WINDIMURRA VANADIUM

DOCUMENT REVIEW AND APPROVAL COMMENT SHEET

PREPARED BY	
Name	Peta Sterrett
Signature	

Document Number	Title
6033-S-00-R-001_1	Concrete Design Criteria

No	Comment

DOCUMENT REVIEW

1 ☑ Approved

2 ☐ Approved as noted – revise and resubmit

3 ☐ Not approved – revise and resubmit

4 ☐ Review not required

Approval does not relieve contractor from full compliance with contractual obligations.

Name DENNIS

Signature

Date 9/4/8

MIDWEST VANADIUM

WINDIMURRA VANADIUM PROJECT

STANDARD SPECIFICATION

FOR

CONCRETE

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CONTENTS

1.0 SCOPE

This Specification defines the minimum requirements for the supply, delivery, placement and curing of reinforced and plain concrete for use in structures, slabs, pits, walls and foundations.

2.0 CODES AND STANDARDS

The work shall comply with all Statutory requirements and the relevant current Australian Standards. The following documents are referred to in this specification:

2.1 Australian Standards

AS 1012	Methods of testing concrete
AS 1141	Methods for sampling and testing aggregates
AS 1214	Hot-dip galvanised coatings on threaded fasteners (ISO metric coarse thread series)
AS 1302	Steel reinforcing bars for concrete
AS 1303	Steel reinforcing wire for concrete
AS 1304	Welded wire reinforcing fabric for concrete
AS 1379	The specification and manufacture of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
AS/NZS 1554	Structural steel welding
AS 2758	Aggregate and rock for engineering purposes
AS 3582	Supplementary cementitious materials for use with portland and blended cement
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS/NZS 3679	Structural Steel – Hot rolled bars and sections
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3972	Portland and blended cements
AS 3990	Mechanical equipment - steelwork
AS 4100	Steel structures
AS/NZS 4671	Steel reinforcing materials

2.2 Codes and Regulations

West Australian Mines Safety and Inspection Act

West Australian Mines Safety and Inspection Regulations

3.0 DEFINITIONS

Approval means by the Engineer and shall be in writing.

4.0 ABBREVIATIONS

AS	Australian Standards
AS/NZS	Australian/New Zealand Standard
ITP	Inspection and Test Plan
NATA	National Association of Testing Authorities

5.0 CONCRETE MATERIALS

5.1 Cement

All cement used for concrete shall be in accordance with AS 3972, of Australian manufacture and purchased from an approved cement manufacturer. Type GP Portland cement shall be used unless noted otherwise on the drawings or elsewhere in this specification. Cement more than three months old from the date of manufacture shall not be used for concrete.

5.2 Aggregates

Aggregates for concrete shall be clean, dense, natural, coarse and fine aggregate complying with AS2758.1. Aggregates shall be clean and free from all deleterious materials including organic matter and clay minerals. Coarse and fine aggregates shall be graded. The maximum aggregate size shall be 20 mm unless specified otherwise on the drawings.

5.3 Mixing Water

Mixing water for concrete shall be free from all deleterious substances. Calcium chloride shall not be added to the mix. Water shall meet the requirements of AS 1379. If there are chlorides or sulphates present in the mixing water, the concentration shall not exceed 1000 ppm chlorides and 500 ppm sulphates.

Water shall not be added to the concrete mix after batching including at the site unless permission to do so is given by the Engineer.

5.4 Admixtures and Additives

The Contractor shall submit full mix design details of the proposed concrete to be used prior to use, pursuant to Clause 6.1.

Approval may be sought to use plasticisers, retarders, admixtures or additives. These may maximise workability and reduce the water/cement ratio and control the setting times. The compatibilities of admixtures with each other, the cement and the aggregate shall be checked to ensure that the steel reinforcement or steel to concrete bond is not adversely affected by the admixture or additive.

The approval of the use of plasticisers, retarders, admixtures or additives shall not relieve the Contractor of the responsibility for providing concrete of the required strength and durability. All admixtures shall comply with AS1478 and be used in accordance with the Manufacturer's instructions.

6.0 CONCRETE MIXES

6.1 General

The Contractor shall be responsible for the design of the concrete mix and ensure that the quality of the concrete supplied complies with the requirements of AS 3600 and AS 1379.

The Contractor shall submit a mix design and results of tests conducted on trial mixes for each of the concrete grades supplied. Review of the mix design by the Engineer shall not relieve the Contractor of responsibility to provide the quality of concrete as specified. Proposed mix is to be submitted 2 weeks prior to use. Specific mix design criteria for each concrete grade are included in Table 1.

Table 1: Concrete Mix Design

Mix Type	Min. Strength Grade [MPa]	Slump [mm]	Max. Aggregate Size [mm]	Typical Application (refer design drawings)
S15	15	80	-	Blinding
N25	25	80	20	Footings (not including pedestals)
N32	32	80	20	All areas not otherwise noted
N40	40	80	20	Wet Process Areas
S50	50	80	20	Wet process areas (refer section 6.1.3 and design drawings)

6.1.1 Slump Tests

Samples of wet concrete shall be taken at the point of placement for slump testing to AS 1012. The slump of the concrete which is not pumped shall be as noted in Table 1 (± 15mm) or approved otherwise by the Engineer. The slump of pumped concrete shall be less than 120 mm (± 15mm). The slump of concrete with admixtures shall be referred to the Engineer, not withstanding an initial slump of 40mm for concrete before the addition of superplasticising admixture.

6.1.2 Concrete Faults

The Contractor shall make no attempt to correct any obvious fault in the wet concrete supplied to site or place any such concrete. The Contractor shall report the fault to the Engineer immediately. The Engineer shall then direct the action required to be taken.

Nothing, including water, shall be added to the wet concrete supplied to site to adjust the slump or vary the texture of the concrete supplied without approval by the Engineer.

6.1.3 S50 Additional Mix Specifications

Further to the mix design parameters shown in Table 1 the S50 mix shall meet the following additional specifications:

- 420 to 440kg GP cement
- 20kg silica fume
- max W/C ratio 0.42
- plasticisers - if required, submit for the approval

7.0 FORMWORK

7.1 Formwork Design

The Contractor shall be responsible for formwork and falsework which shall be designed and constructed in accordance with AS 3610 and the requirements of this specification. The cured concrete shall be of the dimensions shown on the drawings after the removal of the formwork. Formwork shall be designed so that it can be removed without damage to the concrete. Where external form vibration is used, the formwork shall be designed for such.

The Contractor when requested by the Engineer shall submit detailed formwork drawings, calculations, design assumptions and other items as specified for formwork documentation in AS 3610. The information shall be submitted at least 1 week before the proposed erection of the formwork.

7.2 Formwork Construction

Formwork shall be set up and maintained making allowance for any deflection and deformation due to the self weight of the wet concrete. Formwork shall be able to withstand the vibration required for placing wet concrete.

Formwork shall produce a smooth, dense finish and if designed for repeated use shall be kept in good order and repair so that the required standard of finish is maintained. The required finish shall be Class 3 to AS 3610 unless shown otherwise on the drawings.

The formwork face shall be timber, steel, plywood or plastic coated formply to give the required surface finish.

Where thermal curing is required or specified for mass or thick concrete elements the formwork shall be constructed of timber or other suitable insulating material.

All formwork joints shall be run in true vertical or horizontal lines, and shall be closed tight against the leakage of concrete slurry with a suitable type of joint sealant.

Formwork shall be constructed with 20 mm corner fillets so that all exposed external edges of the concrete are chamfered unless shown otherwise on the drawings or advised by the Engineer. Formwork held by bolt and rod assemblies shall have no metal closer to the surface of the concrete than the minimum cover specified on the drawings. The assemblies shall be arranged so that cavities caused by their removal form a regular pattern. All such cavities shall be packed with a suitable non-shrink mortar

7.3 Form Release Agent

An approved form release agent shall be applied in accordance with the Manufacturer's instructions and in such a manner so as not to smear the surface of the reinforcing bar. Should any release agent smear the reinforcement, the bar shall be cleaned.

Form release agents shall not be used where the concrete surfaces are to receive an applied finish unless approved or directed by the Engineer. Form release agents shall be compatible with the curing compounds and shall not affect the bond between the curing compounds and the concrete.

7.4 Clean Out

Prior to placing concrete, all formwork shall be clean and free from wire ends and debris. Where the bottom of a panel is inaccessible from within, access panels shall be provided to permit removal of rubbish before placing concrete. Surplus water shall be drained and any temporary openings closed.

7.5 Inspection of Formwork

Erected formwork for each section of the work shall be inspected and approved before concrete is placed. During the progress of the pour, at least one person shall be provided to ensure that the formwork does not leak. Formwork shall be checked during the pour for excess deflection. Any such deflection shall be brought to the attention of the Engineer.

7.6 Permanent Formwork

Permanent or lost formwork, if required, shall be incombustible, should not contain calcium chloride, and shall not impair the structural performance of the concrete.

8.0 CONCRETE ON GROUND

8.1 Concrete Placed on Earth Subgrade

The installation of blinding concrete, formwork, reinforcement or concrete, shall not commence until the sub-grade has been levelled and compacted and the preparation in accordance to all relevant requirements and has been approved by the Engineer.

8.2 Concrete Placed on Rock

The rock surface upon which concrete is to be placed shall be approximately level, clean, free from oil, water, mud, debris and loose or semi detached or unsound fragments and shall be sufficiently rough to assure satisfactory bond with the concrete. Faults or seams shall be cleaned to firm rock on the sides and to a depth satisfactory to the Engineer. Immediately before concrete is placed, rock surfaces shall be cleaned by an approved method and to the satisfaction of the Engineer.

8.3 Blinding Concrete

Unless shown otherwise on the drawings or directed by the Engineer, a layer of blinding concrete shall be placed under all concrete footings, foundations, and retaining wall bases. Blinding concrete is not required under ground slabs unless founded on rock, then a blinding layer is required. The blinding concrete layer thickness shall be 50 mm unless shown otherwise on the drawings.

8.4 Building Membrane

Where blinding concrete is not required, a layer of building membrane shall be placed on the ground under the concrete unless directed otherwise by the Engineer or shown otherwise on the drawings. The membrane shall separate all unformed concrete surfaces from the ground. Unless shown otherwise on the drawings, the building membrane shall be 0.2 mm thick virgin polyethylene building sheet. The membrane shall be lapped and sealed with polyethylene adhesive tape.

9.0 REINFORCEMENT

9.1 General

Reinforcement shall be provided as shown on the drawings. Unless shown otherwise on the drawings, reinforcing bars shall conform to AS/NZS 4671.

The bar grade shall be:

500N for nominal bar diameters greater than 10 mm.

250R for nominal bar diameters less than or equal to 10 mm.

Steel reinforcement shall be clean, free of flaky rust, oil, grease, paint, formwork release agents, dirt, mud, chemicals or any other substance liable to prevent good steel to concrete bond.

Protective caps shall be fitted on all protruding bars.

9.2 Packaging and Delivery

Reinforcement of the same bar mark shall be bundled and securely tied together. Each bundle shall be labelled on a metal tag with its reference to the reinforcement schedule and drawing.

On site, the reinforcement shall be stored in a dry area clear of the ground surface.

9.3 Cover to Reinforcement

Clear cover over the reinforcement shall be provided as noted on the drawings.

9.4 Fixing Reinforcement

Concrete biscuits, chairs, spacers and hangers shall be used to ensure that the correct cover to and position of reinforcement is maintained prior to and during concrete pouring and vibration. All reinforcement shall be secured in place at intersections and tied together using 1.6 mm diameter annealed iron wire ties.

Unless advised or approved otherwise by the Engineer, the following shall be used for fixing the reinforcement:

9.4.1 Concrete biscuits

Underneath reinforcing mats on ground slabs, footings and foundations and between the reinforcement and the sides of excavations and formwork.

9.4.2 Plastic bar chairs

Underneath reinforcement on suspended slabs and between the reinforcement and the sides of the formwork.

Note: Plastic tipped steel chairs shall not be allowed.

9.4.3 Bent deformed bar spacers

Bent deformed bar spaces are to be used between layers of reinforcing to ensure adequate concrete flow between and around all bars.

9.5 Lap Splices

Reinforcement lap splices shall be installed where shown on the drawings. Where splices are not shown or a variation in the location or number of splices is requested, the details of the proposed splices shall be submitted to the Engineer for approval. Unless shown otherwise on the drawings, the minimum lap lengths shall be as given in AS3600 or Table 2, whichever is greatest. Where splices are not detailed on the drawings, but are approved, the laps shall be staggered by a distance of not less than the lap length.

TABLE 2: Reinforcement Splice Lengths – For bars with less than 300mm of concrete cast below.

BAR SIZE	LAP LENGTH (mm)
N12	400
N16	500
N20	650
N24	800
N28	1000
N32	1250
N36	1500
Fabric	250
Trench Mesh	400

For horizontal bars with more than 300mm of concrete cast below the bar lap lengths are to be increased by 1.25 times.

The lapped portions shall be in contact and securely tied together unless otherwise noted on the drawings.

Starter bars of sufficient length shall be provided at all construction joints.

9.6 Reinforcement Schedules

Unless specifically stated otherwise in this specification, the Contractor shall prepare complete Reinforcement Schedules for the supply and bending of reinforcement. Each Reinforcement Schedule shall refer to the relevant drawing title and number. Each reinforcement bar shown on the drawings shall be identified by the mark number on the Reinforcement Schedule.

The Contractor shall maintain a full set of the bar bending schedules on site for review by the Engineer as required. The Contractor shall supply a copy of the bar bending schedules if requested by the Engineer.

9.7 Welding of Reinforcement

Unless shown otherwise on the drawings, lap or butt welding of reinforcement shall be permitted only with approval from the Engineer. Tack welding of reinforcing bars for rigidity is permitted. Welding shall comply with AS/NZS 1554.3.

10.0 CONCRETE SUPPLY & PLACEMENT

All concrete shall be ready mixed and supplied direct from the batching plant to site by an approved concrete supplier. The concrete shall be in accordance with AS 1379. The concrete shall be supplied wet mixed, unless a dry mix is approved by the Engineer.

Concrete shall not be placed until all forms, reinforcing steel, embedded items and the surfaces upon which the concrete is to be placed, have been inspected and approved by the Engineer.

10.1 Transporting and Placing Wet Concrete

Concrete shall only be placed in good daylight or under such artificial lighting as may be approved.

Unretarded concrete shall be placed less than 45 minutes after wet mixing has started. The placing time of concrete with admixtures shall be referred to the Engineer, pursuant to Clause 5.4 and 6.1.

Concrete shall be transported and placed in such a manner as to avoid segregation and avoid loss of concrete material.

The concrete shall be placed as near to its final required position as possible using suitable tremmies, chutes, kibbles, conveyors, barrows or other approved means. The height of free fall of wet concrete shall not exceed 2.0 m without approval. Vibrators shall not be used to shift the concrete within the forms.

The Contractor shall construct substantial gangways or barrow runs which are supported on stools clear of the reinforcement where it is necessary to transport concrete or to work over reinforcement.

Where a pour is continuous, the time between placement of sequential batches shall not exceed 30 minutes. To avoid the formation of cold joints the working face of the concrete shall be maintained in a workable condition until the next batch is placed.

An adequate labour force shall be available for the work on hand during placement and vibration of concrete.

Wet concrete shall be placed in horizontal layers. Each layer of concrete shall be no more than 500 mm thick. The rate of rise of concrete during a pour shall be in accordance with the formwork design.

A copy of all delivery dockets for concrete delivered to site shall be made available to the Engineer for inspection.

10.2 Pumping of Concrete

The use of pumping as means of conveyance shall be subject to the approval of the Engineer. The Contractor shall submit the following information for consideration prior to pumping concrete:

- Description of equipment.
- Concrete mix design including slump and maximum aggregate size.
- Standby arrangements.

The pump shall deliver a continuous column of concrete to the job without air pockets and other voids. When pumping is completed, the quantity of concrete remaining in the pipe may still be used providing that it can be ejected without contamination of concrete or separation of ingredients. After each operation the entire equipment shall be thoroughly cleaned, and debris and flushing water shall not be discharged into formwork.

The Contractor shall be responsible for carrying out trials to confirm the pumpability of the proposed concrete mix.

10.3 Concrete Compaction

10.3.1 Immersion Vibrators

Concrete shall be compacted using suitable immersion type mechanical vibrators. The compacted concrete shall be free from any pockets of air and coarse stone and closed tightly against all the surfaces of forms, reinforcement and embedded items.

Vibrators shall be inserted vertically into the concrete as quickly as possible and then held stationary until the air bubbles rise to the surface.

Each vibrator shall be held within 30° of vertical in the wet concrete for at least 10 to 20 seconds at each vibration spot. The maximum spacing of the vibrator spots shall be 500 mm. The size of the vibrator used shall be appropriate for the thickness of the concrete being vibrated and the space between reinforcing.

One vibrator shall be provided for every 10 m^3/hr of concrete placed. At least two working vibrators and one standby vibrator shall be provided. All vibrators shall be test run prior to commencing the concrete pour.

Each layer of concrete placed shall be compacted before the preceding layer has taken the initial set. The vibrator head shall pass down at least 100 mm into the preceding layer. The vibrator shall have minimum contact with the formwork and reinforcement. After compaction, the vibrator shall be slowly withdrawn from the wet concrete.

10.3.2 External Vibrators

Where practical, vibrating beam screeds should be used for compacting slabs less than 200 mm thick and external form vibrators may be used for walls less than 200 mm thick. Details of the proposed screeds and equipment shall be provided to the Engineer.

10.4 Weather Requirements

10.4.1 Inclement Weather

Unless cover is provided, concrete shall not be placed under inclement weather conditions. Wet concrete shall be protected from falling rain.

10.4.2 Wind Shields

Prior to pouring concrete, wind shields shall be erected on windy days when the wind speed exceeds 7 m/s (25 km/h). The wind shields shall protect the concrete surface from premature drying. The shields shall remain until concrete curing is in place.

10.4.3 Hot Weather Concreting

For hot weather concreting and on windy days, an approved aliphatic alcohol evaporation barrier shall be applied to the curing concrete surface. Hot weather shall mean when the ambient air temperature is greater than 32°C. The concrete mix temperature shall not exceed 32°C. When the ambient air temperature in the shade is greater than 32°C, a suitable means shall be provided to avoid premature stiffening of the concrete placed in contact with hot dry surfaces. These means shall include the following and as directed by the Engineer.

- The surfaces against which concrete is to be placed, including reinforcement and formwork, shall be sprayed with water in advance of concreting and excess water shall be removed from the inside of the forms immediately prior to the placement of concrete.
- The reinforcement, and the formwork if metal forms are used, shall be protected from the effects of hot winds and direct sunlight.
- The concrete shall be held to a temperature not higher than 32°C when placed by using chilled mixing water, spraying the coarse aggregate with cold water and/or covering the container which transports the concrete.
- Evaporation retardant shall be applied to the working face of the concrete pour to alleviate the potential for cold joints between concrete deliveries. The evaporation retardant shall also be applied immediately on commencement of the initial screeding of the concrete surface and shall be reapplied immediately after each rescreeding.

10.4.4 Cold Weather Concreting

Concrete shall not be poured when the ambient air temperature is below 5°C.

11.0 CONCRETE JOINTS

Concrete joints shall be installed in the locations and to the details shown on the drawings unless approved otherwise by the Engineer.

11.1 Schedule of Joints

Where construction joints are not shown on the drawings or where additional joints are considered necessary by the Contractor, a schedule showing the location of the proposed joints shall be submitted for approval to the Engineer 1 week prior to pouring concrete.

11.2 Control Joints

Control joints for ground slabs shall be constructed where shown on the drawings or advised by the Engineer.

11.3 Joint Preparation

The surfaces of set concrete to which new concrete is to be bonded to, shall be thoroughly scabbled to expose the coarse aggregate (protruding 5mm but firmly fixed in the concrete matrix) and cleaned of all laitance and loose, broken or foreign material. The surface shall be made damp, but have no free water, prior to the pouring of fresh concrete.

The Engineer may order the application of cement slurry or bonding agent prior to the placement of new concrete.

11.4 Joint Filler

Joint filler product to be as nominated on the drawings. Note that for joints which will be sealed, polystyrene foam is not permitted for use as a joint filler. Prior to placing the joint sealant, the joint shall be clean and primed.

11.5 Joint Sealer

Where a joint sealer is required, a two-part polysulphide or polyurethane product shall be used as shown on the drawings. The sealant shall be used in accordance with the Manufacturer's instructions. For vertical joints or joints where a pouring grade sealant is not suitable, gun grade shall be used.

Where a joint sealer is specified and the arris is not true, the arris shall be repaired using an approved epoxy based repair material.

Joint sealing shall not take place sooner than 28 days after pouring of the concrete or in accordance with the manufacturer's requirements unless approved otherwise by the Engineer.

12.0 HOLDING DOWN BOLTS AND EMBEDDED STEEL

12.1 Design

Unless noted otherwise on the drawings, holding down bolts shall be made of merchant bar rounds of Grade 250 or 350 steel which complies with AS/NZS 3679.1.

Except for alloy steels, all steel holding down bolts, nuts, washers and embedded steel (except steel reinforcement) shall be hot dip galvanised, unless noted otherwise on the drawings.

Holding down bolts shall be supplied complete with nuts and washers. One nut and one washer shall be fitted to each bolt, unless shown otherwise on the drawings.

Tolerance tubes shall be made from 1.5 mm thick galvanised steel sheet.

Steel fabricated items for concrete shall comply with AS 4100.

12.2 Construction

Threads for holding down bolts shall be covered. Bolts shall be protected against damage during transport, the placement of concrete and other activities.

All voids of sleeves and inserts shall be sealed with a blockout which shall be removed by the Contractor using non-chemical means, and fully grouted, prior to or at the time of grouting under the baseplate if applicable.

The Contractor shall remove concrete from the projecting portion of holding down bolts, thoroughly clean and grease the threaded portion and fit washers and nuts.

12.3 Tolerances

Holding down bolts and embedded steel shall be firmly fixed in position, preferably by templates, whilst the wet concrete is being poured and compacted.

The following tolerances shall apply to the location of holding down bolts and embedded steel, (except reinforcement), unless shown otherwise on the drawings or approved otherwise.

- Absolute bolt position ±3 mm
- Bolt projections from the specified concrete level or line +5 mm, -0 mm
- Embedded steel shall line up with relevant concrete surfaces to within ±2 mm
- Bolt reduced level +5 mm, -0 mm
- Tolerance on verticality of any bolt 1:300
- A pre-concrete pour survey and a post pour survey shall be provided for all the critical bolts.

13.0 PROTECTION, CURING AND STRIPPING

13.1 Protection of Concrete

After completion of concrete placement, the Contractor shall protect all concrete against damage due to load overstress, heavy shock and excessive vibration during the required curing period or disfiguration caused by construction plant until final acceptance by the Engineer. When the ambient temperature in the vicinity of the works is likely to reach or exceed the range 5º C to 32º C, the Contractor shall protect all concrete in accordance with the requirements of AS 3600 and this specification and any additional requirement deemed necessary by the Engineer.

13.2 Curing Methods

13.2.1 General

All concrete surfaces shall be cured by treating with a curing compound as soon as the surface is accessible and then be wet cured for a minimum period of fourteen (14) days.

Formed units shall undergo cure and protection measures immediately upon formwork removal. The type curing compound adopted shall be submitted to the Engineer for approval 1 week prior to its use.

Water curing by the placing and wetting/flooding of foam mats with a suitable sprinkler or hose system shall be used wherever possible. Curing shall commence as soon as the concrete has hardened sufficiently to prevent surface damage. Mats are to be a minimum of 20mm thick foam blankets, (Joyce L16/100). Unless sealed with polythene sheeting or other medium, all concrete shall be kept moist by spraying with water throughout the curing period.

Surfaces subjected to rainfall within 3 hours of the compound being applied, or surfaces damaged by subsequent construction operations within the curing period, shall be resprayed in accordance with the manufacturer's instructions to achieve a finish pursuant to the original required finish.

Curing compounds shall not be allowed to come into contact with the surfaces of construction joints.

Plastic cracking greater than 0.3mm wide during the curing period will be subject to repair using a repair procedure approved by the Engineer.

13.2.2 Curing in Hot Weather

When the surrounding air temperature is 32ºC or above, an aliphatic alcohol compound, eg Confilm, shall be applied immediately after screeding to reduce moisture loss.

Any plastic cracks that occur after final finishing and before curing commences are to be locally reworked (with minimal water spray if necessary) to remove them, prior to curing.

13.3 Formwork Stripping

13.3.1 Stripping Time

For all classes of surface finish, the formwork shall remain in place for a period of at least the stripping time shown in Table 3. Type GP or SR Portland cement has been assumed for the concrete mix. In Table 3 it has been assumed that the three day strength of concrete is at least 45% of the characteristic compressive strength at 28 days, and the seven day strength is at least 75% of the characteristic compressive strength. If the concrete test strengths at three or seven days are not sufficient, then the stripping times shown in Table 3 shall be increased proportionally.

Stripping of the formwork is to comply with the requirements of Section 19.6 of AS3600, where these are more stringent then the requirements of this section.

TABLE 3: Minimum Formwork Stripping Times

FORMED SURFACE	FORMWORK COMPONENTS	HOT CONDITIONS > □20	AVERAGE CONDITIONS C□20□>C□12	COLD CONDITIONS C□ 12□
Vertical and sloping walls	Form face	1 day	2 days	3 days
Columns	Form face	2 days	3 days	4 days
Beams and slab soffits	Form face	4 days	6 days	8 days
	Supporting members (eg., backprops, shores)	12 days	18 days	24 days

13.3.2 Stripping Approval

Formwork shall not be stripped without approval by the Engineer. Unless shown otherwise on the drawings props for suspended slabs and beams shall remain in place for at least the durations shown in Table 3.

14.0 CONCRETE FINISHES TOLERANCES & REMEDIATION

14.1 Finishing of Concrete Surfaces

14.1.1 Blemishes

- Shebolt holes shall be plugged. Where required to achieve the surface finish specified, fins and formwork blemishes shall be removed from the exposed concrete surface. Where protective coating is required to be applied, fins shall be removed by grinding.

- Details of the proposed method of repair or replacement for all defects in the concrete surface shall be submitted in writing for approval by the Engineer before proceeding with repairs or replacement.

14.1.2 Concrete Finish

- Unless noted otherwise on the drawings or directed by the Engineer, the finishes of top surfaces shall be in accordance with the following:

- **Class U1: Screeded**

  This finish is generally used for footings and machinery foundations which are to be covered with backfill. Wood floating will also be required where surface plastic shrinkage cracks occur.

  Surface flatness deviations shall not exceed 10 mm in 3 m when measured with a 3-metre straight edge.

- **Class U2: Floated**

  This is a non-skid finish for slabs that will not be exposed to slurries and slabs that are to receive epoxy or similar coatings. Hand or power-driven floats may be used. Where a hand float is used the final polishing operations shall be omitted. The Engineer may specify a follow up with a sponge float.

  Surface flatness deviations shall not exceed 5 mm in 3 m when measured with a 3-metre straight edge.

- **Class U3: Steel Trowel**

  This finish is for the tops of walls and dry area slabs such as workshops, stores, switchrooms and other buildings; and slabs to receive thin pavings bedded in adhesives such as non-rigid tiles. The Engineer will specify the required smoothness of the surface.

  Surface flatness deviations shall not exceed 3 mm in 3 m when measured with a 3-metre straight edge.

- **Class U4: Broomed**

  This is a non-skid finish for slabs exposed to slurries. Following initial steel trowelling a fibre bristle broom shall be dragged across the surface.

  Surface flatness deviations shall not exceed 5 mm in 3 m when measured with a 3-metre straight edge.

14.2 Tolerances

Tolerances as nominated in AS 3610 and AS 3600 shall not be exceeded.

14.3 Defective Concrete

14.3.1 Concrete Faults

Any portion of the concrete placed in the work may be classed as defective concrete by the Engineer if any of the following occur:

- The Contractor did not obtain the Owner Representative's prior approval of materials and work as specified.
- The finished concrete dimensions do not conform with those shown on the drawings subject to the tolerances specified.
- There is evidence of segregation of the components within the concrete mix, or air voids in the concrete.
- There is evidence of damage to the concrete caused by the removal of formwork, or operation of plant or storage or transporting of materials.
- There are shrinkage cracks in the concrete caused by insufficient curing or any other reason.
- Any of the performance criteria in accordance with AS 3600 and this specification is not complied with.

14.3.2 Repair of Defective Concrete

Defective concrete components, mortar or grout shall be repaired or completely or partially removed and replaced by the Contractor under the direction and to the satisfaction of the Engineer. Repairs or replacements shall be subject to all specified requirements including curing.

14.4 Remedial Work

14.4.1 Concrete Repair Work

Repair of hardened concrete shall be performed by skilled workmen. The Contractor shall keep the Engineer advised as to when repair of concrete will be performed. Unless inspection is waived by the Engineer in each specified case, the repair of concrete shall be performed only in his presence.

The Contractor shall correct all imperfections on concrete surfaces to produce surfaces that conform to the requirements of this specification.

Unless otherwise directed by the Engineer, repair of imperfections in formed concrete shall be commenced within 24 hours after removal of the forms or, in the case of unformed concrete, within 24 hours after the placing of concrete. An approved repair method shall be used.

Repairs to concrete shall comply with the requirements of AS 3610.

Proposed methods of repair are to be submitted in writing to the Engineer for approval prior to commencing repair work.

14.4.2 Cracks

Pre-hardening cracks (plastic settlement and plastic shrinkage cracks) which occur before initial set takes place can be rectified by re-vibration of the surface and re-screeding or re-trowelling.

Shrinkage and contraction cracks shall be repaired by an approved method using an approved epoxy system. The repair shall be to the satisfaction of the Engineer.

15.0 INSPECTION AND TESTING

15.1 Mix Design and Testing

- Normal Class Concrete

  Production assessment shall be in accordance with AS 3600.

- Special Class Concrete – Project Assessment.

  The mix design (including admixtures) shall be submitted for approval at least two weeks prior to delivery to site.

  No less than 3 test cylinders shall be taken per 25 m^3 of concrete per pour with a minimum of 3 test cylinders taken per pour.

15.2 Test Certificates

The Contractor shall supply the originals or copies of the NATA endorsed Test Certificates to the Engineer. The Test Certificates shall include the pour date, location, docket number, measured slump, specified slump, strength and age at testing and the test cylinder size used.

15.3 Test Non-Compliance

The Engineer shall be informed of any non-complying concrete samples immediately the test results are known. Concrete which does not comply with slump or compression test requirements may be rejected at the discretion of the Engineer.