2.10 Pole (Reference only)

2.10.1 General

(1) This Specification covers requirements for reinforced concrete poles and accessories.

(2) The poles shall in general conform to ETC standard relating to reinforced concrete poles for Telecommunication Lines, and also satisfy the conditions set out below. They shall be according to Figure 1 to 5.

(3) Alternatives excluding wooden poles, which shall have physical and mechanical strength equal to or more than that of concrete pole may be also acceptable. Tenderer shall state detailed specifications of alternatives.

2.10.2 Terminology and definitions

(a) Failure : The inability of a pole to support further load under test.

(b) Transverse : The direction along the line bisecting the angle made by the conductors at the pole.

(c) Ultimate load : The load which when applied at a point 500 mm below the top and perpendicular to the axis normal to one of the edges of the cross-section at that point of the pole causes failure.

(d) Working load : The load which the pole is designed to carry continuously, in the transverse direction calculated as a single force applied at a point 500 mm below the top of the pole.

2.10.3 Requirements

(1) Cement

All cement used for concrete poles shall be Portland Cement and in accordance with BS 12 or equivalent. The cement shall be stocked in such a manner as to afford easy access for inspection. Cement shall be kept dry at all times prior to use in order to prevent deterioration. Open-air storage of cement shall not be permitted. Deteriorated cement, which contains lumps, which are too difficult to powder by hand, shall not be used.

(2) Fine Aggregate

(a) The fine aggregate for concrete shall consist of natural river sand or equivalent material.

(b) The fine aggregate shall be uniformly graded and shall meet the grading requirements as shown in Table 2-16 below:

Table 2-16 Fine Aggregate Grading Requirement

Sieve Designation (mm)	Percentage by Weight Passing Square Mesh Sieve
10	100
5	95 to 100
1.2	45 to 80
0.3	10 to 30
0.15	2 to 10

(c) The fine aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to use and also to prevent inclusion of foreign materials.

(3) Coarse Aggregate

(a) The coarse aggregate for concrete shall consist of gravels and/or crushed stones having hard, strong and durable pieces free from adherent coatings such as mud or other foreign materials. The coarse aggregate shall be graded between a maximum sieve size of 19 mm and a minimum size corresponding to 5-mm sieve size. It must be free from dirt, floury stone dust, earth or any similar materials.

(b) The coarse aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to use and also to prevent inclusion of foreign materials.

(4) Water

Clean, fresh water that is free from inorganic or organic matter in solution or in suspension in such amounts that may impair the strength and durability of the concrete shall be used during both mixing and maturing. All water used for mixing and curing of concrete shall be from the Public supply. Water from other sources may be used only if authorised by ETC.

(5) Composition of concrete

The portion of cement to total aggregate shall not be less than 1 to 6 by mass, and the characteristic cube strength at 28 days when made, cured and tested by sampling in accordance with ISO standard (or Ethiopian standard), analysis and testing of concrete, shall not be less than 30 M-Pa (2,900 N/cm^2).

(6) Reinforcement

Steel used for reinforcement shall conform to the relevant Ethiopian standard for hot rolled mild steel round bars for concrete reinforcement or for cold worked deformed bars for the reinforcement of concrete.

2.10.4 Manufacture

(1) Reinforcement

(a) Preparation

Reinforcement shall be cleaned and free from loose mill scale, loose rust, mud, oil, grease and any other coating which could reduce the bond between the concrete and the steel. A slight film of rust shall not be regarded as harmful, but the steel shall not be visibly pitted by rust.

(b) Positioning

Longitudinal reinforcing bars shall where possible be continuous throughout

the length of the pole, but may contain not more than one lap in each bar line, subject to the following conditions.

(i) The laps shall be staggered.

(ii) The length of lap shall not less than 40 times the diameter of the smaller bar, unless welded in which case the strength of the welded joint shall be not less than the strength of the smaller of the 2 bars being jointed.

(c) All reinforcement shall be accurately placed and effective means shall be provided for maintaining it in position during the manufacture of the pole.

(d) The cover of concrete over all reinforcement shall be not less than 25 mm.

(2) Placing and curing of concrete

The concrete shall be used as soon as possible after being mixed and no material, which has developed an initial set, shall be used in the work. Each mould shall be filled with concrete in one continuous operation. After the material has been placed in the moulds it shall be compacted and shall not be disturbed during the period of setting.

After placing, concrete shall be protected, during setting and in the first stage of hardening from shocks, running of surface water and the harmful effects of sunshine and drying winds. The concrete shall be prevented from drying out for at least 7 days.

Concrete made from Portland cement may be steam cured if the manufacturer so desires, in which case it shall be prevented from drying for at least 4 days.

(3) Construction

(a) Each pole shall be made of concrete proportioned, mixed, placed and compacted to give dense concrete free from voids.

(b) Each pole shall have a dense surface finish showing no coarse aggregate, and shall have no crevices likely to assist in the disintegration of concrete or rusting of the steel by the action of natural agencies.

(4) Earthing

Unless or otherwise specified by ETC, provision shall be made for connecting the metal work at the top of the pole to the earth electrode by one of the methods specified below:

(a) An annealed bare copper conductor in the concrete

or

An annealed bare copper conductor attached to the exterior of the pole

or

The provision of means by which an external annealed bare copper can be attached.

(b) Where the main reinforcement bars are continuous or welded but not prestressed and the total cross sectional area of the bar or the group of bars where the reinforcing cage is welded together is not less than 250 mm^2, either two copper tails or suitable non-ferrous terminals brazed one to each end of the reinforcement at the butt end together with a galvanised nut and socket arrangement also welded to the main reinforcement at the top as shown in Figure 5. The protruding length and the cross-sectional area of any tail or bare conductor shall be not less than 300 mm and 30 mm^2

respectively.

Above item (a) specifies the method of connection between the points shown in Figure 1, whereas (b) specifies the methods of connection when tails are used.

Where copper conductor or galvanised mild steel tails or arrangement in Figure 5 are not used, provision shall be made for suitable external connections at the respective points shown in Figure 1.

(5) Maturing

Poles shall be matured for the following periods from the date of their manufacture before testing or dispatch:

(a) Ordinary Portland Cement : 28 Days

(b) Rapid-hardening Portland Cement : 21 Days

(c) Ordinary Portland Cement (Steam cured) : 14 Days

(6) Dimensions

(a) Shape (refer to Figures 1 to 5)

The poles shall generally be square in section and they may be of uniform section throughout their length or tapering along their length on all four faces. The cross sectional dimensions shall be adequate to conform to the strength requirements given in following Clause (7) unless otherwise specified by the purchaser and provided the strength requirements are fulfilled, the dimensions given in this Clause (a) and (b) shall be used.

(b) Standard lengths and sections (refer to Figures 1 to 5)

Table 2-17 Standard heights (lengths) and Cross sections

Total Height of Pole in meter (feet)	Max Height of Pole Above Ground Level in meter (feet)	Cross Sectional Dimension at the Base in cm (inches)
5.6 (18'4")	4.57 (15'0")	14 x 14 (5.5" x 5.5")
6.7 (22'0")	5.59 (18'4")	18 x 18 (7" x 7")
7.5 (24'8")	6.10 (20'0")	18.5 x 18.5 (7.3" x 7.3")
8.0 (26'4")	6.50 (21'8")	19 x 19 (7.5" x 7.5")
9.0 (29'8")	7.62 (25'0")	20.5 x 20.5 (8" x 8")

(c) Tolerances

Tolerance on Height (length) : $\pm$ 15 mm

Tolerance on cross-sectional dimension : $\pm$ 3 mm

Tolerance on percentage : 0.5 percents

(7) Ultimate transverse load

The minimum ultimate transverse load for each height of pole shall be as stated in Table 2-18 below:

Table 2-18 Minimum ultimate transverse load of poles

Height of Pole in meter (feet)	Minimum Ultimate Transverse Load at 0.5 m from Top of Pole
5.6 (18'4")	2.6 kN
6.7 (22'0")	3.6 kN
7.5 (24'8")	3.6 kN
8.0 (26'4")	3.6 kN
9.0 (29'8")	3.6 kN

The working load shall be taken as 40 percent of the ultimate load.

(8) Fitting and holes

Concrete fittings attached to or forming part of a pole shall comply with the specification as far as practicable.

The provision of holes for the attachment of fittings and the recess for seating of cross arms are given in Clause 2.10.10 and a typical arrangement of holes is shown in Figure 1.

2.10.5 Tests

(1) Type test

Unless otherwise specified with the enquiry or order, a written statement that the number of poles specified in Table 2-19, identical in all essential features of design with those provided, have passed the type test shall be deemed to be sufficient evidence that the poles comply with the requirements of this specification. The statement shall give all tests and state the age of the poles when tested.

The poles selected for the test shall be tested in accordance with Clause 2.10.9. The permanent set after removal of a test load of 60 percent of the minimum ultimate load specified in Table 2-18 shall not exceed 10 percent of the deflection at the test load. The hair cracks produced in testing shall clearly close up on removal of the test load specified above. The test load at failure shall exceed the minimum ultimate load specified in Table 2-18.

(2) Proof test

The poles shall be tested in accordance with Clause 2.10.9, except that the minimum load applied shall be equal to 40 percent of the ultimate load specified in Table 2-18. The deflection at each measurement, and the permanent set after removal of the test load, shall not exceed by more than 15 percent the average of the corresponding values, for the poles subjected to the type test.

2.10.6 Sampling and Inspection

(1) Sampling

(a) Lot:

In any batch, all poles of the same dimensions shall be grouped together to constitute a lot.

(b) Sub-lot:

If the number of poles in a lot exceed 500, the lot shall be divided into a suitable number of sub-lots, such that the number of poles in any sub-lot shall not exceed 500.

(c) Sample size:

Sample size shall be made up of poles selected at random from lot or sub-lot.

(2) Number of tests

The number of poles to be tested for dimensional requirements (overall length cross-section and uprightness) and strength shall be in accordance with Clause 2.10.4, (6).

(3) Criterion for conformity

(a) The number of poles which do not satisfy the requirements of overall length, cross-section and uprightness shall not exceed the corresponding number given in Column 3 of Table 2-19.

(b) All the poles for strength test shall satisfy the requirement of the test. If one or more poles fail in test twice the number of poles originally tested shall be selected from the lot or sub-lot and subjected to the test. If there is no failure of the test among these poles, the lot or the sub-lot shall be considered to have satisfied the requirements of this test.

Table 2-19 Sample size and criterion for conformity

Size of Lot or Sub-Lot (1)	Dimensional Requirements		No. of Poles for Strength Test	
	Sample Size (2)	Permissible number of defectives (3)	Type Test (4)	Proof Test (5)
Up to 100	10	1	5	5
101 to 200	15	1	7	8
201 to 300	20	2	10	10
301 to 500	30	3	15	15

2.10.7 Identification Marks

For purpose of identification the following marking shall be provided at a height of three metres from the bottom of the pole:

(a) ETC

(b) Height of the pole in metres.

(c) Manufacturer's code.

(d) Manufacturer's Serial Number.

(e) Year of Manufacture.

(f) The sizes of the figures and letters shall be at least 2.5 cm by 2.5 cm. The depth of the lettering shall be at least 3 mm.

2.10.8 Finish

(a) The poles shall have a smooth finish.

(b) They shall be free from any damage, e.g. broken corners, hair cracks.

(c) The holes for arm bolts shall not be fouled by concrete, cement, etc.

(d) The bolt fixed on the cap shall be removable.

2.10.9 Structural test for pole (Reference)

(1) A pole may be tested in either the horizontal or vertical position. Hold the pole at the butt end in accordance with the supported length specified in Table 2-20 below:

Table 2-20 Supported length

Height (Length) of Pole in meter (feet)	Supported Length in meter (inches)
5.6 (18'4")	0.9 (36")
6.7 (22'0")	1.1 (44")
7.5 (24'8")	1.2 (48")
8.0 (26'4")	1.4 (56")
9.0 (29'8")	1.5 (60")

(2) Type test

At 40 percent and at 60 percent of the ultimate load reduce the load to zero and measure the permanent set. Then increase the load in steps of 10 percent of the ultimate load until failure occurs. Maintain each load above 60 percent of the ultimate load for at least two minutes.

(3) Proof test

At 40 percent of the ultimate load reduce the load to zero and measure the permanent set.

2.10.10 Recommendations for the Provision of Holes

A typical arrangement of holes is shown in Figure 1, but other arrangements may be submitted to ETC for approval.

Figure 1: Elevation of typical pole in direction of line indicating holes markings

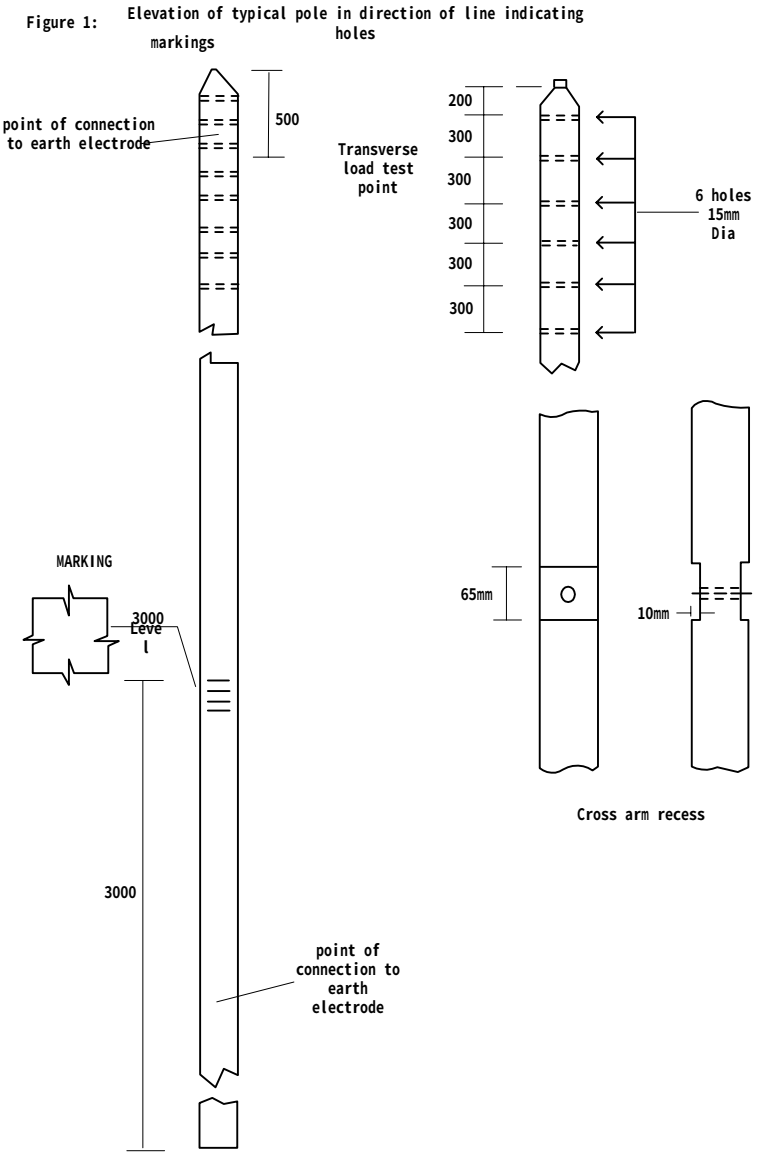


Figure 2: Elevation of 6.7 m Pole

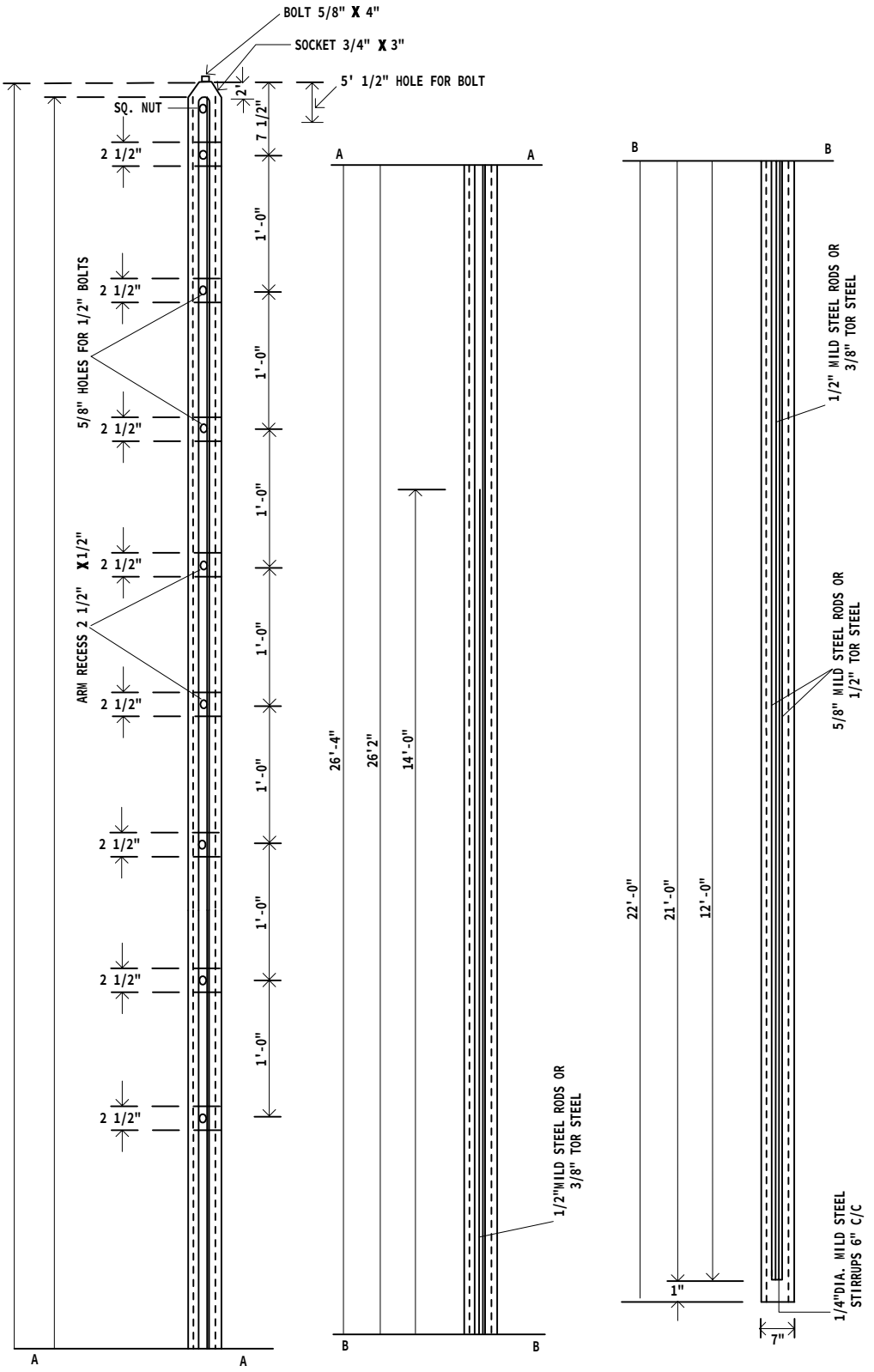


Figure 3: Elevation of 8.0 m Pole

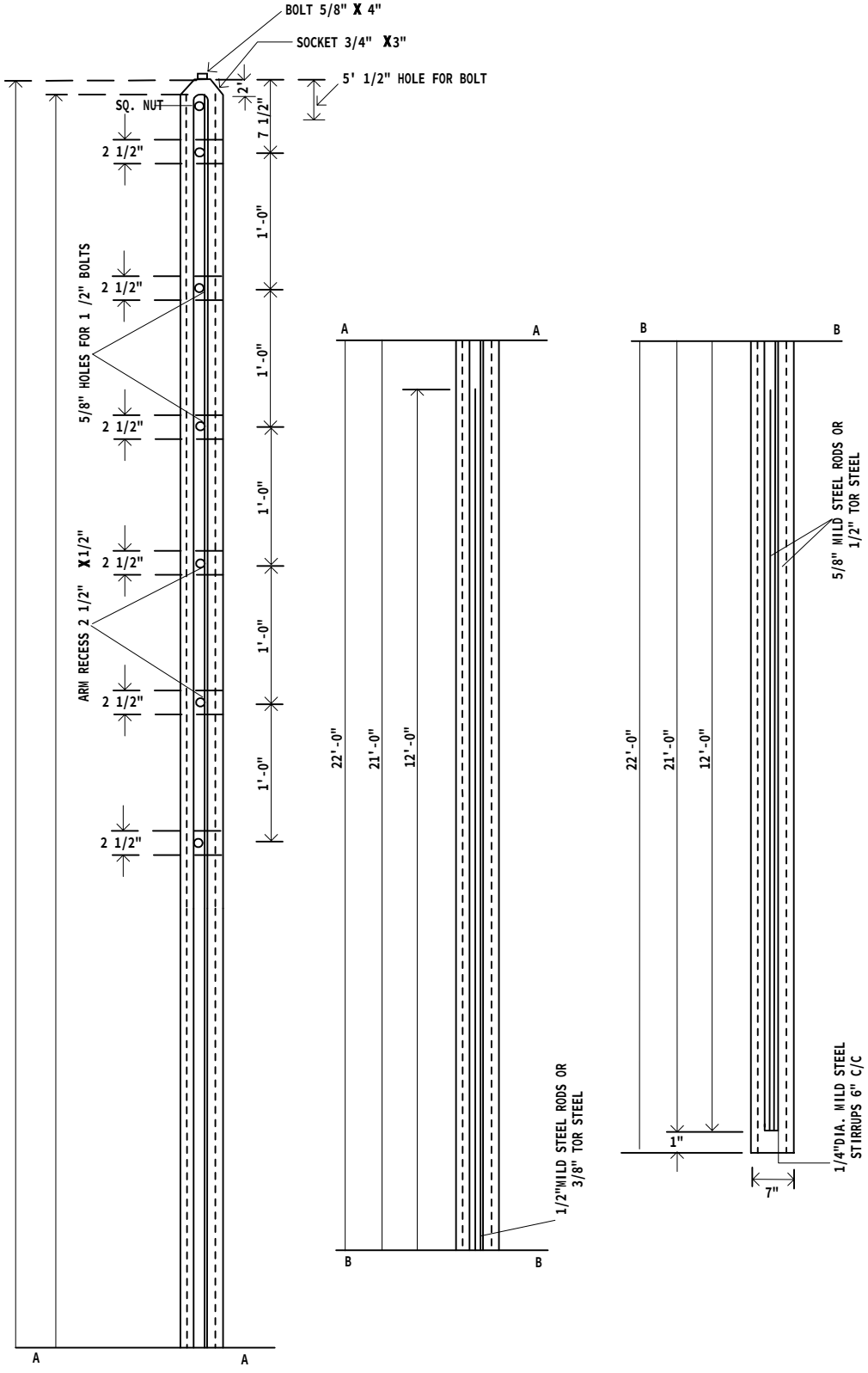


Figure 4: Detail of Base End of Pole

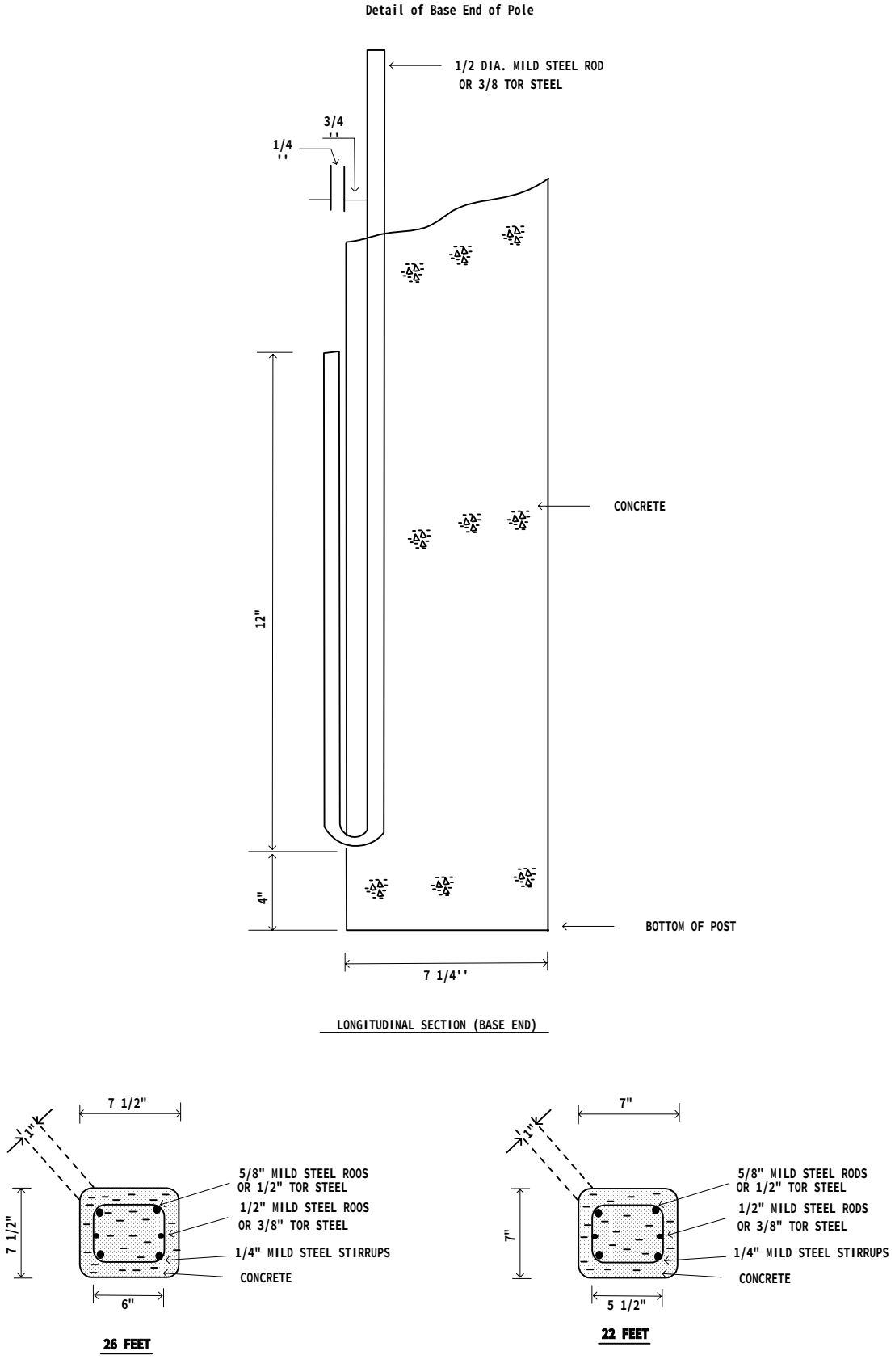
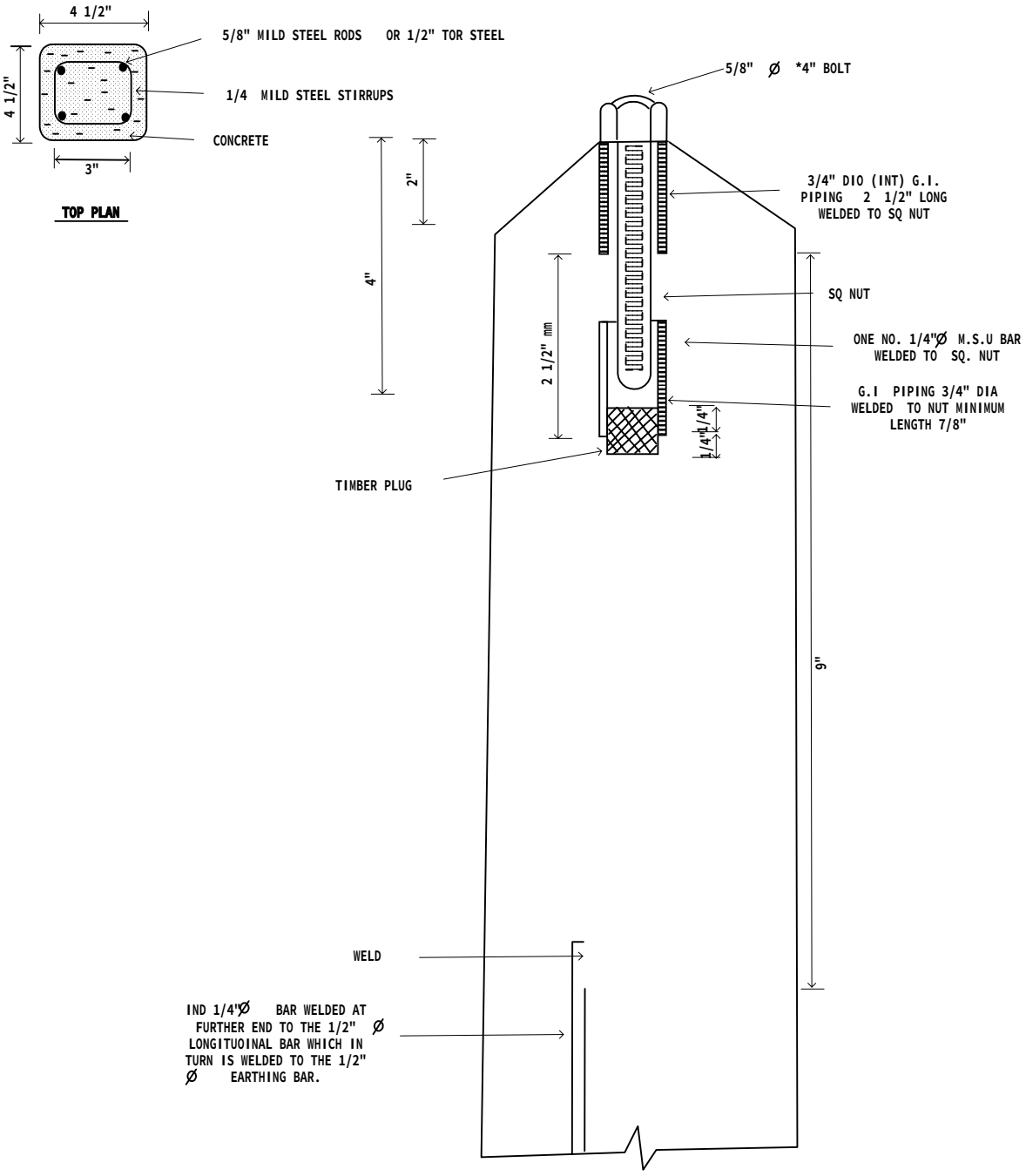


Figure 5: Sectional Detail of Top of Pole



2.11 Guy

2.11.1 General

The guys shall be supplied, complete in all respects and include the steel band and bolt for guy, guy rod, guy wire, pole fixing guy guard and insulator.

2.11.2 Wire

(1) The guy wire shall be manufactured of individual, hardened while drawing, steel wires with a tensile strength of 125 kg/mm^2. The individual wires shall have a circular cross-section and shall be without flakes, cracks or other defects. It shall be possible to wind and unwind the steel wire around its own diameter without breaking.

(2) The diameter of each steel wire shall be 2.6 ± 0.08 mm. Its tensile strength shall be within the range 6,200 N and 7,000 N.

(3) Each wire shall be galvanised with pure zinc at the rate of 220 grams per square metre for wire surface. The zinc layer shall have an even thickness as possible with adhesion such that the wire can be wound around a mandrel with a diameter 10 times the diameter of the wire without the zinc flaking or significant cracks occurring.

(4) Seven galvanised steel wires shall be twisted together. The guy wire shall be compact without any tension between the individual wires making it difficult to bend.

(5) The tensile strength of the guy wire shall not be less than 4,180 kg (ultimate tensile strength).

(6) The ends of the guy wire shall be bound with a 1 mm soft galvanised steel wire at 10 mm from the ends of the guy wire, or some other method preventing the strands from separating.

2.11.3 Other Materials for Guying

(1) The steel bank and bolt for guy, guy rod, insulator and so forth for guying shall be able to withstand sufficiently the strength required for guying. A concrete block or driven type of plank used for anchoring shall have sufficient strength and dimension so as to be able to grasp the ground endurance.

(2) The steel accessories and hardware for guying shall be galvanised sufficiently with zinc for anti-corrosive properties.

(3) The minimum thickness of the zinc coat shall be 56μm at any point of the surface and in addition, the thickness of the zinc coat shall not be lower than 70μm at more than 10% of the test points.

2.11.4 Packing

(1) Guy wire shall be shipped in coils and provided with a label marked with the manufacturer's name, wire type and length of the wire.

(2) Guy accessories shall be packed in boxes marked with the manufacturer's name, designation and quantity.

(3) Fitting and fixing materials shall be packed in cartons or equivalent marked with the manufacturer's name, designation and quantity.