STRUCTURAL WORKS SPECIFICATIONS

WESTERN SYDNEY SCHOOLS

2304785T – MAY 2017

Vol 2

Rev	Date	Details
1	28/02/18	Schematic Design
A	11/10/18	Tender Issue

PREPARED BY: WILLIAM SMITH

WSP
LEVEL 27, 680 GEORGE STREET
SYDNEY NSW 2000
GPO BOX 5394
SYDNEY NSW 2001

TEL: +61 2 9272 5100
FAX: +61 2 9272 5101
wsp.com

TABLE OF CONTENTS

NOTE TO TENDERERS:

These specifications have been developed using NATSPEC, and The Educational Facilities Standards & Guidelines (EFSG) Specifications. It will be the Contractors responsibility to check that they are working to the latest EFSG Specifications which are available on the EFSG website. (https://efsg.det.nsw.edu.au/)

PILING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide installed piles which carry the design loads within the required settlement limits/acceptance criteria and with pile heads ready for incorporation into the structure.

Performance

Requirements: As documented in the pile loading schedule in the structural drawings.

Design

General: Design piles which, when properly installed, meet performance requirements.

Designer: Contractor

In addition to the design loads, certain minimum prescriptive requirements are specified, which may include system type, materials, minimum sizes and depths, protection methods, et cetera. The contractor is required to design the system subject to these limitations, and to provide whatever additional information is necessary to define it contractually.

The contractor shall provide, as part of its tender, the additional information required to define the proposed system characteristics; and may be invited to submit alternatives to the specified system.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete in-situ.*
- *Concrete reinforcement.*
- *Structural steel.*

1.3 STANDARD

General

Standard: To AS 2159.

1.4 INSPECTION

Notice

Inspection: Give sufficient notice so that inspection may be made of the following:

- Setting out.
- Piles and piling material after delivery to site and before installation.
- Installation of piling.
- Pile heads after preparation.
- Pile load tests.
- Concrete piles:
  - . Reinforcement cages after assembly and before installation.
  - . Excavated shafts, including casings and sockets before placing reinforcement.
  - . Reinforcement in excavated shafts, before concreting.
  - . Concreting of piles.

1.5 TOLERANCES

General

Requirement: To AS 2159 Section 7 and as documented in the **Tolerances schedule**.

1.6 SUBMISSIONS

Design

Performance: Submit calculations demonstrating that the proposed piling will meet the performance requirements. Submit the sources of geotechnical information and design parameters used in the calculations.

Safety: Submit calculations demonstrating that the piles can be safely installed to the specified levels by the proposed methods, without damaging the piles or adjacent piles or structures.

Splices: Submit details of proposed splices supported by appropriate professional engineer's documentation.

Design depth: Submit details of pre-drilling and lateral support of preformed pile driving to achieve final design set where the toe level is determined by excavation for adjacent structures.

Execution details

Equipment: Submit details of proposed piling methods, equipment and sequence.

Jetting and pre-boring: If jetting or pre-boring methods are proposed in conjunction with pile driving, submit details of the proposed equipment and methods.

Concrete piles: Submit proposal for using high alumina and early strength cements.

Warranty: Submit details of the proposed warranty for the piling.

Submit: Record of data for piles showing information in AS 2159 clause 7.7.

Preservative treated timber piles: Submit treatment records.

Rectification: Submit details of proposed warranty to correct faults and rectify damage which is caused by the pile installation or subsequent movement to that part of the superstructure supported on the piling, or to adjacent property, or to both.

Subcontractors

Subcontractor: Submit name and contact details for the proposed subcontractor specialising in foundation engineering.

Tests

Other tests: Submit results, as follows:

- Load tests report.
- Acid sulfate soil test.
- Site geotechnical investigations: Submit all findings including Cone penetration test (CPT), sampling analysis and water table information.

Noise and Vibrations

General: Piling installation procedures and equipment shall not cause excessive noise and vibration and comply with the relevant codes and specific requirements referred to in "Information for tenderers"

- To AS 1055: Acoustics – description and measurement of environmental noise.

- To AS2436: Guide to noise control on construction, maintenance and demolition sites.

-For work near existing buildings, structures and underground services, construction methods shall be adopted which will minimise ground vibrations. The contractor shall bear all costs associated with any claim for damages resulting from the effects of ground vibration directly caused by the Contractor's construction methods, The cost of such damage shall be in addition to damage caused by other action attributed to the Contractor's work.

Warranties

Requirement: Submit a warranty to correct faults and make good damage which is caused by the pile installation or subsequent movement to that part of the superstructure supported on the piling, or to adjacent property, or to both.

General: Provide warranty for the required period.

Warranty period: 7 years

2 PRODUCTS

2.1 TIMBER PILES

Standards

General: To AS 1720.1 , AS 2159 and AS 3818.3.

Untreated hardwood piles

Timber species: To AS 3818.1 with natural durability complying with AS 3818.1

Durability class to AS 5604: Class 1 or Class 2

Strength group to AS/NZS 2878: To be approved by the structural engineer

Treated timber piles

Timber Type: Hardwood

Species: [complete/delete]

Durability class to AS 5604: To be approved by the structural engineer

Strength group to AS/NZS 2878: To be approved by the structural engineer

Preservative treatment

Preservative treatment: To AS1604.1. Refer to AS 2519 Supp1 Clause 4.3.1. Obtain manufacturer's recommendations for preservatives suited to the species of timber and exposure hazard

Preservative chemical:

Acidic groundwater: Creosote

Alkaline groundwater: Waterborne multi-salt (CCA).

Identification:

Disc location: On the butt end.

Disc format: 3.

2.2 CONCRETE AND GROUT PILES

Standard

Concrete: To AS 1379 , AS 2159 and AS 3600.

Grout: To AS 3600 and AS 3972.

Steel reinforcement: To AS/NZS 4671.

Durability

Concrete strength: To AS 2159 Table 6.4.3.

Grout strength: To AS 2159 Table 6.4.3.

Minimum cover to reinforcement: To AS 2159 Table 6.4.3. but not less than 40mm or as specified on the structural drawings

Restrictions on chemical content in concrete pile: To AS 3600 and AS 5100.5 for 100 year design.

Crack width: < 0.3 mm.

Tests

Moisture content: Testing for grout to ASTM C566 with expansion less than 4%.

Minimum cement content

Generally: 320 kg/m^3.

High alumina and high early strength cements

General: Do not use.

Reinforcement

Standard: To AS/NZS 4671.

Cover: Provide spacers on the reinforcement cage to maintain the correct cover. During installation of reinforcement in uncased holes keep the reinforcement cage clear of the sides of the hole.

Minimum cover (mm): To AS 2159 Table 6.4.3. but not less than 40mm or as specified on the structural drawings

2.3 STEEL PILES

Standards

General: To AS 2159 and AS 4100.

Steel tubes: To AS/NZS 1163 , AS 1450 , AS 1579.

Structural steel: To AS/NZS 1594 , AS/NZS 3678 , AS/NZS 3679.1 and AS/NZS 3679.2.

Durability

Steel grade: 300

Exposure classification: To AS2159 Clause 6.5.2.

Uncoated steel: To AS 2159 clause 6.5.3.

Coating protection system: To AS/NZS 2312.

Cathodic protection: To AS 2832.2 or AS 2832.3 , as appropriate.

3 EXECUTION

3.1 GEOTECHNICAL

General

Refer to the geotechnical engineer for all requirements

3.2 INSTALLATION

Adjoining property

Damage: If damage is caused to adjoining property, stop piling operations and give notice.

Setting out

Requirement: Peg the position of each pile and establish a grid of recovery pegs to enable the setting out to be checked. Provide survey record of in situ piles.

Method of installation

Type: As specified on the drawings, or an alternative agreed to by the structural and geotechnical engineer.

Inspection

General: Provide facilities necessary for inspection of piling including safe access, lighting and ventilation.

Monitor: Maintain pile integrity during driving. Stop and re-assess hammer type/size/drop if damage is detected.

Piling system

Installation: To AS 2159 Section 7.

Concrete bored piles:

- Loose material: Do not allow loose material to fall down pile holes before or during concreting.
- Liner: Pack well into position.

Pile capacity

Requirements: As documented on the drawings

Overdriven piles

General: If the pile is driven below the specified level, give notice.

Records of data

Ground level: Record the level of the surrounding ground at the time when the pile is installed.

Records: During installation, keep records to conform to AS 2159 clause 7.7.

3.3 TESTING

Load tests

General: Refer to the recommendations from the geotechnical engineer.

Data: Record the results of the pile load test in accordance with AS2159

Failure: If a test pile fails to meet the load test requirements, give notice.

Additional requirements

Maximum differential settlement between adjacent piles (not in the same pile group) or pile groups shall not exceed 10mm including elastic shortening under load, or less if specified by the structural engineer. Maximum differential settlement at the top of adjacent piles within a group shall not exceed 3mm (including elastic shortening under load).

Concrete and grout

During installation: Sample and test concrete/grout to the AS 1012 series.

Preservative treated timber piles

Testing to AS 2209 Appendix E.

3.4 PREPARING PILE HEADS

General

Requirement: Prepare pile heads for inclusion into the structure.

Defective material: If the pile at or below cut off level, is damaged by driving, or is otherwise unsound, give notice.

Concrete piles

Preparation: Roughen the surface at cut-off level. Clean and straighten any projecting reinforcement.

Steel piles

Preparation: Clean the surfaces which will be embedded in concrete. Remove temporary protective treatment where appropriate, but maintain intact for at least 75 mm inside encasing concrete.

Timber foundation piles

Cutting: Cut off piles a minimum of 0.5 m below ground line perpendicular to the axis of the pile.

Clean: Remove debris and sharp edges from exposed areas and coat with a 5 mm thick layer of copper napthenate emulsion.

Cover: With impervious plastic membrane, overlap the sides of the pile by at least 50 mm and secure with wire around the circumference of the pile.

.

4 SELECTIONS

4.1 SCHEDULES

Tolerance schedule

Property	**Permitted deviation**
Position in plan (mm)	75mm in any direction
Cut-off level (mm)	+0mm or -20mm
Cross sectional dimensions	Not less than the nominated dimension at any point along the pile length
Straightness	Not more than 2%

CONCRETE FORMWORK

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide formwork, so that the concrete when cast in forms will have the required:

- Dimensions
- Locations
- Profile
- Shape
- Surface Finish

Provide finishes to formed concrete surfaces which are as follows:

- Appropriate to the importance of (visual or physical) concrete elements
- Compatible with the following trades and finishes

Design

Formwork: The design and certification of ALL formwork is the contractor's responsibility. Allow for dimensional changes, deflec and cambers resulting from thefollowing:

- Imposed actions.
- Concrete shrinkage and creep.
- Temperature changes.
- The application of prestressing forces (if any).

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete finishes*.
- *Concrete in-situ*
- *Concrete post tensioned*
- *Concrete reinforcement*

1.3 STANDARDS

General

Formwork design and construction: To AS 3610 and AS 3610.1.

Plywood formwork: To AS 6669.

Profiled steel sheeting, including shear connectors: To AS 2327.1.

Reinforced concrete construction: To AS 3600.

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions apply:

- Formwork:
  - . Jump formwork: Incrementally moved formwork.
  - . Lost formwork: Sacrificial formwork left in place.
  - . Slip formwork: Continuously slipped or moving formwork.
  - . Table forms: Prefabricated and reusable formwork systems for slabs and beams.

1.5 INSPECTION

Notice (DO NOT PROCEED WITHOUT PRIOR WRITTEN APPROVAL)

Inspection: Give sufficient notice so that inspection may be made of the following:

- Completed formwork before placing concrete.
- Used formwork, after cleaning and before re-use.

1.6 TOLERANCES

Formwork

Plumb of elements > 8 m high: 1:1000.

Plumb of elements ≤ 8 m high: To AS 3600 or AS 3610.1, whichever is more stringent.

Position: Construct formwork so that finished concrete conforms to AS 3600 clause 17.5.2 and as documented in the **Dimensional deviations schedule**.

1.7 SUBMISSIONS

Calculations

Formwork calculations: Submit calculations by a professional engineer experienced in formwork design to show that allowable concrete stresses will not be exceeded and formwork capability will be maintained for the following:

- Proposed formwork procedures or loadings which differ from those documented.
- Props above a floor that do not coincide with the props below.
- Undocumented formwork shoring or stripping procedures or allowable loadings from stacked materials not allowed for, in the project documentation.

Certification

Formwork design certification: For other than profiled steel sheeting composite formwork, submit certification by a professional engineer experienced in formwork design verifying conformance of the design.

Formwork execution certification: Submit certification by a professional engineer experienced in formwork design and construction verifying conformance of the completed formwork, including the suitability of the formwork for the documented surface finish class.

Execution details

Moveable formwork: Provide the following details on the formwork drawings:

- Table, slip and jump forms: Proposed method and sequence of moving the formwork to provide concrete of the documented quality and surface finish.
- Slip forms: The average rate of movement.

Re-shoring: Submit details of any proposed re-shoring.

Surface repair method: Submit details of any proposed surface method before starting repairs.

Materials

Void formers: Use void formers tested under laboratory conditions. Place formers on damp sand and load with a mass of wet concrete at least equal to the mass of the beams or slabs to be supported. Submit certified test results to verify conformance with the following requirements:

- Deflection during placing and compaction of the concrete does not exceed beam or slab span/1000.
- Additional deflection between initial set and 7 days does not exceed span/400.
- Collapse and loss of load carrying capacity occurs not more than 48 hours after flooding with water, creating a void at least 60% of the original depth of the void former.

Shop drawings

Formwork: Submit shop drawings including details of proposed linings, bolt positions, facings, release agents and, where applicable, re-use of formwork.

2 PRODUCTS

2.1 MATERIALS

General

Form linings, facings and release agents: Compatible with finishes applied to concrete.

Lost formwork: Free of timber or chlorides and not to impair the structural performance of the concrete members.

Void formers: Material capable of maintaining rigidity and shape until the concrete has set, collapsible on absorption of moisture.

Profiled steel sheeting composite formwork

Material: Hot-dipped zinc-coated sheet steel to AS 1397.

Minimum steel grade: G550.

Zinc coating weight: 350g/m^2 unless noted otherwise on the drawings

Accessories: Adopt material and corrosion protection to match the profiled steel sheeting.

Plywood formwork

Material: Plywood sheeting to AS 6669.

Grade: Use appropriate grade for the documented design dimensions, loading and surface quality.

Joints: Seal the joints consistent with the documented surface finish class.

Tolerances: To AS 3610.1 Section 3.

3 EXECUTION

3.1 PREPARATION

Cleaning: Before placing concrete remove free water, dust, debris and stains from the formwork and the formed space.

3.2 CONSTRUCTION

General

Requirement: Conform to the *Concrete finishes* worksection.

Bolt hole filling

Removable bolts: Remove tie bolts without damaging the concrete.

Formwork tie bolts left in the concrete: Position more than 50 mm from the finished surface.

Bolt hole filling: Provide material with durability and colour matching the concrete.

Recessed filling: Fill or plug the hole to 6 mm below the finished surface.

Corners

Work above ground: Chamfer at re-entrant angles, and fillet at corners.

Face of bevel: 25 mm.

Embedments

Fixing: Fix embedments through formwork to prevent movement, or loss of slurry or concrete, during concrete placement.

Openings

General: In vertical forms provide form openings or removable panels for inspection and cleaning, at the base of columns, walls and deep beams.

Access: For thin walls and columns, provide access panels for placing concrete.

Release agents

Application: Before placing reinforcement, apply a release agent to form linings and facings.

Slip formwork

Provision for inspection: Provide access below the movable formwork, from which surface treatment and inspection may be carried out.

Profiled steel sheeting composite formwork

Fixing: If sheeting cannot be fixed to structural steel supports with puddle welds, or with welded shear studs in composite construction, provide details of proposed fixings.

Steel linings

Rust: Clean off any rust and apply rust inhibiting agent prior to reuse.

Visually important surfaces

Surface finish classes 1, 2 or 3: Set out the formwork to give a regular arrangement of panels, joints, bolt holes, and similar visible elements in the formed surface.

Void formers

Protection: Keep void formers dry until use, install on a firm level surface and place reinforcement and concrete with minimum delay.

3.3 COMPLETION

Formwork removal

Extent: Remove formwork, other than profiled steel sheeting composite formwork and lost formwork, including formwork in concealed locations.

Timing: Do not disturb formwork until concrete is hardened enough to withstand formwork movements and removal without damage. Do not erect masonry walls or other brittle elements on beams or slabs while they are still supported by formwork.

Stripping:

- General: To AS 3600 where it is more stringent than AS 3610.1.
- Vertical formwork: To AS 3610.1 Appendix B Table B1.
- Multi-storey work: Remove formwork without disturbing props supporting succeeding floors.
- Post-tensioned concrete: Remove formwork supporting post-tensioned concrete members to AS 3600 clause 17.6.2.7 and only when sufficient prestress has been added to support the loads.

4 SELECTIONS

4.1 SCHEDULE

Formwork dimensional deviation schedule

Dimension or measurement	**Location or element**	**Deviation (mm)**	**Maximum Misalignment (mm)**	
			Between Pours:	**Across Joints:**
Absolute position	Class 1 surface	10	1	0
	Class 2 surface	15	2	2
	Class 3 surface	20		
	Class 4 surface	25		
	Class 5 surface	30		

CONCRETE REINFORCEMENT

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide concrete reinforcement, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *General requirements*.
- *Concrete in situ*.

1.3 STANDARDS

General
Reinforced concrete construction: To AS 3600.

1.4 INSPECTION

Notice
Inspection: Give sufficient notice so that inspection may be made of the following:
- Cores and embedments fixed in place.
- Reinforcement fixed in place, with formwork completed.

1.5 TOLERANCES

General
Fabrication and fixing: To AS 3600 clause 17.2.

Reinforcement position: To AS 3600 clause 17.5.3.

1.6 SUBMISSIONS

Execution details
Reinforcement: Submit the following:
- General: Details of any proposed changes to documented reinforcement.
- Damaged galvanizing: Details of proposed repair to AS/NZS 4680 Section 8.
- Mechanical bar splices: Details and test certificates for each size and type of bar to be spliced.
- Provision for concrete placement: Details of spacing or cover to reinforcement that does not conform to AS 3600.
- Splicing: Details of any proposed changes to documented requirements.
- Welding: Details of any proposed welding of reinforcement.

Materials
Reinforcement strength and ductility: Submit type-test reports to verify strength and ductility conformance to AS 3600

Table 3.2.1 for each reinforcement type.

2 PRODUCTS

2.1 MATERIALS

Fibre reinforcement
Standard: To CIA CPN35.

Steel reinforcement
Standard: To AS/NZS 4671:

Shape: D

Ductility class: N

Strength grade: 500 or as shown in drawings

Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

Protective coating

Standard: To AS 3600 clause 17.2.1.2.

General: For concrete elements containing protective coated reinforcement, provide the same coating type to all that element's reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, stirrups, plates and ferrules, and protect other embedded metals with a suitable coating.

Epoxy coating: Provide a high build, high solids, chemically resistant coating.

- Thickness: 200 µm minimum.

Galvanizing: To AS/NZS 4680, as follows:

- Sequence: If fabricating after galvanizing, repair damaged galvanizing and coat cut ends.
- Zinc-coating (minimum): 600 g/m^2.

Tie wire

General: Annealed steel 1.25 mm diameter (minimum).

3 EXTERNAL AND CORROSIVE APPLICATIONS: GALVANIZED.EXECUTION

3.1 CONSTRUCTION

Dowels

Fixing: If a dowel has an unpainted half, embed in the concrete placed first.

Tolerances:

- Alignment: 1:150.
- Location: ± half the diameter of the dowel.

Grade: 250 N or as specified on the drawings

Cover

Concrete cover generally: To AS 3600 clause 4.10.

Concrete cover for structures for retaining liquids: To AS 3735.

Concrete cover for residential ground slabs and footings: To AS 2870.

Supports

Proprietary concrete, metal or plastic supports: Provide chairs, spacers, stools, hangers and ties, as follows:

- Able to withstand construction and traffic loads.
- With a protective coating if they are ferrous metal, located within the concrete cover zone, or are used with galvanized or zinc-coated reinforcement.
- Spacing:
  - Bars: ≤ 60 diameters.
  - Mesh: ≤ 750 mm.

Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. Place a metal or plastic plate under each support.

Projecting reinforcement

Protection: If starter or other bars extend beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is cast into later work.

Tying

General: Secure the reinforcement against displacement at intersections with either wire ties, or clips. Bend the ends of wire ties away from nearby faces of formwork or unformed faces to prevent the ties projecting into the concrete cover.

Beams: Tie stirrups to bars in each corner of each stirrup. Fix other longitudinal bars to stirrups at 1 m maximum intervals.

Bundled bars: Tie bundled bars in closest possible contact. Provide tie wire at least 2.5 mm diameter and spaced not more than 24 times the diameter of the smallest bar in the bundle.

Columns: Secure longitudinal column reinforcement to all ties at every intersection.

Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections

Tolerances: To AS 3600

Welding

If welding of reinforcement is proposed, provide details

4 COMPLETION

4.1 UNENCASED REINFORCEMENT

If ‘starter bars’ and other items project from cast concrete for future additions and are exposed to the weather, provide details of protection.

CONCRETE POST-TENSIONED

1 GENERAL

1.1 RESPONSIBILITIES

Requirement: Provide bonded post-tensioning of concrete as documented.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete formwork*.
- *Concrete in-situ.*
- *Conccrete reinforcement.*

1.3 STANDARDS

General

Post-tensioning: To AS 3600.

Strand, bar and wire: To AS/NZS 4672.1.

1.4 INTERPRETATION

Definitions

General: For the purpose of this worksection the definitions given in AS/NZS 1314 and the following apply:

- Anti-burst reinforcement: Reinforcement cage surrounding anchorages to control the tensile bursting stresses.

1.5 INSPECTION

Notice

Inspection: Give a minimum of two working days' notice and provide access so that inspection may be made of the following:

- Tendons fixed in place before concreting.

1.6 SUBMISSIONS

Calculations

Post-extensions calculations: Submit the following:

- Calculations of tendon jacking forces, theoretical extensions and losses for each stressing stage.
- Amount of draw-in expected in seating anchorages, friction along tendon (wobble) coefficient and friction curvature coefficient for tendons and duct-forming material.

Execution details

Post-tensioning: Submit the following:

- Details of the proposed post-tensioning system tested and certified to AS/NZS 1314, including performance test certificates for each type and size of anchorage and coupler.
- Safe work method statements including the name and contact details of the subcontractor.
- Details of proposed gauging, stressing and grouting equipment. Submit current calibration certificates for tensioning and tension measuring equipment.
- Concrete strength early age test results.
- Calculated tendon extensions (theoretical extensions) at final stressing and for staged stressing if required, before stressing operations begin.

Materials

Grout: Submit proposed grout mix and certified test results (including grading, proportions, compressive strength, shrinkage and additives if any).

Epoxy grout: If required, submit proposed formulation.

Duct-forming material: Submit samples of proposed material.

Prestressing steel: Submit test certificates to AS/NZS 4672.2 for every delivery of strand, bar or wire and anchorage components proposed.

Records

Post-tensioned concrete: submit the following:

- Post-tensioning record.
- Post-tensioning stressing schedule.
- Post-tensioning grouting record.
- Details of placing of reinforcement and tendons
- Dates of post-tensioning operations

Shop drawings

Post tensioned drawings: Submit shop drawings showing the following:

- Profiles, sizes and details of tendons, tendon numbers, anchorages, ducts, duct formers, splicing, sheathing, end block reinforcement and other associated components.
- Stressing requirements including sequence of stressing, jacking forces and the basis of assumed loss calculations.
- Number, size and position of grout openings, vents and drain holes in the ducts.

2 PRODUCTS

2.1 GROUT

Grout properties

Standard: To AS 3600 clause 17.1.8.

Maximum shrinkage: 1% by volume after 24 hours.

Maximum water: cement ratio: 0.45 (by weight).

Compressive strength: 32 MPa at 7 days.

Grout materials

Fine aggregates: Do not use aggregates for post tensioning grout unless cross sectional area of ducts is 5 times the cross sectional area of the tendon.

Cement: To AS 3972 and free from calcium chloride and less than two months old.

Admixtures: To AS 1478.1. Include an anti-bleed additive.

Fly ash: To AS 3582.1 and proportioned according to early strength requirements.

Water: To AS 1379. Use clean water, free from oil, acid, alkali, organic or vegetable matter and not more than 500 mg/l of chloride ions.

Epoxy grout

Type: Commercial epoxy formulation of compressive strength exceeding 40 MPa.

2.2 DUCTS

Material

Robustness: Provide ducts with sufficient strength to retain their shape, resist damage during construction, and prevents deterioration or electrolytic action by the entrance of cement paste or water from the concrete.

Wall thickness: To allow for abrasion during stressing of the tendon.

Size: To allow feeding of tendons and grouting.

2.3 STEEL

Tendon material

Prestressing steel: Type and grade of strand, wire or bar to AS/NZS 4672.1.

Type: 7 wire, stress relieved, high tensile steel and strand.

Quality: Make sure tendons have no nicks, damage or foreign matter such as mud and dirt. Inspect at delivery and store the prestressing steel on supports clear of the ground.

Straightening of tendons: Not permitted. Supply tendons in coils large enough to self-straighten.

High tensile steel bars: Inspect individually and reject any bars with surface imperfections more than 0.40 mm deep.

Other steel

Anchor plates: Hot-dip galvanized to AS/NZS 4680.

Anchorages: To AS/NZS 1314. Submit performance test certificates for each type and size of anchorage and coupler

Reinforcement: To AS/NZS 4671.

2.4 CONCRETE

Properties

Concrete mix and supply: Conform to AS 1379.

Early strength requirements:

- For initial stressing stage: 7MPa and not more than 24 hrs after casting
- For final stressing stage:
    - strands≥15.2mm: 25MPa and not less than four days after casting
    - strands ≤12.7mm: 22MPa and not less than four days after casting
-
-

Portland cement content (minimum): 330kg/m^3

56 day shrinkage strain tested to AS 1012.13: 700με

Sampling and testing

Sampling: To AS 1012.1.

Testing: To the AS 1012 series.

Sampling frequency: For each post tensioned element, take at least 3 samples for testing at the age of each intended stage of stressing plus at least 3 reserve samples. Take at least one sample every 2 batches.

Sampling locations: Distribute sampling locations randomly, include anchorage area and the final concrete placement area. Reference the structural element from which the sample is taken.

Curing: Site cure all test cylinders for early age testing. For slab samples, maintain exposure to the same weather and temperature by curing the samples on the adjacent deck. Leave test cylinders on site until the morning of the test.

3 EXECUTION

3.1 INSTALLATION

General

Provide: Post-tensioning tendons, anchorages, ducts, supports, grout and anchorage protection

Protection: Protect post-tensioning tendons, anchorages, ducts, supports and grout from damage or contaminants, including from swarf, loose grease, oil and paint.

Tolerances: To AS 3600 clause 17.5.3.

Minimum concrete cover: As documented.

Post-tensioning record: Provide details of the following:

- Concrete mix.
- Concrete placing and curing, including dates.
- Placing of reinforcement and tendons.
- Dates of post-tensioning operations.
- Name of operator.
- Identification of tendons.
- Stressing method (single or double end, monostrand or multistrand).
- Tendon breakage and non-conformance reports.

Ducts

Standard: To AS 3600 clause 17.3.

Placement: Locate and secure to positions, as documented.

Supports: Support and fix at regular intervals. Protect from collapse and other damage.

Sheathing: If ducts are formed with sheaths, provide sheathing material capable of transferring the tendon stresses into the body of the concrete.

Sequence: Assemble tendons on site by installing strand, bar or wire within the duct before concreting.

Damage: If damaged, repair ducts as follows:

- Small holes: Waterproof adhesive tape.
- Larger holes: Metal strips wrapped around the duct, with 100 mm overlap and sealed by a waterproof adhesive tape.

Crossover points: If ducts running in opposite directions clash, consult the professional engineer. Do not relocate ducts without approval.

Anchorages

Anti-burst reinforcement: As documented.

Tendons

Care: Do not weld tendons. Do not expose tendons to sparks, ground current or excessive temperatures such as flame or oxyacetylene cutting.

Grout fittings and ducts: For bonded construction, protect from collapse and other damage.

Conformance: Provide tendons as documented.

Protection: Make sure tendons are not displaced by heavy and prolonged vibration, the pressure of the concrete being placed, workmen or construction traffic.

Temperature: Maintain concrete around grouted tendons at 5 C or more for at least 3 days after grouting.

Soffit marking: If there is possibility for future slab penetrations, mark the tendon locations.

Couplers

Standard: To AS/NZS 1314 Section 5.

Cover: Position and fix couplers to provide adequate cover.

Laying: Give coupled strands the same lay to prevent rotation.

Grout openings

Provision: Provide grout openings, vents and drain holes as documented, including at each end, and at high points except where the tendon curvature is small and the tendon is relatively level.

Removal: Remove protruding vents and drains after the grout has set and rectify to match surrounding surfaces.

Maximum spacing: 15 m.

Tubing: Provide plastic or other non-metallic material tubing to grout openings.

- Protection: Protect tubing from accidental damage during grouting and other construction operations.
- Fixings: Fasten tubing to the duct and make sure joints are air tight.

Tendons and Anchorages: On completion of stressing and grouting, permanently protect anchorage parts and parts of tendons anchored to them. Provide at least 40mm of cover over the cut tendons when the recesses are concreted. Keep free of foreign matter end anchorages which are to be protected.

3.2 EQUIPMENT

Gauges and jacks

Standard: To AS 1349.

Maximum error in pressure indication: 1% of the maximum scale (concentric) value.

Period: Calibrate gauges and jacks at intervals not exceeding 6 months, after re-sealing of jack or gauge, or if any inaccuracy in the gauges is suspected.

Sets: Calibrate and use jacks and gauges as a set.

Grouting pumps

Type: Positive displacement with outlet pressure of at least 1.0 MPa.

Capabilities: Include:

- Pumping the grout at the required rate.
- Seals: Make sure pumps are sealed to prevent oil and air contamination of the grout.
- Flow meters and pressure gauges used during air testing or grouting: To a NATA accredited laboratory calibration.

3.3 STRESSING

General

Post-tensioning: To AS 3600 clause 17.3.4.5.

Concrete strength: Complete early age tests before stressing.

Stressing procedure: Apart from light initial stressing to avoid early shrinkage cracking, carry out stressing after age tests results indicate concrete has attained the required strength.

Stressing stages: As documented.

Notification: Give notification before final stressing.

Multiple strands: Stress all strands equally and simultaneously.

Clearance: Use extended stressing stools either straight or deflected if clearances for jacks are insufficient.

Tendon extensions: To allow for variations in the duct friction characteristics, modify tendon extensions as required.

Measurement of site extensions

Marking: Mark strands after wedges are installed and before initial stress.

Slip: Check markings whilst stressing to make sure there is no slip of strands.

Stress records: Measure gross extensions on site and include initial and final stress extensions.

Site extensions: Submit the site extensions on the same day as measured for review and approval by the structural engineer.

Non-conformance: If the difference between theoretical and measured extensions is greater than 10%, provide an explanation of the cause.

Initial Force: If tendons are not marked at nil load, apply initial force or pressure if tendons are marked for measurement of elongations.

Cutting tendons: Do not cut tendons until the actual extensions are approved and until 7 days after grouting.

Re-stress or de-stress: Adjust stress in tendons if necessary, after the theoretical and site extensions are compared.

Records

Post-tensioning stressing schedule: Provide a stressing schedule, including the following information.

- Setting out, elongation and jacking forces.
- Identification number of dynamometers, gauges, pumps and jacks.
- Initial stressing force (or pressure) when tendons are marked for measurement of elongation.
- Force applied (dynamometers).
- Pump or jack pressure and area of the piston.
- Elongation before anchoring.
- Elongation remaining after anchoring.

3.4 GROUTING DUCTS

Preparation

Water: Blow out any water within the duct with compressed oil-free air and keep the ducts dry until grouting starts.

Rectification: Before grouting, rectify any leaks, blockages or holes.

Grouting

Timing: Grout tendons as soon as practicable after stressing and for corrosive environments within 3 weeks or as documented.

Procedure: Prevent damage to grout vents and fittings during grouting. Do not use manually powered grouting machines. Completely fill the duct during grouting. Inject grout into voids between tendons, ducts and anchorages, until grout flows from vents without air bubbles. Close vents as they fill, progressively in the direction of flow. If there is a blockage or interruption, completely flush grout from the duct using water.

Grout caps: Provide at each anchorage and seal for grouting and venting operations.

Grout pressure

Duct sealing: Seal the duct on completion of grouting at a suitable pressure. Fit pressure tap connections to each duct for this purpose.

Testing of grout

Bleeding: Test to ASTM C940.

Acceptance criterion: No more than 2% bleed with all bleed water being re-absorbed within 24 hours.

Records

Post-tensioning grouting record: For each duct grouted, provide the following:

- Duct and tendon identification.
- Grouting date.
- Composition of the grout (water:cement ratio, admixtures).
- Grout tests, including air tests of ducts.
- Details of grouting (including pumping or supply interruptions, topping up).

Protection

Grout ducts: Do not subject grouted ducts to shock, vibration, construction traffic or similar loads until 24 hours after completion of grouting.

Voids

Voids within ducts at anchorages: If voids occur, fill using vacuum injected grouting or provide alternative proposal.

3.5 COMPLETION

Cutting tendons

Trimming: Use high speed cutting discs. Cut within 50 mm of anchor block.

Permanent protection

Tendons and anchorages: On completion of stressing and grouting, permanently protect anchorage and tendons. Provide at least 40 mm of cover over the cut tendons when the recesses are concreted. Keep anchorages free of foreign matter (rust, grease, oil, paint).

Removal of formwork

Formwork removal: Remove formwork supporting post-tensioned members to AS 3600 clause 17.6.2.7.

CONCRETE IN SITU

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide concrete in situ, as documented and as follows:

- Conforming to the design details and performance criteria.
- Satisfying the quality and inspection requirements.
- Can be readily placed into corners and angles of forms, and around reinforcement without segregation
- Is not porous, cracked or honeycombed.
- Has acceptable plastic settlement cracking.
- Has acceptable levels of bleed water.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete finishes*.
- *Concrete formwork*.
- *Concrete post-tensioned*.

1.3 STANDARDS

General

Reinforced concrete construction: To AS 3600.

Specification and supply of concrete: AS 1379.

Concrete structures for retaining liquids: To AS 3735.

1.4 INTERPRETATION

General: For the purposes of this worksection the following definitions apply:

- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Average ambient temperature: Average value of the daily maximum and minimum ambient temperatures over the relevant period at a site.
- Batch: A quantity of concrete containing a fixed quantity of ingredients and produced in a discrete operation.
- Concrete class:
  - . Normal: Concrete which is specified primarily by a standard compressive strength grade and otherwise conforming to with AS 1379 clause 1.5.3.
  - . Special: Concrete which is specified to have certain properties or characteristics different from, or additional to, those of normal-class concrete and otherwise conforming to with AS 1379 clause 1.5.4.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in AS 1379 Table 1.2.
- Green concrete: Concrete which has set but not appreciably hardened.
- Production assessment: An assessment procedure for concrete specified by strength grade, carried out by the supplier on concrete produced by a specific supplying plant and based on the statistical assessment of standard compressive strength tests on concrete.

- Project assessment: An assessment procedure for concrete specified by strength grade, specified at the customer's option, which provides additional test data for the statistical assessment of concrete supplied to a specific project.
- Sample: A physical example that illustrates workmanship, materials or equipment, and establishes standards by which the work will be judged. It includes samples, prototypes and sample panels.
- Specimen: A portion of a sample which is submitted for testing.
- Joint:
  . Construction: A joint provided to suit construction sequence with reinforcement continuous across the joint.
  . Contraction: An unreinforced joint with a bond-breaking coating separating the concrete joint surfaces.
  . Control: A weakened plane contraction joint created by forming a groove, extending at least one quarter the depth of the section, either by using a grooving tool, by sawing, or by inserting a premoulded strip.
  . Expansion: An unreinforced joint with the joint surfaces separated by a compressible filler.
  . Isolation: A joint without keying, dowelling, or reinforcement, which imposes no restraint on movement.

  Weather:
  . Cold: Ambient shade temperature less than 10°C.
  . Hot: Ambient shade temperature greater than 32°C.

1.5 INSPECTION

Notice

Inspection: Give sufficient notice so that inspection may be made of the following:

- Base or subgrade before covering.
- Membrane or film underlay installed on the base or subgrade.
- Completed formwork and reinforcement, tendons, cores, fixings and embedded items fixed in place.
- Concealed surfaces or elements before covering.
- Commencement of concrete placing.

1.6 SHRINKAGE SENSITIVE STRUCTURES

The drying shrinkage limits for the concrete in any part of the works shall, where required, be as specifed for that part and shall be measured by submitting samples to drying shrinkage tests as specifed. The measure of drying shrinkage shall be the percentage change in dimension of the sample after a period of 8 weeks, in accordance with AS 1012.13 Methods of testing concrete – Determination of the drying shrinkage of concrete...

Unless otherwise specifed the maximum permissible drying shrinkage shall be as follows:

F'c (MPa)	**Shrinkage (microstrain)**
10, 15, 20	600
25, 32 ,40, 45, 50	700

1.7 SUBMISSIONS

Design

Loading: Submit details of proposed construction systems, loads and procedures, including propping and re-shoring.

Execution details

Concrete: Submit proposals for mixing, placing, finishing and curing concrete including the following:

- Changes to the concrete mix.
- Curing and protection methods.

- Curing period for low-pressure steam curing.
- Cutting or displacing reinforcement, or cutting or coring hardened concrete.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Placing under water.
- Sequence and times for concrete placement, and construction joint locations and relocations.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.
- Sequence of concrete placement: Submit details of any proposed sequential placement of slab segments.
- Sawn joints: Submit details of proposed methods, timing and sequence of sawing joints.

Pre-mixed supply delivery dockets: For each batch, submit a docket listing the information required by AS 1379, and the following:

- For special class performance concrete: Documented performance and type of cement binder.
- For special class prescription concrete: Details of mix, additives, and type of cement binder.
- Method of placement and climate conditions during pour.
- Name of concrete delivery supervisor.
- Project assessment carried out each day.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.
- The total amount of water added at the plant and the maximum amount permitted to be added at the site.

Materials

Product conformity: Submit current assessments of conformity, as appropriate, as follows:

- Certificate of conformity by a JAS-ANZ accredited third party. (e.g. reinforcement to AS/NZS 4671)
- Declaration of conformity by an ISO 9001 quality management system certified supplier. (e.g. Premixed concrete: Production assessment to AS 1379)
- Mark of conformity of a JAS-ANZ accredited third party applied to the product. (e.g. Milled radiate pine products : Plantation Timber Certification)
- Report by a NATA accredited laboratory describing tests and giving results which demonstrate that the product conforms.

Concrete mixes: Submit details, for each grade and type of concrete including any proposed use of special-purpose cement types.

Curing compounds: Submit details of any proposed liquid membrane-forming curing compound, including the following:

- Certified test results for water retention to AS 3799 Appendix B.
- Evidence of compatibility with concrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.
- For visually important surfaces, evidence that an acceptable final surface colour will be obtained.

Admixtures: Submit details of any proposed admixtures, including the following:

- Brand name.
- Place of manufacture.
- Basic chemical composition.

Samples

Coloured concrete: To AS 3610. Submit sample blocks of coloured concrete produced using the proposed mix and method before casting final concrete as follows:

- Number: 4.
- Size (nominal): 300 x 300 x 50 mm.

Shop drawings

Cores, fixings and embedded items: Submit the proposed locations, clearances and cover and show any proposed repositioning of reinforcement.

Subcontractors

Pre-mixed supply: Submit names and contact details of proposed pre-mixed concrete suppliers and alternative source of supply in the event of breakdown of pre-mixed or site mixed supply.

Tests

Other tests: Submit results, as follows:

- Concrete compressive strength test results to AS 1012.9.
- Other concrete properties. Test results as documented in the **Tests schedule**.

Testing Authority

Submit names of the testing authority and personnel engaged in sampling, preparing and handling test specimens to the Principal's Authorised Person / Principal's Representative for approval. The testing authority must be NATA registered

Curing compounds

Do not use inefective or inappropriate curing compounds. Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to toppings such as concrete toppings and cement-based render. Apply as a continuous coating without visible breaks or pinholes, at the rate recommended by the manufacturer.

Coarse aggregate

To AS 2758.1 Sampling and Testing to AS 1141& AS1012

If so directed by the Principal's Authorised Person / Principal's Representative, and under his supervision, take in accordance with AS 1141 a 50 kg sample of each aggregate type, individually or in combination proposed for use in the concrete mix, and submit to the approved NATA registered independent testing authority three weeks prior to commencement of concrete supply. Accompany the samples with a written request stating the particular tests required by the Principal's Authorised Person / Principal's Representative. In the case of individual aggregate samples, state the mix proportions proposed. The cost of such handling and testing of the aggregate shall be treated as a variation to the Contract.

1.8 SPECIMEN DEMOULDING AND TRANSPORT

Standard

To AS 1012, Part 8, clauses 1.8.1 and 1.9 except as follows:-• The

- specimen shall remain in its metal mould for 24 hours, without movement, before de-moulding.
- Sydney Metropolitan Area: Preference shall be given to sub-clause (a) or (b) in clause 1.8.2 of AS 1012.

Site De-moulding: When carried out, remove each specimen from its mould in the presence of the Principal's Authorised Person / Principal's Representative, who will indelibly mark the side of each specimen for identifcation.

NATA Laboratory Handling: If cylinders have been cast by the approved independent testing authority, the authority will be permitted to de-mould and transport the concrete specimens to its laboratories, in the same manner as that in which the authority would normally process specimens. Under these circumstances, specimens for 28 day testing shall be delivered to the testing laboratory no later than 14 days prior to the due date, and specimens for 7 day testing no later than 3 days prior to the due date.

2 PRODUCTS

2.1 MATERIALS

General

Stockpile: If uniform, consistent colour is documented, stockpile sand, cement and aggregates. Use materials complying with Australian Standards. Do not use breccia or dolerite in concrete mixes and limit fly ash content to 20% by weight of cementitious content.

Aggregates

Standard: To AS 2758.1.

Aggregate properties: As documented in the **Aggregate property schedule**.

Coarse aggregate Types:

• Washed crushed river gravel, fne-grained basalt, or other materials approved by the

Principal's Authorised Person / Principal's Representative. State the source of the aggregate on delivery dockets. Obtain approval before changing the source of the aggregate.

• Metallurgical furnace slag aggregate: To AS 2758.1 Clause 16, except that non-ferrous slags must not be used.

Cement

Standard: To AS 3972.

Age: Less than 6 months old.

Storage: Store cement bags under cover and above ground.

Cement type: Portland cement to AS 3972

Water

Standard: To AS 1379 clause 2.4.

Requirement: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

Polymeric film underlay

Vapour barriers and damp-proofing membranes: To AS 2870 clause 5.3.3.

Chemical admixtures

Standard: To AS 1478.1. Free of chlorides, fluorides and nitrates.

Curing compounds

Standard: To AS 3799.

2.2 CONCRETE

Properties

Concrete mix and supply: Conform to the following:

- Normal-class: To AS 1379 clause 1.5.3.
  . Properties: As documented in the **Concrete properties schedule - performance**.
- Special-class: To AS 1379 clause 1.5.4.
  . Properties: As documented in the **Concrete properties schedule - performance**.

Coloured concrete

Refer to SG / PAVEMENTS - CONCRETE PAVEMENT

Standard: To AS 3610.1.

2.3 TESTING

General

Test authority: Concrete supplier or NATA registered laboratory.

Reports and records of test results: To the relevant parts of the AS 1012 series. Keep results on site.

Assessment process of test results

Standard: To AS 1379.

Method of assessment: Project assessment.

Additional to the above, hardened concrete represented by any one sample with a test strength less than 0.8 times the required characteristic strength shall be liable to rejection.

Rejected concrete shall be removed from the site.

Sampling

Method of sampling: AS 1012.1.

Sampling locations: To AS 1012.1 and the following:

- Slump tests: On site, at the point of discharge from the agitator.
- Compressive strength tests: Spread the site sampling evenly throughout the pour.

Frequency of sampling: To AS 1379 Sections 5 and 6 and the following:

- Slump tests: Take at least one sample from each batch.
- Compressive strength tests: To the **Project assessment strength grade sampling table**.

Project assessment strength grade sampling table

Number of batches for each type and grade of concrete per day	Minimum number of samples Columns and load bearing wall elements (per batch)	Minimum number of samples Other elements (per day)
1	1	1
2-5	1	2
6-10	1	3
11-20	1	4
each additional 10	1	1 additional

Making and curing of specimens

General: To AS 1012.8.1 and AS 1012.8.2.

Specimen size:

- Aggregate size ≤ 20 mm: Nominally 200 x 100 mm diameter.
- Aggregate size > 20 mm: Nominally 300 x 150 mm diameter.

Test methods

General: To the relevant parts of the AS 1012 series.

Acceptance criteria:

- General: As documented in the **Concrete properties schedule – performance**.

Slump tests: Assess slump for every batch. Perform slump test on each strength sample.

Drying shrinkage at 56 days: To AS 1012.13.

Embedded pressure pipes

General: Complete leak tests before embedding pipes.

Liquid retaining structures

Testing for liquid tightness: To AS 3735.

3 EXECUTION

3.1 POLYMERIC FILM UNDERLAY

Location

General: Under slabs on ground, including integral ground beams and footings, provide a vapour barrier or, in areas prone to rising damp or salt attack, a damp-proofing membrane.

Base preparation

General: Conforming to base type, as follows:

- Concrete working base: Remove projections above the plane surface, and loose material.
- Graded prepared subgrade: Blind with sand to create a smooth surface free from hard projections. Lightly wet the sand just before laying the underlay.

Installation

Standard: To AS 2870 clause 5.3.3.

General: Lay underlay over the base as follows:

- Lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape.
- Face the laps away from the direction of concrete pour.
- Continue up vertical faces past the damp-proof course where applicable, and tape fix at the top.
- Patch or seal punctures or tears before placing concrete.
- Cut back as required after concrete has gained strength and formwork has been removed.

3.2 CONCRETE

General

Performance properties: As documented in the **Concrete properties schedule – performance**.

Elapsed delivery time

General: Make sure the elapsed time between the wetting of the mix and the discharge of the mix at the site conforms to the **Elapsed delivery time table**. Do not discharge at ambient temperature below 10°C or above 30°C unless approved heating or cooling measures are taken to deliver concrete within the range 5°C to 35°C.

Elapsed delivery time table

Concrete temperature at time of discharge (C)	Maximum elapsed time (minutes)
10 – 24	120
24 – 27	90
27 – 30	60
30 – 32	45

Pre-mixed supply

Addition of water: To AS 1379 clause 4.2.3.

Transport method: Prevent segregation, loss of material and contamination of the environment, and do not adversely affect placing or compaction.

Site mixed supply

Emergencies: If mixing by hand, provide details.

Plant: Mix concrete in plant located on the construction site.

3.3 CORES, FIXINGS AND EMBEDDED ITEMS

Adjoining elements

Fixings: Provide fixings for adjoining elements. If required, provide temporary support to the adjoining elements during concreting, to prevent movement.

Protection

General: Grease threads. Protect embedded items against damage.

Compatibility: Provide inserts, fixings and embedded items that are compatible with each other, with the reinforcement and with the documented concrete mix and the documented surface finish.

Corrosion: In external or exposed locations, galvanize anchor bolts and embedded fixings or submit proposed alternate materials.

Structural integrity

Position: Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, displace but do not cut reinforcement, and maintain cover to reinforcement.

Isolation: Isolate embedded items to prevent water tracking to concrete providing minimum cover to reinforcement.

Tolerances

General: Maximum deviation from correct positions:

- Anchor bolt groups for structural steel: To AS 4100.
- Cores and embedded items generally: 10 mm.
- Other fixing bolts: 3 mm.

Penetrations

Termite barrier:

Chemical Barriers: Must not be used (Mandatory)

3.4 CONCRETE WORKING BASE

Finish

Membrane support: Wood float finish or equivalent.

Installation

General: Lay over the base or subgrade and screed to the required level.

Surface tolerance

Deviation: Flatness tolerance Class B.

3.5 PLACING AND COMPACTION

Placing

Horizontal transport: Use suitable conveyors, clean chutes, troughs, hoppers or pipes.

Methods: Avoid segregation and loss of concrete, and minimise plastic settlement. Maintain a nominally vertical and plastic concrete edge during placement.

Horizontal elements: Place concrete in layers not more than 300 mm thick. Compact the following layer into previous layer before previous layer has taken initial set.

Compaction

Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove entrapped air and to fully compact the mix.

Vibrators: Do not allow vibrators to contact set concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the formwork. Avoid causing segregation by over-vibration.

Placing records

Log book: Keep on site and make available for inspection a log book recording each placement of concrete, including the following:

- Date.
- Specified grade and source of concrete.
- Slump measurements.
- The portion of work.
- Volume placed.

Rain

Protection: During placement and before setting, protect the surface from damage.

Time between adjacent placements

Minimum time delay: As documented in the **Minimum time delay schedule.**

Vertical elements

Placement: Limit the free fall of concrete to maximum of 2000 mm.

Placing in cold weather

Cement: Do not use high alumina cement.

Placing concrete: Maintain temperature of the freshly mixed concrete at 5 C or more.

Formwork and reinforcement: Before and during placing maintain temperature at 5 C or more.

Severe weather: If severe weather conditions are predicted, use high early strength cement.

Temperature control: Heat the concrete materials, other than cement, to the minimum temperature necessary so that the temperature of the placed concrete is within the documented limits.

Admixtures: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

Frozen materials: Do not allow frozen materials or materials containing ice to enter the mixer, and keep free of frost and ice any formwork, materials, and equipment coming in contact with the concrete.

Maximum temperature of water: 60 C when placed in the mixer.

Freezing: Prevent concrete from freezing.

Placing in hot weather

Handling: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete conforming to the **Elapsed delivery time table**.

Placing concrete: Maintain the temperature of the freshly mixed concrete conforming to the **Hot weather placing table**.

Evaporation control barriers: Erect barriers to protect freshly placed concrete from drying winds.

Formwork and reinforcement: Before and during placing, maintain temperature at 35 C or less.

Temperature control: Select one or more of the following methods of maintaining the temperature of the placed concrete at 35 C or less:

- Cool the concrete using liquid nitrogen injection before placing.
- Cover horizontal transport containers.

- Spray the coarse aggregate using cold water before mixing.
- Use chilled mixing water.

Hot weather placing table

Concrete element	Temperature limit
Normal concrete in footings, beams, columns, walls and slabs	35°C
Concrete in sections 1 m or more in all dimensions except for concrete of strength 40 MPa or more, in sections exceeding 600 mm in thickness	27°C

Placing under water

General: Do not place under water unless conditions prevent dewatering.

Minimum cement content for the mix: Increase by 25%.

3.6 CURING

General

Requirements: Taking into account the average ambient temperature at site over the relevant period affecting the curing, adopt procedures to make sure of the following:

- Curing: Cure continuously from completion of finishing until the total cumulative number of days or fractions of days, during which the air temperature in contact with the concrete is above 10 C, conforms to the following, unless accelerated curing is adopted:

  . Fully enclosed internal surfaces/Early age concrete: 3 days.
  . Other concrete surfaces: 7 days.
- End of curing period: Prevent rapid drying out at the end of the curing period.
- Protection: Maintain at a reasonably constant temperature with minimum moisture loss, during the curing period.
- If strength of concrete required by AS 3600 clauses 4.4 or 4.5 has not been achieved, extend the curing period until strength is achieved.

Curing compounds

Application: Provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken at least for the required curing period after application.

Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to applied finishes, concrete toppings and cement-based render.

Self levelling toppings: If used also as curing compounds, conform to AS 3799.

Visually important surfaces: Apply curing compounds to produce uniform colour on adjacent surfaces.

Cold weather curing

Temperature: Maintain concrete surface temperatures above 5°C for the duration of the curing period.

Hot weather curing

Curing compounds: If curing compounds are proposed, provide details.

Protection: Select a protection method from the following:

- If the concrete temperature is more than 25°C or if not protected against drying winds, protect the concrete using a fog spray application of aliphatic alcohol evaporation retardant.
- If ambient shade temperature is more than 35°C, protect from wind and sun using an evaporative retarder until curing is commenced.
- Immediately after finishing, either cover exposed surfaces using an impervious membrane or hessian kept wet until curing begins, or apply a curing compound.

Water curing

Method: Select a method of ponding or continuously sprinkling to prevent damage to the concrete surface during the required curing period.

3.7 JOINTS

Construction joints

Location: Do not relocate or eliminate construction joints, or form undocumented construction joints. If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, submit a report on the action taken.

Finish: Butt join the surfaces of adjoining pours. In visually important surfaces make the joint straight and true, and free from blemishes impermissible for its surface finish class.

Preparation: Roughen and clean the hardened concrete joint surface. Remove loose or soft material, free water, foreign matter and laitance. Dampen the surface just before placing the fresh concrete and coat with a neat cement slurry.

Termite barrier:

Chemical Barriers: Must not be used (Mandatory)

Expansion joints

Joint filling: Fill with jointing materials as documented. Finish visible jointing material neatly, flush with adjoining surfaces.

Preparation: Before filling, dry and clean the joint surfaces, and prime.

Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.

Jointing materials: Provide jointing materials compatible with each other, and non-staining to concrete in visible locations.

Bond breaking: Provide back-up materials for sealants, including backing rods, which do not adhere to the sealant.

Foamed materials (in compressible fillers): Closed-cell or impregnated, not water absorbing.

Termite barrier:

Chemical Barriers: Must not be used (Mandatory)

Slip joints

Requirement: If concrete slabs are supported on masonry, provide proprietary slip joints.

3.8 COMPLETION

Protection

General: Protect the concrete from damage due to construction load, physical and thermal shocks, and excessive vibrations, particularly during the curing period.

Surface protection: Protect finished concrete surfaces and applied finishes from damage.

4 SELECTIONS

4.1 SCHEDULES

Concrete properties schedule – performance

Property	**RC elements**
Normal and special class	
Maximum aggregate size (mm)	20
Assessment process	Project
Slump (mm)	80
Special class	
Maximum drying shrinkage (56 days)	700 με
Minimum Portland cement content	330 kg/m^3
Water:cement ratio maximum	0.5

Minimum time delay schedule

Between (pour locations)	**Minimum period between adjacent pours (days)**
Adjacent pours abutting horizontal construction joints in walls or columns	3
Adjacent pours abutting vertical construction joints in walls	3
Columns and slabs	3
Floor slab construction joints	3
Pour strips and adjacent concrete	3
Retaining wall construction joints	3

Material tests schedule

Material	**Test method**	**Test frequency**
Admixtures (each type used)	To AS 1478.1	Daily
Coarse aggregate, dense and lightweight: LA value	To AS 1141.23	Daily
Coarse aggregate, dense and lightweight: Particle density and water absorption	To AS 1141.6.1	Daily
Coarse aggregate, dense and lightweight: Particle size analysis	To AS 1141.11.1 and AS 1141.12	Daily
Coarse aggregate, dense and lightweight: Soundness	To AS 1141.24	Daily
Fine aggregate: Friable particles	To AS 1141.32	Daily
Fine aggregate: Light particles	To AS 1141.31	Daily
Fine aggregate: Organic impurities	To AS 1141.34	Daily
Fine aggregate: Particle size analysis	To AS 1141.11.1 and AS 1141.12	Daily
Fine aggregate: Particle density and water absorption	To AS 1141.5	Daily
Fine aggregate: Soundness	To AS 1141.24	Daily
Fine aggregate: Sugar	To AS 1141.35	Daily
Fly ash	To AS 3582.1	Daily
Ground slag	To AS 3582.2	Daily
General purpose and blended cement (each type used)	To AS 3972	Daily

CONCRETE FINISHES

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide finishes to formed and unformed concrete surfaces, as documented and as follows:

- Compatible with documented finishes.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete formwork*
- *Concrete in-situ*
- *Precast concrete*
- *Concrete post-tensioned*
- *Shotcrete*

1.3 STANDARDS

General

Formed surfaces: To AS 3610.1.

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definition applies:

- Green concrete: Concrete which has set but not appreciably hardened.

1.5 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Evaluation of the off-form finishes.
- Evaluation of surface finish.

1.6 TOLERANCES

Formed surfaces

Quality of the surface finish: To AS 3610.1 Table 3.3.2.

Unformed surfaces

Flatness: To the **Flatness tolerance class table**, for the documented class of finish, using a straightedge placed anywhere on the surface in any direction.

Flatness tolerance class table

Class	Measurement	Maximum deviation (mm)
A	3 m straightedge	3
B	3 m straightedge	6
C	600 mm straightedge	6

1.7 SUBMISSIONS

Prototypes

Test panels: Provide test panels to AS 3610.1 and as documented in the **Test panels schedule**.

Manufacture: Cast the panels using the formwork, concrete, compaction equipment, form release agents, curing and formwork removal methods which are to be used in the final work.

Storage: Once accepted, maintain the panels on site undamaged and protected from the weather, as reference prototypes for evaluation of completed work.

Surface treatment: Do not proceed with the related work until the acceptable range of surface treatments has been determined.

Tests

Slip resistance: Submit test results, as follows:

- Site slip resistance test of completed installation to AS 4663.

2 PRODUCTS

2.1 MATERIALS

Surface hardeners, sealants and protectors

Supply: If documented, provide proprietary products to the manufacturer's recommendations.

Slip resistance treatment

Slip resistance classification: To AS 4586.

3 EXECUTION

3.1 SURFACE MODIFIERS

General

Application: Apply to clean surfaces to the manufacturer's recommendations.

3.2 FORMED SURFACES

General

Surface finish: Provide formed concrete finishes as documented in the **Formed surface finishes schedule.**

Damage: Do not damage concrete works through premature removal of formwork.

Curing

General: If formwork is stripped before the minimum curing period for the concrete has elapsed, continue curing the exposed faces as soon as the stripping is completed.

Evaluation of formed surfaces

General: If evaluation of formed surface tolerance or colour is required, complete the evaluation before surface treatment.

Surface repairs

Method: If surface repairs are required, submit proposals.

Finishing methods

Details: If soffits of concrete elements or faces of concrete columns are to have a finish other than an off-form finish, provide finishes as documented.

Blasted finishes:

- Abrasive: Blast the cured surface using hard, sharp graded abrasive particles until the coarse aggregate is in uniform relief.
- Light abrasive: Blast the cured surface using hard, sharp graded abrasive particles to provide a uniform matt finish without exposing the coarse aggregate.

Bush hammered finish: Remove the minimum matrix using bush hammering to expose the coarse aggregate, recessing the matrix no deeper than half the aggregate size, to give a uniform texture.

Exposed aggregate finish: Remove the vertical face formwork while the concrete is green. Wet the surface and scrub with stiff fibre or wire brushes, flushing continuously with clean water, until the aggregate is uniformly exposed. Do not use acid etching. Rinse the surface with water.

Floated finishes:

- Sand floated finish: Remove the vertical face formwork while the concrete is green. Wet the surface and rub using a wood float. Rub fine sand into the surface until a uniform colour and texture are produced.

- Grout floated finish: Remove the vertical face formwork while the concrete is green. Dampen the surface and spread a slurry, using hessian pads or sponge rubber floats. Remove surplus slurry and work until a uniform colour and texture are produced.

Smooth rubbed finish: Remove the vertical face formwork while the concrete is green. Wet the surface and rub using a carborundum or similar abrasive brick until a uniform colour and texture are produced.

3.3 UNFORMED SURFACES

General

Surface finish: As documented in the **Unformed surface finishes schedule**.

Finished levels: Strike off, screed and level slab surfaces to finished levels and to the flatness tolerance class documented.

Surface repairs

Method: If surface repairs are required, submit proposals.

Finishing methods – primary finish

Machine float finish:

- After levelling, and when the concrete has hardened sufficiently, consolidate the surface using a machine float.
- Cut and fill and re-float immediately to a uniform, smooth, granular texture.
- Hand float in locations inaccessible to the machine float.

Steel trowel finish: After machine floating finish, as follows:

- Use power or hand steel trowels to produce a smooth surface relatively free from defects.
- When the surface has hardened sufficiently, re-trowel to produce the final consolidated finish free of trowel marks and uniform in texture and appearance.

Burnished finish: Continue steel trowelling until the concrete surface attains a polished or glossy finish, uniform in texture and appearance, and free of trowel marks and defects.

Wood float finish: After machine floating, use wood or plastic hand floats to produce the final consolidated finish free of float marks and uniform in texture and appearance.

Broom finish: After machine floating and steel trowelling use a broom or hessian belt drawn across the surface to produce a coarse even-textured transverse-scored surface.

Scored or scratch finish: After screeding, use a stiff brush or rake drawn across the surface before final set, to produce a coarse scored texture.

Sponge finish: After machine floating and steel trowelling, use a damp sponge to wipe the surface to produce an even textured sand finish.

Exposed aggregate finish: After floating and when concrete has stiffened, wet the surface and scrub with stiff fibre or wire brushes, flushing continuously with clean water, until the aggregate is uniformly exposed. Rinse the surface with water.

Finishing methods – supplementary finish

Abrasive blast: After steel trowelling, abrasive blast the cured surface to provide texture or to form patterns without exposing the coarse aggregate, using hard, sharp graded abrasive particles.

Coloured applied finish: After machine floating, apply a proprietary liquid or dry shake material to the manufacturer's recommendations and trowel to achieve the required appearance.

Stamped and coloured faux paved or cobblestone finish: Provide a proprietary finishing system.

Polished finish: After steel trowelling, grind the cured surface of the concrete.

4 SELECTIONS

General

- Formed surface finishes to Architects specifications
- Sample panel schedules to Architects specifications

4.1 SCHEDULES

Test panels schedule

To Architect's Specifications

Formed surface finishes schedule

Property	A	B	C
Location	Vertical surfaces	Beam soffits	Horizontal surfaces tother than beam soffits
Surface finish class to AS 3610.1	2	2	2
Formwork lining type			
Colour control			
Bolt hole filling	flush	flush	flush
Surface finish type			
Evaluation			

Surface finish class 1 formwork

Colour control: As per architect's specification. Prepare sample panels for tonal range to be selected by architect where colour control is required.

Critical faces of elements: To AS 3610.1

Distance between face steps (mm): To AS 3610.1

Formwork face span and direction of span: To AS 3610.1

Repairs: Not permitted.

Surface pattern details and accuracy: To AS 3610.1

Surface treatment pattern of part of surface: To AS 3610.1

Tie rod pattern: To AS3610.1

Surface finish class 2 and class 3 formwork

Colour control: As per architect's specification. Prepare sample panels for tonal range to be selected by architect where colour control is required.

Critical faces of elements: To AS 3610.1

Distance between face steps (mm): To AS 3610.1

Formwork face span and direction of span (class 2 only): To AS 3610.1

Liner details, pattern and accuracy: To AS 3610.1

Surface pattern details and accuracy: To AS 3610.1

Surface treatment of whole: To AS 3610.1

Surface treatment pattern of part of surface: To AS 3610.1

Tie rod pattern: To AS 3610.1

Surface finish class 4 and 5 formwork

To AS 3610.1

Unformed surface finishes schedule

Property	A	B	C
Location	Exposed Surfaces	Covered Surfaces	Carpark Slabs
Flatness tolerance class	B	B	B
Primary finish	To Architect's Specifications	To Architect's Specifications	To Architect's Specifications
Supplementary finish	To Architect's Specifications	To Architect's Specifications	To Architect's Specifications
Slip resistance treatment	To Architect's Specifications	To Architect's Specifications	To Architect's Specifications

Property	A	B	C
Slip resistance classification	To Architect's Specifications	To Architect's Specifications	To Architect's Specifications
Slip resistance site test of completed installation	To Architect's Specifications	To Architect's Specifications	To Architect's Specifications
Surface modifier	To Architect's Specifications	To Architect's Specifications	Surface Hardener

PRECAST CONCRETE

1 GENERAL

1.1 RESPONSIBILITIES

General

Responsibility: Provide precast concrete elements, as documented and as follows:

- Fabricated in conformance with the shop drawings.
- Designed and certified for lifting, handling, transport erection and temporary propping by a professional engineer.
- Undamaged by handling and installation.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete finishes*
- *Concrete formwork*
- *Concrete in-situ*
- *Concrete post-tensioned.*
- *Concrete reinforcement*

1.3 STANDARDS

General

Materials and construction: To AS 3600

Precast members: Conform to the recommendations of NP PCH (Precast concrete handbook).

Transport, erection and installation: To AS 3850.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviation applies:

- WLL: Working Load Limit.

Definitions

General: For the purposes of this worksection the definitions given in AS 3850 clause 1.3 and the following apply:

- Precast concrete: Concrete building elements, cast in moulds and cured away from the final structural position, and then transported, lifted and fixed into position.

1.5 INSPECTION

Notice

Inspection: Give sufficient notice so that inspection may be made of the following:

- Formwork dimensions and stability.
- Panel edge details and penetrations.
- Connection materials and inserts in place.
- Reinforcement and/or prestressing tendons in place.
- Concreting.
- First precast element of each type at the earliest possible time before and immediately after stripping.
- Stripping and storage.
- Site erection including fixings and any in in situ topping.
- Installed temporary bracing.

- Final structure before removal of temporary bracing.

1.6 TOLERANCES

General

Position of reinforcement and tendons: To AS 3600 clause 17.5.3.

Manufacturing and installation tolerance for precast elements: To AS 3610.1 Table 3.3.3 and AS 3850 clause 3.11.

Fixings and embedded items in precast elements: To AS 3850 Table 3.11(B) and AS 3610.1 Table 3.3.3.

1.7 SUBMISSIONS

Execution details

Panel casting: Submit panel casting checklist.

Manufacturer's details: Submit name, contact details and credentials of proposed manufacturer of precast elements.

Safe work method statement: Prepare a safe work method statement specific to the project for the precast erection and submit on request.

Erection documentation: Submit lifting device locations and specification including marking plans and shop drawings.

Early lifting: If it is proposed to lift the precast elements by their designated lifting points before 28 day strength has been achieved, submit evidence to demonstrate that the element has adequate strength to carry its own weight without damage or residual cracking or deflection on removal of the lifting device.

Lifting and handling equipment: Submit details of proposed equipment along with qualifications and training of the operating personnel in the form of a qualification register.

Products

Protective coating details: Submit proposals for protective coatings to exposed metallic components to AS/NZS 2312 with regard to site-specific corrosivity zoning.

Colour: Provide details of method of achieving the selected colour including details of the type and colour of the cement, sand and aggregates as well as colouring oxide pigments or stain.

Proprietary documentation: Submit proprietary documentation for any lifting, bracing or fixing inserts. Include make, type and WLL.

Non-proprietary inserts: Submit certificate from a professional engineer.

Concrete mix: Submit concrete mix details including the proportions and source of the constituents, admixtures, release agents and curing compounds.

Prototypes

Requirement: Provide prototypes as documented in the **Prototypes schedule**.

Manufacture: Cast the precast elements using the formwork, concrete, compaction equipment, form release agents, curing and formwork removal methods which are to be used in the final work.

Prototype storage: Maintain prototypes on site, undamaged and protected from discolouration for comparison with manufactured precast elements.

Prototype use: Use prototypes in the works if they conform with the structural drawings.

Samples

Surface finish: Submit samples for texture and colour.

Shop drawings

Precast concrete drawings: Submit shop drawings of architectural and structural precast concrete elements showing the proposed details for their design, manufacture, assembly, transport and installation, including the following:

- Project title and manufacturer's name.
- Marking plans and elevations referenced to the building grids and floors to locate each precast element.
- Shape or profile drawings (submit these before fabrication of moulds and tooling).
- Concrete mix and type of cement if special-class concrete.
- Locations, sizes, details, materials, ductility and stress grades of tendons and reinforcement.

- Locations, sizes, details, materials, corrosion protection and grades of cast-in ferrules, locating plates and angles, cut outs and openings, bolts, anchors and lifting devices.
- Cast-in services.
- Site fitments.
- Surface finish class and surface treatment, if applicable.
- Curing and protection methods.
- Weight of precast elements.
- Calculated maximum loading on lifting and bracing inserts and attachments.
- Equipment and methods for handling, transport and installation, including lifting inserts and pick-up points.
- Evidence of load capacity of lifting and bracing inserts and attachments in the form of test reports or calculations.
- Specification of plugs for sealing recesses for cast-in fixings.
- Veneer details, if applicable
- Formwork type
- Jack clearance, procedures, stressing sequence, initial tensioning forces gauge pressure and tendon elongation.

Tests

Lifting inserts and attachments for precast elements: Submit test results.

Static load tests: If structural performance requirements are nominated for the precast unit, perform static load tests on the prototype to AS 3600 and submit results.

2 PRODUCTS

2.1 MATERIALS

General

Stockpile: If uniform, consistent colour is documented, stockpile sand, cement and aggregates.

Aggregates

Standard: To AS 2758.1.

Aggregate properties: As documented in the **Aggregate property schedule**.

Cement

Standard: To AS 3972.

Age: Less than 6 months old.

Storage: Store cement bags under cover and above ground.

Type: Do not use high alumina cement.

Water

Standard: To AS 1379 clause 2.4.

Quality: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

Other

Chemical admixtures: To AS 1478.1.

Pigments: Make sure that the pigments are:

- Chemically inert.
- Alkaline resistant.
- Insoluble.
- Light-fast.

Reinforcement

Standard: To AS/NZS 4671.

Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

Structural welding: To AS/NZS 1554.3.

Corrosion: Protect from corrosion in conformance with AS 3600 clause 17.2.1.2.

Prestressing tendons

Standard: To AS/NZS 4672.1.

Type: 7 wire, stress relieved, high tensile steel and strand.

Prestressing hardware (including ducts, anchorages): To AS 3600.

Welding tendons: Do not weld prestressing tendons.

Post-tensioning bars/tendons

Requirements: To the *Concrete post-tensioned* worksection.

2.2 PRECAST CONCRETE

General

Concrete: To AS 3600 and AS 1379.

Testing: To the AS 1012 series.

Finishes

To architect's specification

2.3 GROUTS AND MORTARS

General

Grout: Non-shrink grout of a grade equal to or higher than the precast element

Grout duct size: Large enough to provide erection tolerance and clearance for grout flow and as shown on drawings.

Post tensioning grout: Conform to *Concrete post-tensioned* worksection.

2.4 CAST-IN ITEMS

Fixings and embedded items

Compatibility: Provide inserts, fixings and embedded items that are compatible with each other, with the reinforcement and with the documented concrete finish.

Corrosion: In external or exposed locations, galvanize anchor bolts and embedded fixings.

2.5 MISCELLANEOUS

Bearing pads

Selections and testing: To AS 5100.4.

Flashings

Standard: To AS/NZS 2904.

Sealants

Compression-seals: Polyethylene or polyurethane foam strip.

2.6 VENEERED CONSTRUCTION

General

Method: Use a method which ensures that delamination of the veneer will not occur.

Cover to reinforcement: Excludes applied finish or finishing layer that has thermal or chemical properties different from, and/or lesser water penetration resistance than, the main body of concrete in the unit.

3 EXECUTION

3.1 PRECAST ELEMENTS

Marking

Precast element identification: Include the following:

- Plank thickness (mm).
- Number of strands.
- Strand diameter (mm).
- Concrete cover (mm).
- Remain legible until after the element has been fixed in place.

- Not visible in the completed structure.
- Date of casting.
- Orientation of the element.
- On precast elements other than those manufactured as a standard product, indicate their location within the structure, in conformance with the marking plan.
- Mass of the element.

Attachments for structural or architectural fixings

Ferrules: Provide ferrules anchored behind the reinforcing as documented.

Dowel bars: Provide dowel bars loose, cast in or screwed into a ferrule or coupler and projecting from the precast element. Alternatively, where dowels are cast into and project from in situ concrete, provide a mating sleeve with grout tube.

Grout tube: Provide grout tubes as documented, made from thin wall galvanized duct or similar cast into either in situ concrete or the precast element into which a dowel bar will be grouted.

Cast in plates and bolts: Provide purpose made steel brackets with bars, bolts or studs welded to them.

Restraint brackets: Provide all restraint brackets for the precast elements as documented or as required.

Starter bars: Provide all starter bars as documented or as required.

Welding of connections: To AS/NZS 1554.1.

Requirement: Cast in all lifting, bracing and fixing inserts.

External walls: Wall panels and connections to BCA C1.11.

Curing

Curing compounds: To AS 3799.

Release agent: Provide a release agent that is compatible with the curing compound.

Rejection

Assessment: Set aside for inspection any element having damage such as cracking, deformation or spalling, or exhibiting lack of adequate concrete cover. Repair or recast, as instructed.

Lifting points

Standard: To AS 3850.

General: Provide proprietary lifting devices with published load data designed specifically for lifting concrete elements. Use face and edge lifters as required.

Cast in inserts: Provide hot-dipped galvanized finish with a minimum coating mass of 600 g/m^2 to all cast-in lifting and bracing devices.

Bracing inserts or strongbacks: Provide bracing inserts or strongbacks designed and certified by a professional engineer.

Proprietary systems: Use in conformance with manufacturer’s specifications and recommendations.

Lifting loops: Do not use deformed bars or stressing tendons as lifting loops.

Sealing: Recess lifting attachments such as bracing ferrules, or other types of cast-in fixings, and provide plugs for sealing.

Location: Do not place lifting attachments, holes and other temporary fixings for handling purposes on faces visible upon completion.

Marking: Clearly mark all lifting points and the positions for temporary bearing for storage and transport.

Welding: Do not site weld lifting, bracing or fixing inserts.

Requirement: Only lift or support members at specified points.

Lifting devices: Do not use the fixing devices for lifting or hoisting unless they have been designed to do so and confirmed by a professional engineer.

Precautions: Use handling methods which do not overstress, warp or damage the elements.

Completion: Remove, seal and rectify temporary attachments after erection.

Storage

Support points: Support elements at designated support points during storage.

Prevent damage: Store precast elements and protect to prevent warping, twisting, crushing, cracking, staining, discolouration and other damage until they are installed in their final location.

3.2 INSTALLATION

Lifting and Handling

- Lifting and handling: Conform to the ASCC National code and AS 3850. Lift or support units only at designated or other approved points. Use handling methods which do not overstress, warp or damage the units.
- Remove temporary attachments after erection. Seal or otherwise make good residual recesses.
- Fix the units securely and accurately in their final positions.
- Provide components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar, necessary for the installation of the units.

Site conditions: Make sure the wind and temperature conditions allow handling and fixing, and are consistent with the structural capability and geometry of the element.

Early Lifting

If it is proposed to lift the units by their designated lifting points before 28 day strength has been achieved, submit evidence to demonstrate that the unit has adequate strength to carry its own weight without damage or residual cracking or deflection on removal of the lifting device.

Attachments for handling purposes

If it is proposed to locate lifting attachments, holes and other temporary fixings for handling purposes on visible faces of units, submit proposals.

Lifting units

If it is proposed to lift or support units at other than specified points, submit proposals.

Lifting devices

Capacity: Design each lifting device for a working load at least 1.65 times the maximum calculated static load at that point and an ultimate load 4 times the maximum static load.

Attachments

Sealing: Recess lifting attachments such as ferrules, or other types of cast-in fixings, and provide plugs for sealing.

Welding of connections

Standard: To AS/NZS 1554.3.

1.7 PROTOTYPES

Site Cranes: To AS 2550.1.

Temporary bracing and propping: To AS 3850.

Fixing

Fixing: Fix the precast elements securely and accurately in their final position.

Ancillaries: Provide components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar, bearing pads or strips, ties and dowels, clips and fixings necessary for the installation of the elements.

Surfaces bonded to in situ concrete

Requirement: Fully scabble and roughen all surfaces required to bond with in situ concrete to achieve a shear plane surface coefficient in conformance with AS 3600 Table 8.4.3.

3.3 TESTING

Compliance

Tolerances: Check element compliance with **Tolerances** in conformance with AS 3610.1 Section 5.

Rejection: Reject any precast elements not conforming to the documented tolerances.

4 SELECTIONS

4.1 SCHEDULES

Prototypes schedule

Element type	Number of prototypes
All	To architect's specification

SHOTCRETE

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide shotcrete, as documented and as follows:

- Conforming to design details and performance criteria.
- Not porous, cracked or honeycombed.Satisfying quality and inspection requirements.
- Readily sprayable into corners and around reinforcement and built-in items without segregation, vertical slumping or sag.
- Compatible with documented finishes.
- Has acceptable plastic shrinkage

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Concrete finishes*
- *Concrete in-situ*
- *Concrete reinforcement*

1.3 STANDARDS

General

Specification and supply of concrete: To AS 1379.

Reinforced concrete construction: To AS 3600.

Concrete structures for retaining liquids: To AS 3735

Curing compounds: To AS 3799.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviation applies:

- SDS: Safety Data Sheets.

Definitions

General: For the purposes of this worksection the definitions given in CIA Z5 and the following apply:

- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Average ambient temperature: Average value of the daily maximum and minimum ambient temperatures over the relevant period at a site.
- Batch: A quantity of concrete containing a fixed quantity of ingredients and produced in a discrete operation.
- Sample: A physical example that illustrates workmanship, materials or equipment, and establishes standards by which the work will be judged. It includes samples, prototypes and sample panels.
- Shotcrete: Concrete, containing aggregate up to 13 mm in size, applied from a spray nozzle by means of compressed air.
- Specimen: A portion of a sample which is submitted for testing.
- Weather:
  - Cold: Ambient shade temperature less than 10°C.
  - Hot: Ambient shade temperature greater than 30°C.

1.5 INSPECTION

Notice

Inspection: Give sufficient notice so that inspection may be made of the following:

- Any excavated or exposed face before covering.
- Any membrane or drainage strips installed against the excavated or exposed face.
- Any embedments and reinforcement fixed in place.
- Concealed surfaces or elements before covering.
- Commencement of shotcreting.
- Evaluation of surface finish.

1.6 TOLERANCES

Reinforcement

Fabrication and fixing: To AS 3600 clause 17.2.

Reinforcement position: To AS 3600 clause 17.5.3.

Finishes

Unformed surfaces flatness: To the **Flatness tolerance class table**, for the documented class of finish, using a straightedge placed anywhere on the surface in any direction.

Flatness tolerance class table

Class	Measurement	Maximum deviation (mm)
A	2 m straightedge	4
B	3 m straightedge	6
C	600 mm straightedge	6

1.7 SUBMISSIONS

Subcontractors

Submit names and contact details of proposed shotcrete concrete supplies, and alternative source of supply in the event of breakdown.

Control of water

General: Submit proposals for the temporary and permanent control of ground water flows and seepage, if encountered.

Execution details

General: Submit proposals for placing, finishing and curing shotcrete including the following:

- Changes to concrete mix.
- Cutting or displacing reinforcement, or cutting hardened concrete.
- Finishing methods and shotcreting equipment.
- Name, contact details and experience of proposed sprayers.

Reinforcement: Submit the following:

- General: Details of any proposed changes to documented reinforcement.
- Damaged galvanizing: Details of proposed repair to AS/NZS 4680 Section 8.
- .

Pre-mixed concrete supply delivery dockets: For each batch, submit a docket listing the information required by AS 1379, and the following:

- Name of concrete delivery supervisor.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.

Materials

General: Submit details of proposed sources of materials.

Alternative supply: Submit an alternate source in the event of breakdown of supply.

Mix: Submit proposed concrete mix for shotcrete to the structural engineer for approval.

Curing compounds: Submit details of any proposed liquid membrane-forming curing compound, including the following:

- Certified test results for water retention to AS 3799 Appendix B.
- Evidence of compatibility with shotcrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.

Admixtures: Submit details of any proposed admixtures, including the following:

- Brand name.
- Place of manufacture.
- Basic chemical composition.
- Accelerating admixture initial set time.
- Accelerating admixture final set time.

Reinforcement: Submit details of any fibre reinforcement proposed for use.

Safety

Plan: Submit a full safety plan to include the following minimum requirements:

- Equipment prestart checks and maintenance.
- Housekeeping.
- Job safety and environmental analysis.
- Moving equipment.
- Product SDS requirements.
- Risk assessments.
- Safe work method statements.
- Toolbox talks.
- Unsupported ground work procedures.
- Work place inspections.

Tests

Other tests: Before applying shotcrete, submit results, as follows:

- Concrete test results: Submit compressive strength test results to AS 1012.9. Sample the concrete onsite.
- Embedded pressure pipes: Submit results of leak tests.
- Liquid retaining structures: Submit results of liquid tightness tests.

2 PRODUCTS

2.1 MATERIALS

Aggregates

Standard: To AS 2758.1.

Individual aggregates in mix: Consistent grading within allowable variation to AS 2758.1 clause 8.

Cement

Standard: To AS 3972.

Age: Less than 6 months old.

Storage: Store cement bags under cover and above ground.

Supplementary cementitious materials: Fly ash to AS 3582.1.

Water

Standard: To AS 1379 clause 2.4.

Requirement: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

Accelerating admixture

Standard: To AS 1478.1.

Purpose: Use where required to develop quick set and high early strength to suit site requirements and finishing. Do not use calcium chloride based accelerators. If unusually wet conditions are

encountered on site, submit a proposal varying the mix proportions including increasing the admixture content.

Time for initial set: 5 minutes

Time for final set: 20 minutes

Other chemical admixtures

Standard: To AS 1478.1.

Curing compounds

Curing compounds: To AS 3799.

2.2 CONCRETE

Properties

Concrete mix and supply: Conform to the documented properties and the following:

- . Normal class: To AS 1379 clause 1.5.3.
- . Special class: To AS 1379 clause 1.5.4.

2.3 TESTING

General

Test authority: Concrete supplier or NATA registered laboratory.

Reports and records of test results: To the relevant parts of the AS 1012 series. Keep results on site.

Sampling

Method of sampling: AS 1012.1.

Sampling locations: To AS 1012.1 and the following:

- Slump tests: On site, at the point of discharge from the agitator.
- Compressive strength tests: Spread the site sampling evenly throughout the spray.

Frequency of sampling: To AS 1379 Sections 5 and 6, and the following:

- Slump tests: Take at least one sample from each batch.
- Compressive strength tests: Sample as documented in the **Strength grade assessment sampling table**.

Strength grade assessment sampling table

Number of batches for each type and grade of concrete per day	Minimum number of samples per day
1	1
2-5	2
6-10	3
11-20	4
each additional 10	1 additional

Making and curing of specimens

General: To AS 1012.8.1 and AS 1012.8.2.

Specimens for compressive strength tests: Make and cure at least two specimens from the sample of each grade.

Specimen size: Nominally 200 x 100 mm diameter.

Test methods

General: To the relevant parts of the AS 1012 series.

Acceptance criteria:

- Average strength of all samples must equal or exceed the required value.
- Strength of any one sample must be at least 0.85 of the required value.

Slump tests: Assess slump for every batch. Perform slump test on each strength sample.

Embedded pressure pipes
General: Complete leak tests before embedding pipes.

Liquid retaining structures
Testing for liquid tightness: To AS 3735.

3 EXECUTION

3.1 MIXING

General
Time: Use mixed materials within 60 minutes of the addition of cement to the mix.

Admixture: Add the accelerating admixture at the nozzle of delivery hose immediately before placing shotcrete.

3.2 REINFORCEMENT

Cover
Concrete cover generally: To AS 3600 clause 4.10.

Concrete cover for structures for retaining liquids: To AS 3735.

Supports
Proprietary concrete, metal or plastic supports: Provide chairs, spacers, stools, hangers and ties, as follows:

- Able to withstand construction and traffic loads.
- With a protective coating if they are ferrous metal, located within the concrete cover zone, or are used with galvanized or zinc-coated reinforcement.

Spacing:

- Bars: ≤ 60 diameters.
- Mesh: ≤ 800 mm.

Projecting reinforcement
Protection: If starter or other bars extend beyond reinforcement mats or cages or from cast concrete, provide a plastic protective cap to each bar until it is cast into later work.

Tying
General: Secure the reinforcement against displacement at intersections with either wire ties, or clips. Bend the ends of wire ties to prevent the ties projecting into the concrete cover.

3.3 CORES, FIXINGS AND EMBEDDED ITEMS

Adjoining elements
Fixings: Provide fixings for adjoining elements. If required, provide temporary supports to the adjoining elements during shotcreting to prevent movement.

Inserted fixings
Installation: To manufacturer's recommendations.

Methods: Do not insert fixings using explosive tools.

Protection
General: Grease any threads. Protect embedded items against damage.

Compatibility: Provide inserts, fixings and embedded items that are compatible with each other, with the reinforcement, with the documented concrete mix and with the documented surface finish.

Corrosion: In external or exposed locations, galvanize anchor bolts and embedded fixings.

Structural integrity
Position: Fix cores and embedded items to prevent movement during shotcreting. In locating cores, fixings and embedded items, displace but do not cut reinforcement, and maintain cover to reinforcement.

Tolerances
General: Maximum deviation from correct positions:

- Anchor bolt groups for structural steel: To AS 4100.
- Cores and embedded items generally: 10 mm.

- Other fixing bolts: 3 mm.

3.4 APPLICATION

Preparation

Preparation: Clean loose material and other foreign matter from surfaces to receive shotcrete and compact earth surfaces.

Equipment: Use clean delivery hoses and provide back-up equipment to allow continuous application of shotcrete to all surfaces in the event of equipment breakdown.

Spraying

Technique: Minimise rebound by directing the nozzle perpendicular to the surface to be covered at all times, unless varying angle to encapsulate reinforcement. Apply shotcrete in a circular motion to build up the required thickness in layers, starting at the lower sections and moving upwards.

Layer thickness: Such that the cured concrete satisfies all design requirements

Sprayer: Use a sprayer with previous experience in the application of coarse aggregate shotcrete, or they must work under the immediate supervision of a sprayer or instructor with such experience.

Joints: Provide construction or control joints as required, or as documented, to the details shown in CIA Z5 clause 9.5.3.

Adverse weather

Rain: Do not place shotcrete during rain, unless adequate shelter can be provided. Protect all exposed faces of fresh shotcrete from rain.

Strong winds: Provide for screening of nozzle, jet and surface if shotcreting in windy conditions. Protect all exposed faces of fresh shotcrete with screening.

Control of water

General: If water flows and seepage occur, submit proposals for their control, to avoid detrimental effects.

Acceptance

General: Provide dense uniform shotcrete without discernible weakness of bond (between layers).

Consistency: Provide a uniform consistency in order to maximise binding, bonding, cohesion and density, minimise rebound and prevent sagging of the applied shotcrete.

Soundness: Remove all laitance, loose material and rebound. Sound the surface with a hammer to locate any voids, aggregate pockets or un-bonded areas.

Defective work: If drummy areas are found or if probing, drilling or other observations indicate non-conformance with thickness or strength requirements, core to determine and replace such defective areas.

Removal: Remove defective shotcrete from site.

3.5 SHOTCRETING IN COLD WEATHER

Cement

- General: Do not use high alumina cement.

Placing

Concrete: Maintain temperature of the freshly mixed concrete at 5°C or more.

Embedments and reinforcement: Before and during placing maintain temperature at 5°C or more.

Temperature control

General: Heat the concrete materials, other than cement, to the minimum temperature necessary so that the temperature of the shotcrete is within the documented limits.

If severe weather conditions are predicted, use high early strength cement.

Admixtures: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

Frozen materials: Do not allow frozen materials or materials containing ice to enter the mixer, and keep free of frost and ice any materials, substrates and equipment coming in contact with the concrete.

Maximum temperature of water: 60°C when placed in the mixer.

Freezing: Prevent shotcrete from freezing without using salts or chemicals.

3.6 SHOTCRETING IN HOT WEATHER

Handling

General: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses.

Placing

Concrete: Maintain temperature at 35°C or less.

Embedments and reinforcement: Before and during placing maintain temperature at 35°C or less.

If surrounding outdoor shade is 38 degrees or more, do not mix concrete.

Temperature control

General: Select one or more of the following methods of maintaining the temperature of the placed shotcrete at 35°C or less:

- Cool the concrete using liquid nitrogen injection before placing.
- Spray the coarse aggregate using cold water before mixing.
- Use chilled mixing water.

3.7 FINISHING

General

Surface finish: Refer Architect.

Finished surface: Unless an off-nozzle finish has been documented, strike off, screed and level surfaces to the documented position or level and the flatness tolerance class documented.

Surface repairs

Method: If surface repairs are required, submit proposals.

Finishing methods

Off-nozzle finish: No additional finishing required to the natural textured surface left by spraying.

Screed finish: Trim, slice or screed surface to a true line and grade to produce a surface which may exhibit defects such as drag marks from aggregate.

Steel trowel finish: After screeding finish, as follows:

- Use power or hand steel trowels to produce a smooth surface relatively free from defects.
- When the surface has hardened sufficiently, re-trowel to produce the final consolidated finish free of trowel marks and uniform in texture and appearance.

Burnished finish: Continue steel trowelling until the concrete surface attains a polished or glossy finish, uniform in texture and appearance, and free of trowel marks and defects.

Wood float finish: After screeding, use wood or plastic hand floats to produce the final consolidated finish free of float marks and uniform in texture and appearance.

Broom finish: After screeding and steel trowelling use a broom or hessian belt drawn across the surface to produce a coarse even-textured transverse-scored surface.

Scored or scratch finish: After screeding, use a stiff brush or rake drawn across the surface before final set, to produce a coarse scored texture.

Sponge finish: After screeding and steel trowelling, use a damp sponge to wipe the surface to produce an even textured sand finish.

3.8 CURING

General

Requirements: Protect fresh shotcrete during the curing period from premature drying and from excessively hot or cold temperatures. Take into account the average ambient temperature at site over the relevant period affecting the curing, adopt procedures to make sure of the following:

- Curing: Cure continuously from completion of finishing until the total cumulative number of days or fractions of days, during which the air temperature in contact with the shotcrete is above 10°C, is at least 7 days.
- End of curing period: Prevent rapid drying out at the end of the curing period.
- Protection: Maintain at a reasonably constant temperature with minimum moisture loss, during the curing period.

Curing compounds

Application: Provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken for at least 7 days after application.

Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to subsequent shotcrete layers, applied finishes, concrete toppings and cement-based render.

Cold weather curing

Temperature: Maintain shotcrete surface temperature above 5°C for the duration of the curing period.

Hot weather curing

Curing compounds: If curing compounds are proposed, provide details.

Protection: Select a protection method from the following:

- If the shotcrete temperature is more than 25°C or if not protected against drying winds, protect the shotcrete using a fog spray application of aliphatic alcohol evaporation retardant.
- If ambient shade temperature is more than 35°C, protect the shotcrete from wind and sun using an evaporative retarder until curing is commenced.
- Immediately after finishing, either cover exposed surfaces using an impervious membrane or hessian kept wet until curing begins, or apply a curing compound.

Water curing

Method: Select a method of ponding or continuously sprinkling to prevent damage to the shotcrete surface during the required curing period.

STRUCTURAL STEEL

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide structural steelwork, as documented and provide for the fixing of adjoining building elements that are to be connected to or supported on the structural steel.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Steel – hot-dip galvanized coatings*.
- *Steel – protective paint coatings*.

1.3 STANDARDS

General

Materials, construction, fabrication and erection: To AS 4100.

Cold-formed steel: To AS/NZS 4600.

1.4 INTERPRETATION

Abbreviations

AESS: Architecturally Exposed Structural Steel.

ILAC: International Laboratory Accreditation Cooperation.

1.5 INSPECTION

Notice – off site

Inspection: Give sufficient notice so that inspection may be made of the following:

- Materials including welding consumables before fabrication.
- Submission of the proposed welding procedure to prevent distortion and non-ductile welds in tension zones.
- Testing of welding procedures and welder qualification tests.
- Commencement of shop fabrication.
- Commencement of welding.
- Before placement of root runs of complete penetration butt welds.
- Completion of fabrication before surface preparation.
- Surface preparation before shop painting.
- Completion of protective coating before delivery to site.

Notice – on site

Inspection: Give sufficient notice so that inspection may be made of the following:

- Steelwork on site before erection.
- Anchor bolts in position before casting in.
- Steelwork and column bases erected on site, before grouting, encasing, site painting or cladding.
- Tensioning of bolts in categories 8.8/TB and 8.8/TF.
- Reinforcement and formwork in place before any encasement.
- Completed grouting, encasement, fire protection or site painting.

1.6 SUBMISSIONS

Anchors

Concrete or masonry anchors: If masonry anchors other than as shown on the drawings are required or proposed for the support or fixing of structural steel, submit evidence of the anchor capacity to carry the load.

Bolts

Compliance: Submit a manufacturer's compliance/test certificate from an ILAC accredited testing organisation confirming conformance with AS/NZS 1252.

Independent certification: Provide a local NATA-accredited laboratory independent compliance certificate based on appropriate testing and verification.

Execution

Survey certificates: Submit survey certificates from a licensed surveyor.

Anchor bolts: If anchor bolts do not meet specified location tolerances, submit proposals that will allow steel erection to proceed.

Splicing: If splicing of structural members is intended, submit proposals for review and approval.

Welding procedures: Submit details of proposed welding procedures, using the WPS form in Appendix C of AS/NZS 1554.1.

Identification marks: If members and/or connections are to be exposed to view submit details of proposed marking.

Distortions: Submit proposals for preventing or minimising distortion of galvanized components, welded components or welded and galvanized components; and proposals for restoration to design shape.

Record drawings

General: Supply as-built structural and shop drawings.

Shop drawings

General: Submit shop drawings showing the following information:

- Relevant details of each assembly, component and connection.
- Information relative to fabrication, surface treatment, transport and erection.

Specific requirements: Include the following information:

- Marking plans.
- Identification.
- Steel type and grade.
- Dimensions of items.
- Required camber, where applicable.
- Fabrication methods including, where applicable, hot or cold forming and post weld heat treatment.
- Location, type and size of welds and/or bolts and bolt holes.
- Weld categories and bolting categories.
- Orientation of members.
- Surface preparation methods and coating system if shop applied.
- Best practice details in relation to application of protective coatings.
- Breather holes for hollow sections (with seal plates) being hot-dip galvanized.
- Procedures necessary for shop and site assembly, and erection.
- Location of and preparation for site welds.
- Temporary works such as lifting lugs, support points, temporary cleats and bracing which are required for transport and erection of the structural steelwork, and the procedure for final removal.
- Required fixings for adjoining building elements.

Splices: If variations to documented splice locations or additional splices are proposed, submit details.

Do not commence fabrication until final approved shop drawings are received. Allow seven (7) working days for review of shop drawings after submission.

Subcontractors

General: Submit names and contact details of proposed fabricator and installer.

Tests

Steel properties: Submit evidence that the steel used in the work conforms to the cited material standards.

Bars and sections: Submit results of all non-destructive tests.

Plates: Submit results of all ultrasonic tests.

Welds: Submit results of all non-destructive examinations.

2 PRODUCTS

2.1 STEEL TYPE AND GRADE

Material

Steel members and sections: Conform to the **Steel grade (minimum) table** and as documented in the drawings.

Steel grade (minimum) table

Type of steel	Grade
Universal beams and columns, parallel flange channels, large angles to AS/NZS 3679.1	300
Flat, small angles, taper flange beams and columns to AS/NZS 3679.1	250
Welded sections to AS/NZS 3679.2	300
Hot rolled plates, floor plates and slabs to AS/NZS 3678	250
Hollow sections to AS/NZS 1163: Circular sections less than 165 mm nominal outside diameter	C250 or C350
Hollow sections to AS/NZS 1163: Sections other than the above	C350 or C450
Cold formed purlins and girts to AS 1397	G450 Z350 or Z450

Steel certification

Acceptable evidence: Certified mill test reports, or test certificates issued by the mill in conformance with AS/NZS 1163 clause 13.2.2 for cold formed hollow sections, AS/NZS 3679.1 clause 11.2.2 for hot rolled bars or sections or AS/NZS 3679.2 clause 10.2.3 for welded I sections.

Alternative: Have the steel tested by an independent NATA or ILAC accredited testing authority for compliance with the chemical composition and mechanical test requirements of the cited material standard.

2.2 BOLTS

Bolts, nuts and washers

Finish: Hot-dip galvanized, corrosion-free, and in serviceable condition.

3 EXECUTION

3.1 FABRICATION AND ERECTION

General

Care: Shop detail and fabricate members so that they can be properly erected.

Substitution: If substitution of members is proposed, provide details for review and approval.

Beam camber

General: If beam members have a natural camber within the straightness tolerance, fabricate and erect them with the camber up.

Straightening

Care: If correcting distorted members, conform to the submitted procedures and avoid damage.

Site work
General: Other than work shown on the shop drawings as site work, do not fabricate, modify or weld structural steel on site.

Identification marks
General: Provide marks or other means of identifying each member compatible with the finish, for the setting out, location, erection and connection of the steelwork in conformance with the marking plans.

High strength bolting: If the work includes more than one bolting category, mark high-strength structural bolted connections with a 75 mm wide flash of colour, clear of holes.

Cold formed members: Clearly mark material thickness.

Monorail beams: Identify and mark rated capacity in conformance with AS 1418.18 clause 5.12.6.

Tolerances
Measurement: Check tolerances by measurement after fabrication and application of corrosion protection.

Conformance: To AS 4100 clause 14.4.

Work exposed to view
Welds: Grind smooth but do not reduce the weld below its nominal size.

Shearing, flame cutting and chipping: Perform carefully and accurately.

Corners and edges: Grind fair those corners and edges which are sharp, marred or roughened.

3.2 WELDING

General
Standard: To AS/NZS 1554 series.

Weld category
Weld categories not shown on the drawings: Category SP.

Weld type
Weld type not shown on the drawings: Submit proposals for weld type and electrodes.

Non-destructive weld examination
Standard: To AS/NZS 1554 series.

Methods: Conform to the **Non-destructive weld examination (NDE) table**.

Radiographic and ultrasonic examination: By an independent testing authority.

Repairs: Repair welds revealed as faulty by non-destructive examination and repeat the examination.

Non-destructive weld examination (NDE) table

Type of weld and category	Examination method	Extent (% of total length of weld type)
Shop fillet welds	Visual means	100
Site fillet welds	Visual means	100
Butt welds, GP	Visual means	100
Butt welds, SP	Visual means	100
Fillet and butt welds, SP	Radiographic or ultrasonic examination	10

3.3 BOLTING

General
Standards: To AS 1110.1, AS 1111.1 and AS/NZS 1252.

Bolting category
General: In conformance with the structural drawings.

Connections
Connection type: For connections not documented, submit proposals, for review and approval.

Bolting category 8.8/TF contact surfaces: Clean, as rolled and free from applied finishes.

Anchor bolts

General: Provide each anchor bolt with two (2) nuts and two (2) oversize washers and provide sufficient thread to permit the levelling nut and washer to be set below the base plate.

Galvanizing: Galvanize all components.

Hexagonal bolts: To AS 1111.1.

Hexagonal nuts: To AS 1112.3.

Plain washers: To AS 1237.1.

Set out: Set out bolt groups using templates and subject to survey check.

Lock nuts

General: Provide lock nuts for bolts in moving parts or parts subject to vibration and for vertical bolts in tension.

Tensioning of bolting categories 8.8/TB and 8.8/TF

Method: Use part-turn-of-nut or load indicating washers as per AS 4100.

Permanent bolting

Completion: Bolt only when correct alignment and preset or camber has been achieved.

3.4 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

General

Requirement: Provide AESS as documented in the **AESS schedule**.

Fabrication

Requirement: Conform to the requirements of *ASI AESS F - AESS Code of practice*.

Welds: Make intermittent welds appear continuous, either with additional welding, caulking or filler.

Corners and edges: Grind fair those corners and edges, which are sharp, marred, or roughened.

Rough surfaces: Deburr and grind smooth.

3.5 SURFACE PREPARATION AND TREATMENT

General

General: Conform to the *Steel – protective paint coatings* and/or *Steel – hot-dip galvanized coatings* worksections and the architect's specification as appropriate.

General: Structural steelwork not encased in concrete shall be coated.

Standards: To AS 1627 and AS/NZS 2312 Section 1.

Steel surfaces: Remove loose mill scale, loose rust, oil, grease, dirt, globules of weld metal, weld slag and other foreign matter. Ensure surfaces are dry.

Surface preparation: Class 1 blast.

Coating: Coat prepared steelwork as follows:

- Primer: Zinc phosphate primer.
- Thickness: 70 μm.
- Requirement: Verify and record thickness.
- Time delay: Prime the steel surface as soon as possible after surface preparation and before the surface deteriorates. If the surface is contaminated or rust bloomed, repeat surface preparation before priming.
- Conditions: Do not prime in adverse conditions.
- Concrete encasing: Where members are part concrete encased extend the priming 25 mm into the surface to be encased.
- Clearances: Keep priming clear of members and components to be site welded, and surfaces against which concrete is to be poured (including concrete encasing except as noted above). On completion of site welding, of concrete pouring and of 8.8/TF bolting, prime to give complete coverage of exposed surfaces.
- Inaccessible surfaces: Where surfaces will be in contact or near contact after fabrication or erection, apply the finish and allow it to dry before assembly.

Marking: On the contact surfaces of friction type joints, confine the use of marking ink to the minimum necessary for marking hole positions.

Shop work: Apply the primer coat or protective system to the structural steel before delivery to the site.

Transport and handling: Do not damage the paintwork.

3.6 SPECIAL FINISHES

General

General: Apply special finishes as documented in the architect's specification.

3.7 METAL SPRAYING

General

General: Apply sprayed metal finishes as documented in the architect's specification.

3.8 FIRE PROTECTION COATINGS

General

General: Apply fire protection to structural steelwork in conformance with the appropriate worksection.

- Fire rated plaster to be an approved proprietary system
- Sprayed coatings such as sprayed mineral fire protection and intumescent paint to be an approved proprietary system.

All fire protection to be installed to achieve a fire protection rating as specified by the Building Surveyor.

All fire protection methods are to be approved by the Building Surveyor.

3.9 ERECTION

General

Standard: To AS 3828.

Execution: Make sure that every part of the structure has sufficient design capacity and is stable under construction loads produced by the construction procedure or as a result of construction loads, which are applied.

Calculations: If required to justify the adequacy of the structure to sustain any loads and/or procedures, which may be imposed, provide calculations.

Temporary work

General: Provide all necessary temporary bracing or propping.

Temporary connections: If required cleats are not shown on shop drawings, submit details.

Temporary members: If temporary members are required, fix so as not to weaken or deface permanent steelwork.

Hand cutting

General: If hand cutting of bolt holes appears to be necessary, submit a report and proposed alternative options.

Cold-formed purlins

Trimming members: Provide to support edges of roof sheeting along hips, valleys and roof penetrations.

Movements

General: Allow for thermal movements during erection.

Site welds

Completion: Weld only when correct alignment and preset or camber have been achieved.

Overhead welding: If overhead welding is required, submit proposals.

Clearances

End clearances at connections (mm): refer drawings

Anchor bolts

General: For each group of anchor bolts, provide a template with setting out lines clearly marked for positioning the bolts when casting in.

Grouting at supports

Preparation: Before grouting steelwork to be supported by concrete or masonry, set steelwork on packing or wedges.

- Permanent packing or wedges: Form with solid steel or grout of similar strength to the permanent grout.

- Temporary packing or wedges: Remove before completion of grouting.

Timing: Grout at supports before the construction of any supported floors, walls, roofing, wall cladding or precast.

Temperature: Do not grout if the temperature of the base plate or the footing surface exceeds 35°C.

Method: In strict accordance with the manufacturer's specifications and instructions.

Type: A proprietary product to match the compressive strength specified on the drawings and approved by the engineer.

Minimum compressive strength (MPa): 40MPa or as per the drawings

Minimum thickness (mm): 15mm or as per the drawings

Maximum thickness (mm): 50mm or as per the drawings

Handling

Care: Handle members or components without overstressing or deforming them.

Protection: Wrap or otherwise protect members or components to prevent damage to surface finishes during handling and erection.

Drifting

Limitation: Use drifting only to bring members into position, without enlarging holes or distorting components.

3.10 REPAIRS

General

General: Repair finishes to restore the full integrity of each phase and each coating.

3.11 COMPLETION

Tolerances

Conformance: After erection is complete confirm conformance with AS 4100 clause 15.3.

Temporary connections

General: Remove temporary cleats on completion and restore the surface.