

ACS610 Concrete construction

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ACS610.1 Scope

This Specification covers the general construction of steel reinforced concrete structures including water-retaining structures. It does not include precast concrete components.

ACS610.1.1 Concrete

Concrete shall only be supplied by a certification-graded ready mixed concrete plant to NZS3104 (high grade or special grade).

ACS610.1.1.1 Mix design

As soon as possible after accepting the contract, and not later than two weeks before commencing concreting, the Contractor shall supply to the Engineer for his approval, proposals for concrete supply as required by NZS 3109 and NSZ 3104.

Unless specified otherwise on the Drawings or in the particular section or the Specifications, concrete mix shall be designed to achieve a 28-day compressive strength of 40 MPa.

The ratio of 7 to 28-day strength shall be not less than 1.3 (or 60% of 28 day strength), unless otherwise as specified in the Drawings or Particular Specifications. Construction shall not progress if the 7-day test indicates that, in the opinion of the Engineer, the full 28-day strength may not be achieved.

Where concrete is used in conduits, water retaining structures, manholes, stormwater chambers and wet wells or where concrete is in contact with the ground, the water-cement ratio shall not exceed 0.45 or such lower value as is specified in the Drawings or Particular Specifications.

ACS610.1.1.2 Admixtures

The use of all admixtures, for whatever purpose, shall be approved by the Engineer.

Any admixture used shall be applied strictly in accordance with the manufacturer's instructions and recommendations.

ACS610.1.1.3 Restrictions on chemical content in concrete

The calculated and/or tested total chloride content based on measurement of chloride content arising from aggregate, mixing water and admixture shall not exceed the values given in Table 3.11 (NZS 3101).

The sulphate content of concrete as placed, expressed as the percentage by mass of acid soluble SO_3 to cement, shall not be greater than 5%.

The Contractor shall minimise the risk of structural damage from alkali silica reaction. The concrete supplier shall demonstrate (to the Engineer's satisfaction) that the supplied concrete is free from concrete aggregates that are potentially reactive with alkalis.

ACS610.1.2 Dry pack mortar

Dry pack mortar shall be a sand-cement mortar in the proportions of one part of the same cement as used in the concrete to two parts of sand by weight. The mix shall be of a very dry consistency such that, when squeezed in the hands to a ball, it will retain its shape. Non-shrink additives of a type approved by the Engineer shall be used. The sand used shall comply with the requirements of NZS 3121. Where water tightness is required, the Contractor shall ensure that the sand grading is suitable for the purpose.

ACS610.1.3 Reinforcement

All deformed bar reinforcements, noted on the Drawings as either H or HD followed by the bar size, shall be Micro Alloyed Manufacture Grade 500 Ductility Class E to comply with AS/NZS 4671. It shall carry the SEISMIC 500E MA identifier.

Plain round reinforcing, noted on the Drawings as D, followed by the bar size, shall be Grade 300 complying with AS/NZS 3679.1.

ACS610.1.3.1 Storage of reinforcement

Bundles of reinforcement shall be stored in a clean location, off the ground and away from mud and oil. They shall be stacked with sufficient timber supports so that the bars do not buckle, bend or sag. The bundles should be clearly identified.

ACS610.1.4 Quality assurance

The Contractor shall ensure that the materials comply in all respects with the Drawings and Specifications.

ACS610.2 Tolerances

Unless otherwise specified in the Drawings or Particular Specifications, tolerances shall be as follows:

- Concrete faces shall be within ± 10 mm of the positions indicated in the Drawings
- Notwithstanding the above, slab and wall thicknesses shall be within ± 5 mm of the thickness indicated on the Drawings
- Cover to reinforcement shall be not less than the nominal cover and not greater than the nominal cover by 10 mm
- Notwithstanding the above, the distance between the outer reinforcement layer in opposite faces shall not be less than 5 mm of the distance indicated on the Drawings.

ACS610.3 Construction

Construction of structures and parts of structures shall be in accordance with NZS3109.

Where concrete is used in conduits, water retaining structures and manholes, the provisions of NZS 3106 shall apply. Where there is conflict, NZS 3106 will take precedence over NZS 3109.

ACS610.3.1 Formwork

ACS610.3.1.1 Construction of formwork

Formwork shall be constructed rigid and tight to prevent loss of mortar from the concrete and to ensure that the correct position, shape and dimensions are achieved after pouring. Formwork shall be constructed to allow stripping from the cast concrete without shock or damage.

The forms shall be constructed to achieve the specified surface finish.

Holes to accommodate projecting reinforcement, couplers, waterstops, or other built-in items, shall be constructed to prevent loss of the mortar matrix.

Formwork shall be constructed to permit required access for the preparation of joint surfaces before the concrete has hardened.

Falsework shall allow for props to remain in position continuously until the required strength of slabs and beams is achieved.

All exposed edges of concrete shall have 25 mm chamfers to extend to 150 mm below finished ground level.

Top formwork shall be provided to slopes 30° or more from the horizontal, except where placing and compaction can achieve the specified surface finish without top formwork.

ACS610.3.1.2 Cleaning and treatment of forms

The inside of forms shall be thoroughly cleaned before any concrete is placed. The faces of the forms in contact with the concrete shall be free from oils and loose material and treated with a suitable release agent.

Release agents shall be applied evenly and shall not touch reinforcement.

ACS610.3.1.3 Striking of formwork

Formwork shall be removed carefully to ensure that there is no damage to the concrete.

Formwork to vertical or sloping surfaces shall not be removed until the concrete strength is adequate to meet any wind or other potential loading or the concrete strength (as confirmed by tests in cylinders cured under representative conditions) has reached 5 N/mm², whichever is greater.

Falsework shall not be removed until the concrete strength (as confirmed by tests on cylinders cured under representative conditions) has reached 10 N/mm², or twice the stress to which the concrete will then be subjected, whichever is the greater.

The Contractor shall maintain records that demonstrate the time from pouring of any section to the striking of the formwork and these shall be available on site for inspection.

The Contractor shall not be relieved of responsibility for any damage that may occur due to overloading of the concrete by whatever means, or due to any other cause.

ACS610.3.2 Reinforcement

ACS610.3.2.1 Handling

Reinforcement shall be placed straight between specified bends.

Approval to weld reinforcement shall be obtained from the Engineer in every case, and drawings shall be included with each application for approval showing the position and type of each weld.

Welds shall be in compliance with AS/NZS 1554. Welds shall not be made closer than 10 bar diameters from bends.

In addition to the requirements of NZS 3101 and NZS 3190, the manufacturer’s instructions with respect to the bending and re-bending of steel shall be strictly followed.

ACS610.3.2.2 Fixing reinforcement

Prior to fixing reinforcement, the base shall be cleaned of all loose material and any oils thoroughly removed.

Only bar chairs and spacers specifically designed for the purpose and manufactured from plastic or concrete shall be used. Sufficient chairs shall be used (in the opinion of the Engineer) to ensure that the weight of steel and pedestrian traffic on the reinforcement during fixing and placement of concrete.

Tying wire shall be finished neatly with no ends protruding into the cover zone.

No couplers shall be used, unless otherwise specified in the Drawings or Particular Specifications, or with the prior approval of the Engineer.

Laps shall be as specified in the Drawings and Particular Specifications and shall be staggered to avoid congestion.

ACS610.3.2.3 Cover to reinforcement

Unless otherwise specified in the Drawings or Particular Specifications, the concrete cover to steel reinforcement shall be as indicated in Table 1: Minimum cover to reinforcement.

Table 1: Minimum cover to reinforcement

Concrete cast on or against the ground	75 mm
Concrete cast on or against the ground with a damp proof membrane	50 mm
Other concrete faces	50 mm

Where concrete is cast on or against ground, the minimum cover for a surface in contact with the ground shall be 75 mm or 50 mm if using a damp-proof membrane between the ground and concrete to be cast.

Refer to the Particular Specification for the exposure classification to be used. If the exposure classification is not specified in the particular clauses, the covers required for exposure classification B2 for an intended life of 100 years shall be used.

ACS610.3.3 Embedded items

In addition to Clause 5.5 of NZS 3109, where pipes, or other items penetrate the structure, the Contractor shall place such pipes or items in the forms before placing the concrete, or with the approval of the Engineer or as otherwise specified in the Particular Specifications or Drawings, blockouts in the forms shall be provided.

Penetrations shall be positioned on construction joints to minimise shrinkage cracking. Construction joints around blockouts shall have keys formed and/or be roughened to an amplitude of 5 mm. Blockouts shall be shaped to allow egress of all air displaced by the subsequent grouting of the penetration.

When grouting in pipes and other items, a concrete grout (or approved alternative) of at least equal strength to the surround concrete shall be used. An expansive admixture, to be approved by the Engineer, shall be applied in accordance with the manufacturer's instructions, shall be used in the grout to ensure a watertight joint.

Penetrations to the structure shall be grouted in place by placing the grout under a head of at least 100 mm. The concrete shall be worked into place to completely fill the space between the pipes, or other items, and the sides of the openings, to obtain the same water tightness as through the structure itself. The concrete so placed shall be surfaced when the forms are removed to give a uniform appearance to the wall if such wall will be exposed to view. Pipes less than 75 mm diameter in cored holes shall be fixed in place by dry pack mortar or cement grout with a suitable bonding agent.

All embedded items shall be accurately set and supported in place until the concrete has set.

ACS610.3.4 Construction joints

At all construction joints, special care shall be taken to ensure that no joint will be a source of future weakness or leakage in the opinion of the Engineer. Construction joints shall be in continuous unbroken lines. In cases where they are not shown on the Drawings or specified, they shall be placed only in positions approved by the Engineer.

In water retaining structures, immediately before placing the new concrete on a horizontal joint, the roughened surface shall be primed with a neat cement grout layer of 5 mm thickness and a water cement ratio not exceeding 0.32. Any alternative joint surface preparation shall be subject to approval by the Engineer.

ACS610.3.5 Contraction joints

Contraction joints shall be formed where specified, or required, or approved by the Engineer. In water retaining structures, the joints shall incorporate an approved water stop, unless otherwise specified.

The surfaces of contraction joints shall be left smooth, and where details of any such joint are not specified or shown on the Drawings, the Contractor shall, unless instructed otherwise by the Engineer, form a tapered rebate in the joint with an average width of one third of the thickness of the concrete and a depth of not more than half the width.

ACS610.3.6 Placing of concrete

The Engineer shall be given 24 hours' notice of the Contractor's intention to place concrete in any section of the work, at which time all formwork and reinforcement shall be ready for inspection. Concrete shall not be placed until approval of each section of the work has been given.

ACS610.3.7 Concrete agitation period

Placing of concrete in its final position shall be completed within one and a half hours or such other period as may be approved by the Engineer, after the introduction of the cement to the aggregates.

Unless otherwise approved, the time of handling from the mixer, or from the agitator truck, to the place of final deposit, shall not exceed 30 minutes.

ACS610.3.8 Pumping of concrete

When the Contractor proposes to place concrete by pumping, compressed air or other special equipment, they shall submit full details of the proposed equipment, method of use and concrete mix design to the Engineer for approval at least two weeks in advance of the concrete placing operation.

Aluminium pipes shall not be used. When starting pumping operations, a lubricating mortar shall first be used, and it shall be allowed to run to waste without being incorporated in any new work.

Concrete samples for slump tests shall be taken at the supply hopper and at the placement end of the pipeline. Concrete for compression tests shall be taken at the placement end of the pipeline.

ACS610.3.9 Ready-mix docket

In addition to Clause 2.11 of NZS 3104, the mix design shall be identified, and any admixtures shall be included on the delivery docket.

ACS610.3.10 Site mixing of concrete

Site mixed concrete will be permitted only on the approval of the Engineer, subject to the requirements of NZS3109 clause 6.9 (c)(i).

ACS610.3.11 Slump tests

A slump test shall be taken from every concrete load delivered to site. An additional slump test shall be taken at the discharge of the concrete pump where used. For water retaining structures, slump tolerances shall be half those given in Table 9.1 of NZS: 3109.

ACS610.3.12 Vibrators

In addition to Clause 7.6 of NZS 3109, internal vibrators shall be approved by the Engineer.

If scum, devoid of coarse aggregate, appears on top of, or ahead of, concrete after specified compaction (Clause 7.6 of NZS 3109), the scum shall be removed to waste and replaced with concrete.

ACS610.3.13 Surface finish

The surface finish of concrete shall comply with the appropriate class as described and illustrated in NZS 3114. Formwork, concrete proportions and workmanship shall be such that no patching of concrete surfaces will be required. The minimum standard of surface finish shall be as indicated in Table 2 following. A uniform finish standard shall be provided to any designated location.

Table 2: Minimum Standard of Surface Finish

Location	Surface finish
Concealed foundation surfaces	F1
Top surface of foundation pads	U2
Visible foundation surfaces	F5
Site concrete	U1
Interior walls	F3
Exterior walls	F5
Floor and roof slabs	U2

ACS610.3.14 Curing

Curing compounds will be permitted only where specified elsewhere in these Contract Documents or specifically approved by the Engineer in writing.

Curing compounds shall be clear or translucent with fugitive dye and shall be readily distinguishable upon the concrete surface for at least 4 hours after application but shall be inconspicuous within 7 days after application, if exposed to direct sunlight.

Curing compounds shall be biodegradable and leave no toxic residue within the pores of the concrete. They shall be applied strictly in accordance with the manufacturer's recommendations, as early as possible, and while the concrete is moist, and at no time later than 6 hours after final screeding unless approved by the Engineer.

ACS610.3.14.1 Minimum concrete curing requirements

The concrete curing method applied shall be in compliance with Table 3.5 (NZS 3101). On request by the Engineer, the Contractor shall be able to demonstrate that appropriate curing regime has been applied in practice.

ACS610.4 Acceptance testing

The Contractor shall submit an on-site sampling and testing programme that is in accordance with NZS 3104.

The sampling and testing programme, shall as a minimum, include tests on fresh and cured concrete at the frequency indicated in the Particular Specifications.

The Contractor shall, when required by the Engineer, provide labour and materials to carry any concrete testing required (in accordance with NZS 3112).

ACS610.4.1 Test results

Where the results of the test reports (as required by the sampling and testing programme) indicate that the anticipated 28-day results are unlikely to conform with the requirements of NZS 3109 (in the opinion of the Engineer), the Contractor shall not place any further concrete until the cause of the low results has been ascertained and until the Contractor has taken steps, to the satisfaction of the Engineer, that will ensure the production of concrete complying with the Specifications.

Written reports of the results of all concrete testing shall be delivered to the Engineer within 35 days of the test samples being taken.

ACS610.4.2 Rejection of concrete

When concrete is liable to rejection, the Engineer will notify the Contractor of the rejection in writing. In return, the Contractor shall notify the Engineer, in writing and within one week of the rejection order, whether he will remove the batch indicated or make confirmatory tests.

If the test results prove that only a portion of a pour has to be removed, then the limits of the substandard concrete can be located using an approved type of impact test hammer.

The method of removal of defective concrete and the subsequent repair of affected areas shall be subject to the Engineer's approval.

If the compressive strength is in compliance with that specified, the concrete shall be deemed to be satisfactory, and the structure will be accepted after the core holes have been repaired to the satisfaction of the Engineer.