

<b>0319 MINOR CONCRETE WORKS</b>
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## 1 GENERAL

### 1.1 RESPONSIBILITIES

#### Objectives

General: Provide cast concrete as documented and as follows:

- In conformance with the design details.
- Which satisfies quality and inspection requirements.
- Compatible with following finishes.

#### Design

Formwork: The design of the formwork, other than profiled steel sheeting composite formwork is the contractor's responsibility.

### 1.2 CROSS REFERENCES

#### General

- Requirement: Conform to the following:
- 0136 General requirements (Construction).
- 0152 Schedule of rates – supply projects.
- 0161 Quality (Construction).
- 0165 Buildings and facilities maintenance plan.

### 1.3 REFERENCED DOCUMENTS

#### Standards

General: The following documents are incorporated into this worksection by reference:

AS 1012	Methods of testing concrete
AS 1012.3.1-1998	Determination of properties related to the consistency of concrete— Slump test
AS 1012.14-1991	Method for securing and testing cores from hardened concrete for compressive strength
AS 1141	Methods for sampling and testing aggregates
AS 1141.14-2007	Particle shape by proportional calliper
AS 1141.21-1997	Aggregate crushing value
AS 1141.23-2009	Los Angeles value
AS 1141.24-1997	Aggregate soundness—Evaluation by exposure to sodium sulphate solution
AS 1348-2002	Glossary of terms - Roads and traffic engineering
AS 1379-2007	Specification and supply of concrete
AS 1397-2001	Steel sheet and strip - Hot-dipped zinc-coated or aluminium/zinc-coated
AS 1478	Chemical admixtures for concrete, mortar and grout
AS 1478.1-2000	Admixtures for concrete
AS 1554	Structural steel welding
AS 1554.3-2008	Welding of reinforcing steel
AS 2327	Composite structures
AS 2327.1-2003	Simply supported beams
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1-1998	Concrete aggregates
AS 2870-2011	Residential slabs and footings
AS 3600-2009	Concrete structures
AS 3610-1995	Formwork for concrete
AS 3610.1-2010	Documentation and surface finish
AS 3735-2001	Concrete structures retaining liquids
AS 3799-1998	Liquid membrane-forming curing compounds for concrete
AS 3972-2010	General purpose and blended cements

AS/NZS 4586: 2004	Slip resistance classification of new pedestrian surface materials
AS/NZS 4671: 2001	Steel reinforcing materials
AS/NZS 4680: 2006	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles
AS 6669-2007	Plywood – Formwork
AS/NZS ISO 9001: 2008	Quality management systems - Requirements
CIA CPN35-2003	Fibres in concrete
NP:PCH-2009	Precast concrete handbook

#### Other publications

Environmental Best Management Practice Guideline for Concreting Contractors from the *Department of Environment and Conservation (NSW)*

CIA CPN17-2008	The use of galvanised reinforcement in concrete
DECC-2004	Environmental Best Management Practice Guideline for Concreting Contractors <a href="http://www.environment.nsw.gov.au/sustainbus/concreters.htm">http://www.environment.nsw.gov.au/sustainbus/concreters.htm</a>
NATSPEC DES 001-2005	Slip resistance performance
NATSPEC DES 006-2007	Specifying concrete
NATSPEC TECHreport-2011	Specifying ESD
SAA HB 197-1999	An introductory guide to the slip resistance of pedestrian surface materials
WTIA TN11-2004	Commentary on the Structural Steel Welding - Standard AS/NZS 1554

## 1.4 STANDARDS

### General

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

Plywood formwork: To AS 6669.

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

Specification and supply of concrete: To AS 1379.

Concrete materials and construction: To AS 3600.

Concrete structures for retaining liquids: To AS 3735.

### Methods and equipment

Precast elements: Comply with the recommendations of NP:PCH.

## 1.5 INTERPRETATION

### Definitions

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.
- Concrete class:
  - . Normal: Concrete which is specified primarily by a standard compressive strength grade and otherwise to conform 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 in conformance with AS 1379 clause 1.5.4.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in Table 1.2 of AS 1379.
- Green concrete: Concrete which has set but not appreciably hardened.
- Joints:
  - . Construction joint: A joint with continuous reinforcement provided to suit construction sequence.
  - . Control joint: An unreinforced joint between or within discrete elements of construction which allows for relative movement of the elements.
  - . Contraction joint: An opening control joint with a bond breaking coating separating the joint surfaces to allow independent and controlled contraction of different parts or components,

induced by shrinkage, temperature changes or other causes. It may include unbound dowels to assist vertical deflection control.

- . 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.
- . Isolation joint: A joint between elements of a structure designed to isolate structural movement while permitting horizontal and/or vertical movement between abutting elements
- . Weakened plane joint: A 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.
- . Structural control joint: A control joints (contraction, expansion and isolation) in structural elements when used with applied material and finishes.
- . Substrate joint: A joint in the substrate which includes construction joints and joints between different materials.
- . Sealant joint: A joint filled with a flexible synthetic compound which adheres to surfaces within the joint to prevent the passage of dust, moisture and gases.
- Pavements: The definitions given in AS 1348 apply.
- 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 surface finish reasonably uniform in texture and free from blemishes.
- Weather:
  - . Cold: Ambient shade temperature < 10°C.
  - . Hot: Ambient shade temperature > 30°C.

## 1.6 SUBMISSIONS

### Approval

Submissions: To the Superintendent's approval.

### Construction proposals

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

- Addition of water at the site.
- Changes to the plastic concrete mix.
- Curing and protection methods.
- Cutting or displacing reinforcement, or cutting hardened concrete.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Placing under water.
- Sequence and times for concrete pours, and construction joint locations and relocations.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.

### Design

Submit: Shop drawings for cores, fixings, embedded items and precast concrete items.

### Materials

Submit: Test results for all materials.

### Samples

Submit: Concrete spray test panels.

Execution details: Formwork certificate.

## 1.7 HOLD POINTS AND WITNESS POINTS

### Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

**HOLD POINTS table**

Clause/subclause	Requirement	Notice for inspection	Release by
<b>PRE-CONSTRUCTION PLANNING</b>			
<b>Loads on minor concrete structures</b>	Approval for early loading of the structure by design strength in situ tests	3 working days	<i>Principal Certifying Authority</i>
<b>Design documentation</b>	Formwork design certificates	3 working days	<i>Principal Certifying Authority</i>
<b>Design documentation</b>	Proposed loading schedule	3 working days	<i>Principal Certifying Authority</i>
<b>EXECUTION</b>			
<b>Ground preparation – Base preparation</b>	Inspect membrane or film underlay installed	1 working day prior to covering	<i>Principal Certifying Authority</i>
<b>Ground preparation – Polymeric film underlay installation</b>	Inspect membrane or film underlay installed	1 working days prior to covering	<i>Principal Certifying Authority</i>
<b>Formwork - General</b>	Certification of installed formwork and inspection	1 working day prior to covering	<i>Principal Certifying Authority</i>
<b>Steel reinforcement placement – Approval of reinforcement before concrete placement</b>	Inspect reinforcement placement	2 working day prior to covering	<i>Principal Certifying Authority</i>
<b>Cores, fixings and embedded items - General</b>	Shop drawings for cores, fixings and embedded items	7 working days prior to commencing works	<i>Principal Certifying Authority</i>
<b>Sprayed concrete – Method statement</b>	Submit proposal for spraying	14 days prior	<i>Principal Certifying Authority</i>

**WITNESS POINTS table**

Clause title/Item	Requirement	Notice for inspection
<b>PRE-CONSTRUCTION PLANNING</b>		
<b>Certificate of compliance</b>	NATA certificates for all materials	7 days prior to commencing on site
<b>Concrete curing</b>	Certified test results for curing compound	7 days prior
<b>EXECUTION</b>		
<b>Ground preparation – Mass concrete bedding on earth foundations</b>	Inspect concrete blinding slab	1 working day prior to covering
<b>Concrete quality requirements – Formwork</b>	Check erection tolerances	1 working day
<b>Concrete quality requirements – Surface quality</b>	Confirm surface quality	1 working day
<b>Concrete quality requirements – Flatness</b>	Confirm unformed surfaces	1 working day
<b>Formwork – void formers</b>	Test certificates for void formers	Prior to using in the works
<b>Steel reinforcement placement – Delivery and</b>	Submit notice for test inspection	10 working days

Clause title/Item	Requirement	Notice for inspection
receipt of reinforcement		
Steel reinforcement placement – Placing	Submit proposed changes to reinforcement	7 days prior to commencing on site
Steel reinforcement placement – Damaged galvanizing	Submit proposed repair method	2 working days prior
Steel reinforcement placement – Provision for concrete placement	Submit proposed changes to spacing, cover, splicing or welding or reinforcement	2 working days prior
Cores, fixings and embedded items - Cutting or coring	Approval for cutting or coring hardened concrete	2 working days prior
Mixing of concrete – Consistency	Submit proposal for concrete mixing plan	7 days prior
Mixing of concrete – Pre-mixed supply	Submit delivery dockets and subcontractors details	Progressive
Concrete placing and compaction - Placing	Proposed sequence of concrete placement	7 days prior
Concrete placing and compaction - Concrete placing under water	Submit proposal for placing concrete under water	7 days prior
Joints - General	Submit proposal for sawn joints	7 days prior
Formed surfaces - General	Proposed method of surface repair	2 working days prior
Sprayed concrete – Method statement	Submit proposal for sprayed concrete	14 days
Sprayed concrete – Sprayed concrete test panel	Approval of sample panels	2 working days

## 2 PRE-CONSTRUCTION PLANNING

### 2.1 LOADING

#### Loads on minor concrete structures

Prohibition: Avoid application of superimposed load on any part of what will become a load bearing structure within 21 days after placing concrete unless the structure is effectively and independently supported to the satisfaction of the Superintendent or until the Contractor can demonstrate that 95% of the design strength of the concrete has been achieved. This is a **HOLD POINT**.

### 2.2 PRODUCT CONFORMITY

#### Requirement

General: Submit current assessments of conformity, as follows:

- Certificate of conformity by a JAS-ANZ accredited third party.
- Declaration of conformity by an AS/NZS ISO 9001 quality management system certified supplier.
- Mark of conformity of a JAS-ANZ accredited third party applied to the product.
- Report by a NATA accredited laboratory describing tests and giving results which demonstrate that the product conforms.

Curing compounds: If it is proposed to use a liquid membrane-forming curing compound submit the following information:

- 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. This is a **WITNESS POINT**.

### 2.3 DESIGN DOCUMENTATION

#### Requirement

Formwork design: Conform to AS 3610.1.

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

This is a **HOLD POINT**.

- Loading: Submit details of proposed construction systems, loads and procedures, including propping and re-shoring. This is a **HOLD POINT**.

### 2.4 CERTIFICATES OF COMPLIANCE

#### Requirement

Verification: Provide certificates from a NATA registered laboratory. Perform all phases of any particular test at one laboratory. Accompany the certificate with all relevant test results carried out within twelve months of the submission date. This is a **WITNESS POINT**.

General: Use materials only after receipt of the Superintendent's notification of acceptance of test reports and other submissions, and then only if they conform to this worksection.

### 2.5 SELECTIONS

#### General

All selection schedules are located in the Annexure A.

## 3 MATERIALS

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### 3.1 GENERAL

#### Stockpile

General: If uniform, consistent colour is required, stockpile sand, cement and aggregates for the project.

#### Cement

Standard: To AS 3972.

Age: Less than 6 months old.

Storage: Store cement bags under cover and above ground.

#### Aggregates

Standard: To AS 2758.1.

Coarse aggregate: Grading to AS 1141.11 and limits of deviation to AS 2758.1 Table 2.

Fine aggregate: Grading to AS 1141.11 and limits of deviation to AS 2758.1 Table 3.

Aggregate properties: Conform to the **Aggregate property schedule**.

Special aggregates: Stockpile special aggregates at the beginning of the project to minimise colour and other variations.

#### Water

Standard: To AS 1379.

Quality: Provide clean water, 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**

Chemical admixtures: To AS 1478.1.

Chemical admixture content: Free of chlorides, fluorides and nitrates.

**Curing compounds**

Curing compounds: To AS 3799.

**3.2 CONCRETE****Properties**

Concrete mix and supply: Conform to the following:

- Normal-class: To AS 1379 clause 1.5.3.
  - . Properties: Conform to the **Concrete properties schedule - performance**.
- Special-class: To AS 1379 clause 1.5.4.
  - . Properties: Conform to the **Concrete properties schedule - performance**.

**Cover**

Concrete cover generally: To AS 3600.

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

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

**3.3 FORMWORK****General**

Linings, facings and release agents: Form for compatibility with applied finishes.

Lost formwork: Provide lost formwork which is without chlorides, and without impairment to the structural performance of the concrete members.

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

**Steel decking**

Material: Hot-dipped zinc-coated sheet steel to AS 1397, minimum G500-Z350.

Profiled steel sheeting composite formwork: Minimum steel grade G550.

~~Corrosion protection: Zinc coating weight of [complete/delete]~~

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

**Plywood formwork**

Material: Plywood sheeting to AS 6669.

Grade: To meet the design dimensions, loading and surface quality specified to AS 3610 and AS 3610.1.

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

**3.4 REINFORCEMENT****Fibre reinforcement**

Standard: To CIA CPN35.

**Steel reinforcement**

Standard: To AS/NZS 4671.

~~Type: [complete/delete]~~

~~Ductility grade: [complete/delete]~~

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**

Corrosion: Protect from corrosion in conformance with AS 3600.

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

- Thickness: 200 µm minimum.

Galvanizing: To AS/NZS 4680:

- Sequence: If fabrication is to occur after galvanizing, submit proposals for galvanizing repair and coating of cut ends.

- Zinc-coating (minimum): 600 g/m<sup>2</sup>.

**Tie wire**

General: Annealed steel 1.25 mm diameter (minimum).

External and corrosive applications: Galvanized.

**3.5 MISCELLANEOUS****Coloured concrete**

Standard: To AS 3610.1.

Manufacture: Using the same mix and method used in the works, supply sample blocks of concrete before colouring with mineral oxides.

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

**Surface hardeners, sealants and protectors**

Material supply: If required by the project documentation, provide proprietary products in conformance with the manufacturer's written requirements.

**3.6 MINOR PRECAST UNITS****Marking**

Identification: Identify units by marks which are as follows:

- Remain legible until after the unit has been fixed in place.
- Are not visible in the completed structure.
- Show the date of casting.
- Show the correct orientation of the unit.
- On other than units manufactured as a standard product, indicate the locations within the structure in conformance with the marking plan.

**Structural performance requirements**

~~Comply with the following requirements: [complete/delete]~~

**Tolerances**

Fixings and embedded items in precast units: To AS 3610.1, as applicable.

**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.

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**4 EXECUTION**

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**4.1 GROUND PREPARATION****Base preparation**

General: According to base type, as follows:

- Concrete working base: Remove projections above the plane surface, and loose material.
- Graded prepared subgrade: Blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay. This is a **HOLD POINT**.

**Polymeric film underlay installation**

General: Lay over the base, 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. Take the underlay up vertical faces past the damp proof course where applicable, and tape fix at the top. Patch or seal punctures or tears before pouring concrete. Cut back as required after concrete has gained strength and forms have been removed. This is a **HOLD POINT**.

**Rock foundations**

Minimum depth: Extend the excavation for a minimum depth of 150 mm into the rock for retaining walls, headwalls and wingwalls

Cut-off walls: Provide a depth of cut-off in rock foundations less than that shown in the drawings, if approved by the Superintendent.

**Mass concrete bedding on earth foundations (concrete blinding slab)**

Concrete walls: Prior to the construction of footings for cast-in-situ concrete walls on earth foundations, cover the latter with a mass concrete blinding slab.

Precast concrete: Unless otherwise specified, place precast concrete wall sections on a fresh mass concrete bedding layer while it is still in a plastic state.

Earth foundation: Place concrete not less than 50 mm thick.

Rock foundation: Place the concrete at least 50 mm above the highest points of rock.

Restriction: Place neither forms nor other materials on the bedding layer within 48 hours of the concrete being placed. This is a **WITNESS POINT**.

**4.2 CONCRETE QUALITY REQUIREMENTS****Formwork**

Formed element: AS 3610.1 clause 5.2.2.

Position: Construct formwork so that finished concrete conforms to AS 3600 clause 17.5.

Erection tolerances: Check dimensions and position of forms, after the forms are erected.

Align forms accurately and check the location of all fittings and void formers prior to placing concrete. This is a **WITNESS POINT**.

**Surface quality**

Formed surfaces: To AS 3610.1 for the surface class nominated in the **Formed surface finishes schedule**. This is a **WITNESS POINT**.

**Flatness**

Unformed surfaces: Conform with the **Flatness tolerance class table** for the class of finish nominated using a straight edge placed anywhere on the surface in any direction.

This is a **WITNESS POINT**.

**Flatness tolerance class table**

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

**Type and frequency**

Sampling, identification and testing of specimens: Sample the concrete on site, at the point of discharge from the agitator to AS 1012 and AS 1379.

Frequency: To *0161 Quality (Construction)* Sub-annexure C14.

Records and reports: To AS 1012.

Test certificates and records: Submit test certificates, and also retain results on site.

Location: ~~[complete/delete]~~

**Concrete testing methods**

Slump: Test at least one sample from each batch before placing concrete from that batch in the work.

Strength grade/Characteristic compressive strength: Spread the site sampling evenly throughout the concrete placement.

- Sampling frequency: 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
1	1
2-5	2
6-10	3
11-20	4
each additional 10	1 additional

**Cores and test acceptance**

General: If the test specimens fail to achieve the specified strength, arrange for cores to be taken from the work. Submit locations of proposed cores for approval. This is a **WITNESS POINT**.

Acceptance: For acceptance, demonstrate compliance of the average strength of cores with the requirements of the **Concrete age conversion factors table** and the **Concrete strength requirements table**.

**Strength age factor**

Increase: If the testing is carried out at ages in excess of 28 days, validate against the 28 day strength increased by the factors given in the **Concrete age conversion factors table**.

**Failure of cores**

Deduction: If cores taken fail to satisfy the strength requirements, apply the deduction provisions in **Measurement and payment**.

**Concrete age conversion factors table**

*Age of test specimen in days of date of testing	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 and greater	1.25

\*For intermediate ages the factor shall be determined by proper interpolation.

**Coarse aggregate**

Wear: To AS 1141.23.

Loss of weight: < 30%.

Standard tests: When required, test coarse aggregate for conformance to the following properties:

- Aggregate crushing value: To AS 1141.21: < 25%.
- Soundness: To AS 1141.24.
- The loss of mass when tested with sodium sulphate: < 12%.
- Particle Shape: To AS 1141.14.
- The proportion of misshapen particles (2:1 ratio): < 35%.

**Control tests**

General: Determine strength using site cured specimens in conformance with the **Control tests schedule**.

**Embedded pressure pipes**

General: If leak tests have not been successfully completed, do not embed pipes.

**Liquid retaining structures**

Testing for liquid tightness: To AS 3735.

**Test authority**

General: Concrete supplier or NATA registered laboratory.

**4.3 FORMWORK****General**

Standard: To AS 3610.1.

Certification and inspection: Submit certification by a professional structural 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. This is a **HOLD POINT**.

**Requirements**

Profile: Provide formwork to produce hardened concrete to the lines, levels and shapes documented.

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 for removal without risk of damage to the completed structure.

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

Design for placement of concrete: Design formwork so that for high sections concrete cannot fall freely for a height greater than 1.2 m or so that concrete is not moved along the formwork after deposition.

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

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

Projection: Do not use wires and or bolts extending to the surface of the concrete except where documented or approved by the Superintendent.

**Finish**

General: Conform to the **Formed surfaces finishes schedule**.

**Material**

Formwork material: Provide the type and quality of material for formwork and the workmanship in construction to obtain the surface finish documented. Construct to achieve the erection tolerances.

**Preparation**

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

**Corners**

All work above ground: Fillet at re-entrant angles, and chamfer at corners.

- Face of bevel 25 mm.

**Embedments**

General: 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 hatches for placing concrete.

**Release agents**

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

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

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

Unlined timber forms: Wet the timber thoroughly before oiling.

**Steel decking**

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

**Steel linings**

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

**Visually important surfaces**

General: For concrete of 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.

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 the specified panel dimensions.

Pattern: Place all form panels in a neat, symmetrical pattern.

Plywood panels: Placed with the 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 form panels are less than 15 mm thick, otherwise conforming to these requirements, provide a continuous backing of dressed material of 20 mm minimum thickness.

Side forms: Where concrete is placed in earth excavations, side forms shall be provided to prevent contact between concrete and the in situ earth.

Mild steel form surfaces: Customise all bolt and rivet heads counter-sunk and grind back all welds to even and smooth surfaces.

Joints: Provide joints in the formwork perpendicular to the main axis of the shape of the concrete.

**Hidden surfaces**

General: Construct forms for all surfaces which will be completely enclosed or permanently hidden below the ground from dressed or undressed timber, steel, plywood or particleboard.

**Void formers**

Use: Cast designated suspended ground floor slabs and beams on void formers.

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

Void formers: Submit test certificates to confirm that the formers comply with the following requirements under laboratory conditions, when placed on damp sand and loaded with a mass of wet concrete equal to at least the mass of the beams or slabs they are required to support:

- Deflection during placing and compaction of the concrete is less than the span of the beam or slab divided by 1000.
- Additional deflection between initial set and 7 days does not exceed span/400.

- Collapse and loss of load carrying capacity will occur not more than 48 hours after flooding with water, creating a void at least 60% of the original depth of the void former. This is a **WITNESS POINT**.

#### 4.4 CONCRETE SUPPLY

##### General

General: Provide concrete in conformance with the **Concrete properties schedule - performance**.

##### Strength requirement

Variation: For departure from the minimum requirements cited in the **Concrete strength requirements table** reference a specific minimum cement content on the drawings, or submit for approval.

##### Concrete strength requirements table

Use	MPa	Minimum Portland cement GP (GB)	Coarse aggregate nominal size	Cylinder strength required	
				7 days	28 days
		Kg/m <sup>3</sup>	mm	MPa	MPa
Foundations, mass retaining walls	20	270 (330)	40	15	20
Mass concrete footings, pitching, linings etc.	20	270 (330)	20	15	20
Drainage structures, driveways, footpaths, miscellaneous minor concrete work	20	270 (330)	20	15	20
Reinforced concrete culverts, headwalls, base slabs, sign structure large footings, retaining walls	32	320 (380)	20	24	32
Safety barriers	40	330 (380)	20	24	40
Extruded concrete	20	270 (330)	14	15	20

##### Elapsed delivery time

General: Ensure 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 measures are taken by heating or cooling so that the delivered concrete is within the range 5°C - 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 if water is approved for addition.

Transport: Mode must prevent segregation, loss of material and contamination of the environment, and must not adversely affect placing or compaction.

## 4.5 STEEL REINFORCEMENT PLACEMENT

### Tolerances

Fabrication and fixing: To AS 3600 clause 17.2.

### Dowels

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

Tolerances:

- Alignment: 2 mm in 300 mm.
- Location tolerance:  $\pm$  half the diameter of the dowel.

Grade: 250 N.

### Supports

General: Provide proprietary concrete, metal or plastic supports to reinforcement in the form of chairs, spacers, stools, hangers and ties, as follows:

- With a protective coating if they are ferrous metal extending to the surface of the concrete, or are used with galvanized or zinc-coated reinforcement.

Minimum spacing:

- Bars:  $\leq$  60 diameters.
- Fabric:  $\leq$  800 mm.

Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. If appropriate, place a metal or plastic plate under each support.

### Projecting reinforcement

General: If 'starter' or other bars project beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is incorporated into subsequent work.

### Tying

General: Secure the reinforcement against displacement by tying at intersections with either wire ties, or clips. Bend the ends of wire ties away from nearby faces of forms so that the ties do not project 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.

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

### Welding

General: If welding of reinforcement is proposed, provide details.

### Bending

General: Do not be bend or straighten in a manner that will injure the material. Do not provide bars with kinks or bends not documented.

- Heating: Do not use heat to bend or straighten reinforcement.

### Splicing

Plan lengths: Provide all reinforcement in the lengths documented. If splicing is required conform to AS/NZS 4671.

Testing of splices not as shown on the drawings: Costs to the Contractor.

Lapped splices: Provide laps in reinforcing bars, wire or fabric as shown on the drawing or as follows:

- Plain bars, Grade 250: Minimum 40 bar diameters.
- Deformed bars, Grade 400: Minimum 35 bar diameters.
- Hard-drawn wire: Minimum 50 bar diameters.
- Securely wired together in at least two places, unless welded.

Splicing in reinforcing fabric: Provide an overlap, measured between outermost transverse wires of each sheet of fabric of not less than the spacing of those wires plus 25 mm.

Staggering: Stagger splices as shown on the drawings or submit proposal for approval.

#### **Marking**

Bundles: Bundle bars of identical shape in bundles of three and securely tie together by soft iron wire.

Label: Provide each bundle with a stout metal label of not less than 40 mm diameter.

Marking: Ensure that each metal label has been punched with the appropriate marking in conformance with the documented steel list.

Prefix: If documented, ensure that the marking incorporates a prefix. Store bars with different prefixes separately.

#### **Storage**

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

#### **Delivery and receipt of reinforcement**

Test before delivery: If it is proposed to have the reinforcement tested off-site, obtain the approval before reinforcement is delivered to site. This is a **WITNESS POINT**.

Payment: No extra payment will be made as a result of any delays incurred by the Superintendent carrying out, or waiving, the inspection with reasonable expediency.

#### **Placing**

Reinforcement position: Place reinforcement as documented and hold securely by blocking from the forms, by supporting on concrete or plastic chairs, or metal hangers, and by wiring together at all intersections or at 0.5 m centres, whichever is the greater distance, using annealed iron wire of diameter not less than 1.25 mm.

Prohibition: Do not support steel on metal supports which extend to the surface of concrete, on wooden supports, or on pieces of coarse aggregate.

Cover: Provide reinforcement with the minimum cover documented, or as follows, but in no case less than 1.5 times the diameter of the bar:

- Concrete normally in contact only with air:
  - . Slabs: 40 mm.
  - . Other than slabs: 45 mm.
- Concrete in contact with earth or fresh water:
  - . Slabs of box culverts: 50 mm.
  - . Other than culverts: 50 mm.

Reinforcement: If changes are proposed to reinforcement shown on the drawings, submit details. This is a **WITNESS POINT**.

Damaged galvanizing: If repair is required, submit proposals to AS/NZS 4680 Section 8. This is a **WITNESS POINT**.

Provision for concrete placement: If spacing, splicing, welding or cover of reinforcement does not comply give notice. This is a **WITNESS POINT**.

#### **Tack welding**

Approval: If the use of tack welding instead of wire ties on reinforcing wire is proposed, submit for approval.

Standard: All welding of reinforcing steel to AS 1554.3.

Prohibition: Do not tack weld cold-worked and hard grade bars.

#### **Approval of reinforcement before concrete placement**

General: Submit the approval for the reinforcement in each section of the work before any concrete is deposited in that section. Allow adequate time for inspections and any corrective work. This is a **HOLD POINT**.

#### 4.6 CORES, FIXINGS AND EMBEDDED ITEMS

##### General

Cores, fixings and embedded items: Submit shop drawings showing the proposed locations, clearances and cover, and indicating proposed repositioning of reinforcement. This is a **HOLD POINT**.

Cutting or coring: If cutting or coring of hardened concrete is proposed, provide details. This is a **WITNESS POINT**.

##### Adjoining elements

General: For adjoining elements to be fixed to or supported on the concrete, provide for the required fixings. If required, provide for temporary support of adjoining elements during construction of the concrete.

Corrosion: If in external or exposed locations, galvanize anchor bolts and embedded fixings, or propose alternative materials such as stainless steel.

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

Isolation: Isolate embedded items so that water cannot track to concrete providing minimum cover to reinforcement.

#### 4.7 MIXING OF CONCRETE

##### Measurement of materials

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

- 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 smaller works: Submit for approval.

##### Measuring by weight: On-site mixing

Mixing by weight on site: If mixing concrete on site, and if mix control is likely to be less efficient than at a central batching plant, conform to the **Materials in batch containing 1 bag (40 kg) cement table** as a guide to produce the classes of concrete specified.

Small changes: Adopt small changes in the proportions of fine and coarse aggregate to improve density or workability of the concrete if required.

##### Materials in batch containing 1 bag (40 kg) cement table

MPa	Cement (kg)	Fine aggregates (kg)	Coarse aggregates (kg)	Total aggregates (kg)
10	40	130	250	380
15	40	100	190	290
20	40	88	126	214

Variation in aggregate moisture content: If the moisture content of fine and coarse aggregates exceeds 8% or 3% respectively, adjust the proportions of the mix to compensate for the excess water in the aggregate.

##### Measuring by volume: On-site mixing

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

Volume batching: Adopt the nominal proportions given in **Volume batching table** may be used as a guide for volume batching.

**Volume batching table**

MPa	Parts by volume		
	Cement	Fine aggregate	Coarse aggregate
10	1	3	6
15	1	2.25	4.5
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 a corresponding amount.

**Batch measurement:** Measure the volumes of fine and coarse aggregates for each batch in boxes or bins, to details approved by the Superintendent including:

- 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.

**Consistency**

**General:** If approved add sufficient quantity of water to the mix so that the consistency of the concrete enables it to be placed in the forms, compacted and worked into all corners without permitting the ingredients to segregate, or excess free water to collect on the surface.

**Standard:** Determine the consistency of the concrete to AS 1012.3.1.

**Slump:** Except for extruded concrete, concrete slump  $\leq 75$  mm for concrete compacted by vibrators.

**Extrusion machine:** If concrete is placed by an extrusion machine, provide only sufficient water in the mix to produce a slump of 10 mm to 15 mm.

**Mechanical mixing:** Mix all concrete with mechanically operated mixers. If there is an emergency, provide proposals for hand mixing.

**Mixing location:** Submit proposal for concrete mixing location. This is a **WITNESS POINT**

**Segregation of concrete:** Reject any concrete which exhibits signs of segregation as directed by the Superintendent.

**Mixing at site**

**Machine mixing at site:** Conform to the following:

- **Mixer requirements:** Adopt a batch mixer which will ensure a uniform distribution of the materials throughout the batch.
- **Mixer capacity:** Provide 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 prior to any portion of the batch being removed.
- **Total mix discharge:** Discharge the entire contents of a batch from the mixer before any materials are placed therein for the succeeding batch.

**Mixing in an emergency**

**Mixing in an emergency:** Conform to the following:

- **Hand mixing:** If there is a breakdown of the mechanical mixing equipment, seek approval of the Superintendent to hand mix in small quantities so as to complete a section of the work or reach a suitable construction joint.
- **Hand mixing conditions:** Hand mix on an approved water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. Use an amount of cement 10% more than the amount specified for machine mixed concrete.
- **Hand mixing procedure:**

- . 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.
- Hand-mixed batches: Do not exceed 0.25 cubic metres each.

#### **Pre-mixed supply**

Delivery docket: For each batch, submit a docket listing the information required by AS 1379, and the following information:

- For special class performance concrete, specified 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 amount of water, if any, added at the site.
- 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.

Subcontractors: 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. This is a **WITNESS POINT**.

### **4.8 CONCRETE PLACING AND COMPACTION**

#### **Placing**

Activities include: Taking delivery of fresh concrete, placing, transfer and/or finishing the concrete into its final position.

Sequence of placement: If sequential placement of slab segments is proposed, provide details. This is a **WITNESS POINT**.

Preparation: Clean and moisten the area prior to placing concrete: Remove any ponding water.

Method: Use placing methods which avoid segregation and loss of concrete, and which minimise plastic settlement. Maintain a generally vertical and plastic concrete edge during placement.

Layers: Place concrete in layers  $\leq 300$  mm thick, such that each succeeding layer is compacted before previous layer has taken initial set. Compact into previous layer.

Conveying equipment: Provide conveying equipment including open troughs and chutes, where required, of metal, or with metal linings.

Steep slopes: Provide troughs and chutes with baffles, or place in short lengths in such a way that the direction of flow of the concrete is changed.

Positioning of chutes: Provide chutes long enough to permit delivery to the whole of the area enclosed by the forms.

Discharge of cleaning water: Discharge the water used for flushing the chutes and for cleaning in an area acceptable to the Superintendent.

#### **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 come into contact with set concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the forms. Avoid over-vibration that may cause segregation.

#### **Placing records**

General: 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**

General: During placement and prior to setting, do not expose concrete to rain.

Protection: Protect surface from damage by covering until hardened.

#### **Time between adjacent placements**

General: Conform to the **Minimum time delay schedule**.

#### **Slurry for extruded concrete**

General: If concrete is placed by an extrusion machine place in the special receptacle in the machine, if the machine is so equipped, mix small quantities of cement-sand slurry, comprised of two parts of plasterer's sand and one part of 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.

#### **Concrete placing in cold weather**

Cement: Do not use high alumina cement.

Placing concrete: Maintain the temperature of the freshly mixed concrete at  $\geq 5^{\circ}\text{C}$ .

Formwork and reinforcement: Before and during placing maintain temperature at  $\geq 5^{\circ}\text{C}$ .

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 to ensure that the temperature of the placed concrete is within the limits specified.

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 forms, materials, and equipment coming in contact with the concrete.

Maximum temperature of water:  $60^{\circ}\text{C}$  when it is placed in the mixer.

Plastic concrete: Prevent plastic concrete from freezing, without using salts or chemicals.

#### **Concrete 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 in conformance with the **Elapsed delivery time table**.

Placing concrete: Maintain the temperature of the freshly mixed concrete in conformance with the **Hot weather placing table**.

Formwork and reinforcement: Before and during placing maintain temperature at  $\leq 35^{\circ}\text{C}$ .

Temperature control: Select one or more of the following methods of maintaining the specified temperature of the placed concrete at  $35^{\circ}\text{C}$ :

- Cool the concrete using liquid nitrogen injection before placing.
- Cover the container in which the concrete is transported to the forms.
- Spray the coarse aggregate using cold water prior to 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 $\geq 1$ m in all dimensions except for concrete of strength 40 MPa or greater, in sections exceeding 600 mm in thickness	27°C

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

#### Concrete placing under water

Condition: If placing in the dry is practicable by pumping or other means of dewatering, do not place under water.

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

Method: If required, submit proposals. This is a **WITNESS POINT**.

### 4.9 CONCRETE CURING

#### General

Requirements: Taking into account the average ambient temperature at site over the relevant period affecting the curing, adopt procedures to ensure 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, is at least 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.

Curing method: ~~[complete/delete]~~

#### Cold weather curing

General: Maintain concrete temperature between 10 – 20°C for curing period.

#### Curing compounds

Standard: To AS 3799.

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, confirm compliance with AS 3799.

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

#### Hot weather curing

Curing compounds: If it is proposed to use curing compounds, provide details.

Protection: Select a protection method as applicable.

- If the concrete temperature exceeds 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 exceeds 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**

General: If water is used, pond or continuously sprinkle in such a way as to not cause damage to the concrete surface, for the required curing period.

**4.10 JOINTS****General**

Sawn joints: Submit proposed methods, timing and sequence of sawing joints. This is a **WITNESS POINT**.

**Horizontal construction joint**

Location: If horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures, make the joints at the base of walls and at other locations in the walls where approved by the Superintendent.

Preparation: In order to provide for bond between the new concrete and the concrete which has already set, clean the surface on which the new concrete is to be placed of loose material, foreign matter and laitance prior to:

- Roughening or keying and saturating with water.
- Removing any excess water, and thinly coating the surface with a neat cement grout.

**Retaining wall vertical expansion joints**

Location: Provide vertical expansion joints as documented.

Material: Provide jointing material of approved quality, and of thickness as documented, for the full depth of the joint.

Trim: Trim to match the surface of the concrete.

**Footpaths, medians, driveways**

Location: In footpaths, median toppings and driveways, unless otherwise documented, provide expansion joints 15 mm in width for the full depth of paving, constructed at intervals not exceeding 15 m and where the pavement abuts against gutters, pits and structures.

Material: Preformed jointing material of bituminous fibreboard or approved equivalent.

**Unreinforced paving**

Location: Provide all unreinforced paving with narrow vertical grooves, 20 mm deep to induce contraction joints for the control of cracking.

Timing and set out: Form joints in the freshly placed concrete in a neat regular pattern to form 'slabs' no bigger than 2 m square.

Proportion: The ratio of the longest side to the shortest side  $\leq 1.6$ .

**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 when used together, 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. They may be faced with a non-adhering material.

Foamed materials (in compressible fillers): Closed-cell or impregnated types which do not absorb water.

**Slip joints**

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

#### 4.11 FORMED SURFACES

##### General

General: Provide formed concrete finishes in conformance with the **Formed surface finishes schedule**.

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

Surface repair method: If required, submit details of the proposed method before commencing repairs. This is a **WITNESS POINT**.

##### Curing

General: If forms are stripped when concrete is at an age less than the minimum curing period, commence curing exposed faces as soon as the stripping is completed.

##### Quality of surfaces

General: Provide concrete surfaces which are true and even, free from stone pockets, depressions or projections beyond the surface. Ensure all arrises are sharp and true, and mouldings evenly mitred or rounded.

##### Repair of defects

General: As soon as the forms are removed from mass or reinforced concrete work, repair all rough places, holes and porous spots by removing defective work and after wetting, filling with stiff cement mortar having the same proportions of cement and fine aggregate as used in the concrete, and bring to an even surface with a wooden float. Similarly repair all cavities caused by removal of fitments or tie wires and pack with cement mortar.

Removal of the wires: Cut back any tie wires or other fitments extending to outside surfaces after removal of forms, to a depth of at least 40 mm with sharp chisels or cutters.

Coating with bonding agent: If required, coat the surfaces of bolt cavities, tie wire holes, and all defects prior to the placing of mortar, grout, or fresh concrete, with an approved bonding agent, in lieu of wetting with water, generally as required by the manufacturer.

#### 4.12 REMOVAL OF FORMS

##### Formwork removal

Extent: Remove formwork, other than profiled steel reinforcement decking, including formwork in concealed locations, but excepting lost formwork.

Timing: Do not disturb forms until concrete is hardened enough to withstand formwork movements and removal without damage.

##### Stripping:

- General: To AS 3600 where it is more stringent than AS 3610.1.

##### Walls, sumps and other structures

General: Maintain all forms in place, after placement of concrete, for following minimum periods, or as extended by the Superintendent if the air shade temperature falls below 10°C:

- Mass retaining walls, headwalls, wingwalls, gully pits, sumps and similar drainage structures: 2 days.
- Footpaths, driveways and similar: 2 days.
- Sides of reinforced concrete walls when height of each day pour is:
  - . Under 0.6 metres: 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.

Concrete containing special additives: In case of concrete containing special additives, conform to stripping times as determined by the Superintendent.

Protection of concrete during form removal: Remove forms so that the concrete will not be cracked, chipped or otherwise damaged. Do not use of crowbars or other levering devices 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 for this to be done without damage to the concrete.

#### **Superimposed load**

Prohibition: Do not apply superimposed load to any part of a structure until the concrete has reached at least 70% of the design strength.

### **4.13 UNFORMED SURFACES**

#### **General**

General: Strike off, screed and level slab surfaces to finished levels, to the tolerance class noted in the **Unformed surface finishes schedule**.

#### **Surface finishes**

General: Provide surface finishes in conformance with the **Unformed surface finishes schedule**.

#### **Surface repairs**

Surface repair method: If surface repairs are required, submit proposals.

Mortar capping: Not permitted.

#### **Finishing methods – surfaces other than wearing surfaces**

General: Compact and tamp so as to flush mortar to the surface, screed off and finally dress with a wooden float to an even surface, including to:

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

#### **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 metres.

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

Tolerance: Conform to the following

- The finished surfaces of concrete structures not adjacent to road pavements – Deviation is  $\leq 25$  mm in plan position and  $\leq 25$  mm from the specified levels.
- In the case of drainage pits and other structures adjacent to road pavements, the finished concrete  $\leq 10$  mm from the specified levels and alignment.
- Longitudinal surfaces greater than 10 metres in length: Deviation from level or alignment  $< 5$  mm from a straight-edge 3 metres long, subject to any necessary allowances on vertical and horizontal curves.

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, or by the use of belting in an approved manner.

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 directed by the Superintendent.

### **4.14 PRECAST UNITS**

#### **Handling**

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

**Attachments**

Remove temporary attachments after erection. Seal and make good residual recesses.

**Installation**

Fixing: Fix the units securely and accurately in their final positions.

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

**Protection**

General: Protect the units against staining, discolouration and other damage until they are installed in their final location.

**Storage**

Support points: Store elements at designated storage points.

Prevent damage: Adequately store units to prevent warping, twisting, crushing, cracking and staining.

Protection: Protect the units against staining, discolouration and other damage until they are installed in their final location.

**Lifting and handling**

Lifting and handling: Conform to the ASCC National code and AS 3850.

Site conditions: Ensure the wind and temperature conditions allow handling and fixing consistent with structural capability and geometry of the element.

Cranes: To AS 2550.

Temporary bracing and propping: To AS 3850 and AS/NZS 1170.2.

**4.15 SPRAYED CONCRETE****Materials**

Standard to AS 3600.

**Detail**

Minimum depth: 75 mm.

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

**Strength**

Minimum cement content: 380 kg/m<sup>3</sup> 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.

**Test cores**

Securing, accepting, curing, capping and testing: To AS 1012.14.

Equipment and facilities: Provide for taking of the cores from the work.

Curing and testing: NATA registered laboratory.

Results: Submit copies of test results.

**Method statement**

General: Submit at least 14 days prior to applying any sprayed concrete including details of the proposed procedure, plant, materials and mix proportions. This is a **WITNESS POINT**.

**Sprayed concrete Test panels**

General: Conform to the following:

- Number and dimensions of panels: Not less than 10 days before applying concrete, prepare at least 3 test panels for each mix proposed, in conditions similar to those in the works and in the presence of the Superintendent.
- Make the test panels by applying a 75 mm thickness of sprayed concrete to a hardboard panel approximately 750 mm square.
- Apply the sprayed concrete to the panels in the same manner, using materials including steel reinforcing fabric, equipment, pressures and curing that will be used in the Works.
- Submit the panels for examination and approval.

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 tests 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.

Approval of panels: Apply sprayed concrete to the works only after test panels have been approved. This is a **WITNESS POINT**.

#### **Surface preparation**

Earth: Grade, trim, compact and dampen earth surfaces prior to 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 prior to applying the sprayed concrete.

Steel pipes: Corrugated steel pipes are cleaned of loose material, mud and any other foreign matter.

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

#### **Application of 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 impinges as nearly as possible perpendicularly 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: Remove and dispose of splash and rebound material from the surface after the initial set as work proceeds 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.

#### **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.

#### **Curing**

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

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

#### 4.16 COMPLETION

##### Loading

General: Do not erect masonry walls or other brittle elements on beams and slabs while they are still supported by formwork.

##### Unencased reinforcement

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

##### 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.

### 5 LIMITS AND TOLERANCES

#### 5.1 APPLICATION

##### Summary

The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

##### Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection Clause Reference
<b>Subgrade</b>		
Relative compaction	≥ 95% (standard compactive effort).	<b>Foundations</b>
<b>Formwork</b>		
Position of forms	Align forms accurately so that departure of the forms from the surfaces specified on the drawings do not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work.	<b>Erection</b>
<b>Fine aggregate</b>		
Grading	To be evenly graded within the absolute limits and not deviate from the grading of sample aggregate as per the <b>Fine aggregate grading table</b> to AS 2758.1 Table 3.	<b>Fine aggregate</b>
<b>Coarse aggregate</b>		
Percentage of wear	Loss of weight < 30%.	<b>Coarse aggregate</b>
Crushing value	Crushing value < 25%.	<b>Coarse aggregate</b>
Soundness	The loss of mass when tested with sodium sulphate < 12%	<b>Coarse aggregate</b>
Particle shape	The proportion of mis-shapen particles (2:1 ratio) < 35%.	<b>Coarse aggregate</b>
Grading	To be evenly graded within the absolute limits and not deviate from the grading of sample aggregate as per the <b>Coarse aggregate grading table</b> .	<b>Coarse aggregate</b>
<b>Aggregate moisture content</b>	Where moisture content of fine aggregate exceeds 8%, or moisture content of coarse	<b>Measuring by weight, on-site</b>

Activity	Limits/Tolerances	Worksection Clause Reference
	aggregate exceeds 3%, change the proportion of mix.	<b>mixing</b>
<b>Bulking of fine aggregate</b>	Where bulking of the fine aggregate exceeds 10%, make a corresponding increase in volume of fine aggregate.	<b>Measuring by volume, on-site mixing</b>
<b>Consistency</b>	In conformance with AS 1012.3.1, the slump < 75 mm for concrete compacted by vibrators.	<b>Consistency</b>
	In the case of concrete placed by extrusion machine, the slump will be between 10 mm and 15 mm.	<b>Consistency</b>
<b>Finishing of unformed/ formed concrete surfaces</b>		
Wearing surface	To be finished true and uniform so that departure from designed grade < 5 mm in any 3 metre length.	<b>Finishing of unformed surfaces</b>
<b>Finished surfaces</b>		
Not adjacent to roads	≤ 25 mm plan position. ≤ 25 mm level.	<b>Finishing of unformed surfaces</b>
Adjacent to roads	≤ 10 mm alignment. ≤ 10 mm level.	<b>Finishing of unformed surfaces</b>

## 6 MEASUREMENT AND PAYMENT

### 6.1 MEASUREMENT

#### General

Payment to the schedule of rates: To *0152 Schedule of rates – supply projects*, this worksection, as shown on the drawings and **Pay items 0310.1 to 0310.5** inclusive.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

#### Methodology

The following methodology will be applied for measurement and payment:

- Concrete payment rates: At the scheduled rates provided the concrete meets the strength requirements shown in the **Concrete strength requirements table** or as otherwise documented.
- Reduction in payment rates: Where any concrete does not reach the strength specified in the **Concrete strength requirements table**, 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 specified 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.

## Pay items table

Pay items	Unit of measurement	Schedule rate scope
<b>0319.1 Excavation</b>	m <sup>3</sup> , measured in bank volume of excavation	This pay item applies to works included in <b>pay items 0310.2 and 0310.3</b> . Include in the rate for excavation: - Excavation and backfilling of all types of materials, with no separate rates for earth and rock. - The disposal of surplus material - The control of stormwater runoff. Do not include: - Drying out wet excavated material or replacement of over excavation beyond the design cross-sectional limits defined above.
<b>0319.2 Footpaths, driveways, median toppings and works of similar nature</b>	m <sup>2</sup> , measured as the horizontal surface area of the concrete footpath, driveways, median topping, or similar as constructed	Include all operations involved in the forming and compaction of foundations, subbase, concreting, finishing, curing and backfilling. Where specified on the Drawings, include the supply and placement of reinforcing steel.
<b>0319.3 Sprayed concrete</b>	m <sup>2</sup> of sprayed concrete in place	Include all the operations involved in the surface preparation, spraying, jointing, removal of splash and rebound material, curing and testing.
<b>0319.4 20 MPa Concrete for miscellaneous minor concrete work</b>	m <sup>3</sup> of concrete supplied and placed	
<b>0319.5 32 MPa Concrete for miscellaneous minor concrete work</b>	m <sup>3</sup> of concrete supplied and placed	

## 7 ANNEXURE A

## 7.1 SELECTIONS

## Aggregate property schedule

Aggregate property	Tests	Limits
Particle density		
Water absorption		
Particle size		
Durability		

## Formed surface finishes schedule

Property	Type		
	A	B	C
Location			
Surface finish class to AS 3610.1			
Form lining type			
Colour control			
Bolt hole filling			

Property	Type		
	A	B	C
Surface finish type			

**Concrete properties schedule – performance**

	Type		
	A	B	C
<b>Normal and special class</b>			
Air entrainment – air volume (%)			
Maximum aggregate size (mm)			
Assessment process			
Slump (mm)			
Strength grade/characteristic compressive strength (MPa)	Refer to the <b>Concrete strength requirements table.</b>		
<b>Special class</b>			
Bleeding (mL/mm <sup>2</sup> )			
Cement type			
Density of hardened concrete (kg/m <sup>3</sup> )			
Density of plastic concrete (kg/m <sup>3</sup> )			
Drying shrinkage			
Duration of air drying			
Early age strength (MPa)			
Flexural strength (MPa)			
Indirect tensile strength (MPa)			
Mineral oxide content			
Mix type			
Water:cement ratio maximum			
56 day shrinkage strain tested to AS 1012.13			

**Control tests schedule**

Concrete element	28 day strength	Transfer strength (MPa)	Days after pouring	Early strength (MPa)	Days after pouring

**Minimum time delay schedule**

Between (pour locations)	Minimum period between adjacent pours (days)
Adjacent pours abutting horizontal construction joints in walls	
Adjacent pours abutting vertical construction joints in walls	
Floor slab construction joints	
“Pour strips” and adjacent concrete	
Retaining wall construction joints	

**Unformed surface finishes schedule**

<b>Property</b>	<b>Type</b>		
	<b>A</b>	<b>B</b>	<b>C</b>
Location			
Flatness tolerance class			
Primary finish			
Supplementary finish			
Slip resistance classification to AS/NZS 4586			
Slip resistance treatment			
Slip resistance tests			
Surface modifier			