



Ergon Energy Corporation Limited

Specification for the Manufacture of Concrete Poles

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1. Purpose and Scope

This section covers the manufacture of precast concrete pole elements by centrifugally spun, cast or prestressed methods.

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 – Methods for sampling and testing aggregates – List of methods

AS/NZS 4671 - Steel Reinforcing Materials

AS/NZS 4672.1 - Steel Prestressing Materials – General requirements

AS/NZS 4672.2 - Steel Prestressing Materials – Testing requirements

AS 1379 – Specification and supply of concrete

AS 1554.3 – Structural steel welding - Welding of Reinforcing Steel

3. Definitions, Acronyms, and Abbreviations

3.1 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. General Requirements

This section shall be read in conjunction with Australian Standard 3600 - SAA Concrete Structures Code where applicable.

The Contractor shall carry out the design of concrete mixes, setting out quality control of the workmanship and materials for all specified precast concrete manufacture subject to the approval of the Superintendent.

The Contractor's quality control programme shall encompass all phases of the pole manufacture and supply to site.

The Contractor shall appoint a representative to co-ordinate and control this part of the quality assurance program. He shall maintain all required inspection and test checklists and records and have authority to resolve quality matters should a need arise.

The Contractor shall supply all formwork, concrete, prestressing and reinforcing steel and manufactured items to the design and method of manufacture approved by the Superintendent.

7. Materials

7.1 Cement

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

7.2 Aggregates

Aggregates shall comply with AS 2758.1 and AS 1141 - "Concrete Aggregates" (Excluding Lightweight Aggregates). 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.

7.3 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.

7.4 Fly Ash and Admixtures

Fly ash and admixtures, if used, shall be in accordance with Australian Standards. Admixtures shall not be used if they have a deleterious effect upon durability.

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

7.5 Reinforcement

Reinforcement shall comply with the following specifications where applicable.

AS/NZS 4671 Steel Reinforcing Materials

Other higher strength reinforcement may be used in concrete poles if the manufacturer proves by extensive test evidence the satisfactory ductility and anchorage performance of the reinforcement.

7.6 Prestressing Steel

Prestressing steel shall comply with the following, as applicable.

AS/NZS 4672.1 Steel Prestressing Materials – General requirements

AS/NZS 4672.2 Steel Prestressing Materials – Testing requirements

Hard-drawn high-tensile steel wire which has not been stress-relieved shall be permitted only for wire winding, unless its percentage elongation is 2% or greater.

19-wire steel strand shall not be used for pre-tensioned work.

Copies of manufacturers test certificates for the tendons showing breaking and proof strength, together with a stress strain diagram shall be made available by the manufacturer on request. Each coil of strand shall carry a label showing the batch identification, serial number or other mark to identify it with the test certificates.

8. 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 admixture 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 and mortars 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 and mortars 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.

Prestressing steel and 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.

A slight film of rust shall not be regarded as harmful, if the steel is not visibly pitted.

All prestressing steel and reinforcing steel shall be stored clear of the ground.

9. Concrete Mixes

Concrete mixes shall be proportioned to produce the strength, durability and workability required by the approved mix design. The Contractor shall submit his proposed mix designs to the Superintendent for approval at least six weeks before manufacture 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 are acceptable. 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.

Property

**Required
Values**

(i)	Maximum Water/Cement Ratio by Weight	0.6
(ii)	Minimum Cement Content (kg per cubic metre of concrete)	280
(iii)	Nominal Maximum Size of Aggregate (mm) (cast & prestressed)	20
(iv)	Nominal Maximum Size of Aggregate (mm) (Centrifugally spun)	14
(v)	Minimum characteristic compressive strength for cast concrete F'c at 28 days	25 MPa
(vi)	Minimum characteristic compressive strength for Centrifugally spun F'c at 28 days	50 MPa
(vii)	Minimum characteristic compressive strength for Prestressed at 28 days	30 MPa
(viii)	Minimum characteristic compressive strength for Prestressed at transfer	25 MPa

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 tendons and 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.

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 calibration shall be supplied to the Superintendent upon request.

Mixing shall be by an efficient type of power driven batch mixer operated at the speeds recommended by the manufacturer with particular regard to the use of low slump concrete. 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
27°C to 30°C
30°C to 32°C
Over 32°C

2 hours
1.5 hours
1 hour

Only as approved by the Superintendent

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 - Ready Mixed Concrete and the requirements of this Specification, whether manufactured in a plant operated by the Contractor or approved Subcontractors, may be used.

10. Formwork

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.

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

A high standard of finish is required, and all surfaces of precast, spun and prestressed concrete members shall be true, hard, smooth, and free from any defects due to leakage of mortar from the moulds.

Moulds should preferably be made of steel.

Every care shall be taken to ensure that no marks or fins appear on the finished surface.

The inside of 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.

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

When forms 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 be removed so as not to damage the concrete.

11. 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.

The fabricated cage shall be accurately positioned in the mould by the use of stainless steel studs welded to the reinforcing cage. Care shall be taken to ensure that the cage is correctly aligned and positioned in relation to the through-bolt holes, ferrules and the pole axis, and that the cage reinforcement is not spirally deformed or displaced.

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 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.

All prestressing tendons shall be accurately located and restrained in position. No welding will be permitted in close proximity to any prestressing tendon without suitable shielding.

Prestressing tendons where supplied in coils shall be of large enough diameter to be self straightening. Kinked or damaged tendons will not be permitted.

Prestressing steel shall not be welded and shall be flame cut only with the approval of the Superintendent.

12. Stressing of Tendons

12.1 General Requirements

The stressing operations shall be performed under the supervision of an experienced and competent person. Special precautions shall be taken when working with or near tendons which have been tensioned, or are in the process of being tensioned. The requirements as described in AS 3600 shall be complied with at all times.

All jacks used for prestressing shall be of the type applicable to the system adopted.

Before being used on the works all jacks and gauges shall be calibrated at an approved testing laboratory and the Superintendent shall be furnished with copies of the test certificates.

During the course of the prestressing operations the Superintendent may require that further calibration tests are carried out. These tests shall be carried out at a testing laboratory approved by the Superintendent and the cost of such testing will be borne by the Principal. In general, such further calibration will not be required unless jacking equipment has been roughly handled or damaged or tensioning operations show some anomalies.

12.2 Stressing Records

The Contractor shall keep full records of all tensioning operations including the following information, and shall furnish this to the Superintendent on request.

- date and time stressed
- cable identification number
- end stressed (post-tensioning only)
- jack and gauge identification number
- specified jacking force
- gauge reading corresponding to above with allowance for losses in jack and anchorage
- take up load
- calculated extension from take-up to final load
- actual extension
- draw-in at both anchorages

12.3 Stressing Procedure

Post-tensioning or release of load in pretensioned strands shall not proceed until the concrete has acquired the necessary compressive strength as required by the designer at transfer obtained from the mean of two cylinders tested.

Before starting the stressing operation, the Contractor shall calculate the amount of extension that should take place from the take-up load to the final load. Take-up load shall be sufficiently large so that no slack remains in pre-tensioned strands or wires and that the load in the cable in post-tensioned members has been transmitted to the dead-end anchorage.

All tensioning work shall be carried out in accordance with the requirements of AS 3600.

The prestress shall be transferred to the units in such a manner that the tendons are released gradually and preferably simultaneously.

12.4 Finishing Off

After the transfer of prestress, tendons shall be trimmed flush with the end of the units using power grinders.

After trimming, the ends of the tendon and the area immediately adjacent to the tendons shall be painted with two coats of an approved epoxy compound to provide a film thickness of at least 0.3 mm dry or 0.6 mm wet.

No painting shall be carried out until the concrete is dry, clean and brushed free of all loose dirt, and is in a satisfactory condition to receive the paint.

13. 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 forms and reinforcement have been inspected. All forms shall be cleaned of debris and loose material. The concrete shall be placed to ensure that the concrete penetrates between the reinforcing bars and leaves a smooth clean external surface to the pole, free from honeycombing or other surface defects. Surface plastering to cover such defects will not be accepted without the approval in writing of the Superintendent in each case. Care shall also be taken to ensure that all reinforcing and built-in fixings maintain their correct alignment.

No concrete shall be placed when the shade temperature is less than 5°C or more than 35°C.

Where the temperature of the surrounding air is higher than 32°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 shall be protected from the effects of hot winds and direct sunlight.
- (ii) The concrete shall have a temperature not higher than 30°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 curing begins.

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

13.1 Cast or Prestressed Poles

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.

Concrete shall be thoroughly compacted by means of approved high speed mechanical vibrators.

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 on concrete no longer plastic under vibration. Alternatively vibrators attached externally to steel forms may be used.

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.

13.2 Centrifugally Spun Poles

Pole elements shall be manufactured in continuously tapered horizontally spun rigid steel moulds. Premeasured quantities of concrete shall be added to the moulds prior to the commencement of spinning and compaction by centrifugal force.

Placement shall be such as to ensure segregation dropouts and other defects do not occur. The Contractor shall establish and implement methods for the detection of dropouts, bony concrete, mould bleed and lack of internal cover during his routine Quality inspection.

14. Built in Fixings

Holes shall be provided in poles where specified by the accurate positioning of stainless steel tubes as detailed on the drawings. Stainless steel or approved equivalent threaded earth ferrules shall be accurately positioned in poles as detailed on the drawings. Care shall be taken to ensure all inbuilt fixings remain correctly aligned during all stages of manufacture.

14.1 Reinforced Poles

All earth ferrules shall be interconnected by 195 mm² or greater steel straps and a minimum of four longitudinal wires or bars. All such connections are to be welded or suitably clamped to ensure electrical continuity and equivalent conductivity.

14.2 Prestressed Poles

All earth ferrules shall be interconnected by 195 mm² or greater steel strap. This strap shall continue to within 50 mm of the pole butt. The section of strap between the pole butt and the nearest earth ferrule shall be welded to spiral reinforcing at intervals of not greater than 300 mm.

All earth ferrules shall be cleaned and tapped after curing and then sealed with plastic plugs prior to transport to site.

Where pole sections are joined by field splices all embedded metal work shall be electrically connected to longitudinal reinforcement or internal earthing by a minimum of 40 mm of weld metal for each joint bolt anchorage.

The Principal may test the resistance of selected poles after casting to confirm they meet the electrical type test acceptance criteria. Poles failing this test may be rejected.

15. Curing

Curing shall be carried out in accordance with AS 3600 unless otherwise determined by the Superintendent.

Curing shall be effected by using water sprays or damp hessian for at least seven days or by using an approved curing membrane in the form of a paraffin wax emulsion in water which shall be applied using a spray.

Prestressed and post tensioned unit may be cured as described above. Alternatively, low pressure steam curing may be used during the initial curing phase.

16. Tolerances

Precast elements shall be manufactured to the following tolerances:

- | | | |
|-----|---|--|
| (a) | Cross Section Dimensions - Less than 300 | ± 3 mm |
| | - Greater than 300 | ± 6 mm |
| (b) | Wall thickness | -2 mm
+ No Limit provided cover is met |
| (c) | Cover (inside and outside of Pole) | -2 mm
+4 mm |
| (d) | Bow or deviation of camber | 0.10 percent of length overall
2 mm/m locally |
| (e) | Out of square | not greater than 3 mm |
| (f) | Position of inserts, ferrules, etc. | ± 3 mm generally
± 1 mm for pole tip ferrules |
| (g) | Pole tip (with top mounted earthwire riser) | Perpendicular to pole axis to within 1° |

17. Surface Finish

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.

18. Marking

All precast pole elements shall be fitted with a stainless steel identification plate as shown on the drawings, these shall be located 2.5 metres above the nominated foundation depth indication mark

on single section poles or the lower section of multiple piece poles, and 0.5 m above the joint on other sections. The plate shall be permanently marked by stamping or other approved means with the pole designation, length, weight, strength, unique production number and place of manufacture.

In addition, temporary markings shall be made on the butt and tip of each pole element for end viewing giving the date of manufacture and the unique element number.

19. Head Sealing

The heads of concrete poles shall be so shaped or sealed as to shed water and prevent water entry to the pole. For hollow concrete poles a concrete plug or corrosion resistant metal cap shall be fixed to the head of the pole.

20. Pole Splices

The design, detailing, fabrication, corrosion protection and attachment of pole splices shall be the responsibility of the Contractor. However, all of these facets of the pole splices shall be subject to the approval of the Superintendent.

The Contractor shall supply full details of pole splices for the Superintendent's approval prior to commencement of production of joints. Type tests will be required to prove the capacity of pole splices. However, this requirement may be waived by the Superintendent if detailed reports of previous joint tests satisfactory to the Superintendent are submitted.

Jointed poles may be nominated for type tests of complete structures to be supplied under this Contract. The cost of any additional type testing of joints shall be deemed to be included in the supply cost of jointed poles and no additional payment shall be made for these tests.

21. Repair to Poles

Poles exhibiting defects shall generally be rejected and not used in the works. However, where the Superintendent so approves the method, materials and workmanship, minor repairs may be carried out with epoxy grouts.