



Ergon Energy Corporation Limited

Specification for Concrete Work

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1. Purpose and Scope

This specification covers the manufacture, placing and curing of reinforced and unreinforced concrete and shall be read in conjunction with the Contract Specification and Australian Standard AS 3600 - "Concrete Structures".

The Contractor shall carry out the design of concrete mixes, setting out and quality control of the workmanship and materials for all specified concrete work. He shall supply, deliver and place all reinforcing steel, formwork and concrete necessary to complete the concrete works shown on the Drawings.

2. References

2.1 Ergon Energy controlled documents

Nil

2.2 Other sources

AS 3600 – Concrete Structures

AS 3972 – General purpose and blended cements

AS 2758.1 – Aggregates and rock for engineering purposes – Concrete aggregates

AS 1141 – Method for sampling and testing aggregates

AS 1379 – Specification and supply of concrete

AS 3582 – Supplementary cementitious materials for use with portland and blended cement

AS 3583 – Methods of test for supplementary cementitious materials for use with Portland and blended cement

AS 1478 – Chemical admixtures for concrete, mortar and grout

AS/NZS 4671 – Steel reinforcing materials

AS 3610 – Formwork for concrete

AS 1554 – Structural steel welding

3. Definitions, Acronyms, and Abbreviations

3.1 Definitions

For the purposes of this standard, the following definitions apply.

3.1.1 Contractor: The Contractor, sub-contractor/s, agent/s, and includes all their staff undertaking work to this Standard. Absence shall be constructor.

3.1.2 Superintendent: Nominated administrator of the contract. In absence of a contract it shall be a Project Manager.

3.2 Acronyms and Abbreviations

The following acronyms appear in this standard:

AS Australian Standard

AS/NZS Australian/New Zealand Standard

4. Security

Nil

5. Safety, Environmental and Ergonomic Considerations

As per Ergon Energy's Safety, Environmental & Ergonomic Policies.

6. Materials

6.1 Cement

The cement used shall be Type 'GP' or 'GB' for normal use, or, Type 'SR' Sulphate Resisting Cement where the Superintendent so specifies, and shall comply with AS 3972.

6.2 Aggregates

Aggregates shall comply with AS 2758.1 and AS 1141.

Six weeks in advance of the date when concreting operations are due to commence, the Contractor shall advise the Superintendent, the names of the pits, quarries, or manufacturing plants from which he proposes to obtain aggregates, and submit evidence showing that the material complies with the requirements of AS 2758.1 and AS 1141.

Lightweight or metallurgical furnace slag aggregates shall not be used.

6.3 Water

Water shall be clean, free from oil and injurious amounts of acid, alkali and organic matter and other deleterious substances and shall be fit for human consumption.

If required by the Superintendent, the Contractor shall provide, at the Contractor's expense, an analysis of the water to ensure compliance with the requirements of AS 1379.

6.4 Fly Ash and Admixtures

Fly ash or other supplementary cementitious materials approved by the Superintendent shall be supplied and used in accordance with AS 3582 and AS 3583.

Chemical admixtures may be used only if approved by the Superintendent.

Where the use of admixtures is approved by the Superintendent, the admixtures shall comply with AS 1478 - "Chemical Admixtures for Concrete" and shall be used in accordance with the Manufacturer's instructions and AS 1379.

Calcium chloride or any admixture containing calcium chloride shall not be used.

6.5 Reinforcement

Reinforcement shall comply with the following specifications where applicable.
AS/NZS 4671 Steel Reinforcing Materials.

7. Storage of Materials

All cement shall be stored in silos or suitable weatherproof buildings so as to protect the cement from dampness and other causes of injury. Cement in bags shall be arranged in orderly stacks so that it can be easily inspected and shall be used in order of delivery.

All cement used must be thoroughly dry and free from lumps, caking and watermarks. The handling and storage of concrete aggregates shall be such as to prevent segregation and the inclusion of foreign materials. The aggregates shall be stored sufficiently far apart to prevent materials becoming intermixed or aggregates shall be contained by adequate divisional walls.

Aggregates shall be stored on site for at least 24 hours before use, to permit the draining away of any excess moisture in the aggregates. Proprietary grouts, mortars and resins shall be stored so as to ensure that the grouts, mortars or resins are kept dry and free from contamination and such that they do not deteriorate due to excessive heat.

The Contractor shall ensure that grouts, mortars and resins are stored in accordance with manufacturer's recommendations and if requested to do so by the Superintendent, the Contractor shall at his cost, provide evidence of the date of manufacture and the date of expiry of the useful life of any proprietary grouts, mortars or resins proposed for use.

Reinforcing steel shall be kept free from loose mill scale and rust and contamination from oil, grease, dirt and other deleterious materials, saltwater or spray. Reinforcing steel shall be stored so as to prevent rust staining of formwork, concrete and other materials.

Any material that has deteriorated or become damaged shall not be used for construction purposes.

8. Concrete Mixes

Concrete mixes shall be proportioned to produce the strength, durability and workability required by the specification. The Contractor shall submit his proposed mix designs to the Superintendent for approval at least six weeks before concreting work is due to commence. The Superintendent may direct the Contractor to undertake trial mixes and strength, durability and workability tests to prove that the proposed mixes meet the Specification. Such trial mixes and tests shall be carried out prior to placement of concrete in the works and their costs shall be borne by the Contractor.

Unless otherwise specified or approved by the Superintendent, concrete shall have the following properties.

Values	Property	Required
(i)	Maximum Water/Cement Ratio by Weight	0.6
(ii)	Minimum effective Cement Content (kg per cubic metre of concrete)	280
(iii)	Where concrete is placed under water or where it may be wetted by salt water (kg per cubic metre of concrete)	400
(iv)	Nominal Maximum Size of Aggregate (mm)	20
(v)	Slump (mm) (at time of mixing and placing)	80 ±20
(vi)	Where concrete is placed underwater	150 ±30
(vii)	Minimum characteristic compressive strength F _c at 28 days	25 Mpa

The effective cement content shall be taken as the total of the Portland cement plus other cementitious material such as flyash (to a maximum of 25%). However the minimum effective cement content shall in no case be less than 280 kg per cubic metre of concrete.

The Contractor shall keep, at the mixing site, records showing for each batch of concrete produced, the time and date of water addition, the weight of cement, weight of each grade of aggregate, weight of added water, results of tests made to determine the water contained in the aggregate, the results of any strength tests and the location of concrete in the works. These records shall be made available to the Superintendent.

The proportions of aggregate and cement for any concrete shall be such as to produce a mix which will work readily into corners and angles of the forms and around reinforcement with the method of placing employed on the work, but without permitting the materials to segregate or water to collect on the surface.

The concrete materials, excluding water, shall be measured by weighing separately. However, a complete standard bag of cement may be assumed to weigh 20 kg. When bagged cement is used, fractions of a bag shall not be permitted.

Water shall be accurately measured by a calibrated tank or by an approved type of calibrated water meter attached to the mixer. Certification of water meter and weighting devices calibration shall be supplied to the Superintendent on request.

Mixing shall be by an efficient type of power driven batch mixer operated at the speeds recommended by the manufacturer. All concrete shall be mixed for a period of not less than 2 minutes after all materials including water are placed in the mixer.

No concrete that has reached its initial set (partially hardened) or that has left the mixer or agitator for more than 30 minutes shall be placed in the structure. Remixing shall not be permitted. All concrete shall be placed within the following elapsed times from the introduction of water or cement.

Concrete Temperature at Time of Placement	Maximum Elapsed Time
Up to 27°C	2 hours
27°C to 30°C	1-1/2 hours
30°C to 32°C	1 hour
32°C to 35°C	45 minutes

Under no circumstances shall water or any other substance be added to the concrete between batching and placing without the approval of the Superintendent.

Ready-mixed concrete complying with AS 1379 and the requirements of this Specification whether manufactured in a plant operated by the Contractor or approved Subcontractor, may be used.

9. Formwork

Formwork for exposed surfaces shall conform to Class 3 AS 3610 surface finish. All forms shall be built mortar-tight, of sufficient rigidity and adequately supported to prevent distortion or displacement due to the pressure of the concrete and other loads incidental to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the timber. All curves shall be smooth and neatly joined to straights.

Forms shall be built with provision for easy inspection and cleaning out immediately before concrete is placed.

Forms for exposed surfaces shall have a smooth finish and shall be made of dressed timber of uniform thickness lined with plastic faced plywood or waterproof hardboard or steel. Joints in the form material shall be arranged in a regular pattern. Joints shall be uniformly spaced over the width of the work and shall be kept to a minimum. Every care shall be taken to ensure that no marks or fins appear on the finished surface. Angle fillets shall be used in the angles of the forms and re-entrant angles shall be chamfered unless otherwise specified. Fillets and chamfers shall be 15 mm unless shown otherwise on the Drawings and shall be evenly mitred.

The inside forms shall be thoroughly wetted or coated with non-staining form release oil or other approved material. Where oil or surfacing material is used, it shall be applied before the reinforcement is placed. Any bolts supporting forms shall be so greased and arranged that they may be removed from the concrete after removal of forms without excessive jarring or hammering and without injury to the concrete surfaces by spalling or other damage. Tie wires passing through the concrete shall not be permitted. Bolt holes and form tie end fitting holes shall be filled with 1:1 cement/fine sand mortar well rammed in.

The Superintendent may call for drawings of forms and false work to be submitted for approval before their construction is undertaken.

When forms, or form panels, have become warped, damaged, or burred so that in the opinion of the Superintendent the surface or dimensional tolerances of the concrete will not be satisfactory, the Contractor shall, when so directed by the Superintendent, remove such forms and replace them with forms or form panels satisfactory in all respects.

Forms shall not be disturbed until the concrete has attained sufficient strength to support its own weight and any construction live loads. Formwork shall not be disturbed within 24 hours of placing the concrete or within such other times (not exceeding 14 days) as may be determined by the Superintendent.

Forms shall be removed so as not to damage the concrete.

10. Placing of Reinforcement

Steel shall be free from all loose rust, grease, tar, paint, oil, mud, mill scale or other coating which would tend to destroy its bond with the concrete. All reinforcing bars shall be bent as shown on the Drawings and shall be placed accurately and be well secured by tie wiring or welding where permitted so that no displacement can occur during placing of concrete. The specified clear cover shall be maintained. Tie wire of at least 18 s.w.g. soft iron wire shall be bent inwards or cut off. Bar chairs of 25 MPA concrete or other material approved by the Superintendent shall be used to space and support the reinforcing bars; galvanised steel chairs shall not be permitted. Bending and splicing of reinforcing shall be carried out as required by AS 3600. Splices shall be of length sufficient to fully develop the capacity of the bars.

Reinforcing steel of structural grade may be secured by welding. Welding shall be in accordance with AS 1554 Part 3 Welding of Reinforcing Steel and welding procedure shall be subject to approval by the Superintendent.

Galvanising of reinforcing bars shall be carried out prior to bending and with procedures designed to minimise embrittlement. Reinforcing bars shall not be hot bent.

Steel reinforcing and tower steelwork shall have a minimum concrete cover of 50 mm.

11. Handling and Placing Concrete

Before placing concrete all equipment used for mixing and transporting the concrete shall be cleaned, and forms shall be thoroughly wetted. Concrete shall not be placed until the excavations, forms and reinforcement have been inspected and approved by the Superintendent. All excavations and forms shall be cleaned of debris and loose material and unless otherwise approved by the Superintendent, excavations shall be free of water while concrete is being placed. Where concrete is placed on soft ground the base of the excavation shall be covered with a layer of blinding concrete prior to the placing of structural concrete. All concrete shall be placed in the presence of the Superintendent.

Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods which shall prevent segregation or loss of ingredients. It shall be placed so as not to displace steel reinforcing, steel stubs and cleats or formwork. Pneumatically placed or pumped concrete or mortar shall only be used with the approval of the Superintendent.

Concrete shall be thoroughly compacted by means of approved high speed mechanical vibrators. The minimum number of vibrators to be provided shall be not less than one for each 15 m³ of concrete or part thereof placed per hour, with a minimum of 2 vibrators to be used on any placement of concrete. The vibrators shall operate such that the concrete is affected at a radius of 300 mm.

Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and/or embedded fixtures and into the corners and angles of the forms. Vibration shall be supplied at the point of deposit and the area freshly deposited for sufficient duration to thoroughly compact the concrete without causing segregation. Vibration shall not be used in concrete no longer plastic under vibration.

The Superintendent may stop the placing of concrete, or he may order that concrete operations shall not commence on account of wet weather or other causes which in his opinion would prevent the satisfactory placing of concrete.

Concrete shall be placed in water only with the approval of the Superintendent.

Concrete shall not be placed in running water and cofferdams or cylinders shall be sufficiently tight to maintain still water at the location of placement. The concrete shall be placed carefully in a compact mass in its final position by means of a tremie, concrete pump, 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 so as to maintain an approximately horizontal surface.

When a tremie or concrete pump is used it shall consist of a tube not less than 150 mm in diameter constructed in sections with flanged water-tight couplings and fitted with a device which will prevent water rising above the lower level of the concrete in the tube when it is being filled. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the concrete and to permit it being lowered rapidly when necessary to choke off or retard the flow of concrete. The discharge end shall be completely submerged in concrete at all times and the tremie or pump tube shall contain sufficient concrete to prevent any entry of water.

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.

No concrete shall be placed at a concrete temperature of greater than 35°C.

Where the temperature of the surrounding air during placement of the concrete is, or is likely to be, higher than 35°C, the following provisions shall apply:

- (i) The formwork shall be continuously sprayed with cold water in advance of the concreting. Excess water shall be removed from the inside of the forms immediately prior to the concrete placement. The reinforcement, and the formwork if metal forms are used, shall be protected from the effects of hot winds and direct sunlight. The provisions of this clause shall not apply to formwork below ground level in excavated tower foundations unless otherwise directed.

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- (ii) The concrete shall have a temperature not higher than 35°C when placed, either following the use of chilled mixing water, or by water spraying of the coarse aggregate, or both, and if necessary, by covering the container in which the concrete is transported to the forms.
 - (iii) The concrete shall be mixed, transported, placed and compacted as rapidly as possible, and the element or structure shall then be covered with an impervious membrane or with wet sand or wet hessian, kept wet until moist curing begins.

These precautions shall be undertaken by the Contractor at his own cost.

12. Surface Finish

The surface finish of formwork shall be equivalent to a Class 3 formwork surface finish in accordance with AS 3610 unless otherwise specified.

All concrete surfaces shall be true and free from stone pockets, depressions or projections beyond the surface. All arrises shall be sharp and true. Care shall be exercised in removing forms to ensure this result. All surfaces shall be free from voids, honeycombing, or other large blemishes. Exposed faces shall be uniform in appearance, free from obvious joint lines or with joint lines arranged in an approved regular pattern.

As soon as the forms are removed all rough places and projections shall be removed. If directed by the Superintendent, the surface shall be bagged over with a 1:1 sand cement paste, mixed from fine sand.

All unformed concrete surfaces above ground level shall have a smooth, steel trowelled surface finish and shall be uniformly and evenly shaped. Concrete columns at tower legs shall have their top surfaces sloped at approximately 15 degrees to the horizontal away from steelwork at every point to allow free drainage.

Cement shall not be used to dry up surface moisture on concrete. Splashes of mortar shall be completely removed from surfaces of tower steelwork and earth straps.

13. Construction Joints

Construction joints shall be made where located on the Drawings or as directed by the Superintendent.

No construction joint shall be permitted in concrete exposed to tidal waters between R.L.–3.0 m and R.L. +3.0 m (State Datum) without the written approval of the Superintendent.

No construction joint shall be made below ground level in bored foundations.

The placing of concrete shall proceed continuously from joint to joint. The edges of all joints which are exposed to view, shall be carefully finished true to line and elevation by the use of 25 mm x 25 mm square strip or alternative means attached to the form at the construction joint as approved.

Before depositing new concrete against concrete which has hardened, the forms shall be re-tightened and the surfaces of the old concrete treated as set out below:

(i) Bonding concrete to that which is less than four hours old

The laitance and thin layer of porous concrete immediately below shall be removed to a depth of 12 mm and the new concrete added immediately.

(ii) **Bonding concrete to that which has been in position for more than four hours but not longer than three days**

The laitance and porous layer shall be removed as in (i). The surface of the concrete shall be brushed with a wire brush and thoroughly washed with clean water. After excess water has been removed, a layer of neat cement mortar about 5 mm in thickness and of plastic consistency shall be well brushed into the prepared surface and the new concrete placed immediately.

(iii) **Bonding concrete to concrete which is more than three days old**

The hardened surface shall be chipped away, brushed with a wire brush and thoroughly washed with clean water. After excess water has been removed, neat cement mortar shall be applied as in (ii) and the new concrete placed immediately.

Where the aggregate at the top of the previous lift has been exposed before the concrete has hardened, and where this surface has been cured with adequate moisture and kept clean, the Superintendent may give permission to place concrete on the construction joint without chipping off the hardened concrete. The aggregate may be exposed by spraying with water, or with an air/water jet or by wire brushing. This operation shall be timed to avoid disturbing the concrete immediately below the top surface.

14. Tolerances

Tolerance for in-situ concrete shall comply with AS 3600 and AS 3610 except as specified below.

14.1 Concrete Tower Foundations

Plan dimensions of base slab	+75 mm* -75 mm
Thickness of columns	±12 mm
Thickness of other members	±25 mm
Cover of concrete over reinforcement	+12 mm - 5 mm
Plan position of column stub steelwork	±12 mm

* may be exceeded at the discretion of the Superintendent

The average dimensions of finished concrete work shall be not less than those required on the Drawings. Overbreak of excavation in excess of the above tolerances shall be reinstated to the satisfaction of the Superintendent at the Contractor's cost.

14.2 Pile Caps and General Work

Width, depth, or thickness of any structural member	+ 6 mm - 0
Cover of concrete over reinforcement	+10 mm - 5 mm
Deviation from line and grade	1/360 of length of Member (and the following)

Departure from plan in exposed surfaces	6 mm in 3.0 metres
Departure from line on exposed edge	3 mm in 3.0 metres
Departure from the designed length of any member:	
up to 10 metres	± 6 mm
above 10 metres	± 12 mm

Departure from plan position of any part of the structure (with each particular element conforming to the tolerances given above) ±12 mm

15. Curing

Finished unformed surfaces above ground level shall be sprayed with an approved curing compound immediately on completion of finishing. Other surfaces above ground level shall be sprayed with the curing compound after removal of forms (if less than seven days from placement of concrete) on completion of such work as may be required to produce a satisfactory finish. Surfaces of concrete shall be kept moist until application of the curing compound. Curing compound shall be applied to exposed concrete foundations below ground level if temperature conditions are exceptionally high and/or backfilling is delayed.

Surfaces against which concrete is to be cast shall not be treated with the curing compound but shall be kept moist until new concrete is cast, or for at least seven days.

Upon application by the Contractor, the Superintendent may give approval for an alternative method of curing normal concrete. The surface of the concrete shall be protected against loss of moisture for seven (7) days. This may be accomplished by either ponding, waterproof sheeting, retention of formwork, covering with wet sand or sprinkling.

If inadequate methods of curing are used the Superintendent may direct that the Contractor assign sufficient labour to the task of continually watering exposed concrete surfaces.

16. Testing and Assessment for Compliance

Sampling, testing and assessment of concrete shall be in accordance with Section 6 of AS 1379. In addition to production assessment, project assessment shall be carried out with samples taken at tower sites. Samples shall also be taken as and when the Superintendent so directs.

Copies of all records and reports required under AS 1379 shall be forwarded to the Superintendent within 48 hours of completion.

17. Failure to Meet Requirements

If the concrete strength should at any time fail to meet the requirement of the Specification, immediate steps shall be taken to increase the strength of concrete in succeeding batches by increasing the cement content or otherwise as directed by the Superintendent.

The Superintendent may require strengthening or replacement of those portions of the structure affected by the reduced strength.

Where, in the opinion of the Superintendent, defective areas may be made good by remedial work then the defective areas shall be cut out to expose sound concrete, and the area made good as

directed by the Superintendent. The area cut out shall be inspected and approved by the Superintendent before filling.

Where in the opinion of the Superintendent, defective work cannot be made good by remedial work, the entire work of which the defective area forms a part, or such portions of the entire work as the Superintendent directs, shall be rejected and removed.

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