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STRUCTURAL SERVICES DESIGN & CONSTRUCTION CONCRETE PERFORMANCE SPECIFICATION

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1. GENERAL

1.1 Contract Documents

The "General Conditions of Contract", "Special Conditions of Contract" and the "Preliminaries" clauses shall form an integral part of this specification.

This section of the specification shall be read in conjunction with all other sections as the requirements may be interrelated.

In the event of discrepancies between the documents, the following order of precedence shall apply:

- Drawings
- This specification
- General standards

1.2 Scope

The extent of the concrete work shall be as described on the drawings and shall include but not be limited to the following:

- Providing and laying of all vapour barriers, waterproof membranes etc
- Design, supply, erection and removal of all formwork
- Supply and fixing of inserts, anchor bolts, embedded fixings, water stops etc
- Penetrations and embedded services
- Joints and jointing materials
- Supply and placing of reinforcement including prestressing tendons, ducts and anchorages and concrete
- Stressing and grouting prestressing tendons
- Finishing the surface of unformed concrete
- Curing the concrete
- Making good of stressing pockets
- Sampling and testing of concrete
- Manufacture, supply and erection of precast concrete elements

1.3 Responsibility

The Contractor shall be wholly responsible for carrying out the works in accordance with the drawings and this specification.

Any discrepancies in the documents must be referred to the Managing Contractor for a decision before proceeding.

1.4 Standards

All works shall be performed in accordance with the relevant Australia Standard.

The Contractor shall be familiar with the following Australian Standards:

- AS 3600 Concrete Structures
- AS 1302 Steel Reinforcing Bars for Concrete
- AS 1303 Hard Drawn Steel Reinforcing Wire for Concrete
- AS 1304 Welded Wire Reinforcing Fabric for Concrete
- AS/NZS 4671 Steel Reinforcing Materials
- AS 1379 The Specification and Manufacture of Concrete
- AS 3972 Portland and Blended Cements
- AS 3610 Formwork for Concrete
- AS 1012 Methods of Testing Concrete

Part 1 Method of Sampling Fresh Concrete

Part 8 Method for Making and Curing Concrete Compression, Indirect Tensile and Flexure Test Specimens in the Laboratory or in the Field

Copies of AS 3600, AS 3610, AS 1379 and AS 1012 Parts 1 and 8 shall be kept on site for reference purposes.

1.5 Setting Out

The Contractor shall employ a qualified surveyor to set out the works and establish levels. No portion of the works shall encroach over the site boundary.

1.6 Coordination of Services

The Contractor shall be responsible for coordinating all penetrations and services required through all concrete elements. Refer "Embedment, Cores and Fixings" subsection of this specification.

1.7 Inspections

The Contractor shall provide 24 hours notice to The Managing Contractor for an inspection prior to the proposed concrete placement. Concrete shall not be placed until the inspection has been made and any adjustments that are required to formwork or reinforcement have been carried out.

1.8 Construction Procedure

1.8.1 Responsibility

The Contractor is responsible for his construction procedures and shall ensure that no part of the structure is overloaded during the progress of the work.

1.8.2 Construction Joints

Where the structural drawings show the location of joints in the concrete these must be observed. Pour breaks must be agreed with the Managing Contractor prior to commencing work. All costs associated with joint preparation required by the Managing Contractor shall be borne by the Contractor.

1.9 Records

The Contractor shall retain on site records of slump tests, concrete test results, weather conditions under which concrete is placed, and the location of the concrete in the structure.

1.10 Prototypes and Samples

For surface texture and colour of precast concrete make three samples each 600 x 600 x 100 thick for each mix type and surface finish specified. These shall be retained on site as a permanent record for comparison.

2. QUALITY CONTROL

2.1 Quality Assurance

The suppliers of all materials and services, manufactured products, fabricated steel and reinforcement, precast concrete units etc shall provide to the Managing Contractor proof of the quality of the above items and the method of assuring that the required quality is obtained and maintained.

It is the Reinforcing Steelworker's responsibility to ensure that the fixed reinforcement complies in all respects with the drawings and the specification. The Foreman Steel Fixer shall inspect all completed sections of reinforcing steelwork and shall advise the Managing Contractor that the reinforcement is correct and complete prior to any inspection by the Managing Contractor.

3. TESTING AND ASSESSMENT

3.1 General

Concrete supplied to this project shall be subject to assessment as follows:

- Concrete Grade All
- Type of Assessment Production Assessment

3.2 Approved Supplier

All concrete shall be obtained from an approved concrete supplier.

3.3 Sampling for Project Assessment

Sampling shall comply with AS 1379.

If the Contractor requires early strength results, then additional cylinders shall be taken in the sample as required and at the cost of the Contractor. Samples taken to determine stripping or prestressing times shall be stored so as to match the conditions of the tested concrete.

3.3.1 Laboratory

The samples shall be taken by a NATA registered testing laboratory and stored on site in the correct manner, until taken to the laboratory for testing. Sampling procedures shall be in accordance with AS 1012 Part 1.

Concrete test reports shall be submitted to The Managing Contractor as soon as practicable after completion of testing a sample.

3.4 Records for Production Assessment

Where production assessment is specified, the Contractor shall register the project with the concrete supplier and nominate a recipient of production assessment information in accordance with AS 1379. A copy of all information received, including notification of potentially low strength, shall immediately be forwarded to the Managing Contractor.

3.5 Mix Designs

The mix design(s) must be submitted to the Managing Contractor for acceptance for use on the project prior to any concrete being poured. This acceptance will be based upon compliance with the design intent. The mix shall not be varied without permission from the Managing Contractor.

3.6 Mixing of Concrete

All concrete shall be ready mixed concrete transported in a mixer truck. Site mixing will only be allowed in an emergency and with the written permission of the Managing Contractor. Hand mixing will not be allowed.

3.7 Acceptance for Concrete Strength

Acceptance shall be in accordance with AS 3600. The Managing Contractor shall at his sole discretion decide whether the structural adequacy is to be investigated.

3.8 Rejection

The Managing Contractor may reject any concrete after placement because of unsatisfactory finish, incorrect positioning or other failure to conform to the requirements of the drawings and this specification.

3.9 Surface Repair

Concrete liable to rejection because of surface defects may in some cases be accepted subject to the successful repair of the defects. A repair may only be attempted if approval is given, and this should be done as soon as practicable following removal of the formwork.

3.10 Cast-in Elements

Allow for specialised inspection services and engineering testing of any fabricated cast-in plates, ferrules, etc. The nominated Inspection Organisation will be subject to approval by the Managing Contractor. The rate for testing shall be:

Item	Type of Test	Number of Tests
Cast-in plates	Visual inspection	50%
Cast-in plates	N D T (eg Magnetic particle)	10%

4. FORMWORK

4.1 General

All formwork shall be designed and constructed to produce concrete members which will conform within the specified tolerances to the shapes lines, levels, dimensions and surface finish required by the Contract Drawings and this specification.

4.2 Greenstar Requirement for Formwork Credit 20.2 & 20.3

All timber used in the building and construction works must be certified by a forest certification scheme that meets the GBCA's 'Essential' criteria for forest certification (currently FSC or PEFC); or be from a reused source. New formwork must be made from certified timber suppliers to comply with this credit criteria. This credit applies to all new permanent and temporary timber applications within the building and construction works, including but not limited to all formwork and hoardings;

If recycled timber is used, third-party verification must be provided by an auditor registered by the Registrar Accreditation Board Quality Society of Australasia (RABQSA), or other equivalent national or international auditor accreditation system, to confirm the 100% recycled content of recycled timber. The contractor shall ensure all requirements for timber use are met and provide the relevant documentary evidence, as required by the Green Star manual, including a full timber schedule/bill of quantities and Chain of Custody documentation for all timber.

All permanent formwork, cables, pipes, floor and blinds in the project must not contain PVC, or meet Green Star Best Practice Guidelines for PVC in the Built Environment. Reused PVC products may be excluded.

4.3 Responsibility

The responsibility for the sufficiency of the whole of the formwork shall rest entirely with the Contractor.

4.4 Codes and Standards

All formwork shall conform to the current requirements of AS 3610, Formwork for Concrete and referenced Codes therein. Computations where required shall be prepared by a Chartered Professional Engineer experienced in the design of formwork.

4.5 Inspection

The Contractor shall give 24 hours notice to the Managing Contractor of the formwork being completed and ready for inspection.

4.6 Dimensional Tolerances

The dimensional tolerances shall be appropriate for the class of formwork specified and in accordance with AS 3610 (Refer also 4.01).

4.7 Formed Surfaces

4.7.1 Surface Finish

The surface finishes required from the formwork in the various concrete elements shall be in accordance with AS 3610 except where modified by this specification and the Contract Drawings. Formwork shall comply with the following table:

Concrete Element	Formwork Class	Colour Control Type
Buried footings	5	-
Beams, walls and slab soffits	3	-
Slab soffits	2	-

4.7.2 Arrangement of Forms

Where the arrangement of forms and/or the surface finish is an architectural feature the proposed layout of formwork panels and tie bolts shall be submitted to the Managing Contractor for approval.

4.7.3 Corners or Angles

All corners and angles unless otherwise specified, shall be formed with a 45 bevel, 25 mm across the face, by chamfering or filleting the forms.

4.7.4 Form Bolts

Shall be designed and installed so that they may be extracted without damaging the surrounding concrete. All bolt holes shall be caulked-up using 2 sand: 1 cement mortar unless directed otherwise.

4.8 Formwork Design

4.8.1 General

Formwork shall be designed generally in accordance with AS 3610 and this specification.

4.8.2 Loading

The formwork, stripping and re-shoring procedure shall be designed to ensure that the supporting concrete is not overloaded. (Refer to design live loads and superimposed dead loads nominated on the drawings.)

4.8.3 Stability

The formwork and supporting falsework shall be designed for the appropriate vertical and horizontal loading and internal pressures from the placement, vibration and dumping of the concrete, wind loading etc.

4.8.4 Deflection

The formwork shall be designed to withstand the applied loads such that the deflection under load, falsework settlement, and any initial inaccuracy shall not exceed the specified tolerances.

4.9 Cambering of Formwork

4.9.1 General

Formwork shall be constructed to produce the camber in the concrete element where nominated on the drawings.

4.10 Types of Formwork

4.10.1 General

The types of formwork required shall be determined by the Contractor to achieve the surface finishes, shapes, lines, levels and dimensions of the concrete as required by the drawings and specification.

4.10.2 Void Formers

The material and construction used for the forming of voids, block-outs and the like shall be of sufficient strength to prevent deformation under the load of wet concrete and able to be securely positioned and removed cleanly.

Void Formers provided to allow relative vertical movement of structural elements on or in the ground shall be of unwaxed cardboard which will rapidly degrade in the presence of moisture.

4.10.3 Ground Formwork

Where concrete is to be cast on the ground, whether natural or filled, the ground shall be compacted to a firm surface and, if specified, blinding concrete or sand and a vapour barrier laid, all as described on the drawings.

4.10.4 Permanent or Lost Formwork

Where it is not possible or practicable to remove formwork from formed surfaces, provide all necessary permanent or lost formwork.

4.11 Treatment of Forms

4.11.1 Form Linings and Facings

The Contractor shall select the form lining or facing to produce the required finished concrete surface.

4.11.2 Release Agents

Form linings shall be coated with a suitable release agent prior to placing concrete, in compliance with AS 3610, which will not affect the colour or other specified requirements. No part of the reinforcement or adjacent concrete faces shall be coated with release agent.

4.11.3 Colour Control

Where colour control is a requirement, then trial pours shall be made to the satisfaction of the Managing Contractor using known procedures to achieve uniformity.

4.11.4 Cleaning Forms

Forms shall be thoroughly cleaned and dust, debris and rust removed. Before concrete is placed forms shall be "blown-out" to remove dust, minor debris and free water.

4.12 Formwork Openings

4.12.1 Inspection Openings and Tall Members

The Contractor shall develop a written construction procedure for the placing of concrete in tall members. This may require the provision of inspection and pouring openings in the formwork, or construction joints at locations approved by the Managing Contractor. The construction procedure shall be submitted to the Managing Contractor for acceptance with respect to compliance with the design intent.

4.13 Formwork Temperature

4.13.1 Cold and Hot Conditions

When the ambient air temperature is less than 5°C, forms must be warmed by an approved method so that the form faces are above 5°C at the time of concrete placement.

In hot conditions, the forms shall be sprayed with water and/or shaded to prevent the form faces exceeding 32°C prior to concrete placement.

4.14 Stripping and Removal of Formwork

4.14.1 Generally

Stripping and removal of formwork shall comply with AS 3610. In particular, backpropping shall occur progressively as formwork is stripped. Under no circumstances shall whole spans be stripped before commencing backpropping.

4.14.2 Off-form Surfaces

Where off-form surfaces and colour control are important the forms will be required to be in contact with the concrete surface for comparable times, and the stripping times predetermined from trial samples.

4.14.3 Masonry Walls

No masonry walls or other similar permanent loading shall be erected on the structure while it is supported on formwork, or propped.

5. CONCRETE MATERIALS

5.1 General

5.1.1 Responsibility

The Contractor shall be wholly responsible for the supply of the concrete in accordance with this specification and the associated contract documents.

5.1.2 Standards

All concrete and its constituent materials shall comply with the current requirements of the relevant standards, except where modified by this specification.

5.2 Materials

5.2.1 Compliance

Cementitious materials and aggregates shall comply with AS 3600 and referenced standards therein.

5.2.2 Fine Aggregates

Sodium Sulphate Soundness tests in accordance with AS 2758.1 shall be performed on all fine aggregates intended for use in concrete of durability Classifications of "C" or "U".

5.2.3 Aggregate Properties

The maximum permissible water absorption shall not exceed 2%. The Contractor shall advise, with the tender, the proposed method of durability assessment for the aggregate. This shall be selected from AS 2758.1, Clause 10.2. Provide a Certificate of Compliance in accordance with AS 2758.1, Appendix A. Non-conformance assessment shall be by the Referee Sample System described in AS 2758.1, Appendix A.

5.2.4 Admixtures

Details of proposed admixtures shall be submitted to the Managing Contractor for acceptance prior to work commencing. Under no circumstances shall materials containing calcium chloride, other salts or other deleterious chemicals be added to the concrete. The dosage rate for each admixture shall not exceed the manufacturers recommendations.

5.2.5 Greenstar Requirements for Fly Ash Replacement

It is a Greenstar requirement for this project for the concrete supplier to provide concrete with cement content that has been reduced by 40%, measured by mass, using fly ash replacement for all concrete used in this project.

5.3 Concrete Mix Proportions

5.3.1 Responsibility

The Contractor is responsible for the mix design and the production of the concrete in conformity with this specification and the structural drawings. The mix design shall be submitted to the Managing Contractor for acceptance with respect to compliance with the design intent, a minimum of 14 days prior to the proposed commencement of concrete placement. Included in the submission shall be the actual results of drying shrinkage tests if shrinkage limits are specified, and details of all admixtures proposed for inclusion, together with the manufacturers data sheets.

5.4 Concrete Characteristics

5.4.1 Strength Grade

The strength grade is as defined in AS 3600 and is shown on the drawings.

5.4.2 Slump

The slump for the various parts of the work shall be noted in the concrete mix design submission unless specified on the drawings.

5.5 Ready-Mixed Concrete

5.5.1 General

The concrete for every part of the works shall be supplied as ready-mixed concrete from a plant which qualifies for Production Assessment in compliance with AS 3600.

5.5.2 Ready-Mixed Concrete

Ready-mixed concrete shall be supplied in accordance with AS 1379 from a supplier approved by the Managing Contractor. Delivery in non-agitating trucks will not be permitted.

5.5.3 Elapsed Delivery Time

Concrete is liable to rejection if the elapsed time from charging the mixer and commencing mixing exceeds:

- 2 hours in temperature up to 19°C*
- 1½ in temperature of 20°C to 24°C
- 1 hour in temperature of 25°C to 30°C
- 45 minutes in temperature of 31°C to 32°C

* 1½ hours for concrete of Grade 50MPa or greater

5.5.4 Delivery Docket

The Contractor shall ensure that each truck of ready mixed concrete is accompanied by a delivery docket containing the information required by AS 1379.

5.5.5 Added Water on Site

Adding water on site after the initial delivery of concrete to the site will not be permitted.

5.6 Pumped Concrete Mixes

5.6.1 Approval

Approval to pump concrete shall be obtained from the Managing Contractor.

6. REINFORCEMENT

6.1 Reinforcement Supply

6.1.1 General

The Contractor shall supply and incorporate in the work all the reinforcement specified and shown on the contract drawings, including all tie-wires, support bars, spacers, bar chairs and stools necessary to complete the work.

6.1.2 Compliance with Standards

All work shall comply with the relevant clauses of AS 3600 and other relevant standards referenced therein.

6.1.3 Greenstar Requirements for Reinforcing Steel Credit 20.1

All structural must be sourced from a responsible steel maker; and all reinforcing bar and mesh used must be produced using energy reducing processes in its manufacture (measured by average mass by steel maker annually). For a steel manufacturer or a steel maker to be considered a responsible source of steel, they must show that they comply with both of the following initiatives:

- The steel making facilities where the structural and/or reinforcing steel for the project is sourced have a currently valid and certified ISO 14001 environmental management system (EMS) in place. Valid ISO 14001 environmental management system (EMS) certificates must be provided from the steel making facilities where the structural and/or reinforcing steels in the project were produced; and
- The steel maker supplying the steel is a member of the World Steel Association's (WSA) Climate Action Programme (CAP). A current CAP certificate from the WSA, confirming that the steel maker is a member of the CAP, must be provided. Certificates are valid for a period of two years and must be current at the time that the Green Star documentation is submitted to achieve points for this criterion.

For steel reinforcement, energy reduction arising from energy-reducing processes must equate to at least 40 MJ/tonne, measured as a percentage of annual mass of reinforcing steel produced by the steel maker. Reinforcing steel products sourced from a steel maker using a Polymer Injection Technology in manufacturing their reinforcing products is an acceptable method of demonstrating compliance with this criterion.

6.2 Bending, Splicing and Welding

6.2.1 Site Bending

Bending of bars shall be in accordance with AS 3600. If heated, the temperature of the bar shall not exceed 450°C. The Contractor shall submit details of the proposed monitoring technique (heat crayons would be acceptable), and provide written confirmation upon completion of the works that this temperature has not been exceeded.

6.2.2 Splicing

All splices shall comply with AS 3600 and the drawings.

6.2.3 Welding

No welding will be permitted on hot rolled high strength deformed bars without written acceptance by the Managing Contractor. Where welding is permitted it shall comply with AS 3600.

6.2.4 Surface Condition

Reinforcement shall be supplied and maintained free from loose mill scale, loose rust, mud, oil, grease and other coatings which would reduce the bond.

6.3 Fabrication Tolerances

6.3.1 Position of Reinforcement

Unless shown otherwise the reinforcement shall be cut, bent, and fabricated to the dimensional tolerances allowed by AS 3600.

6.4 Protective Coating to Reinforcement

Reinforcing bars specified on the drawings as being galvanised shall be hot-dip galvanised in accordance with AS1650. Bars shall be galvanised before bending to achieve a zinc coating of at least 700 grams per square metre. Damaged surfaces or welded areas shall be made good with an approved organic zinc rich paint applied strictly in accordance with the manufacturer's recommendations.

6.4.1 Un-encased Reinforcement

Reinforcement left projecting for "starter bars" etc and exposed to the weather for prolonged periods shall be coated with an approved cement wash for corrosion protection.

6.5 Placing and Fixing of Reinforcement

6.5.1 Generally

Reinforcement shall be as shown on the contract drawings and shall be securely tied and held in position within the tolerances specified in AS 3600.

6.5.2 Fixing Requirements

Reinforcement shall be secured against displacement by tying at intersections with 1.6 mm diameter annealed iron wire or approved clips or ties. Bend ends of wire ties away from the formed faces so that the wire does not project into the cover.

6.5.3 Supports for Reinforcement

Provide and install spacers, stools, hangers and chairs spaced at not more than 1000 mm. Obtain acceptance from the Managing Contractor for the proposed metal, concrete, or plastic supports to be used. Timber, brick and other porous or degradable materials shall not be used. Unprotected ferrous metal shall not be used in supports that extend to the surface of the concrete. For off-form finish special precautions must be taken and approved by the Managing Contractor.

The supports must be strong enough to support construction activities.

6.5.4 Membranes

In slab on the ground construction bar chair and other support legs must be placed on plastic discs to prevent damage to the membrane and/or sinking into the ground.

6.5.5 Surfaces Exposed to Moisture

Where surfaces are exposed to the weather or water, including those to receive applied finishes, only plastic or concrete spacers and chairs will be used. If concrete spacers are used then these shall be to the same mix as the section of work.

6.5.6 Protection in Hot Weather

Reinforcement shall be sprayed with water to keep the temperature of the steel below 32°C immediately prior to pouring concrete.

During concrete pouring, a reinforcing steel fixer shall be available to correct any damaged or displaced reinforcement.

6.6 Inspection of Reinforcement

The Contractor shall give not less than 24 hours notice to the Managing Contractor of the completion of fixing of the reinforcement. The Contractor shall inspect the reinforcement and correct any defects prior to requesting an inspection by the Managing Contractor.

7. PLACING OF CONCRETE

7.1 Requirements

7.1.1 Responsibility

The Contractor is wholly responsible for the placing of the concrete in compliance with this specification and the contract documents.

7.1.2 Inspections

The Contractor shall give not less than 24 hours notice to the Managing Contractor of the proposed concrete pour and adequate time shall be made available for inspection of the reinforcement prior to the commencement of the pour.

7.1.3 Transporting

The concrete shall be transported to the site in a mixer truck and from the truck to the location on site by means that will not cause segregation, loss of materials, contamination or adversely affect the placement or final properties of the concrete.

7.1.4 Pumping

The Contractor shall obtain approval from the Managing Contractor for the use of pumping equipment and the pumping of concrete.

7.2 Placing

7.2.1 Segregation

The concrete shall be placed in such a manner as to avoid segregation. The placing of concrete shall be by normally accepted practices only, unless unusual circumstances prevail in which case a written construction procedure shall be submitted to the Managing Contractor for acceptance with respect to design intent.

7.2.2 Movement of Concrete

The concrete shall be deposited in the correct location and vibrators shall not be used for moving concrete along the forms.

7.2.3 Joints

Joints shall be in the locations shown on the drawings or as agreed with the Managing Contractor, and to the details shown.

7.2.4 Layers

Concrete in deep members shall be deposited in horizontal layers not exceeding 300 mm thick and each layer compacted before the preceding layer has taken initial set.

7.2.5 Wet Conditions

Concrete shall not be placed in wet trenches or running water or during heavy rain.

7.2.6 Wet Weather

The Contractor shall have adequate covers on site for the protection of fresh concrete surfaces.

7.2.7 Sequence of Pours

Shrinkage effect shall be minimised by pouring the sections of the work between construction joints in such a sequence to allow suitable delays between adjacent pours.

7.2.8 Camber

Where the drawings nominate a camber for slabs or beams, the top surface of the concrete shall be finished to create the nominated camber in a smooth profile between high and low points.

7.2.9 Slabs on the Ground

Where slabs are cast on sand filling or blinding without the use of a vapour barrier, the sand shall be thoroughly wetted just prior to casting in order to prevent excessive water loss from the concrete into the sand.

7.2.10 Compaction

The concrete shall be thoroughly compacted by using poker vibrators, vibrating screeds, and hand methods as appropriate and carefully worked into corners and around embedded fixtures and water bars etc.

Deep concrete sections with top reinforcement may require revibrating to prevent plastic settlement cracking of the top surface. Such cracking in the hardened concrete may be cause for rejection.

7.2.11 Off-Form Surfaces

Where off-form surfaces are specified ensure uniform procedures and times and implement high quality concreting techniques.

7.2.12 Vibrators

Shall be capable of transmitting vibration to the concrete at frequencies in excess of 8,000 impulses per minute. The Contractor shall have a sufficient number of vibrators to adequately vibrate all concrete placed. In no instances shall this be less than two vibrators, with an additional vibrator readily accessible on site as a standby.

7.3 Hot and Cold Water

Concrete shall not be placed when the air temperature is at or above 32°C unless special approved cooling precautions are taken.

Concrete shall not be placed when the air temperature is 5°C or less unless special approved warming precautions are taken.

8. CURING AND PROTECTION

8.1 Requirements

8.1.1 Standards

The requirements of AS 3600 shall apply.

8.1.2 Responsibility

The Contractor shall be responsible for the provision of curing and protection of the concrete.

8.1.3 Protection

Freshly cast concrete shall be protected from premature drying due to hot temperatures and/or drying winds by the use of screens or by spraying the surface with aliphatic alcohol.

Typically, such precautions are necessary when the rate of evaporation from the freshly placed concrete exceeds 0.75 kg per m² per hour. (The concrete supplier should be able to provide a nomograph to enable the rate to be assessed, based on temperature, relative humidity, concrete temperature and wind velocity).

8.2 Curing Methods for Normal Conditions

8.2.1 Methods

During the curing period the concrete shall be cured by an approved method, such as providing an impermeable sheet membrane on a moistened surface, fixed and lapped so that no air can circulate. Slab soffits (where exposed), beam soffits and beam sides may be cured by using an approved curing compound. Columns shall be wrapped in clear plastic sheet taped firmly in position.

8.2.2 Submission

Submit full details of all curing methods proposed prior to commencement of formwork erection.

8.3 Curing Period

8.3.1 Generally

Curing shall commence immediately after the final set of the concrete and continue for seven days. Curing to formed surfaces shall commence immediately following stripping of formwork, and shall continue until seven days after the pouring of the concrete. Rapid drying out at the end of the curing period should be prevented.

8.4 Curing Compounds

Curing compounds conforming to AS 3799 may be used in certain situations with the written acceptance of the Managing Contractor. Curing compounds may not be allowed on surfaces that are to have an applied finish. Concrete with a water cement ration of less than 0.45 should be water cured.

Submit the following information with any request to use a curing compound:

- Certified test results for the requirements of AS 3799
- Evidence that an acceptable final surface colour will be obtained
- Evidence of compatibility of applied finishes, if any

8.5 Protection

The concrete shall be protected from damage due to overstress, and on suspended structures the Contractor shall provide calculations by a Chartered Professional Engineer to the Managing Contractor to justify the adequacy of the structure to sustain construction loads.

8.6 Surface Protection

8.6.1 Generally

All finished concrete shall be protected from damage from any cause such as construction equipment, materials or methods of construction, rain, running water or wind.

8.6.2 Off-Form Surfaces

Completed off-form concrete surfaces shall be protected from mortar splashes and other damage.

8.6.3 Protection Against Staining

Exposed reinforcement, timber and other materials shall be protected to prevent staining of completed surfaces. Timber debris, nails, pop-rivets and other metal shall be removed from finished surfaces to prevent staining.

9. EMBEDMENTS, CORES AND FIXINGS

9.1 Requirements

9.1.1 Responsibility

The Contractor shall be wholly responsible for coordinating cores, penetrations, and cast-in fitments required by various trades. The Contractor shall prepare a drawing showing all of the penetrations and submit it to the Managing Contractor for acceptance, prior to erecting formwork.

In general, penetrations through walls and slabs must have at least 150 mm of concrete between the penetrations. Reinforcement bars shall not be left out or cut to accommodate penetrations without approval from the Managing Contractor.

9.1.2 Welded Members and Ferrules

All welded members (eg cast-in plates) and ferrules shall be available for inspection by the Managing Contractor. Provide sufficient notice for inspection such that should they be rejected, sufficient time is available for rectification prior to casting into the concrete. Refer also to subsection 3.11 for cast-in elements testing.

9.1.3 Protection

Inserts, fitments, and anchor bolts shall be galvanised unless indicated otherwise.

9.1.4 Threads

Projecting threads shall be greased in all embedded fixings and wrapped or covered to protect against damage.

9.2 Integrity of Concrete and Reinforcement

9.2.1 Reinforcement

Reinforcement shall not be cut to provide space for penetrations or embedments. Extra trimming bars shall be provided as shown on the drawings.

9.2.2 Hardened Concrete

Concrete shall not be cut or cored without written permission from the Managing Contractor.

9.2.3 Concrete Cover

Pipes, services or fitments shall at no place have less cover than the reinforcing bars.

10. UNDERLAYS AND MEMBRANES

10.1 Requirements

Location and extent of the moisture barrier or membrane shall be as shown on the drawings.

10.2 Film Moisture Barrier

10.2.1 Material

The material shall be high impact resistant polyethylene film 200 microns thick to AS 1326 ("FORTECON" or similar).

10.2.2 Base

The base shall be blinded with sand to provide a smooth base free from hard or sharp projections and watered down prior to laying the membrane.

10.2.3 Laying

Provide adequate overlaps sealed with pressure tape at each joint.

10.2.4 Repair and Protection

The moisture barrier shall be inspected prior to pouring concrete and any punctures or tears repaired.

10.3 Membranes

When a membrane is required, a detailed specification will be provided. The laying of membranes shall be strictly in accordance with the manufacturers requirements.

11. JOINTS

11.1 Requirements

11.1.1 Location

Joints are generally as shown on the drawings. If the Contractor requires additional joints or joints at different locations, written permission shall be obtained from the Managing Contractor before proceeding. The Contractor shall pay all costs associated with the approval of such joints and necessary redocumentation incurred by the Engineer and/or Architect.

11.1.2 Responsibility

The Contractor shall be responsible for providing joints and jointing as specified.

11.1.3 Standards

Construction joints shall comply with AS 3600. The vertical or horizontal joint surface shall be roughened by vigorously hosing the freshly set concrete with water or by other means approved by The Managing Contractor and providing sound, exposed aggregate concrete. Retarding the set of the surface cement and water washing to remove approximately 2 mm of cement slurry is also acceptable.

If scabbling is carried out, the whole surface shall be scabbled to remove all laitance and to create a surface with an amplitude of roughness of about 2 mm.

11.1.4 Types

The types and details of the various types of joints shall be as shown on the drawings.

11.1.5 Emergency Joints

In the event of an unexpected interruption, the Contractor shall form an emergency joint using the construction joint detail. A decision will be made by the Managing Contractor whether the joint is satisfactory or the concrete should be broken back to a more satisfactory location.

11.2 Period Between Pours

11.2.1 Generally

In order to minimise shrinkage effects of the concrete, a delay between adjacent pours should be observed. Refer to the drawings for details of a "pour strip", where this applies. Do not pour columns and slabs in one operation. Delay pouring the slab at least until the column concrete has achieved its initial set.

11.3 Sawcutting

In slabs poured on the ground saw-cuts shall be made as described on the drawings. The elapsed time from final set to commencement of cutting shall be as soon as practicable without damage to the concrete. This will vary with concrete strength and ambient temperature and may require night-time work. (Use of a Soff-cut saw will allow cutting as soon as the steel trowelling is complete).

11.4 Jointing Material

11.4.1 Generally

Joint fillers and sealers shall be as shown on the drawings. In the absence of a specific detail, seal joints using a closed cell polyethylene backing rod and a two-part polysulphide sealant.

11.5 Water Stops

11.5.1 Location and Extent

The water stops or water bars shall be installed where shown on the drawings.

11.5.2 Types

The types of water stops and water bars shall be as shown on the drawings. These shall be made from polyvinyl chloride unless noted otherwise. Specific product details shall be submitted for acceptance with respect to compliance with the design intent prior to installation.

11.5.3 Workmanship and Support

The water stops and water bars shall be installed to the manufacturers recommendations and be firmly located in position so as to allow compaction of concrete and prevent movement during concreting.

11.5.4 Splicing

Where possible the water stops and water bars should be prefabricated in the workshop. Where joints have to be made on site these shall be heat welded carried out with the correct equipment and by an experienced operator in the correct manner.

11.6 Dowels

11.6.1 Location, Size and Spacing

Dowels shall be provided as shown on the drawings.

11.6.2 Type

Unless otherwise detailed on the drawings, dowels shall be plain round grade 250 bar with sawn ends or, if sheared, with a loose cap taped over the sliding end. The sliding length of the dowel shall be debonded by coating with bituminous paint or another easily visible bond breaker approved by the Managing Contractor.

Except for proprietary dowel systems fixed rigidly to the formwork, dowels shall be supported on continuous N12 reinforcing bars provided solely for that purpose and chaired to the required height. Dowels shall be securely tied to ensure they remain aligned with the axis of the slab and parallel to its surface within a tolerance of 1 in 50.

11.7 Epoxy Grouting of Reinforcing Bars

Drill and epoxy grout deformed reinforcing bars into concrete as shown on the drawings and when specifically instructed by The Managing Contractor. Epoxy grouting is not an alternative construction method to the details shown on the drawings. All epoxy grouted bars shall comply with the following provisions and shall be subject to the approval of the Managing Contractor.

The holes must be drilled with hammer drills. Diamond core drilling is not acceptable.

Holes for vertical bars shall be vertical and holes for horizontal bars shall slope downward at 15.

The depth of the hole and embedment of the reinforcing bars shall be to the minimum depths set out in the table below unless noted otherwise on the drawings.

Deformed Bar Size (mm)	Minimum Hole Diameter (mm)	Embedment Depth Grade 400 Bars (mm)	Embedment Depth Grade 500 Bars (mm)
12	18	220	270
16	22	330	420
20	26	460	580

Deformed Bar Size (mm)	Minimum Hole Diameter (mm)	Embedment Depth Grade 400 Bars (mm)	Embedment Depth Grade 500 Bars (mm)
24	30	610	760

Holes must be dry prior to filling with epoxy unless the epoxy used is suitable for wet holes or underwater application and shall be cleaned out using a stiff bristled wire bottle brush and an oil free compressed air source so that all dust and debris are removed from the side of the hole.

The holes shall be partially filled with epoxy grout prior to inserting the reinforcing bar. Holes shall be filled from the bottom up (rather than pouring from the top). Vertical holes can be filled with a pourable grade epoxy. Horizontal holes must be filled with “plastic” epoxy using purpose made and filled cartridges in a “sealant” gun. Standard cartridges shall be modified by placing plastic hosing over the cartridge nozzle of sufficient length to reach the base of the drilled hole.

After the bars have been placed in position, ensure that the epoxy fills the hole to the surface of the concrete. Top up holes if necessary. Bars shall be placed in the holes, given one turn to expel air voids and shall be fully supported (if necessary) and left undisturbed for at least 24 hours. After 24 hours horizontal bars installed at 15 degree slope can be bent horizontal.

The grout shall be non-shrink. Moisture sensitive epoxy resins shall not be used. If the hole size is larger than the minimum specified, a sand filled grout may be required. The epoxy grouts shall be used strictly in accordance with the manufacturer’s instructions.

12. INTEGRAL FINISHES

12.1 Finishes to Unformed Surfaces

12.1.1 Generally

Slabs and other unformed surfaces shall be finished as described on the drawings, or in the Architectural specification.

12.1.2 Monolithic Finishes

Finishes to horizontal surfaces shall be obtained by finishing with a mechanical rotary trowel to a fine even dense surface, finished off by hand with a steel trowel, leaving a surface without blemish. Edges and corners to be finished by hand to match the adjoining surfaces. Edges of joints and rises to be tooled to a pencil radius. Concrete shall be kept as dry as possible to prevent bleeding and fines shall not be worked up to the surface. Excessive working shall be avoided.

12.1.3 Floor Flatness

The flatness of the finished floors shall be inspected by the Managing Contractor prior to removal of supporting formwork. Provide 24 hours notice of availability of floor areas for inspection. All areas requiring rectification shall be identified at this inspection, and all costs associated with rectification works shall be borne by the Contractor. Proposed rectification methods shall be submitted for acceptance.

12.1.4 Level Tolerance

The floor shall be constructed such that the maximum vertical clearance under a 3m straight edge placed anywhere on a finished surface and resting on two high spots shall not exceed 6 mm.

12.1.5 Workmanship

Only tradesmen skilled in the various operations of concrete finishing shall be employed.

12.2 Applied Finishes

Floor screed and granolithic topping, epoxy and other special finishes shall be as shown on the drawings and specified elsewhere.

12.3 Finishes to Formed Concrete Surfaces

The finishes shall be as nominated in Clause 4.06 Formed Surfaces and/or in the Architectural specification and shall be in accordance with AS 3610.

12.4 Curing of Finishes

Adequate curing of the surface finishes and off-form concrete is necessary to ensure a dense, hardwearing surface free of shrinkage cracks. Curing of off-form surfaces requires a high degree of uniformity to obtain uniform colouring. The type of curing to be as agreed with The Managing Contractor prior to commencement. Trial samples may be requested to demonstrate a satisfactory result.

13. PRECAST “TILT UP” CONCRETE

13.1 General

Precast concrete “tilt-up” panels shall be constructed in accordance with the structural and architectural drawings, this specification and relevant sections of this specification.

13.2 Scope

The extent of precast concrete “tilt-up” panels shall be as shown on the drawings and includes, but is not limited to:

- The supply of all materials, fixings and accessories
- The production of fully detailed and dimensioned shop drawings
- The manufacture of precast “tilt-up” panels
- The storage and delivery to site of panels and provision of all craneage and temporary propping etc
- Installation, levelling, plumbing and fixing of panels
- Making good any damage to panels or their fixings
- Painting or other surface finishes in accordance with the architectural specification

13.3 Responsibility

The responsibility for the manufacture and erection of the precast “tilt-up” panels shall rest entirely with the Contractor.

13.4 Codes and Standards

All work shall comply with the relevant Australian Standard, in particular:

- AS 3600 Concrete Structures
- AS 3610 Formwork for Concrete
- AS 3850 Tilt-up Concrete and Precast Concrete Elements for Use in Buildings
Part 1: Safety Requirements
Part 2: Guide to Design, Casting and Erection of Tilt-up Panels

13.5 Inspection

The Contractor shall give the Managing Contractor 24 hours notice of the formwork, reinforcement and inserts being complete and ready for inspection prior to the pouring of concrete.

13.6 Design for Handling

Generally, the panels detailed on the drawings have been designed for structural adequacy in their final position. It is the responsibility of the Contractor to ensure that the panels are reinforced to meet the requirements of stripping, lifting, transport and erection.

Where galvanised reinforcement has been specified, any additional reinforcement shall be galvanised to a similar standard.

13.6.1 Handling Stresses

The maximum allowable tensile stress in the concrete at any stage shall be $0.6 f_c$ where f_c is the concrete compressive strength at the time under consideration. The number and location of lifting points shall be such that this stress limitation is achieved.

The design work required to satisfy the handling requirements of the precast panels shall be carried out by a Chartered Professional Engineer experienced in work of this type and subject to acceptance by the Managing Contractor. All additional reinforcement and inserts for lifting and temporary restraint together with the crane lifting arrangements shall be shown on the shop drawings.

13.6.2 Lifting Points

Ferrules or other cast-in elements may occur on a visible panel face only with the prior written approval of the Managing Contractor. Where approved, they shall be recessed to allow the surface to be made good after erection.

13.7 Shop Drawings

13.7.1 Generally

Provide fully detailed and dimensioned shop drawings for every panel type and accurate set out drawings showing all dowels, pockets, plates, ferrules etc required in the structure for the support of the panels.

Where the architectural or structural drawings include a panel numbering system, the same numbering system shall be used on the shop drawings.

13.7.2 Approvals

Shop drawings shall be submitted to the Managing Contractor so as to provide ample time for review by the architect and structural engineer and for subsequent correction if required.

13.8 Quality Assurance

13.8.1 Generally

Develop and implement a quality assurance system for the manufacture and erection of precast “tilt-up” panels. The quality assurance system shall comply with the requirements of ISO3902.

13.8.2 Records

Allow for a person experienced in the manufacture of precast panels to inspect and verify the panels at all stages of construction. A proforma shall be used to record verification of:

- Formwork dimensions
- Reinforcement size, support and cover
- Size and location of inserts
- Concrete strength, slump and any special requirements
- Concrete placing and compaction
- Concrete curing
- Visual defects before and after lifting

Number each panel and maintain a separate proforma for each. Submit a sample of the proforma to the Managing Contractor prior to commencing precasting work. Keep proformas on site and make available to the Managing Contractor for review whenever requested.

Each panel shall have its identifying label and casting date stencilled indelibly on its rear face immediately after removal from its forms or prior to casting another panel above it. The labelling system shall comply with the system shown on the shop drawings.

13.9 Materials

13.9.1 Generally

Concrete and reinforcement shall comply with the Concrete section of this specification.

13.9.2 Inserts

Metal attachments and inserts, including brackets, dowels, ferrules, bolts, nuts, washers and plates shall be of structural steel, hot dip galvanised after fabrication, unless stainless steel has been specified on the drawings.

Shims used for levelling panels shall be of rigid plastic.

13.9.3 Release Agents

Release agent, to allow separation of a precast unit from its form (timber, steel or concrete) shall be of a type which will not collect and trap dust and other contaminants which could adversely affect the surface of the concrete. The release agent shall also be compatible with paint or other finishes to be applied to the units.

13.10 Formwork

Formwork shall allow for all cast-in fixing elements to be accurately located and rigidly held in position during concrete pouring.

All edges of the exposed face of panels shall be chamfered 20 mm x 20 mm unless otherwise shown on the drawings.

Where precast units are to be stack cast, the concrete surfaces which are later to become forms shall be finished to ensure panel surface finish conformance with this specification.

13.11 Surface Finish

Comply with the requirements of AS 3610 for a class 2 surface finish for exposed surfaces. Unformed surfaces shall be steel trowelled to achieve a level tolerance of 3 mm within the length of a 3 m straight-edge placed anywhere on the panel.

Precast panels which do not comply with this specification and which, in the opinion of the Managing Contractor, cannot satisfactorily be rectified, shall not be used on the project.

13.12 Reinforcement

Reinforcement shall be securely tied together and ends of tie wire shall be bent away from the faces of the unit. Reinforcement shall be suspended from the formwork in its specified location within the panel or, if approved, supported on plastic bar chairs. Ferrous bar chairs including plastic tipped ferrous bar chairs shall not be used.

13.13 Placing of Concrete

Concrete shall be placed and compacted using a vibrating screed or poker vibrators. If a vibrating screed is used, a poker vibrator shall be used to compact the concrete in corners, around edges and in the vicinity of cast-in fixings.

Strict supervision shall be provided to ensure that reinforcement and cast-in elements are not displaced during concrete pouring.

13.14 Curing

Concrete shall be cured in accordance with the Concrete section of this specification. If sprayed on curing compounds are used, full details shall be supplied to the Managing Contractor at least 14 days prior to their intended use. Such materials must be fully compatible with any paint to be applied to the precast panels.

13.15 Lifting and Handling

Panels shall not be lifted from the forms until the concrete strength, as determined by test cylinders cured under the same conditions as the panels, has attained the strength upon which the design for lifting has been based.

Panels shall be lifted only from the designated lifting points and shall be stored above the ground in a manner which will not result in permanent deformation, staining or other unacceptable blemishes.

13.16 Erection

The Contractor shall be fully responsible for the erection of precast concrete units including access, craneage, propping existing floors for crane loadings, temporary lateral supports etc.

Before erection commences, accurately measure the supporting structure and ensure that the panels will match dowel holes and the supporting structure.

Should it be necessary to use drilled-in anchors to fix panels because of errors in the location of cast-in fixings, the type of anchors shall be subject to approval by the Managing Contractor. In general, chemical anchors will not be acceptable unless it can be demonstrated that they will retain their design strength in a fire.

13.17 Erected Tolerances

The following tolerances shall apply to the erected precast units:

- Width of joints between units ± 5 mm
- Variation in verticality ± 5 mm
- Maximum surface misalignment between adjacent panels 5 mm
- Variation in the level of the exposed top of units ± 3 mm
- Location in plan ± 5 mm

13.18 Grouting

Following satisfactory erection of precast units, the bearing surface of the units shall be grouted using a poured, non-shrink proprietary grout or dry packed mortar.

14. SUBMISSIONS

14.1 Summary of Submissions Required

Clause	Item	When Required
1.10	Prototype of Surface Finishes	Prior to commencement
2.1	Quality Assurance	Prior to commencement
3.2	Concrete Supplier	Prior to commencement
3.3 and 3.4	Concrete Slump and Compression Tests	Progressively
3.5	Concrete Shrinkage Tests	Upon mix approval, then three-monthly
3.6 and 5.3	Concrete Mix Designs	14 days prior to commencement
5.2	Source of Aggregates	Prior to commencement
5.6 and 7.1	Pumped Concrete	Prior to commencement
6.5	Bar Chairs	Prior to commencement
8.2 and 12.4	Detail of curing to be adopted	Prior to erecting formwork
9.1	Coordinated embedments and fixings drawing for all concrete pours	Prior to erecting formwork
9.1	Notice for inspection/testing of cast-in plates, ferrules etc	Prior to installation (allow approximately five days)
14.06	Chartered Professional Engineer	Prior to commencement of precast
14.07	Shop Drawings	Prior to commencement of precast
14.08	QA Proforma	Prior to commencement of precast
14.14	Curing Compound	14 days prior to use
14.16	Drilled-in Anchors	Prior to use
14.5	Water stop/water bar product information	Prior to installation
14.6	Chartered Professional Engineer	Prior to commencement of precast
14.7	Shop Drawings	Prior to commencement of precast
14.8	QA Proforma	Prior to commencement of precast
14.14	Curing Compound	14 days prior to use
14.16	Drilled-in Anchors	Prior to use