



FNQROC DEVELOPMENT MANUAL

SPECIFICATION

S7

CONCRETE WORKS

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GENERAL

S7.01 SCOPE

1. This specification details all matters pertaining to the supply, placement, compaction and finishing of Concrete Works.
2. Where there is any conflict determined between the requirements specified herein and the requirements of any referenced Australian Standard, Statutory Authority Standards or otherwise, the requirements specified herein shall apply.

S7.02 REFERENCE DOCUMENTS

Note: Where Acts or reference documents are updated, reference should be made to the current version.

Australian Standards

- AS 1012 Methods of Test Concrete
- AS/NZS 4671 Steel reinforcing bars for concrete
- AS/NZS 4671 Steel reinforcing wire for concrete
- AS/NZS 4671 Welded wire reinforcing fabric for concrete
- AS 1379 The specification and manufacture of concrete
- AS 1478 Chemical Admixtures for Concrete
- AS 1554.3 Welding of Reinforcing Steel
- AS 1553.1 Low Carbon Steel Electrodes for Manual Welding Arc Welding of Carbon Steels & Carbon – Manganese Steels
- AS 2203 Cored Steel Electrodes for Arc Welding
- AS 2717.1 Ferritic Steel Electrodes
- AS 3600 Concrete structures
- AS 3610 Formwork for concrete
- AS 3735 Concrete Structures for retaining liquids
- AS 3799 Liquid membrane-forming curing compounds for concrete,

All Australian Standards referenced in this specification shall be the current edition.

MATERIALS

S7.03 CONCRETE - GENERAL

1. All concrete to be incorporated in the works shall be sourced from a Quality Assured Concrete supplier.
2. The production and delivery of ready-mixed concrete shall be in accordance with the requirements of AS 1379.
3. The quantity of concrete delivered in any truck shall not exceed the rated capacity of its agitator drum. The timing of deliveries shall be such as to ensure an essentially continuous placing operation.
4. Ready-mixed concrete shall be placed and compacted within 1 hour of charging the mixer for concrete temperatures up to 32°C and within 45 minutes of charging the mixer for concrete temperatures exceeding 32°C but less than 35°C. These times may be varied at the Consulting Engineer's discretion where approved set-retarding admixtures are used. In this instance approved admixtures shall conform with the requirements of AS 1478 and shall be used in accordance with AS 1379. Calcium Chloride shall not be used as an admixture in concrete works.
5. A Manufacturer's Certificate in the form of a delivery docket in accordance with AS 1379 shall be supplied for each batch and shall be retained by the Contractor. Such certificates shall be held and maintained in the Contractors Quality records for the project. Further, the Contractor shall obtain a statement from the manufacturer qualifying the quality standard of the concrete in accordance with the requirements as specified herein.
6. The consistency and workability of concrete shall be such that it can be handled and transported without segregation and can be placed, worked and compacted into all corners, angles and narrow sections of forms, and around all reinforcement.
7. Concrete class shall be classed as N "x" where "x" is the minimum 28-day compressive strength in megapascals.
8. For construction elements involving structural concrete construction activities, (eg. bridge slabs, bridge abutment footings etc.) the concrete class and slump shall be as detailed in the Project Documentation. The material quality compliance testing in this instance shall involve on-site sampling and testing in accordance with Australian Standard AS 1012. The testing of the 200mm x 100mm diameter test cylinders shall be at a frequency not exceeding one sample of 2 cylinders for each 15m³ or part thereof placed in an essentially continuous manner with a minimum of two samples of 2 cylinders for each casting day.
9. All testing shall be undertaken by a NATA registered testing authority.
10. The class of concrete relative to each construction element shall be as shown in Table S7.1.

Table S7.1 Concrete Classes

Construction Element	Concrete Strength ¹
Kerb / Kerb & Channel	N25
Manholes (Sewer & Stormwater) ²	N25 or N32 as shown on Standard Drawings
Gully Pits / Field Inlets ²	N25 or N32 as shown on Standard Drawings
Headwalls/Wingwalls & Apron Slabs ²	N25
Pathways / Bikeways	N25
Access Driveways	N25
Edge Restraints for Segmental Pavers (On Road Pavements)	N25
Edge Restraints for Segmental Pavers (On footpaths, bikeways and medians)	N20
Stamped Concrete (where used in road pavement)	N32
Stamped Concrete (where used as parking bay behind kerb or not subject to regular street traffic loadings)	N25
Thrust Blocks	N20
Concrete Surrounds for Sewerage House Connection Branches	N20
Concrete Cradle for Sewer Bedding Type 3	N15
General Concrete Works (Sign Post Bases, Bases for Post and Rail Fences etc.)	N20

Notes:

1. Tested in accordance with the relevant sections of AS 1012.
2. Where any part of the structure is located below RL 1.800 AHD, concrete to be in accordance with the appropriate exposure condition in AS3600

S7.04 NO FINES CONCRETE

1. No fines concrete shall consist of cement, water and coarse aggregate. The quantity of cement used shall be as specified below. The nominal size of the aggregate for no-fines concrete shall conform with the grading limits specified in Table S7.2.
2. The water / cement ratio shall be within the range 0.5 to 0.6 by mass.

Table S7.2 No Fines Concrete – Grading Limits

AS Metric Sieve (mm)	Percentage Passing by Mass	
	Nom. Size 20 mm	Nom. Size 10 mm
26.5	100	-
19.0	85 - 100	-
13.2	0 - 10	100
9.5	0 - 5	85 - 100
4.75	0	0 - 10
2.36	0	0 - 2
Minimum Cement Content (kg/m ³)	210	250

S7.05 LEAN MIX CONCRETE

1. Lean mix concrete shall consist of a graded sand and gravel aggregate of 40mm maximum size with the addition of 5% by mass of Portland Cement or 1 part Portland Cement to 19 parts of graded aggregate and sufficient water to ensure a slump of less than 12mm.

S7.06 REINFORCING STEEL

1. All reinforcement shall comply with AS/NZS 4671:2001 requirements where applicable:-
2. All reinforcement shall be sourced from and Quality Assured manufacturer of such products and the Contractor shall obtain a statement from the manufacturer qualifying the Quality Standard of the reinforcing steel in accordance with the above noted standards.

CONSTRUCTION

S7.07 TEMPERATURE LIMITS FOR CONCRETE PLACEMENT

1. No concrete shall be placed in the Works if:
 - (a) The temperature of the concrete is less than 10°C or exceeds 35°C;
 - (b) The ambient air temperature is likely to be greater than 45°C during placement or within two (2) hours subsequent to placement.
2. If the ambient air temperature measured at the point of placement is likely to exceed 35°C during placing and finishing operations, the Contractor shall take practical precautions, to ensure that the temperature of the concrete does not exceed the permitted maximum so that the concrete can be placed and finished without defects, otherwise it shall be rejected. Typical precautions include those listed below:

At the Concrete Manufacturing Plant

- a. Shading aggregate stockpiles;
- b. Painting water tanks white;
- c. Insulating or burying delivery lines;
- d. Adding crushed ice to replace mixing water (in part) or chilling the water;
- e. Injection of liquid nitrogen into the mixer.

At the Site

- f. Cooling the formwork and reinforcing by dampening with water sprays;
 - g. Shading the work areas;
 - h. Erecting wind breaks;
 - i. Minimising the time for placing and finishing;
 - j. Use of evaporation retarding curing oil.
3. Special attention shall be paid to providing early curing for hot weather concreting operations.

S7.08 FOUNDATIONS

1. Foundations for concrete structures shall be prepared as specified on the Project Drawings.
2. Rock foundations shall be neatly excavated to form a bed for the concrete, and shall be thoroughly scraped and cleaned.
3. Soil foundation shall, as far as possible, be excavated neatly from the solid material to coincide with the under-surface of the concrete, or of the subbase material (where specified).
4. All soft, yielding or other unsuitable material shall be replaced with sound material and the subgrade shall be compacted to provide a minimum of 95 per cent standard compaction as determined by AS 1289.5.4.1 for standard compactive effort. If the subgrade is dry it shall be sprinkled with as much water as it will readily absorb, before the concrete is placed.
5. The surface shall then be checked for uniformity, line and level, and all irregularities shall be made good.

S7.09 FORMWORK AND FALSEWORK

1. All Formwork and Falsework shall conform to AS 3610 unless otherwise required by the specific Project Documentation.
2. All forms shall be built mortar tight and of sufficient rigidity to prevent distortion by the pressure of the concrete and other loads incident to the construction operations. Forms shall be constructed and maintained to prevent warping and the opening of joints due to shrinkage of the timber. The forms shall be substantial and unyielding and shall be so designed and set that the finished concrete will conform to the proper dimensions and within the tolerances specified herein. The design of the forms shall take into account the effect of vibration of the concrete as it is placed.
3. When forms are re-used, their original shape, strength, rigidity, mortar tightness and surface smoothness shall be maintained at all times. Material previously used in formwork must be cleaned off and oiled before re-use. Warped timber shall not be used.
4. Forms, which are unsatisfactory in any respect, shall not be re-used.
5. All timber shall be free from knotholes, loose knots, cracks, splits, warps and other defects, which would affect the strength of the structure or the appearance of exposed surfaces.
6. For narrow walls and columns where the bottom of the form is otherwise inaccessible, openings shall be provided so that they may be cleaned before placing the concrete, and for purposes of compaction and inspection.
7. All forms shall be treated with the lightest practical coating of release agent before the reinforcement is placed. Release agent shall not be placed on reinforcement or construction joints.
8. All forms shall be set and maintained to the line and level designated. Forms shall remain in place for periods, which shall be determined as specified herein. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the work shall not proceed until the defects have been corrected.
9. Metal form ties shall be of an approved type, and if cast in, shall be of a type which permits removal of the end fittings to a depth of at least 30mm below the finished surface of the concrete. Ordinary wire ties shall not be used.
10. Form ties shall be located in a uniform symmetrical pattern relative to the finished surface. The cavities left when the end fittings of embedded ties are removed shall be as small as possible and shall be filled with cement mortar at the earliest possible time. The surface of such filled cavities shall be left smooth and uniform in colour.
11. Forms for plain exposed surfaces shall consist of plastic-coated plywood, waterproof plywood, timber lined with tempered hard-board or close-fitting unwarped metal forms. Unless otherwise specified, joints in the form sheeting for plain exposed concrete surfaces shall be either vertical or horizontal and spaced with a regular pattern.
12. Forms for surfaces not exposed to general view may consist of modular timber or metal panels. Timber forms shall be constructed and maintained in such a manner as to prevent warping and opening of joints due to shrinkage of the timber. The timber shall be free of any defects, which will affect the structure.
13. Forms shall be removed with care and without unnecessary hammering or wedging, and so as not to injure the concrete or disturb the remaining supports. Methods of form removal likely to cause overstressing of the concrete shall not be used.

S7.10 REINFORCING STEEL

1. Reinforcement shall be free of kinks or other unwanted deformations, and shall be cut to length, and bent in accordance with the Project Drawings. Fabric reinforcement shipped in rolls shall be straightened into flat sheets before use.
2. The surface condition of reinforcement shall comply with the following requirements:
 - a. At the time concrete is placed reinforcement shall be free from mud, oil, grease and other non-metallic coatings and loose rust which would reduce the bond between the concrete and the reinforcement.
 - b. For the purpose of this Specification, rust shall not be deemed to be loose if on rubbing with the thumb it leaves only a stain thereon.
 - c. Nevertheless, a deformed bar or welded wire fabric complying with AS/NZS 4671:2001, and having mill scale or rust or both shall be deemed to comply with this Specification if, after wire-brushing the cross-sectional dimensions, including height of deformations; and mass, are not less than the dimensions and mass required by the applicable Australian Standard.
 - d. Any reinforcement projecting from a previous concreting operation shall be cleaned free of adhering concrete or loose slurry prior to any further embedment.
 - e. Any reinforcement placed within 1km of the coastline shall be thoroughly washed with a high pressure fresh water jet immediately prior to pouring concrete to remove any salts deposited during storage and placement.
 - f. Reinforcement which has been submerged by tidal or flood waters shall also be cleaned with a high pressure fresh water jet prior to pouring concrete.
3. Reinforcement shall be placed in position as shown on the Project Drawings. In the case of bar reinforcement, the bars shall be tied together by wiring each intersection using annealed wire not less than 1.25mm in diameter or by such other fastening devices as may be approved by the Designer, provided that, where the bar spacing is 300 mm or less, alternate intersections only need to be tied.
4. Clearance from forms shall be maintained by use of approved chairs. The shape of the chair shall be such that minimum obstruction is offered to the formation of the homogeneous concrete both within and around the chair. Tubular or cylindrical types shall not be used. Some bar chairs are suitable for soffit use only and should not be used against side forms. Bar chairs shall be sufficient structural strength to support the weight of reinforcement and workmen at temperatures experienced on site.
5. Metal chairs shall not be approved for any locations.
6. Precast mortar blocks shall not be used unless the blocks are manufactured from vibrated concrete of strength equivalent to that of the main concrete, and to a size and shape so as not to interfere with the structural integrity of the works. Such blocks shall have suitable fixing wires cast-in.
7. Layers of bars shall be separated by means of approved bar spacers. Stirrups and ligatures shall pass around the main reinforcement and shall be securely tied thereto.
8. Reinforcement shall be spliced by lapping or where permitted, by welding or by approved mechanical splices. Fabric reinforcement shall be lap spliced only.
9. The system of fixing shall be such as to form a rigid cage which maintains dimensional tolerances under loads experienced during placement of concrete. Welding of reinforcement to form a rigid cage shall comply with the following requirements:-
 - a. Welding shall be in accordance with AS 1554.3. In particular tack welds shall not substantially reduce the cross-section of the reinforcing steel nor adversely affect its strength and shall have:-
 - b. a throat thickness not less than 4 mm;

- c. a length not less than the diameter of the smaller bar.
 - d. Welding shall not be carried out within 75 mm of any portion of a bar which has been bent or will be bent.
 - e. No more than one-third of the main reinforcement at any cross-section shall be so welded.
 - f. Hard drawn wire and fabric reinforcement shall not be welded or heated unless approved by the Engineer.
 - g. Welding electrodes that are to be used complying with AS 1553.1 or AS 2203 or AS 2717.1.
 - h. Splices shall be made by butt or by fillet welding. Butt welds shall be qualified complete penetration butt joints in accordance with AS 1554.3.
 - i. Suitability experienced and competent welding personnel shall be engaged to complete the works.
10. Splicing of reinforcement shall occur only in the locations shown on the Project Drawings. Where practical, splices in bar reinforcement shall be staggered.
11. The length of lap splices in bar reinforcement shall be as shown on the Project Drawings. All reinforcement shall be spliced in such a manner as to maintain specified clear cover to the surface of the concrete. Splicing of fabric reinforcement shall be achieved so that the two outermost transverse wires of one sheet of fabric overlap the outermost transverse wire of the sheet being lapped.

S7.11 CONCRETE PLACEMENT - GENERAL

1. The Contractor shall be solely responsible for placing and compacting the concrete in the forms to comply with this Specification and for achieving dense, sound concrete without voids and to the lines and levels shown on the Project Drawings.
2. When rain threatens or seepage exists in excavations, the Contractor shall have on site sufficient dewatering equipment and covers as applicable to prevent any additional water entering the concrete.
3. Concrete shall be placed in an essentially continuous manner between approved construction joints so as to avoid being placed against partially set concrete.
4. Any troughs and chutes used as aids in placing concrete shall be metal or metal lined and shall be arranged and used in a manner that does not cause segregation. The use of water to facilitate the movement of concrete along troughs or chutes is expressly prohibited, but all troughs and chutes shall be kept clean and free of coating of hardened concrete by flushing thoroughly with water, which shall be discharged well clear of concrete in place.
5. Troughs and chutes shall discharge into vertical downpipes at least 1 metre in length. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement so that the concrete slides without segregation.
6. Pneumatic placers and concrete pump may be permitted for use subject to such equipment being arranged so that no vibrations will damage freshly placed concrete. The delivery end of the pipe shall terminate in a fitting of approved design, which shall prevent segregation of the concrete. After the completion of any concreting operations the equipment shall be thoroughly cleaned before re-use.
7. Concrete shall not be dropped from a height or in such a manner as will cause segregation or loss of material on the reinforcing steel or forms. When placing operations would involve dropping the concrete more than 2 metres it shall be deposited through a sheet metal or other approved downpipe in such a way that the concrete does not segregate. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. The depositing of a large quantity of concrete at any point with the intention of moving it along the forms, will not be permitted.

8. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcing bars which project.

S7.12 CONCRETE PLACEMENT – UNDER WATER

1. Concrete shall not be placed under water unless specifically approved. The slump of the concrete to be placed underwater shall be between 150mm and 200mm.
2. Concrete shall not be placed in running water. Any pumping must cease and the water level must be constant where placement commences. The concrete shall be placed carefully in position by a tremie, a closed bottom-dump bucket or by other approved means. Concrete seals shall be placed in one continuous operation, the concrete shall not be disturbed after being deposited and the placing shall be regulated to continually maintain an approximately horizontal surface.
3. When a tremie is used it shall consist of a watertight tube and at no time shall concrete in the tube come in contact with water when it is being filled. The means of supporting the tremie shall be such as to permit free movement of the discharge end and to permit its being lowered rapidly when necessary to choke off or retard the flow of concrete. No water shall enter the tremie tube. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall always be filled to a height to overcome the head of water.
4. When concrete is placed with a bottom-dump bucket, the bucket shall be lowered gradually and carefully until it rests upon the prepared foundation or upon concrete already placed. It shall then be raised slowly during the discharge travel so as to maintain as far as is practicable still water at the point of discharge and to avoid agitating the mixture. The concrete so placed shall not be disturbed.

S7.13 COMPACTION IN CONCRETE FORMS

1. Concrete during and immediately after depositing shall be thoroughly compacted. Concrete other than no fines concrete shall be compacted with high frequency internal vibrations in the manner described below:-
2. The vibrators shall be of an approved type and shall be capable of transmitting vibrations at a frequency not less than 150 Hz with an intensity which will visibly affect the concrete at a radius of 300mm.
3. The number of vibrators to be used by the Contractor shall be not less than one for each 4m³ of concrete placed per hour, with a minimum of 2 vibrators to be provided at any time.
4. Vibrators shall be inserted vertically at successive positions not more than 450mm apart and in a manner, which ensures compaction of the concrete around the reinforcing steel and any other embedded fixtures, and into all parts of the forms.
5. Vibration shall continue at each position until air bubbles cease to emerge from the concrete. The vibrators shall then be withdrawn slowly so as to avoid leaving a "pocket". The vibration shall be of sufficient duration to thoroughly compact the concrete, but shall not be continued so as to cause segregation.
6. Care shall be taken to ensure that newly deposited concrete is vibrated into any fresh concrete adjacent to it to provide a homogeneous concrete mass.
7. Vibration shall not be applied either directly or through the reinforcement to any concrete, which has taken its initial set.

S7.14 REMOVAL OF FORMS AND FALSEWORK

1. Unless otherwise specified, forms and falsework shall remain in position until the times stated below have elapsed after completion of concreting:

Non Structural Concrete

- a. Until such time as the concrete has reached 50% of the characteristic 28-day strength or a period of 3 days, whichever is the lesser.

Structural concrete

- b. Soffits of slabs, headstock and diaphragms - Until such time as the concrete has reached 70% of the characteristic 28-day strength or 7 days, whichever is the lesser.
 - c. Side forms on structural concrete - 3 days minimum.
2. Where the timing for the removal of forms is based on concrete strength as specified herein, the strength shall be proven by testing in accordance with AS 1012.
 3. Forms shall be removed with care, without hammering and wedging, and in a manner, which will not injure the concrete or disturb the remaining supports. Centre Forms shall be lowered gradually and uniformly in such a manner as to avoid injurious stress in any part of the structure.
 4. Hole formers such as pipes and bars shall be removed as soon as the concrete has hardened sufficiently for this to be done without damage to the concrete.

S7.15 FINISHING OF EXPOSED SURFACES

1. Unless otherwise specified in the Project Documentation, all surfaces of concrete exposed to view in the completed structure shall be finished in accordance with the following:
 - a. Kerb and channel, invert crossings, vehicle crossings and industrial crossings shall be finished with an approved steel finishing tool.
 - b. Footpaths, bikeways and pram ramps shall be finished with a wooden float and broomed.
 - c. Where a sample panel is supplied or specified associated with a particular project. The concrete finish shall be in accordance with the specified requirement.
2. All concrete surfaces shall be true and even, free from stone pockets, depressions or projections beyond the surface. All arrises shall be sharp and true, and mouldings shall be evenly mitred or rounded. Care shall be exercised in removing forms to ensure this result.
3. Immediately after removal of forms from mass or reinforced concrete work, all rough places, holes and porous spots shall be repaired by removing defective work and filling with stiff cement mortar having the same proportions of cement and fine aggregate as used in the concrete, and shall be brought to an even surface with a wooden float.
4. Any tie wires or other fitments extending to outside surfaces, shall be cut back after removal of forms, to a depth of at least 40mm with sharp chisels or cutters. All cavities caused by removal of fitments or tie wires shall be wetted and carefully packed with cement mortar, as above.
5. The surfaces of bolt cavities, tie wire holes, and all defects in concrete shall be coated prior to the placing of mortar, grout, or fresh concrete, with an approved bonding agent, in lieu of wetting with water. The method of application of such agent and the conditions in which it is to be used shall generally be as laid down by the manufacturer.

S7.16 WEEPHOLES

1. Drainage adjacent to weepholes shall be provided by either a layer of broken stone or river gravel consisting of clean, hard, durable particles graded from 50mm to 10mm such that:

- (a) The maximum particle dimension shall not exceed 50mm
 - (b) No more than 5 per cent by mass shall pass the 9.5mm A.S. sieve.
2. The broken stone or river gravel, enclosed in a filter fabric suitable for drainage without scour, shall be continuous in the line of the weepholes, extend at least 300mm horizontally into the fill and extend at least 450mm vertically above the level of the weepholes.
 3. Alternatively the Contractor may provide a synthetic membrane of equivalent drainage characteristics. It shall be stored and installed in accordance with Manufacturer's instructions.

S7.17 JOINTS

1. Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures the joints may be made at the base of walls and at other locations in the walls where approved by the Consulting Engineer. In order to provide for bond between the new concrete and the concrete which has already set, the surface on which the new concrete is to be placed shall be thoroughly cleaned of loose material, foreign matter and laitance. The surface shall be roughened or keyed and saturated with water. After any excess water has been removed, the surface shall be thinly coated with a neat cement grout.
2. Where vertical expansion joints are shown on the approved Project Drawings in retaining walls or other walls and structures the expansion joints shall consist of jointing material of approved quality, and of thickness stated on the drawings, and a depth sufficient to fill the joint. The jointing material shall be neatly cut to fit the surface of the concrete.
3. Extruded or cast in place kerbing, shall have narrow transverse vertical grooves, 40mm deep and not more than 6mm wide, formed neatly in the surface of the freshly placed concrete to produce contraction joints for the control of cracking. The contraction joints shall be at intervals not exceeding 3 metres.
4. In footpaths, median toppings and driveways, unless otherwise shown on the approved Project Drawings, expansion joints, 10mm in width for the full depth of paving, shall be constructed at intervals not exceeding 16m and where the pavement abuts against gutters, pits and structures. Expansion joints shall have an approved preformed jointing material. In addition, narrow vertical grooves 25mm deep and not more than 4mm wide shall be formed at intervals not exceeding 2m to induce contraction joints for the control of cracking.
5. All unreinforced paving shall be provided with narrow vertical grooves, 20mm deep and not more than 6mm wide to induce contraction joints for the control of cracking. The joints shall be formed in the freshly placed concrete in a neat regular pattern to form "slabs" no bigger than 2m². The ratio of the longest side to the shortest side shall not exceed 1.6.

S7.18 CURING

1. The curing of unformed surfaces of concrete shall commence as soon as finishing operations are complete.
2. If forms are removed in less than 7 days, curing of the formed surface shall commence within two hours of stripping.
3. Curing shall continue for a period after placing the concrete of not less than:-
 - a. Top surface of slabs - 14 days;
 - b. Other surfaces - 7 days.
4. Curing shall be effected by either Water or Membrane Curing.
5. Water curing shall comprise surfaces being kept moist for the period specified by continuous spraying, ponding, wet hessian or wet sand blankets.
6. Membrane curing shall be effected by application of a sprayed curing compound or by covering with polythene sheet.
7. Sprayed curing compounds shall be of a paraffin wax emulsion type formulated and tested by the manufacturer to conform to AS 3799. The compound shall be mixed if necessary and applied at the rate recommended by the manufacturer.
8. Resin and PVA based compounds shall not be used.
9. Polythene sheet shall be of sufficient strength to withstand wind and any imposed foot traffic. Torn or punctured sheeting shall not be used. Laps should be 300mm minimum and edges and laps shall be sealed by tape or held down by boards or reinforcing bars. Water shall be sprayed under the sheeting at edges and at laps on the day after placing concrete and at regular intervals to maintain moist conditions.

S7.19 BACKFILLING

1. Backfilling at barriers, paving, etc, and minor concrete works shall not commence until after the concrete has hardened and not earlier than three days after placing.
2. No filling shall be placed against retaining walls, headwalls or wingwalls within 21 days after placing of the concrete, unless the walls are effectively supported by struts or when the Contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved.
3. Selected backfill shall be placed against retaining walls and cast-in-place box culverts for a horizontal distance equal to one-third of the height of the wall. It shall consist of granular material, free from clay and stone larger than 50mm gauge. The Plasticity Index of this selected backfill material shall not be less than 2 or more than 12 when tested in accordance with AS 12893.3.1. The material shall be placed in layers not exceeding 150mm and shall be compacted to provide a relative compaction of not less than 98 per cent as determined by AS 1289.5.4.1 for standard compactive effort.

S7.20 SPRAYED CONCRETE

1. The minimum depth of sprayed concrete to be applied shall be 75mm.
2. Sprayed concrete shall have a minimum 28-day compressive strength of 25 MPa.
3. Earth surfaces shall be graded, trimmed and compacted and shall be dampened prior to applying the sprayed concrete. The Contractor shall take any precautions necessary to prevent erosion when the sprayed concrete is applied.
4. Rock surfaces shall be cleaned of loose material, mud and other foreign matter that might prevent bonding of the sprayed concrete onto the rock surface. The rock surface shall be dampened prior to applying the sprayed concrete.
5. The Contractor shall remove free water and prevent the flow of water, which could adversely affect the quality of the sprayed concrete.
6. Application shall begin at the bottom of the area being sprayed and shall be built up making several passes of the nozzle over the working area. The nozzle shall be held so that the stream of material shall impinge as nearly as possible perpendicular to the surface being coated. The velocity of discharge from the nozzle, the distance of the nozzle from the surface and the amount of water in the mix shall be regulated so as to produce a dense coating with minimum rebound of the material and no sagging. Rebound material shall be removed after the initial set by air jet or other suitable means from the surface as work proceeds and disposed of.
7. Spraying shall be discontinued if wind causes separation of the nozzle stream.
8. Concrete shall not be sprayed in air temperatures less than 5°C.
9. Construction joints shall be kept to a minimum. A joint shall be formed by placing or trimming the sprayed concrete to an angle between 30° and 45° to the sprayed concrete surface. The joint edge shall be cleaned and wetted by air-water jet before recommencing concrete spraying.
10. When spraying around reinforcement, concrete is to be sprayed behind the reinforcement before concrete is allowed to accumulate on the face of the reinforcement.
11. Adjoining surfaces not requiring sprayed concrete shall be protected from splash and spray rebound. Splash or rebound material on these adjoining surfaces shall be removed by air-water jet or other suitable means as work proceeds.
12. Curing shall commence within one hour of the application of sprayed concrete and may be by water or by colourless wax emulsion curing compound complying with AS 3799 and applied in accordance with manufacturer's specifications.
13. In water curing, the surface of the sprayed concrete shall be kept continuously wet for at least seven days.

S7.21 NO FINES CONCRETE

1. Where no fines concrete is incorporated in the works it shall be rodded sufficiently only to ensure the form is completely filled. It shall be screeded to the required surface level without tamping or vibrating. No fines concrete shall be moist cured for at least four (4) days by covering with wet hessian, polythene sheet or other similar materials. The use of wet sand or any other material, which can enter the voids, will not be permitted for curing purposes.

S7.22 TOLERANCES

1. Where tolerances for individual components and associated dimensions are not specified on the Project Drawings, deviations from established lines, grades and dimensions in the completed work shall not exceed the values stated herein.
2. The dimensional tolerances as shown in Table S7.3 are to cover strength, durability and fit of prefabricated elements and cast-in-situ elements.

Table S7.3 Dimensional Tolerances

Description	Tolerance (mm)
Cross-sectional dimension of members and thickness of slabs	+ 10, - 3
Length of members, length and width of slabs: - Up to 18m dimension - 18m or over dimension	± 6 1mm for every 3m in length
Clear cover to reinforcement	+ 6, - 3
Fitments for prefabricated elements – girder anchorages (including dimensions between anchorages on adjacent piers), cored holes, handrail anchorages and other embedded items	± 5 max. 1mm for every 1m in length

3. Positional tolerances, as shown in Table S7.4 refer to the departure of any point, plane or component of a structure from its correct position within the layout of the structure as shown on the Project Drawings.

Table S7.4 Positional Tolerances

Description	Tolerance (mm)
Level of footings	± 20
Level other than footings	± 5
Horizontal location, where tolerances on fit is not applicable	+ 25

4. Relative tolerances refer to departures from linearity or planarity in any part of the structure. Tolerances are measured as the departure of any point in a line or surface from the remainder of that line or surface.
5. Departure may be sudden (eg. misfit at joint in formwork) or gradual (eg. a wobble in the surface). Tolerance on gradual departure is the value calculated by multiplying the overall length of the line or surface under consideration by the factor given below in Table S7.5.

Table S7.5 Relative Tolerances

Description	Tolerance (mm)
Exposed edge - Gradual departure	0.001
Exposed surface - Gradual departure - Sudden departure	0.004 (10mm max.) 3mm max.