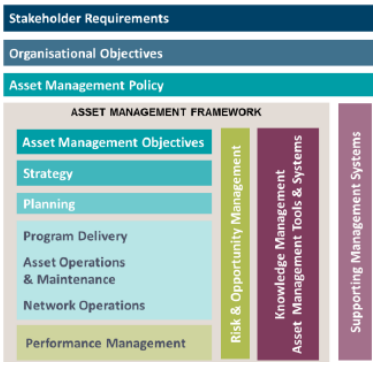
Transmission Substation Concrete

Design Standard (Technical Specification)



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RESPONSIBILITIES

Western Power's Engineering & Design Function is responsible for this document

CONTACT

Western Power welcomes your comments, questions, and feedback on this document, which can be emailed to standards.excellence@westernpower.com.au

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Revision Details

Version	Date	EDM Version	Description
0	August 2019	1	First Issue
1	October 2021	2	Refer to the side bar for updates
2	March 2024	3	Standard Online Update

1 Introduction

This Technical Specification outlines the minimum requirements for the construction of concrete components for Western Power Transmission Substation projects.

1.1 Purpose and scope

The requirements outlined in this specification are intended to cover the following for both cast in-situ and prefabricated concrete works:

- Supply, testing, placing, finishing, and curing of concrete
- Supply, Scheduling, placing, and supporting of reinforcement
- Supply, fabrication, erection, and stripping of formwork
- Supply, fabrication, and installation of prefabricated concrete panels, including proprietary systems
- Supply and installation of all brackets, packers, bolts, grout, etc., to complete the installation of prefabricated concrete panels

In all matters, the requirements of this specification are relevant unless otherwise specifically stated elsewhere within the construction SoW of the project or specifically shown on the drawings included in the Project Deliverables.

This specification applies to both 'Greenfield' and 'Brownfield' sites.

1.2 Acronyms

Acronym	Definition

1.3 Definitions

Terms and definitions used in this document

Term	Definition
ACRS	Australian Certification Authority for Reinforcing and Structural Steels
AS	Australian Standard
Brownfield site	Site with existing or previous electrical assets
CE	European Conformity
EDM	Enterprise Document Management
Greenfield site	New site with no previously installed electrical assets
NATA	National Association of Testing Authorities, Australia
NCC	National Construction Code of Australia
SoW	Scope of Work

1.4 References

References which support implementation of this document

Table 1.1 References

Reference No.	Title

2 Supporting Documentation[1]

3 Compliance

3.1 General[2]

All temporary works, shop drawings, materials, plant, equipment, workmanship, fabrication, and installations must comply with the latest revision of the Western Power technical documents such as Standards, Specifications, and relevant Australian Standards relating to the relevant component of the works unless otherwise noted in this specification or advised at the time of Tender.

There should not be any deviation from the provisions of the relevant standards and specifications without obtaining written approval from Western Power.

All work and materials must comply with higher-level Western Power technical documents, such as relevant Network Standards and Functional Specifications.

This Technical Specification should encompass all requirements of the relevant Australian Standards which are current at the time of issue. These relevant Australian Standards are listed in Table 3.1 below. A period

[1] See Western Power Internal Document
[2] See Western Power Internal Document

will be set when the Technical Specification needs to be reviewed. If significant changes occur on an Australian Standard which affects safety, then an out of cycle review can be completed.

Table 3.1: Standards and Guidelines

Standard Number	Standard Title
AS 1012	Methods of testing concrete
AS 1111.1	ISO Metric hexagon bolts and screws – Product grade C, Part 1: Bolts
AS 1112.3	ISO Metric hexagon nuts, part 3: Product grade C
AS 1141	Methods for sampling and testing aggregates
AS/NZS 1214	Hop dip galvanised coatings on threaded fasteners
AS 1237.1	Plain washers for metric bolts/screws & nuts for general purposes
AS 1275	Metric screw threads for fasteners
AS 1379	Specification and supply of concrete
AS 1478.1	Chemical admixtures for concrete, mortar and grout
AS/NZS 1554.1	Structural steel welding – Welding of steel structures
AS/NZS 1554.3	Structural steel welding – Welding of reinforcing steel
AS 2159	Piling – Design and installation
AS 2350	Methods of testing Portland and blended cements
AS/NZS 2425	Bar chairs in reinforced concrete - Product requirements and test methods
AS 2550	Cranes, hoists and winches – Safe use (series)
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates
AS 3600	Concrete structures
AS 3610.1	Formwork for concrete - Specifications
AS/NZS 3678	Structural Steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679.1	Structural Steel – Hot-rolled bars and sections
AS 3799	Liquid membrane forming curing compounds for concrete
AS 3850.1	Prefabricated concrete elements – General requirements
AS 3850.2	Prefabricated concrete elements – Building construction
AS 3972	Portland and blended cements
AS 4100	Steel structures
AS/NZS 4671	Steel reinforcing materials
AS/NZS 5131	Structural steelwork – Fabrication and erection
	National Code of Practice for Precast, Tilt-up and Concrete Elements in Building Construction
ISO 13270	Steel fibres for concrete – Definitions and specifications

Standard Number	Standard Title
EN 14889-1	Fibres for concrete – Part 1: Steel fibres – Definitions, Specifications and Conformity

3.2 Acceptance Criteria

Compliance with the requirements of this specification for materials and construction of concrete works shall be based on the minimum requirements and acceptance criteria set out in this specification, construction SoW of the project, construction drawings included in the project deliverables and relevant Australian and International Standards listed in Table 3.1.

3.3 Order of Precedence

Where this specification is inconsistent with another document making up the construction SoW of the project, the following order of precedence shall apply to determine which document prevails to the extent of inconsistency, with (a) being the highest precedence and (e) being the lowest:

a) the specific terms and conditions of the construction SoW of the project

b) the 'Policies and Guidelines' of the project

c) any construction drawings included in the project deliverables

d) any specific technical requirements stipulated to the project works

e) this Technical Specification

3.4 Certification

The contractor shall submit test reports or certificates of all materials and manufactured components, including items supplied from overseas that are used in the construction of concrete works to the Western Power representative for acceptance. The documents must state compliance with this specification and applicable Western Power technical documents, Australian Standards as described by these documents, and the project quality plan.

Requirements for test reports or test certificates are provided in the relevant Australian Standards listed in Table 3.1. All such testing shall be carried out by an independent NATA-accredited laboratory approved by the Western Power representative.

4 Concrete Materials

4.1 Cement

Cement for concrete and mortar for the works shall be type GP Portland Cement or approved equivalent to AS 3972 and used per the requirements of AS 1379.

Bagged cement shall be stored in a weatherproof ventilated building clear of external walls and on a sub-floor raised at least 300 mm above ground level. Bags shall be stacked in a manner that will minimise the effects of hot or humid weather conditions.

Cement that is either more than three months old or is suspected of showing signs of any deterioration shall not be incorporated in structural concrete.

The contractor shall provide manufacture's test certificates showing the cement type used has been sampled and tested per the requirements of AS 3972.

4.2 Water

Water used in concrete and mortar shall comply with the provisions of AS 1379. It shall be of a general potable quality, free from harmful matter to concrete, reinforcement, tendons, or other embedded items.

Chilled water shall be used where the concrete temperature is to be limited.

4.3 Aggregates

4.3.1 General

Sampling, selection and testing of concrete aggregates proposed for use in site mixed concrete shall be arranged and be carried out by an independent NATA-accredited testing laboratory. The Contractor shall provide test results to the Western Power representative for acceptance of aggregates for use in the works.

Aggregates shall be stockpiled, handled, and managed in such a manner as to minimise dust and collection or concentration of dust within the stockpiles. Each nominal size of coarse aggregate shall be stored separately. Precautions shall be taken to protect or prevent contamination of aggregates by ground, dust, or any other matters.

All aggregates shall comply with the requirements of 'alkali reactive material' per AS 2758.1.

4.3.2 Fine Aggregate

Fine aggregate for concrete and mortar shall be natural silica sands. It shall consist of hard, durable grains and shall be free from dust, soft particles, alkali, organic matter, loam, or other deleterious substances. Chert shall not be used as fine aggregate.

Fine aggregate shall not produce a colour darker than the standard in the colorimetric test for organic impurities described in AS 1141. The fine aggregate shall be well-graded per AS 2758.1.

The maximum water absorption of the fine aggregates shall not exceed 1.5% unless approved otherwise by the Western Power representative.

4.3.3 Coarse Aggregate

Coarse aggregate shall consist of crushed unweathered granite, diorite, basalt, and other approved hard durable rock or approved screened river shingle which does not contain minerals known to react deleteriously with cement alkalis. Chert shall not be used as coarse aggregate.

Coarse aggregates shall be single-size grading and be produced in a crushing circuit to produce a regular uniform product satisfying the requirements of AS 2758.1. Graded coarse aggregates shall not be used.

Using coarse aggregates of nominal size greater than 20mm shall not be permitted.

The maximum water absorption of the coarse aggregates shall not exceed 2.5% unless approved otherwise by the Western Power representative.

4.4 Concrete Admixtures

Admixtures proposed for use in concrete work shall be subject to the prior approval of the Western Power representative. Admixtures that contain chloride-ions or chloride shall not be used. All concrete admixtures shall comply with AS 1478.1.

Admixtures shall not be used as a replacement of Portland cement. Acceptance of admixtures for use in the works shall not relieve the responsibility of the Contractor for manufacturing and constructing sound, workable concrete in compliance with the specification.

At least ten (10) working days before the proposed use of any concrete admixture, upon request, a certificate from an independent NATA-accredited laboratory shall be provided, stating that the admixture proposed for use has been tested and found to meet the requirements of AS 1478.1.

Where two or more admixtures are proposed in concrete mix design, the contractor shall provide a certificate from the manufacturer stating the compatibility of the admixtures used for review by the Western Power representative.

5 Steel Reinforcement

5.1 General

All steel reinforcement shall be supplied and installed as shown on the drawings. Steel reinforcing bars, wire and fabric shall comply with AS/NZS 4671.

Reinforcing bars shall be bent cold in a manner that will not damage them and shall be dimensioned and shaped per the Reinforced Concrete Detailing Manual of the Concrete Institute of Australia and AS 3600. Reinforcement fabrication tolerances shall be per AS 3600.

All steel reinforcing material shall be certified by ACRS (Australian Certification Authority for Reinforcing and Structural Steels).

5.2 Non-Australian Steel/Materials

If any alternative steel and/or materials that are manufactured to a standard other than the appropriate Australian standards are offered, documented evidence that such steel and/or materials shall be entirely suitable for the intended application, design method, nominated design life and the environment where the structures will be located shall be provided.

The Contractor shall provide copies of the standard(s) or code(s) with their offer and a table showing all the relevant properties of the proposed alternative steel/material for comparison and compliance with relevant AS.

Acceptance of any such alternative steel/material shall be entirely at the discretion of the Western Power representative.

5.3 Preparation of Steel Reinforcement

All steel reinforcement shall be delivered from the supplier/manufacturer or bending yard to site with clear waterproof identification as to grade, size and marked per the bending schedules and drawings.

Upon delivery to the site, all steel reinforcement materials shall be stored on blocks which shall be raised above ground and well clear of sand, vegetation and other deleterious substances and handled in a manner that will avoid permanent deformation. Damaged steel reinforcement materials shall not be incorporated in the works.

Before the steel reinforcement is placed, the surface of the reinforcement materials and supports shall be cleaned of any rust, loose mill scale, dried mortar or grout, dirt, grease, and other deleterious substances. Flaky rust may be removed by firm rubbing with hessian or by means of an equivalent treatment.

5.4 Placement of Steel Reinforcement

Steel reinforcement shall be placed as shown on the drawings. Unless otherwise directed or shown on the drawings, measurement shall be to the centre lines of the reinforcing bars. Steel reinforcement shall be fixed in position by means of 1.6 mm diameter annealed black iron tie wire to avoid displacement by concreting work. Steel reinforcement materials shall not be disturbed after incorporation into concrete. Chairs, hangers, spacers, or other acceptable steel reinforcement supports made of metal, plastic or concrete may be used. Metal supports shall not, however, be placed within reinforcement cover zones of structural concrete.

Welding of steel reinforcement shall not be permitted unless shown on the construction drawings or approved by the Western Power representative. Tack welding of intersecting reinforcement bars shall not be permitted unless approved by the Western Power representative. Reinforcement welding, including tack welding, shall comply with AS/NZS 1554.3 requirements .

Steel reinforcement for bored piles shall be spaced evenly and positioned to avoid clashing with holding down bolts or any embedded items.

After being placed, the steel reinforcement shall be maintained clean until it has been incorporated into the concrete.

5.5 Splicing of Steel Reinforcement

Splicing of steel reinforcement may be made by lapping. Splices shall be staggered so that splices in adjacent bars are not within the same lap length. Splices shall be lapped as shown on the drawings. Where splices in steel reinforcement are not shown, details of proposed splices shall be submitted to the Western Power representative for approval before use.

5.6 Steel Fibres

Steel fibres used for the production of steel fibre reinforced concrete (SFRC) shall conform with ISO 13270 and EN 14889-1. Steel fibres shall be collated (glued) in clips and free of any dirt, rust, oil, and deleterious substances.

The Contractor shall provide a copy of the current ‘Declaration of Performance’ document and, where applicable, the relevant European Conformity (CE) certification for the proposed steel fibre for acceptance by Western Power.

Steel reinforcing material shall be as shown in the construction drawings. Where conventional steel reinforcement bars are shown in the project drawings, the use of steel fibres in place of the reinforcement bars is not permitted. Substitution of the fibre material type that is specified in the construction drawings with any alternative fibre is subject to approval by Western Power.

6 Formwork

6.1 General

All concrete construction shall be formed unless otherwise stated on the project drawings or approved by the Western Power representative. Concrete forms and the use of formwork shall be per AS 3610.1.

6.2 Structural Adequacy of Formwork

Formwork shall be structurally adequate so as not to deflect, bulge, sag or distort when supporting concrete and steel reinforcement, and all impact loads transmitted from equipment during concrete placement .

Formwork shall be designed, constructed, and maintained in position and shape during and after placing of the concrete to achieve the finished surface tolerances as specified in the specification.

Form linings may be steel, select grade tongued and grooved hardwood, or plywood.

Formwork for successive lifts shall not be supported by previously placed concrete until that concrete has achieved a minimum average compressive strength of two-thirds (2/3) of its 28day characteristic strength or more.

6.3 Form Ties in Formwork

Use of tie wire passing from one face of a concrete form to another face shall not be permitted. Bolts for fixing or supporting the formwork shall be greased and arranged so that they may easily be removed from the concrete without damage.

6.4 Block-outs, Inserts, Ducts or Embedded Items

Block-outs, inserts, ducts, and embedded items shall be located and fixed so that the construction tolerances specified are complied with. Embedded metallic items shall be isolated from the steel reinforcement materials. For all holes and ducts in walls that require curtailed reinforcement, an equal amount of steel reinforcing shall be placed on either side of the hole with laps as specified.

Where required, block-outs for holding down bolts, shall be cut to length from split polystyrene pipe insulation.

6.5 Form Oils and Releasing Agents

Form oils or releasing agents, if approved for use, shall be used at the interior surfaces of the forms to prevent adhesion to the mortar.

Release agents shall be of a stable, non-toxic, and non-staining type and shall be applied as a thin film before placement of steel reinforcement. The steel reinforcement shall not come in contact with the release agent.

Where the finished concrete surface is to receive a bituminous waterproofing membrane, render, topping, or the surface is to be painted, the releasing material applied to the form surfaces shall be compatible with any such surface finishing. It shall leave the concrete surface free of residue, which will affect the bonding of the coating, and be approved as compatible by the manufacturer of the finishing material.

If future coatings lift, blister, or peel due to incompatible form release agents, the removal of the damaged coating and re-coating of the prefabricated concrete panels shall be completed to the satisfaction of the Western Power representative at no additional cost to Western Power.

Temporary openings shall be provided where necessary to facilitate cleaning and inspection.

6.6 Inspection of Formwork

Formwork shall be subject to inspection and acceptance by Western Power's representative at least 24 hours before any concrete placing operation. All forms shall be clean and free from deleterious material and surplus moisture before concrete placement. All formwork jointing shall be sufficiently tight to prevent the escape of any mortar, slurry, or free water.

Should any formwork show signs of bulging or sagging after the concrete has been placed, the concrete shall be removed and reconstructed as directed by the Western Power representative.

6.7 Tolerances

Formwork tolerances shall be per the most stringent requirements from AS 3600 and AS 3610.1 unless otherwise specified.

6.8 Removal of Formwork

Formwork shall be removed only per the minimum formwork stripping times set out in AS 3610.1. Forms shall be removed in a manner to assure complete safety and integrity of the structure without any damage to the concrete. The minimum average concrete compressive strength at the time of stripping of forms shall be two-thirds (2/3) of the 28-day characteristic strength or more.

The minimum stripping time for vertical formwork, including for formed walls, shall be three (3) days unless otherwise stated.

6.9 Concrete Edges

The concrete edges shall be accurately formed as described and shown on the drawings.

All prefabricated concrete panel edges shall be mitred to 15mm formed mitres to the approval of the Western Power representative.

7 Holding Down Bolts

7.1 Materials and Manufacture

Holding down bolts shall comply with AS 1111.1.

Holding down bolts shall be fabricated from plain round steel bars conforming to AS/NZS 3679.1 Grade 300 or as nominated on the construction drawings. All steel shall be clean and free of loose rust, scale, oil, and other detrimental matter. Hooks and cogs shall be cold-formed.

The holding-down bolts shall be manufactured to the dimensions indicated in the respective construction drawings.

Steel plate, where required, shall be per AS/NZS 3678 Grade 300 or as nominated on the construction drawings.

All welding, where required, such as for the connection of anchor plates, shall be a special purpose (SP) category per AS/NZS 1554.1 unless otherwise specified.

The bars shall be cut to the correct length during manufacture, not sheared. The bar shall be threaded per AS 1275 to the lengths indicated on the drawings.

Holding down bolts shall be supplied with hexagon nuts and square/rectangle steel plate washers, as shown on the construction drawings.

7.2 Installation

Holding down bolts shall be installed in position and to the tolerances specified in Section 7.3.

A solid timber or steel template shall be used to maintain the exact position of the bolts during concrete casting operations, and such templates shall be rigidly fixed to the formwork.

On completion of concrete casting operations, the templates shall be removed while taking care not to disturb the position of the bolts. Any concrete surfaces obscured by the templates shall be then finished as required.

Where shown on the drawings, other fixtures shall be set in the concrete to the details given and to the approval of the Western Power representative.

Under no circumstances the minimum protrusion of the holding down bolt above the upper fixing nut shall be less than one and a half ($1\,{}^{1}/_{2}$) full threads unless otherwise specifically approved by the Western Power representative.

7.3 Tolerances

Holding down bolts shall be manufactured and installed to the tolerances per the requirements of AS/NZS 5131, except where specified in Table 7.1 below.

Table 7.1: Holding down bolt tolerances

Criteria	Tolerance (mm)
Overall lengths of any anchor bolt	+25mm / – 0mm
Overall dimensions of the hooks after bending	± 6mm
Horizontal dimension from the specified location	± 3mm
Horizontal dimension between the centre of adjacent anchor bolt groups	± 3mm
Horizontal dimension between the centre of anchor bolt groups every 30m	± 6mm
Vertical dimension (level)	± 5mm

7.4 Chemical Anchors

Where shown in the drawings, all post drilled-in chemical anchors shall be installed per the manufacturer's written instructions and to the satisfaction of the Western Power representative.

Unless otherwise specified, the tolerance on the hole location shall be ± 1.5mm, and the tolerance on hole depth shall be -0, +5mm.

8 Concrete Manufacture and Supply

8.1 General

All plants, equipment and trucks manufacturing and delivering concrete shall comply with AS 1379. The preparation, batching and mixing of admixtures shall be per AS 1478.

8.2 Concrete Mix Design

The design of concrete mixes shall be the contractor's responsibility to ensure that the quality of the concrete complies with the requirements of AS 1379 and AS 3600. Concrete mix designs shall aim to produce a workable and durable concrete of the required strength consistent with proper transport, placement, and compaction of the concrete without segregation.

Concrete mix designs for each strength grade shall be submitted to the Western Power representative for review at least ten (10) working days before concrete manufacture and supply commencement.

8.3 Ready-Mixed Concrete

Concrete for the works shall be supplied as ready-mixed concrete from an approved manufacturer and shall comply with AS 1379.

The production assessment reports shall be obtained over the most recent two-monthly period for each concrete strength grade to be incorporated into the works as produced by the proposed ready-mixed concrete manufacturer. The Western Power representative shall be provided copies of these reports at least ten (10) working days before any concrete work is undertaken. Approval of a manufacturer shall be subject to compliance with these production assessment reports per the requirement of AS 3600 as determined by the Western Power representative.

8.4 Strength Grade

The structural concrete strength grade shall be as shown on the construction drawings. Where the strength grade is not specified in the drawings or relevant project documents, Grade N32 'Normal Class' concrete shall be supplied per AS 1379 and this specification.

8.5 Workability

Unless otherwise specified on the construction drawings, the concrete slump shall not exceed the values shown in Table 8.1 below.

Table 8.1: Concrete slump

Concrete Grade	Maximum Slump (mm)
Grade N25 to N50	80 ± 15mm
Pumped concrete	120 ± 30mm
Concrete for prefabricated concrete panels	120 ± 30mm

Concrete slump shall be tested per AS 1379. They shall be measured from every truck, for each set of compressive strength samples or as directed by the Western Power representative.

8.6 Compressive Strength Testing

All concrete pours shall be tested for compressive strength. Concrete sampling and testing shall be per AS 1379.

The sampling frequency for compressive strength testing shall be as set out in Table 8.2 below; however, the Western Power representative may request further sampling as necessary.

Table 8.2: Compressive Strength Testing

Number of Trucks	Number of Samples Required
Up to 3	1
4 to 5	2
6 to 10	3
11 to 20	4
Each additional 10 trucks	5

All samples shall be taken at the point of discharge from the delivery truck. Each sample shall consist of three cylinders – one tested at 7 days, one tested at 28 days, with the reserve being retained for check testing as required by the Western Power representative.

Compressive strengths shall be assessed per AS 1379. Testing of all concrete cylinders shall be carried out by an independent NATA-accredited laboratory approved by the Western Power representative.

8.7 Duration of Delivery

The period between the commencement of mixing fresh concrete and completion of its placement shall not exceed 90 minutes or a duration after which proper placement and compaction of the concrete can no longer be achieved, whichever occurs first. The Western Power representative may consider a variation of this period, if required, subject to weather conditions and any site-specific constraints.

On arrival at the site, water shall not be added to the concrete drum before concrete placement to modify the workability.

8.8 Concrete Supply Records

The Contractor shall maintain a permanent record of all concrete supplied for the works. As a minimum, the following information shall be recorded for each truckload leaving the batching plant. The Contractor shall make all concrete supply records and truck dockets available to the Western Power representative when requested.

- Name of manufacturer and place of manufacture
- Serial number of identification certificate
- Date of supply
- Project name and location
- Delivery vehicle identification
- Quantity of concrete covered by certificate
- Specified class and strength grade or other mix identification

- Cement content and water/cement ratio
- Specified slump
- Maximum nominal size of aggregate
- Method of placement
- Time of commencement of mixing

The copies of delivery dockets for all concrete not tested shall be submitted.

8.9 Rejection of Concrete

Concrete that is supplied but does not conform to the specified acceptance criteria and/or hardened concrete that exhibits any of the defects listed in AS 3600 shall not be incorporated into the works.

The Western Power representative reserves the right remove from the site any concrete outside the specified slump and tolerances, any concrete from which tests have failed to meet the required strength and any concrete that fails to meet the specified finish. This concrete shall be removed and replaced to the Western Power representative's instructions at no additional cost to Western Power.

8.10 Quality Audit and Non-Conformances

The system of records that provides objective evidence that the slump, compressive strength, weather, and location associated with each concrete pour have been satisfied is to be established and maintained.

All records about the works should be made available by the Contractor to the Western Power representative as soon as they are available. Where requested by the Western Power representative, a copy of the records shall be provided.

Uninterrupted access shall be provided to the Western Power representative to all project work-related premises/working areas and all relevant documentation.

The contractor shall provide access to access to all facilities, documentation, records, and personnel that are required for any audits or surveillance undertaken by the Western Power representative to ensure specified requirements are met.

All non-conformances shall be promptly reported to the Western Power representative via non-conformance reports. Details of the action taken, and subsequent satisfactory close-out of the non-conformance report shall be reported to the Western Power representative.

8.11 Preparation for Concreting

Formwork shall be inspected before concreting. All formwork joints shall be sealed, and all debris removed from the space to be occupied by the concrete. Formwork and all surfaces against which concrete is to be placed shall be clean and thoroughly wetted with water. A 50mm thick, blinding concrete shall be placed under all footings, slabs, and bunds of more than 250mm thick unless otherwise specified in the drawings.

Concrete delivery chutes, and tubes shall also be cleaned and flushed with water before and after each concreting operation. All pipes, covers, frames, tubes, ducts, and bolts that are to be embedded in the concrete, together with formwork for structural openings, shall be cleaned of loose rust, scale, paint, dirt, and oil and shall be secured in their specified positions before placing of concrete.

Embedded items shall not be secured to the reinforcement by electrically conductive fixings. Where small embedments or openings obstruct reinforcement placement and special details are not shown on the

drawings, the reinforcement shall be displaced or bent in gradual curves locally around the embedment. Surfaces of forms, steel reinforcement and embedded materials encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.

8.12 Notification of Concreting Work

The Western Power representative shall be given at least two (2) working days prior notice by the contractor of its intention to place concrete and also provide the Western Power representative at least one working day prior notice of cancellation or rescheduling of any planned concreting operation.

8.13 Pre-Concreting Inspection

Concrete shall not be placed until the subgrade, formwork, steel reinforcement, embedded items and all prepared joint surfaces have been inspected and accepted by the Western Power representative for compliance with the relevant construction drawings and specifications.

8.14 Concrete Placed in Excavations

No concrete shall be placed in excavations or on filled ground until the subgrade has been inspected and approved. Subgrade preparation, including compaction, shall be carried out as specified on the construction drawings or relevant technical specifications. Before concrete placement in an excavation, the contractor shall ensure that the excavation is dry and clean and that the sides of excavations are such that no material will fall, or water will permeate into freshly placed concrete.

Refer to Technical Specification – Earthworks, Roads and Drainage for excavation and subgrade compaction requirements.

8.15 Temperature of Fresh Concrete

The temperature of fresh concrete, including ready-mixed concrete, at discharge point shall not exceed 32°C unless otherwise approved. Concrete temperature shall be tested per AS 1379. It shall be measured from every truck, for each set of compressive strength samples or as directed by the Western Power representative.

8.16 Gravity Placing of Concrete

All concrete shall be placed in position as soon as possible after the addition of mixing water and per the requirements of the specification. Concrete that has begun to set before its placement and/or final compaction has been completed shall be removed from the works.

Concrete shall not be allowed to free fall from chutes, hoppers, or pump lines for a distance greater than 2.0m.

All concrete shall be placed in its final position and compacted within 15 minutes of discharging from the truck. To prevent the formation of cold joints, the time lapse between placing adjacent layers or strips of concrete shall not exceed 30 minutes unless otherwise approved.

8.17 Pumping of Concrete

If concrete placement by pumping is proposed, the concrete mix specification shall be submitted to the Western Power representative for approval before use. Before pumping, the concrete discharge pipeline shall be lubricated with mortar with the same proportions of cement to fine aggregate as the approved

concrete mix to be discharged through it. The lubricating mix shall not be discharged into the forms. The concrete shall be pumped in a continuous, uninterrupted process, and a pump feed-hopper equipped with an agitator shall be used to minimise segregation of concrete mix components. The delivery point of the pipeline shall be continually relocated to avoid the deposition of large quantities of concrete in any single location.

8.18 Maximum Concrete Lifts in Structures

The concrete shall be placed in lifts not exceeding 2.5 metres in depth, and these lifts shall comprise layers not exceeding 500 mm in depth, except that the first layer of the first lift shall not exceed 300 mm in depth. The placing procedures shall be arranged to avoid cold joints between adjoining layers of a lift.

8.19 Prevention of Concrete Segregation

The methods and equipment used for transporting concrete and the duration of transportation operations shall be such as will prevent the segregation of coarse aggregate. As far as practicable, concrete shall be deposited directly in its final position to avoid segregation.

8.20 Compaction of Concrete

The compaction of concrete shall be by immersion-type high-frequency mechanical vibrators. Concrete vibrators shall be operated at speeds of at least 10,000 vibrations per minute when immersed in the concrete. At least two such vibrators in working condition shall be on the site at the commencement of each day's concrete placing.

The use of other types of vibrators in situations where immersion vibrating is not practicable, such as for thin or heavily reinforced sections, shall be subject to the approval of the Western Power representative.

In consolidating each layer of concrete, the vibrator shall be operated in a near vertical position, and the vibrating head shall be allowed to penetrate and revibrate the concrete in the upper portion of the underlying layer. Vibrators shall be inserted at intervals not exceeding 600mm and shall not be immersed in any one location for more than 30 seconds.

In the zone where freshly placed concrete joins previously placed concrete, additional vibration shall be performed, the vibrator penetrating deeply at close intervals along these contacts. Layers of concrete shall not be placed until layers previously placed have been vibrated thoroughly. Contact of the vibrating head with surfaces of the forms shall be avoided.

8.21 Non-Acceptance of Retempered Concrete

The use of retempered concrete in the works shall not be permitted. Concrete that has begun to set before its placement and/or final compaction has been completed shall be removed from the works and replaced at no additional cost to Western Power.

8.22 Control of Concreting in Rain

Concrete shall not be placed during rain that is sufficiently heavy or prolonged to wash mortar from the coarse aggregate unless protected from rain in a manner acceptable to the Western Power representative. During such rain, mortar shall not be placed in construction joints. The mortar which has been placed but has been diluted by rain shall be removed and replaced by mortar of acceptable quality prior to completion of the affected work at no additional cost to Western Power.

8.23 Concrete in Bored Piles

Bored pile construction shall comply with AS 2159.

The pile shaft and base shall be cleaned of any loose materials and debris before placement of the reinforcement cage and concreting. Concrete in bored piles shall be placed in a continuous pour within 24 hours of the completion of the excavations. Where it is not practical to complete a concrete placement within 24 hours, the excavated hole shall be protected from drying out by a suitable method approved by the Western Power's representative.

Concreting methodology and placing of concrete in water is subject to acceptance and prior approval by the Western Power representative.

8.24 Steel Fibre Reinforced Concrete (SFRC)

Concrete footings and slabs on grade shall be constructed with SFRC, where specified in the construction drawings. SFRC shall be manufactured and constructed per this section.

Steel fibre type and dosage shall be as shown in the construction drawings.

Structural concrete strength grade shall be as shown in the construction drawings. Concrete for the works shall be supplied as only ready-mixed concrete from an approved manufacturer in compliance with AS 1379. Concrete mix design shall be per Section 8.2 of this specification.

Duration of delivery shall be per Section 8.7 of this specification. Where site-specific constraints require longer concrete transportation and delayed placement, the concrete mix design shall suitably be adjusted with the addition of suitable set-retarders, subject to approval of the mix design and trial mix results by Western Power.

Steel fibres shall only be mixed at the batching plant using a calibrated automatic dosing machine or any other suitable method. Adding or mixing the steel fibres to the concrete at the site is not permitted.

Steel fibres shall be added to the concrete load at the batching plant only after all other components have been batched. Fibres shall be added gradually in such a manner to ensure uniform fibre distribution and a homogeneous mix, free of any fibre balling.

In the absence of any automatic dosing facilities, the following procedure shall be followed.

- Batch all other components and load them onto the truck
- While the truck is rotating at full mixing speed, add steel fibres no faster than the mixing concrete, which takes them away approximately at a rate of 60kg/min. Do not add the fibres of a whole bag in a single action.
- After the fibre addition, mix the load at full mixing speed for a minimum of 5 minutes.
- Consideration shall be given to reduced batch size, increased mixing time, or both, , if a uniform dispersion of the fibres is not achieved.

Upon arrival of the truck at the site, , the delivery docket shall be checked before concrete discharge to confirm the concrete compressive strength, fibre type and dosage. Any loads that show fibre balling or inconsistent fibre distribution shall not be incorporated into the works. Adding additional water to the mix at site before concrete placement is not permitted.

Requirements of concrete workability, sampling and testing, placement and compaction shall be per the relevant sub-sections of Section 8. In addition, where specified in the project documents, a wash-out test for fibre content shall be undertaken per AS 3600.

On completion of the concrete curing period, the exposed concrete surfaces shall be inspected, and any protruding steel fibres shall be clipped to be flush with the concrete surface using suitable offset pliers or wire cutters.

9 Surface Finish

9.1 Formed Concrete Surfaces

The classes of finish and requirements for finishing of formed concrete surfaces shall be per and as defined in AS 3610.1. Surfaces that will remain permanently exposed shall be formed using Class 2 formwork, and surfaces that will be permanently concealed shall be formed using Class 3 formwork unless otherwise noted on the drawings. Surface colour control shall be Class 2 as defined in AS 3610.1.

The finished surface tolerances shall be per AS 3600 unless otherwise specified.

9.2 Unformed Concrete Surfaces

The finish of unformed concrete surfaces shall be limited to the upper faces of slabs, footings, and permanently concealed surfaces are constructed to required tolerances without formwork by agreement with the Western Power representative.

Unformed concrete surfaces which are permanently concealed shall be of finish Class U1, and unformed surfaces which are exposed, or above ground shall be of finish Class U3.

Unformed concrete surface finish classes shall be designated Classes U1, U2, U3 or U4 as described hereunder in Section 9.2.1 to Section 9.2.4.

9.2.1 Class U1: Screeded Finish

The procedure shall consist of levelling and screeding the concrete to produce an even uniform surface – used when the surface will be covered/tiled. Surplus concrete shall be removed after compaction by means of screeding with a screed board of an approved design.

9.2.2 Class U2: Power-floated Finish

The procedure shall consist of a floated finish using hand or power-driven equipment. Floating work shall not commence until some stiffening of the concrete has taken place, and the moisture film or shine on the concrete surface has disappeared.

Floating work shall be the minimum necessary to produce a surface that is uniform in texture and free of screed marks. All necessary concrete surface cutting or filling shall be carried out during floating operations. Concrete element joints and edges shall be finished using approved edging tools.

9.2.3 Class U3: Trowelled Finish

The procedure shall consist of steel trowelling work, which shall commence only after the moisture film and shine have disappeared from the concrete surface and after the concrete has hardened sufficiently to prevent an excess of fine materials and water from being drawn to the surface. Excessive delay in the commencement of trowelling may leave the surface too hard for proper finishing, and excessive trowelling may cause surface crazing and damage concrete surface durability.

Steel trowelling shall be applied with firm uniform pressure, which will flatten the sandy texture of the concrete surface and produce a dense uniform surface free from visible blemishes and trowel marks. A mechanical trowelling machine shall preferably be used for the finish class operation.

9.2.4 Class U4: Broomed finish

The procedure shall apply to unformed horizontal or near horizontal concrete surfaces where indicated in the drawings or specified. It shall consist of slight roughening of the concrete surface by broom to produce a non-slip surface. Finishing operations, by wooden float only, shall commence as soon as the screeded concrete has stiffened sufficiently to prevent the formation of laitance and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture.

Floating shall be followed by brooming with a bass broom until a regular but non smooth surface texture has been achieved.

10 Concrete Curing

10.1 General

Curing and protection of concrete shall be per AS 3600.

Curing shall commence as soon as practical after the surfaces are sufficiently hard not to be damaged and the finishing of any unformed surfaces has been completed. Concrete curing shall continue for at least than seven (7) days or longer as directed by the Western Power representative. All exposed concrete surfaces shall be cured.

10.2 Curing Methods

Curing shall be achieved either by water application water retention methods in freshly cast concrete. The Contractor shall submit the proposed curing methodology, which is practical and suitable for the actual work conditions, to the Western Power representative for approval. It shall be ensured that the curing methodology is compatible with the specified final surface finish.

The following acceptable methods can be used to cure concrete:

10.2.1 Liquid Membrane Curing Compounds

Membrane-forming liquid chemical curing compounds shall comply with the requirements of AS 3799 and shall be approved by the Western Power representative before use. The compound shall have a recognisable pigment unless otherwise specified and approved. Any approved compound must be used per the manufacturers' written instructions.

Membrane curing compounds shall not be used on surfaces that are to receive bituminous membrane waterproofing, renders, toppings or on surfaces that are to be painted.

10.2.2 Ponding and Water Curing

The top surface of the concrete surfaces shall be kept ponded with water to a minimum depth of 25mm over the entire area.

Alternatively, a watering system such as sprinklers or perforated hoses over a water-saturated material such as sand, hessian or canvas may be used to ensure that the concrete surfaces are maintained continuously wet. The Contractor shall ensure adequate methods, water sources, and personnel are available to keep the surfaces wet constantly during the curing period.

The water temperature shall be kept within 10°C of the concrete surface temperature to avoid thermal shock cracking before application.

10.2.3 Sheeting

The concrete surfaces shall be kept thoroughly damp by completely covering them with a continuous layer of plastic sheeting or other approved covering material securely held to maintain full enclosure so that there cannot be any air-circulation at the concrete surface during the curing period.

Fastening and holding down methods shall be arranged to prevent wind damage to and displacement of the coverings. Where necessary, additional precautions, such as windbreaks to shield the surface under curing, shall be erected and maintained.

For brownfield sites, curing by sheeting shall not be used.

11 Concrete Joints

11.1 General

Concrete joints shall include joints over which monolithic action of the concrete is required and those that require grooving and sealing, as shown on the drawings. Concrete joints, including construction, expansion, and control joints, shall be positioned at locations and directions only where shown on the construction drawings unless otherwise specified or approved by the Western Power representative.

11.2 Construction Joints

As soon as the placed concrete has been set to the degree that the specified cleaning processes cannot dislodge its coarse aggregates , construction joint surfaces shall be cleaned by sandblasting or wet scabbling which shall remove all laitance, loose or defective concrete and other foreign materials. The coarse aggregate shall be exposed for a minimum depth of 6mm. Joint surfaces shall then be washed with water, and excess water shall be blown off by air-jetting or equivalent procedure.

The resulting joint surfaces shall be flat, with clean and protruding coarse aggregate. After cleaning, construction joints shall be kept continuously moist until the placement of the adjoining concrete.

The surface of cleaned horizontal construction joints shall be applied with a layer of neat cement grout approximately 1-2 mm thick. The grout shall have the same water/cement ratio as prescribed for the concrete to be placed upon it, and the consistency of the grout shall enable it to be uniformly spread and to be thoroughly worked into all joint surface irregularities. Concrete may then be placed against the cleaned and grouted joint surface.

In the event of an unscheduled delay in a concreting operation, a proposal to introduce an unplanned construction joint may be considered by the Western Power representative if the concrete already in place has commenced its initial set and if the proposed joint workmanship and methodology conforms to the standards specified for the planned construction joints. Otherwise, the concrete already in place shall be removed and replaced by fresh concrete at no additional cost to Western Power.

11.3 Expansion Joints

Expansion joints, where specified, shall be formed by forming the concrete on one side of the joint and separating it from the concrete on the other side by using joint fillers. Except for dowel bars, other embedded items or reinforcement shall not extend through the expansion joints.

11.4 Control Joints

Control joints, where specified, shall be formed by reducing the cross-section by saw-cutting the joint after the concrete has been set. Control joints shall be formed within 24 hours of concrete placement.

11.5 Joint Fillers and Sealants

Concrete joint fillers and sealants shall be provided to the requirements shown on the relevant construction drawings. All construction and control joints shall be provided with an approved polyethylene backing rod or equivalent and polyurethane sealant on the exposed face of the joint. Similarly, expansion joints shall have an approved polyethylene backing board or equivalent for the full depth of the joint and polyurethane/silicon sealant on the exposed face of the joint.

12 Hot Weather Concreting

12.1 General

The requirements of this section of the specification shall apply to concreting works when the air temperature in the shade at the site at the time of mixing the concrete is above 32°C. The Western Power representative shall approve hot weather concreting for any specific work before application.

12.2 Moisture Retention in Concrete

A 0.2 mm polyethylene (polythene) sheeting over all natural surfaces and blinding layers on which structural concrete is to be placed shall be provided, acting as a vapour barrier to retain water in the fresh concrete. The sheeting shall be lapped a minimum of 150mm at all joints and sealed with 50mm wide pressure sensitive tape.

12.3 Aggregate Protection

Concrete aggregates shall be stored and shaded to protect from direct exposure to the sun. In the event of an anticipated air temperature above 32°C, the shading for the aggregates shall be provided for at least two days before concreting and coarse aggregates shall be kept moist by continuous sprinkling with water during the night preceding concrete work in which the aggregates are to be incorporated.

12.4 Plant and Cement Protection

Concrete batching plants and mixers, mixing water containers and pipework, and stored cement shall be shaded to protect from direct exposure to the sun.

The shading procedures and methodologies shall be subject to acceptance by the Western Power representative before consideration of any concreting operation.

12.5 Water Temperature Control

Water for concrete shall be chilled to ensure that the concrete temperature in the forms does not exceed 32°C.

12.6 Control of Concrete Placement Period

Concrete shall be mixed, transported, and compacted in place as rapidly as practicable. The period from commencement of mixing to final screeding or concrete finishing shall not exceed one hour per the specification.

12.7 Exposed Concrete Surface Protection

Exposed surfaces of structural concrete elements shall be shaded to protect them from direct exposure to the sun in an approved manner for at least ten (10) days after concreting that element.

13 Prefabricated Concrete Panels

13.1 General

Concrete supply, reinforcement, fixings, formwork, placement and curing of prefabricated concrete panels shall comply with the relevant sections contained within this specification. Unless otherwise approved by the Western Power representative, all prefabricated concrete manufacturing works shall be performed off-site at an approved casting yard.

The details of the location and the type of processes to be used in the manufacture, transport and handling of the prefabricated concrete panels shall be submitted to the Western Power representative for approval before the commencement of the works.

13.2 Shop Detailed Drawings

Shop detail drawings complying with the recommendations of this specification and AS 3850.1 shall be prepared from the construction drawings with reference to all relevant project drawings. In addition to the requirements of AS 3850.1, shop drawings shall indicate:

- Shape or profile of prefabricated concrete panels, formwork type, surface finish class and surface treatment, curing and protection methods and concrete strength grade
- The size, details, location, materials and installations of all reinforcement and accessories
- Lifting eyes and picking up points
- Penetrations, core, embedded items, cast-in fixings for in-service and erection and the like

All relevant lifting design documents, including calculations and drawings, shall be submitted to the Western Power representative for review before the commencement of the works. All such documents shall be certified by a qualified practicing chartered professional engineer registered with Engineers Australia.

13.3 Manufacture

13.3.1 General

The prefabricated concrete panels shall be manufactured accurately to the dimensions shown on the drawings per the requirements of AS 3610.1 and AS 3850.2. Notwithstanding these requirements, the position and size of all members shall be such that necessary clearances for later work, fittings, glazing, etc, are maintained and the specified tolerances achieved.

A detailed construction and erection sequence shall be prepared and submitted to the Western Power representative for approval at least ten (10) working days before manufacturing the prefabricated panels.

13.3.2 Dimensional Tolerances

The prefabricated concrete panels shall be manufactured to the tolerances per the requirements of AS 3610.1 and AS 3850.2, except where shown in Table 13.1 below.

Table 13.1: Prefabricated panel tolerances

Criteria	Tolerance (mm)
Width	± 3mm
Length	+0, -3mm
Thickness	+3, -0mm
Plane of face	± 3mm
Diagonals	± 1.5 x linear tolerance
Dowel bar locations	± 5mm

13.3.3 Fixings, Fittings and Cored Holes

Fixings, fittings, and cored holes shall be provided in the prefabricated concrete panels where required. They shall be accurately positioned by using attachments to the forms or other devices.

All screwed sockets, ferrules, and the like shall be thoroughly cleaned out before lifting to ensure that all future fittings can be attached easily. After this cleaning-out, internally screwed threads shall be packed with grease, and a cork inserted in the open end. The threads of projected screw thread rods or bolts shall be cleaned out as in the foregoing, the thread greased, and a protective cardboard sleeve placed over the threaded portion of the rod or bolt.

All lifting fittings, holes, etc, shall be located in the internal faces of all walls in neat even consistent lines. No fittings or connecting bolts, etc, shall be fixed to the exterior faces of the concrete without prior approval by the Western Power representative.

All fittings and fixings shall be patched to neatly squared areas after erection to the approval of the Western Power representative or left with exposed flush fittings, painted, or galvanised and cleaned if designed for exposure and approved otherwise.

Where it is found that any fixtures, including ferrules, bolts, etc., are missing or misaligned, the contractor shall rectify the panels to include all required fixtures at the specified locations. The contractor shall prepare a documented procedure for the repair works and submit it to the Western Power representative for approval before the commencement of the repair works. Where the panels cannot be repaired to the satisfaction of the Western Power representative, they shall be rejected and replaced.

13.3.4 Joints

Joints in prefabricated concrete works shall be prepared per the details on the architectural and relevant project drawings.

13.3.5 Connection Brackets

The cast-in connection brackets shall be supplied and installed for prefabricated concrete and steelwork connections, as detailed on the drawings, or as required by the Western Power representative. Brackets shall be located in positions shown on the drawings to the specified tolerances.

All loose connection plates and steel packers, as shown on the drawings, shall also be supplied, and installed.

13.3.6 Ferrules

The cast-in ferrules, as detailed on the drawings, are to be supplied and installed as required to achieve the performance requirement of the concrete panels.

Ferrules for fixing prefabricated concrete panels shall be positioned within the specified tolerances.

Cast-in metal lifting devices shall be hot-dipped galvanised and have test certificates issued by an independent NATA-accredited testing company.

13.3.7 Bolts and Proprietary Anchors

Proprietary anchors shall be installed only where detailed on the drawings and shall be installed strictly per the manufacturer's written instructions. A torque wrench shall be used to tighten the anchors to the manufacturer's recommendations.

13.3.8 Penetrations

Openings in the prefabricated concrete panels for service penetrations and the like where shown on the drawings shall be provided as required.

13.3.9 Fire Stopping

Approved fire-stopping material packed into the gap around the wall penetrations through fire walls shall be provided. The material and installation shall comply with the National Construction Code of Australia (NCC) and this specification to maintain the fire rating integrity of the wall.

13.3.10 Inspection

No concrete panels shall be poured without inspection and approval by the Western Power representative.

Any prefabricated concrete panels supplied shall still be liable to subsequent rejection by the Western Power representative due to faulty quality, unsatisfactory performance, or damage.

13.3.11 Records

Each prefabricated concrete panel shall be clearly and adequately marked together with the date of casting per the marking plans so that its correct position in the works may be readily identified.

13.3.12 Panel Samples

For surface texture and colour of prefabricated concrete panels, the contractor shall provide samples of size 600 x 600 x 100 thick for each mix type and surface finish specified to the Western Power representative for approval before commencing manufacture. These shall be retained on-site as a permanent record for quality auditing purposes.

13.4 Surface Finishes

13.4.1 General

Prefabricated concrete panels shall be formed and finished to smooth Class 2 finish to the approval of the Western Power representative. Should the surface finish not achieve Class 2 finish, the whole of the exposed surfaces shall be sandblasted to 'salt and pepper' light sanded finish to the direction and approval of the Western Power representative.

13.4.2 Defects

Chips, holes, voids, honeycomb, and such defects of a depth not more than one-tenth of the thickness of the section shall be acceptable if:

- They will not reduce the strength of the panel to less than the required design strength
- The concrete cover to the reinforcement is not reduced to less than the minimum cover required by AS 3600
- The defects will not be obvious to a person in any place that is normally available for access or occupation
- The aggregate area of all defects shall not exceed one per cent (1%) of the total surface area in which the defects occur

Accepting of any patch-up works shall be at the discretion of the Western Power representative.

13.4.3 Discolouration

Prefabricated concrete panel faces which are not specified to be coated, shall be of uniform colour finish and shall not have:

- Stains or discolouration as a result of contact with any deleterious liquid or materials or
- Scuff or scrape marks resulting from handling, transport, or any other actions.

13.4.4 Rectification

If the surface of the prefabricated concrete panels is defective or poor or if such discolouration marks exist and are obvious in the opinion of the Western Power representative and cannot be satisfactorily cleaned because of the nature of the marks, it is required to lightly sandblast the panels to a uniform 'salt and pepper' finish to all other panels in the same interior room space, or the case of exterior face of the building, it shall be required to sandblast the whole of all of the surfaces of the building to provide a uniform colour.

13.4.5 Surface Coating

If any anti-graffiti coating is required, the exterior faces of the prefabricated concrete panels shall be provided with an approved clear anti-graffiti coat or low-gloss finish, as shown on the construction drawings.

All external faces of the prefabricated concrete panels in contact with the ground shall be coated with an approved waterproof membrane as per the manufacture's written instructions.

13.5 Installation

13.5.1 Lifting and Storage

Prefabricated concrete panels shall not be lifted until the concrete compressive strength reaches the value specified on the drawings. The contractor shall submit lifting plans to the Western Power representative for approval. Concrete test reports shall be submitted before any panel lifting. If it is proposed to lift the prefabricated concrete panels before the required strength of the concrete has been fully achieved, the contractor shall submit evidence to the Western Power representative to demonstrate that the panel is fit and safe for this purpose.

Prefabricated concrete panels shall be lifted only by their designated lifting points, as shown on the shop drawings. The design and provision of additional reinforcement and/or strong backs that may be required to suit the lifting procedure are also to be considered, and details supplied to the Western Power representative.

Prefabricated concrete panels shall be stacked on timber spacers in configurations that provide adequate structural support and to minimise warping and dimensional changes.

13.5.2 Handling and Erection

Handling and erection of all prefabricated concrete panels shall be done with extreme care so as not to cause any shock loading, damage, or overstressing. Pick-up points for handling shall be as shown on the shop drawings.

The contractor shall be responsible for all the safe lifting, handling, transportation, and erection associated with the prefabricated concrete panel installation.

The contractor shall submit the following documents, but not limited to those associated with prefabricated concrete panel construction, to the Western Power representative for approval at least ten (10) working days before the commencement of the respective works. All such documents shall be certified by a qualified practicing chartered professional engineer registered with Engineers Australia.

- Lifting and installation plans
- All necessary supporting calculations are fully compliant with WorkSafe WA requirements for transportation, lifting, handling, rigging and erection
- Safe work method statement listing all emergency procedures, risk management assessment, and controls to be in place.
- Detailed construction and erection sequence
- Cranage assessment, including lifting study, layout showing crane locations, outrigger pads and loads, soil bearing capacity requirements, etc.
- Temporary props plan including design of braces and attachments
- Temporary props removal sequence
- Lifting plan shall meet the requirements of Western Power Technical Specification-Transmission Substation Lifting Plan Requirements

Prefabricated concrete panels shall be installed accurately to the line and levels shown on the construction drawings and per the requirements of AS 3610.1, AS 3850.2 and National Code of Practice – Precast, Tilt-up and Concrete Elements in Building Construction.

The contractor shall provide all necessary additional locating devices as may be required to accurately position the prefabricated concrete panels and hold them in position until a permanent connection is completed. All prefabricated concrete panel joints shall be sealed after final positioning as specified.

Before removing any temporary props, the building in-service engineer (structural design engineer) shall inspect and provide written confirmation that the panels have been thoroughly secured to their final position and is safe to remove them.

Cranage assessment shall be undertaken per WorkSafe WA safety requirements and AS 2550 (series). Only experienced personnel with current licences and proven safe equipment/cranes shall be employed for the works. At all times, the structure shall be adequately propped in a stable condition and able to withstand the impact of a vehicle.

The contractor shall consider conditions, such as maintaining safe electrical clearances, site limitations, street access, delivery sequence, transport requirements, inclement weather, and overhead obstructions for the entire duration of all works associated with the prefabricated concrete panel construction.

Grouting shall be provided where required under the prefabricated concrete panels as shown on the construction drawings. Refer to Section 14 of this specification for grouting details.

13.6 Prefabricated concrete cable trenches

This section provides additional requirements over Sections 13.1 to 13.5 to manufacture and install prefabricated concrete cable trenches. Should the contractor opt to construct and install prefabricated concrete cable trenches, then the following, but not limited to, shall be considered:

- To have a minimum of 4.0m long for straight runs
- Allow for all conduits and drainage block outs
- To cast in situ all T-junctions, corner junctions and changes in the widths and levels
- Prepare, compact, level and screed the ground as required per WP Technical Specification before installation of prefabricated concrete modules to ensure modules are fully supported along the length.
- Provide a concrete slab where two different modules form an expansion joint to ensure trench covers sitting or crossing over the joint are supported at the same level. Levelling shims shall be provided if required. The concrete slab shall be a minimum of 100mm thick with the same width as the prefabricated module and support a minimum of 400mm long along each module joint.

14 Grouting

14.1 General

Where indicated on the construction drawings, grouting shall be provided under the prefabricated panels and bearing plates, if any.

Where required, the floor rebate on each side of panels shall be filled flush with the top of the adjacent floor slab.

No grouting work shall commence until the erected panels have been correctly aligned, plumbed, and levelled.

Grout thickness shall be a minimum of 25mm unless specified otherwise.

A detailed grouting procedure shall be prepared and submitted to the Western Power representative for approval.

14.2 Material

Grout material shall be approved cement based pre-proportioned factory packaged proprietary non-shrink type unless otherwise specified. Other grout types, such as epoxy grouts, shall only be used with prior approval from the Western Power representative.

Grout compressive strength shall be a minimum of 50MPa at 28 days unless specified otherwise.

14.3 Workmanship

The concrete surface under the panels and bearing plates shall be scabbled back to sound concrete and thoroughly cleaned. The concrete surface shall be free of all laitance, defective concrete, moisture, oil, grease, debris, and any contaminants before commencement of grouting works. Any bolt holes or fixing pockets shall be cleaned of any dirt, loose materials, or debris.

Chemical scabbling or acid etching shall not be used.

Formwork for grouting shall be provided where required. Formwork shall be made from materials of adequate strength and shall be securely anchored to withstand the grout pressure. It shall be adequately watertight to prevent any leakage.

Concrete surfaces that are to be grouted with a cement based non-shrink grout shall be soaked in water for a minimum period of 8 hours before grouting. Just before grouting, all free water shall be removed from the surfaces, bolt holes and fixing pockets. For epoxy grouts, if used, the surface shall be kept completely dry.

Grout shall be mixed, placed, and cured to the required thickness per the manufacturer's written instructions until the space has been filled solid and free of cavities.

15 Repair of Concrete

15.1 General

Unless otherwise approved by the Western Power representative, repair of all concrete or concrete surface imperfections shall be completed within forty-eight (48) hours after removal of the forms. All concrete repair filling shall be bonded tightly to the concrete surfaces to be repaired and sound and free of shrinkage cracks and drummy areas. Shallow depressions to be repaired shall be cut out to a neat, lined-up and regularly located position to produce an undercut sharp-edge key face.

Defective prefabricated concrete panels shall be replaced and not repaired.

All concrete repair works are subject to approval and acceptance of the Western Power representative.

15.2 Imperfections for Repair

Concrete liable to rejection because of surface defects may, in some cases, be accepted after successful repair of the defects subject to approval by the Western Power representative. The following imperfections shall be repaired:

- Concrete damaged from any cause
- Honeycombed, fractured or otherwise defective concrete
- Concrete surface deviations beyond specified dimensional and/or finish tolerances

- Holes left by the removal of form ties and fittings

15.3 Concrete Repair Materials and Procedures

Concrete repair materials and procedures shall be subject to acceptance by the Western Power representative in each instance. The Western Power representative shall be provided with the details of concrete repair proposals at least two working days before any concrete repair works commence.

Unless otherwise specified, repair of concrete may be by means of using dry pack mortar, replacement concrete epoxy resin, epoxy mortar or cement mortar in which the mixing water contains approved latex bonding admixtures. Preparation and application of repair mortars shall be strictly as per the manufacturer's written instructions.

15.4 Repair of Exposed Concrete Surfaces

Repair of exposed concrete surfaces shall be to the direction and approval of the Western Power representative and to achieve a colour match with adjoining concrete when repair work has been set fully.

Appendix A: Approval Record and Document Control[3]

[3] See Western Power Internal Document