



Hunter Water Corporation A.B.N. 46 228 513 446

Standard Technical Specification for:

STS 404
CONCRETE SUPPLY AND CONSTRUCTION
(WATER RETAINING STRUCTURES)

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Standard – STS 404 – Concrete Supply and Construction (Water Retaining Structures)

1 Purpose

This standard technical specification (STS 404) details the requirements for the supply and construction of Hunter Water concrete works.

This specification applies to all plain, reinforced concrete cast in situ structures. It includes the supply and construction of concrete, reinforcement and other items required to be cast into the concrete.

The specification includes both normal and special class concrete types.

This specification covers special class concrete, Class SX, where X is the characteristic 28-day compressive strength of the concrete in megapascals (MPa). For normal class concrete, Class NX, the requirements of Australian Standards (AS) 1379 shall apply.

The contractor shall consider the environment in which the new concrete asset is to be located when selecting the type of concrete and constructability (for example, extreme H₂S, acidic or other).

Refer to Section 7.5 for performance requirements of both normal and special class concretes.

2 Interpretation

For the purposes of interpretation of STS 404, except where the context is provided otherwise:

- 'drawings' means the drawings detailing the work involved in a particular project in hand
- 'include' means including but not limited to, and is used to provide clarification or examples of the type and nature of items intended
- 'specification' means a specification detailing the work involved in a particular project
- 'standards' means applicable industry standards including the Australian Standards (AS), Australian/New Zealand Standards (AS/NZS), American National Standards Institute (ANSI) and ISO Standards (ISO) referenced in Appendix A
- 'standard drawings' means Hunter Water Corporation Limited drawings
- 'standard technical specification' (STS) references any of Hunter Water's standard technical specifications, as implied by the text.

Headings are for the convenience of the reader and shall not be used in the interpretation of this STS.

Unless stated otherwise any expression such as 'give notice', 'submit', 'approval', or 'directed' means give notice to, submit to, approval by, or directed by the person nominated by Hunter Water to act on its behalf.

Approval does not imply acceptance of responsibility by Hunter Water for compliance with this technical specification. Unless approval has been issued in writing, approval has not been granted.

Failure to comply with the requirements of this STS or any referred documentation may result in rejection. Where equipment and/or manufacture is rejected, notice will be given by Hunter Water in writing. All associated rectification work shall be completed by the contractor at their cost.

2.1 Order of precedence

Specific requirements, including those in project specifications or standard drawings, take precedence over requirements in this STS. Any deviation from this STS shall be approved in writing on a case by case basis by Hunter Water.

3 Roles and responsibilities

3.1 Document owner

The Document Owner of this Hunter Water standard technical specification is the Hunter Water Manager Asset Management.

3.2 Responsibilities

Any request for a variation to STS 404 shall be in accordance with the change management process in the Hunter Water Asset Standards Management Plan.

The Document Owner shall approve any updated revisions of STS 404.

4 Definitions

Where the following term, abbreviation or expression occurs in this STS, it is defined as follows, unless the context implies otherwise.

Term/Abbreviation/Expression	Definition
AS	Australian Standard
AS/ANZ	Australian and New Zealand Standards
Hunter Water Corporation	Hunter Water
TWL	Top Water Level
FSL	Finished Surface Level

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5 General requirements

5.1 Compliance and regulatory requirements

In addition to STS 404, all work shall comply with the details as defined in other Hunter Water standard technical specifications.

5.1.1 Legislative requirements

The relevant Commonwealth and New South Wales (NSW) legislation shall apply to all materials and equipment supplied to and constructed for Hunter Water.

The Designer, Manufacturer, Supplier, and Installer shall comply with the requirements of:

- the Work Health and Safety (WHS) Act, NSW, 2011 (WHS Act)
- the Work Health and Safety Regulation, NSW, 2011 (WHS Regulation) and
- NSW WorkCover Codes of Practice.

5.2 Standards

Any standards relevant to concrete supplied, constructed or installed for Hunter Water shall apply, including specific standards referenced in STS 404.

A list of relevant standards is provided in Appendix A.

5.3 Material and equipment

Use only equipment and materials:

- as specified within STS 404.

All materials and equipment used shall be from items stocked within Australia and shall be from local suppliers within the Newcastle region who provide support services for their products.

Where items are described by reference to a trade brand name or catalogue number, such a description is intended to indicate the type, quality, appearance and method of construction required. An item of a similar or equal standard may be incorporated in the works, subject to written approval from Hunter Water.

6 Quality assurance

6.1 Witness points

Give at least one working days' notice of the following:

- base or subgrade prior to covering
- membrane installed on the base
- reinforcement fixed in place
- polyvinyl chloride (PVC)/swellable water-stops fixed in place
- cores and embedments fixed in place
- completed formwork prior to concrete placing
- placing of concrete and establishment of curing protection
- used formwork, after cleaning and prior to reuse
- surfaces or elements to be concealed in the final work prior to covering or undertaking repair.

Do not proceed to the next phase in this process before the expiration of the required notification period unless formal approval is given to do so.

6.2 Watertightness test

6.2.1 General

All water retaining structures shall undergo a watertightness test unless the project documents specify otherwise.

A minimum of one week before the programmed date to commence the test, submit a report detailing the procedure that is proposed to be adopted. Include details such as anticipated flow rate, estimated fill time and proposed sequencing to enable reuse of water.

Do not install any mechanical equipment in a tank until the watertightness test is completed successfully.

Prior to carrying out a watertightness test:

- remove all debris
- clean all surfaces
- clean and remove debris from all pressure relief devices on the floor of the tank
- install temporary blank flanges, plugs or caps on pipework cast through concrete walls
- seal with temporary covers all openings in the concrete below top water level
- generally ensure that each structure is watertight and ready for testing.

Following this, fill the structure with water, sourced from the town water supply to the top water level or overflow level of the structure (if one exists).

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Water sourced from the town's water supply required for testing will be supplied by Hunter Water at no cost. Minimise the total quantity of tested water by re-using water to test adjacent structures. This is especially applicable to the testing of larger structures.

Hunter Water may direct that the filling rate be reduced, or not occur at all during certain periods of the day, if the filling of tanks detrimentally impacts on the water distribution network in the local area (e.g. if residents experience low or fluctuating water pressure). Filling rate shall not exceed the maximum rate in AS 3735 Section 7.

6.2.2 Test procedure

Comply with AS 3735 Section 7.3.

Record all losses and submit a leakage report within one week of the completion of the test.

Measure rainfall at the site at a minimum of 12 hour intervals for the duration of the test periods. The rainfall measuring device shall be a proprietary product designed for such use. Locate the rain measuring device to avoid rain shadow effects from structures, trees and the like.

Upon completion of the tests, empty and clean the structures and any equipment therein. If feasible, store the water used for the watertightness tests on site so that it can be reused during pre-commissioning and commissioning.

If the test fails, detect and repair the fault and then retest. Continue to repair and retest until a satisfactory test is obtained.

Do not dismantle any dewatering equipment used in the construction until the watertightness tests have been successfully completed.

7 Materials

7.1 Composition

7.1.1 Cement

Fly ash blended cement shall conform to the requirements of Type SR to AS 3972 and contain 25% to 35% fly ash to AS 3582 Part 1, 'fine grade' only.

7.1.2 Aggregates

Aggregates used in the manufacture of concrete shall be of clean, hard, chemically inert and durable particles that comply with AS 2758.1 for an exposure classification 'C' and comprise either normal weight or heavy weight aggregates.

The water absorption of aggregates shall not be more than 3% when tested in accordance with AS 1141.5, AS 1141.6.1 and AS 1141.6.2.

Assess aggregates in accordance with AS 2758.1 Section 14.3 (a), (b) and (c). Assess the alkali reactivity of the aggregate in accordance with AS 2758.1 Section 10.

Submit the test results for the aggregate along with the trial mix results. Refer to Section 7.2.

The grading of each class and size of aggregate and any combination thereof used for the works shall comply with the requirements of AS 2758.1 Section 9.

7.1.3 Water

Water used in the manufacture of concrete shall be of good quality complying with AS 1379.

The onsite addition of water to concrete that takes the concrete out of the allowable tolerance range or renders the water-to-cement ratio above the specified limit is not permitted.

7.1.4 Chemical admixtures

Admixtures shall comply with AS 1478. Admixtures that enhance the workability, reduce water cement ratio, control slump, minimise shrinkage and control the setting time of the concrete may be included in the mix in a controlled manner and in accordance with the manufacturer's recommendation, provided they have been proven to not impair the performance of the concrete.

Air entraining admixtures may be used provided that the air content determined in accordance with AS 1012.4.1, AS 1012.4.2 or AS 1012.4.3 meets the nominated value of 4% (allowing 1% for variation).

The procedures to be adopted for addition of admixtures (e.g. what admixtures will be used, whether they will be a normal component of the design mix or only used under adverse environmental conditions etc) shall be identified at the time that the results from the trial mix are submitted.

The onsite addition of admixtures to concrete that takes the concrete out of the allowable tolerance range is not permitted.

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7.1.5 Mortar

Mortar shall comprise cement (type as specified for element in which mortar is used), fine sand and water.

Mix proportions by weight shall be:

- 2.5 kg sand to 1 kg cement
- 0.35 kg water to 1 kg cement

Mortar shall be workable but not fluid, and free of voids, honeycombing or segregation when placed in position.

Dry packed mortar shall be compacted by ramming without crumbling.

7.1.6 Epoxy paste

Use a moisture tolerant (adheres to damp concrete), solventless epoxy paste mixed in accordance with the manufacturer's requirements for topping and benching. Refer to 8.13.

7.2 Trial mix

Undertake concrete trial mixes to AS 1012, Parts 2 to 6, 8, 9, 12 and 13.

Two weeks before supply of concrete, undertake a trial mix where required in AS 1012 (Table 20.7 and Table 20.8).

Trial mixes shall be batched and tested for compliance in a laboratory with relevant National Association of Testing Authorities (NATA) registration.

Laboratory trial mixes shall use mix proportions as proposed, with additional water to achieve a slump at the upper permissible tolerance limit in AS 1379 of the nominal slump specified.

Use aggregates that are in a saturated surface dry condition or slightly above. Do not use aggregates that are oven dried for the trial mix. Determine particle size distribution of aggregates used in the trial mix by dry sieving in accordance with AS 1141.11.

Repeat the trial mix if the requirements are not met or where changes to mix proportions or materials are made.

The test certificate for each trial mix shall include:

- details as required in AS 1012.2, Section 14
- details of each proposed mix
- source of supply of all raw materials
- current NATA registration details for the laboratory preparing the trial mix
- a statement that the proposed mix complies at a slump at the upper tolerance limit of the nominal slump
- batch proportions set out in accordance with AS 1012.2, Appendix B.

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A test certificate for a trial mix tested up to 12 months before the supply of concrete occurs will be accepted, provided that the mix proportions, source of materials and aggregate properties and grading are identical to the proposed mix.

7.3 Concrete delivery identification certificate and placement log book

All batching operations shall be accessible to the Hunter Water Construction Representative with prior arrangement when concrete products are being manufactured.

7.3.1 Concrete delivery identification

Provide a completed identification certificate with each load of concrete delivered to site.

For both normal and special class concrete, as a minimum include the following details on each concrete identification certificate:

- date
- unique batch identification number
- size of the load in cubic metres
- source of concrete
- type of concrete (e.g. Type S40)
- total cement content of the load (kg)
- amount of free water batched (L) at the plant
- slump at time of batching (mm)
- type of cement used
- time of batching
- expiry time of batch
- the maximum amount of water that may be added at the site to meet performance requirements along with the actual measured amount added at the site.

A completed concrete delivery identification certificate must be submitted before concrete placement may commence.

7.3.2 Placement of log book

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

- the structure and the particular portion of work
- details of samples taken for testing
- volume placed

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- unique batch identification number to allow cross-reference with the concrete delivery identification certificate
- start and end time of the pouring of concrete
- start and end time of concrete finishing work.

7.4 Concrete testing

7.4.1 Testing special class fresh concrete

7.4.1.1 Slump

For each load of ready-mix concrete delivered to site, test the slump of the concrete in the load in accordance with AS 1012.3.1, prior to placing the concrete.

7.4.1.2 Compressive strength

At the following frequency and from the same truck load of ready-mix, prepare three test cylinders for later compressive strength testing:

- mass concrete (except blinding): every 50 m³ or part thereof
- reinforced concrete: every 50 m³ or part thereof
- prestressed concrete: every 50 m³ or part thereof.

Test for compressive strength in accordance with AS 1012.8.1 and AS 1012.9 as follows:

- 28 days: 2 cylinders.

Test the remaining cylinder at a time nominated and only if directed to do so.

Submit all concrete cylinder test results to Hunter Water.

Give immediate verbal notification if any test result suggests that the concrete strength is below the acceptable strength range for that time period.

7.4.2 Testing normal class fresh concrete

Normal class concrete may be tested under production control testing unless noted otherwise on the drawings. No site testing is required for no-fines concrete or blinding concrete.

7.5 Performance schedule

Table 1: Performance schedule – concrete (Water Retaining Structures)

Limitation/requirement		Grade			
		S40	S32	S25	S20
Materials and mix	Cement type	Refer to Table 2	Fly ash blended (Fly ash content to comply with AS 3972)	General purpose or GB (Fly ash content to comply with AS 3972)	General purpose or GB (Fly ash content to comply with AS 3972)
	Minimum cementitious material (kg/m ³)		360	320	270
	Maximum cementitious material (kg/m ³)		410	360	330
	W/C ratio maximum		0.45	0.5	0.5
	Admixture types		-	-	-
	Lab trial mix required?		Yes	Yes	Yes
Strength grade	Compressive f _c 28 days (MPa)		32	25	30
Other requirements	Nominal slump (mm)		80 +/- 15	80 +/- 15	80 +/- 15
	Drying shrinkage at 3 weeks (strain x 10 ⁻⁶)		500	500	500
	Air content (%)		-	-	-
	Curing compound permitted?		Yes	Yes	Yes
	Minimum days between pours		2	2	2

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Table 2: Performance schedule – S40 concrete

Specification	Requirement	Comment
Concrete designation	S40	
Purpose	All water retaining structures	
Lab trial mix required?	Yes	
Slump (mm) at point of acceptance	80 mm + 15 mm	
Binder content minimum maximum	350 kg/m ³ 425 kg/m ³	
Binder type (AS 3972)	Fly ash blended cement	
Fly ash	Compliant to AS3582.1 – fine grade with the following exceptions: <ul style="list-style-type: none"> • fineness > 85% passing 45µm sieve • relative water demand > 95% • relative strength @ 28 days > 95% 	
Fly ash replacement range	25% to 35%	
Portland cement minimum content	250 kg/m ³	
Drying shrinkage* 21 days of drying** 56 days of drying**	400µS maximum*** (trial mix only) 600µS maximum*** (trial mix only) (refer note 1)	* AS 1012.13 ** Drying shrinkage at 21 and 56 days of drying values are used in compliance evaluation *** The maximum drying shrinkage allowable is the average of three test specimens. No single test result will be more than specified maximum + 10%
Maximum semi-adiabatic temperature rise	35°C	* Test procedures to determine semi-adiabatic temperature rise and maximum temperature are to be finalised by the contractor and will involve the measurement of temperature development in concrete in insulated form
Maximum temperature	65°C	
Minimum compressive strength development 7 days 28 days	30 MPa (trial mix only) 50 MPa (trial mix) – 40 MPa (production mix)	When cured in standard laboratory condition
Maximum water content (L/m ³)	190	
Maximum water/binder ratio	0.45	
Maximum air content (and variation) when air entraining agent is used in the mix	5% (variation 1% of nominated value) (refer note 2)	

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Specification	Requirement	Comment
Water reducing agent	Compliant to AS1478.1 – Chemical admixtures for concrete	
Maximum plastic density variation (kg/m ³) (including high range)	+/- 30 of nominated value	
Maximum total alkali content (kg/m ³) expressed as Na ₂ O equivalent	3.0	
Maximum acid soluble chloride ion content (kg/m ³ concrete)	0.3	
Maximum acid soluble sulphate ion content (as SO ₃) by mass of cementitious material (%)	2.5	

Notes:

- 1) The maximum drying shrinkage allowable for this concrete is 600 microstrain (+5% maximum) after 56 days drying. The mean drying shrinkage for all tests (with each test being five prisms) shall not exceed 550 microstrain after 56 days drying. The results for all tests shall be no greater than 600 micro strains after 56 days drying.
- 2) Concrete shall be rejected if, at the point of delivery, tests for air content (measured as percentage by volume of concrete in accordance with AS 1012.1 and AS 1012.4) are not within the specified range.

8 Construction

8.1 Formwork

Refer to AS 3610.

Make all formwork mortar-tight.

8.1.1 Formwork oil

Only use formwork oils that do not stain or discolour the concrete.

Apply formwork oil in accordance with the manufacturer's recommendation.

Do not use surface retarding agents.

8.1.2 Form ties

Observe cover requirements for embedded sections. Flat section ties shall be installed with their longer cross-section vertical.

Remove ends or end fasteners without damaging concrete. Fill resultant holes on surfaces to be exposed to air with fully bonded cementitious mortar to Section 7.1.5 with surface matching that of the surrounding concrete. On surfaces to be exposed to liquids or salt spray (including splash zones) or that are buried or non-visible, fill holes with Epoxy Paste to Section 7.1.6 or approved proprietary products. Ensure all material in the hole (e.g. dirt, PVC sleeve etc) is removed before filling.

Wall ties shall be suitable for water retaining structures.

Do not use through ties/bar system which leaves embedded pipes, sleeves etc and/or cavities in the concrete for water retaining structures.

If the project documents specify a concrete protection lining, inspect the lining for damage following removal of formwork. Submit materials and techniques for repair for approval and undertake repair of all penetrations and other damage.

8.1.3 Tolerances

The tolerances given are for individual measurements and are not cumulative.

Where tolerances are not stated in the specifications or shown on the contract documents for any individual structure or feature thereof, deviations from established lines, grades and dimensions shall not be greater than those set out in Tables 3.4.2 and 3.4.3 of AS 3610 for formed surfaces and Section 17.5 of AS 3600 for all other surfaces.

8.1.3.1 Position and size

The following dimensional tolerances for formed and unformed surfaces of structural concretes apply.

Table 3: Dimensional tolerances for formed and unformed surfaces

Criteria	Tolerance
Footings	
Plan dimensions for formed footings and pile caps	-10 to +50 mm
Plan dimensions for unformed footings	0 to +150 mm
Thickness < 300 mm	-5 to +25 mm
Thickness ≥ 300 mm	-10 to +50 mm
Top of footing or pile cap reduced level	-25 to +25 mm
Departure from plan position in any direction	50 mm
Variation in cross-section of columns, piers, walls, beams and similar parts	
< 3 m	-5 to +15 mm
≥ 3 m	-10 to +25 mm
Departure from plan position in any direction	
< 3 m	15 to + 15 mm
≥ 3 m	-15 to +25 mm
Plumb	-10 to +10 mm
Slabs	
Variation in thickness	-5 to +15 mm
Surface level (of specified level)	-10 to +10 mm
Departure from plan position in any direction	25 mm

The following dimensional tolerances for formed and unformed surfaces of non-structural concrete apply:

- variation in thickness: -10 to +15 mm
- surface level (of specified level): -10 to +10 mm
- departure from plan position in any direction: 50 mm.

8.1.3.2 Surfaces

Use AS 3610, Section 3.4. For tolerances, substitute AS 3600, Section 17.5 tolerances for the asterisks in Table 3.4.2 in AS 3610.

Depressions on flat surfaces, and reverse slopes on sloping surfaces are prohibited.

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8.1.3.3 Matching alignment and/or elevation

Apply the following for relative positions of adjacent edges or points specified as being on the same level or alignment.

Table 4: Separation tolerances

Separation (mm)	Tolerance (mm)
Below 150	± 3
150 to 300	± 6
Over 300	± 12

8.1.3.4 Reinforcement

Between bars in a row ± 10% of specified spacing, or 15 mm, whichever is greater:

- between rows of bars: ±6 mm
- cover to reinforcement: -0 +10 mm
- restriction: AS 3600 requirements.

8.1.3.5 Tendons, sheaths and ducts

Position and spacing:

- pre-tensioned work: ± 3 mm
- post-tensioned work: ± 6 mm
- cover: -0 +6 mm.

8.1.3.6 Other dimensions

Apply the following for any specified dimension not included above.

Table 5: Other tolerances

Dimension (m)	Tolerance (mm)
< 0.3	± 3
0.3 <=>= 3	± 6
3 <=>= 6	± 12
6 <=>=12	± 18
>12	± 25

8.1.4 Formwork removal

The minimum time for stripping of forms in structures other than water retaining structures shall be as per AS 3600, Section 19.6.2.

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The minimum time for stripping of forms in water retaining structures after completion of placing concrete shall comply with the following.

Formwork to vertical surfaces or sloping formwork not supporting concrete in flexure shall not be removed until the following criteria are met:

- A minimum period shall have elapsed since the concrete was poured equivalent to 11 hours at 15°C for unsealed plywood forms, or 8 hours for impermeable forms (in accordance with AS 3600, Section 19.6.2).
- The concrete strength shall be sufficient to meet any loading upon the concrete likely to arise.

Formwork to vertical surfaces or sloping formwork that is supporting concrete in flexure shall not be removed until the concrete strength (as confirmed by tests on cylinders) has reached 10MPa, or twice the stress to which the concrete will then be subjected, whichever is the greater.

In absence of test results or any formal procedure agreed in writing, the periods before stripping, given in the following table, shall be used.

Table 6: Minimum periods required prior to formwork removal

Member Type	Member	Effective Span (m)	Form Stripping Time (days) for average air temperature (°C)		
			> = 20	10 =<> 20	5 <>10
Vertical, unloaded	Wall, beam side	N/A	2	2	5
Vertical load-bearing	Wall, column or load-bearing structure	N/A	4	7	8
Horizontal slab	N/A	Under 3	7	9	14
		3 to 6	9	11	16
		Over 6	11	14	20
Horizontal beam	N/A	Under 3	6	8	12
		3 to 6	8	10	14
		Over 6	10	12	18
Tunnel arch	N/A	N/A	2	4	5

Do not remove support from any span until all the concrete in adjacent spans has gained the specified characteristic strength.

Do not exert pressure on fresh concrete with crowbars or similar. Transfer load from formwork to concrete gradually and smoothly.

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8.2 Reinforcement

General requirements include:

- Use AS 3600, Section 19.2.
- Supply and fix reinforcement, including soft ferrous un-galvanised tie wires, support chairs, formwork spacers and the like.
- Ensure chairs and spacers to be plastic and purpose-made.
- Ensure chair spacing is a maximum 60 bar diameters and 750 mm for fabric.
- Reinforcement to be readily identifiable as to grade, origin and element location.
- Provide a manufacturer's certificate of compliance with the relevant standard AS 4671, or a test certificate to the relevant standard from a NATA accredited laboratory.

8.2.1 Steel reinforcement quality

All reinforcement of concrete shall be in accordance with AS 4671.

All reinforcement shall be of Grade 500N deformed bar in accordance with AS 4671 unless otherwise noted in the documents.

8.2.2 Testing

Following delivery of reinforcement to site, and if requested, take samples of the requested classes of steel reinforcement and test in accordance with AS 4671.

Testing of samples shall be carried out by a NATA accredited laboratory.

Should tests on a test piece made from these samples not fulfil the test requirements, two additional tests shall be made on samples taken from the bar from which the original test piece was prepared. Provided that the results of both these further tests fulfil the test requirements, all the material represented shall be deemed to comply with this specification.

If the result of either of the additional tests does not fulfil the test requirements, the bar from which the test pieces were cut shall be deemed to not comply with this specification, but the remaining material represented shall be accepted provided that two of the remaining bars are tested in accordance with this specification and meets its requirements. Should either of the two bars selected for further testing fail to fulfil the test requirements, the whole of the material shall be deemed not to comply with this specification.

In the event of any of the steel proving unsatisfactory in the course of being worked, such steel shall be rejected, notwithstanding any previous acceptance and at the subcontractor's expense.

8.2.3 Cover

Unless otherwise shown on the design drawings, reinforcing steel shall have at least 50 mm clear cover everywhere except to internal faces of all water retaining structures or any other structures in contact with sewage where minimum clear cover shall be 65 mm.

Do not place cast pipes or conduits within the concrete cover to reinforcement.

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8.2.4 Galvanised reinforcement

Where specified, galvanised steel reinforcing bar shall be compliant to ASTM A767 M.

Galvanised reinforcing bar shall not be heated or welded.

Galvanised reinforcement shall be electrically isolated from other metalwork, including non-galvanised reinforcement. Tie wire used on galvanised reinforcement shall also be galvanised.

Prior to delivery to site and following galvanising in the factory, all galvanised reinforcement shall be passivated by dipping in a 0.2% sodium dichromate solution.

Use appropriate measures (e.g. mechanical handling, personal protective equipment etc) when handling galvanised reinforcement following passivation.

8.2.5 Bending

Bend reinforcement in accordance with Section 19.2.3 of AS 3600.

8.2.6 Tagging

After cutting and bending, bars shall be bundled or stacked according to their respective 'marks' as shown in the bending schedule. All reinforcing shall be labelled with strong wired tags for absolute identification.

8.2.7 Storage on site

Reinforcement when delivered on to the work site shall be suitably stored to avoid damage and contamination. Do not allow the reinforcement to come into contact with the ground.

8.2.8 Cleaning

At the time concrete is placed, reinforcement shall be free from mud, oil, grease, other non-metallic coatings and loose rust which would reduce the bond between the concrete and the reinforcement.

Rust shall not be deemed to be loose if, on rubbing with the thumb, it leaves only a stain.

Deformed bar or welded wire fabric complying with AS/NZS 4671 – Steel reinforcing materials, with mill-scale, rust or both shall comply with this STS if, for a hand wire-brushed specimen, the requirements of AS 4671 are met for:

- the dimensions of cross-section, including height of deformations
- the mass.

8.2.9 Placing and fixing

All steel reinforcement shall be accurately placed in the positions shown on the drawings and firmly held during placing and setting of the concrete.

Reinforcement shall be placed in its specified position, within the tolerances given in Section 19.5.3 of AS 3600 so that the reinforcement shall not encroach on the nominal cover specified.

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Bars shall be held in position by wiring at all intersections with annealed wire not less than number 18 gauge. Where spacing is less than 300 mm in each direction, alternate intersections shall be tied.

Distances from forms shall be maintained by precast mortar blocks, plastic chairs or other Hunter Water endorsed devices.

Metal supports and tie wires which extend into the cover zone of the concrete shall not be permitted.

Stirrups and ligatures shall pass around the main bars and be securely wired.

Do not use plastic tipped steel bar chairs.

Cure concrete blocks by immersion in water for at least 7 days. Remove blocks from immersion 24 hours before the blocks are to be used.

Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. Do not use pebbles, pieces of reinforcing bar stirrups, stone, brick, metal pipe or wooden blocks as spacers.

8.2.10 Welding

Welding of reinforcement shall not be carried out unless identified on the drawings or technical documents. Any welding shall comply with AS 1554, Part 3 – Welding of reinforcing steel.

Welding shall not be carried out within 75 mm of a bend having an internal diameter less than 12 bar diameters, or of any part of a bar that has been bent and subsequently bent in the reverse direction or straightened.

With the endorsement of Hunter Water and the Designer, it shall be permissible to tack-weld bars sufficiently to maintain the reinforcement in its correct position.

8.2.11 Rolled mesh

Deliver reinforcing mesh to site as flat sheets. Rolls will not be accepted.

8.2.12 Inspection

Do not place concrete until reinforcement has been inspected by the Hunter Water Construction Representative. Any concrete placed in violation of this provision will be rejected and its removal required.

8.2.13 Splicing

Use AS 3600, Section 13.2.

Supply all reinforcement as full lengths. Do not splice bars unless explicitly specified in the project documents. Splices shall be staggered as far as possible. Where bars are spliced they shall be lapped the distances shown on the drawings or if not on the drawings in accordance with this section. In lapped splices, the bars being spliced shall be placed in contact and wired together.

Table 7: Reinforcement splicing requirements

Bar	Minimum Lap (mm)
N12	500
N16	600
N20	900
N24	1,100
N28	1,300
N32	1,500

Splicing shall not compromise specified bar spacings, cover requirements and all other requirements for reinforcement where no splice exists.

8.2.14 Lapping of reinforcing mesh

Sheets of mesh reinforcement shall overlap as per Section 13.2.3 of AS 3600.

8.2.15 Mechanical couplings

Mechanical couplings shall be proprietary products designed specifically for splicing of steel reinforcing bars from an approved supplier/manufacturer. The couplings shall be designed, and confirmed by testing, to be capable of developing a stress, in tension or compression (AS 1391), of greater than 1.5 times the yield stress of the weaker bar at the splice.

Full technical data sheets of the products must be submitted for approval at least 14 days prior to proposed use.

Unless approved otherwise, mechanical couplings must be used only at locations shown on drawings and must be of the type specified or approved equivalent.

8.3 Cast-in items

All items to be cast into concrete shall be accurately positioned and held securely in forms. Do not remove forms or other devices used to secure items in position until the concrete has set and a bond has developed between the item and concrete.

8.3.1 Anchor bolts

Refer to STS 600 General Mechanical Requirements.

8.3.2 Cast-in aluminium items

Aluminium surfaces which will come into direct contact with concrete shall be protected from corrosion in accordance with STS 600 General Mechanical Requirements.

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8.4 Joints

General requirements include:

- Use AS 3600 and AS 3735.
- Concrete at joints shall be adequately compacted to prevent any segregation at the joint surface.
- Provide water-stops in accordance with Section 8.4.4 at all construction and movement joints in water retaining structures.

8.4.1 Movement joints

Movement joints, such as expansion and contraction joints, are required. Positions and spacing shown on drawings shall not be altered without Hunter Water's written approval.

8.4.2 Joint dowels

Unless noted otherwise, joint dowels shall be galvanised plain bars. A heavy coating of water-based bitumen paint shall be applied to one half of the dowel. For expansion joints, a cap shall be fitted to the end of the coated dowel or the dowel wrapped in denso tape.

8.4.3 Construction joints

Concrete work shall be carried out with the minimum number of construction joints.

Construction joints where not shown on the drawings or specified in this STS shall be located based on the advice of a Structural Engineer. Submit details of proposed construction joints 3 working days prior to installation of reinforcement.

Before new concrete is placed at a construction joint, roughen and clean the hardened concrete surface of the joint to remove loose or soft material, foreign matter and laitance and expose clean coarse aggregate.

The existing concrete surface shall be scabbled to remove all laitance and weak concrete, and reinforcing starter bars shall be cleaned and bent to the required shape.

Just prior to concrete placement, dampen the hardened concrete surface, without leaving free water.

Surfaces of adjoining pours shall be butt joined, unless otherwise specified.

Surfaces/edges that remain visible are to meet AS 3610, physical quality requirements, Class 2.

Surface retarders are prohibited.

8.4.4 Water-stops

Submit the following documentation a minimum of 2 weeks prior to the first use of each particular brand and type of water-stop:

- manufacturers technical details
- supplier confirmation of water-stop compliance to the specification.

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8.4.4.1 PVC water-stops

Water-stops shall be made from an extruded plasticised PVC compound (BS 2571, Class 3, Type G3) of SG \leq 1.4.

Internal type water-stops shall have a minimum width of 200 mm and a minimum web thickness of 4 mm. On vertical joints, internal type water-stops shall extend vertically to 300 mm above the greater of top water level (TWL) or finished surface level (FSL), but shall not extend higher than 50 mm below the coping level.

Surface type water-stops (rear-guard) shall have a minimum width of 250 mm and a minimum of four flange internal ribs or bulbs.

Material properties:

- free from surface imperfections, blisters, porosity or other blemishes
- minimum properties at 25 °C:
 - tensile strength: 14 MPa
 - elongation at break: 250%
 - hardness: Shore A 70-90
- minimum movement accommodation: 10 mm.

Water-stops shall be fabricated into the longest practical units at the supplier's works and shall be continuous throughout the structure below highest water level. Intersections and joints shall be factory made where possible.

The water-stops shall be installed so that they are securely held in their correct positions during the placing of the concrete. Concrete shall be fully compacted around the water-stop to ensure no voids or porous areas.

Where reinforcement is present, adequate clearance between the reinforcement and the water-stop shall be provided.

No holes are to be made through the body of the water-stop.

Where joining water-stops is required, comply with the manufacturer's recommended welding system.

8.4.4.2 Swellable water-stop

A swellable water-stop shall be provided where shown on the drawings.

The swellable water-stop shall have a minimum width of 20 mm and a minimum thickness of 10 mm.

Material properties:

- polyolefine – rubber combined with water soluble resins which swell in contact with water
- tensile strength at 50% elongation: ≥ 0.6 N/mm²
- elongation at break: > 150%
- minimum volume of increase when stored in tap water at 23°C for 14 days: 150%.

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The swellable water-stop shall be installed in accordance with the manufacturer's instructions and shall not be punctured.

8.4.5 Joint sealant

8.4.5.1 Experienced personnel only

The preparation, priming and sealing of all joints shall be carried out by personnel experienced in the use of the specified sealants.

Submit details of the training, experience and competence of all personnel who will be undertaking the joint sealing work a minimum of 3 working days before work commences on site.

8.4.5.2 Installation

The joint recesses shall be constructed to a tolerance of -10% to +20%.

All defects in the joint recesses, such as abrupt irregularities and honeycomb concrete, shall be cut out and repaired as necessary using cementitious mortar/grout to Section 7.1.5 or approved proprietary products in accordance with the manufacturer's instructions.

The joint recesses shall be cleaned and dried in accordance with the sealant manufacturer's instructions.

All exposed joints shall be taped prior to application of primer and sealants to give straight edges to applied sealant upon completion. Joints in water retaining structures above a level of 300 mm below the 'normal' low operating water level shall be considered exposed.

Before installing joint sealant, prime the joints with a two-part epoxy primer.

Apply a silicone-coated adhesive tape bond breaker to the base of the joint recess for its full width immediately before application of the sealant.

The sealant to be used in all wall and floor joints shall be a two-part polyurethane based proprietary product. Use 'Parchem Emer-Seal 200' or equivalent.

Joint preparation, primer mixing and application, and sealant mixing and application shall be in strict accordance with the manufacturer's instructions. All products shall be compatible to ensure a complete sealing system.

8.4.6 Joint filler

Joint filler shall be a self-expanding joint filler of cork granules bound by suitable resins and moulded to form strips. It must expand in contact with moisture. It must be capable of recovering at least 90% of its original thickness after compression.

The joint filler shall be fixed to the required dimensions of the joint cross-section and shall provide a firm base for the joint sealer. It shall be placed immediately before placing concrete. Any filler swollen by water or moisture prior to placing concrete shall be rejected.

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8.5 Blinding

Blinding concrete shall be located as shown on the drawings and specifications and shall be a minimum of 50 mm thick, or as specified.

If required, carry out localised excavations to permit construction of blinding concrete.

Blinding concrete shall be constructed without a foundation bedding unless otherwise specified.

The top surfaces of blinding concrete shall be screeded to the shapes specified except where noted otherwise on the drawings and specifications

8.5.1 Polyethylene membrane

After the blinding concrete has hardened, cover blinding concrete with a 0.2 mm thick polyethylene membrane.

The membrane shall comprise a high-impact resistant concrete underlay polyethylene membrane to AS 2870.

Remove loose material and any projections above the plane surface immediately prior to laying the membrane over the base.

Joints of the membrane shall be lapped not less than 200 mm.

Laps shall:

- face away from the direction of concrete pour
- be sealed with double-sided butyl adhesive tape or equivalent.

The membrane shall be similarly sealed around unavoidable penetrations such as service pipes and the like. The underlay shall be taken up vertical faces as far as the damp proof course where applicable, and fixed at the top by tape sealing. Vertical or inclined surfaces shall only have vertical laps.

Patch and seal any punctures or tears before placing concrete.

8.5.2 No-fines concrete

Use no-fines concrete for blinding where specified on the project documents.

No-fines concrete shall be placed without tamping, rodding or vibrating. It shall be moist cured for at least 4 days by covering with wet hessian, building paper, or other similar material. Sand or other material likely to enter the voids shall not be permitted to be used for curing purposes.

No-fines concrete mix proportion and properties shall be submitted for approval prior to construction.

8.6 Workmanship

8.6.1 Procedures

Submit written information regarding the procedures to be adopted for placing and compacting concrete and sequencing of pours a minimum of 5 days before the first concrete pour of that particular type is scheduled to occur (e.g. base slab, wall etc).

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Submit modified written information a minimum of 5 days before any changes to the placing and compaction procedures are implemented.

8.6.2 Placing and compaction

Place and compact concrete in accordance with AS 3600, Section 17.1.3.

In vertical elements, limit the free fall of concrete to 1500 mm per 100 mm element thickness, up to a maximum free fall of 2000 mm.

Place concrete in maximum 500 mm layers such that each succeeding layer is blended into the preceding one by the compaction process.

Minimise shrinkage effect by pouring the sections of the work between construction joints in a sequence such that there will be suitable time delays between adjacent pours. Provide location of construction joints, pour sequence and time delays if not shown on the drawings or specified.

Place concrete within:

- 90 minutes of batching for ambient temperatures of < 27 °C
- 60 minutes of batching for ambient temperatures of 27 - 30 °C
- 45 minutes of batching for ambient temperatures of 31 - 35 °C

Do not place concrete if the ambient temperature is > 35 °C

8.6.3 Vibrators

Use immersion and screed vibrators, accompanied by hand methods as appropriate, and form vibrators where use of immersion vibrators is impracticable.

Ensure concrete is fully compacted and entrapped air removed. Do not allow vibrators to come into contact with partially hardened concrete, or embedded reinforcement.

Do not use vibrators to move concrete along the forms.

Insert at points maximum 500 mm apart.

8.6.4 Preparation for placing

Ensure adjoining surfaces and/or embedded items against which concrete is to be placed are clean, moist (if absorbent), free from laitance and other coatings, and free of weak or loose material. In hot weather, cool non-absorptive surfaces by watering (remove the excess).

At the time of placing, temperature of fresh concrete shall be within the 5°C and 35°C range.

Do not place concrete when ambient temperature is at or above 35°C, or is forecast to be at or above 35°C at the work site within the next 5 days.

Note: Placement of concrete in up to 40°C ambient temperatures is only permitted on a case by case basis.

Do not place concrete if relative humidity is below 20%.

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Do not place concrete if wind speeds over the previous hour have averaged higher than 30 km/h.

Do not place concrete when ambient temperature is lower than 3°C.

8.6.5 Requirements for hot weather placing of concrete

Hot weather is defined as ambient temperature above 30°C at the time of concrete mixing or expected during the following 48 hours.

A minimum of 1 working day prior to the pour, submit details of proposed temperature control methods including:

- method of maintaining the specified temperature of the placed concrete
- details of any special methods of handling, placing and finishing the concrete to minimise the impact of the hot weather
- special protection measures to be adopted to:
 - prevent premature stiffening of fresh concrete
 - reduce water absorption
 - reduce evaporation losses.

8.6.6 Requirements for cold weather placing of concrete

Cold weather is defined as ambient temperature below 10°C at the time of concrete mixing or expected during the following 48 hours.

A minimum of 1 working day prior to the pour, submit details of methods of protection of placed concrete against freezing and provisions made for extended setting times/strength gain including formwork stripping.

At the time of placing, temperature of fresh concrete shall not be less than 10°C when air temperatures are below 10°C.

Do not use anti-freeze additives.

Do not allow frozen materials or materials containing ice in the concrete mixer or to come into contact with concrete.

If heated ingredients are used during batching, the temperatures of aggregates and water shall not exceed 80°C. Do not add cement to the mix until the temperature of the mix of other ingredients is below 38°C.

8.7 Surface considerations

8.7.1 Level surfaces

Provide the following cross-fall to weather exposed surfaces:

- narrow surfaces: (up to 1000 mm) 3 mm per 100 mm width
- broad surfaces: (over 1000 mm) 2 mm per 100 mm width.

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When providing cross-fall consider the most appropriate side to direct runoff.

8.7.2 Surface finishes

8.7.2.1 Schedule of surface finishes

The surface finishes required at particular locations are detailed in the below table.

Table 8: Schedule of surface finishes

Location	Surface Finish (all classes and grades)	
	Formed	Unformed
Surfaces exposed to sewage, effluent or sewage gases	F3	U3
Surfaces of water retaining structures exposed to water	F3	U3
Internal surfaces and all exposed surfaces, except trafficable surfaces	F2	U2
Trafficable surfaces – internal	F2	U5
Trafficable surfaces – external	F2	U4
Concealed surfaces	F1	U1

8.7.2.2 Surface finish requirements

Table 9: Surface finishes (requirements)

Class	Acceptance Criteria
F1	Abrupt and gradual irregularities less than 25 mm AS 3610 – Class 3 finish. Blowholes to Appendix B, Figures B3 (a) and (b) Blowhole depth less than 10 mm
F2	Abrupt irregularities less than 6 mm Gradual irregularities less than 12 mm AS 3610 – Class 2 finish. Blowholes to Appendix B, Figures B2 (a) and (b) Blowhole depth less than 10 mm
F3	Abrupt irregularities not accepted Gradual irregularities less than 6 mm AS 3610 – Class 1 finish. Blowholes to Appendix B, Figures B1 (a) and (b) Blowhole depth less than 6 mm

Offsets resulting from displaced or misplaced form sections, from loose knots or otherwise defective forms, to be classed as abrupt irregularities and be assessed by direct measurement.

Gradual irregularities to be measured from a straight template 1500 mm long.

Bagged surface finish prohibited.

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8.7.2.3 Unformed surfaces finish

Table 10: Unformed surfaces finish

Class	Finish	Acceptance Criteria
U1	Screeded finish	Abrupt and gradual irregularities less than 10 mm
U2	Wood float finish	Abrupt and gradual irregularities less than 5 mm
U3	Steel trowelled finish	Abrupt irregularities not accepted Gradual irregularities less than 5 mm
U4	Broom finish Wood float finish Class U2 to be lightly broomed at right angles to the alignment of the pavement	Abrupt and gradual irregularities less than 5 mm
U5	Sponge float – trafficable Steel trowelled finish Class U3 to be sponge floated	Abrupt irregularities less than 2 mm Gradual irregularities less than 5 mm

Vertical offsets to be classed as abrupt irregularities and be assessed by direct measurement.

Gradual irregularities to be measured from a 3000 mm long straight template.

8.8 Curing

8.8.1 Water and membrane curing

All concrete shall be cured continuously during the specified curing period either by water curing or by membrane curing.

Concrete components shall be cured continuously for a period of time that ensures that the design requirements for strength, serviceability and stripping are satisfied. To satisfy durability requirements, the initial curing periods shall be those provided in AS 3600 Sections 4.4 to 4.6 based on the specified concrete strength.

The proposed curing methodology for concrete components is to be submitted to Hunter Water at least 7 days prior to placing the concrete.

The curing compounds proposed shall be verified with evidence submitted for bond compatibility with any subsequent concrete surface finish such as a sealer paint or membrane.

If it is proposed to use a membrane curing compound, a sample of the compound and data sheets shall be submitted to the Hunter Water at least 30 days prior to use.

The unformed top surfaces of walls shall be moistened by covering with water saturated material or by other effective means as soon as the concrete has hardened sufficiently to prevent damage by water. These surfaces and steeply sloping and vertical formed surfaces shall be kept completely and continually moist prior to, and during, form removal by water applied at the unformed top surfaces and allowed to pass down between the forms and the formed concrete faces.

Concrete shall be cured continuously until the average compressive strength reaches greater than 85% of the 28-day characteristic value or a minimum of 7 days, whichever is the greater period.

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Concrete cured with water shall be kept wet immediately following the placement of concrete, or until covered by fresh concrete, by covering with water or an endorsed water saturated covering or by sprinkling so that the surface will be kept continuously wet during the specified curing period.

Covering with an impervious sheet such as polyethylene shall be acceptable on horizontal surfaces or near horizontal surfaces. The concrete surface under the sheet shall be saturated with water at all times during the curing period.

Membrane curing shall be through the application of an endorsed curing compound which forms a water retaining membrane on the surfaces of the concrete. The curing efficiency index, in accordance with requirements of AS 3735 Supplement 1, shall be at least 90% and shall be demonstrated by certification to AS 3799. Resin, wax, chlorinated rubber and polyvinyl alcohol (PVA) based compounds shall not be used.

Apply membranes in accordance with the manufacturer's instructions.

The second coat of curing compound shall be applied by spraying in a direction at right angles to the first coat.

The repair of surface imperfections shall not be made until after curing is complete. If repairs are required, curing compounds shall be removed in accordance with Section 8.15.1.

Where a curing compound is to be used on unformed concrete surfaces, applications of the compound shall commence immediately after the finishing operations are completed and any bleed water on the surface has evaporated.

When a curing compound is to be used on formed concrete surfaces, the surfaces shall be moistened with a light spray of water immediately after the forms are removed to a point where they will not readily absorb more moisture. As soon as the surface film of moisture disappears, but while the surface still has a damp appearance, curing compound shall be applied.

Do not damage the coatings of curing compound for a period of not less than 28 days after the application of the compound.

Protect the concrete surface from damage during the specified curing period.

8.9 Block-outs, core holes and embedding

All pipes and fittings shall be cast into the structure when the structure itself is poured. Where this is not possible, submit details of block-outs or alternative methods a minimum of 3 working days before commencing installation of reinforcement.

All pipes which are cast into the concrete shall be cleaned (using cleaning methods appropriate to the type of pipe material) to remove all traces of dust, grease, rust, paint and protective coatings prior to the placement of concrete.

Where cored holes are to be grouted to hold pipework, bolts and other fittings, the cored holes shall be scabbled and treated with cementitious mortar/grout to Section 7.1.5 or approved proprietary products in accordance with the manufacturer's instructions.

Block-outs provided for openings shall be constructed so as to leave a minimum clearance of 100 mm between finished concrete and the location of the item to be cast-in. Reinforcement shall be constructed

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continuously through openings as detailed on the reinforcement drawings and shall be trimmed around the item to be cast-in at a maximum distance of 50 mm from the item.

After placing the pipe and fitting within the opening or cored hole, the remaining void shall be carefully filled with concrete or grout of the appropriate grade. A watertight joint is required. The concrete shall be retained by a form which shall be built up as concrete filling proceeds.

Where fixing bolts to be cast-in are positioned by means of a template they shall be supplied with a backing nut and a face nut for secure fixing of the bolt. The backing nut shall be cast into the concrete.

Aluminium or ferrous structural members built into brick or concrete shall have their contact surfaces first painted with two coats of bituminous paint.

8.10 Machinery bases and grouting

Concrete plinths and machinery bases shall be constructed for all mechanical and electrical equipment including all in pour conduits as required. The existing concrete surface shall be scabbled to remove all laitance and weak concrete, and reinforcing starter bars shall be cleaned and bent to the required shape. The surface of the concrete shall be coated with 'Epirez 133' wet to dry epoxy adhesive in accordance with the manufacturer's instructions prior to pouring concrete. All concrete items shall be constructed from the same grade and class of concrete as specified for the relevant structure.

Bases shall be tied to the structural concrete with vertical reinforcement. Horizontal reinforcement shall also normally be required at the level of the pockets for the holding down bolts. Where starter bars have not been provided, the structural concrete shall be removed sufficiently to permit the base reinforcement to hook around the main reinforcement.

Before placing the equipment on the plinths or bases, the top surface shall be scabbled to remove all laitance and weak concrete. The surface shall be coated with 'Epirez 133' wet to dry epoxy adhesive in accordance with the manufacturer's instructions. The equipment to be grouted shall be put in place and levelled using shims and wedges or jacking screws which can later be removed. The baseplates shall be fully grouted using 'Embeco 636' grout or equivalent. Shims, wedges and jacking screws shall be removed after the grout has taken its initial set and the grout made good at these points. The equipment shall not be levelled by using nuts on the underside of the baseplates on the anchor bolts.

Anchor bolts shall not be tightened until a minimum of 36 hours after the equipment has been grouted.

8.11 Installation of cast-in place piles

Refer to AS 2159.

Assess acceptability of piling operations and vibration levels prior to construction and, a minimum of 5 days prior to undertaking any piling work, submit a report identifying the risk of impact to adjacent structures and any mitigation measures required.

Fully compact the concrete and eliminate air voids.

Measure the volume of concrete that is placed for each pile. At the end of each day of pouring concrete for piles, submit a table comparing calculated volume of each pile with the measured amount of concrete used in each pile.

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Place concrete in a manner such that segregation of the concrete does not occur and that the position of the reinforcement is maintained.

Piles constructed in a stable cohesive soil without the use of a temporary liner or other form of support shall be concreted on the day the excavation is completed, unless otherwise specified. The concrete shall be placed so that it does not cause the excavation to collapse or cause spoil or other foreign matter to contaminate the concrete.

The concrete shall be placed in sufficient quantity and with sufficient fluidity to ensure that, if the liner is withdrawn, the concrete is not lifted with the liner, there is no separation of the concrete and no inflow of soil or water.

Concrete which is cast under water or under drilling fluid by tremie methods shall be placed without withdrawal of the tremie pipe from the concrete during the concrete discharge. Concrete placement shall continue until all laitance and contaminated concrete is above the pile cut-off level. Tremie concrete shall not be vibrated.

Concrete placed by tremie shall have a cementitious content of not less than 400 kg/m³.

The construction method must not overstress any element of the works, particularly the adjacent structures. Monitoring during the piling operations shall be carried out to ensure that vibrations do not exceed acceptable limits deemed to cause damage to the surrounding structures.

8.12 Mass concrete stairs

Requirements for stairs are:

- material – Class N20 MPa mass concrete
- finish – Class U4 (broom finish) wood float finish Class U2 to be lightly broomed at right angles to the direction of movement of pedestrians.

8.13 Topping and benching

Unless otherwise shown on the project documents, benching shall have a minimum thickness of 25 mm. Cement content of the topping mix shall be the same as that of the structural concrete being topped or benched. Apply a moisture tolerant (adheres to damp concrete), solventless epoxy paste mixed in accordance with the manufacturer's requirements on the prepared concrete surface prior to placing of benching. Mix design, placing and finishing shall be such to ensure the topping or benching is dense, uniform and the surface free from blemishes.

8.14 Concrete sumps, maintenance holes and chambers

This section shall be read in conjunction with:

- WSA 02 (HWC Ed) and associated drawings:
 - SEW-1300-V
 - SEW-1301-V
 - SEW-1302-V

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- SEW-1308-V
- SEW-1309-V
- SEW-1313-V.

8.14.1 General

Unless otherwise specified, concrete sumps shall be cast in situ. Work shall include:

- supply of construction materials
- localised excavations
- utilising/disposing of excavated material
- compacting material at bottom of excavations
- fabricating and placing steel reinforcement (if specified)
- placing and compacting concrete
- finishing and curing concrete
- placing cement mortar
- placing and compacting fill material
- fabricating, coating and installing grates and frames, lids, step irons etc
- installing precast concrete lintels, top slabs etc
- placing and shaping concrete benching.

8.14.2 Material requirements

Precast concrete components (lintels, roof slabs etc) shall be proprietary products constructed to a high quality finish with dense and even surfaces and all angles sharp.

Grates and frames shall be black (or low carbon) steel, cast iron or reinforced concrete as shown on the contract documents.

Black steel components shall comply with the requirements of the following standards:

- AS 3678
- AS 3679
- AS 4671
- AS 4680.

Only use concrete lids and surrounds from Hunter Water Approved Suppliers for standard precast maintenance holes, unless otherwise advised.

Step irons or access ladders, if required, shall be hot-dip galvanised mild steel bars or other endorsed alternative. Black steel bars shall comply with the requirements specified in AS 4671 and the step irons

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shall be hot-dip galvanised in accordance with the requirements specified in AS 4680 except that the zinc coating shall be not less than 600 gms/m² of surface area and be free of coating defects.

Epoxy mortar shall be 'Epirez 633' or a similar material endorsed by Hunter Water. Sand filled epoxy mortar shall incorporate 'Epirez 633' or a similar endorsed material as well as fine quartz sand or a blend of fine quartz sand and durable small gravel particles.

Unless otherwise specified, concrete for stormwater structures shall be:

- sumps: Class S32
- maintenance holes: Class S32
- reinforced concrete chambers: Class S32.

Reinforcing steel shall be Grade 500N unless otherwise specified.

8.14.3 Construction

Localised excavation shall be carried out as required to enable construction of sumps, maintenance holes and chambers. Where in situ material at the bottom of excavations is other than rock, it shall be compacted to 95-98% standard compaction to a depth of 200 mm below the base of excavations.

The outside face of the structure shall be backfilled and compacted.

Where a reinforced concrete pipe or culvert has to be cut to suit a sump, maintenance hole or chamber location, it shall be cut to provide a neat finish generally conforming with the inside face of the structure. Pipes and culverts which require cutting must be cut by endorsed mechanical saws. Do not use hammers to cut or trim pipes.

Any exposed reinforcing steel shall be cut as close as possible to the concrete and covered with epoxy mortar at a minimum thickness of 15 mm.

Joints between drainage structure walls and adjoining pipes or culverts shall be filled using a 1:3 cement mortar. The mortar shall be used within 1 hour of mixing and shall not be retempered. Joints shall be finished to provide a neat, curved surface between the pipe and the inside face of the structure.

The floors of sumps, maintenance holes and chambers shall be benched as shown on the contract documents. Use 1:3 cement mortar for benching. Ensure benching has smooth even surfaces and neat edges.

Step irons or access ladders shall be installed where shown on the contract documents. They shall be installed horizontal, vertically in line and project uniformly from structure walls. Where step irons are not cast in situ, they shall be epoxy mortared into drilled holes. Gaps between step irons and structure walls shall be completely filled so that step irons are held rigid and joints are watertight.

Precast concrete lintels, top slabs, frames etc shall be joined to cast in situ structures using cement mortar or epoxy mortar. Close-fitting units shall be installed with epoxy mortared joints only.

All circular manholes and structures shall be formed internally and externally.

Stormwater sumps may be poured with approved external slip forms providing spacers are fixed to the slip forms to ensure the minimum concrete wall thickness is achieved.

Do not place excavated material against the external surface of fresh poured concrete to build sumps.

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8.14.4 Maintenance hole and chamber access openings

Access openings in top slabs of maintenance holes and chambers shall be closed with temporary covers to enable backfilling to occur. Cast in situ concrete surrounds shall be constructed on the top slabs to encase frames. Alternatively, precast concrete surrounds may be employed, using epoxy mortared joints. Covers shall be installed in the frames.

Temporary covers may remain in position and installation of frames and surrounds deferred until pavement construction has reached a stage where the frame and surrounds can be positioned accurately to match the finished level, grade and cross-fall. Cover levels given on the contract documents may be varied where necessary to suit finished profiles.

8.14.5 Tolerances

Vertical tolerances shall apply provided that drainage structures join neatly to existing structures (where applicable) and are at heights compatible with other structures constructed as part of the work.

The following horizontal and vertical tolerances shall apply.

Table 11: Horizontal and vertical tolerances for structures

Type of Structure	Setting Out (Horizontal) Tolerance	Vertical Tolerance
Sumps	+/- 75 mm in direction of channel +/- 10 mm laterally	Invert level +/- 30 mm Lintel, grate etc +/- 10 mm
Maintenance holes	+/- 50 mm to centre of maintenance hole both longitudinally and laterally	Invert level +/- 30 mm Covers +/- 10 mm Backfall in maintenance holes not permitted
Chambers	+/- 50 mm at each corner	Invert level +/- 30 mm Covers +/- 10 mm

8.15 Rectification and repairs

8.15.1 Concrete repairs

Do not undertake and concrete repairs until all formwork has been removed and curing is complete.

All air voids, bolt holes and honeycombing shall be chased out and repaired using cementitious mortar/grout to Section 7.1.5 or approved proprietary products.

Repairs by bagging and cement mortar are not permitted for surfaces that will be exposed to liquids or salt spray (including splash zones) or are buried or non-visible.

8.15.2 Patching concrete surfaces

In areas where the existing concrete surface has been broken back or has been attacked, resulting in an uneven and irregular surface profile or exposure of reinforcement, the surface shall be cut back and filled with a polymer modified repair mortar to provide a smooth concrete surface.

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The extremities of the repair locations shall be saw cut or cut back to a depth of at least 10 mm to prevent feather edging. The concrete repair area shall be broken back to a minimum depth of 10 mm. Where breaking out is not required the surface shall be roughened and any laitance removed by scabbling or abrasive blasting. The surface shall then be cleaned to ensure it is free from contamination such as oil, dust, loose particles and organic growth prior to placement of the repair mortar.

The concrete surface to be filled/repared shall have 'Renderoc HB25/HB40' as appropriate or equivalent proprietary mortar applied to it. The mortar shall be applied strictly in accordance with the manufacturer's recommendations and trowelled to a smooth finish with the existing undamaged concrete surface.

8.15.3 Defective concrete

Concrete which is not placed and completed in accordance with this specification or which, in the opinion of Hunter Water, is defective shall be removed and replaced by concrete placed and completed in accordance with this specification.

9 Related documents

In addition to STS 404, all work shall comply with relevant current standards and regulations inclusive of all amendments.

Appendix A lists standards referenced in this specification and other standards relevant to the scope.

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10 Document control

Document Controller: Manager Asset Management

Version	Date	Author's name	Details of change	Approval date	Approved by	Next scheduled review
3.0	20 June 2017	M Kendall, S Groves	Complete update	31 July 2017	S Horvath	July 2019

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Appendix A: Standards

Works shall comply with the requirements of the following current standards to the extent that they are relevant and not overridden by this specification.

Table 12: Standards applicable to STS 404

Reference Number	Title
AS 1012	Methods of testing concrete
AS 1141	Methods for sampling and testing aggregates
AS 1379	Specification and supply of concrete
AS 1391	Metallic materials – Tensile testing at ambient temperature
AS 1478	Parts 1 & 2 Chemical admixtures for concrete, mortar and grout
AS 1554.3	Structural steel welding – Part 3 Welding of reinforcing steel
AS 2159	Piling – Design and installation
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates
AS 2870	Residential slabs and footings – Construction
AS 3582	Supplementary cementitious materials for use with portland and blended cement
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS 3678	Structural steel – Hot-rolled plates, floorplates and slabs
AS 3679	Structural steel – Hot-rolled bars and section
AS 3735	Concrete structures retaining liquids
AS 3972	Portland and blended cements
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3850	Tilt-up concrete construction
AS 4671	Steel reinforcing materials
AS 4680	Hot-dip galvanized coatings on fabricated ferrous articles
ASTM A767M	Standard Specification for Zinc-coated (Galvanized) Steel Bars for Concrete Reinforcement
BS 2571	Specification for general-purpose flexible PVC compounds for moulding and extrusion
WSA 02 (HWC Ed)	Water Services Association of Australia – Sewerage Code of Australia – Hunter Water Edition
WSA PS – 357	Concrete, Pre-mixed, Normal class
WSA PS – 358	Concrete, Pre-mixed, Special class
WSA PS – 367	Steel Reinforcing Materials for Concrete
STS 600	General Mechanical Requirements

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