with an intricate shape and/or heavily congested reinforcement or other specific applications warranting a high degree of workability.

A2.1  Self-Compacting Concrete

Refer to Clauses 3.6 and 7.8 and Annexure B80/G1.

A2.2  High Workability Concrete

Refer to Clauses 3.6 and 7.8, and Annexure B80/G2.

A3  FORMWORK CATEGORY C (JOB SPECIFIC)

Refer to Clause 5.2.4.

A4  SURFACE FINISH REQUIREMENTS (JOB SPECIFIC)

Refer to Clause 5.3.

A5  BRIDGE DECKS FOR WHICH SCREEDING USING VIBRATING POWER SCREEDS AND HEIGHT PINS IS PERMITTED (JOB SPECIFIC)

Refer to Clause 7.11.2.1.
ANNEXURE B80/B – (NOT USED)

ANNEXURE B80/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>Hold</td>
<td>Nomination of concrete mix, including submission of all details for new concrete mixes.</td>
</tr>
<tr>
<td>5.2.4</td>
<td>Hold</td>
<td>Submission of formwork documentation and design certification.</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Hold</td>
<td>Construction of test members.</td>
</tr>
<tr>
<td>6.7.3</td>
<td>Witness</td>
<td>Assembly, lifting and transport of prefabricated reinforcement cages.</td>
</tr>
<tr>
<td>7.1</td>
<td>Hold</td>
<td>Submission of names of personnel involved in concreting operations and evidence that at least half of them hold a RMS Bridgeworks Concreting Grey Card.</td>
</tr>
<tr>
<td>7.3</td>
<td>Hold</td>
<td>Submission of checklists for verifying conformity of the nominated concrete mix, formwork, reinforcement and embedments for precast concrete members cast off the site.</td>
</tr>
<tr>
<td>7.3</td>
<td>Hold</td>
<td>Submission of Certificate of Conformity of formwork, reinforcement and embedments for concrete other than precast concrete members cast off the site.</td>
</tr>
<tr>
<td>7.15</td>
<td>Hold</td>
<td>Early trafficking of concrete bridge deck.</td>
</tr>
</tbody>
</table>

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of Specification RMS D&C Q6 Annexure Q/E.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Identified Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>Submission of nominated mixes</td>
</tr>
<tr>
<td>3.9</td>
<td>Variations from nominated mixes</td>
</tr>
<tr>
<td>7.3</td>
<td>Certificate of Conformity in respect of formwork, reinforcement, embedments and other relevant details or precast concrete members cast off the site</td>
</tr>
<tr>
<td>7.12.3.2</td>
<td>Certificate of Conformity of Curing Compound</td>
</tr>
</tbody>
</table>
ANNEXURE B80/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. Review the requirements of this Specification and other contract documents to determine any additional documentation requirements.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.2</td>
<td>Procedures for addition of corrosion inhibitors</td>
</tr>
<tr>
<td>3.8</td>
<td>All concrete mix designs and trial mix reports</td>
</tr>
<tr>
<td>4.3.5</td>
<td>Procedures for trialling and details of set retarding admixture to delay hydration</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Details of the design and construction of test members</td>
</tr>
<tr>
<td>5.9.2</td>
<td>Details of the methods to be used in determining the stripping time of formwork other than by direct testing of representative cylinders</td>
</tr>
<tr>
<td>5.10</td>
<td>Approved procedure for repair to minor surface imperfections</td>
</tr>
<tr>
<td>6.3.3</td>
<td>Welding procedures and design of load bearing welds in reinforcement cages</td>
</tr>
<tr>
<td>6.7.5</td>
<td>Details of the method of placing embedments</td>
</tr>
<tr>
<td>7</td>
<td>Technical Procedures in accordance with Specification RMS D&amp;C Q6 for the placing, compacting, screeding, finishing and curing operations. The personnel required to carry out the operations together with proof of any relevant training and experience must be included; As well as the methods for placing, the procedures must include the delivery method and placing rates for varying pour sizes; The compaction procedures must include detailed plans for the use of vibrators in the concrete and the method for ensuring full compaction of the whole of the concrete member</td>
</tr>
<tr>
<td>7.1</td>
<td>Details of the methods to be used to prevent thermal cracking</td>
</tr>
<tr>
<td>7.3</td>
<td>Name, qualifications and experience of the Concrete Supervisor for concrete pours other than precast members cast off the site</td>
</tr>
<tr>
<td>7.6</td>
<td>Technical Procedures for the restriction of the evaporation rates</td>
</tr>
<tr>
<td>7.11.2</td>
<td>Details of the method of fixing and removing screed guide rails or height pins</td>
</tr>
<tr>
<td>7.12.4</td>
<td>Verification of the conformity of a proposed heat accelerated curing method with the Specification requirements</td>
</tr>
<tr>
<td>Annex B80/G6.1</td>
<td>Procedures for supply and placement of self-compacting concrete</td>
</tr>
<tr>
<td>Annex B80/G6.1</td>
<td>Procedures for supply and placement of high workability concrete</td>
</tr>
<tr>
<td>Annex B80/L6</td>
<td>Identification of work Lots and name, qualifications and experience of technicians for cover surveys</td>
</tr>
</tbody>
</table>
**ANNEXURE B80/E – CURING PROVISION B**

Refer to Clause 3.4.2.

For the exposure classifications specified on the Design Documentation drawings, the curing applied must be in accordance with Tables B80/E.1 (wet), B80/E.2 (sealed) and B80/E.3 (heat accelerated).

For formed surfaces, the wet curing provision is applicable only when the formwork is removed within 48 hours of completion of concrete placement, and the surface immediately wet cured.

Concrete made with blended cement containing amorphous silica must be wet cured only.

**Notes for Tables B80/E.1, B80/E.2 and B80/E.3:**

For the definition of cement, refer to Clause 1.3 “Definitions”

- **SL** denotes Shrinkage Limited cement
- **BFS** denotes ground granulated iron blast furnace slag blended cement
- **FA** denotes fly ash blended cement
- **AS** denotes amorphous silica blended cement
- **N/A** Not applicable. Durability Provision B does not apply for this case
- ✔ Applicable. Durability Provision B may apply for this case

**Table B80/E.1 - Wet Curing**

<table>
<thead>
<tr>
<th>Exposure classification</th>
<th>SL cement</th>
<th>Blended cement containing BFS and/or FA</th>
<th>Blended cement containing AS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>7</td>
<td>N/A</td>
</tr>
<tr>
<td>B1</td>
<td>7</td>
<td>7</td>
<td>N/A</td>
</tr>
<tr>
<td>B2</td>
<td>N/A</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>N/A</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td></td>
<td>In accordance with Annexure B80/A1</td>
</tr>
</tbody>
</table>

**Table B80/E.2 - Sealed Curing**

<table>
<thead>
<tr>
<th>Exposure classification</th>
<th>SL cement</th>
<th>Blended cement containing BFS and/or FA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>B1</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>B2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B80/E.3 - Heat Accelerated Curing

<table>
<thead>
<tr>
<th>Exposure classification</th>
<th>Permissibility of curing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SL cement</td>
<td>Blended cement containing BFS and/or FA and/or AS</td>
</tr>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B2</td>
<td>N/A</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>N/A</td>
<td>✓</td>
</tr>
<tr>
<td>U</td>
<td>In accordance with Annexure B80/A1</td>
<td></td>
</tr>
</tbody>
</table>
ANNEXURE B80/F – STAINLESS STEEL REINFORCEMENT

Refer to Clause 6.

F1 GENERAL

All the requirements of this Specification apply to the supply, fabrication, transport, storage, assembly and fixing of stainless steel reinforcement, except where modified by this Annexure.

F2 DURABILITY

Where stainless steel reinforcement is used in members in exposure classification C, a corrosion inhibitor is not required.

F3 SUPPLY

F3.1 Quality Management System Requirements

The reinforcement material supplier must be certified by the UK Certification Authority for Reinforcing Steels for the production of stainless steel reinforcement materials.

F3.2 Materials

Stainless steel reinforcement must be deformed bars, deformed wire or welded wire fabric.

Stainless steel reinforcement must be strength grade 500 in accordance with Table 7, BS 6744:2001 and conform to designation 1.4362, 1.4429, 1.4436 or 1.4462 to BS 10088 (as identified by Table 5, BS 6744:2001). Uniform elongation must conform to AS/NZS 4671 for Grade 500N.

F4 FABRICATION AND ASSEMBLY

F4.1 Fabrication

The reinforcement fabricator must implement and maintain a quality management system in accordance with AS/NZS ISO 9001.

Tools for fabricating stainless steel reinforcement must not have been used and must not be used for other materials. Tools and processes for cutting stainless steel must not reduce the strength of the stainless steel reinforcement or cause contamination with grease, oil, iron or other steels.

F4.2 Bending

Tools for bending stainless steel reinforcement must not have been used and must not be used for other materials. Pins used for bending stainless steel must be made from stainless steel.

Do not heat stainless steel reinforcement for bending.

Do not field bend bars with diameters greater than 20 mm.
Concrete Work for Bridges D&C B80

F4.3 Welding

Carry out welding only when permitted by the RMS Representative in writing.

All welding for stainless steel reinforcement must comply with Specification RMS D&C B203 and the following:

(a) Weld stainless steel reinforcement only in a welding shop set up for the purpose. Any such facility must maintain conditions that prevent any contamination of the stainless steel and any consumables and allows proper welding;

(b) Store, condition and handle all consumables in accordance with the bar manufacturer’s recommendations;

(c) Welding procedures and consumables must comply with the bar manufacturer's recommendations. Welds must conform to Category 1B to AS 1554:6 Table 6.1.1. Assess defects in accordance with AS 1554:3 Sections 9 and 10. Examine welds using dye penetrant or magnetic particle examination methods. Treat any arc strikes as welds;

(d) Demonstrate that the weld does not result in the loss of ductility and corrosion resistance. Test welds in accordance with AS 1554:3 Clause 7.1 and Table 7.2;

(e) Keep the weld area clean and free of any contamination;

(f) Clean and passivate completed welds by stainless steel wire brushing and pickling to finish Category II to AS 1554:6 Table 6.2.1. Pickling compounds must be chloride free;

(g) Test welds and the welded bars in the vicinity of the welds for corrosion resistance against pitting and intergranular corrosion in accordance with AS 1554:6 Appendix E using a laboratory with appropriate NATA registration. Corrosion resistance testing must include qualification tests and be carried out on not less than 10% of all welds performed in the Contractor’s Work;

(h) Where any of the tested bars fails the corrosion resistance test, test all welds and bars in the vicinity of the welds for corrosion resistance.

F4.4 Splicing

Manufacture mechanical splices for stainless steel reinforcement from stainless steel conforming to designation 1.4362, 1.4429, 1.4436 or 1.4462 to BS 10088 (as identified by Table 5, BS 6744:2001).

F5 Assembly

Secure reinforcement in place by tying or tack welding.

Tie wire with stainless steel wire having a diameter of not less than 1.2 mm. Wire used to tie stainless steel must conform to designation 1.4362, 1.4429, 1.4436 or 1.4462 to BS 10088 (as identified by BS 6744:2001).

Perform tack welding in accordance with Clause F4.3.
ANNEXURE B80/G – SELF-COMPACTING CONCRETE AND HIGH WORKABILITY CONCRETE

G1 GENERAL

G1.1 Applicability

The relevant requirements of this Specification apply to the design, supply, delivery, placement and curing of self-compacting concrete or high workability concrete, except where modified by the requirements under this Annexure.

Use self-compacting concrete or high workability concrete only for the specific bridge members listed in Annexures B80/A2.1 and A2.2 respectively.

G1.2 Mix Requirements

Where self-compacting concrete or high workability concrete is proposed, choose the mix composition and proportions carefully to satisfy project specific performance requirements, taking into account the placement method, and the worst possible case arising from the variability in the batching of the mix constituents.

Self-compacting concrete and high workability concrete used for placing concrete in water must be adequately stable and cohesive to avoid wash-out.

G1.3 Slump Flow Spread

For self-compacting concrete or high workability concrete, where “slump” is specified in other than Annexure B80/G of this Specification, use “slump flow spread” instead.

G2 PERFORMANCE REQUIREMENTS

The fresh properties of self-compacting concrete and high workability concrete must conform to Tables B80/G.1 and B80/G.2.
### Table B80/G.1 Fresh Properties of Self-compacting Concrete

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filling ability</td>
<td>ASTM C1611</td>
<td>Spread: 550 – 800 mm</td>
<td>Nominated spread must be a value between 600 mm and 750 mm with a maximum tolerance of ± 50mm</td>
</tr>
<tr>
<td>Stability</td>
<td>ASTM C1611</td>
<td>VSI rating: &lt; 2</td>
<td>VSI rating of 2 may be acceptable depending on the type of concrete pour</td>
</tr>
<tr>
<td></td>
<td>EN 12350-11</td>
<td>Sieved portion: ≤ 15%</td>
<td>Required during trial mixing</td>
</tr>
<tr>
<td></td>
<td>ASTM C1712</td>
<td>Penetration: ≤ 10mm</td>
<td>Penetration depth ≤ 15mm may be acceptable depending on the type of concrete pour</td>
</tr>
<tr>
<td>Passing ability</td>
<td>ASTM C1621</td>
<td>Δ Spread: 25 – 50 mm</td>
<td>Complete test within 6 minutes of ASTM C1611 to harmonise results</td>
</tr>
<tr>
<td></td>
<td>EN 12350-12</td>
<td>Δ Height: ≤ 15 mm</td>
<td>Difference between height at centre and mean height just outside J-ring. Required during trial mixing.</td>
</tr>
<tr>
<td>Viscosity</td>
<td>ASTM C1611</td>
<td>$T_{500}$: 2 – 5 seconds</td>
<td>Gives indication on consistency between batches</td>
</tr>
</tbody>
</table>
### Table B80/G.2 – Fresh Properties of High Workability Concrete

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filling ability</td>
<td></td>
<td>Spread: 350 – 550 mm</td>
<td>All mixes. Nominated spread must be a value between 425 mm and 475 mm with a maximum tolerance of ± 75 mm.</td>
</tr>
<tr>
<td>Stability</td>
<td>ASTM C1611, as modified by Clause G3.2.</td>
<td>VSI rating: 0</td>
<td>All mixes. There must be no evidence of segregation or bleeding. Reflective shine caused by high range water reducing agents, particularly during cold weather, is not to be interpreted as water sheen on the concrete mass. The photographs shown in Figure B80/G2.1 below are examples of VSI rating of “0”.</td>
</tr>
<tr>
<td>Viscosity</td>
<td></td>
<td>$T_{350}$: 1 – 5 seconds</td>
<td>Use a stop watch during trial mixing. Estimate seconds during production by calibrated counting, e.g. 1001, 1002, 1003.</td>
</tr>
<tr>
<td>Slump</td>
<td>AS1012.3.1</td>
<td>$\geq$ 200 mm</td>
<td>Required during trial mixing only.</td>
</tr>
</tbody>
</table>

![Figure B80/G2.1 – Examples of VSI Rating of “0”](image_url)

### G3 TRIAL MIXES

#### G3.1 Self-compacting Concrete

Where self-compacting concrete is trialled, submit:

(a) Spread and corresponding nominated slump flow spread instead of slump;
(b) Time to 500 mm slump flow spread, $T_{500}$, and corresponding nominated $T_{500}$ range;
(c) Visual stability index (VSI) rating and nominated VSI requirement;
(d) Passing ability values and corresponding nominated passing ability values;
(e) Static segregation percentage and corresponding nominated static segregation percentage;
(f) Penetration depth and corresponding nominated degree of static segregation resistance.
G3.2 High Workability Concrete

Where high workability concrete is trialled, submit:

(a) Spread and corresponding nominated slump flow spread, using a slump cone in the inverted position;

(b) Time to 350 mm slump flow spread, $T_{350}$, and corresponding nominated $T_{350}$ range using a slump cone in the inverted position;

(c) Visual stability index (VSI) rating;

(d) Slump, using a slump cone in the upright position.

When moulding test specimens or filling the slump cone for testing relevant concrete fresh properties, entirely fill the mould or the slump cone and compact the concrete using five consolidation strokes with a standard tamping rod.

G4 Test Members

Where a test member is required under Clause 5.3.2, conform to the following:

(a) For columns, the test member must consist of a column not less than the height of the column in question or 6 m, whichever is less, with similar corner detailing and steel reinforcement layout;

(b) For other members, replicate the most complex part of the member;

Cut the concreted test member to demonstrate that segregation has not occurred.

G5 Formwork Design

Where placement time is less than 1.5 hours, design the formwork, including support and fixing systems, for full hydrostatic concrete pressure.

Where greater times for placement are proposed, determine the rate of stiffening of the concrete under the conditions for placement by experiment and design the formwork accordingly.

G6 Supply, Delivery, Placement and Curing

G6.1 General

Implement rigorous production control for all operations, especially of adding water and admixtures during concrete batching and delivery.

High-range water reducers may be added to adjust deformability or flowability at the site at a dosage determined and agreed prior to full production.

Do not add water to the mixed batch while in transit. The Project Verifier may permit the addition of water at site if an approved procedure of stringent control and recording of the total amount of water is in place, the amount of water added does not exceed the limits specified in Clause 4.5 and conformity with the criteria in Tables B80/G.1 and B80/G.2 is verified by re-testing after the addition of water.

Include the following additional details on the concrete batch delivery docket:

(a) nominated spread and accepted range for slump flow spread, instead of nominated slump;
(b) instructions for adding admixtures at the site to adjust workability.
(c) slump reversion time where the concrete is used for piling;

Include in the PROJECT QUALITY PLAN the procedures for achieving the required level of control for supply, delivery, placement, supplementary compaction and curing of self-compacting or high workability concrete, including the action required when a delivered batch of concrete does not have the required rheological properties.

For columns and shafts, to prevent segregation, keep the point of discharge initially as close as possible to the bottom of the pour to limit the free fall height, and keep the point of discharge submerged within the concrete to a depth of at least 300 mm as the pour progresses upwards.

Where compaction is required for complex forms or thin members with congested reinforcement, commence placement from the lowest point of the formwork and progress to the highest point, and apply compaction only as required to achieve the specified concrete finish and properties.

Commence curing as soon as practicable and keep exposed surfaces moist to minimise the risk of surface crusting and shrinkage cracking.

**G6.2 Self-Compacting Concrete**

Keep the distance of horizontal flow less than 10 m. Do not exceed the rate of placement specified in the formwork design for the placement conditions.

Although compaction is not normally required for self-compacting concrete, apply supplementary compaction as required to ensure full compaction of the member.

**G6.3 High Workability Concrete**

For horizontal members, keep the point of discharge just above the surface of the discharged concrete and keep the extent of horizontal flow less than 5 metres or within the limitations demonstrated by the test member. Do not exceed the rate of placement specified in the formwork design.

Apply adequate compaction as required to ensure all spaces in the formwork are filled but without segregation.

**G7 Minimum Frequency of Testing**

**G7.1 Self-compacting Concrete**

Prepare concrete test samples without mechanical or manual compaction.

The minimum frequency of testing during supply and delivery of self-compacting concrete must conform to Table B80/G.3.
Table B80/G.3 - Minimum Frequency of Testing for Self-compacting Concrete

<table>
<thead>
<tr>
<th>Characteristic Analysed</th>
<th>ASTM Test Method</th>
<th>Minimum Frequency of Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply and delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing ability, J-ring slump flow differential</td>
<td>C1621</td>
<td>Initial batch</td>
</tr>
<tr>
<td>Stability, penetration depth</td>
<td>C1712</td>
<td>Initial batch and every fourth batch thereafter</td>
</tr>
<tr>
<td>Filling ability, slump flow spread</td>
<td>C1611</td>
<td>One per batch of concrete</td>
</tr>
<tr>
<td>Viscosity, $T_{500}$</td>
<td>C1611</td>
<td>One per batch of concrete</td>
</tr>
<tr>
<td>Stability, VSI rating</td>
<td>C1611</td>
<td>One per batch of concrete</td>
</tr>
</tbody>
</table>

G7.2 High Workability Concrete

Prepare and compact the concrete test samples and the slump cone, and measure the slump flow spread and the time of flow to 350 mm as specified in Clause G3.2.

The minimum frequency of testing during supply and delivery of high workability concrete must conform to Table B80/G.4.

Table B80/G.4 – Minimum Frequency of Testing for High Workability Concrete

<table>
<thead>
<tr>
<th>Characteristic Analysed</th>
<th>ASTM Test Method</th>
<th>Minimum Frequency of Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply and delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filling ability, slump flow spread</td>
<td>ASTM C1611, as modified by Clause G3.2</td>
<td>One per batch of concrete</td>
</tr>
<tr>
<td>Viscosity, $T_{350}$</td>
<td></td>
<td>One per batch of concrete</td>
</tr>
<tr>
<td>Stability, VSI rating</td>
<td></td>
<td>One per batch of concrete</td>
</tr>
</tbody>
</table>

ANNEXURES B80/H TO B80/K – (NOT USED)
# ANNEXURE B80/L – TESTING PROCEDURES

Refer to Clause 1.2.5.

## L1 MINIMUM FREQUENCY OF TESTING

<table>
<thead>
<tr>
<th>Clause</th>
<th>Characteristic Analysed</th>
<th>Test Method</th>
<th>Minimum Frequency of Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply and Delivery of Concrete</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>All test reports specified in Clause 2</td>
<td>As specified in Clause 2</td>
<td>At start of project and yearly thereafter</td>
</tr>
<tr>
<td>2.3</td>
<td>Each chemical admixture - sample and store for 6 months at batch plant</td>
<td>AS 1478 – Appendix A</td>
<td>At start and every two months during production</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Quantity of calcium nitrite in fresh concrete only where corrosion inhibitor is specified</td>
<td>RMS T371</td>
<td>One pair per 25 m³ or part thereof</td>
</tr>
<tr>
<td>2.4.2 (c)</td>
<td>Particle size distribution of coarse aggregate - deviation from nominated particle size distribution</td>
<td>AS 1141.11</td>
<td>One per week or one per 400 tonnes</td>
</tr>
<tr>
<td>2.4.3 (a)</td>
<td>Particle size distribution of fine aggregate - deviation from nominated particle size distribution</td>
<td>AS 1141.11</td>
<td>One per week or one per 400 tonnes</td>
</tr>
<tr>
<td>2.4.3 (c)</td>
<td>Fine aggregate:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Material &lt; 75 micrometre</td>
<td>AS 1141.12</td>
<td>One per 1000 tonnes</td>
</tr>
<tr>
<td></td>
<td>- Manufactured and unwashed natural sand</td>
<td></td>
<td>One per 5000 tonnes</td>
</tr>
<tr>
<td></td>
<td>- Washed natural sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Soundness</td>
<td>AS 1141.24</td>
<td>One per 4000 tonnes</td>
</tr>
<tr>
<td></td>
<td>- Methylene Blue Value</td>
<td>ISSA 145</td>
<td>One per 10000 tonnes</td>
</tr>
<tr>
<td>4.4</td>
<td>Slump *</td>
<td>AS 1012.3.1</td>
<td>One per batch of concrete</td>
</tr>
<tr>
<td><strong>Hardened Concrete</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.2</td>
<td>Compressive strength 28 days</td>
<td>AS 1012.8 AS 1012.9</td>
<td>One pair per 50 m³ or part thereof</td>
</tr>
<tr>
<td></td>
<td>- Mass concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Reinforced concrete</td>
<td></td>
<td>One pair per 25 m³ or part thereof</td>
</tr>
<tr>
<td></td>
<td>- Prestressed concrete</td>
<td></td>
<td>One pair per 15 m³ or part thereof</td>
</tr>
<tr>
<td>8.2</td>
<td>Compressive strength for other purposes</td>
<td>AS 1012.8 AS 1012.9</td>
<td>One pair per pour or more as required by the Contractor</td>
</tr>
<tr>
<td>8.3</td>
<td>Relative compaction of concrete</td>
<td>AS 1012.12.2 Annexure B80/L5</td>
<td>As required by the RMS Representative or Project Verifier</td>
</tr>
<tr>
<td>8.4</td>
<td>Concrete cover to reinforcement</td>
<td>Annexure B80/L6</td>
<td>If required by the RMS Representative or Project Verifier, as per Table B80/L6.1</td>
</tr>
</tbody>
</table>
For concrete containing a high range water reducer, requirements for test method and minimum frequency of testing must be applied to both initial and final slump.

L2 MOULDING OF SAMPLES

Moulded concrete specimens must be standard cylinders moulded in accordance with the requirements and procedure of AS 1012.8.1 using rodding only.

L3 SPECIMENS CUT FROM THE CONTRACTOR’S WORK (CORES)

When required by the RMS Representative or Project Verifier, core specimens must be cut by means of a core drill, wet pre-treated and tested in accordance with AS 1012.14. The corrected (for length to diameter ratio) strength so determined must be adjusted for age by dividing the result by the factors shown in Table B80/L.1.

Do not cut reinforcement during extracting core specimens. Prior to coring, do cover meter survey at representative locations to identify the rebar positions. Do not test cores containing reinforcement and replacement cores must be cut at new locations.

L4 COMPRESSIVE STRENGTH

L4.1 Testing

The compressive strength of the concrete represented by a pair of specimens moulded from one sample, cured and tested in accordance with AS 1012, is the average strength of the two specimens unless the two results differ by more than 10% of their average, in which case the higher result must be taken as the strength of the concrete.

L4.2 Adjustment for Age of Specimen

Should any specimen be tested more than 28 days after moulding, the equivalent 28 day strength is the test strength divided by the age factor given in Table B80/L.1. Age adjustment factors are given for concrete made with General Purpose and Blended cement. For intermediate ages, the factor must be determined on a pro-rata basis.

<table>
<thead>
<tr>
<th>Age of specimen at time of test (days)</th>
<th>Age factor</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Purpose cement</td>
<td>Blended cement</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>1.08</td>
<td>1.19</td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>1.14</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>224</td>
<td>1.22</td>
<td>1.42</td>
<td></td>
</tr>
<tr>
<td>365 or greater</td>
<td>1.25</td>
<td>1.45</td>
<td></td>
</tr>
</tbody>
</table>
L5 \hspace{1em} \textbf{COMPACTION}

L5.1 \hspace{1em} \textbf{Cores}

Take cores in the deck and elsewhere only where shown on the Design Documentation drawings and when required by the RMS Representative or Project Verifier. The locations of the cores must be selected to clear any reinforcement or other embedments.

Test specimens for determining the relative compaction of concrete must be cores of nominal diameter 75 mm, cut in accordance with the requirements of Clause L3 except that the minimum concrete age for coring must be:

(a) four (4) days from May to December inclusive; or
(b) two (2) days from December to April inclusive.

Within two (2) hours of coring, the cores must be placed in either a tank of lime saturated water or individual plastic bags, sealed to prevent water loss and stored in the shade.

Cores must not be subjected to temperatures:

(i) in excess of the ambient temperature or 28°C, whichever is higher; or
(ii) less than 10°C.

L5.2 \hspace{1em} \textbf{Testing}

Determine the unit mass of representative cylinders for concrete compaction at an age of between four (4) and seven (7) days in accordance with AS 1012.12.2 and the following conditions:

(i) Testing of the representative cylinders must be in the saturated surface-dry condition without dressing of voids, in accordance with Test Method RMS T368; and

(ii) The unit mass for a pair of representative cylinders must be the average of the two results unless they differ by more than 20 kg/m³, in which case the higher result must represent the unit mass of the pair.

Determine the unit mass of the cores and report all results in accordance with AS 1012.12.2 and the following:

(a) assess cores in accordance with Test Method RMS T368 for excessive voids and, if warranted, dress voids prior to testing;
(b) wet conditioning in AS 1012.12.2 Clause 6(c) may be extended from 24 hours to 3 days;
(c) the concrete age at testing must be between three (3) and seven (7) days;
(d) the full depth of the core must be tested except that:
   (i) non-concrete materials such as bitumen must be removed, and
   (ii) up to 20 mm of concrete may be removed from each end of the core;
(e) report the height and diameter of the core, as tested; and
(f) round individual results for unit mass to the nearest 10 kg/m³ in accordance with AS 1012.12.2.

The unit mass of the cores is the average of the test results (rounded to the nearest 10 kg/m³) unless they differ by more than 20 kg/m³, in which case the lower result applies.
L6  COVER

L6.1  Testing

When required by the RMS Representative or Project Verifier, test concrete cover in discrete Lots at the minimum frequency specified in Table B80/L6.1 or as required by the RMS Representative or Project Verifier.

L6.1.1 Identification of Work Lots

A Lot must be representative of concrete bridge members or products produced under essentially constant conditions. Discrete portions of a Lot that are visually non-homogeneous and/or non-representative must be excluded and either treated as separate Lots or repaired/replaced to achieve conformity of this Specification.

The size of a Lot must not exceed the extent of the day’s concrete pour.

Describe in the PROJECT QUALITY PLAN how the Lot is to be identified in the field or the pre-casting yard.

Determine the bounds of each Lot before testing. Set the bounds of each Lot and use statistical methods to determine test locations and compliance. Demonstrate the relationship of the boundaries of all adjacent/following Lots to confirm that the Lots will represent the bridge members or products being examined.

Give each Lot a unique Lot number. Use this Lot number as an identifier on all quality records. The Lot numbering system must be compatible with any activity numbering system used for the bridge construction operations. Record the Lot number on a register that indicates the three-dimensional location of the Lot. Include in the PROJECT QUALITY PLAN details of the Lot numbering system and the place where the Lot register is kept. Record the start, finish, lateral and height locations.

L6.1.2 Exclusion from Work Lots

Portions of a concrete bridge member or product that will be covered by subsequent concreting operations may be excluded from the Lot.

L6.1.3 Technicians

Include in the PROJECT QUALITY PLAN the name(s) of the technician(s) with details of qualifications and experience in concrete cover surveys. The technician(s) must have a proven record in the use of cover meters and must conduct all stages of the survey.

L6.1.4 Reports

Concrete cover survey reports must be provided to the RMS Representative or Project Verifier within 5 working days of the request. Reports must be prepared in a format acceptable to the RMS Representative and must contain Lot numbers, test locations, measurement results, standard deviations on progressive accumulated results, progressive maximum and minimum value of attribute (Q) and comments on compliance with this Specification and the technician’s name and signature.

The report must also list all individual cover survey result which indicates a cover less than 75% of the specified cover, a map of the nonconforming areas and the proposed corrective action to rectify each deficiency.
L6.1.5 Cover Meters

Checks must be made to confirm that cover meters are properly calibrated before and during use to give average site accuracy readings on single bars within ±15% and a maximum error of ±5 mm.

L6.1.6 Resolution Limits

Since bar spacing, \( s \) mm, and cover depth, \( \delta \) mm, influence cover meter resolution, limit readings to:

\[
\delta \text{ cover, where } (s - 20) \geq \delta; \text{ and }
\]

\[
\delta \leq 90
\]

L6.2 Statistical Techniques

Use statistical techniques in accordance with the following subclauses.

L6.2.1 Number and Location of Tests

The number of cover meter tests (n) per Lot must be not less than shown in Table B80/6.1.

<table>
<thead>
<tr>
<th>Concrete Member</th>
<th>Minimum Testing Frequency for Lot Area of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 50 m²</td>
</tr>
<tr>
<td>First member *</td>
<td>1 per 3 m²</td>
</tr>
<tr>
<td>Subsequent similar members #</td>
<td>1 per 7 m²</td>
</tr>
<tr>
<td>First precast member #</td>
<td>1 per 5 m²</td>
</tr>
<tr>
<td>Subsequent similar precast members Α</td>
<td>1 per 10 m²</td>
</tr>
</tbody>
</table>

* Where standard formwork and compaction are used.

# Where rigid formwork and intense compaction are used.

Α Concrete bridge members may be considered similar if produced on a regular time cycle and proportions and concrete volumes and surface areas do not vary by more than 5%.

Testing locations must be determined by the testing personnel in a random or unbiased manner (refer RMS D&C Q6 Clause 8.2.4.1) as follows:

(a) Representing the Lot as a developed rectangle, subdivide the Lot lengthwise into equal-area sub-Lots in accordance with the number of tests selected (n);

(b) Establish six equally spaced grid lines within the Lot, as illustrated in Figure B80/L6.1;

(c) Where the width of Lot is between 0.5 m and 1.7 m, the number of grid lines may be reduced such that the distance between adjacent grid lines (equally spaced) does not exceed 300 mm;

(d) Where the Lot is less than 500 mm wide, the offset locations must be randomly selected;

(e) Determine the order of testing of the six lines by selecting a six digit number from Table B80/L6.2. A starting point on the table (e.g. 1st number, block 6D (= 415236)) will be advised by the RMS Representative prior to the commencement of testing. The numbers are to be used...
sequentially down the Table until further notice from the RMS Representative, starting at the point advised by the RMS Representative, and selecting a new number for each Lot tested;

(f) Where there are less than 6 grid lines in the Lot, delete from the random number selected from Table B80/L6.2, the numerals that exceed the number of gridlines in the Lot (e.g. in the above example, where there are only 4 grid lines, the sequence is 4123);

(g) If for any reason the starting point has not been advised then it must be the first number in the block determined, by the following method, from the date on which testing is first undertaken:

<table>
<thead>
<tr>
<th>Select column:</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>For:</td>
<td>January</td>
<td>February</td>
<td>March</td>
<td>April</td>
</tr>
<tr>
<td>For:</td>
<td>May</td>
<td>June</td>
<td>July</td>
<td>August</td>
</tr>
<tr>
<td>For:</td>
<td>September</td>
<td>December</td>
<td>December</td>
<td>December</td>
</tr>
</tbody>
</table>

Day: select a row on the basis of: 1st, 11th, 21st, 31st = Row 1; 2nd, 12th, 22nd = Row 2; etc.

(h) For each block in Table B80/L6.2, use the Fraction R at the right of the relevant random number. Length coordinate for testing location in sub-Lot 1 = RL/n;

(i) Record the Lot number on Table B80/L6.2 to the right of the applicable random number and indicate the date of the testing on the Table;

(j) For the testing location in the next sub-Lot:

Add L/n to the previous length coordinate.

Go to the next line as indicated by the six-digit number

(e.g. if the number is 415236 the first line tested is 4, followed by 1, 5, 3, 2 and 6 and the sample locations are as shown in Figure B80/L6.1);

(k) If the Lot requires more than six testing locations, repeat the sequence using the same Grid Line Sequence and Fraction R to provide as many additional locations as are required.

(l) Outer bar steel reinforcement may not exist directly under each derived testing location and testing personnel may then offset the location marginally to obtain a reading.

(m) All test locations must be marked with weatherproof chalk or crayon to facilitate audit testing.
Figure B80/L6.1 Testing Locations for the Developed Lot
<table>
<thead>
<tr>
<th>Sequence</th>
<th>R</th>
<th>Lot No.</th>
<th>Sequence</th>
<th>R</th>
<th>Lot No.</th>
<th>Sequence</th>
<th>R</th>
<th>Lot No.</th>
<th>Sequence</th>
<th>D</th>
<th>R</th>
<th>Lot No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.91</td>
<td></td>
<td>245136</td>
<td>.01</td>
<td></td>
<td>532461</td>
<td>.25</td>
<td></td>
<td>425316</td>
<td>.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>634125</td>
<td>.15</td>
<td></td>
<td>641532</td>
<td>.46</td>
<td></td>
<td>431652</td>
<td>.95</td>
<td></td>
<td>613254</td>
<td>.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>165243</td>
<td>.96</td>
<td></td>
<td>265413</td>
<td>.29</td>
<td></td>
<td>124563</td>
<td>.76</td>
<td></td>
<td>352641</td>
<td>.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>452613</td>
<td>.61</td>
<td></td>
<td>236541</td>
<td>.49</td>
<td></td>
<td>324651</td>
<td>.84</td>
<td></td>
<td>546123</td>
<td>.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.14</td>
<td></td>
<td>625413</td>
<td>.76</td>
<td></td>
<td>514236</td>
<td>.68</td>
<td></td>
<td>364251</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>246135</td>
<td>.72</td>
<td></td>
<td>145632</td>
<td>.76</td>
<td></td>
<td>643215</td>
<td>.45</td>
<td></td>
<td>621534</td>
<td>.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>316245</td>
<td>.86</td>
<td></td>
<td>516342</td>
<td>.21</td>
<td></td>
<td>546312</td>
<td>.50</td>
<td></td>
<td>156243</td>
<td>.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>253416</td>
<td>.01</td>
<td></td>
<td>615243</td>
<td>.04</td>
<td></td>
<td>526413</td>
<td>.29</td>
<td></td>
<td>514326</td>
<td>.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.95</td>
<td></td>
<td>162543</td>
<td>.70</td>
<td></td>
<td>263541</td>
<td>.69</td>
<td></td>
<td>145236</td>
<td>.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>352146</td>
<td>.85</td>
<td></td>
<td>624315</td>
<td>.43</td>
<td></td>
<td>435612</td>
<td>.01</td>
<td></td>
<td>412536</td>
<td>.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>245613</td>
<td>.38</td>
<td></td>
<td>526314</td>
<td>.02</td>
<td></td>
<td>356412</td>
<td>.23</td>
<td></td>
<td>614253</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>451623</td>
<td>.08</td>
<td></td>
<td>631245</td>
<td>.13</td>
<td></td>
<td>163425</td>
<td>.07</td>
<td></td>
<td>652143</td>
<td>.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.49</td>
<td></td>
<td>213465</td>
<td>.97</td>
<td></td>
<td>356142</td>
<td>.29</td>
<td></td>
<td>163254</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>621354</td>
<td>.45</td>
<td></td>
<td>536214</td>
<td>.36</td>
<td></td>
<td>325461</td>
<td>.88</td>
<td></td>
<td>342165</td>
<td>.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>613425</td>
<td>.34</td>
<td></td>
<td>425136</td>
<td>.78</td>
<td></td>
<td>125463</td>
<td>.91</td>
<td></td>
<td>564231</td>
<td>.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>456321</td>
<td>.35</td>
<td></td>
<td>514623</td>
<td>.75</td>
<td></td>
<td>438251</td>
<td>.61</td>
<td></td>
<td>326451</td>
<td>.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.44</td>
<td></td>
<td>214563</td>
<td>.43</td>
<td></td>
<td>124356</td>
<td>.45</td>
<td></td>
<td>325164</td>
<td>.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>516234</td>
<td>.52</td>
<td></td>
<td>425631</td>
<td>.23</td>
<td></td>
<td>536412</td>
<td>.64</td>
<td></td>
<td>246153</td>
<td>.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>462513</td>
<td>.83</td>
<td></td>
<td>645213</td>
<td>.86</td>
<td></td>
<td>653124</td>
<td>.32</td>
<td></td>
<td>516423</td>
<td>.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>532146</td>
<td>.83</td>
<td></td>
<td>531624</td>
<td>.19</td>
<td></td>
<td>453612</td>
<td>.93</td>
<td></td>
<td>125643</td>
<td>.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.16</td>
<td></td>
<td>654132</td>
<td>.64</td>
<td></td>
<td>153462</td>
<td>.19</td>
<td></td>
<td>415236</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>321456</td>
<td>.07</td>
<td></td>
<td>352416</td>
<td>.64</td>
<td></td>
<td>526431</td>
<td>.42</td>
<td></td>
<td>524163</td>
<td>.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>426135</td>
<td>.52</td>
<td></td>
<td>436125</td>
<td>.63</td>
<td></td>
<td>125436</td>
<td>.40</td>
<td></td>
<td>641352</td>
<td>.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>154632</td>
<td>.64</td>
<td></td>
<td>625341</td>
<td>.20</td>
<td></td>
<td>613452</td>
<td>.36</td>
<td></td>
<td>251436</td>
<td>.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.13</td>
<td></td>
<td>362451</td>
<td>.16</td>
<td></td>
<td>125346</td>
<td>.12</td>
<td></td>
<td>136542</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>264315</td>
<td>.85</td>
<td></td>
<td>251634</td>
<td>.99</td>
<td></td>
<td>431625</td>
<td>.10</td>
<td></td>
<td>132546</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>453216</td>
<td>.15</td>
<td></td>
<td>136254</td>
<td>.72</td>
<td></td>
<td>425361</td>
<td>.79</td>
<td></td>
<td>145326</td>
<td>.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>532164</td>
<td>.12</td>
<td></td>
<td>523641</td>
<td>.85</td>
<td></td>
<td>614352</td>
<td>.02</td>
<td></td>
<td>245361</td>
<td>.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.33</td>
<td></td>
<td>634521</td>
<td>.23</td>
<td></td>
<td>632154</td>
<td>.48</td>
<td></td>
<td>263451</td>
<td>.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>532614</td>
<td>.01</td>
<td></td>
<td>152364</td>
<td>.35</td>
<td></td>
<td>452316</td>
<td>.16</td>
<td></td>
<td>465312</td>
<td>.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>253641</td>
<td>.28</td>
<td></td>
<td>152634</td>
<td>.53</td>
<td></td>
<td>153642</td>
<td>.22</td>
<td></td>
<td>635412</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>261453</td>
<td>.75</td>
<td></td>
<td>624135</td>
<td>.08</td>
<td></td>
<td>423561</td>
<td>.87</td>
<td></td>
<td>312645</td>
<td>.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.68</td>
<td></td>
<td>532164</td>
<td>.63</td>
<td></td>
<td>652431</td>
<td>.90</td>
<td></td>
<td>516432</td>
<td>.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>654321</td>
<td>.19</td>
<td></td>
<td>415362</td>
<td>.05</td>
<td></td>
<td>613542</td>
<td>.64</td>
<td></td>
<td>461523</td>
<td>.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>614523</td>
<td>.13</td>
<td></td>
<td>316524</td>
<td>.48</td>
<td></td>
<td>463521</td>
<td>.66</td>
<td></td>
<td>236415</td>
<td>.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>361524</td>
<td>.51</td>
<td></td>
<td>432165</td>
<td>.54</td>
<td></td>
<td>621435</td>
<td>.39</td>
<td></td>
<td>346512</td>
<td>.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>.04</td>
<td></td>
<td>365142</td>
<td>.29</td>
<td></td>
<td>146253</td>
<td>.97</td>
<td></td>
<td>241365</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>625314</td>
<td>.43</td>
<td></td>
<td>315624</td>
<td>.90</td>
<td></td>
<td>162354</td>
<td>.96</td>
<td></td>
<td>452631</td>
<td>.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>346251</td>
<td>.54</td>
<td></td>
<td>142356</td>
<td>.60</td>
<td></td>
<td>461352</td>
<td>.62</td>
<td></td>
<td>241356</td>
<td>.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>513246</td>
<td>.70</td>
<td></td>
<td>513624</td>
<td>.74</td>
<td></td>
<td>163542</td>
<td>.61</td>
<td></td>
<td>352614</td>
<td>.97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
L6.2.2 Method for Statistical Calculation for Conformity of Lots

When acceptance criteria specify a maximum and/or minimum characteristic value of attribute \( Q \), \( Q_U \) and/or \( Q_L \) must be used to determine \( Q \).

The calculation of the characteristic value of attribute \( Q \) for the Lot/s must be as follows:

\[
\begin{align*}
Q_U &= \bar{x} + ks \\
Q_L &= \bar{x} - ks
\end{align*}
\]

where \( \bar{x} \) = arithmetic mean of attribute test results for all Lots and sub-Lots (mm)

\( s \) = standard deviation of Lots and sub-Lots attribute test results

\[
\sum_{i=1}^{n} (x_i - \bar{x})^2 = n - 1
\]

\( k \) = acceptance constant from Table B80/L6.3 (based on 10% producer's risk)

<table>
<thead>
<tr>
<th>No of tests</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10 - 14</th>
<th>15 - 19</th>
<th>20 +</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k )</td>
<td>0.52</td>
<td>0.62</td>
<td>0.67</td>
<td>0.72</td>
<td>0.75</td>
<td>0.78</td>
<td>0.81</td>
<td>0.83</td>
<td>0.90</td>
<td>0.95</td>
</tr>
</tbody>
</table>

L6.2.3 Conformity

For the first Lot and subsequent accumulated Lots, conformity is achieved if:

\[ Q_U \leq 1.15 \times \text{specified upper limit for characteristic value of the attribute}; \text{ and} \]
\[ Q_L \geq 0.87 \times \text{specified lower limit for characteristic value of the attribute}. \]

The concrete bridge member(s) or product(s) is/(are) nonconforming if:

\[ Q_U \text{ is more than } 1.15 \times \text{specified upper limit for the characteristic value}; \text{ or} \]
\[ Q_L \text{ is less than } 0.87 \times \text{specified lower limit for the characteristic value}. \]
ANNEXURE B80/M – REFERENCED DOCUMENTS AND ABBREVIATIONS

Refer to Clause 1.2.6.

M1 REFERENCES

RMS Specifications

RMS D&C G36 Environmental Protection
RMS D&C G71 Construction Surveys
RMS D&C Q6 Quality Management System (Type 6)
RMS D&C B110 Manufacture of Pretensioned Precast Concrete Members
RMS D&C B113 Post Tensioning of Concrete
RMS D&C B115 Precast Concrete Members (Not Pretensioned)
RMS D&C B170 Supply and Installation of Void Formers
RMS D&C B201 Steelwork for Bridges
RMS D&C B203 Welding of Steel Reinforcement
RMS D&C 3211 Cements, Binders and Fillers

RMS Test Methods

RMS T240 Texture Depth of Coarse Textured Road Surfaces
RMS T362 Interim Test for Verification of Curing Regime - Sorptivity
RMS T363 Accelerated Mortar Bar Test for AAR Assessment
RMS T364 Concrete Prism Test for AAR Assessment
RMS T368 Dressing of Voids in Concrete Specimens and Adjustment for Embedded Steel
RMS T371 Determination of Calcium Nitrite Quantity in Fresh Concrete (Test Strips)
RMS T375 Sampling and Testing of Grout
RMS T1005 Recording the Infrared Spectrum of Materials

Australian Standards

AS 1012 Methods of testing concrete
AS 1141 Methods for sampling and testing aggregates
AS 1289 Methods of testing soils for engineering purposes
AS 1379 Specification and supply of concrete
AS 1391 Methods for tensile testing of metals
AS 1478.1 Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
AS/NZS 1594 Hot-rolled steel flat products
AS/NZS 2271 Plywood and blockboard for exterior use
<table>
<thead>
<tr>
<th>Standards and Methods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 2758.1</td>
<td>Aggregates and rock for engineering purposes - Concrete aggregates</td>
</tr>
<tr>
<td>AS 3610</td>
<td>Formwork for concrete</td>
</tr>
<tr>
<td>AS 3799</td>
<td>Liquid membrane-Forming curing compounds for concrete</td>
</tr>
<tr>
<td>AS/NZS 4671</td>
<td>Steel reinforcing materials</td>
</tr>
<tr>
<td>AS 5100</td>
<td>Bridge design</td>
</tr>
<tr>
<td>AS 5100.5</td>
<td>Concrete</td>
</tr>
<tr>
<td>AS/NZS ISO 9001</td>
<td>Quality management systems - Requirements</td>
</tr>
<tr>
<td><strong>ASTM Standards</strong></td>
<td></td>
</tr>
<tr>
<td>C295</td>
<td>Standard Guide for Petrographic Examination of Aggregates for Concrete</td>
</tr>
<tr>
<td>C1611</td>
<td>Standard Test Method for Slump Flow of Self-Consolidating Concrete</td>
</tr>
<tr>
<td>C1621</td>
<td>Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring</td>
</tr>
<tr>
<td>C1712</td>
<td>Standard Test Method for Rapid Assessment of Static Segregation Resistance of Self-Consolidating Concrete Using Penetration Test</td>
</tr>
<tr>
<td><strong>British Standards</strong></td>
<td></td>
</tr>
<tr>
<td>BS 10088</td>
<td>Stainless steels. List of stainless steels</td>
</tr>
<tr>
<td>BS 6744:2001</td>
<td>Stainless steel bars for the reinforcement of and use in concrete. Requirements and test methods</td>
</tr>
<tr>
<td>BS EN 12350-11</td>
<td>Testing fresh concrete - Part 11: Self-compacting concrete - Sieve segregation test</td>
</tr>
<tr>
<td>BS EN 12350-12</td>
<td>Testing fresh concrete - Part 12: Self-compacting concrete - J-ring test</td>
</tr>
<tr>
<td><strong>Nordtest Methods</strong></td>
<td></td>
</tr>
<tr>
<td>NT Build 443</td>
<td>Concrete, Hardened: Accelerated Chloride Penetration</td>
</tr>
<tr>
<td>NT Build 492</td>
<td>Concrete, Mortar and Cement-Based Repair Materials: Chloride Migration Coefficient from Non-Steady-State Migration Experiments</td>
</tr>
<tr>
<td><strong>International Slurry Surfacing Association (ISSA) Document</strong></td>
<td></td>
</tr>
<tr>
<td>ISSA 145</td>
<td>Technical Bulletin No 145 - Test method for determination of methylene blue adsorption value (MBV) of mineral aggregate fillers and fines</td>
</tr>
</tbody>
</table>

**M2 ABBREVIATIONS**

NATA National Association of Testing Authorities, Australia

RMS Roads and Maritime Services