044 - 2: 1997

CEB
STANDARD

PRE - STRESSED POLES

CEYLON ELECTRICITY BOARD
SRI LANKA

Specification

for

PRE-STRESSED POLES

CEB Standard 044 - 2: 1997

CEYLON ELECTRICITY BOARD

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C O N T E N T S

SPECIFICATION FOR THE PRE-STRESSED POLES

1. GENERAL

The Specification for the manufacture, testing and delivery to the site of pre-stressed concrete poles, for which the detailed drawings are annexed.

2. DESIGN LOADINGS

Each pole shall be able to withstand 2.5 times the design working load in the transverse direction, as indicated in the corresponding drawing.

Each Pole shall be able to withstand an independent load in the longitudinal direction of at least 25% of the transverse loading given above.

The ultimate design load used for designing each class of pole shall be that calculated by applying a point load of 2.5 (factor of safety) times the appropriate standard design working load when the pole is held in the test frame specified in the Clause 9 of the standard.

3. STANDARDS AND CODES OF PRACTICE

Unless otherwise specified, the materials and workmanship specified under this standard shall confirm to the latest version of the appropriate British Standards and SLS as given below;

BS 8110		1985	Structural use of Concrete
BS 12		1991	Specification for Ordinary Portland Cement
BS 4449		1988	Specification for Carbon steel bars for the reinforcement of concrete
BS 5896		1980	Specification for High tensile steel wire and strand for pre-stressing of concrete
BS 882		1992	Specification for Aggregates from natural sources for concrete
BS 1881		1993	
	Part	101	Sampling of fresh concrete
		102	Determination of slump
		108	Method of making test cubes from fresh concrete

110	Method of making test cylinders from fresh concrete
111	Method of normal curing of test specimens
116	Method for determination of compressive strength of concrete cubes
BS 812	Testing of aggregates
BS 4251	Truck type concrete mixer

4. STANDARDIZED TYPES/SIZES OF PRE-STRESSED CONCRETE POLES

HEIGHT OF POLE (m)	BURRIED LENGTH (m)	WORKING LOAD	PURPOSE	C E B DRAWING NO.
8.3	1.4	100	LV Line	DS&S/2003/7803 Annex – 1
11.0	1.8	350	Combined-run HT & LT with intermediate LT Pole	DS&S/98/7713 - Annex - 2
11.0	1.8	500	Combined-run HT & LT with intermediate LT Pole & Substation Installation	DS&S/2002/7715 - Annex - 3
11.0	1.8	850	Combined-run HT & LT with intermediate LT Pole	DS&S/98/7730 - Annex - 4
11.0	1.8	1200	Combined-run HT & LT with intermediate LT Pole	DS&S/2003/7732 - Annex - 5
13.0	2.2	500	Combined-run HT (double circuit) & LT with intermediate LT Pole	DS&S/98/7714 - Annex - 6
13.0	2.2	850	Combined-run HT (double circuit) & LT with intermediate LT Pole	DS&S/98/7712 - Annex - 7
13.0	2.2	1200	Combined-run HT (double circuit) & LT with intermediate LT Pole	DS&S/99/7725 - Annex - 8

Reduced size drawings of each type of pole used are annexed to this standard. Detailed drawings could be obtained from the respective branches of the CEB.

5. MATERIALS

5.1 General

All materials shall conform to the relevant standard specifications referred to in this specification. However, CEB reserves the right to inspect, and if deem to be necessary, to test samples from raw materials stockpiled for use, in any of the contractor's work sites. In the event of such samples not confirming to the

standards given herein, CEB may inform same, to the contractor, in writing. On the receipt of such complaint, the contractor shall make immediate arrangements to remove those unsuitable materials completely from the work site, and replace them with materials confirming to the standards, at the contractors own expense.

Manufacturer's test certificates for all reinforcing and pre stressing steel shall be supplied to the CEB in accordance with the said standards in Clause 3. These test certificates shall show compliance with the relevant standard specifications in all respects and shall be issued by an independent testing laboratory acceptable to the CEB. If the manufacturer's test certificates are not available it shall be the contractor's responsibility for arrange all testing and provide test certificates, before using such materials.

The test information so obtained shall conform to the relevant standard specification. Expenses for same shall be borne by the contractor.

5.2 Reinforcing Steel

Steel reinforcement shall be one of the following :

a) (i) Hot rolled mild steel round bars complying with BS 4449.

(ii) High yield steel cold worked deformed bars complying with BS 4449.

b) High tensile steel wire for pre-stressing BS 5896

The contractor shall provide to the CEB a certificate for each consignment from the steel manufacturers showing that the steel meets the requirements of the specification. One tension test and one bond test shall be made for each lot of 50 tonnes.

Steel reinforcing bars shall be free from pitting, loose rust, mill scale, oil, grease, mortar, earth, paint or nay harmful material.

5.3 Cement

Portland cement conforming to BS 12 and BS 1370, Part 2 shall only be used for casting of poles under this contract and shall pass the following tests;

i) Fineness
ii) Chemical composition
iii) Compression strength
iv) Setting time
v) Soundness

These tests shall be conducted at the expense of the contractor. Once approved the quality of the cement used shall not be changed without approval of the CEB.

5.4 Aggregates

The Contractor shall silt content furnish the following data of aggregate source for approval.

a) Shape
b) Surface texture
c) Silt content
d) Salt content
e) Grading curves
f) Flakiness Index
g) Impact value
h) Water absorption
i) Soundness

The fine and coarse aggregates shall comply with BS 882 - 1992.

5.5 Water

The water used for the making concrete, mortar and grout shall be clean, fresh and free from injurious amounts of oil, vegetable or organic matter or any other deleterious substance in suspension or in solution. The mix water shall be continuously monitored for salt content and the concrete mix so designed to limit total salt content.

The water should comply with the requirements of BS 3148.

5.6 Admixtures

All admixtures shall comply with BS 5075.

No admixtures shall be added to the concrete mix without prior approval of the CEB.

Any admixtures containing calcium chloride shall not be permitted in the concrete used to manufacture prestressed concrete poles

6. STORAGE AND PROTECTION OF MATERIALS

6.1 Cement

Cement shall be stored in a suitable weather-tight enclosure on a broad platform raised off the ground. The enclosure should be such that free circulation of air around the bags of cement is kept to a minimum.

Any cement that has become damp, caked or lumpy shall not be used. Concrete batching operations shall be organised so that cement that has been longest at the place of manufacture of the poles is used first.

6.2 Aggregates

Both fine and coarse aggregates shall be separately stored so that they are kept clean and free from contamination and are not subjected to intermingling. Where a clean hard surface is not available for the stockpiles the bottom 150 mm of the aggregate piles which are in contact with the ground shall not be used.

Heaps of fine aggregate shall be capable of draining freely. Wet fine aggregate shall not be used until; it has drained sufficiently to ensure proper control of the water/cement ratio.

6.3 Reinforcing Steel

All reinforcement shall be stored clear off the ground on sufficient supports to prevent distortion of bars and in clean dry place. Grease, oil, paint or any other substance that effects the bonding of reinforcement shall not be allowed to come in contact with them. If it does, then all such substances shall be cleaned off from the reinforcement before use. Mild steel, high yield steel and high tensile steel are to be stored separately.

6.4 Prestressing Steel

All prestressing tendons shall be stored in a clean dry place off the ground and must be kept dry at all times. All loose surface, rust, protective oil, or other contaminants that will effect the bond of the tendons shall be thoroughly removed before use. Any part of the tendons that have become pitted, have any tears or nicks, or/permanently deformed or otherwise damaged shall not be used and shall be removed from the site.

7. REINFORCEMENT AND PRESTRESSING STEEL INSTALLATION

7.1 Covers

The **minimum cover** from the outermost reinforcement or pre-stressing steel to the nearest permanent surface of the concrete member shall be 20mm. All steel shall be accurately placed and shall be held in position during manufacture.

Pre-stressing tendons shall pass through rigidly held guide plates at the ends of members to maintain the minimum covers.

7.2 Spacing

The clearance between two parallel reinforcing bars shall be not less than the greatest bar diameter or, 1.33 times the maximum nominal size of the aggregate or 25 mm.

The clearance between prestressing tendon shall be greater than the greater of either four times the nominal diameter of the tendon or 1.33 times the maximum nominal size of the aggregate which ever is greater.

7.3 Stirrups and Ties

The inside diameter of bends in stirrups and ties shall not be less than the enclosed diameter or two times the diameter of the stirrup or tie, whichever is greater.

The ends of the stirrups and ties shall be anchored with a minimum of 90° bend plus a straight 8 times the bar diameters but not less that 65 mm. They shall be firmly attached to the supporting tendons or reinforcement using soft wire ties.

7.4 Welding

Welding or tack-welding of reinforcement will not be permitted.

7.5 Prestressing Tendon Stressing

All stressing operations shall be carried out under the direct supervision of a person who is thoroughly experienced with all aspects of prestressed concrete construction.

The stressing procedure adopted shall ensure that the force in a tendon increases at a reasonably constant rate. After stressing and anchoring, the force in a tendon shall be the initial force specified in the manufacturing drawings. During stressing the maximum force applied to a tendon shall not exceed 0.8 times of its ultimate tensile strength.

The required amount of prestressing force shall be measured by both tendon elongation and jack force or pressure. If the two measurements differ by more than 5 percent then appropriate corrections shall be made.

Tendon elongation shall be calculated from the actual load/elongation graphs supplied by the steel manufacturer. Appropriate anchorage-draw-in shall be accurately assessed and allowed for. A correction shall be applied to the total elongation observed to compensate for any initial tensioning of the tendon applied to take up irregularities and slackness. Jack and anchorage friction shall be assessed and an appropriate correction made to the jacking pressure.

Records shall be kept for the following stressing operations,

a. Amount of tendon elongation up to the stage of anchoring the tendon

b. Allowance for anchorage-draw-in

c. Jack force at anchorage

d. Allowance for jack friction

e. Manufacturer's identification mark for prestressing tendons used.

f. Date and time of stressing

g. Date and time of de-stressing

h. Curing sequence and concrete strength at time of de-stressing

i. Identification mark placed on each particular pole

The jacking force shall be measured to an accuracy of one-in-forty Prestressing force and the tendon elongation to an accuracy of 2 mm.

If the tendons are stressed then left for more than 2 weeks before being fully surrounded with concrete they shall be removed from the moulds and discarded.

Prestressing equipment shall be maintained in a serviceable condition and its calibration and accuracy checked every 3 months.

7.6 De-stressing

The transfer of prestress into the hardened concrete shall take place **gradually** and in such a determined order that tensile stresses sufficient to cause cracking are not induced in the concrete. Immediately after de-stressing the maximum stress in the tendons shall not be exceed 0.75 the ultimate tensile stress of those tendons.

If all the tendons are not to be released simultaneously then prior approval for releasing sequence shall be obtained from the CEB.

Any releasing device shall be so designed that during the period between stressing and de-stressing the tension in the prestressing tendons does not alter. It shall also be designed so that there is no increase in the stress in the tendons above the stress level in the tendons just prior to de-stressing.

7.7 De-bonding of tendens

Where a tendon or a number of tendons has to be de-bonded at a certain length as specified in the corresponding drawing, the particular tendon(s) shall be fully covered for the total de-bonded length only, using a plastic sheath. Application of grease onto the tendons for de-bonding is not allowed.

7.8 Cutting and finishing of tendons

After de-stressing is completed the ends of the tendons shall be cut off flush with the surface of the concrete.

If flame cutting is used there shall be an excess of oxygen in the flame and the cutting shall take place as rapidly as possible.

The ends of the poles shall be finished with a cement plaster (1:3 or richer) to a thickness not less than 25 mm after flush trimming the tendons. An epoxy paint to be applied to the top and bottom surfaces after cement plastering.

8. MIXING, PLACING AND CURING CONCRETE

8.1 Mix design

Concrete used for casting of poles shall be of grade 40 and shall posses the following minimum qualities as per BS 5328.

i) Minimum cement content	-	325 kg/m^3
ii) Maximum free water-cement ratio	-	0.55
iii) Minimum strength at an age of 28 days	-	40N/mm^2
iv) Nominal maximum aggregate size mm	-	20

Full details of the components forming the concrete mix proposed to be used by the Contractor shall be submitted to the CEB for approval **at least 2 weeks before any concreting operations are commenced.** Once the proposed mix has been approved it shall not be varied by the contractor without prior approval.

The concrete mix shall be designed and tested and their submission shall include the following information.

a) Source, nature and gradings of both the fine and coarse aggregates.

b) Type and supplier of the cement to be used

c) Proportions by weight of fine and coarse aggregates

d) Weight of cement per cubic metre of concrete.

e) Water-cement ratio by weight

f) Estimated slump of the mix

g) Arithmetic mean compression strength of the mix at 7 days and 28 days using either cylinder compression test or cube compression samples plus the standard deviation of the test strengths of the number of cylinders and cubes tested.

h) Any admixtures used

The ratio of the weight of the fine aggregates (sand) to the total weight of aggregates shall be between 0.35 and 0.50. All testing costs shall be borne by the contractor.

8.2 Ready-mixed Concrete

Ready-mixed concrete as defined in BS 2426, batch off the site, may be used and comply with all requirements of this standard.

The ready mix concrete shall be carried in agitators, operating continuously or truck mixers made for this purpose. The concrete shall be compact in its final position within 1 hour of the introduction of cement to the aggregates. The time of such introduction shall be recorded on the delivery note together with the weight of the constituents of each mix.

When truck-mixed concrete is used, water may be added under supervision, either at the site or at the central batching plant, but no water be added in transit.

Mixing and discharge performance of truck mixer units shall comply with the requirements of BS 4251. Mixing shall continue for the number and rate of revolutions recommended in accordance with BS 4251, mixing shall continue for not less than 100 revolutions at a rate of not less than 7 revolutions per minute.

8.3 Concrete Mixing

All concrete shall be mixed in weigh batch mixing machines. The machine shall have a large water storage tank with a gauge so that a predetermined quantity of water can be injected direct into the mixer drum.

The dry concrete shall be mixed until a uniform colour is obtained. After the addition of the water the concrete shall be mixed until a uniform colour is achieved. The total water in the mix shall not exceed the amount used in the trial mix.

Water contents of the aggregates should be considered in determining the quantity of water to be added. The amount of water shall be sufficient to ensure through hydration, good workability and high strength.

8.4 Workability

The consistency of the concrete shall be such that it can be readily worked into the corners and angles of the form work and around reinforcement without segregation of the materials or bleeding of free water at the surface. On striking the form work it shall present a face which is uniform, free from honeycombing, surface crazing or excessive dusting. The workability of the proposed mix in the various grades is adequate for the requirements of the specification. The contractor shall carry out workability tests on the preliminary trial mixes required elsewhere. These tests shall be carried out in accordance with BS 1881, or any other applicable standards.

The samples to be tested shall be obtained from the batches used for the preliminary test cubes. The mould shall be filled in the presence of the CEB representative with concrete from which the preliminary test cubes are made and shall be compacted in the same manner with the same equipment as proposed for the works. This procedure shall if necessary, be repeated with modified mixes until the appearance of the concrete after striking the mould is acceptable to the CEB, after which it shall be used as the standard for that grade.

When a specific workability is called for a check shall be maintained by measuring slump at the rate of one test for each 10 cubic metres of concrete or three tests for each day of concreting.

8.5 Transport of Concrete Mix

The concrete shall be discharged from the mixer and transported to the works in such a way to as to prevent adulteration, segregation or loss of ingredients, and ensure that the concrete is of the required workability at the point and time of placing.

8.6 Placement and Compaction

Placement rate of concrete shall be such that concrete is at all times plastic and flows readily into the space between reinforcements. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the moulds, nor shall re-tempered concrete or concrete that has been re-used after initial set be used.

The placement of concrete in the moulds shall be completed within half an hour after the introduction of water to the cement and aggregate in the concrete mixer. Each mould shall be filled with concrete in continuous operation. Construction joints will not be permitted in the poles. Should there be an interruption during the placement of concrete into the mould such pole shall be discarded.

All concrete shall be consolidated in the moulds using high frequency internal or external vibrators. The amount of vibration shall be uniform along the length of the mould and shall be carefully controlled so that adequate consolidation is achieved without segregation of the concrete mix by over vibration.

8.7 Protection and Curing of Concrete

During the initial stages of hardening the concrete shall be protected from the direct rays of sun light and from drying winds. The moulds containing the hardened concrete shall not be disturbed or shifted unless it is made sure that such movements will not damage the cast.

8.7.1 Moist Curing at Ambient Temperature

All surfaces of the pole exposed to the atmosphere shall be kept constantly wet or damp for at least 7 days after casting. Concrete manufactured from type iii cement (high early strength) shall be moist cured at least for 4 days.

8.7.2 Curing at Elevated Temperatures

Curing at elevated temperatures is permitted subject to the following precautions.

i) Adequate means shall be provided to prevent moisture loss from the concrete from the time of initial set to the end of the elevated temperature curing cycle.

ii) An initial maturing period shall be allowed before any increase of ambient temperature. This maturing period shall be measured from the time of completion of casting and shall be such that the product of time and ambient temperature at the place of casting the concrete is not less than 40°C hours (eg. 2 hours at 20°C = 40°C hours). During this maturity period the surface of the concrete shall not exceed 30°C.

iii) All pins and other fitments which pass through the mould and concrete shall be withdrawn after initial maturing to prevent damage to the concrete caused by differential expansion between the mould and the concrete.

iv) After initial maturity heat may be introduced to the concrete at a rate that limits the temperature rise to a maximum of 24°C per hour. Under no circumstances shall the temperature rise during any 15 minute exceed 6°C.

v) The temperature during the curing cycle shall not exceed 75°C.

vi) The rate of cooling of the concrete and the removal of any steam covers, blankets etc., shall be controlled prevent any damage due to thermal shock or differential cooling.

vii) The heat source shall be well distributed to ensure that a uniform temperature distribution exists in the concrete and no local overheating occurs to the concrete, the precasting moulds or to any test specimens.

viii) Concrete test specimens shall be cured exactly in the same manner as the concrete poles.

Temperature records shall be as follows, during curing at elevated temperature.

a) The temperature during the initial maturing period

b) Temperature at ½ hourly intervals during the temperature rise period.

c) Temperature at 2 hourly intervals during the maximum constant temperature period and at the end of this period after shutting off the heat source.

Elevated temperature cured concrete poles shall be moist cured for further 4 days at ambient temperatures. During this period all surfaces of the pole exposed to the atmosphere shall be kept constantly wet or damp.

9. CONCRETE SAMPLING AND TESTING

9.1.1 General

A random sampling procedure, to obtain the samples for compression strength tests of concrete has to be adopted the minimum frequency of sampling of the concrete shall be (01) one sample per (50) fifty poles, but not less than one sample per day, whichever is higher. "Casting of Samples" is described in Cl. 9.1.2. Contractor shall make arrangements to carry out the compression strength test as per BS 1881, for each of above samples, at an independent testing laboratory.

The concrete shall be considered acceptable when the test results are in accordance with para 4.0 of BS 5328. The cost of these tests shall be borne by the contractor.

In the event the above tests results are not in a accordance with the relevant standards the poles so manufactured shall be rejected.

9.1.2 Casting of Samples

Samples for compression strength tests shall be moulded in 150mm cubes, 100mm diameter x 200mm high cylinders or 150mm diameter x 300mm high cylinders. The date of casting of the sample shall be clearly and indelibly marked on the fresh concrete. Subsequent marking on freshly applied motor/grout layer is not allowed. For the purposes of this specification to convert from cylinder strength to cube strength the following conversion factors shall be used:

Cylinder Strength	Conversion Factor
15 Mpa and Less	0.77
20 Mpa	0.82
25 Mpa	0.86
30 Mpa and more	0.91

A sample shall consist of 4 cubes or cylinders made concurrently from the same batch of concrete. Two of the cubes or cylinders shall be used to establish the 28 day compression strength and the other two of the cubes or cylinders shall be used to establish the rate of gain in strength approx. 7 days of the concrete before de-stressing the tendons.

All samples shall be taken moulded and cured in accordance with the procedures in BS 1881 and except that cylinders or cubes taken to check the rate of gain of compression strength before 28 days shall be cured in the same manner as the concrete poles from which the samples are taken.

9.2 Compression Strength Tests

Testing of the compression strength samples shall be carried out in accordance with the procedures in BS 1881.

The minimum required 28 day cylinder compression strength of all concrete used to manufacture concrete poles shall be 40 N/mm^2.

The minimum required cylinder compression strength before the transfer of any prestress force into the concrete is permitted shall be 30 Mpa.

9.3 Acceptance Criteria for Compression strength

The concrete shall be considered acceptable when tested and found satisfactory according to stipulations in B.S. 5328 Part 4.

9.4 Cost of Testing

All testing shall be carried out in an approved independent testing laboratory at the expense of the contractor in accordance with standards specified.

9.5 Pole Moulds and Surface Finishes

Moulds shall be designed, constructed and finished to ensure that they can be removed without damaging the hardened concrete, and shall be securely braced and supported to prevent sagging and bulging during the deposition of the concrete. Joints in the materials used to manufacture the moulds shall be tight and shall not permit any leakage of cement paste from the concrete mix. Retaining pins which form bolt holes in the finished pole shall be provided with flexible seals or some similar means to prevent the loss of any cement paste from the concrete mix.

All poles shall have a smooth, hard, uniform in colour surface finish and free from any honey combing and air pockets not exceeding 4mm in diameter. All fins and other projections shall be rubbed down or ground flush with the general surface of the pole.

Repairs to defective casting will **not be permitted** and any pole of such nature will be **rejected**.

9.6 Dimensional Tolerances

Recommended dimensional tolerance shall be as follows:-

Length	± 15 mm	(allowance shall be made during design for length reduction to prestress).
Cross Section	+ 4mm - 2mm	(Overall dimensions and dimensions of parts such as webs etc.)
Straightness	± 15 mm	(Deviation from a straight line joining the top and the widest dimensions at the butt)
Holes sizes	- 0 + 2 ± 5 mm	relative position
Location of Reinforcement	± 3mm	(but specified covers shall not be reduced)

Any poles with dimensional deviations falling short, of the aforesaid will be rejected.

9.7 Marking of Poles

Following data of the pole should be clearly and indelibly marked at a position approximately 1.5m above the ground level, by **embossing** the marks on **fresh** concrete, just after the casting of pole. Subsequent marking on cement motor/grout applied **later** into the pole is **not** allowed.

a) Date of manufacture, Identification Mark of Manufacturer and the Serial No. of the Pole - No two poles belonging to same manufacturer could bear the same Serial Number.

b) **Length of pole** in meters and its **design working load** as defined in this Specification - for example a 8.3 meter pole with a 100 kg working load shall be marked as 8.3m/100 kg, as indicated in the relevant drawing.

Note: A performed template indicating (a) and (b) above may be used for this purpose.

9.8 Lifting, Handling and Shifting

Poles shall not be lifted or handled until the concrete has attained strength of not less twice the stress induced by the methods of handling and lifting. Pole shall be held from at least two points while lifting.

Pole shall be transported on vehicles that provide full length support without any over hang.

Any pole that shows signs of any damage shall be rejected.

While lifting and shifting major axis of the pole shall be kept in vertical position.

10. POLE LENGTH AND SHAPE

10.1 General

The pole shape shall be vierendeel section conforming to details on corresponding drawing and shall have a tapering section from bottom to top. The manufacturer shall submit a detailed description of the method of pole fabrication including the details of moulds.

All bolt holes shown on corresponding drawing shall be cast into the pole.

11. INSPECTION & TESTING OF POLES

11.1 General

The CEB reserves the right to inspect plant and machinery and raw materials used for the manufacture of poles. At any time the contractor shall provide access to the plant to the CEB representative. Facilities as necessary, free of charge, labour, gauges, tools, materials testing equipments etc. for testing and inspection of poles shall be provided by the Contractor.

The CEB reserves the right to reject any pole which does not confirm to the CEB standard.

11.2 Testing of Poles

One-in-hundred of each type of poles selected at random will be tested in the following manner.

A pole shall be tested in the horizontal position only. The pole is to be held rigidly at the butt end in accordance with the supported length, 1/6th of the total length of each pole.

For horizontal testing, provision may be made by suitable supports to neutralise the bending moment induced by the weight of the pole. (Ref. drawing No. DS&S/51-1/98)

"Apply the test load at a point 0.60m from the top of the pole and raise it in increments of 10% of the ultimate load. Take measurements of deflection after each increment of 10% of the ultimate load. At 40% and at 60% of ultimate load reduce the load to zero and measure the permanent set. Then increase the load in steps of 10% of the ultimate load until failure occurs, maintaining each load above 60% of the ultimate load for at least two minutes (failure load is the load at which the dynamometer indicates no further increase in load)".

The whole batch of 100 would be acceptable to the CEB, if the tested pole passes the criteria given in (a), (b), (c), (d) and (e).

a) During the application of load upto 40% of the ultimate load, the pole shall not have developed any hair cracks.

b) The permanent set recorded, after removal of a test load of 60% of ultimate load shall not exceed 10% of the deflection recorded for same test load.

c) The hair cracks produced while loading upto 60% of the ultimate load, shall clearly close up on removal of the test load.

d) The test load at failure shall exceed the ultimate load.

e) On breaking the concrete after failure it shall be established that the following requirements are in accordance with the corresponding drawing/specification of Pole.

i) Type, diameter, length number of bars and positioning of the main reinforcement.

ii) Type, diameter, shape and spacing of stirrups.

11.3 Failure to satisfy acceptance criteria

In the event that a pole does not satisfy any of the above acceptance criteria for the type tests, then one more pole shall be tested for all the five acceptance criteria. If additional pole tested fails to satisfy the acceptance criteria then the entire batch shall be rejected. All the poles rejected shall be marked with a permanent ink, of at a distance of 2.5 m from the bottom of the pole and removed from the site immediately.

11.4 The cost of testing shall be borne by the contractor. This also includes the cost of poles used for testing.

12. TRANSPORTATION

12.1 Transport to Site

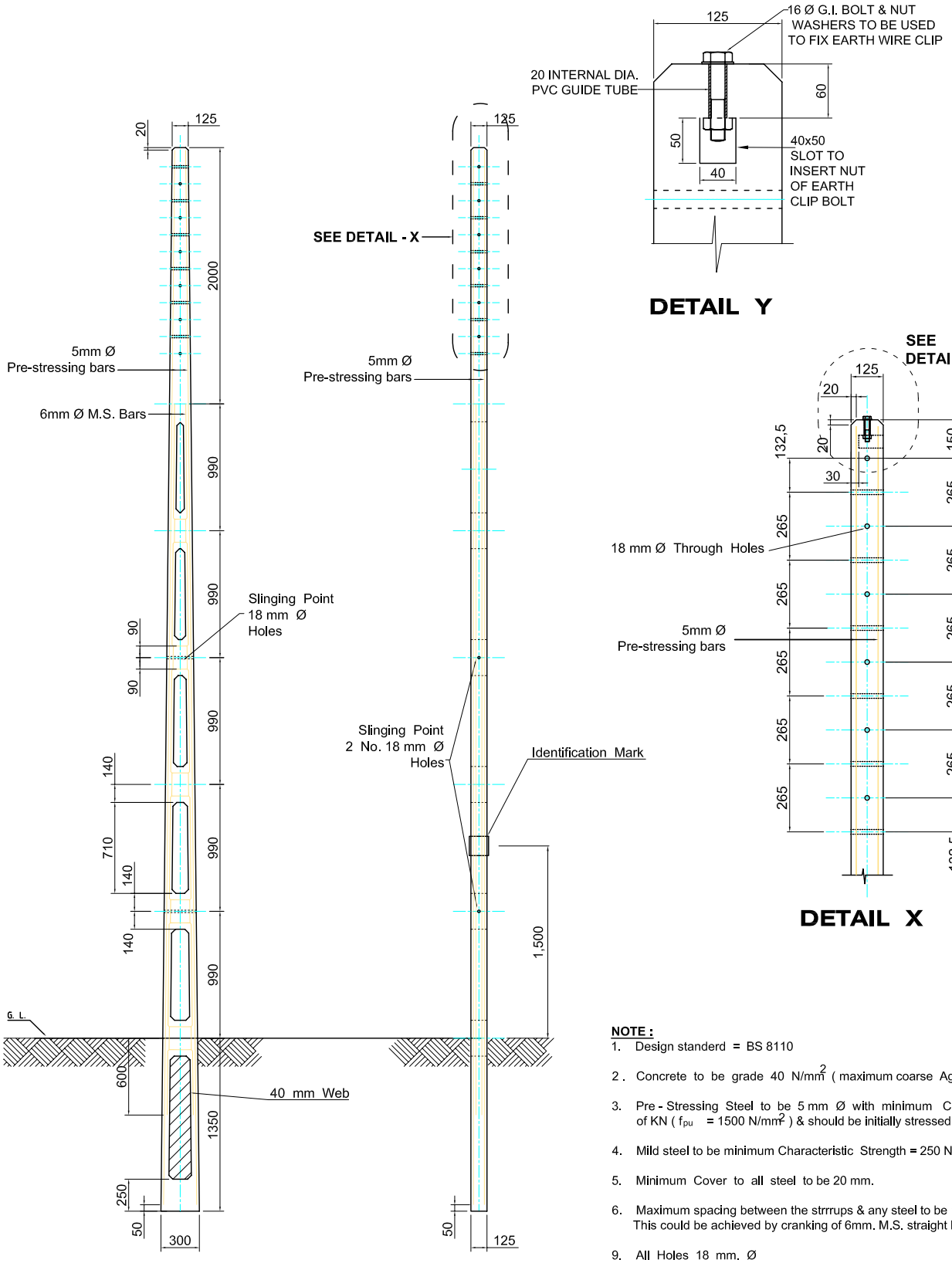
They shall be transported on vehicles that provide full length support without any overhang.

Any poles that show sign of damage shall be rejected and shall be removed by the Contractor.

While transporting the major axis of the pole shall be kept in vertical position.

12.2 Lifting and Storage

Poles shall only be lifted by the points designated on the manufacturing drawings and when stacked at the manufacturing plant or at the point of delivery shall be separated by timber bearers placed between each unit at the designated lifting points. Timber bearers shall be placed only on lines vertically above each other. Poles shall be stacked such that the major axis of the pole will be kept in the vertical position.



NOTE :

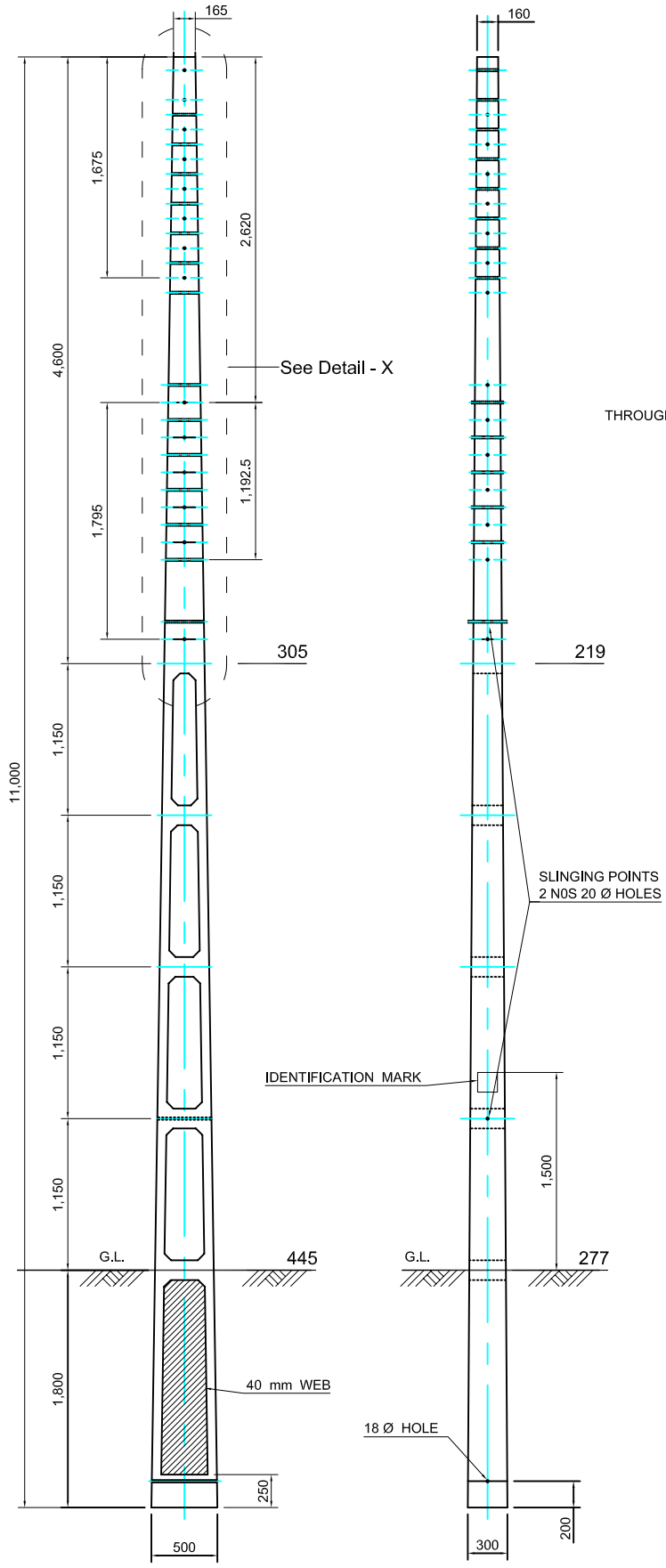
1. Design standerd = BS 8110
2. Concrete to be grade 40 N/mm^2 (maximum coarse Agg. size = 15 mm)
3. Pre - Stressing Steel to be 5 mm Ø with minimum Characteristic Strength of KN (f_{pu} = 1500 N/mm^2) & should be initially stressed to 75% of this value.
4. Mild steel to be minimum Characteristic Strength = 250 N/mm^2
5. Minimum Cover to all steel to be 20 mm.
6. Maximum spacing between the strrrups & any steel to be 15mm. This could be achieved by cranking of 6mm. M.S. straight bars.
9. All Holes 18 mm. Ø

DESIGN DATA

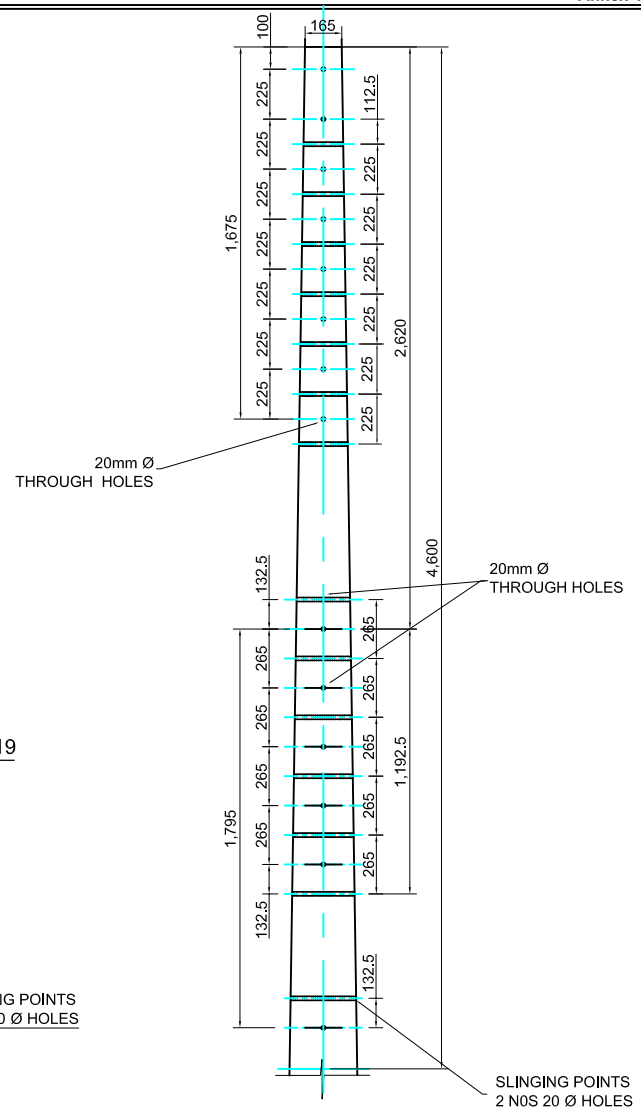
Maximum working load = 100 Kg.
Overall height of pole = 8.3m
Buried Length = 1.35m
Type of construction = Vierendeel type
Factor of Safety = 2.5

ALL DIMENSIONS ARE IN mm.

CEYLON ELECTRICITY BOARD	DISTRIBUTION STANDARDS & SPECIFICATION	SCALE : NOT TO SCALE
	8.3 METER 100 KG PRE-STRESSED CONC. POLE	DRAWN : LALANI
	DESIGNED BY / APPROVED BY	DATE : Jan. , 2003
		DRG. NO : DS&S/2003/7803
DIST. PLANNING BRANCH	CHIEF ENGINEER (DS & S) / CHAIRMAN, SPECIFICATION COMMITTEE	CAD NO :



ELEVATION



DETAIL X

ALL DIMENSIONS ARE IN MM.

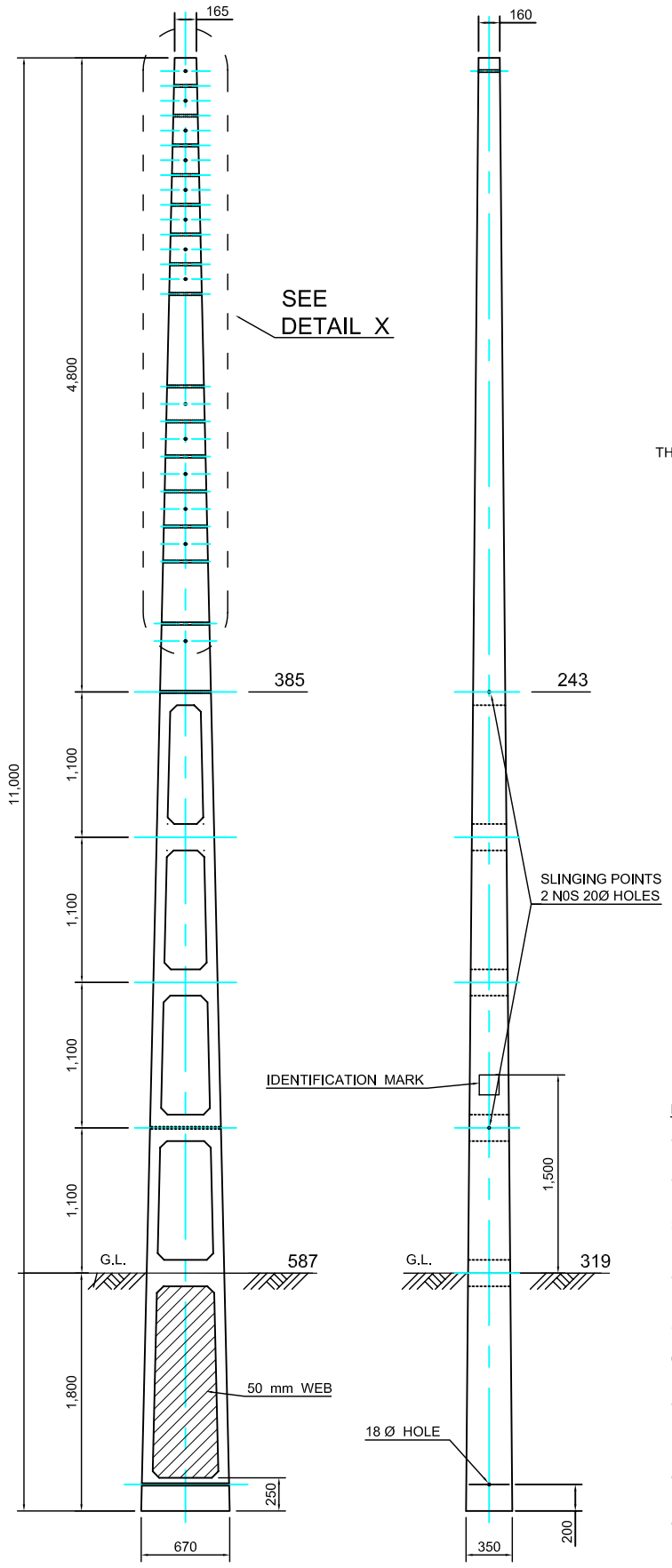
NOTE

1. CONCRETE TO BE GRADE C40 (NOMINL AGG. SIZE = 15 mm
2. PRE STRESSING STEEL TO BE Ø 5 mm HIGH TENSILE STEEL WITH MIN. 32 KN CHARACTERISTIC
3. SECONDARY STEEL TO BE 10 mm. TOR STEEL WITH MIN. 450 N/mm^2 CHARATERISTIC STRENGTH
4. STIRRUPS & WEB REINFORCEMENT TO BE MILD STEEL HAVING MINIMUM 250 N/mm^2 CHARACTERISTIC STRENGTH
5. MIN. COVER TO ALL STEEL 20 mm.
6. MIN. SPACING BETWEEN SECONDARY STEEL TO BE 25 mm. MIN. SPACING BETWEEN H.T. STEEL TO BE 20mm.
7. H.T. WIRES DE BONDED (1/2 No. EACH FACE)
   2 Nos. FOR THE TOP 1500
   2 Nos. FOR THE TOP 1000
8. 10 Nos. Ø6mm MILD STEEL STIRRUPS AT 150 CTRS FROM FROM TOP OF POLE
9. 4 Nos. 5mm UNITENSIONED H.T. WIRES UP TO 6.8 M FROM BOTTOM END
10. ALL HOLES Ø20 mm UNLESS SPECIFIED OTHERWISE.

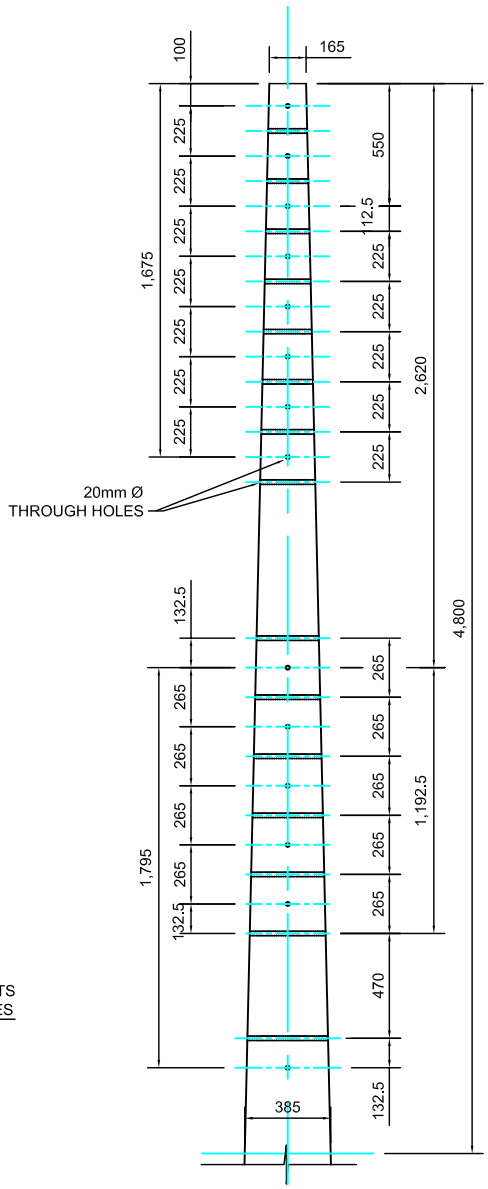
DESIGN CRITERIA

1. THIS POLE IS DESIGNED FOR A WORKING LOAD OF 500Kg IN THE TRANSVERSE DIRECTION & 125Kg. IN THE LONGITUDINAL DIRECTION, APPLIED AT A POINT 0.6M BELOW TOP OF POLE.
2. FACTOR OF SAFETY - 2.5

CEYLON ELECTRICITY BOARD	DISTRIBUTION STANDARDS & SPECIFICATION	SCALE : NOT TO SCALE
	11.0 METER 500 KG PRE-STRESSED CONCRETE POLE	DRAWN : LALANI
	DESIGNED BY / APPROVED BY	DATE : SEP. 2002
		DRG. NO : DS&S/2002/7715
DIST. PLANNING BRANCH	CHIEF ENGINEER (DS & S) / CHAIRMAN, SPECIFICATION COMMITTEE	CAD NO :



ELEVATION



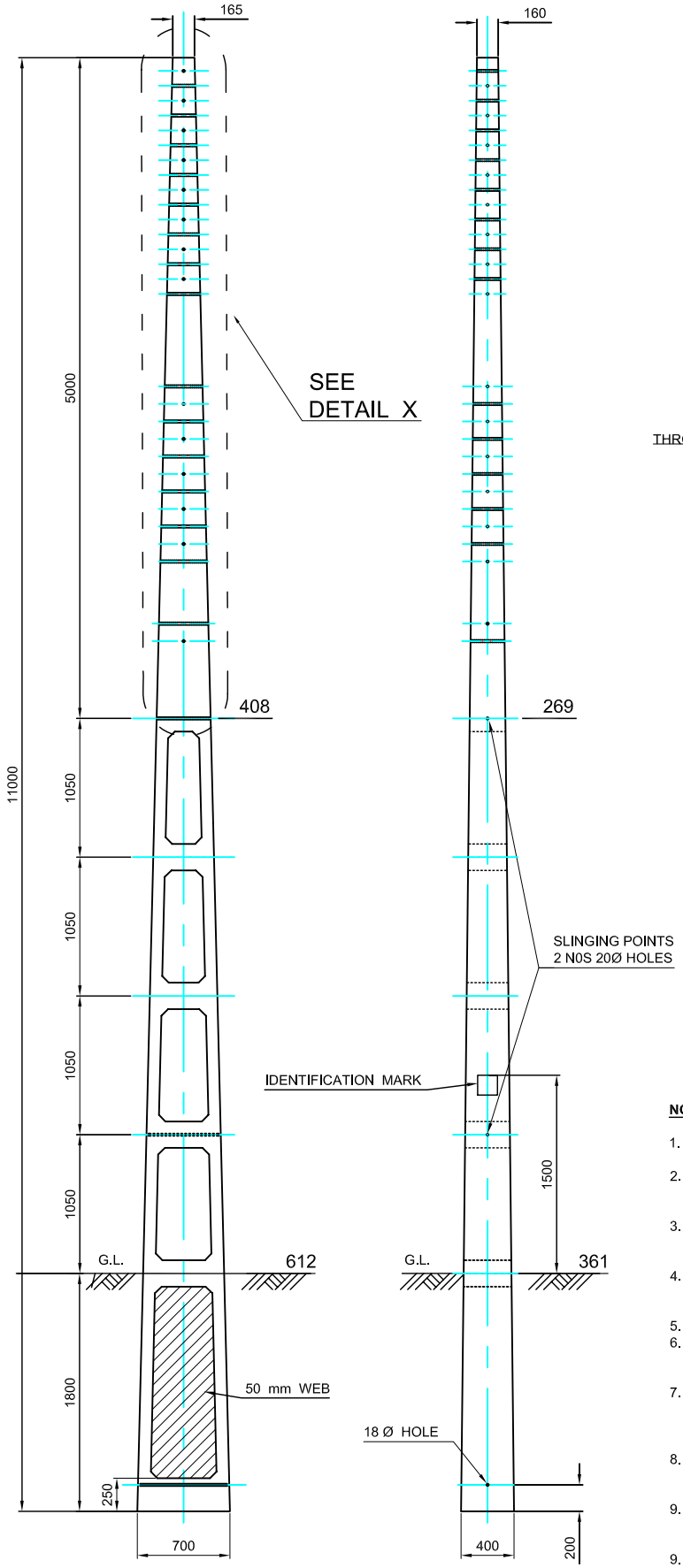
DETAIL X

NOTE

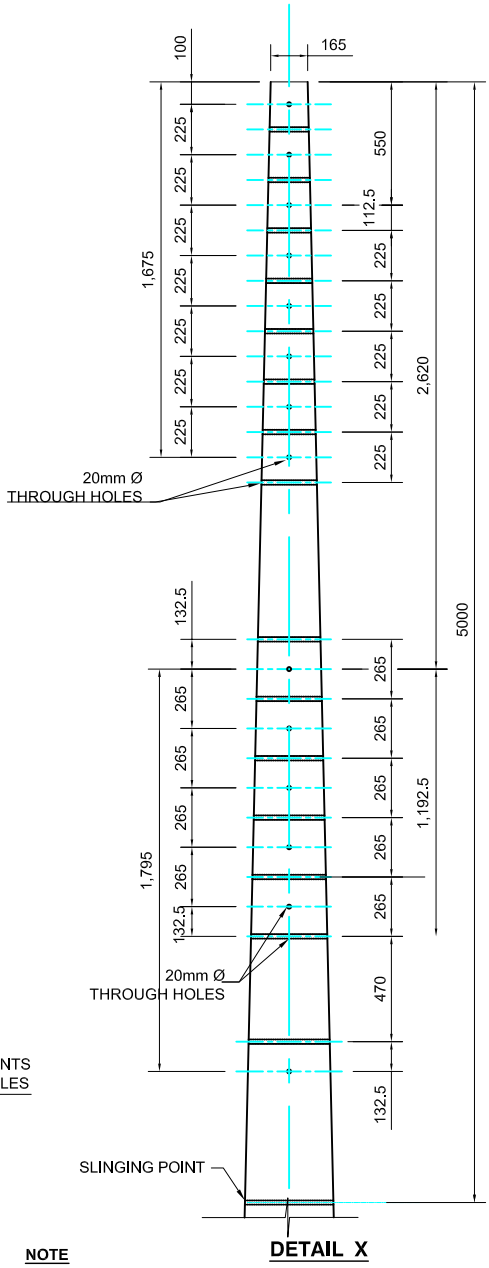
1. CONCRETE TO BE GRADE C40 (NOMINL AGG. SIZE = 15 mm
2. PRE STRESSING STEEL TO BE Ø 5 mm HIGH TENSILE STEEL WIRES WITH MIN. 32 KN CHARACTERISTIC.
3. SECONDARY STEEL TO BE 10 mm. TOR STEEL WITH MIN. 450 N/mm^2 CHARATERISTIC STRENGTH.
4. STIRRUPS & WEB REINFORCEMENT TO BE MILD STEEL HAVING MINIUM 250 N/mm^2 CHARACTERISTIC STRENGTH.
5. MIN. COVER TO ALL STEEL 20 mm
6. MIN. SPACING BETWEEN SECONDARY STEEL TO BE 25 mm. MIN. SPACING BETWEEN H.T. STEEL TO BE 20 mm.
7. H.T. WIRES DE BONDED (1/2 No. EACH FACE)
   2 Nos. FOR THE TOP 1500
   2 Nos. FOR THE TOP 1000
8. 10 Nos. Ø 6mm MILD STEEL STIRRUPS AT 150 CTRS FROM TOP OF POLE
9. 4 Nos. 5mm UNITENSIONED H.T. WIRES UP TO 6.8 M FROM BOTTOM END
9. ALL HOLES Ø20 mm UNLESS SPECIFIED OTHERWISE.

ALL DIMENSIONS ARE IN MM.

CEYLON ELECTRICITY BOARD	DISTRIBUTION STANDARDS & SPECIFICATION	SCALE : NOT TO SCALE
	11.0 METER 850 KG PRE-STRESSED POLE	DRAWN : LALANI
	CHECKED BY / APPROVED BY	DATE : Dec. 2002
		DRG. NO : DS&S/98/7730
DIST. PLANNING BRANCH	CHIEF ENGINEER (DS & S) / CHAIRMAN, SPECIFICATION COMMITTEE	CAD NO :



ELEVATION



DETAIL X

NOTE

1. CONCRETE TO BE GRADE C40 (NOMINL AGG. SIZE = 15 mm
2. PRE STRESSING STEEL TO BE Ø 5 mm HIGH TENSILE STEEL WITH MIN. 32 KN CHARACTERISTIC.
3. SECONDARY STEEL TO BE 10 mm. TOR STEEL WITH MIN. 450 N/mm^2 CHARATERISTIC STRENGTH.
4. STIRRUPS & WEB REINFORCEMENT TO BE MILD STEEL HAVING MINIMUM 250 N/mm^2 CHARACTERISTIC STRENGTH.
5. MIN. COVER TO ALL STEEL 20 mm.
6. MIN. SPACING BETWEEN SECONDARY STEEL TO BE 25 mm. MIN. SPACING BETWEEN H.T. STEEL TO BE 20 mm.
7. H.T. WIRES DE - BONDED (1/2 No. EACH FACE)
   2 Nos. FOR THE TOP 1500
   2 Nos. FOR THE TOP 1000
8. 10 Nos. Ø 6mm MILD STEEL STIRRUPS AT 150 CTRS FROM TOP OF POLE.
9. 4 Nos. 5mm UNITENSIONED H.T. WIRES UP TO 6.8 M FROM BOTTOM END.
9. ALL HOLES Ø20 mm UNLESS SPECIFIED OTHERWISE.

ALL DIMENSIONS ARE IN MM.

CEYLON ELECTRICITY BOARD

DIST. PLANNING BRANCH

DISTRIBUTION STANDARDS & SPECIFICATION

11.0 METER 1200 KG PRE-STRESSED CONCRETE POLE

CHECKED BY — CHIEF ENGINEER (DS & S)

APPROVED BY — CHAIRMAN, SPECIFICATION COMMITTEE

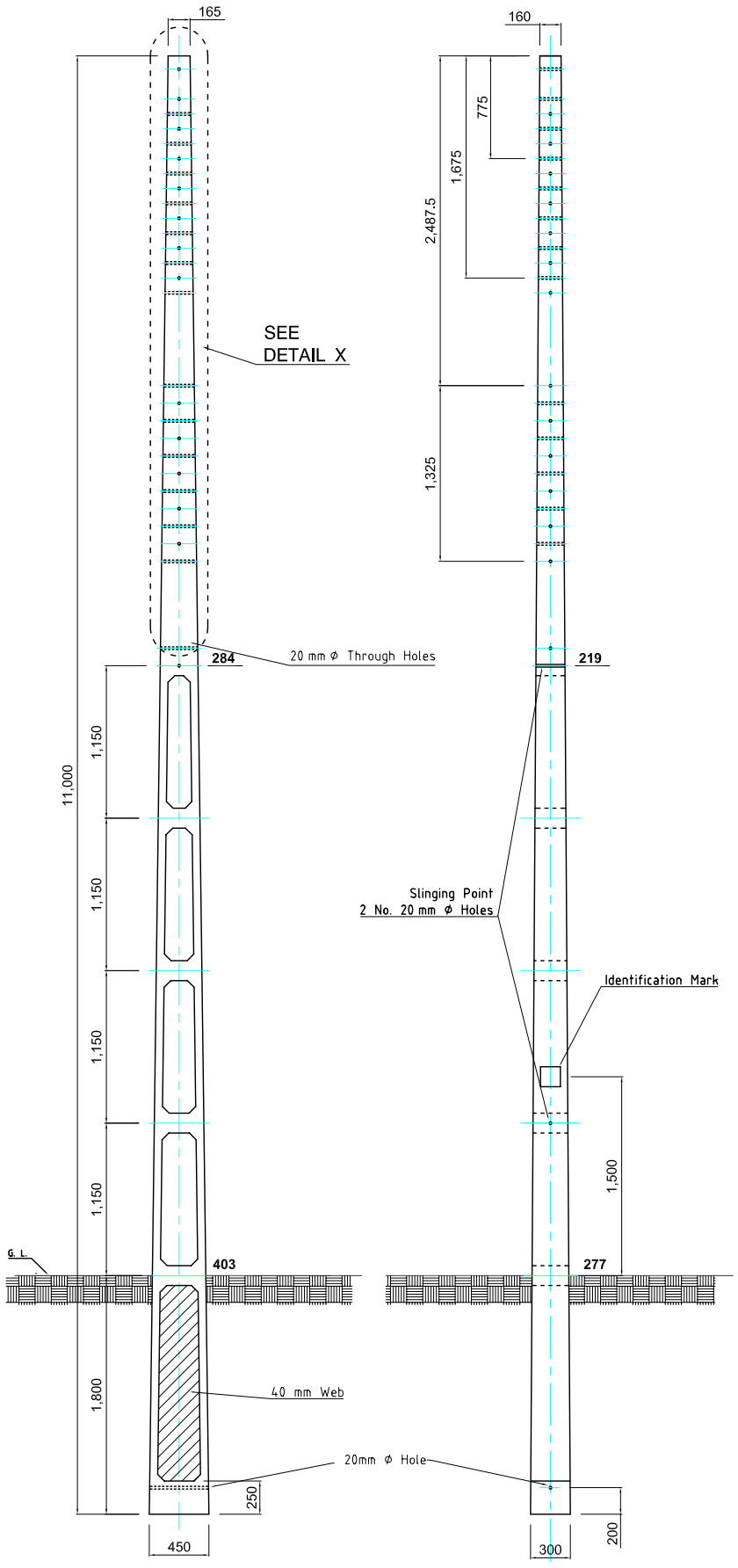
SCALE : NOT TO SCALE

DRAWN : LALANI

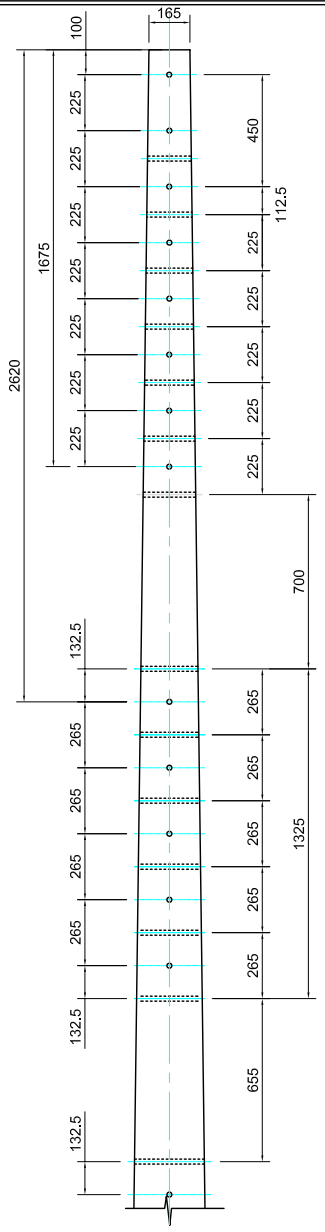
DATE : Jan. 2003

DRG. NO : DS&S/2003/7732

CAD NO :



ELEVATION



DETAIL X

ALL DIMENSIONS ARE IN mm.

NOTE :

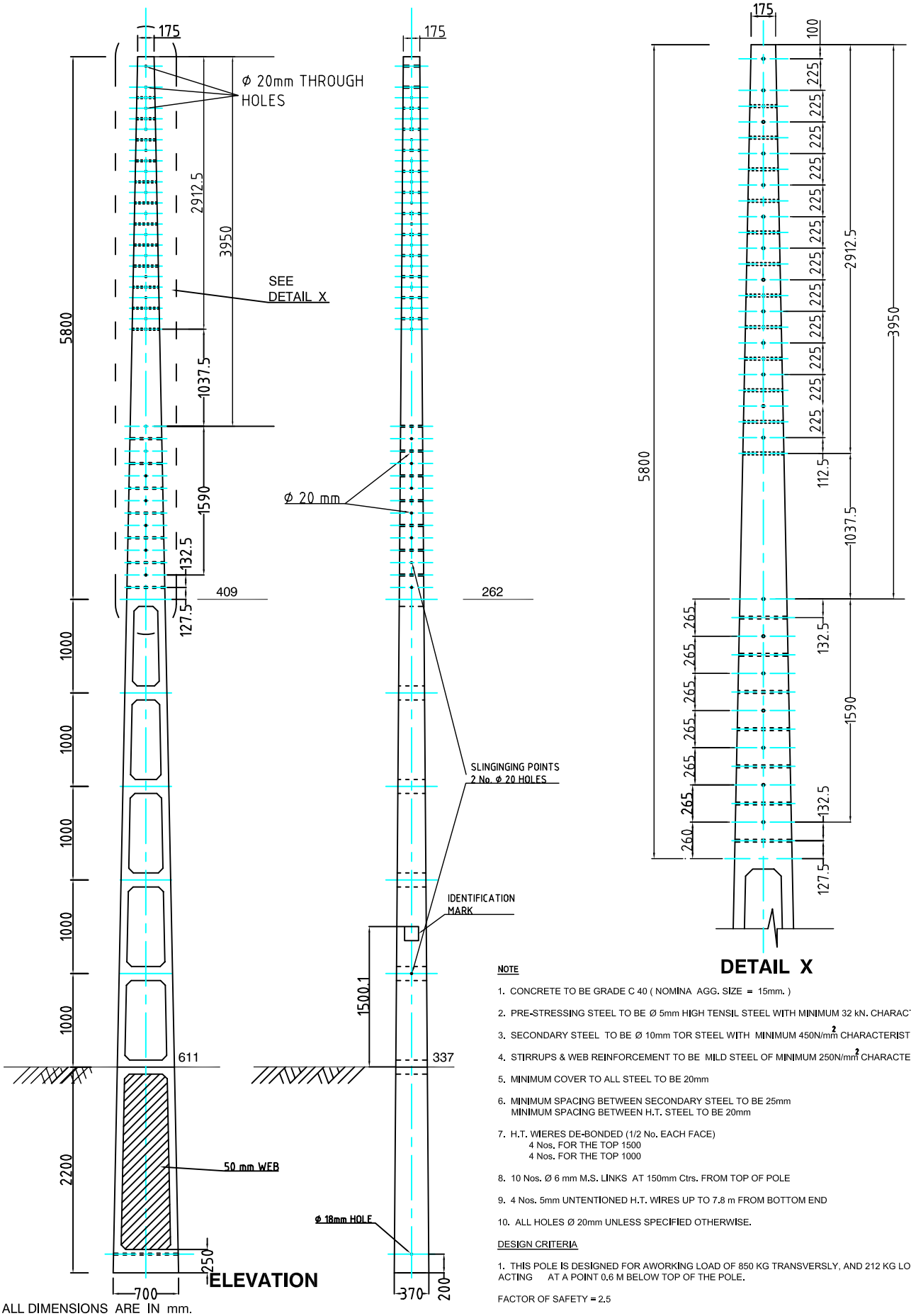
1. Concrete to be grade C40 (Normal Agg. size = 15 mm
2. Pre - Stressing Steel to be 10 mm Ø High Tensile Steel wires with 32 kN Characteristic Strength.
3. Secondary Steel to be 10 mm Ø Tor Steel with min. 450 N/mm^2 Characteristic Strength.
4. 4 Links to be 6 mm Ø Mild steel with minimum 250 N/mm^2 Characteristic Strength.
5. Minimum Cover to all steel 20 mm.
6. Minimum spacing between secondary steel to be 25 mm. Minimum spacing between H. T. steel to be 20 mm.
7. H. T. wires De - Bonded (1/2 No. of each)
   2 Nos. for the top 1500
   2 Nos. for the top 1000
8. 10 Nos. Links of 6 mm Ø Mild steel at 150 mm. Ctrs. from top end of Pole.
9. All Holes 20 mm. Ø Unless specified otherwise.

DESIGN CRITERIA

This pole is designed for a working load of 350 Kg. Transverly, and 87 Kg. Longitudinally, acting at a point 0.6 m. below the top of the pole.

Factor of Safety = 2.5

CEYLON ELECTRICITY BOARD	DISTRIBUTION STANDARDS & SPECIFICATION	SCALE : NOT TO SCALE
	11.0 METER 350 KG PRE-STRESSED POLE	DRAWN : LALANI
	CHECKED BY / APPROVED BY	DATE : SEP. 1998
		DRG. NO : DS&S/98/7713
DIST. PLANNING BRANCH	CHIEF ENGINEER (DS & S) / CHAIRMAN, SPECIFICATION COMMITTEE	CAD NO :



ALL DIMENSIONS ARE IN mm.

NOTE

1. CONCRETE TO BE GRADE C 40 (NOMINA AGG. SIZE = 15mm.)
2. PRE-STRESSING STEEL TO BE Ø 5mm HIGH TENSIL STEEL WITH MINIMUM 32 kN. CHARACTERISTIC U. T. S
3. SECONDARY STEEL TO BE Ø 10mm TOR STEEL WITH MINIMUM 450N/mm^2 CHARACTERISTIC STRENGTH
4. STIRRUPS & WEB REINFORCEMENT TO BE MILD STEEL OF MINIMUM 250N/mm^2 CHARACTERISTIC STRENGTH.
5. MINIMUM COVER TO ALL STEEL TO BE 20mm
6. MINIMUM SPACING BETWEEN SECONDARY STEEL TO BE 25mm
   MINIMUM SPACING BETWEEN H.T. STEEL TO BE 20mm
7. H.T. WIERES DE-BONDED (1/2 No. EACH FACE)
   4 Nos. FOR THE TOP 1500
   4 Nos. FOR THE TOP 1000
8. 10 Nos. Ø 6 mm M.S. LINKS AT 150mm Ctrs. FROM TOP OF POLE
9. 4 Nos. 5mm UNTENTIONED H.T. WIRES UP TO 7.8 m FROM BOTTOM END
10. ALL HOLES Ø 20mm UNLESS SPECIFIED OTHERWISE.

DESIGN CRITERIA

1. THIS POLE IS DESIGNED FOR AWORKING LOAD OF 850 KG TRANSVERSLY, AND 212 KG LONGITUDINALLY ACTING AT A POINT 0.6 M BELOW TOP OF THE POLE.

FACTOR OF SAFETY = 2.5

CEYLON ELECTRICITY BOARD

DIST. PLANNING BRANCH

DISTRIBUTION STANDARDS & SPECIFICATION

13 m / 850 KG PRE-STRESSED CONCRETE POLES

CHECKED BY — CHIEF ENGINEER (DS & S)

APPROVED BY — CHAIRMAN, SPECIFICATION COMMITTEE

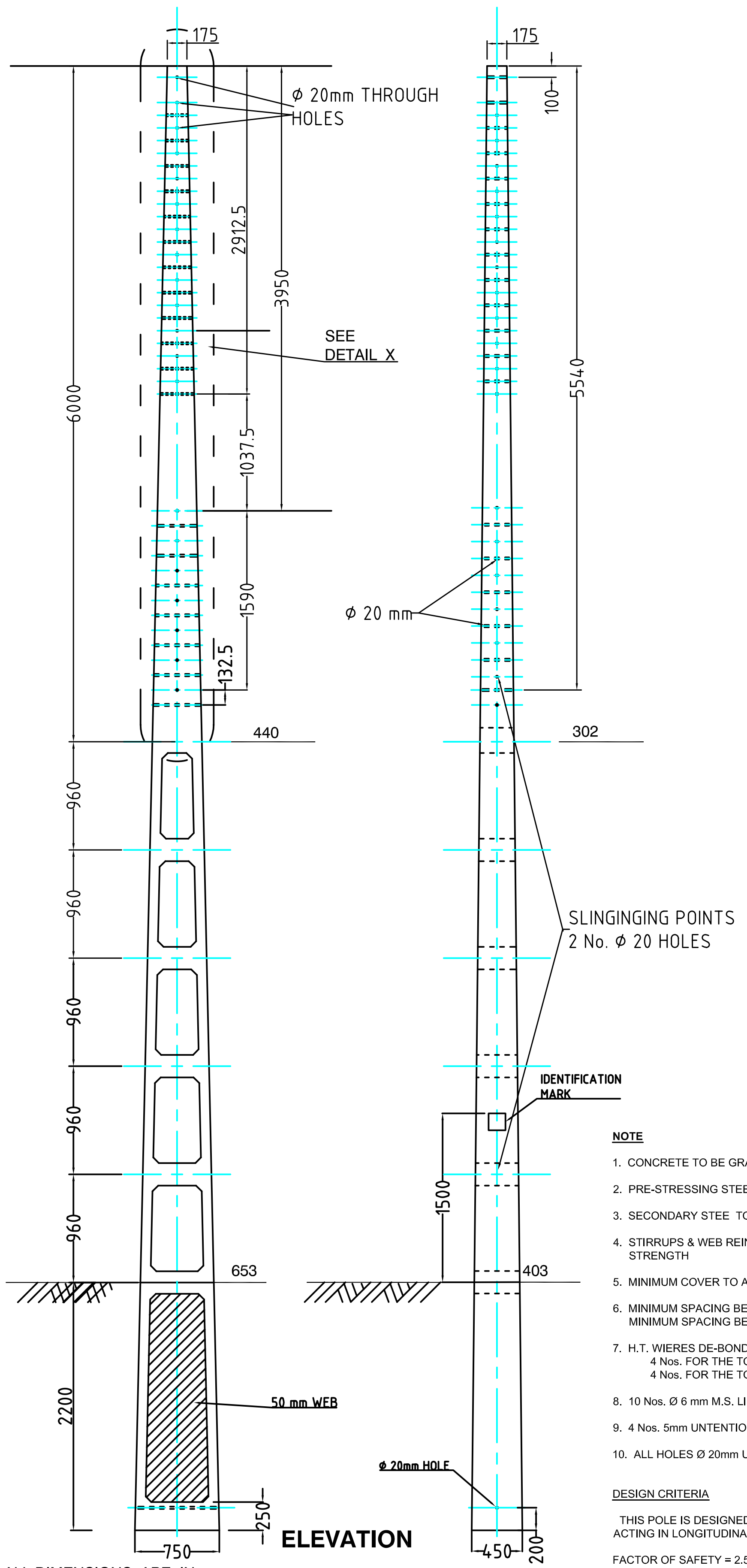
SCALE : NOT TO SCALE

DRAWN : LALANI

DATE : SEP. 1999

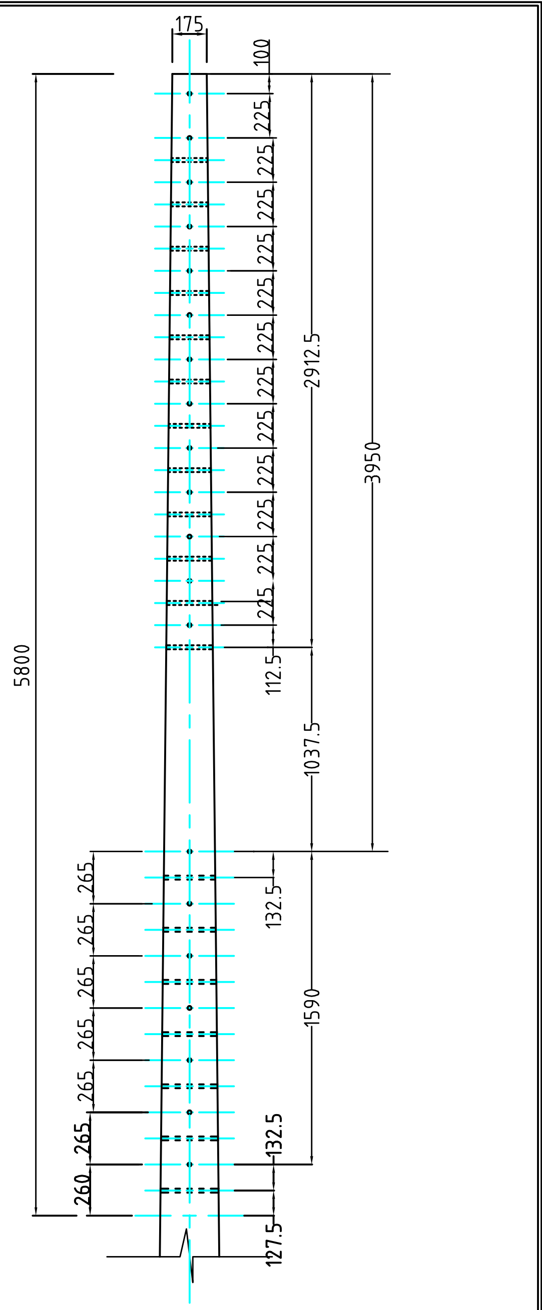
DRG. NO : DS&S/98/7712

CAD NO :



ELEVATION

ALL DIMENSIONS ARE IN mm.



DETAIL X

NOTE

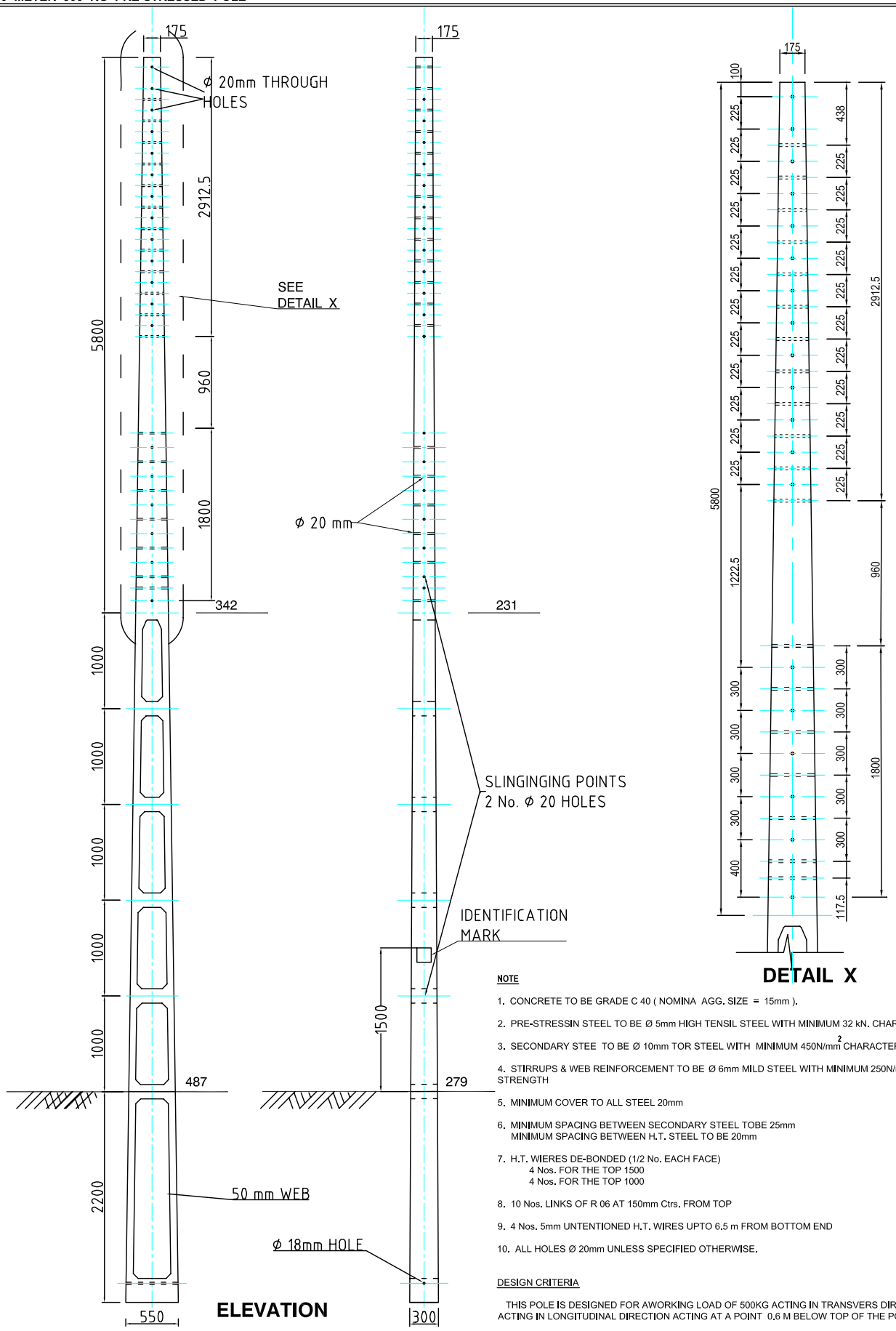
1. CONCRETE TO BE GRADE C 40 (NOMINA AGG. SIZE = 15mm.)
2. PRE-STRESSING STEEL TO BE Ø 5mm HIGH TENSIL STEEL WITH MINIMUM 32 kN. CHARACTERISTIC U. T. S
3. SECONDARY STEE TO BE Ø 10mm TOR STEEL WITH MINIMUM 450N/mm^2 CHARACTERISTIC STRENGTH
4. STIRRUPS & WEB REINFORCEMENT TO BE Ø 6mm MILD STEEL WITH MINIMUM 250N/mm^2 CHARACTERISTIC STRENGTH
5. MINIMUM COVER TO ALL STEEL 20mm
6. MINIMUM SPACING BETWEEN SECONDARY STEEL TO BE 25mm
   MINIMUM SPACING BETWEEN H.T. STEEL TO BE 20mm
7. H.T. WIERES DE-BONDED (1/2 No. EACH FACE)
   4 Nos. FOR THE TOP 1500
   4 Nos. FOR THE TOP 1000
8. 10 Nos. Ø 6 mm M.S. LINKS AT 150mm Ctrs. FROM TOP OF POLE
9. 4 Nos. 5mm UNTENTIONED H.T. WIRES UPTO 7.8 m FROM BOTTOM END
10. ALL HOLES Ø 20mm UNLESS SPECIFIED OTHERWISE.

DESIGN CRITERIA

THIS POLE IS DESIGNED FOR AWORKING LOAD OF 1200 KG ACTING IN TRANSVERS DIRECTION, AND 212 KG ACTING IN LONGITUDINAL DIRECTION ACTING AT A POINT 0.6 M BELOW TOP OF THE POLE.

FACTOR OF SAFETY = 2.5

CEYLON ELECTRICITY BOARD	DISTRIBUTION STANDARDS & SPECIFICATION		SCALE : NOT TO SCALE
	13 m / 1200 KG PRE-STRESSED CONCRETE POLES		DRAWN : LALANI
	CHECKED BY	APPROVED BY	DATE : SEP. 1999
			DRG. NO : DS&S/99/7725
DIST. PLANNING BRANCH	CHIEF ENGINEER (DS & S)	CHAIRMAN, SPECIFICATION COMMITTEE	CAD NO :



ALL DIMENSIONS ARE IN mm.

NOTE

1. CONCRETE TO BE GRADE C 40 (NOMINA AGG. SIZE = 15mm).
2. PRE-STRESSIN STEEL TO BE Ø 5mm HIGH TENSIL STEEL WITH MINIMUM 32 kN. CHARACTERISTIC U. T. S
3. SECONDARY STEE TO BE Ø 10mm TOR STEEL WITH MINIMUM 450N/mm^2 CHARACTERISTIC STRENGTH
4. STIRRUPS & WEB REINFORCEMENT TO BE Ø 6mm MILD STEEL WITH MINIMUM 250N/mm^2 CHARACTERISTIC STRENGTH
5. MINIMUM COVER TO ALL STEEL 20mm
6. MINIMUM SPACING BETWEEN SECONDARY STEEL TOBE 25mm
   MINIMUM SPACING BETWEEN H.T. STEEL TO BE 20mm
7. H.T. WIERES DE-BONDED (1/2 No. EACH FACE)
   4 Nos. FOR THE TOP 1500
   4 Nos. FOR THE TOP 1000
8. 10 Nos. LINKS OF R 06 AT 150mm Ctrs. FROM TOP
9. 4 Nos. 5mm UNTENTIONED H.T. WIRES UPTO 6.5 m FROM BOTTOM END
10. ALL HOLES Ø 20mm UNLESS SPECIFIED OTHERWISE.

DESIGN CRITERIA

THIS POLE IS DESIGNED FOR AWORKING LOAD OF 500KG ACTING IN TRANSVERS DIRECTION, AND 125KG ACTING IN LONGITUDINAL DIRECTION ACTING AT A POINT 0.6 M BELOW TOP OF THE POLE.

FACTOR OF SAFETY = 2.5

CEYLON ELECTRICITY BOARD	DISTRIBUTION STANDARDS & SPECIFICATION	SCALE : NOT TO SCALE
	13 m / 500 KG PRE-STRESSED CONCRETE POLES	DRAWN : LALANI
	CHECKED BY / APPROVED BY	DATE : SEP. 1998
		DRG. NO : DS&S/98/7714
DIST. PLANNING BRANCH	CHIEF ENGINEER (DS & S) / CHAIRMAN, SPECIFICATION COMMITTEE	CAD NO :