

TECHNICAL STANDARD**REINFORCED CONCRETE CONSTRUCTION
FOR LIQUID RETAINING STRUCTURES
AND/OR AGGRESSIVE ENVIRONMENTS**

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Manager Engineering

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APPROVAL TO DEVIATE FROM THIS STANDARD

Approval may be granted by the Asset Owner to deviate from the requirements as stipulated in this Standard if the functional requirements (e.g. Asset Life) for the asset differs from those stated in the Standard, but is assessed as still being acceptable by the Asset Owner's nominated representative.

Any approval to deviate from the stated requirements of this Standard will not be seen as creating a precedent for future like project. Any request to deviate from this Standard must be carried out on a project by project basis where each alternate proposal will be individually assessed on its own merit.

CHANGES TO THE JANUARY 2007 EDITION

The following lists the major changes to the 10th January 2007 edition of TS 68:

- 1. AS 3582.1 included to list of referenced documents to cover the use of flyash.*
- 2. Clause 1.1: Modified to include coastal marine environment where previously no mention made of this type of exposure classification.*
- 3. Clause 1.3: New clause added to emphasise the strict requirements needed to ensure the expected longevity of the concrete structure.*

4. *Clause 1.4: New clause added to provide information on the optimal use of flyash as a partial replacement of cement. Also included is information for the use of shrinkage reducers, stearate waterproofers and superplasticisers to assist the Contractor in achieving the tight durability requirements of this Specification. Guidelines for corrective action for fluctuations in strength due to seasonal factors and variations in material quality are also mentioned.*
5. *Table 2.1: Slump altered to ensure lower end of range is targeted for achieving lower water/cement ratios.*
6. *Table 2.1: A wider range in flyash replacement given.*
7. *Table 2.1: Limits for apparent volume of permeable voids and acid soluble chloride included in Table.*
8. *Table 2.1 Notes: Note (2) deleted and replaced with new slump requirements. Also Note (3) added to signify exposure conditions corresponding to their appropriate concrete grade which are applicable for use under the specified parameters of this Table.*
9. *Clause 3.1: Clause rephrased with reference to the correct wording as specified in Australian Standard. Clause amended to ensure distinction made between cement blended at the Batch Plant and pre-blended cement purchased from the cement Manufacturer. Requirement for flyash certificate also added.*
10. *Clause 3.3: Conditions for the use of marble aggregate emphasised.*
11. *Clause 3.4 Clause totally replaced with updated version encompassing the newer developed admixtures and excluding some additives no longer in use.*
12. *Clause 4.2: Acceptable volumetric size of laboratory mix reduced. Apparent volume of permeable voids included in list of tests. Requirement introduced for additional trial mixes in longer duration projects.*
13. *Clause 4.5: The percentage yield tightened to a lower limit before the required mix adjustment becomes applicable. The limit for apparent volume of permeable voids included as a further requirement for a mix adjustment.*
14. *Clause 5.5: Amendments made to clarify the requirements for delivery of concrete from offsite batching plants. Limits to initial and final slumps after addition of superplasticiser altered in accordance with current industry practices. Period allowed for concrete discharge altered from a loss in slump to a specific time.*
15. *Clause 6.1.4: NATA calibrated thermometer included for the measurement of concrete temperature. Also the moment when measurement needs to be made*
16. *Clause 6.8.1: Curing period for flyash concrete reduced.*
17. *Clause 7.1: Certificates to include mill test results.*
18. *Clause 10.3: Apparent volume of permeable voids included in test requirements.*

19. *Clause 10.4.2: Slump range altered. The moment and location when measurement of initial and final slump needs to be made has been included with limits stipulated for the slumps.*
20. *Clause 10.4.4.1: Modifications made to quality control benchmark to ensure concurrence with updated version of AS 1379.*
21. *Clause 10.5.1: Amendments to rejection of concrete in line with requirements of Clause 4.2. Tolerance specified for concrete that has been retested after initially failing the slump test.*
22. *Clause 10.5.2: Apparent volume of permeable voids added as a conditional rejection of hardened concrete.*

The following lists the major changes to the July 1996 edition and published in the January 2005 edition of TS 68:

1. Reformatted from DS to TS (Departmental Standard to Technical Standard), and updated referenced Australian Standards.
2. TS 68a (minor projects) and TS 68b (major projects) combined to form TS 68 which covers all projects.
3. Title amended to indicate that the standard embraces all requirements of reinforced concrete construction to ensure structures are durable and will achieve the required service life.
4. Clause 1.2: Highlighted as it is critical to the understanding of this document.
5. Clauses 1.6, 4.2 & 4.3: Updated such that the Contractor is responsible for and required to conduct trial mixes.
6. Clause 4.2: Parameters to be tested for in Trial Mix amended to include chloride level. The results shall be submitted to the SA Water's Representative.
7. Clause 5.2.1: Updated to consider offsite and onsite premix plants.
8. Clause 5.3: Batching practices revised to suit current practices.
9. Clause 6.1.3: Adverse weather conditions maximum temperature reduced to 35°C.
10. Clause 6.1.4: Amended to include timing of concrete temperature tests.
11. Clause 6.2.8: Amended such that the Principal will not supply the waterstop.
12. Clause 6.2.11: Updated such that EPA guidelines will be satisfied in the disposal of waste.
13. Clause 6.4.2 & 6.7.2: Updated to suit current practices in surface cleaning and preparation.

14. Clause 6.5.3.8: Method of measurement of unformed surface tolerances revised.
15. Clause 6.6 & 6.7.1: Repair of damaged structures revised such that it shall occur within 7 days of the damage occurring.
16. Clause 6.7.4: Treatment of cracks revised and updated.
17. Clause 6.8.1: Amended such that disposal of water from the curing operation shall satisfy EPA guidelines.
18. Clause 6.10.2: Revised such that no plastic sleeves shall remain embedded in the concrete.
19. Clause 7.4.2: Amended such that samples of spacers shall be submitted for approval.
20. Clause 8.4: Clause on levelling pins removed.
21. Clause 10.1: Updated such that a NATA approved laboratory shall be used for testing.
22. Clause 10.3.1: Updated such that the Contractor shall notify the SA Water's Representative immediately of non-compliances.
23. Clause 10.3.7: Parameters to be included in mix water analysis revised and Langelier Index is not required.
24. Clause 10.4.4 (& 10.4.4.1): Compressive strength tests adapted to suit both smaller and larger projects and current practices.
25. Clause 10.4.5: Updated minimum ultimate tensile strength of welded joint to be 500 MPa to suit current practices.
26. Conversion to a technical standard by removal of contractual conditions (to be included in the contract that references this standard).

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REFERENCED DOCUMENTS

- AS 1012: **Methods of testing concrete**
- AS 1379: **Specification and supply of concrete**

AS 1478: Chemical admixtures for concrete, mortar and grout
AS/NZS 1554: Structural Steel Welding
AS 3582.1 Use of Flyash in cement
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
AS 3972: Portland and Blended Cements
AS/NZS 4020: Testing of products for use in contact with drinking water
AS 4671: Steel reinforcing materials
AS/NZS ISO 9001: Quality management systems - Requirements
TS 2: Polyvinyl Chloride Waterstop
TS 3b: Fine and Coarse Aggregates for Concrete for Water Retaining Structures and in Aggressive Environments
TS 3c: Fine and Coarse Calcareous Aggregates for Concrete in Sewerage Structures
Occupational Health Safety and Welfare Act, 1986

SECTION 1: PRELIMINARY CLAUSES

1.1 Scope

This is a Technical Standard (TS) which sets out the relative requirements to be followed for achieving high durability reinforced concrete. This Technical Standard is intended for use in the construction of liquid retaining structures pertaining to water and sewage treatment and, where specified, in conditions where the concrete is to be exposed to aggressive environments, notably marine type exposures in coastal zones.

The parameters set for the marine type of exposure classification are tabled in this Specification. These parameters do not apply to conditions of greater severity which exist in tidal and marine splash zones. The durability parameters required for such exposure classification are even more stringent as specified in AS 3600 and AS 3735.

1.2 Performance Indicators

The parameters governing the performance of the concrete have been set on the basis of the durability requirements. The most accurate measurement of that performance is by compressive strength. Depending on the source of materials used, a wide range of strengths are achievable using those set parameters. Therefore the strength required (Q) for establishing the benchmark, by which the quality of concrete can be ascertained, is deliberately not fixed for each project, but derived from laboratory results conducted on the materials submitted.

1.3 NOTICES TO CONTRACTORS

The aim of the application of this standard is to ensure that concrete structures are built with a life expectancy of 100 years plus.

To achieve that longevity of life the Contractor shall ensure the following key steps are implemented during construction:

- strict quality control of the concrete production to achieve high durability
- use of rigid formwork and correct fixing of reinforcement to ensure the specified cover
- careful placement of wet concrete ensuring maximum compaction and a high grade of surface finish
- adequate application of moist curing to finished concrete by constant wetting to avoid any premature drying during the curing cycle.

The specification requirements detailing these processes must be rigorously followed. Any deviation or non-conformity of these processes could result in unnecessary delays or even rejection of affected structural members.

1.4 INFORMATION FOR CONTRACTORS

From results of laboratory trials and investigations conducted by SA Water the following information is provided to assist the Contractor in achieving the objectives of this Specification:

- the drying shrinkage limits specified are very stringent. Depending on the aggregate source, the total fines present in the mix and the mix design used, the Contractor may have difficulties in meeting the limits imposed without the aid of suitable shrinkage reducers. To achieve maximum benefit a mid range dosage rate is recommended in accordance with the Manufacturer's instructions.
- it is common industry practice to start with a low initial slump at the Batch Plant followed by addition on site of an approved superplasticiser to raise the slump to a more flowing consistency mix. This practice is a safeguard to ensure that the maximum water-cement ratio is not exceeded. In this Specification the slump requirements have been deliberately set at the lower range to that purpose.
- use of flyash as a part replacement of Portland cement provides measurable benefits to long term concrete durability. The Contractor is encouraged to use flyash concrete at a replacement rate of between 15 – 30%. Flyash at the higher end of the replacement range provides extra benefits with regard to reduction in water demand of the mix and a lower shrinkage but it comes as an impediment to early strip of formwork because of a reduction in early strength. The Contractor is advised to take these matters into consideration when submitting the proposed mix design for approval.
- In long duration projects concrete strengths may fluctuate due to seasonal factors, changes in cement properties and, at times, a shortage of flyash supply. The Contractor needs to be alert to the changes and take corrective action. In these instances it is recommended that additional laboratory trial mixes be conducted at regular intervals to reflect the changes so that correct assessments of strength are made against each new calculated benchmark in accordance with the requirements of this Specification.
- for structures where use of a stearate generic type waterproofer is intended, the Contractor needs to be aware of potential strength losses of anything up to 20% resulting from addition of such material. Adjustments to the mix such as an increase in cementitious content to counter the loss in strength may be required. SA Water's Representative may approve an increase in cementitious content above the maximum specified providing the Contractor can show evidence that the shrinkage limits will not be exceeded.

1.5 Referenced Standards

1.5.1 Standards Australia

The concrete shall be in accordance with this Technical Standard and the applicable Australian Standards listed in the Reference Documents at the beginning of the document. Where this standard differs from Australian Standards then the requirements of this Technical Standard shall take precedence over any Australian Standard.

1.5.2 SA Water Standards

The following SA Water standards form part of this document.

TS 2	Polyvinyl Chloride Waterstop
TS 3b	Fine and Coarse Aggregates for Concrete for Water Retaining Structures and in Aggressive Environments
TS 3c	Fine and Coarse Calcareous Aggregates for Concrete in Sewerage Structures

1.6 Quality Control and Quality Assurance

The Contractor shall be responsible for monitoring and maintaining a level of quality control which conforms with the requirements of this standard.

The Contractor shall have in place a quality assurance system which meets the requirements of this standard (see Section 9) and complies with the relevant system elements of AS/NZS ISO 9001.

1.7 Information to be Supplied by Contractors

Contractors shall complete the attached Schedule of Technical Data and Schedule of Quality Functions and submit them to SA Water's Representative.

1.8 Programming

Contractors are reminded that Clauses 4.2 and 4.3 of this standard require trial mixes to be conducted for assessment and quality control benchmarking by the Contractor before the commencement of any insitu concrete production. A time span of at least 36 days after the Date of Acceptance of Works shall be set aside for laboratory trial mixing and an extra 8 days minimum for site trial mixing.

The Contractor shall submit a Program of Works Schedule (in the form of a bar chart or equivalent) indicating the size, location and the timing of all concrete pours for the duration of the project.

1.9 Approvals

Where materials and procedures are subject to the approval of SA Water's Representative prior to their use, the Contractor shall allow two (2) working days, unless directed otherwise, to obtain such approvals.

1.10 SA Water's Representative

SA Water's Representative in this Technical Standard will be nominated by SA Water.

SECTION 2: PERFORMANCE REQUIREMENTS

2.1 Class of Concrete

The concrete shall be **special class performance** as defined in AS 1379 unless specified otherwise.

For the purpose of design the nominal strength shall be 40 MPa.

For reference in drawings or to delivery dockets the concrete shall be designated as **S40 Grade** concrete in accordance with this Technical Standard (refer Clause 1.2).

2.2 Parameters

Table 2.1 - Required Parameters

Wet concrete	
Maximum water/cement ratio	0.45
Cementitious content: - minimum - maximum	360 kg/m ³ 400 kg/m ³
Maximum aggregate size	20 mm
Slump to AS 1012 Part 3	50 mm +10, -30 mm
Cementitious binder materials	GP Portland cement with 15 to 30% Flyash
Hardened concrete	
28-day required quality control strength (Q) Measured in accordance with AS 1012 Part 9	see Clause 10.4.4.1 but not < 40 MPa
Maximum drying shrinkage at 28 days: • approved trial mix • insitu concrete Measured in accordance with AS 1012 Part 13	390 microstrain 420 microstrain
Apparent Volume of Permeable Voids	≤ 14%
Acid Soluble Chloride	≤ 0.5 kg/m ³

Notes:

- (1) A cementitious content of 400kg/m³ has been specified as the maximum to control shrinkage. If the Contractor has difficulty in meeting the water/cement ratio requirement, SA Water's Representative may allow a higher cement content, provided the shrinkage limit is not exceeded.
- (2) The initial slump, as specified in Table 2.1, has been deliberately biased towards the lower end of the slump range to reduce the risk of overshooting the slump at the higher end of the range. The slump shall be measured at two intervals, the initial slump at first arrival on site and the final slump after addition of superplasticiser. The upper limit of the final slump shall not exceed 150 mm.

- (3) The parameters specified in Table 2.1 apply to concrete structures under B2 exposure conditions such as those described in AS 3600 and AS 3735. The strength requirement specified for that exposure is S40 Grade concrete. For a greater severity C type classification exposure, typically those that exist in severe marine environments, a S50 Grade concrete will be required. In approved circumstances SA Water's Representative may allow the use of the lesser S40 Grade concrete where a stearate generic type waterproofer has been approved as an additive to the concrete.

2.3 Workability

The concrete shall have a workability with the assurance that it can be readily worked into the corners and angles of forms and around reinforcement without segregation or the accumulation of excess bleed water on the concrete surfaces.

The Contractor may be asked to provide evidence to that effect with regards to the workability factor and the amount of bleeding of the concrete ie the Vebe or Compacting Factor Test and the Bleeding Test in accordance with AS 1012 Parts 3 and 5 respectively.

2.4 Pumped Concrete

The Contractor shall ensure that all pump equipment is kept clean at all times to the satisfaction of SA Water's Representative. Pumps and pipelines shall be washed clean daily after each pour to remove any hardened concrete pieces and ensure a smooth uninterrupted flow for the next pour. Any concrete that has been delayed due to blockages in the lines or faulty equipment may be subject to rejection.

SECTION 3: MATERIALS

All chemicals and coatings used for concrete (eg membrane curing compounds) which is to be later in contact with water intended for human consumption shall comply with the requirements of AS/NZS 4020 to qualify for safe use. The Contractor shall provide such evidence in the form of certification for approval by SA Water's Representative.

3.1 Cement

The cement shall be Type GP, general purpose Portland cement, or Type GB general purpose blended cement, in accordance with AS 3972. If during the Contract the supplied brand is supplemented from another source mixed in with the original, the Contractor shall notify SA Water's Representative in writing of this event. SA Water's Representative may direct the Contractor to conduct a new laboratory trial as this constitutes a change in material.

All flyash used as a partial replacement for GP cement, whether blended at the concrete plant, or purchased as a pre-blended GB cement from the Manufacturer, shall be in accordance with AS 3582.1.

All cement shall be stored under weatherproof conditions.

Bagged cement shall be used in the order of delivery and any cement which contains conglomerated lumps or has exceeded the 'by use' date shall not be used.

On request, test certificates representing flyash, GP or GB cement used in the Works shall be submitted by the Contractor.

3.2 Water

The mix water shall be potable and free from harmful matter to concrete and the reinforcement and where possible drawn from a stable reticulated drinking water supply having a conductivity not exceeding 1000 EC units. Sources of water other than from a stable reticulated drinking supply shall be analysed (see Clause 10.3.7) by the Contractor and submitted for approval by the SA Water's Representative.

At the discretion of SA Water's Representative, water with a higher conductivity may be used provided the Contractor produces evidence that the maximum chloride content specified will not be exceeded as a consequence of the higher chloride present in the mix water, whilst taking into consideration the contribution from each ingredient comprising the mix to the total chloride content (refer to Clause 3.5 - Chloride Levels).

The limits of impurities shall be in accordance with AS 1379 unless specified otherwise.

3.3 Aggregates

Fine and coarse aggregates shall be in accordance with TS 3b.

Where Marble aggregate is required by the project specification it shall be in accordance with TS 3c. (this type of aggregate, commonly termed "calcareous", will generally be specified for all structures where the concrete faces are at risk to attack by aggressive sewer elements caused by the accumulation of sewer gases).

Contractors shall nominate the source and type of aggregate they intend to use in the Contract. The source of supply shall not be changed without the written approval of SA Water's Representative.

3.4 Admixtures

Admixtures shall be in accordance with AS 1478.

The Contractor shall submit for approval technical details of all intended admixtures to be used.

Only the admixtures contained in the accepted laboratory and field trial mixes shall be used in production concrete. No admixture shall be substituted without the approval of the SA Water's Representative.

To achieve the specified water/cement ratio, use of suitable water reducing admixtures will be required. They shall be medium or high range water reducers as selected by the Contractor in the approved mix.

A suitable superplasticiser shall be used on site to raise the slump to a level as required by the Contractor and within the specified limit for ease of workability and placement.

A suitable shrinkage reducer as selected by the Contractor shall be used to ensure shrinkage limits specified are not exceeded.

Where specified and as directed by the SA Water's Representative, stearate generic type waterproofers shall be used. The water component contained in this admixture shall be included in the water/cement ratio determination.

Admixture use and dosage rates shall be in accordance with the Manufacturer's instructions.

3.5 Chloride Levels

The total acid-soluble chloride-ion content in concrete as placed shall not exceed 0.5 kg/m³ (or 0.02 % w/v) (refer to Clause 10.3.8 - Testing of Chlorides).

As a precautionary measure to ensure that the above specified total chloride limit is not exceeded and to alleviate the possibility of rejection of the hardened concrete at a later stage, the following chloride levels are limited to each individual ingredient comprising the mix.

water	500 mg/L	or 0.05% (w/v)
admixture	2000 mg/L	or 0.20% (w/v)
cement	100 µg/g	or 0.01% (w/w)
sand	600 µg/g	or 0.06% (w/w)
10 mm aggregate	100 µg/g	or 0.01% (w/w)
20 mm aggregate	100 µg/g	or 0.01% (w/w)

SA Water's Representative may permit the limit(s) of any one or more of the ingredients to be relaxed, provided the Contractor submits evidence that the total chloride level will not be exceeded.

SECTION 4: MIX DESIGN

4.1 Mix Details

Contractors shall submit details of their proposed mix for approval. Any work or testing done in the optimisation and establishment of a suitable mix design will be the responsibility of the Contractor including any associated cost.

4.2 Laboratory Trial Mix

The Contractor shall engage the services of a NATA registered laboratory to carry out trial mixes and testing on the concrete mix(es).

At least 36 days before the commencement of concrete production, the Contractor shall deliver sufficient quantities of aggregates, as specified in TS 3b

or TS 3c, whichever is appropriate, to enable the laboratory to conduct a trial mix(es) of 0.04 m³ minimum volume using the approved submitted mix details.

From the trial(s), the laboratory shall assess the suitability of the mix design and test for slump, water/cement ratio, shrinkage, strength, apparent volume of permeable voids and chloride level to confirm that the specified performance requirements tabled in Clause 2.2 and Clause 3.5 have been achieved. The results shall be submitted to the SA Water's Representative.

The result of the 28-day laboratory trial mix compressive strength (verified by the site trial mix result) will be the value used by SA Water's Representative to set the benchmark for compliance by virtue of strength testing (see Clause 10.4.4.1).

Further mix designs and materials may be requested for subsequent trials if the initial submission has been determined as unsuitable and not within specified requirements.

Projects of lengthy duration require follow up trial mixes of no less than 6 monthly intervals to establish new benchmarks due to seasonal changes in strength, cement and aggregate properties.

4.3 Site Trial Mix

The Contractor shall conduct a site trial mix(es) of 1.0 m³ minimum volume in the presence of SA Water's Representative to verify the laboratory results of slump, water/cement ratio, shrinkage and strength.

Further site trial mixes may be required at any given time during the construction period, as directed by SA Water's Representative, where a change in the mix or aggregate source has been approved or where the Contractor is requested to ascertain the causes of non-conforming concrete.

A mix design identical to the laboratory trial shall be used in the site trial.

The site trial mix shall be conducted not less than 8 days before commencement of production concrete to provide early results for predicting 28 day strengths within the time frame specified (refer to Clause 1.6 - Programming).

SA Water's Representative may permit the Contractor to use the remaining site trial mix concrete in a non-critical structure.

4.4 Approved Mix

A concrete mix accepted by both SA Water's Representative and the Contractor shall become the **approved mix** for the period of construction. It shall not be altered without the written approval of SA Water's Representative (see also Clause 4.5).

4.5 Mix Adjustment

Concrete failing to meet the performance requirements and quality specified may be subject to a mix adjustment as approved by SA Water's Representative, particularly if:

- The maximum specified water/cement ratio is exceeded
- The mean strength fails to meet the benchmark set
- The maximum specified drying shrinkage is exceeded
- The variation in the yield is more than $\pm 2\%$
- The apparent volume of permeable voids is exceeded

Prior to any alteration to the mix, the Contractor shall fully investigate the possible causes of failure and take the necessary corrective action.

Mix adjustments may be approved based on early test results.

SECTION 5: CONCRETE PRODUCTION

5.1 General

The concrete shall be manufactured in accordance with AS 1379 unless specified otherwise in this standard.

Manufacture of concrete shall be from a reputable premix plant or an approved on site batching plant. The Contractor shall be responsible for the quality of all concrete produced, irrespective of the source of supply, whether manufactured on site or purchased from a premix plant.

Contractors shall submit to SA Water's Representative details of their on site batch plant or their source of supply if purchase from a premix plant is proposed (information to be completed in the Technical Schedule).

5.2 Concrete Manufacturing Plant

The Contractor shall guarantee that the plant used has the capabilities to produce concrete to the performance requirements specified. Quality assurance certification, plant records, test results and plant calibrations shall be evidence of that guarantee. However, SA Water's Representative reserves the right to undertake an audit(s) including inspection(s) of the plant and associated equipment.

The acceptance, installation and operation of the on site batching plant shall be subject to the approval of SA Water's Representative. Approval of plant, equipment or the operation shall not, however, waive or modify any provision or requirement of this standard.

Irrespective of the type of plant used, the Contractor shall provide and apply such means and equipment that are required to determine accurately and to control the prescribed amounts of the various materials introduced into the concrete mixer throughout the construction period to the approval of SA Water's Representative.

5.2.1 Plant Calibrations

5.2.1.1 Offsite Premix Plant

The most recent calibrations shall be submitted for the initial approval provided they have not lapsed by more than 6 months, in which case, a complete updated calibration shall be undertaken including submission of the resultant certificates. At the discretion of SA Water's Representative, an inspection and audit of the nominated off site Plant and associated records may be undertaken prior to any approval.

5.2.1.2 Onsite Premix Plant

The Contractor shall arrange for a complete initial calibration of all measurement and dispensing equipment by an approved authorising body once the Plant has been established on site and before commencement of any production concrete. Calibration certificates shall be submitted to SA Water's Representative for approval.

The Contractor shall conduct regular updated re-calibrations of the Plant. Certificates representing the updated re-calibrations may be required for submission as requested by SA Water's Representative. In-house re-calibrations may be accepted if the Contractor can provide proof of accuracy.

5.2.2 Plant Records

The Contractor shall keep a record of each batch of concrete supplied, providing relevant information of the wet concrete such as total water addition, slump, water/cement ratio etc, and also indicating the adjustments in the batch weights as a consequence of corrections made due to variations in moisture conditions and absorptive characteristics of the aggregates (see Clause 5.2.3). Appendix C is an attached blank pro-forma sheet exemplifying what is required to be kept as a record.

These records shall be submitted to SA Water's Representative on request. This includes the appropriate monthly Production Assessment results relative to the project, separately tested in-house by the Plant.

5.2.3 QUALITY CONTROL

The monitoring and control of all operations determining the final quality of concrete delivered to the Works shall be the responsibility of the Contractor including any delegated authority to sub-Contractors and premix concrete suppliers.

The moisture content and absorption values of all aggregates shall be monitored on a regular basis to correct for adjustments to the batch weights and mix water. The moisture contents (to nearest 0.2%) shall be determined before commencement of each day's pour and during the pour if changes to the moisture state are suspected. Absorptions (to nearest 0.1%) shall be determined prior to the first pour and for each subsequent delivery of fresh aggregates (figures supplied by the quarry may be used).

5.3 Batching

Ingredients shall be batched by direct weighing only. Volumetric batching will not be allowed excluding admixtures which shall be introduced by means of suitable dispensing equipment.

SA Water's Representative may permit the mix water to be metered into the mixer, providing the Contractor can show evidence (in the form of calibrations) that the amount of metered water is accurate within the tolerance specified.

Batching of the ingredients shall be within the following tolerances:

For batch sizes (All batches $\geq 1.0\text{m}^3$)	$> 1\text{m}^3, < 2\text{m}^3$	$> 2\text{m}^3, < 4\text{m}^3$	$> 4\text{m}^3$
water	± 2 kg (or litres)	± 4 kg	± 8 kg
cement	± 5 kg	± 10 kg	± 15 kg
aggregate(s)	± 40 kg	± 60 kg	± 75 kg
admixture	$\pm 3.0\%$ of dosage	$\pm 5.0\%$	

Care shall be exercised when batching by cumulative weighing to ensure the tolerance of each ingredient is not exceeded and thus avoid the risk of rejection of any concrete load where this occurs.

Water shall not be added in excess of that predetermined on the batch record and also after 10 minutes from first introducing the ingredients into the mixer.

To avoid overshooting the slump it is advisable to withhold at least 10% of the calculated mix water and regulate the final addition of water to obtain the specified slump.

The predetermined amounts of cement, aggregates and water to make the required batch quantity shall be weighed in a ratio exact to the proportions used in the approved mix.

Each batch shall be thoroughly mixed to ensure a uniform and consistent wet concrete free of dry lumps of unmixed material. Re-mixing with fresh material after the concrete has been initially batched will not be permitted. Addition of water will not be allowed at the work site or once the transit mixer has left the Plant.

5.4 Equipment and Materials

5.4.1 General

The Contractor shall operate and maintain the Plant which will ensure the minimum risk of breakdown in equipment and interruption to the pour. The cost incurred due to such delays shall be borne by the Contractor.

5.4.2 Bulk Storage Bins, Silos and Liquid Holding Tanks

Bins and silos for bulk storage of aggregates and cement shall be of sufficient capacity to facilitate the concrete production rate as per the required Program of Works Schedule (see Clause 1.6) submitted by the Contractor.

Cement facilities shall be such that they allow independent weighing and discharge of cement from the other ingredients.

Admixture bulk storage containers and 'weigh water' facilities shall be such that they are free from contamination. Recycled water from the washings of transit mixers will not be permitted for use as mix water.

Each aggregate size shall be stored in separate bins and cross contamination between the different sizes shall be prevented. The bulk storage bins shall have a concrete floor which shall be sloped to provide free drainage and they shall be operated in such a manner to prevent the batching of material containing excess fines viz. the bottom most layer of the stockpile where the fines tend to accumulate. This portion of material shall be regularly emptied to ensure conformance with the Standard. The aggregates shall be adequately covered and protected to the satisfaction of SA Water's Representative.

The Contractor shall make provisions on site for checking the quality of aggregate for each new truckload.

The aggregates shall be kept at saturated surface dry conditions (SSD) by use of sprinklers or other suitable means.

5.4.3 Discharge Bins and Weigh-Hopper

Transfer of materials from the bulk bins to the weighing hopper via the discharge bins, onto the conveyor and finally into the transit mixer shall be without spillage.

The weigh-hoppers shall be such as to accommodate convenient removal of overweight material in excess of the specified tolerances. Weighing apparatus shall be accurate to within 0.4% of full scale capacity and the maximum range shall be 25% greater than the maximum anticipated batch size.

5.4.4 Mixers

Mixers shall be capable and have an acceptable degree of uniformity of mixing for producing concrete to the specified requirements. SA Water's Representative may request for proof of uniformity as stipulated in AS 1379 - Appendix C.

The ingredients conveyed into the transit mixer shall be "dry" i.e. in their natural states without addition of any water. The final mixing operation to produce fresh concrete shall be done within the transit mixers. Use of independent wet mixers (processes in which fresh concrete is produced and then transferred into the transit mixer) shall not be permitted.

Mixers failing to comply with the provisions of this Clause shall be replaced or repaired immediately to the satisfaction of SA Water's Representative.

5.5 Delivery

Concrete batched at offsite plants shall be transported to the Works in approved transit mixers with minimum delay and in a manner which will prevent segregation or loss of ingredients. The transit mixer bowl shall be kept revolving for the duration of delivery to the site.

Supply of concrete will not be accepted if the concrete arrives on site with a slump outside the specified range. The initial slump has been specified in the range of 20 to 60 mm. The final slump after addition of superplasticiser shall not exceed 150 mm.

If, after the first addition of superplasticiser on site, the concrete suffers minor slump losses due to unscheduled delays it may be 'rescued' by second and even third additions of the approved superplasticiser provided the time limit specified for discharge and also the slump limit are not exceeded.

Raising the slump above the specified limit by water addition to compensate for slump losses will not be permitted.

All delivered concrete, regardless of batch size, shall be discharged within 90 minutes from the commencement of mixing. The Contractor is advised to consider on site batching using a mobile plant where long hauls are anticipated.

On request, the Contractor shall provide details of the location of the offsite batching plant, its distance from the site and the estimated time of delivery.

SECTION 6: CONSTRUCTION REQUIREMENTS

6.1 Placement

6.1.1 General

Concrete shall only be placed in the presence of SA Water's Representative and the Contractor shall give not less than 24 hours (excluding weekends and public holidays) notice of the intention to commence placing. The sequence and procedure of placing shall be approved by SA Water's Representative.

Contractors shall provide information, as required in the Schedule of Technical Data, on methods of placement and the precautions taken in adverse weather conditions.

6.1.2 Preparation

Before placing concrete against earth or rock the surface shall be stable and free from loose material and shall be inspected and approved by SA Water's Representative.

Earth or rock sub-grades shall be damp, but not wet, when the concrete is placed. Free draining sub-grades shall be thoroughly wetted to a minimum depth of 150 mm.

Concrete shall not be placed until all formwork, screed guides, reinforcement, spacers, blockouts, inserts, waterstops and all joint preparations have been inspected and approved by SA Water's Representative.

Any dirt, sawdust, shavings and other foreign material shall be removed from the space to be occupied by the concrete.

6.1.3 Adverse Weather Conditions

Concrete pouring shall not commence if, in the opinion of SA Water's Representative, the existing conditions or the Bureau's forecasted conditions are such that they could have a detrimental effect to the concrete and the finished work. Adverse weather conditions include rain, high winds above 30 knots or high and low temperatures (below 5°C and above 35°C).

Where the placement of concrete is interrupted because of adverse weather conditions, a construction joint shall be formed (see Clause 6.4).

6.1.4 Temperature of Concrete

The temperature of the concrete shall not exceed 32°C as measured onsite just prior to pouring. Any concrete above 32°C shall be liable to rejection (see Clause 10.5.1).

The temperature shall be recorded immediately after the final slump has been measured from concrete used in the slump determination. Measurement shall be done with a NATA approved calibrated thermometer.

The Contractor shall ensure the temperature of the concrete is not higher than 32°C by approved methods of cooling eg liquid nitrogen cooling of the wet concrete, using chilled mix water or spraying the coarse aggregate with cold water.

6.1.5 Hot Weather Precautions

The Contractor shall take all the necessary precautions, as directed by SA Water's Representative, to ensure adequate protection at the location of the pour during hot weather (shade temperatures higher than 32°C). The precautions include:

- Formwork and reinforcement shall be protected from the effects of hot winds and direct sunlight.
- Suitable barriers shall be provided to protect the freshly placed concrete until it has hardened sufficiently to allow it to be covered without affecting the finish.
- The freshly placed wet concrete shall be kept covered with plastic sheeting or wet hessian until curing begins.

6.2 Method of Placing

6.2.1 General

Concrete shall be conveyed and deposited as swiftly and as close as possible to its final point of discharge in one continuous operation without unplanned interruptions until completion of the scheduled pour as approved by SA Water's Representative.

The Contractor shall not discharge copious quantities of concrete at any one point, run or work the concrete along the forms, or employ practices which could lead to segregation.

Where necessary openings shall be provided in the forms to assist in the placing of concrete in such a manner as to prevent segregation, to avoid accumulation of hardened concrete on the forms or reinforcement, and to facilitate cleaning and inspection prior to placing, and to ensure the concrete is thoroughly worked around the reinforcement, inserts and into the corners of forms.

6.2.2 Cold Joints

Fresh concrete shall not be placed against concrete which has become unworkable to the extent that a vibrator forms holes and cannot induce the concrete to flow, or on concrete which has hardened sufficiently to form cold joints.

If this occurs the Contractor shall stop the pour and allow the concrete to set for a minimum of 24 hours and treat the face as a construction joint (see Clause 6.4).

6.2.3 Maximum Height of Drop

The concrete shall not be dropped from a height greater than 1.5 metres.

6.2.4 Layer Thickness

The concrete shall be placed in horizontal layers not exceeding 300 mm and as rapidly as possible. Each layer shall be fully compacted before addition of the next layer until the concrete reaches the full height of the pour.

6.2.5 Wall Pours

In wall pours the concrete shall be discharged to slope away at a stepped slope of not greater than 20 degrees to the horizontal and it shall be advanced at a uniform, steady rate along the wall until the scheduled pour is completed.

On a sloping wall pour (gradients of 1:3 or less) discharge shall commence from the lowest point and proceed up the slope. The Contractor shall submit details of the intended method and any machinery proposed (eg framework and screed guides) for placing and finishing the concrete.

6.2.6 Column Pours

Concrete in columns shall be placed to the full height in one continuous operation with regard to the conditions specified in Clause 6.2.3.

The bottom of the forms shall be initially filled to a depth of 25 mm with a 1:2 cement:sand mortar followed by the discharge of concrete in layers not greater than 300mm, ensuring full compaction of each layer until completion of pour. The column may be cast by first making an upstand with a construction joint at the column base, then later forming and placing the remaining concrete by the method described above.

6.2.7 Floor Pours

Placing shall be in layers not exceeding 300 mm and the pour shall be spread uniformly and continuously using the least area of fresh faces. Walking directly over steel reinforcement or fabric during the pour will not be permitted. The Contractor shall provide suitable access for the floor pour to the satisfaction of SA Water's Representative.

6.2.8 Placing Around Waterstops

Concrete shall be placed at the waterstop in accordance with TS 2.

6.2.9 Disturbance after Placing

The formwork and projecting reinforcement shall not be shaken, displaced or disturbed within 24 hours of placement and compaction of the concrete.

6.2.10 Placing in Daylight

Unless approved otherwise all concrete shall be placed in daylight.

6.2.11 Disposal of Waste

The Contractor shall dispose of excess concrete and wastes from the washing of concrete equipment in accordance with EPA requirements as approved by the SA Water's Representative.

6.3 Compaction

6.3.1 General

The Contractor shall ensure the concrete is fully compacted to the satisfaction of SA Water's Representative.

Care shall be exercised to ensure all spaces within the forms are completely filled particularly to concrete around the reinforcement and other embedded items without displacing them. The concrete at the proximity of the forms shall be given extra attention to avoid honeycombing and to remove all entrapped air or voids.

Compaction shall be carried out by internal vibration unless the situation demands otherwise, as approved by SA Water's Representative.

If requested, the Contractor shall forward details of any proposed alternate methods of compaction, other than internal vibration, at least 48 hours prior to commencement of the pour.

Contractors shall submit details on the methods and equipment proposed for placing and compaction.

6.3.2 Vibrators

Immersion type vibrators (flexible-shaft or electric motor-in-head) shall be generally used for compacting the concrete. Surface type vibrators (vibrating screeds, pans, plates, grids or roller screeds) may be used for compacting sloping walls or the final layer of floors as approved by SA Water's Representative.

Mechanically powered (petrol or diesel driven) vibrators shall be preferably used. Electrically powered vibrators may be used providing the Contractor has adequate available backup in case of power failures to the satisfaction of SA Water's Representative

Vibrators shall be inserted vertically in a regular pattern ensuring the visible zones of influence overlap and that they penetrate at least halfway through to the previous layer. Vibrators shall be held in each position until no more bubbles emerge to the surface before they are slowly withdrawn and moved to their next position. The largest size vibrator possible shall be used, taking into consideration restrictions imposed by forms, inserts, reinforcement and section thicknesses.

Internal vibrators shall have the following general characteristics:

- Diameter of head (mm) 50 - 90
- Frequency of vibration (Hz) 130 - 200
- Radius of action (mm) 180 - 360

The Contractor shall have available a pencil vibrator for compacting in situations where there is congested reinforcement.

6.4 Construction Joints

6.4.1 General

Construction joints shall be in accordance with AS 3735, except where specified otherwise in this standard.

The number of construction joints shall be kept to a minimum.

The location of all planned construction joints shall be submitted for approval. The positioning of unplanned construction joints shall be to the approval of SA Water's Representative.

6.4.2 Treatment of Construction Joint

The Contractor shall make the necessary preparations and take precautions to ensure maximum bond between the existing concrete surface (substrate) and the adjoining concrete from the next pour.

The substrate shall be thoroughly cleaned by wet abrasive grit blasting or scabbling to remove any laitance, coating, dirt or debris to a point where the coarse aggregate is exposed.

Green cutting ie the use of water and/or air jetting prior to final set of concrete may be permitted if the Contractor can provide proof of competency with the use of this method in accordance with the requirements of this standard and to the satisfaction of SA Water's Representative. Alternatively, SA Water's Representative may allow the use of an approved surface retarder in accordance with the Manufacturer's written instructions.

The reinforcement shall be cleaned of all adhering mortar, concrete, rust and dirt.

Surface preparation and cleaning operations shall be carried out at the closest opportune moment prior to the next pour. The substrate, including all vertical or near vertical surfaces, shall be kept damp in the interim period of preparation/cleaning and the next pour.

Immediately before placement of the next pour, the joint surface shall be coated with a cement/water slurry, of a water/cement ratio not greater than 0.45, followed with a 25 mm coating of a 1:2 cement:sand mortar, also of a water/cement ratio not greater than 0.45. Fresh concrete shall be poured within 15 minutes of applying the slurry and mortar coatings.

6.5 Finish

6.5.1 General

The surface finish produced shall be dense, free from honeycombing, air bubbles, cavities and blowholes in accordance with the requirements of this standard and AS 3610.

6.5.2 Formed Surfaces

The class of finish shall be as a minimum that defined in AS 3610. Unless specified otherwise, colour control is not required.

Depending on the structure, the finish of all formed surfaces shall be either Class 2 or Class 3 as shown on the Drawings. All water retaining surfaces shall have a Class 2 finish as a minimum.

The allowable deviations from correct position and misalignments of formed surfaces shall be as specified in AS 3610.

The Contractor shall rectify any areas (refer to Clause 6.7 - Repair) which have not conformed to the specified requirements on surface finish to the satisfaction of SA Water's Representative.

6.5.3 Unformed Surfaces

The concrete shall be worked to its required finish as soon as possible following placement. Working of the unformed surfaces shall be the minimum necessary to produce the desired finish.

No finishing tool shall be operated in areas where excess water has accumulated. Finishing shall be delayed until the excess water has been removed by means approved by SA Water's Representative.

The reworking or repair of the freshly completed unformed surfaces which may have been damaged, eg plastic shrinkage cracking, shall be carried out by the Contractor before the concrete has set to the satisfaction of SA Water's Representative.

The edges of the unformed surfaces shall be neatly rounded with an approved jointing tool, having a minimum radius of 5 mm, to a finish conforming to the requirements of this Standard.

Unless specified otherwise, toppings shall not be used.

The classes of finish for unformed surfaces shall be as specified or as shown on the Drawings.

The designated classes for unformed surfaces are U1, U2, U3, U4 and U5 as defined in Clauses 6.5.3.1 to 6.5.3.5.

6.5.3.1 Class U1

Finish U1 applies to surfaces where roughness is not objectionable such as those upon or against which fill material or concrete will be placed and surfaces that will otherwise be permanently concealed. It is also the first stage of all other finishes.

The finishing operations shall consist of levelling and screeding the concrete to produce an even uniform surface. Surplus concrete shall be removed immediately after compaction by striking it off with a sawing motion using a straight edge or screed across wood or metal strips which have been set as guide. Special screeds shall be used for curved surfaces.

6.5.3.2 Class U2

Finish U2 is a wood float finish and shall apply only to surfaces specified to receive this finish. This finish shall not apply to water retaining surfaces. Finish U2 is also used as the second stage of finishes U3, U4 and U5.

The surface shall be first levelled and screeded as for finish U1. Floating shall only begin when the screeded surface has stiffened sufficiently and only after all bleed water has evaporated or has been removed. For finishing larger floor areas or to eliminate any ridges and fill in any depressions left by the straight edge, floating operations by the use of bull floating or darbying may be employed.

A U2 finish shall be a surface uniform in texture and free from screed marks.

6.5.3.3 Class U3

Finish U3 is a steel trowelled finish and shall apply only to surfaces specified for this finish. It includes all flat traffic surfaces, all surfaces which are periodically wetted but not used as walkways, such as the tops of tank walls, valve chambers, foundations, stair wells, exposed floors of water retaining structures, and all expansion and contraction joint seatings.

The preliminary operations as specified for finish U2 shall be carried out and any necessary cutting with edging or jointing tools and any filling shall be done during floating.

Steel trowelling shall begin immediately after floating. It shall be performed with a firm pressure that will flatten and smooth the sandy texture of the previously floated surface, and shall produce a dense, uniform surface free from blemishes and trowel marks.

6.5.3.4 Class U4

Finish U4 is a hard and smooth steel trowelled finish produced by the successive trowelling of a U3 finish. Powered steel trowels (helicopters) may be used in lieu of hand trowels where appropriate.

A U4 finish shall be used where specified and on uncovered slabs in control rooms, switchboard rooms, chlorination stations and where appearance and cleanliness are of paramount importance and where added resistance to wear is required.

6.5.3.5 Class U5

Finish U5 is a 'broomed' steel trowelled finish used on surfaces where specified and on all walkways and slabs that will be walked on regularly during subsequent operation and will be periodically wetted by rain and/or wash-down water. Such surfaces include walkways, external cover slabs on tanks at water filtration work, and wet well floors in water and sewage pumping stations.

The surface shall be first worked to a U3 finish and it shall be broom finished at an appropriate stage when the concrete has hardened to a state where a broom finish can be applied without 'tearing' the surface and one which matches the finish of the reference sample slab (see Clause 6.5.3.6).

Brooming shall be in one direction only and it shall be carried out using a medium stiff long handled broom and by applying the necessary pressure to produce the desired non-slip finish.

6.5.3.6 Reference Sample Slabs

At the request of SA Water's Representative, the Contractor shall cast on site a sample slab of approximately 1.0 x 0.5 metres as a reference for any one or more of the specified surface finishes.

The surface finish of the approved sample slabs will be used by SA Water's Representative as a reference for acceptance of finished work.

6.5.3.7 Non-slip Aggregates

When stairways, ramps, landings and any other surfaces are specified to retain high non-slip textures under traffic the non-slip surfaces shall be attained by the addition of approved non-slip aggregate evenly applied to the surface at the rate of 1 kg/m³.

The non-slip aggregate shall be sprinkled evenly over the surface during final trowelling and shall be worked into the surface and trowelled over to achieve the required finish.

6.5.3.8 Tolerances and Irregularities

For unformed concrete surfaces the maximum allowable tolerances from the true line and the maximum allowable surface irregularities shall be as follows:

Table 6. 1 – Limits in Millimetres for each Class

Class of Finish	U1	U2	U3	U4	U5
Maximum allowable tolerance from the true line	+20 -0	+6 -6	+6 -3	+6 -3	+6 -3
Maximum allowable surface irregularity - all surfaces	12	6	6	3	6

The maximum allowable irregularities of surface shall be measured with a 3 meter long template consisting of a straight edge for plane surfaces or its equivalent for curved surfaces.

The tolerances and irregularities shall apply to all work except that finished surfaces graded for drainage shall not retain pools of surface water. Slabs where the grading is shown must be free to drain irrespective of tolerances.

6.6 Stripping

Unless specified otherwise no form shall be disturbed until the compressive strength of the concrete has attained at least 4.5 MPa. It includes any bolts and fastening devices. Column forms shall not be disturbed until 11.0MPa has been attained. The Contractor may be required to cast concrete test cylinders, cured under insitu conditions, for proof of adequate strength.

The time determined by the Contractor for removal of forms shall be subject to the approval of SA Water's Representative. No metal tools shall be used in contact with the concrete.

The Contractor shall exercise extreme care to avoid any damage during stripping operations. Damage sustained to any part of the structure or member shall be repaired or replaced at the Contractor's expense to the satisfaction of SA Water's Representative. Repair shall be within 7 days of the damage occurring (see Clause 6.7).

6.7 Repair

6.7.1 General

The Contractor shall make good any imperfections to the concrete surfaces and remove any protrusions or excess concrete to the finish requirements specified in Clause 6.5 as directed by SA Water's Representative. Imperfections include honeycombing, blowholes, air pockets, bleed marks and concrete in which the surfaces have been excessively stripped during removal of forms.

Damaged or defective concrete (poorly compacted and high voids concrete) shall be removed and reinstated with a suitable repair material to the required profile. Also, concrete having excessive surface depressions shall be built up to the prescribed lines.

All proposed repair methods and materials are to be submitted to SA Water's Representative for approval.

All repairs shall be completed within 7 days of removal of forms or 7 days from the time of casting with respect to unformed surfaces.

6.7.2 Preparation

The surface area to be repaired shall be thoroughly cleaned and all laitance removed by scabbling or wet grit blasting until achievement of a rough texture and a partially exposed aggregate condition.

All protrusions and excess concrete shall be reduced to within the specified limits by grinding.

Removal of damaged or defective concrete shall be by scabbling, chiselling or jack-hammering.

For repairs using cementitious materials, the substrate shall be dampened and prior to applying the repair material coated with a cement slurry.

All repairs shall be carried out in accordance with Clause 6.8.

6.7.3 Repair Material

The repair material shall comprise of one of the following:

- sand/cement dry-pack mortar
- filling concrete
- prepacked formulations (cementitious or polymer/cement type)
- proprietary epoxy mortars

The material selected shall be adapted to suit the situation as determined by SA Water's Representative and agreed with the Contractor. For smaller and shallow depth repairs, mortars are more suitable, whilst larger gaps and voids are better served by filling with concrete. Bagged, proprietary cementitious or polymer/cement type mortars and concretes having low shrinkage characteristics may be used in both situations. Epoxy mortars shall only be used in situations approved by SA Water's Representative.

The sand/cement mortar shall be proportioned by weight or volume to 2½ parts of sand and 1 part of cement. The sand shall be a washed concrete sand passing the 2.36 mm sieve and the cement shall be general purpose Type GP or Type GB.

The filling concrete shall be concrete in accordance with this Standard.

Where approved for use, the prepacked formulations and epoxy mortars shall be used in accordance with the Manufacturer's written instructions. This also refers to any bonding agent included in the repair system. The use of cement slurries as a bonding aid (as specified in Clause 6.7.2 - Preparation) shall be waived where special bonding agents comprise part of the repair kit.

6.7.4 Treatment of Cracks

The Contractor shall treat all cracks at the Contractor's expense as directed by SA Water's Representative by the method described as follows:

- (a) Cracks of width less than 0.1 mm may be required to be sealed with an approved low viscosity (capillary) epoxy at the discretion of SA Water's Representative.
- (b) Cracks (including those which have developed along construction joints) of width between 0.1 and 1.0 mm shall be sealed using an approved low viscosity epoxy.
- (c) Cracks in walls (including sloping), columns or any other vertical structural members of the same width as in (a) and (b) shall be sealed with a low viscosity epoxy by a suitable injection method. Introduction of material into the crack shall be by a pressure or balloon type injection method to the Manufacturer's instructions.
- (d) Cracks of width greater than 1.0 mm shall be sealed by a method approved of by the SA Water's Representative.

Low viscosity epoxies shall be used in accordance with the Manufacturer's written instructions and allowance made for the time to complete full cure.

Where a low viscosity epoxy is used, the surface of the concrete in the vicinity of the construction joints and cracks shall be wire brushed, dried and all dust removed by air blasting or other approved methods before application of the epoxy.

6.8 Curing

6.8.1 General

The Contractor shall commence curing immediately after the concrete has attained final set (as defined in AS 1012 Part 18).

Water curing for a minimum period of 7 days shall be used for all liquid retaining surfaces except in situations where water curing is not possible and SA Water's Representative allows the application of an approved membrane curing compound. Water from the curing operation shall be disposed of in a manner that will not cause any damage and hindrance to the work completed or in progress and to the satisfaction of the EPA and SA Water's Representative.

The use of membrane curing compounds in accordance with AS 3799 is optional to water curing for non-liquid retaining surfaces.

All concrete, regardless of cement type used, shall have a minimum curing period of 7 days.

Contractors shall provide full details of the equipment, procedures and timing of their proposals for curing.

6.8.2 Water Curing Methods

All surfaces shall be kept damp throughout the water curing cycle by means and methods approved by SA Water's Representative.

Horizontal surfaces such as floors may be saturated with soaker hoses and covered with plastic for the duration of curing, or they may be kept damp by a layer of wet sand kept damp by frequent hosing with water.

The plastic shall be adequately weighed down during curing.

Vertical faces eg walls shall have soaker hoses placed on top for their full length and turned on once the forms have been 'cracked', normally 24 hours after the pour (see Clause 6.6), and allowed to run down inside the formwork. Immediately after stripping of formwork they shall be covered with soaked hessian or burlap and a plastic sheeting overlay.

The concrete shall not be allowed to dry at any stage during the curing cycle.

6.9 Protection

The Contractor shall protect the concrete from damage during the period between placement and final acceptance of the work. This includes protection from rain, flowing water, mechanical damage, high winds and direct sunlight on hot days. SA Water's Representative may request the provision of adequate covers to protect the concrete from adverse weather conditions (see Clause 6.1.5).

Any damage to the work caused by failure of the Contractor to provide adequate protection shall be rectified to the satisfaction of SA Water's Representative.

Masonry anchors or other fasteners shall not be used on any surface except where specified.

Care shall be taken to prevent contamination from oils, coatings, drainage water and other harmful foreign matter.

6.10 Formwork

6.10.1 General

Formwork shall be in accordance with AS 3610 unless specified otherwise.

Design and construction of formwork shall be such as to achieve the class of finish specified in Clause 6.5.2 and details shall be forwarded to SA Water's Representative at least 5 working days before installation.

Installation and fixing of forms shall be such as to produce a finished concrete having the shapes, levels and dimensions shown on the Contract Drawings and that their subsequent removal will not result in damage to the concrete. All forms shall be sealed, by means of suitable taping or sealing compounds, to prevent the leakage of water or mortar to the satisfaction of SA Water's Representative.

Upon request from SA Water's Representative, Contractors shall submit details of their proposed formwork systems.

6.10.2 Form Ties

Form ties shall consist of bolts, rods or other fastening systems that will ensure that forms or falsework are rigidly fixed to the satisfaction of SA Water's Representative. They shall be designed so that the centre section of the fastening device is left embedded in the concrete after removal of the formwork, that no metal is within 35 mm of the surface and that no plastic sleeves remain embedded in the concrete.

Form ties which leave a hole after removal extending throughout the thickness of a concrete section will not be permitted.

Holes or gaps left from form ties (eg she-bolt cones) shall be filled with an approved repair mortar (see Clause 6.7).

Top form ties shall not be located within 150 mm of the top of the pour.

Wire or snap ties shall not be permitted.

6.10.3 Release Agents and Form Oils

No chemical form release agent shall be used.

Uncontaminated dieseline shall be applied by brush or spray to coat the forms for release purposes. Excessive applications shall be avoided.

The dieseline shall not make contact with joint surfaces, reinforcing bars, PVC, rubber, neoprene, polystyrene, cork or other materials on which it may have a detrimental effect.

6.10.4 Height of Forms

Formed sections shall be limited to the height that concrete can be placed and compacted in accordance with this Standard.

6.10.5 Keyway Forms

Forms for keyways in foundations or other locations shall be constructed and rigidly fixed before commencement of the pour. They shall be also designed for easy removal.

6.10.6 Holes/Gaps

Forms for holes or special gaps shall be designed and constructed so that they can be easily removed without damage to the surrounding concrete.

6.10.7 Corners and Edges

To facilitate the desired formation of 18 – 25 mm fillets or chamfers at internal/ external corners or edges of the finished concrete, approved mouldings shall be wedged in the angles or on tops of forms.

6.10.8 Exposed Construction Joints

At exposed construction joints where a smooth surface is required, forms shall not lap over hardened concrete by more than 25 mm and the forms shall be pulled or braced and sealed onto the hardened concrete to prevent any loss of mortar or concrete.

SECTION 7: STEEL REINFORCEMENT

7.1 General

Reinforcement shall be deformed bars or welded wire fabric except that plain bars or wire may be used for fitments. All reinforcement shall comply with AS 4671, as appropriate.

The Contractor may be required to provide test and or mill certificates for all reinforcing steel at least 7 days before intended use.

Materials, cutting, bending, splicing, welding and fixing of steel reinforcement shall be to AS 3600 and to the approval of SA Water's Representative.

7.2 Condition of Reinforcement

Reinforcement shall be free from loose mill scale, excessive rust, dirt, coatings, pitting, kinks and other defects prior to concrete placement.

7.3 Cutting and Bending

Reinforcement shall be cut and bent to comply with the dimensions shown on the Drawings.

Bends for ties, stirrups, ligatures or other fitments shall be to AS 3600 unless shown otherwise in the Drawings.

7.4 Placing and Fixing

Reinforcement shall be placed and fixed in position as shown on the Drawings by fastening with annealed iron wire of 1.6 mm minimum diameter to ensure the bars are held rigidly during placing of concrete.

Welding as a means of fixing reinforcement will not be allowed except in special circumstances and under conditions approved by SA Water's Representative. Any bar undercut below its nominal cross-sectional area, notched or damaged by welding shall be replaced at the expense of the Contractor.

7.6 Welded Joints

All welded joints shall be in accordance with AS/NZS 1554 Part 3 and in positions shown in the Drawing or as approved by SA Water's Representative.

Butt welds shall be made with the bars in a horizontal position and all welded splices shall be staggered unless directed otherwise.

The butt welding shall be performed using approved low hydrogen electrodes and special copper moulds for the reinforcing bars concerned. The moulds shall be made from 10 mm rolled copper section by annealing and then cold pressing. Details of a suitable mould will be available from SA Water's Representative.

Welding materials and procedures shall be approved and operators shall carry out qualification tests under site conditions prior to commencement of any welding.

Welding arcs shall not be struck on any reinforcing bar except at the point of welding.

All welds shall be subject to a visual assessment for quality by SA Water's Representative. In addition the Contractor shall carry out tests on any welded joint as directed by SA Water's Representative (see Clause 10.3.12).

SECTION 8: INSERTS AND SUPPORTS

8.1 General

Inserts and supports shall be in accordance with AS 3600 and as specified in this standard and to the satisfaction of SA Water's Representative.

They shall be accurately built into the concrete by the Contractor, within 4 mm of their indicated position unless shown otherwise on the Drawings. The provision of holes or pockets and the subsequent grouting of inserts and supports will not be allowed unless approved in writing by SA Water's Representative.

Tapped holes and other recesses shall be sealed and the sealing material later removed. After stripping of formwork all concrete and other materials shall be cleaned from the surfaces of inserts and supports.

8.2 Embedment of Inserts

The Contractor shall install, fix and cast in all pipes, pipe sleeves, bolts, conduits, frames, castings, steel beams and other items which are required to be wholly or partially embedded in the concrete as shown on the Drawings.

Before casting of inserts and openings, the Contractor shall check their positioning, alignment and elevation to ensure they are accurately placed and adequately supported in suitable templates, frames and forms. Any misplacement or deviation from the specified tolerance shall be corrected by the

Contractor at the Contractor's expense to the satisfaction of SA Water's Representative.

The Contractor shall ensure adequate compaction of the concrete around the inserts and openings as specified in Clause 6.3.

8.3 Supports

The Contractor shall check the positioning of supports for floor plates, floor gratings, or other fixtures requiring even and uniform bearing, before setting the supports with concrete or mortar. Failure to obtain satisfactory uniformity of bearing shall be rectified by the Contractor, as directed by SA Water's Representative, at the Contractor's expense.

SECTION 9: QUALITY ASSURANCE

9.1 General

The following requirements are in addition to those contained in the Contract Specification.

The Contractor shall plan, establish and maintain a quality system for the project which conforms to this standard and complies, as a minimum, with all the relevant system elements of AS/NZS ISO 9001 and includes quality records, hold points, witness points and work instructions.

Quality management systems and quality plans offered by the Contractor and/or SubContractors shall be used as an aid to achieving conformance with this Standard, but they shall not relieve the Contractor of the responsibility to comply with the Contract requirements.

A copy of the quality plan shall be submitted to SA Water's Representative for approval prior to commencement of works.

The Schedule of Quality Functions shall be completed.

9.2 Certification

The Contractor shall have a third party certified quality assurance system. Consideration will be given to Contractors not covered by such schemes after SA Water's Representative has carried out an audit of the proposed quality system. The cost incurred in undertaking such an audit will be assessed before a fixed price is set.

9.3 Quality Audits

The Contractor shall be responsible for scheduling and undertaking quality assurance audits during the Contract as directed and in the presence of SA Water's Representative.

The Contractor shall provide SA Water's Representative at all times with access to the Contractor's quality procedures and records to enable monitoring and quality auditing. This also includes the taking of random samples for proof testing or to carry out or to arrange for destructive or non-destructive testing.

Auditing and proof testing by SA Water's Representative shall in no way relieve the Contractor of any of the obligations under this standard.

SECTION 10: INSPECTION AND TESTING

10.1 General

The Contractor shall be responsible for all testing, as specified, to prove compliance with the requirements of this standard. This includes any inspections, checks, calibrations or self-audits as required by this Standard. The Contractor may choose an independent laboratory to conduct the tests or the services of the concrete supplier's laboratory.

The Contractor shall nominate the testing authority.

Testing shall be conducted by a NATA registered laboratory. All relevant test certificates shall be submitted to SA Water's Representative immediately they become available.

Irrespective of the testing carried out by the Contractor, SA Water's Representative reserves the right to carry out independent inspections and audit testing. These costs shall be borne by the Principal, except in the case of failure and subsequent re-tests to validate conformity, they shall be at the Contractor's expense.

Whether the independent inspections are random or full time shall be left to the discretion of SA Water's Representative.

10.2 Additional Testing and Re-Tests

SA Water's Representative may direct the Contractor to carry out additional testing (increase in the frequency of testing) to that specified. The cost of additional testing will be at the Principal's expense, but where failure to comply with the specified requirements has been identified, they shall be borne by the Contractor.

The cost of re-testing of work which has failed and been subsequently rectified as a result of additional testing shall be borne by the Contractor.

10.3 Testing Requirements

10.3.1 General

All test results shall be recorded and the relevant NATA endorsed certificates submitted as appropriate.

The Contractor shall assess the results and immediately notify SA Water's Representative in writing of non-compliances.

10.3.2 Sampling of Concrete

The Contractor shall sample the concrete in accordance with AS 1012.1.

Sampling shall be done only by competent personnel, ie a representative from a NATA endorsed laboratory or a person qualified to a minimum of Level One Certification gained from the Construction Materials Tester Certification Scheme conducted by NATA.

10.3.3 Slump

Slump testing shall be done on delivery to the site of every batch of concrete in accordance with AS 1012.3. Where a superplasticiser is used the slump shall be tested before and after addition of the admixture, and both shall be recorded on the test certificate.

SA Water's Representative may direct the Contractor to carry out slump testing at the manufacturing plant in addition to site testing to ensure compliance within the slump limits specified. It applies particularly to concrete likely to suffer excessive slump losses due to long hauls (refer to Clause 5.5 - Delivery).

10.3.4 Density

The wet density of the freshly mixed concrete shall be determined in accordance with AS 1012.5 at the start of the Contract and then at every 500 m³ of concrete batched.

The dry density of the hardened concrete shall be determined in accordance with AS 1012.12 on each cylinder taken for compressive strength testing.

10.3.5 Compressive Strength

The concrete test cylinders shall be cast and cured in accordance with AS 1012.8 and then tested to AS 1012.9 for compressive strength.

The minimum rate of sampling shall be one sample per 25 m³ of production concrete and one sample per day if the daily pour is less than 25 m³.

The concrete shall be subject to **project assessment** in accordance with AS 1379, except where modified in this Standard.

Where supply of concrete is from an off site premix plant the concrete shall be subject to production assessment in addition to project assessment. The Contractor shall submit to SA Water's Representative monthly reports of the analysed data as specified in AS 1379 (refer to Clause 5.2.2 - Plant Records). The Contractor may incorporate the 28-day strength results taken for project assessment in collating production assessment data.

10.3.6 Drying Shrinkage

Drying shrinkage testing of the concrete shall be carried out in accordance with AS 1012.13 and in addition the specimens cast in the field shall be wrapped in wet hessian and covered with a plastic sheet.

The frequency of testing shall be one sample per 100 m³ (or part thereof).

10.3.7 Water Analysis

The proposed mix water other than from a stable reticulated supply (mains water) shall be fully analysed to qualify for use in the Contract. The analysis shall include all anions, cations, pH, total dissolved salts, calcium hardness and conductivity (EC units) for assessment by SA Water's Representative.

Subsequent testing may be required as directed by SA Water's Representative.

Mains water shall be tested for conductivity as directed by SA Water's Representative.

10.3.8 Testing for Chlorides

The hardened concrete and the solid ingredients comprising the wet concrete mix shall be tested for chloride concentrations in accordance with AS 1012.20. The liquid ingredients shall be tested as per method described in AS 1379.

Only the chloride content present in the hardened concrete shall be used to ascertain the criterion for compliance. Samples for chloride analysis, of not less than 50 g, shall be taken from drilled shavings from the 28 day compressive cylinder representative of the pour or, if directed by SA Water's Representative, of the insitu cast concrete. However, the Contractor is advised to check the chloride levels of all the individual ingredients comprising the mix to avoid possible rejection later.

Chloride testing shall be carried out for the laboratory trial mix, at the start of the Contract and then at every 500 m³ of concrete batched and at the discretion of SA Water's Representative.

10.3.9 Apparent Volume of Permeable Voids

Testing shall be carried out by cutting 4 sliced specimens from a compressive strength cast cylinder in accordance with AS 1012.21. The average of the 4 readings shall be used as the final result.

A test shall be performed on each laboratory and field trial mix and then one for every 100 m³ (or part thereof) of production concrete.

10.3.10 Core Testing

Core specimens shall be secured and tested for compressive strength in accordance with AS 1012.14 in situations where the tested concrete is below the

critical strength required for structural adequacy as determined by SA Water's Representative (refer to Clause 10.5 - Rejection).

The cost of securing and testing of such cores shall be at the expense of the Contractor.

The repair of the holes left from coring shall be as specified in Clause 6.7 at the Contractor's expense.

SA Water's Representative reserves the right to secure and test cores for strength, density and voidage where the quality of the concrete is suspect or full compaction (eg compaction of sloping walls) has not been achieved. The cost of such tests will be borne by the Principal, including subsequent repairs. Should the concrete fail to comply with the requirements of this Standard, then the cost shall be borne by the Contractor.

10.3.11 Moisture Content of Aggregates

The Contractor shall determine the moisture contents of the fine and coarse aggregate as specified in Clause 5.2.3.

10.3.12 Absorption of Water by Aggregates

The Contractor shall determine the absorption values of the fine and coarse aggregate as specified in Clause 5.2.3.

10.3.13 Testing of Reinforcement Weld Joints

The Contractor shall test to failure the tensile strength of the welded butt joints in the reinforcement. Each test specimen shall be a 500 mm length of bar cut from the welded reinforcement, with the weld centrally located.

The minimum number of tests shall be one specimen per 50 welded joints and as directed by SA Water's Representative.

After taking the test specimen the Contractor shall replace and re-weld the reinforcement.

10.3.14 Calibrations

The Contractor shall carry out calibration tests on batch plant equipment as specified in Clause 5.2.1.

10.3.15 Materials

The Contractor shall test all materials where proof of compliance is required to be established under this Contract and in accordance with this Standard.

10.4 Compliance Criteria

10.4.1 General

The concrete shall be deemed to comply if it meets all the performance requirements specified and satisfies the conditions stipulated in Clauses 10.4.2, 10.4.3 and 10.4.4.

Concrete failing to comply with the performance requirements of this standard may be subject to an adjustment in the mix (see Clause 4.5) and/or liable to rejection (see Clause 10.5) as determined by SA Water's Representative.

10.4.2 Slump

The initial slump shall be within the range of 20 - 60 mm. Concrete outside the range shall be liable to rejection (see Clause 10.5)

The Contractor shall target the lower end of the slump range at the batch Plant to ensure the maximum specified water/cement ratio is not exceeded. On arrival at site the initial slump shall be measured and the dosage rate of superplasticiser determined to produce a concrete of consistency that does not exceed the upper limit.

The final slump, after addition of superplasticiser, shall be of a consistency that the concrete is easily worked and compacted and having a set time which enables the concrete surface to be finished within the Contractor's scheduled working day.

The upper limit for the superplasticised concrete shall be 150 mm.

Concrete shall not be placed until both initial and final slumps have been verified as having complied with the specified requirements. The initial discharged concrete may be used for placement once the slump has been verified.

10.4.3 Drying Shrinkage

The 28-day drying shrinkage of the production concrete shall not exceed 420 microstrains.

Concrete failing to comply with the shrinkage requirement, representative of the tests, may be liable to rejection. Any subsequent manufactured concrete shall be subject to a mix adjustment.

10.4.4 Compressive Strength

The minimum strength of any one sample shall not be less than 40MPa. Concrete, representative of the test, failing to attain the minimum strength shall be liable to rejection.

The concrete shall be deemed to have complied with the strength requirements of this standard if the 28-day mean strength, represented by a group of samples

taken during a production interval, attains the **benchmark** set by SA Water's Representative as determined below (see Clause 10.4.4.1).

The group of samples, mentioned above, specifically refers to the moving average of the last 15 samples at any stage of assessment chosen by SA Water's Representative (but usually on a monthly basis depending on the number of samples tested).

For smaller projects, the group of samples may consist of all samples in the project and the 28-day mean strength may not be assessed until the project is complete (ie: if all concrete is poured in less than 35 days).

10.4.4.1 *Quality Control Benchmark*

The mean strength shall not be less than:

$$Q + k_c \cdot s$$

Where:

- Q is the required quality control strength
- k_c is the appropriate coefficient (relative to the number of project samples) given in AS 1379.
- s is the standard deviation calculated from a group of project samples.

If at the start of a project an assessment is required and less than 15 samples have been taken, the standard deviation shall be determined from the total number of samples taken to date but shall not be less than 4.0MPa.

The **required quality control strength** shall be calculated from the approved laboratory trial mix(es) 28-day compressive strength results (see Clause 4.2) using the following formula:

$$Q = (\text{the approved laboratory 28-day strength minus } 10.0) \text{ MPa}$$

10.4.4.2 *Coefficient of Variation*

To satisfy the **quality control** provisions of this Standard, the concrete shall be maintained at a **coefficient of variation** of less than 8.0% throughout the production interval, calculated by use of the following formula:

$$\text{coefficient of variation (\%)} = \frac{\text{standard deviation}}{\text{mean compressive strength}} \times 100$$

Concrete failing to comply with this requirement shall be fully investigated and rectified by the Contractor to the approval of SA Water's Representative.

10.4.5 Reinforcement Welded Joint Strength

The test specimens shall attain a minimum ultimate tensile strength of 500 MPa in accordance with AS 4671.

Failure to comply may involve stoppage time and additional testing at the Contractor's expense while SA Water's Representative examines the remainder of the welds.

10.5 Rejection

10.5.1 Wet Concrete

The fresh concrete, representative of the test, shall be liable to rejection if the:

- initial slump is outside the specified range of 50+10,-30 mm
- maximum specified water/cement ratio is exceeded
- concrete temperature is greater than 32°C

Concrete in which the initial slump is outside the specified range shall be retested. After retesting, concrete which is still outside the range set by 10 mm or more shall be rejected.

The slump shall be measured at two intervals, the initial slump at first arrival on site and the final slump after addition of superplasticiser.

Concrete in which the final slump exceeds 150 mm shall be liable to rejection.

10.5.2 Hardened Concrete

Hardened concrete shall be liable to rejection of some or all the concrete representative of the test, if the:

- 28-day compressive strength of any sample is less than 40MPa
- maximum specified shrinkage is exceeded
- permissible chloride level is exceeded
- apparent volume of permeable voids is exceeded

Where shrinkage and chloride levels are excess to specified requirements, SA Water's Representative will assess the degree of failure and its impact on the integrity of the concrete before informing the Contractor in writing regarding the rejection of any concrete.

With under-strength concrete, SA Water's Representative will determine through an examination of the design calculations whether the structural adequacy is impaired by concrete not achieving the critical strength.

The Contractor shall be required to take and test cores (see Clause 10.3.9) where concrete has failed to achieve the minimum specified strength of 40 MPa. The results of the core tests will be used by SA Water's Representative to verify the laboratory test data and for assessing the structural adequacy of the concrete representative of the tests. The Contractor will be informed in writing regarding the rejection of any concrete.

SECTION 11: STORAGE AND HANDLING OF CHEMICALS

All chemicals shall be stored, handled and used in accordance with the Manufacturer's instructions and the Occupational Health Safety and Welfare Act, 1986.

Only chemicals approved for the Contract by SA Water's Representative shall be stored on site. They shall be stored and handled in their original containers and in accordance with the Manufacturer's written instructions. They shall not be poured or stored in unmarked containers or allowed to be used if past the 'by use' date as indicated by the Manufacturer.

APPENDIX A: SCHEDULE OF TECHNICAL DATA TO BE PROVIDED BY THE CONTRACTOR.

ITEM	DESCRIPTION	REQUIREMENT	
1.	CONCRETE Strength Grade Shrinkage Slump	Clause 2.2 Clause 2.2 Clause 2.2	
2.	PUMPED CONCRETE Pumping proposed? Yes/No Details of Pump/Equipment	Clause 2.4 Clause 2.4	
3.	CEMENT Brand/Type proposed	Clause 3.1	
4.	WATER Source Conductivity	Clause 3.2	
5.	AGGREGATE Source of coarse aggregate Source of fine aggregate	Clause 3.3 Clause 3.3	
6.	ADMIXTURES Type Dosage rates	Clause 3.4 Clause 3.4	
7.	CHLORIDES Levels of ingredients Total level	Clause 3.5 Clause 3.5	
8.	BATCH PLANT AND MIXERS Details of the Plant Storage of aggregates	Clause 5.1 Clause 5.4	
9.	TRANSPORTATION Distance from site Minimum travelling time Maximum travelling time	Clause 5.5	

ITEM	DESCRIPTION	REQUIREMENT	OFFER
10.	PLACEMENT Method of cooling wet concrete Precautions for adverse conditions Method of placing concrete	Clause 6.1 Clause 6.1.3 Clause 6.1.4 Clause 6.2	
11.	COMPACTION Details of vibrators a) number b) size c) power source	Clause 6.3	
12.	CONSTRUCTION JOINTS a) Location b) Preparation c) Equipment to be used	Clause 6.4	
13.	CURING Proposed curing methods Manpower and equipment used Provision for after hours curing	Clause 6.8	
14.	FORMWORK Proposed formwork Form lining Form ties Form oil Methods of discharge in forms Formwork fabrication	Clause 6.10	
15.	REINFORCEMENT Source and Manufacturer Steel fixer Supports and spacers proposed	Clause 7.	
16.	INSPECTION AND TESTING Testing Authority (NATA) Sampling (Certificated)	Clause 10.1 Clause 10.3.2	

APPENDIX B: SCHEDULE OF QUALITY FUNCTIONS

SCHEDULE OF QUALITY FUNCTIONS

1. Contractors Registered Under the Supplier Assessment Scheme

- (1) Certificate No.
- (2) Item/Process to which Certificate refers:

- (3) Capability covered by the registration:

2. Contractors Not Registered Under the Supplier Assessment Scheme

- (1) Does the Contractor have a person responsible for quality functions? YES/NO
 If 'yes'
- (a) Name of Representative:
- (b) Anticipated percentage of his/her time to be spent on this contract: %
- (2) Does the Contractor have a documented Quality Plan? YES/NO
- (3) Does the Contractor have a Quality Procedure Manual relevant to this Technical Standard?
 YES/NO
- (4) Can the Contractor implement an adequate quality system appropriate to this Technical Standard? YES/NO
- (5) Is the Contractor's overall quality system based on the format of AS/NZS ISO 9001 and on the standards relevant to the work under this contract?
 YES/NO
- (6) Does the model for quality system comply with AS/NZS ISO 9001? 1 / 2 / 3

3. Details of Any Quality Assessments Carried Out By Other Clients

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.....
.....
.....

Note: All questions shall be answered.

.....
Contractor's Signature Date

APPENDIX C: PROFORMA SHEET CONCRETE PRODUCTION

PROFORMA SHEET CONCRETE PRODUCTION

PROJECT..... DATE: / /20

AGGREGATE CONDITION

AGGREGATE	MOISTURE CONTENT %	ABSORPTION %	CORRECTED DIFFERENCE
20 mm			
10 mm			
Sand			

BATCH WEIGHTS

SSD WEIGHTS	1 m ³	5 m ³	ACTUAL WEIGHTS	CUMULATIVE WEIGHTS	CORRECTED MIX WATER
Cement					
20 mm					
10 mm					
Sand					
Water					
Admixture					

CONCRETE POUR

Truck No.									
Sample No.	1	2	3	4	5	6	7	8	9
Time Batched									
Left Plant									
Time Arrived									
Progressive Total									
Slump (mm)									
Slump After S/P									
Total Water Added									
Effective Water									
W/C Ratio									
Superplasticiser Dosage									

.....
Contractor's Signature

.....
Date