

Engineering Construction Specification C28 Auxiliary concrete works

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1 General

1.1 Responsibilities

1.1.1 General

Requirement: Provide cast, pre-cast and sprayed concrete, as documented.

1.2 Cross references

1.2.1 General

Requirement: This worksection is not a self-contained specification. In addition to the requirements of this worksection, conform to the following:

- *C01 General requirements (Construction)*
- *C02 Quality management (Construction)*
- *C03 Control of traffic*
- *Council's Standard Drawings*

1.3 Standards

1.3.1 General

Specification and supply of concrete: To AS 1379.

Concrete materials, design and construction: To AS 3600.

Concrete structures for retaining liquids: To AS 3735.

Design, installation and testing of post-installed and cast-in fastenings: To AS 5216.

1.4 Interpretation

1.4.1 Definitions

General: For the purposes of this worksection the definitions given in AS 1379, AS 3600 and the following apply:

- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in AS 1379 Table 1.2.
- Expansion joint: A closing control joint with the joint surfaces separated by a compressible filler to allow axial movement due to thermal expansion or contraction with changes in temperature or creep. It may include unbound dowels to assist vertical deflection control.
- Sprayed concrete: Concrete pneumatically applied at high velocity on to a surface. Application may be either a wet or dry process, to produce a sound homogeneous product with a surface finish reasonably uniform in texture and free from blemishes. Sprayed concrete is also called Shotcrete.
- Weather – cold: Ambient shade temperature less than 10°C.
- Weather – hot: Ambient shade temperature greater than 30°C.

1.5 Submissions

1.5.1 Certification

Design: Submit certification verifying conformance of the formwork design for in-situ box culverts and retaining walls.

Completed formwork: Submit certification verifying conformance of completed formwork, including the suitability of the formwork for the documented surface finish class.

1.5.2 Execution details

Modifications: Submit details of any proposed on-site modifications to the documented reinforcement.

Welding: Submit details of any proposed welding of steel reinforcement.

Splicing: Submit details of any proposed mechanical splicing of steel reinforcement.

Galvanizing repair: Submit proposals for any repair to damaged galvanizing of steel reinforcement.

Coring: Submit details of any proposed cutting or coring required in hardened concrete.

Elapsed delivery time: Submit details of any proposed methods for cooling or heating wet concrete before placement.

Measurement of materials: Submit proposal to measure materials by volume for on-site mixing for minor concrete works.

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

- Changes to the concrete mix.
- Curing and protection methods.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.
- Details of any proposed sequential placement of slabs.

Placing under water: Submit detailed method statement for proposed placement of concrete under water.

Construction joints: Submit details of any emergency construction joints included in the works.

Repair of defects: Submit details of the proposed method of defect repair.

Surface repairs: Submit details of the proposed method of surface repair.

Method statement: Submit method statement for all sprayed concrete works.

1.5.3 Products and materials

Curing compounds: Submit details of any proposed liquid membrane forming curing compound, including evidence of conformance to the documented requirements.

Machine mixing: Submit details of proposed concrete mix when on-site machine mixing is proposed.

1.5.4 Samples

Coloured concrete: Submit sample blocks of coloured concrete before casting final concrete.

Sprayed concrete sample panels: Submit 3 sample panels for each mix proposed.

1.5.5 Shop drawings

Submit shop drawings to a scale that best describes the detail, showing the following:

- Location: The location of any cores, anchors, fixings or embedded items, including any requirement to displace reinforcement.

1.5.6 Subcontractors

Pre-mixed subcontractors: Submit details of proposed pre-mixed concrete suppliers.

1.5.7 Tests

Quality: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Cores and test acceptance: Submit proposed locations of test cores.

Other tests: Submit results, as follows:

- Loading: If applying superimposed loads to a future load bearing concrete structure, within 21 days of placing concrete, complete tests to demonstrate that 95% of the concrete design strength has been achieved.

1.6 Inspections

1.6.1 Notice

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

- Base preparation: Completed and prepared base before laying underlay or placing concrete.
- Completed formwork: Completed formwork following certification by a professional engineer.
- Steel reinforcement placement: Completed steel reinforcement placement before placing concrete.
- Galvanizing repair: Any repaired galvanizing of steel reinforcement before placing concrete.
- Emergency hand mixing: Emergency hand mixing of concrete due to mechanical failure.
- Sprayed concrete sample panels: Concrete spraying of sample panels.

2 Materials

2.1 Concrete

2.1.1 Properties

Concrete mix and supply: Conform to the following:

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

2.1.2 Consistency

Stockpile: If uniform, consistent colour is documented, stockpile sand, cement and aggregates at the beginning of the project to minimise colour variations.

2.1.3 Aggregates

Standard: To AS 2758.1.

2.1.4 Cement

Standard: To AS 3972.

Age: Less than 3 months old.

Storage: Store cement bags under cover and above ground. All cement shall be transported in watertight containers and shall be protected from moisture until used. Caked or lumpy cement shall not be used. **Supplementary cementitious materials**

Fly ash: To AS/NZS 3582.1.

Slag: To AS 3582.2.

Amorphous silica: To AS/NZS 3582.3.

2.1.6 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. Water that is not potable for human beings shall not be used in reinforced concrete.

2.1.7 Coloured concrete

Manufacture: Produce 4 sample blocks of each coloured concrete using the proposed mix and method before casting final concrete.

Sample block size (nominal): 300 x 300 x 50 mm.

2.1.8 Chemical admixtures

Standard: To AS 1478.1, used to the manufacturer's recommendations.

2.2 Formwork

2.2.1 General

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

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

2.2.2 Plywood formwork

Material: To AS 6669.

Grade: To suit the documented design dimensions, loading and surface quality.

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

Tolerances: To AS 3610.1 Table 3.3.5.1.

2.3 Reinforcement

2.3.1 Fibre reinforcement

Standard: To AS 3600 Section 16 and CIA CPN35.

Steel fibres: To ISO 13270 or EN 14889-1.

2.3.2 Steel reinforcement

Standard: To AS/NZS 4671.

Properties: To the **Steel reinforcement properties schedule**.

Fabrication tolerances: To AS 3600 clause 17.2.2.

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

Storage: Store reinforcement above the surface of the ground and protect from damage and from deterioration by exposure.

2.3.3 Protective coating

Standard: To AS 3600 clause 17.2.1.2.

Requirement: 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: High build, high solids chemically resistant coating.

- Thickness: 200 µm minimum.

Galvanizing: To AS/NZS 4680:

- Sequence: If fabricating after galvanizing, repair damaged galvanizing and coat cut ends.
- Zinc-coating (minimum): 600 g/m².

2.3.4 Accessories

Reinforcement supports: To AS/NZS 2425.

Tie wire: Galvanized annealed steel 1.25 mm diameter minimum.

2.4 Precast units

2.4.1 General

Requirement: Provide proprietary precast units as documented.

Materials, components and equipment for manufacture: To AS 3850.1.

Planning, design, construction, transportation, erection and installation: To AS 3850.2.

2.4.2 Marking

Identification: Identify all units with easily visible markings that will be hidden once the unit is installed, including the following:

- Date of manufacture.
- Manufacturer's name or registered mark and location of manufacture.
- Maximum mass of unit in kg.
- Batch number.
- Correct orientation of unit.

2.5 Miscellaneous

2.5.1 Surface hardeners, sealants and protectors

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

2.5.2 Polymeric film underlay

Standard: To AS 2870 clause 5.3.3.2.

2.5.3 Curing compounds

Standard: To AS 3799.

Liquid membrane-forming curing compound: Compatible with the following:

- The water retention requirements of AS 3799.
- The concrete and any applied finishes, including toppings and render.
- The surface colour required for visually important surfaces.

2.6 Testing

2.6.1 Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 Execution

3.1 Ground preparation

The subgrade or subbase shall be formed at the required depth below the finished surface levels as shown on the drawings. Rock foundations shall be neatly excavated to form a bed for concrete and shall be thoroughly scraped and cleaned. Soil foundation shall, as far as possible, be excavated neatly from the solid material to coincide with the under surface of the concrete, or the subbase material (where specified).

All soft yielding or other unsuitable material shall be replaced with sound material, and the subgrade compacted to provide a minimum relative compaction of 95 percent (standard compaction) as determined by AS 1289. If the subgrade is dry it shall be sprinkled with as much water as it will readily absorb, before the concrete is placed.

The contractor shall supply all necessary sheeting and bracing to support the excavation in accordance with NSW Workcover requirements.

The excavation must be kept clear of water.

For new jersey kerb barriers, driveways and footpaths a subbase of approved, quality and minimum 150mm compacted thickness shall be placed on the subgrade unless otherwise shown on the drawings. The subbase material shall be compacted to provide a minimum relative compaction as determined by test method T166 of 100 percent for standard compaction effort or 98 percent for modified compactive effort as appropriate. The finished subbase shall not deviate more than 12mm under a straight edge 3 metres long, subject to any necessary allowances on vertical curves.

3.1.1 Rock foundations

Minimum depth: Excavate a minimum depth of 150 mm, or as documented, into the rock for retaining walls, headwalls and wingwalls. Where cut-off walls are to be provided, the depth of the cut-off rock foundations may be reduced to 100mm.

3.1.2 Mass concrete blinding

In situ walls: Place a mass concrete blinding slab on the prepared subgrade before constructing wall footings.

Blinding thickness:

- Earth foundation: Minimum 50 mm.
- Rock foundation: Minimum 50 mm above the highest point of rock.

Restriction: Do not place forms or other materials on the blinding within 48 hours of the blinding being placed.

3.1.3 Pre cast concrete

Unless otherwise specified, precast concrete wall sections shall be placed on a bed of fresh concrete while it is still in plastic state. In the case of rock foundations, the concrete shall be not less than 50mm thick, and where the foundation is in rock, the concrete shall be of such a thickness as is required to provide a uniform surface of at least 50mm above the highest points of rock.

3.1.4 Base preparation

Requirement: Prepare base, as follows:

- Graded prepared subgrade: Blind with sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay, where documented.
- Concrete blinding: Remove projections above the plane surface, and any loose material.

3.1.5 Polymeric film underlay installation

General: Where documented, 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.
- 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 Formwork

3.2.1 General

Standard: To AS 3610.1.

Robustness: Provide formwork of adequate strength to carry all applied loads, including the pressure of fresh concrete, vibration loads, weight of workers and equipment, without loss of shape.

Stripping: Provide forms that can be removed without causing damage to the completed structure.

Side forms: In earth excavations, provide side forms to prevent contact between concrete and the in situ earth.

Corners above ground: Provide 25 mm bevelled fillet at re-entrant angles, and chamfer at corners.

Steel linings: Clean off any rust and apply rust inhibiting agent before use.

3.2.2 Design

General: The design of formwork is the contractor's responsibility.

Certification: For in situ box culverts and retaining walls, obtain certification by a professional structural engineer, experienced in formwork design, verifying conformance of the design.

Design of formwork for high sections shall be such that it shall not be necessary to drop concrete freely from a greater height than 1.2m or move concrete along the formwork after deposition.

3.2.3 Fittings and embedments

Requirement: Make provision for the accurate location and firm support of fittings, bolts, anchorages and formers of holes and recesses, as documented.

Temporary fittings for the support of the formwork: Arrange to allow removal without damage to the concrete.

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

3.2.4 Weepholes

Where shown on the drawings, weepholes of 50mm diameter shall be provided in retaining walls and wing walls.

3.2.5 Openings

Inspection: 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, provide access hatches for placing concrete so that concrete does not fall a distance greater than 2 m.

3.2.6 Release agents

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

Staining: If commercial quality form oil or grease is used, make sure that surfaces to be exposed will not become stained or discoloured.

Application: Spread the coating uniformly in a thin film and remove any surplus before placing concrete.

Unlined timber forms: Wet the timber thoroughly before oiling.

3.2.7 Visually important surfaces

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

Formwork panels: Provide formwork for exposed surfaces from panels having uniform widths of not less than 1 m and uniform lengths of not less than 2 m, except where the dimensions of the member formed are less than these dimensions.

Plywood panels: Conform to the following:

- Orientation: Grain of the outer plies perpendicular to the studding or joists.
- Thickness: Not less than 15 mm thick, where attached directly to the studding or joists.
- Variations: If plywood less than 15 mm thick is used, provide a continuous backing of dressed material of 20 mm minimum thickness.

Mild steel form surfaces: Counter-sink all bolt and rivet heads and grind back all welds to an even and smooth surface.

3.2.8 Completed formwork

Certification: Obtain 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.

3.3 Steel reinforcement placement

3.3.1 General

Fixing: To AS 3600 clause 17.2.5 and as documented.

3.3.2 Modifications

Requirement: Record any on-site modifications to the documented reinforcement, including position, splice location, spacing or cover, to accommodate concrete placement or the requirements of AS 3600.

3.3.3 Dowels

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

Grade: 250 N.

3.3.4 Cover

Concrete cover generally: To AS 3600 clause 4.10.

Concrete cover for structures retaining liquids: To AS 3735 clause 4.4.

3.3.5 Supports

Requirement: Provide reinforcement supports, as follows:

- Able to withstand construction and traffic loads and maintain the concrete cover, as documented.
- With a protective coating if they are ferrous metal extending to the surface of the concrete.
- Use plastic or concrete supports with galvanized or zinc-coated reinforcement.

Spacing:

- Bars: ≤ 60 bar diameters.

- Mesh: ≤ 600 mm.

Supports over underlay: Prevent damage to polymeric film underlays. If appropriate, place a metal or plastic plate under each support.

3.3.6 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.

3.3.7 Tying

Requirement: 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.

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

Fibre reinforced concrete: To AS 3600 Section 16.

3.3.8 Welding

General: If welding of reinforcement is proposed, conform to AS/NZS 1554.3.

3.3.9 Bending

Restriction: Use only bars with bends as documented. If required to bend or straighten bars do not use heat and use only methods that will not damage the steel.

3.3.10 Splicing

Standard: To AS 3600 clause 13.2.

Lapped splices: Provide laps in reinforcing bars as documented and securely tie together in a minimum of two places.

Lapping of reinforcing mesh: Overlap each sheet of reinforcing mesh a minimum length of the spacing of the wires running perpendicular to the edge of the sheet, plus 25 mm.

Staggering: Stagger splices as documented.

3.3.11 Galvanizing repair

Damaged galvanizing: If galvanizing is damaged, propose repairs to AS/NZS 4680 Section 8.

3.4 Cores, fixings and embedded items

3.4.1 Fasteners

General: Install fasteners to manufacturers' recommendations and AS 5216 Appendix D.

3.4.2 Location

Requirement: Produce shop drawings showing the proposed locations, clearances and cover of any cores, fixings or embedded items, indicating any proposed repositioning or displacement of reinforcement.

3.4.3 Coring

Requirement: If cutting or coring of hardened concrete is proposed, prepare details.

3.4.4 Adjoining elements

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

3.4.5 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.

3.4.6 Structural integrity

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

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

3.4.7 Tolerances

Requirement: Maximum deviation from correct positions:

- Anchor bolt groups for structural steel: To AS/NZS 5131.
- Cores and embedded items generally: 10 mm.
- Other fixing bolts: 3 mm.

3.5 Pre-mixed concrete supply

3.5.1 General

Addition of water: To AS 1379 clause 4.2.3.

Transport and production equipment: Use equipment which:

- Prevents segregation or loss of materials.
- Supplies a homogenous product suitable for placing and compaction.

Delivery information: For each batch, obtain a delivery docket and keep a record of the information required by AS 1379, and the following:

- Special class performance concrete: Documented performance and type of cement binder.
- 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.

3.5.2 Pre-mixed concrete subcontractors

Requirement: Compile a list of 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.

3.5.3 Elapsed delivery time

General: Make sure that the elapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with 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.

3.5.4 Elapsed delivery time table

Concrete temperature at time of discharge (°C)	Maximum elapsed time (minutes)
5 – 24	120
24 – 27	90
27 – 30	60
30 – 35	45

3.6 On-site mixing

3.6.1 Machine mixing

Requirement: Mix all materials by machine, conforming to the following:

- Mixer requirements: Use a mixer which will uniformly distribute the materials throughout the batch.
- Mixer capacity: Use a mixer with capacity for one or more whole bags of cement to be used per batch of concrete. Do not exceed the manufacturer's rated capacity of the mixer with the volume of the mixed material.
- Mixing time: Allow a mixing time for each batch of not less than 1.5 minutes after all ingredients are assembled in the mixer, and before any portion of the batch is removed.
- Total mix discharge: Discharge the entire contents of a batch from the mixer before placing any new materials in the mixer for the next batch.

3.6.2 Emergency hand mixing

Restrictions: Hand mixing is only permitted if there is a breakdown of mechanical mixing equipment. Provide notice if hand mixing is required and conform to the following:

- Hand mix in small quantities no greater than 0.25 m³ per batch, to complete a section of the work or reach a suitable construction joint. Do not start a new section of work.
- Hand mix on a water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. Use an amount of cement 10% more than required for machine mixed concrete.

Procedure: Conform to the following:

- First mix the fine aggregate and cement until a uniform colour is obtained, and then spread on the mixing platform in a thin layer.
- Spread the coarse aggregate, previously drenched with water, over the fine aggregate and cement in a uniform layer, and turn the whole mass over as further water is added with a rose sprinkler.
- After the water is added, turn the mass at least three times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance.

3.6.3 Measurement of materials

General: Measure all materials by weight, except if necessary:

- Water: Measure by volume with an approved adjustable water-measuring and discharging device.
- Cement: Measure by bags as packed by the manufacturer. Proportion batches on the basis of one or more unbroken bags of cement, assumed to weigh 40 kg per bag.

Bulk cement: Weigh in an individual hopper and keep separate from the aggregates until the components of the batch are discharged from the batching hopper.

Measurement by volume for minor works: Not permitted, without approval.

3.6.4 Measuring by volume: Minor concrete works only

Mixing by volume on site: If measurement by volume is approved, proportion the materials to produce a mix free of voids and having the documented strength at 28 days.

Volume batching: Use the nominal proportions documented in the **Volume batching table**.

3.6.5 Volume batch table

MPa	Parts by volume		
	Cement	Fine aggregate	Coarse aggregate
20	1	2	3

Fine aggregate bulking: If the fine aggregate contains sufficient moisture to produce 'bulking' in excess of 10%, increase the volume of fine aggregate by a corresponding amount.

Batch measurement: Measure the volumes of fine and coarse aggregates for each batch in boxes or bins, as follows:

- Measure the aggregates loose (i.e. without compaction) in the boxes and strike off level.
- Do not undertake measurements by shovels or like methods.
- Arrange batch proportions for each batch to contain 1 bag of cement. Assume one 40 kg bag of cement to have a volume of 27.5 litres.

3.7 Placing and compaction

3.7.1 Preparation

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

Water: Moisten the area before placing concrete: Remove any ponding water.

3.7.2 Placing

Method: 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.

Vertical elements: Limit the free fall of concrete to a maximum of 2 m.

3.7.3 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.

3.7.4 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.

3.7.5 Rain

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

3.7.6 Time between adjacent placements

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

No concrete shall be placed during rain or while the air temperature is, or is likely to be within 24 hours, below 5 degrees Celsius, or while the shade temperature exceeds 38 degrees Celsius.

3.7.7 Placing in cold weather

Cement: Do not use high alumina cement.

Temperature limits: Maintain the following temperature limits:

- Freshly mixed concrete: $\geq 5^{\circ}\text{C}$.
- Formwork and reinforcement before and during placing: $\geq 5^{\circ}\text{C}$.
- Water: Maximum 60°C when placed in the mixer.

High early strength cement: If deteriorating 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 $\geq 5^{\circ}\text{C}$.

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.

Freezing: Prevent concrete from freezing.

3.7.8 Placing in hot weather

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

Temperature limits: Maintain freshly mixed concrete at the following temperature limits:

- Normal concrete in footings, walls, slabs, culverts and drainage structures: $\leq 35^{\circ}\text{C}$.
- For concrete strength grade less than 40 MPa, with section thickness ≥ 1 m in all dimensions: $\leq 27^{\circ}\text{C}$.
- For concrete strength grade 40 MPa or greater, with section thickness ≥ 600 mm in all dimensions: $\leq 27^{\circ}\text{C}$.
- Formwork and reinforcement before and during placing: $\leq 35^{\circ}\text{C}$.

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

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 or ice.

3.7.9 Placing under water

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

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

Method: Prepare a detailed method statement if proposing to place concrete under water.

3.7.10 Initial Set

Concrete shall not be moved after it has been in the forms for more than 10 minutes.

3.7.11 Extruded concrete

Surface slurry: Where the extrusion machine is equipped with a slurry receptacle place small quantities of cement-sand slurry, comprising two parts plasterer's sand and one part cement (by volume), together with sufficient water to bring it to a semi-fluid condition, and feed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish.

3.7.12 Exposed Surfaces

Exposed surfaces of the concrete shall be struck off and finished with a wooden float. Where shown on the drawings, corners and edges shall be left neatly rounded or chamfered. Re-entrant angles shall be neatly fileted.

3.8 Curing

3.8.1 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 when the concrete has set sufficiently not to be damaged by the curing process, 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:

High early strength concrete: 3 days.

Other concrete: 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 method: All exposed surfaces of freshly placed concrete shall be kept moist by either the use of plastic sheeting, damp sand or commercial curing compounds for a minimum period of 3 days. During this time the work must be adequately protected from traffic and any other causes likely to damage the concrete.

3.8.2 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.

3.8.3 Cold weather curing

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

3.8.4 Hot weather curing

Requirement: If the concrete temperature exceeds 25°C, or the ambient shade temperature exceeds 30°C, protect from drying winds and sun by using an evaporative retarder until curing is commenced.

3.8.5 Water curing

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

3.9 Joints

3.9.1 Construction joints

Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures (other than barriers and footpaths) the joints may be made at the base of the walls and other locations in the walls as approved by council. In order to provide a bond between the new concrete and the concrete that has already set, the surface on which the new concrete is to be placed shall be thoroughly cleaned of loose material, foreign matters and laitance. The surface shall be roughened or keyed and saturated with water. After any excess water has been removed, the surface shall be coated with neat cement grout.

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, provide details of 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.

3.9.2 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.

Where barriers are extruded or cast in place, narrow transverse vertical grooves, 20mm deep shall be formed neatly in the surface of the freshly placed concrete to produce contraction joints for the control of cracking. The contraction joints shall be at intervals of 3m.

In barriers, unless shown otherwise on the Drawings, expansion joints 15mm in width for the full depth of the barrier shall be constructed at intervals not exceeding 15m and where the barrier abuts

gully pits. Expansion joints shall consist of preformed joint filler complying with RMS Specification 3204.

In footpaths, median toppings and driveways, unless otherwise shown on the Drawings, expansion joints 15mm in width for the full depth of paving, shall be constructed at intervals, not exceeding 15m and where the pavement abuts against gutters, pits and structures. Expansion joints shall consist of preformed joint filler complying with RMS Specification 3204.

All reinforced paving shall be provided with narrow vertical grooves, 20mm deep to induce contraction joints for the control of cracking. The joints shall be formed in the freshly placed concrete in a neat regular pattern to form "slabs" no bigger than 2 m². The ratio of the longest side to the shortest side shall not exceed 1:6. Joints in paving to be in accordance with Council's Standard Drawings.

3.10 Formed surfaces

3.10.1 General

Surface finish: Provide formed concrete finishes as documented in the **Formed surface finishes schedule** and conforming to AS 3610.1 Table 3.3.2.

3.10.2 Formwork removal

Extent: Remove all formwork, including formwork in concealed locations, but excepting lost formwork.

Timing: Do not damage concrete works through premature removal of formwork. Do not disturb forms until concrete is hardened enough to withstand formwork movements and removal without damage. It is recommended to maintain all formwork in place, after placement of concrete, for the following minimum periods, provided that the ambient air temperature does not drop below 10°C during that period:

- Mass concrete retaining walls, headwalls, wingwalls, gully pits, sumps and similar drainage structures: 2 days.

3.10.3 Footpaths, Driveway and similar 2 days.

- Reinforced concrete walls when height of pour each day is:
 - Under 0.6 m: 1 day.
 - 0.6 m to 3 m: 2 days.
 - 3 m to 6 m: 3 days.
 - 6 m to 9 m: 5 days.
- Supporting forms under deck slabs of culverts: 10 days.

To permit the satisfactory finishing of barriers, forms shall be removed in not less than 12 hours or more than 48 hours after placing concrete, depending upon weather conditions.

Concrete containing special additives: In case of concrete containing special additives, confirm that the recommended stripping times are still appropriate.

Protection of concrete during form removal: Remove forms so that the concrete will not be cracked, chipped or otherwise damaged. Do not use crowbars or other levering devices for exerting pressure on the fresh concrete to loosen the forms.

Removal of hole formers: Remove hole formers such as pipes and bars as soon as the concrete has hardened sufficiently to prevent damage to the concrete.

3.10.4 Curing

General: If formwork is stripped before the minimum curing period continue curing the exposed faces until the curing period elapses.

3.10.5 Repair of defects

Physical quality evaluation: To AS 3610.1 clause 3.3.

Repair method: If defect repair is required, obtain approval of the proposed method before commencing repairs.

3.11 Unformed surfaces

3.11.1 General

Surface finish: To be compatible with any documented applied finish, as documented, and in accordance with Council's Standard Drawings.

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

3.11.2 Finishing methods – surfaces other than wearing surfaces

General: Compact and tamp, screed off and finally dress with a wooden float to an even surface, also:

- Drain or otherwise promptly remove any water which comes to the surface.
- Roughen all future contact surfaces, so that the coarse aggregate at the surface is firmly embedded but not forced below the surface.

3.11.3 Finishing methods – wearing surfaces

General: Compact then screed off the surface with a vibrating screed, or hand screed if the distance between forms perpendicular to the direction of screed is no greater than 2 m.

Correction: Immediately following compaction and screeding test and correct for high or low spots.

Final finish: Finish the surface true and uniform and free of any glazed or trowelling finish and finally dress with a wooden template or float.

Surface to receive asphalt: After compacting, screeding and correcting, dress with a wooden float and finally broom to produce a rough surface.

Textured patterned surface: Finish coloured, textured or patterned surfaces, as documented.

3.11.4 Tolerances

Finished surface: Conform to the following maximum deviations from documented values:

- Concrete structures not adjacent to road pavements:
 - Absolute level: ± 25 mm.
 - Alignment: 25 mm.
- Concrete structures adjacent to road pavements (e.g. drainage pits):
 - Absolute level: ± 10 mm.
 - Alignment: 10 mm.
- Longitudinal surfaces greater than 10 m in length: 5 mm from a 3 m straightedge, subject to any necessary allowances for vertical and horizontal curves.

3.11.5 Surface repairs

Method: If surface repairs are required, obtain approval of the proposed method before commencing repairs.

3.12 Precast units

3.12.1 Lifting and handling

General: Conform to the handling and installation requirements of the ASCC National code and AS 3850.2.

Requirement: Lift and support units only at designated points. Use handling methods which do not overstress, warp or damage the units.

Site conditions: Only lift units when the wind and temperature conditions allow handling and fixing consistent with the structural capability and geometry of the unit.

Cranes: To AS 2550.1.

Temporary bracing and propping: To AS 3850.2 Section 5.

3.12.2 Attachments

Requirement: Remove temporary attachments after erection. Seal and rectify residual recesses.

3.12.3 Installation

Fixing: Fix the units securely and accurately in their final positions to AS 3850.2 Section 6.

Ancillaries: Provide components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar, necessary for the installation of the units.

3.12.4 Storage

Support points: When storing elements support units only at designated support points.

Protection: Adequately store and protect units to prevent warping, twisting, crushing, cracking, discolouration, staining and any other damage, until they are installed in their final location.

3.13 Sprayed concrete

3.13.1 Detail

Minimum thickness: 75 mm.

Colour: Spray coloured concrete lining in open drains to match the adjoining rock colour.

3.13.2 Strength

Minimum cement content: 380 kg/m³ as discharged from the nozzle.

Minimum compressive strength: 25 MPa at 28 days when tested by means of 75 mm diameter cores taken from in-place sprayed concrete.

3.13.3 Method statement

Requirement: Prepare a method statement for all sprayed concrete works to include details of the proposed procedure, plant, materials and mix proportions.

3.13.4 Sprayed concrete sample panels

Requirement: Prepare sample sprayed concrete test panels on 750 mm square hardboard panels as follows:

- Quantity: 3 panels for each mix proposed.
- Thickness: 75 mm.
- Conditions: Similar to those where works will take place.
- Method: Apply concrete in the same manner, using materials including steel reinforcing fabric, equipment, pressures and curing that will be used in the works.

3.13.5 Sample test cores

Securing, accepting and preparing test specimens: To AS 1012.9.

Testing: To AS 1012.14.

Cores: Cut four 75 mm diameter cores from one test panel for each proposed mix approximately 48 hours after the panel has been sprayed and test as follows:

- As for cores from in situ sprayed concrete. One core compression test at 3 days, one core at 7 days and the remaining two cores at 28 days.

Defective core: If any of the cores reveals defects such as lack of compaction, dry patches, voids or sand pockets or exhibits an unacceptable surface finish, modify the mix design and/or method of placement and prepare fresh test panels for testing and inspection.

3.13.6 Surface preparation

Earth: Grade, trim, compact and dampen earth surfaces before applying the sprayed concrete. Take any necessary precautions to prevent erosion when the sprayed concrete is applied.

Rock: Clean off loose material, mud and other foreign matter that might prevent bonding of the sprayed concrete onto the rock surface. Dampen the rock surfaces before applying the sprayed concrete.

Corrugated steel pipes: Clean off loose material, mud and any other foreign matter that might prevent bonding of the sprayed concrete to the steel.

Water flow: Remove free water and prevent the flow of water which could adversely affect the quality of the sprayed concrete.

3.13.7 Application for sprayed concrete

Procedure: Begin application at the bottom of the area being sprayed and build up making several passes of the nozzle over the working area.

Technique: Hold the nozzle so that the stream of material is as near as possible to perpendicular to the surface being coated.

Spraying around reinforcement: If spraying around reinforcement, spray concrete behind the reinforcement before concrete can accumulate on the face of the reinforcement.

Protection of adjoining surfaces: Protect adjoining surfaces not requiring sprayed concrete from splash and spray rebound.

Regulation: Regulate the velocity of discharge from the nozzle, the distance of the nozzle from the surface and the amount of water in the mix so as to produce a dense coating with minimum rebound of the material and no sagging.

Rebound: After the initial set, as work proceeds, remove and dispose of splash and rebound material from the surface by air-water jet or other suitable means.

Wind problems: If wind causes separation of the nozzle stream, discontinue spraying.

Air temperature: If air temperature is less than 5°C, do not spray.

3.13.8 Construction joints

General: Keep construction joints to a minimum.

Forming: Form joint by placing or trimming the sprayed concrete to an angle between 30° and 45° to the sprayed concrete surface.

Preparation: Clean and wet by air-water jet the joint edge before recommencing concrete spraying.

3.13.9 Curing

Commencement: Commence curing within one hour of the application of sprayed concrete with water or colourless wax emulsion curing compound conforming to AS 3799 and applied to conform to manufacturer's specifications.

Water curing: If water curing, keep the surface of the sprayed concrete continuously wet for at least seven days.

3.14 Testing

3.14.1 Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

3.14.2 Concrete tests

Slump: To AS 1379 clause 5.2.

Test sample location: Spread the site sampling evenly throughout the concrete placement.

Sampling frequency: Provide a minimum of one sample from each 50 m³ of concrete.

3.14.3 Cores and test acceptance

General: If test specimens fail to achieve the documented 28 day strength, arrange for cores to be taken from the corresponding concrete to AS 3600 clause B6 and nominate proposed core locations.

Acceptance: For acceptance, demonstrate conformance of the average strength of cores with the documented 28 day strength requirements to AS 3600 clause B6.

3.14.4 Failure of cores

Deduction: If cores taken fail to satisfy the strength requirements, apply the deduction provisions in **ANNEXURE – DEDUCTIONS**.

3.14.5 Completion tests

Liquid retaining structures: Liquid tightness to AS 3735.

3.15 Completion

3.15.1 Loading

Prohibition: Do not apply any superimposed load to any part of what will become a load bearing structure within 21 days of placing concrete, unless it can be demonstrated that 95% of the design strength of the concrete has been achieved.

3.15.2 Protection

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

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

4 Annexures

4.1 Annexure - Summary of hold and witness points

Reference No:	Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
C28-HP01	SUBMISSIONS, Certification Design	H	Certification of formwork design conformance	10 days before erecting formwork	Erection of formwork
C28-HP02	SUBMISSIONS, Certification Completed formwork	H	Certification of completed formwork conformance	5 days before placing concrete	Placement of concrete
C28-HP03	SUBMISSIONS, Tests Loading	H	Results to show that concrete has achieved 95% of its design strength	2 days before applying superimposed load	Application of super-imposed load
C28-HP04	SUBMISSIONS, Execution details Coring	H	Details of any proposed cutting or coring required in hardened concrete	3 days before coring concrete	Concrete coring
C28-HP05	SUBMISSIONS, Products and materials Machine mixing	H	Details of proposed concrete mix for on-site machine mixing of concrete	7 days before on-site concrete mixing	On-site concrete mixing
C28-HP06	SUBMISSIONS, Execution details Measurement of materials	H	Proposal to measure materials by volume for on-site mixing for minor concrete works	7 days before on-site concrete mixing	On-site concrete mixing
C28-HP07	SUBMISSIONS, Execution details Repair of defects	H	Details of the proposed method of defect repair	3 days before repairing defect	Repair of defect
C28-HP08	SUBMISSIONS, Execution details Surface repairs	H	Details of the proposed method of surface repair	3 days before repairing surface	Repair of surface
C28-HP09	SUBMISSIONS, Execution details	H	Detailed method statement for sprayed concrete works	14 days before spraying concrete	Sprayed concrete works

Reference No:	Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
	Method statement				
C28-HP10	SUBMISSIONS, Samples Sprayed concrete	H	3 sample panels for each proposed mix	10 days before spraying concrete for works	Sprayed concrete works
C28-HP11	SUBMISSIONS, structural certification from a professional engineer	H	Certification for bridges, retaining walls, buildings, water and sewer pump stations, water reservoirs, flood control structures, culverts and causeway and miscellaneous structures	On completion	Prior to Subdivision Certificate/Occupation Certificate
C28-WP12	INSPECTIONS, Notice Base preparation	W	Completed and prepared base	1 day before laying underlay or placing concrete	-
C28-HP13	INSPECTIONS, Notice Completed formwork	H	Completed formwork	1 day before placing concrete	For development inspections book through "MyInspect"
C28-HP14	INSPECTIONS, Notice Steel reinforcement placement	H	Completed installed steel reinforcement, including cores fixings and embedded items fixed in place	3 days before placing concrete	For development inspections book through "MyInspect"
C28-WP15	INSPECTIONS, Notice Galvanizing repair	W	Repairs to damaged galvanizing of steel reinforcement	1 day before placing concrete	-
C28-WP16	INSPECTIONS, Notice Emergency hand mixing	W	Emergency hand mixing of concrete due to mechanical failure	Immediately after mechanical failure	-
C28-WP17	INSPECTIONS, Notice Sprayed concrete sample	W	Concrete spraying of sample panels	3 days before spraying sample panels	-

Reference No:	Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
	panels (where required)				
*H = Hold Point, W = Witness Point					

4.2 Annexure – Maximum lot sizes and minimum test frequencies

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method	
Concrete constituent materials	Material quality – Supplier's documentary evidence and certification of:				
	Cement	1 mth's prod'n	1 per week	AS 3972	
	Fly ash	1 mth's prod'n	1 per month	AS 3582.1	
	Water	1 contract	1 per contract	AS 3583.13, AS 1289.4.2.1	
	Admixtures	1 mth's prod'n	1 per month	AS 1478.1	
	Steel reinforcement	1 delivery	1 per production batch	AS/NZS 4671	
	Fine aggregates				
	Grading	1 wk's prod'n	1 per 200 m ³ concrete*	AS C08.11.1	
	Moisture content	N/A	1 per day		
	Sulphate soundness	1 contract	1 per contract	AS C08.24	
	Bulk density	1 contract	1 per contract	AS 2758.1	
	Unit mass (Particle density)	1 contract	1 per contract	AS 2758.1	
	Water absorption	1 contract	1 per contract	AS 2758.1	
	Material finer 2 m	1 contract	1 per contract	AS 2758.1	
	Deleterious material (impurities/reactive)	1 contract	1 per contract	AS 2758.1	
	Coarse aggregates				
	Grading	1 wk's prod'n	1 per 200 m ³ concrete*	AS C08.11.1	
	Moisture content	N/A	1 per day		
	Wet strength	1 contract	1 per contract	AS C08.22	
	Wet/dry strength variation	1 contract	1 per contract	AS C08.22	
	Wear	1 contract	1 per contract	AS C08.23	
	Crushing value	1 contract	1 per contract	AS C08.21	
	Sulphate soundness	1 contract	1 per contract	AS C08.24	
	Particle shape	1 contract	1 per contract	AS C08.14	
	Fractured faces	1 contract	1 per contract	AS C08.18	

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	Bulk density	1 contract	1 per contract	AS 2758.1
	Unit mass (Particle density)	1 contract	1 per contract	AS 2758.1
	Water absorption	1 contract	1 per contract	AS 2758.1
	Material finer 75 m	1 contract	1 per contract	AS 2758.1
	Weak particles	1 contract	1 per contract	AS 2758.1
	Light particles	1 contract	1 per contract	AS 2758.1
	Deleterious materials (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	Iron unsoundness	1 contract	1 per contract	AS 2758.1
	Falling/dusting unsoundness	1 contract	1 per contract	AS 2758.1
Mix design	Compressive strength	1 contract mix	1 per mix per contract	AS 1012.9
	Aggregate moisture content	1 contract mix	1 per mix per contract	
	Consistency – slump	1 contract mix	1 per mix per contract	AS 1012.3.1
	Air content	1 contract mix	1 per mix per contract	AS 1012.4.2 Method 2
	Shrinkage	1 contract mix	1 per mix per contract	AS 1012.8.4AS 1012.13
Concrete	Consistency – slump	15 m ³	1 per batch	AS 1012.3.1
	Compressive strength (7 and 28 day)	15 m ³	As per the Project assessment strength grade sampling table	AS 1012.1 AS 1012.8.1 AS 1012.9
Concrete placement	Finished levels	15 m ³	1 per element or 1 per 15 m length	Survey and 3 m straightedge
	Surface dimensions	Single fabrication	As required to confirm design dimensions	Measure
Sprayed concrete	Test panels and cores	1 contract	4 cores from 1 test panel of each mix design	AS 1012.9 AS 1012.14
	Compressive strength cores	15 m ³	2 per 15 m ³	AS 1012.9 AS 1012.14
* Note: or part thereof, per lot.				

4.3 Annexure - Deductions

4.3.1 General

Deductions: Conform to the following:

- Concrete payment rates: At the scheduled rates provided the concrete meets the documented strength requirements.
- Reduction in payment rates: Where any concrete does not reach the documented strength, at the scheduled rate of payment reduced by 2% for each 1%, or fraction thereof, by which the strength of the specimen fails to reach the documented strength, up to a maximum deficiency of 10%.
- Rejection: If the deficiency in strength exceeds 10%, the concrete represented by the specimens may be rejected, in which case no payment will be made for the work nor for any remedial work to rectify the deficiency.

4.4 Annexure - Referenced documents

The following documents are incorporated into this worksection by reference:

AS 1012		Methods of testing concrete
AS 1012.1	2014	Sampling of concrete
AS 1012.3.1	2014	Determination of properties related to the consistency of concrete - Slump test
AS 1012.4.2	2014	Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete
AS 1012.8.1	2014	Method for making and curing concrete - Compression and indirect tensile test specimens
AS 1012.8.4	2015	Method for making and curing concrete - Drying shrinkage specimens prepared in the field or in the laboratory
AS 1012.9	2014	Compressive strength tests - Concrete, mortar and grout specimens
AS 1012.13	2015	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1012.14	2018	Method for securing and testing cores from hardened concrete for compressive strength
AS C08		Methods for sampling and testing aggregates
AS C08.11.1	2009	Particle size distribution - Sieving method
AS C08.14	2007	Particle shape, by proportional caliper
AS C08.18	1996	Crushed particles in coarse aggregate derived from gravel
AS C08.21	2007	Aggregate crushing value
AS C08.22	2008	Wet/dry strength variation
AS C08.23	2009	Los Angeles value
AS C08.24	2018	Aggregate soundness - Evaluation by exposure to sodium sulfate solution
AS 1289		Methods of testing soils for engineering purposes
AS 1289.4.2.1	1997	Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method
AS 1379	2007	Specification and supply of concrete
AS 1478		Chemical admixtures for concrete, mortar and grout
AS 1478.1	2000	Admixtures for concrete
AS/NZS 1554		Structural steel welding

AS/NZS 1554.3	2014	Welding of reinforcing steel
AS/NZS 2425	2015	Bar chairs in reinforced concrete - Product requirements and test methods
AS 2550		Cranes, hoists and winches - Safe use
AS 2550.1	2011	General requirements
AS 2758		Aggregates and rock for engineering purposes
AS 2758.1	2014	Concrete aggregates
AS 2870	2011	Residential slabs and footings
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3582.2	2016	Slag - Ground granulated blast-furnace
AS/NZS 3582.3	2016	Amorphous silica
AS 3583		Methods of test for supplementary cementitious materials for use with portland cement
AS 3583.13	1991	Determination of chloride ion content
AS 3600	2018	Concrete structures
AS 3610		Formwork for concrete
AS 3610.1	2018	Specifications
AS 3735	2001	Concrete structures retaining liquids
AS 3799	1998	Liquid membrane-forming curing compounds for concrete
AS 3850		Prefabricated concrete elements
AS 3850.1	2015	General requirements
AS 3850.2	2015	Building construction
AS 3972	2010	General purpose and blended cements
AS/NZS 4671	2001	Steel reinforcing materials
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 5131	2016	Structural steelwork - Fabrication and erection
AS 5216	2018	Design of post-installed and cast-in fastenings in concrete
AS 6669	2016	Plywood - Formwork
ASCC	2008	National Code of Practice for Precast, Tilt-up and Concrete Elements in Building Construction
CIA CPN35	2003	Fibres in concrete
EN 14889		Fibres for concrete
EN 14889-1	2006	Steel fibres. Definitions, specifications and conformity