Clique CONSULTANTS PVT. LTD.
ENGINEERING CONSULTANTS

Our Ref. No. CC 13 /C500/130 Date: September 01, 2014

TO WHOMSOEVER IT MAY CONCERN

This is to certify that at the request of M/s Ramkrishna Iron Works Private Limited, their Design of 120 M Tall Lattice Wind Mast having below mentioned specifications was evaluated and verified by us for Structural Stability:

1. 120m Tall Slender Lattice Structure Supported by Inclined Pre-Tensioned Cables
2. Design Wind Velocity : 55 mps at 10M above Ground Level
3. Wind Loading in conformity to IS : 875 - 1987: Code of Practice for Design Loads, Part 3 – Wind Loads
4. Lattice Structure is 400mm x 400mm, formed using Four Corner Legs of ISA 50 x 50 x 8 till 5m, 50 x 50 x 6 for remaining up to 90m and 40 x 40 x 6 up to 120m, Lacing & Bracing Members of 10mm Square Bars and Section Flange Members of ISA 50 x 50 x 6, all Grade 250MPa (RKIWPL Drg No. BY - 2 - 3010, Rev. R3 dtd 01.09.2014 : Assembly and Details of 120m Lattice Wind Mast)
5. Cables adopted are 8mm dia Galvanized Wire-ropes in 6 x 19 (12 / 6/ 1) Construction in Conformity to IS:2266 : Steel Wire Ropes for General Engineering Purpose - Specification, of Grade 1570MPa (Steel Core) with Minimum Breaking Force of 36 kN
6. Pre-Tensioning of Cable : 7 kN
7. Cable Anchoring Blocks are 3800mm Long x 2000mm Wide x 1500mm Deep Concrete Blocks placed at 27m, 45m and 55m from Mast Centre on Four Orthogonal Directions (RKIWPL Drg No. BY - 4 – 4004, Rev. R3 dtd 01.09.2014 : Foundation Drawing for 120m Lattice Wind Mast)
8. On Each of Four Orthogonal Directions, One Set of Cables is Anchored 27m from Mast Centre and tied with Lattice Structure at 10m,20m,30m and 40m Level
9. On Each of Four Orthogonal Directions, One Set of Cables is Anchored 45m from Mast Centre and tied with Lattice Structure at 50m,60m,70m and 80m Level
10. On Each of Four Orthogonal Directions, One Set of Cables is Anchored 55m from Mast Centre and tied with Lattice Structure at 90m,100m,110m and 118m Level
11. Forces in all Lattice and Cable Elements are found within Permissible Limits
12. Cable Anchor Blocks are found safe against Uplift, Sliding and Overturning
13. Boom Arm made of 25.4 Outer Dia 2 thk MS Pipe (RKIWPL Drg No. BY - 4 – 4025 Rev. R1 dtd 01.09.2014) is certified Structurally Adequate.

After due verification including Non-linear Analysis, it is certified that the design as submitted by M/s Ramkrishna Iron Works Private Limited is structurally sound and stable in conformity to IS 800 and IS 875 up to 55 mps wind velocity

For **Clique Consultants Private Limited**,

A D Paranjape, Director
MIE (India) Regn No. **M 041815**

Encl:
1. RKIWPL Drg No. BY - 1 – 3010, Rev. R3 dtd 01.09.2014: Assembly and Details of 120m Lattice Wind Mast)
2. RKIWPL Drg No. BY - 4 – 4004, Rev. R3 dtd 01.09.2014: Foundation Drawing for 120m Lattice Wind Mast)
3. RKIWPL Drg No. BY - 4 – 4025 Rev. R1 dtd 01.09.2014: Boom Arm

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CLIQUE CONSULTANTS PRIVATE LIMITED

Doc No. : C500 / CI / DS / A4 / 111

Analysis and Design Review

for

120 M Tall Latticed Wind Mast

for

Ramkrishna Iron Works Private Limited
26 Gobind Mahal
Marine Drive
Mumbai - 400 001

By

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R0	1-Sep-14	ISSUED FOR RECORDS	KDK	NPV	ADP
Rev.	Date	Description	By	Chkd.	Appv.

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DESIGN VERIFICATION BASIS FOR 120M TALL WIND MAST

1 Introduction :-

This document validates the Structural Adequacies of all Elements of 120 M Tall Latticed Wind Mast. The Mast is formed by Four Legs which are Laced and Guyed in Four Orthogonal Directions at Multiple Levels

2 References :-

a. IS: 875-1987 : Code of Practice for Design Loads (other than earth-quake) for Buildings & Structures- Part-3 -Wind Loads.

b. IS: 1835-1976 : Specificationz for round steel wire for ropes.

c. IS: 2266-1989 : Steel wire ropes for general engineering purposes-specification.

d. IS: 2363-1981 : Glossary of terms relating to wire ropes.

e. IS: 3459-1977 : Specification for small wire ropes.

f. IS: 6594-2001 : Technical supply conditions for steel wire ropes & strands.

g IS: 800- 1984 : Code of Practice for General Construction in Steel

3 Materials Of Construction :-

a. Angles: 50x50x6, 40x40x6 - Grade - 250 Mpa.

b. Steel Plates & 10 Dia /SQ Round Bar - Grade - 250 Mpa.

c. Steel wire ropes - Grade 1570 Mpa, 8mm diameter.

4 Specification For Steel Wire Ropes :-

a. The wires shall conform to IS : 6594-2001 " Technical supply conditions for wire ropes & Strands (Second Revision)" & IS:2266-1989 "Steel Wire Ropes For General Engineering Purposes-Specifications(Third Revision)"

b. The wires shall be of 6 x 19 (12 / 6 / 1) construction which implies that the wire c/s consists of Total 6 Nos. Strands with 19 Nos. Small Wires Arranged in the Form (12 / 6 / 1)
i.e. 12 Wires in the Outer Layer, 6 in the Middle Layer & 1 Wire in the Inner-most Layer.
(Refer IS : 2266:1989 Steel Wire Ropes For General Engineering Purposes-Specifications.)

5 Software used :-

Staad-Pro V8i for Structural Analysis.

MS Excel for Design Verification Calculations.

6 Design Loads :-

The following are the loads acting on the structure :

a. Self-weight of the structure :-

1) Self weight of the mast and cables is generated through selfweight command in *Staad-Pro V8i*

b. Pre-Tensioning of Guy-Ropes :-

7 kN Pre-Tension in all Guy-Ropes

c. Wind-Loading :-

Wind loads are Estimated in Conformity to IS : 875 - 1987 - Part 3 - Wind Loads.

(Basic wind speed considerd for the design is 55 m/s.)

7 Sub Structure Design Parameters :-

a.	The Unit Weight of Concrete		=	25	kN/m^3
b.	Net Safe Bearing Capacity of Soil		=	100	kN/m^2
c.	Co-efficient of Friction Against Sliding		=	0.5	
d.	Grade Of Concrete	fck	=	20	N/mm^2
e.	Grade Of Steel	fy	=	415	N/mm^2
f.	The Unit Weight of Soil		=	18	kN/m^3
g.	Clear Cover At Bottom (Footing)		=	75	mm
h.	Clear Cover At Sides & Top (Footing)		=	50	mm
i.	Factor Of Safey Against Slinding		=	1.4	
j.	Factor Of Safey Against Overturning		=	1.4	

8 Structural Analysis & Design Review Approach for 120M Tall Lattice Wind Mast :-

1 Structural Analysis and Design Review of 120M Tall Lattice Wind Mast is performed using *Staad-Pro V8i* with steps as under :

1.1 Create a Model which numerically defines the Geometry, Properties, Loading and Analysis Parameters for the Structure.

1.2 Perform an Analysis of the Model.

1.3 Review the Results of the Analysis.

1.4 Check and Optimize The Design of the Strcuture.

2 The Latticed Wind Mast Structure is Modeled using:

2.1 The Beam Element for Three Dimensional Latticed (Truss) Mast Structure.

The Beam Element activates three translational Degrees of Freedom at each end.

2.2 The Cable Element for Guywires predominantly carrying Axial Tension.

Guy Wires are very slender and significant support movement is expected during the duty conditions and hence the Catenary Cable Element is the Best Choice to model guy wires.

The Cable Element activates the three translational degrees of freedom at each end of its connected joints. Rotational degrees of freedom are not activated. The Cable Element contributes stiffness to all these translational degrees of freedom

Guy wires are subjected to self weight and transverse wind load. Adequate Pre-Tension is applied to ensure that Cable Element always remain under Axial Tension for all possible duty conditions/ deformations.

Since the guy wires are not subjected to any intermediate masses/ concentrated loads, Single Segment suffices as the Best choice to define these Catenary Elements.

The Cable Element uses as elastic catenary formulation to represent the behaviour of the slender cable under its own self weight and transverse wind load. This behaviour is highly non-linear and inherently includes tension-stiffening (P-delta) and large deflection effects. Slack and Taut behaviour is automatically considered.

Convergence in Element Formation is attained by adequate iterations under actual load combination.

The specified combination of applied loads is applied incrementally, using as many steps as necessary to satisfy equilibrium.

The Non-linear equations are solved iteratively in each load step. This did require re-forming and re-solving the stiffness matrix. The iterations were carried out until solution converged.

3 Maximum Horizontal Deflection observed at the tip of the mast in normal condition is 626.145 mm. This magnitude of deflection will not have adverse effect on the performance of Wind Velocity Measuring Devices to be mounted there on.

Estimation of Levelwise Wind Pressure Values

Wind loading is calculated in accordance with IS: 875 - Part 3(1987)

Basic Wind Speed(Vb) = 55 m/s

K_1 (Risk Factor.) = 1

K_3 (Topography factor) = 1

Category of Structure = 1

Class of Structure = C

K_2(Terrain,Height and Structure Size Factor) as per Table2 Clause 5.3.2.2 ,IS 875 Part III

Design wind speed (Vb) = K1 X K2 X K3 X Vb

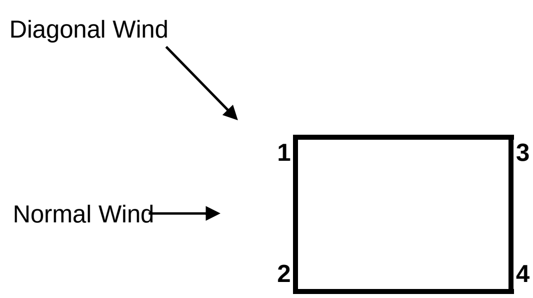
Design wind press. (Pz) = 0.6 X Vb2

Levels (m)	Height (m)	K2	Vz m/s	Pz kN/m2
0 to 10	10	0.99	54.45	1.779
10 to 15	5	1.03	56.65	1.926
15 to 20	5	1.06	58.30	2.039
20 to 25	5	1.075	59.13	2.097
25 to 30	5	1.09	59.95	2.156
30 to 35	5	1.1025	60.64	2.206
35 to 40	5	1.115	61.33	2.256
40 to 45	5	1.1275	62.01	2.307
45 to 50	5	1.14	62.70	2.359
50 to 55	5	1.146	63.03	2.384
55 to 60	5	1.152	63.36	2.409
60 to 65	5	1.158	63.69	2.434
65 to 70	5	1.164	64.02	2.459
70 to 75	5	1.17	64.35	2.485
75 to 80	5	1.176	64.68	2.510
80 to 85	5	1.182	65.01	2.536

85 to 90	5	1.188	65.34	2.562
90 to 95	5	1.194	65.67	2.588
95 to 100	5	1.2	66.00	2.614
100 to 105	5	1.204	66.22	2.631
105 to 110	5	1.208	66.44	2.649
110 to 114	4	1.2112	66.62	2.663
114 to 118	4	1.2144	66.79	2.677
118 to 120	2	1.216	66.88	2.684

Estimation of (Wind Load) Force Co-efficients

Wind Mast is Analysed for Normal and Diagonal Wind Load Cases
These two directions are depicted herebelow:



<u>Sample calculation for first 5m height of the Lattice Structure:</u>

Projected area :
For aproximate analysis of the structure, to calculate the Fondation forces, let us consider that all columns are of ISA 50 x 50 x 6
and all bracings are of 10 mm Dia Bar
Based upon these sections the projected area of all individual members of a frame normal to wind in X-Direction is given by,

Projected Area =

= (5000*50*2)	….	Vertical members of column, ISA 50*50*8
= (400-50*2)*50*2	….	Top an bottom member, ISA 50*50*8
= (650*16*1)	….	Bottom base plate, 16mm thick
= (520*6*1)	….	Top base plate, 6mm thick
= (400-50*2)*10*20	….	horizontal sq. bars, 10mm sq.
= (470*10*20)	….	Diagonal sq. bars, 10mm sq.
= 350*290*1	….	Logger shelter, 350 mm*290 mm

Total projected area = 799020 mm^2

0.80 m^2

Gross Area = 5000 x 400

2.000 X 10^6 mm2

= 2.000 m2

SolidityRatio (ϕ) = Projected Area / Gross Area

= 0.40

Force Coeff (Fc) = 2.30 **(Refer Table 30 of IS :875 Part 3 - 1987 , Pg 47)**

Summary Of Wind Shears as per IS 875 (Part3)-1987						
Sections	Levels (metres)	Projected Area for Normal Wind (m^2)	Force Coefficient (Cf)	Pressure (KN/m^2)	Forces on Each Node due to wind Normal to the Mast (kN)	Forces on Each Node due to Diagonal Wind = 1.2 x Normal Wind(kN)
S1/ 5m	0	0.0164	2.300	1.780	0.067	0.081
	0.25	0.0164	2.300	1.780	0.067	0.081
	0.5	0.0164	2.300	1.780	0.067	0.081
	0.75	0.0164	2.300	1.780	0.067	0.081
	1	0.0164	2.300	1.780	0.067	0.081
	1.25	0.0164	2.300	1.780	0.067	0.081
	1.5	0.0164	2.300	1.780	0.067	0.081
	1.75	0.0164	2.300	1.780	0.067	0.081
	2	0.0164	2.300	1.780	0.067	0.081
	2.25	0.0164	2.300	1.780	0.067	0.081
	2.5	0.0164	2.300	1.780	0.067	0.081
	2.75	0.0164	2.300	1.780	0.067	0.081
	3	0.0164	2.300	1.780	0.067	0.081
	3.25	0.0164	2.300	1.780	0.067	0.081
	3.5	0.0164	2.300	1.780	0.067	0.081
	3.75	0.0164	2.300	1.780	0.067	0.081
	4	0.0164	2.300	1.780	0.067	0.081
	4.25	0.0164	2.300	1.780	0.067	0.081
	4.5	0.0164	2.300	1.780	0.067	0.081
	4.75	0.0164	2.300	1.780	0.067	0.081
	5	0.0164	2.300	1.780	0.067	0.081
S2/ 10m	5.25	0.0164	2.300	1.780	0.067	0.081
	5.5	0.0164	2.300	1.780	0.067	0.081
	5.75	0.0164	2.300	1.780	0.067	0.081
	6	0.0164	2.300	1.780	0.067	0.081
	6.25	0.0164	2.300	1.780	0.067	0.081
	6.5	0.0164	2.300	1.780	0.067	0.081
	6.75	0.0164	2.300	1.780	0.067	0.081
	7	0.0164	2.300	1.780	0.067	0.081
	7.25	0.0164	2.300	1.780	0.067	0.081
	7.5	0.0164	2.300	1.780	0.067	0.081
	7.75	0.0164	2.300	1.780	0.067	0.081
	8	0.0164	2.300	1.780	0.067	0.081
	8.25	0.0164	2.300	1.780	0.067	0.081
	8.5	0.0164	2.300	1.780	0.067	0.081
	8.75	0.0164	2.300	1.780	0.067	0.081
	9	0.0164	2.300	1.780	0.067	0.081
	9.25	0.0164	2.300	1.780	0.067	0.081
	9.5	0.0164	2.300	1.780	0.067	0.081
	9.75	0.0164	2.300	1.780	0.067	0.081
	10	0.0164	2.300	1.780	0.067	0.081
S3/ 15m	10.25	0.0164	2.300	1.926	0.073	0.087
	10.5	0.0164	2.300	1.926	0.073	0.087
	10.75	0.0164	2.300	1.926	0.073	0.087
	11	0.0164	2.300	1.926	0.073	0.087
	11.25	0.0164	2.300	1.926	0.073	0.087
	11.5	0.0164	2.300	1.926	0.073	0.087
	11.75	0.0164	2.300	1.926	0.073	0.087
	12	0.0164	2.300	1.926	0.073	0.087
	12.25	0.0164	2.300	1.926	0.073	0.087
	12.5	0.0164	2.300	1.926	0.073	0.087

	12.75	0.0164	2.300	1.926	0.073	0.087
	13	0.0164	2.300	1.926	0.073	0.087
	13.25	0.0164	2.300	1.926	0.073	0.087
	13.5	0.0164	2.300	1.926	0.073	0.087
	13.75	0.0164	2.300	1.926	0.073	0.087
	14	0.0164	2.300	1.926	0.073	0.087
	14.25	0.0164	2.300	1.926	0.073	0.087
	14.5	0.0164	2.300	1.926	0.073	0.087
	14.75	0.0164	2.300	1.926	0.073	0.087
	15	0.0164	2.300	1.926	0.073	0.087
S2/ 20m	15.25	0.0164	2.300	2.039	0.077	0.092
	15.5	0.0164	2.300	2.039	0.077	0.092
	15.75	0.0164	2.300	2.039	0.077	0.092
	16	0.0164	2.300	2.039	0.077	0.092
	16.25	0.0164	2.300	2.039	0.077	0.092
	16.5	0.0164	2.300	2.039	0.077	0.092
	16.75	0.0164	2.300	2.039	0.077	0.092
	17	0.0164	2.300	2.039	0.077	0.092
	17.25	0.0164	2.300	2.039	0.077	0.092
	17.5	0.0164	2.300	2.039	0.077	0.092
	17.75	0.0164	2.300	2.039	0.077	0.092
	18	0.0164	2.300	2.039	0.077	0.092
	18.25	0.0164	2.300	2.039	0.077	0.092
	18.5	0.0164	2.300	2.039	0.077	0.092
	18.75	0.0164	2.300	2.039	0.077	0.092
	19	0.0164	2.300	2.039	0.077	0.092
	19.25	0.0164	2.300	2.039	0.077	0.092
	19.5	0.0164	2.300	2.039	0.077	0.092
	19.75	0.0164	2.300	2.039	0.077	0.092
	20	0.0164	2.300	2.039	0.077	0.092
S3/ 25m	20.25	0.0164	2.300	2.097	0.079	0.095
	20.5	0.0164	2.300	2.097	0.079	0.095
	20.75	0.0164	2.300	2.097	0.079	0.095
	21	0.0164	2.300	2.097	0.079	0.095
	21.25	0.0164	2.300	2.097	0.079	0.095
	21.5	0.0164	2.300	2.097	0.079	0.095
	21.75	0.0164	2.300	2.097	0.079	0.095
	22	0.0164	2.300	2.097	0.079	0.095
	22.25	0.0164	2.300	2.097	0.079	0.095
	22.5	0.0164	2.300	2.097	0.079	0.095
	22.75	0.0164	2.300	2.097	0.079	0.095
	23	0.0164	2.300	2.097	0.079	0.095
	23.25	0.0164	2.300	2.097	0.079	0.095
	23.5	0.0164	2.300	2.097	0.079	0.095
	23.75	0.0164	2.300	2.097	0.079	0.095
	24	0.0164	2.300	2.097	0.079	0.095
	24.25	0.0164	2.300	2.097	0.079	0.095
	24.5	0.0164	2.300	2.097	0.079	0.095
	24.75	0.0164	2.300	2.097	0.079	0.095
	25	0.0164	2.300	2.097	0.079	0.095
S2/ 30m	25.25	0.0164	2.300	2.156	0.081	0.098
	25.5	0.0164	2.300	2.156	0.081	0.098
	25.75	0.0164	2.300	2.156	0.081	0.098
	26	0.0164	2.300	2.156	0.081	0.098
	26.25	0.0164	2.300	2.156	0.081	0.098
	26.5	0.0164	2.300	2.156	0.081	0.098
	26.75	0.0164	2.300	2.156	0.081	0.098
	27	0.0164	2.300	2.156	0.081	0.098
	27.25	0.0164	2.300	2.156	0.081	0.098

	27.5	0.0164	2.300	2.156	0.081	0.098
	27.75	0.0164	2.300	2.156	0.081	0.098
	28	0.0164	2.300	2.156	0.081	0.098
	28.25	0.0164	2.300	2.156	0.081	0.098
	28.5	0.0164	2.300	2.156	0.081	0.098
	28.75	0.0164	2.300	2.156	0.081	0.098
	29	0.0164	2.300	2.156	0.081	0.098
	29.25	0.0164	2.300	2.156	0.081	0.098
	29.5	0.0164	2.300	2.156	0.081	0.098
	29.75	0.0164	2.300	2.156	0.081	0.098
	30	0.0164	2.300	2.156	0.081	0.098
S3/ 35m	30.25	0.0164	2.300	2.206	0.083	0.100
	30.5	0.0164	2.300	2.206	0.083	0.100
	30.75	0.0164	2.300	2.206	0.083	0.100
	31	0.0164	2.300	2.206	0.083	0.100
	31.25	0.0164	2.300	2.206	0.083	0.100
	31.5	0.0164	2.300	2.206	0.083	0.100
	31.75	0.0164	2.300	2.206	0.083	0.100
	32	0.0164	2.300	2.206	0.083	0.100
	32.25	0.0164	2.300	2.206	0.083	0.100
	32.5	0.0164	2.300	2.206	0.083	0.100
	32.75	0.0164	2.300	2.206	0.083	0.100
	33	0.0164	2.300	2.206	0.083	0.100
	33.25	0.0164	2.300	2.206	0.083	0.100
	33.5	0.0164	2.300	2.206	0.083	0.100
	33.75	0.0164	2.300	2.206	0.083	0.100
	34	0.0164	2.300	2.206	0.083	0.100
	34.25	0.0164	2.300	2.206	0.083	0.100
	34.5	0.0164	2.300	2.206	0.083	0.100
	34.75	0.0164	2.300	2.206	0.083	0.100
	35	0.0164	2.300	2.206	0.083	0.100
S2/ 40m	35.25	0.0164	2.300	2.256	0.085	0.102
	35.5	0.0164	2.300	2.256	0.085	0.102
	35.75	0.0164	2.300	2.256	0.085	0.102
	36	0.0164	2.300	2.256	0.085	0.102
	36.25	0.0164	2.300	2.256	0.085	0.102
	36.5	0.0164	2.300	2.256	0.085	0.102
	36.75	0.0164	2.300	2.256	0.085	0.102
	37	0.0164	2.300	2.256	0.085	0.102
	37.25	0.0164	2.300	2.256	0.085	0.102
	37.5	0.0164	2.300	2.256	0.085	0.102
	37.75	0.0164	2.300	2.256	0.085	0.102
	38	0.0164	2.300	2.256	0.085	0.102
	38.25	0.0164	2.300	2.256	0.085	0.102
	38.5	0.0164	2.300	2.256	0.085	0.102
	38.75	0.0164	2.300	2.256	0.085	0.102
	39	0.0164	2.300	2.256	0.085	0.102
	39.25	0.0164	2.300	2.256	0.085	0.102
	39.5	0.0164	2.300	2.256	0.085	0.102
	39.75	0.0164	2.300	2.256	0.085	0.102
	40	0.0164	2.300	2.256	0.085	0.102
S3/ 45m	40.25	0.0164	2.300	2.307	0.087	0.104
	40.5	0.0164	2.300	2.307	0.087	0.104
	40.75	0.0164	2.300	2.307	0.087	0.104
	41	0.0164	2.300	2.307	0.087	0.104
	41.25	0.0164	2.300	2.307	0.087	0.104
	41.5	0.0164	2.300	2.307	0.087	0.104
	41.75	0.0164	2.300	2.307	0.087	0.104
	42	0.0164	2.300	2.307	0.087	0.104

	42.25	0.0164	2.300	2.307	0.087	0.104
	42.5	0.0164	2.300	2.307	0.087	0.104
	42.75	0.0164	2.300	2.307	0.087	0.104
	43	0.0164	2.300	2.307	0.087	0.104
	43.25	0.0164	2.300	2.307	0.087	0.104
	43.5	0.0164	2.300	2.307	0.087	0.104
	43.75	0.0164	2.300	2.307	0.087	0.104
	44	0.0164	2.300	2.307	0.087	0.104
	44.25	0.0164	2.300	2.307	0.087	0.104
	44.5	0.0164	2.300	2.307	0.087	0.104
	44.75	0.0164	2.300	2.307	0.087	0.104
	45	0.0164	2.300	2.307	0.087	0.104
S2/ 50m	45.25	0.0164	2.300	2.359	0.089	0.107
	45.5	0.0164	2.300	2.359	0.089	0.107
	45.75	0.0164	2.300	2.359	0.089	0.107
	46	0.0164	2.300	2.359	0.089	0.107
	46.25	0.0164	2.300	2.359	0.089	0.107
	46.5	0.0164	2.300	2.359	0.089	0.107
	46.75	0.0164	2.300	2.359	0.089	0.107
	47	0.0164	2.300	2.359	0.089	0.107
	47.25	0.0164	2.300	2.359	0.089	0.107
	47.5	0.0164	2.300	2.359	0.089	0.107
	47.75	0.0164	2.300	2.359	0.089	0.107
	48	0.0164	2.300	2.359	0.089	0.107
	48.25	0.0164	2.300	2.359	0.089	0.107
	48.5	0.0164	2.300	2.359	0.089	0.107
	48.75	0.0164	2.300	2.359	0.089	0.107
	49	0.0164	2.300	2.359	0.089	0.107
	49.25	0.0164	2.300	2.359	0.089	0.107
	49.5	0.0164	2.300	2.359	0.089	0.107
	49.75	0.0164	2.300	2.359	0.089	0.107
	50	0.0164	2.300	2.359	0.089	0.107
S3/ 55m	50.25	0.0164	2.300	2.384	0.090	0.108
	50.5	0.0164	2.300	2.384	0.090	0.108
	50.75	0.0164	2.300	2.384	0.090	0.108
	51	0.0164	2.300	2.384	0.090	0.108
	51.25	0.0164	2.300	2.384	0.090	0.108
	51.5	0.0164	2.300	2.384	0.090	0.108
	51.75	0.0164	2.300	2.384	0.090	0.108
	52	0.0164	2.300	2.384	0.090	0.108
	52.25	0.0164	2.300	2.384	0.090	0.108
	52.5	0.0164	2.300	2.384	0.090	0.108
	52.75	0.0164	2.300	2.384	0.090	0.108
	53	0.0164	2.300	2.384	0.090	0.108
	53.25	0.0164	2.300	2.384	0.090	0.108
	53.5	0.0164	2.300	2.384	0.090	0.108
	53.75	0.0164	2.300	2.384	0.090	0.108
	54	0.0164	2.300	2.384	0.090	0.108
	54.25	0.0164	2.300	2.384	0.090	0.108
	54.5	0.0164	2.300	2.384	0.090	0.108
	54.75	0.0164	2.300	2.384	0.090	0.108
	55	0.0164	2.300	2.384	0.090	0.108
S2/ 60m	55.25	0.0164	2.300	2.409	0.091	0.109
	55.5	0.0164	2.300	2.409	0.091	0.109
	55.75	0.0164	2.300	2.409	0.091	0.109
	56	0.0164	2.300	2.409	0.091	0.109
	56.25	0.0164	2.300	2.409	0.091	0.109
	56.5	0.0164	2.300	2.409	0.091	0.109
	56.75	0.0164	2.300	2.409	0.091	0.109

	57	0.0164	2.300	2.409	0.091	0.109
	57.25	0.0164	2.300	2.409	0.091	0.109
	57.5	0.0164	2.300	2.409	0.091	0.109
	57.75	0.0164	2.300	2.409	0.091	0.109
	58	0.0164	2.300	2.409	0.091	0.109
	58.25	0.0164	2.300	2.409	0.091	0.109
	58.5	0.0164	2.300	2.409	0.091	0.109
	58.75	0.0164	2.300	2.409	0.091	0.109
	59	0.0164	2.300	2.409	0.091	0.109
	59.25	0.0164	2.300	2.409	0.091	0.109
	59.5	0.0164	2.300	2.409	0.091	0.109
	59.75	0.0164	2.300	2.409	0.091	0.109
	60	0.0164	2.300	2.409	0.091	0.109
S3/ 65m	60.25	0.0164	2.300	2.434	0.092	0.110
	60.5	0.0164	2.300	2.434	0.092	0.110
	60.75	0.0164	2.300	2.434	0.092	0.110
	61	0.0164	2.300	2.434	0.092	0.110
	61.25	0.0164	2.300	2.434	0.092	0.110
	61.5	0.0164	2.300	2.434	0.092	0.110
	61.75	0.0164	2.300	2.434	0.092	0.110
	62	0.0164	2.300	2.434	0.092	0.110
	62.25	0.0164	2.300	2.434	0.092	0.110
	62.5	0.0164	2.300	2.434	0.092	0.110
	62.75	0.0164	2.300	2.434	0.092	0.110
	63	0.0164	2.300	2.434	0.092	0.110
	63.25	0.0164	2.300	2.434	0.092	0.110
	63.5	0.0164	2.300	2.434	0.092	0.110
	63.75	0.0164	2.300	2.434	0.092	0.110
	64	0.0164	2.300	2.434	0.092	0.110
	64.25	0.0164	2.300	2.434	0.092	0.110
	64.5	0.0164	2.300	2.434	0.092	0.110
	64.75	0.0164	2.300	2.434	0.092	0.110
	65	0.0164	2.300	2.434	0.092	0.110
S2/ 70m	65.25	0.0164	2.300	2.459	0.093	0.111
	65.5	0.0164	2.300	2.459	0.093	0.111
	65.75	0.0164	2.300	2.459	0.093	0.111
	66	0.0164	2.300	2.459	0.093	0.111
	66.25	0.0164	2.300	2.459	0.093	0.111
	66.5	0.0164	2.300	2.459	0.093	0.111
	66.75	0.0164	2.300	2.459	0.093	0.111
	67	0.0164	2.300	2.459	0.093	0.111
	67.25	0.0164	2.300	2.459	0.093	0.111
	67.5	0.0164	2.300	2.459	0.093	0.111
	67.75	0.0164	2.300	2.459	0.093	0.111
	68	0.0164	2.300	2.459	0.093	0.111
	68.25	0.0164	2.300	2.459	0.093	0.111
	68.5	0.0164	2.300	2.459	0.093	0.111
	68.75	0.0164	2.300	2.459	0.093	0.111
	69	0.0164	2.300	2.459	0.093	0.111
	69.25	0.0164	2.300	2.459	0.093	0.111
	69.5	0.0164	2.300	2.459	0.093	0.111
	69.75	0.0164	2.300	2.459	0.093	0.111
	70	0.0164	2.300	2.459	0.093	0.111
S3/ 75m	70.25	0.0164	2.300	2.485	0.094	0.112
	70.5	0.0164	2.300	2.485	0.094	0.112
	70.75	0.0164	2.300	2.485	0.094	0.112
	71	0.0164	2.300	2.485	0.094	0.112
	71.25	0.0164	2.300	2.485	0.094	0.112
	71.5	0.0164	2.300	2.485	0.094	0.112

	71.75	0.0164	2.300	2.485	0.094	0.112
	72	0.0164	2.300	2.485	0.094	0.112
	72.25	0.0164	2.300	2.485	0.094	0.112
	72.5	0.0164	2.300	2.485	0.094	0.112
	72.75	0.0164	2.300	2.485	0.094	0.112
	73	0.0164	2.300	2.485	0.094	0.112
	73.25	0.0164	2.300	2.485	0.094	0.112
	73.5	0.0164	2.300	2.485	0.094	0.112
	73.75	0.0164	2.300	2.485	0.094	0.112
	74	0.0164	2.300	2.485	0.094	0.112
	74.25	0.0164	2.300	2.485	0.094	0.112
	74.5	0.0164	2.300	2.485	0.094	0.112
	74.75	0.0164	2.300	2.485	0.094	0.112
	75	0.0164	2.300	2.485	0.094	0.112
S2/ 80m	75.25	0.0164	2.300	2.510	0.095	0.114
	75.5	0.0164	2.300	2.510	0.095	0.114
	75.75	0.0164	2.300	2.510	0.095	0.114
	76	0.0164	2.300	2.510	0.095	0.114
	76.25	0.0164	2.300	2.510	0.095	0.114
	76.5	0.0164	2.300	2.510	0.095	0.114
	76.75	0.0164	2.300	2.510	0.095	0.114
	77	0.0164	2.300	2.510	0.095	0.114
	77.25	0.0164	2.300	2.510	0.095	0.114
	77.5	0.0164	2.300	2.510	0.095	0.114
	77.75	0.0164	2.300	2.510	0.095	0.114
	78	0.0164	2.300	2.510	0.095	0.114
	78.25	0.0164	2.300	2.510	0.095	0.114
	78.5	0.0164	2.300	2.510	0.095	0.114
	78.75	0.0164	2.300	2.510	0.095	0.114
	79	0.0164	2.300	2.510	0.095	0.114
	79.25	0.0164	2.300	2.510	0.095	0.114
	79.5	0.0164	2.300	2.510	0.095	0.114
	79.75	0.0164	2.300	2.510	0.095	0.114
	80	0.0164	2.300	2.510	0.095	0.114
S3/ 85m	80.25	0.0164	2.300	2.536	0.096	0.115
	80.5	0.0164	2.300	2.536	0.096	0.115
	80.75	0.0164	2.300	2.536	0.096	0.115
	81	0.0164	2.300	2.536	0.096	0.115
	81.25	0.0164	2.300	2.536	0.096	0.115
	81.5	0.0164	2.300	2.536	0.096	0.115
	81.75	0.0164	2.300	2.536	0.096	0.115
	82	0.0164	2.300	2.536	0.096	0.115
	82.25	0.0164	2.300	2.536	0.096	0.115
	82.5	0.0164	2.300	2.536	0.096	0.115
	82.75	0.0164	2.300	2.536	0.096	0.115
	83	0.0164	2.300	2.536	0.096	0.115
	83.25	0.0164	2.300	2.536	0.096	0.115
	83.5	0.0164	2.300	2.536	0.096	0.115
	83.75	0.0164	2.300	2.536	0.096	0.115
	84	0.0164	2.300	2.536	0.096	0.115
	84.25	0.0164	2.300	2.536	0.096	0.115
	84.5	0.0164	2.300	2.536	0.096	0.115
	84.75	0.0164	2.300	2.536	0.096	0.115
	85	0.0164	2.300	2.536	0.096	0.115
S2/ 90m	85.25	0.0164	2.300	2.562	0.097	0.116
	85.5	0.0164	2.300	2.562	0.097	0.116
	85.75	0.0164	2.300	2.562	0.097	0.116
	86	0.0164	2.300	2.562	0.097	0.116
	86.25	0.0164	2.300	2.562	0.097	0.116

	86.5	0.0164	2.300	2.562	0.097	0.116
	86.75	0.0164	2.300	2.562	0.097	0.116
	87	0.0164	2.300	2.562	0.097	0.116
	87.25	0.0164	2.300	2.562	0.097	0.116
	87.5	0.0164	2.300	2.562	0.097	0.116
	87.75	0.0164	2.300	2.562	0.097	0.116
	88	0.0164	2.300	2.562	0.097	0.116
	88.25	0.0164	2.300	2.562	0.097	0.116
	88.5	0.0164	2.300	2.562	0.097	0.116
	88.75	0.0164	2.300	2.562	0.097	0.116
	89	0.0164	2.300	2.562	0.097	0.116
	89.25	0.0164	2.300	2.562	0.097	0.116
	89.5	0.0164	2.300	2.562	0.097	0.116
	89.75	0.0164	2.300	2.562	0.097	0.116
	90	0.0164	2.300	2.562	0.097	0.116
S4/ 95m	90.25	0.0130	2.300	2.588	0.077	0.093
	90.5	0.0130	2.300	2.588	0.077	0.093
	90.75	0.0130	2.300	2.588	0.077	0.093
	91	0.0130	2.300	2.588	0.077	0.093
	91.25	0.0130	2.300	2.588	0.077	0.093
	91.5	0.0130	2.300	2.588	0.077	0.093
	91.75	0.0130	2.300	2.588	0.077	0.093
	92	0.0130	2.300	2.588	0.077	0.093
	92.25	0.0130	2.300	2.588	0.077	0.093
	92.5	0.0130	2.300	2.588	0.077	0.093
	92.75	0.0130	2.300	2.588	0.077	0.093
	93	0.0130	2.300	2.588	0.077	0.093
	93.25	0.0130	2.300	2.588	0.077	0.093
	93.5	0.0130	2.300	2.588	0.077	0.093
	93.75	0.0130	2.300	2.588	0.077	0.093
	94	0.0130	2.300	2.588	0.077	0.093
	94.25	0.0130	2.300	2.588	0.077	0.093
	94.5	0.0130	2.300	2.588	0.077	0.093
	94.75	0.0130	2.300	2.588	0.077	0.093
	95	0.0130	2.300	2.588	0.077	0.093
S6/ 100m	95.25	0.0130	2.300	2.614	0.078	0.094
	95.5	0.0130	2.300	2.614	0.078	0.094
	95.75	0.0130	2.300	2.614	0.078	0.094
	96	0.0130	2.300	2.614	0.078	0.094
	96.25	0.0130	2.300	2.614	0.078	0.094
	96.5	0.0130	2.300	2.614	0.078	0.094
	96.75	0.0130	2.300	2.614	0.078	0.094
	97	0.0130	2.300	2.614	0.078	0.094
	97.25	0.0130	2.300	2.614	0.078	0.094
	97.5	0.0130	2.300	2.614	0.078	0.094
	97.75	0.0130	2.300	2.614	0.078	0.094
	98	0.0130	2.300	2.614	0.078	0.094
	98.25	0.0130	2.300	2.614	0.078	0.094
	98.5	0.0130	2.300	2.614	0.078	0.094
	98.75	0.0130	2.300	2.614	0.078	0.094
	99	0.0130	2.300	2.614	0.078	0.094
	99.25	0.0130	2.300	2.614	0.078	0.094
	99.5	0.0130	2.300	2.614	0.078	0.094
	99.75	0.0130	2.300	2.614	0.078	0.094
	100	0.0130	2.300	2.614	0.078	0.094
S5/ 105m	100.25	0.0130	2.300	2.631	0.079	0.094
	100.5	0.0130	2.300	2.631	0.079	0.094
	100.75	0.0130	2.300	2.631	0.079	0.094
	101	0.0130	2.300	2.631	0.079	0.094

	101.25	0.0130	2.300	2.631	0.079	0.094
	101.5	0.0130	2.300	2.631	0.079	0.094
	101.75	0.0130	2.300	2.631	0.079	0.094
	102	0.0130	2.300	2.631	0.079	0.094
	102.25	0.0130	2.300	2.631	0.079	0.094
	102.5	0.0130	2.300	2.631	0.079	0.094
	102.75	0.0130	2.300	2.631	0.079	0.094
	103	0.0130	2.300	2.631	0.079	0.094
	103.25	0.0130	2.300	2.631	0.079	0.094
	103.5	0.0130	2.300	2.631	0.079	0.094
	103.75	0.0130	2.300	2.631	0.079	0.094
	104	0.0130	2.300	2.631	0.079	0.094
	104.25	0.0130	2.300	2.631	0.079	0.094
	104.5	0.0130	2.300	2.631	0.079	0.094
	104.75	0.0130	2.300	2.631	0.079	0.094
	105	0.0130	2.300	2.631	0.079	0.094
S6/ 110m	105.25	0.0130	2.300	2.649	0.079	0.095
	105.5	0.0130	2.300	2.649	0.079	0.095
	105.75	0.0130	2.300	2.649	0.079	0.095
	106	0.0130	2.300	2.649	0.079	0.095
	106.25	0.0130	2.300	2.649	0.079	0.095
	106.5	0.0130	2.300	2.649	0.079	0.095
	106.75	0.0130	2.300	2.649	0.079	0.095
	107	0.0130	2.300	2.649	0.079	0.095
	107.25	0.0130	2.300	2.649	0.079	0.095
	107.5	0.0130	2.300	2.649	0.079	0.095
	107.75	0.0130	2.300	2.649	0.079	0.095
	108	0.0130	2.300	2.649	0.079	0.095
	108.25	0.0130	2.300	2.649	0.079	0.095
	108.5	0.0130	2.300	2.649	0.079	0.095
	108.75	0.0130	2.300	2.649	0.079	0.095
	109	0.0130	2.300	2.649	0.079	0.095
	109.25	0.0130	2.300	2.649	0.079	0.095
	109.5	0.0130	2.300	2.649	0.079	0.095
	109.75	0.0130	2.300	2.649	0.079	0.095
	110	0.0130	2.300	2.649	0.079	0.095
S7/ 114m	110.25	0.0130	2.300	2.663	0.080	0.096
	110.5	0.0130	2.300	2.663	0.080	0.096
	110.75	0.0130	2.300	2.663	0.080	0.096
	111	0.0130	2.300	2.663	0.080	0.096
	111.25	0.0130	2.300	2.663	0.080	0.096
	111.5	0.0130	2.300	2.663	0.080	0.096
	111.75	0.0130	2.300	2.663	0.080	0.096
	112	0.0130	2.300	2.663	0.080	0.096
	112.25	0.0130	2.300	2.663	0.080	0.096
	112.5	0.0130	2.300	2.663	0.080	0.096
	112.75	0.0130	2.300	2.663	0.080	0.096
	113	0.0130	2.300	2.663	0.080	0.096
	113.25	0.0130	2.300	2.663	0.080	0.096
	113.5	0.0130	2.300	2.663	0.080	0.096
	113.75	0.0130	2.300	2.663	0.080	0.096
	114	0.0130	2.300	2.663	0.080	0.096
S8/ 118m	114.25	0.0130	2.300	2.677	0.080	0.096
	114.5	0.0130	2.300	2.677	0.080	0.096
	114.75	0.0130	2.300	2.677	0.080	0.096
	115	0.0130	2.300	2.677	0.080	0.096
	115.25	0.0130	2.300	2.677	0.080	0.096
	115.5	0.0130	2.300	2.677	0.080	0.096
	115.75	0.0130	2.300	2.677	0.080	0.096

	116	0.0130	2.300	2.677	0.080	0.096
	116.25	0.0130	2.300	2.677	0.080	0.096
	116.5	0.0130	2.300	2.677	0.080	0.096
	116.75	0.0130	2.300	2.677	0.080	0.096
	117	0.0130	2.300	2.677	0.080	0.096
	117.25	0.0130	2.300	2.677	0.080	0.096
	117.5	0.0130	2.300	2.677	0.080	0.096
	117.75	0.0130	2.300	2.677	0.080	0.096
	118	0.0130	2.300	2.677	0.080	0.096
S9/ 120m	118.25	0.0130	2.300	2.684	0.080	0.096
	118.5	0.0130	2.300	2.684	0.080	0.096
	118.75	0.0130	2.300	2.684	0.080	0.096
	119	0.0130	2.300	2.684	0.080	0.096
	119.25	0.0130	2.300	2.684	0.080	0.096
	119.5	0.0130	2.300	2.684	0.080	0.096
	119.75	0.0130	2.300	2.684	0.080	0.096
	120	0.0130	2.300	2.684	0.080	0.096
				Total =	**160.894**	**193.073**

Estimation of Levelwise Wind Pressure Values on Cables

Wind loading is calculated in accordance with IS: 875 - Part 3(1987)

Basic Wind Speed(Vb) = 55 m/s

K_1 (Risk Factor.) = 1

K_3 (Topography factor) = 1

Category of Structure = 1

Class of Structure = C

K_2(Terrain,Height and Structure Size Factor) as per Table2 Clause 5.3.2.2 ,IS 875 Part III

Design wind speed (Vb) = K1 X K2 X K3 X Vb

Design wind press. (Pz) = 0.6 X Vb2

Force (kN/m) = Cf x Pz x d

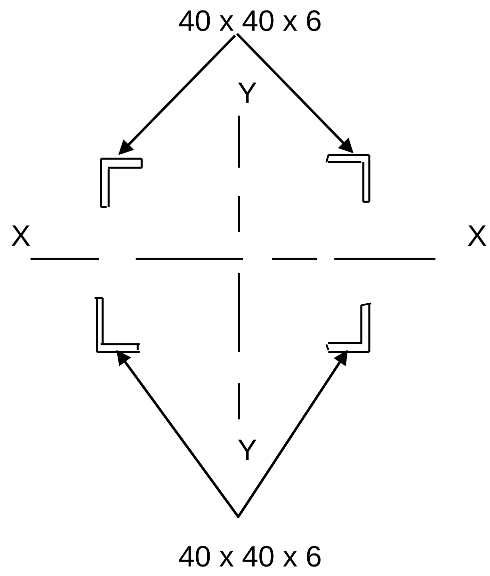
where Cf is the Force coefficient, taken from Table 27, Pg no. 46 of IS 875

d is the diameter of the cable = 0.008 m

Levels (m)	Height (m)	K2	Vz m/s	Pz kN/m2	Cf	Force (kN/m)	Average value taken for analysis
0 to 10	10	0.99	54.45	1.779	1.20	0.017	0.017
10 to 15	5	1.03	56.65	1.926	1.20	0.018	0.018
15 to 20	5	1.06	58.30	2.039	1.20	0.020	0.018
20 to 25	5	1.075	59.13	2.097	1.20	0.020	0.019
25 to 30	5	1.09	59.95	2.156	1.20	0.021	0.019
30 to 35	5	1.1025	60.64	2.206	1.20	0.021	0.020
35 to 40	5	1.115	61.33	2.256	1.20	0.022	0.020
40 to 45	5	1.1275	62.01	2.307	1.20	0.022	0.020
45 to 50	5	1.14	62.70	2.359	1.20	0.023	0.020
50 to 55	5	1.146	63.03	2.384	1.20	0.023	0.021
55 to 60	5	1.152	63.36	2.409	1.20	0.023	0.021
60 to 65	5	1.158	63.69	2.434	1.20	0.023	0.021
65 to 70	5	1.164	64.02	2.459	1.20	0.024	0.021
70 to 75	5	1.17	64.35	2.485	1.20	0.024	0.022
75 to 80	5	1.176	64.68	2.510	1.20	0.024	0.022

80 to 85	5	1.182	65.01	2.536	1.20	0.024	0.022
85 to 90	5	1.188	65.34	2.562	1.20	0.025	0.023
90 to 95	5	1.194	65.67	2.588	1.20	0.025	0.023
95 to 100	5	1.2	66.00	2.614	1.20	0.025	0.023
100 to 105	5	1.204	66.22	2.631	1.20	0.025	0.024
105 to 110	5	1.208	66.44	2.649	1.20	0.025	0.024
110 to 114	5	1.2112	66.62	2.663	1.20	0.026	0.024
114 to 118	5	1.2144	66.79	2.677	1.20	0.026	0.024
118 to 120	5	1.216	66.88	2.684	1.20	0.026	0.025

CHECKING THE SLENDERNESS OF WIND MAST



1).	Length	=	300	mm
2).	Breadth	=	300	mm
3).	Angle Used	=	40 x 40 x 6	
4).	No. of Angles	=	4	nos.
5).	Area of 40 x 40 x 6	=	447	mm^2
6).	Cxx = Cyy	=	12	mm
7).	Ixx = Iyy	=	63000	mm^4

$I_{yy(\text{whole section})}$ = 4 x 63000 + 4 x 447 x ((300/2)-12)^2 mm^4

$I_{yy\ (\text{whole section})}$ = 34302672 mm^4

& Radius of gyration, $R_{yy} = \sqrt{\dfrac{34302672}{4 \times 447}}$ = 138.51 mm

8) Unsupported length of the mast, L = 10.0 m

Shaft is effectively held in position at both ends, but not restrained against rotation.

Recommended value of effective length,

$$L_{eff} = 1 \times L$$

∴ Effective length, L_{eff} = 10000 mm

∴ Slenderness ratio,

$$\lambda = \frac{L_{eff}}{Ry} = 72.1971 < 180$$

Hence OK

Here, it is observed that 300 mm x 300 mm Mast Dimension is adequate to meet the Slenderness Criteria when guyed every 10meters. Further, 400 mm x400 mm are acceptable for similar guy wire support spacing.

Design of Tower Leg from 90-120 m :

					L/C	Member no
1)	Max. compressive force (P) in the column =		40.34	KN	3	4327
	Factored load	=	60.51	KN		
2)	Max Tensile force in the column	=	10.41	KN	3	5503
3)	Total no. of Legs	=	4	nos.		
3)	Max shear on each Leg	=	0.61	KN	2	4327
	Factored load	=	0.915	KN		
4)	Angle used	=	40x40x6	section		
5)	Length	=	250	mm		
6)	Area	=	447	mm2		
7)	Max Compressive force in lacing bar	=	3.1	KN	3	4830
	Factored load	=	4.65	KN		
8)	Max Tensile force in lacing bar	=	2.92	KN	3	4833
	Factored load	=	4.38	KN		
9)	Yield Stress of Steel Section (fy)	=	250	N/mm2		
10)	Partial Safety factor (γ_{mo})	=	1.1			

i) ***Checking the permissible compressive capacity of the column :***

a) $L_{effective}$ = 1 x L = 250 mm

b) Rvv = 7.7 mm

c) Slenderness Ratio = $\frac{L_{effective}}{Rvv}$ = 32.47

By interpolation,

fcd = 200.789 N/mm2 **… from Table 9(c) of IS 800- 2007**

Hence Permissible Axial Load in the column = 89.75 KN

Since 89.75 > 60.51

Hence OK

ii) ***Checking the permissible tensile capacity of the column :***

a) Tensile Force = 15.615 KN

b) Area of Section = 447 mm2

Therefore,

Tensile Stress = $\frac{15.615 \times 1000}{447}$

Tensile Stress 34.93 N/mm2 < **f_y/γ_{mo}** **… from 6.2 pg 32**

< **227.25** N/mm2

where, 227.5 N/mm^2 is the permissible tensile stress of the section

Hence OK

iii) ***Checking the permissible shear capacity of the column :***

a) Shear Area = 40 x 6 mm2

= 240 mm2

b) Shear Stress (ζ) = $\frac{0.915 \times 1000}{240}$

Therefore,

Shear Stress (ζ) = 3.81 N/mm2 **<** $\frac{f_y}{\sqrt{3} \times \gamma_{mo}}$ **…from 8.4 pg 59**

< **131** N/mm2

where,131 N/mm^2 is the avg permissible shear stress of the section

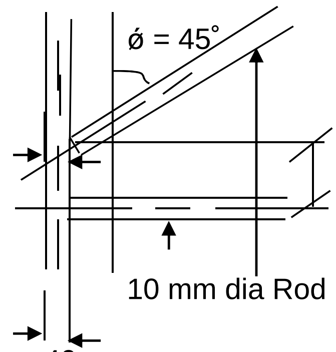
Hence OK

iv) *Design of 10 mm dia Round Bar :*

For 250 x 300 mm2 section , Round Bar is inclined at ǿ with the axis of the column

where ǿ tan-1(300/250)
= 50.1944

Bar is inclined at 45˚ with the axis of the column



Hzl Span of the bar = 300 - 2 x 40 mm
= 170 mm

Ver Span of the bar = 250 -2 x 0 mm
210 mm

Length of the bar = $\sqrt{170^2 + 210^2}$

= 270.19 mm

Le of the bar = 0.7 x 270.19 mm
where Le = Effective Length
= 189.133 mm

Now, for 10 mm Dia rod
Area = $\frac{PI() \times 10 \times 10}{4}$
= 78.54 mm2

Ixx = Iyy $\frac{PI() \times 10^4}{64}$

= 490.87 mm4

r_{yy} = $\sqrt{\frac{490.87}{78.54}}$

= 2.5 mm

Therefore, Le/r_{yy}= $\frac{189.133}{2.5}$

= 75.65 < 180

Hence OK

Checking the permissible compressive capacity of the section,

Therefore, fcd = 156.96 N/mm2 **… from Table 9(c) of IS 800- 2007**

Hence Permissible Axial Load in the column = 12.33 KN

Since 12.33 > 4.65

Hence OK

Checking the permissible tensile capacity of the section,

Tensile Force in the lacing = 4.38 KN

Area of bar = 78.54 mm2

Tensile Stress = 55.77 **<** **f_y/γ_{mo}** **… from 6.2 pg 32**

< **227.25** N/mm2

Hence OK

CONNECTIONS:

a). At the Ring Angles :

			load case	member no
Maximum Axial force in the ring angle =	7.536	kN	3	4307
Factored load =	11.304	KN		

This Axial force will be transferred as a Shear force to the Bolts

No. of Bolts provided = 12 of 12mm Dia

Shear Area of Each Bolt = $\frac{pi() \times 12^2}{4}$

Shear Area = 113.10 mm2

Shear force in Each Bolt = 113.1 x100

where, 100 N/mm2 is the permissible shear & Axial Tension stress for shop driven power rivets

= 113.1 kN

Shear Force of 12 Bolts = 1357.2 kN > 11.304 kN

Hence OK

Maximum Tension in the column = 15.615 kN

No. of bolts provided to resist tension 4

Tensile Area = = 113.10 mm2

Tensile capacity of Each Bolt = 113.1 kN

Tensile Force of 12 Bolts = 452.4 > 15.615 kN

Hence OK

b). For 10 mm Dia Rod :

Maximum Axial force in the ring/brace 10 mm dia bar = 4.65 kN

This Axial force will be transferred as a Shear force to the Weld

Effective Length of the Weld = 20 mm ….. Assumed

Thickness of the Throat = 0.7 x s

where, s is the size of weld

Assuming 6 mm Weld Size

Therefore, Throat thickness = 4.2 mm

Safe Load P = 108 x 20 x 4.2 kN
where 108 kN/mm^2 is the permissible stress in the fillet wel as per IS 816- 1969

Safe Load P = 9.072 kN > 4.65

Hence OK

<u>Gusset Connection Between cable and plate:</u>

				L/C	Member no
Maximum Tension in the cable	=	27.479	kN	5	5801
Factored load	=	41.219	KN		

Assuming 22.63 kN Tension will be present in the gusset plate

The plate may fail at the connection by tearing between rivet holes

Design of Tower Leg upto 90 m :

					L/C	Member no
1)	Max. compressive force (P) in the column	=	93.25	KN	3	8
	Factored load	=	139.875	KN		
2)	Max Tensile force in the column	=	0	KN	-	-
3)	Total no. of Legs	=	4	nos.		
3)	Max shear on each Leg	=	1.39	KN	2	931
	Factored load	=	2.085	KN		
4)	Angle used	=	50x50x8	section	till 5m	
		=	50x50x6	above 5m		
5)	Length	=	250	mm		
6)	Area A1	=	741	mm2		
	Area A2	=	568	mm2		
7)	Max Compressive force in lacing bar	=	3.63	KN	3	3398
	Factored load	=	5.445	KN		
8)	Max Tensile force in lacing bar	=	2.64	KN	3	3402
	Factored load	=	3.96	KN		
9)	Yield Stress of Steel Section (fy)	=	250	N/mm2		
10)	Partial Safety factor (γ_{mo})	=	1.1			

i) ***Checking the permissible compressive capacity of the column :***

a) $L_{effective}$ = 0.7 x L = 175 mm

b) Rvv = 9.6 mm

c) Slenderness Ratio = $\frac{L_{effective}}{Rvv}$ = 18.23

By interpolation,

fcd = 224.531 N/mm2 **… from Table 9(c) of IS 800- 2007**

Hence Permissible Axial Load in the column = 166.38 KN

Since 166.38 > 139.875

Hence OK

ii) *Checking the permissible tensile capacity of the column :*

a) Tensile Force = 0 KN

b) Area of Section = 741 mm2

Therefore,

Tensile Stress = $\frac{0x1000}{741}$

Tensile Stress 0 N/mm2 < **f_y/γ_{mo}** **… from 6.2 pg 32**

< **227.25** N/mm2

where, 227.5 N/mm^2 is the permissible tensile stress of the section

Hence OK

iii) *Checking the permissible shear capacity of the column :*

a) Shear Area = 40 x 6 mm2

= 240 mm2

b) Shear Stress (ζ) = $\frac{2.085x1000}{240}$

Therefore,

Shear Stress (ζ) = 8.69 N/mm2 **<** $\frac{f_y}{\sqrt{3} \times \gamma_{mo}}$ **…from 8.4 pg 59**

< **131** N/mm2

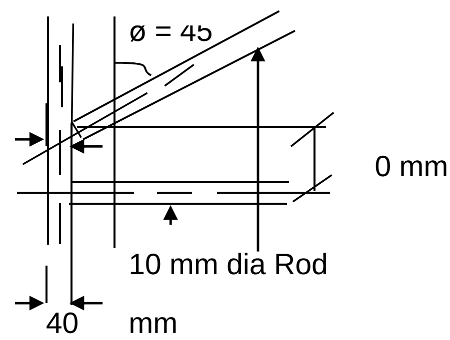
where,131 N/mm^2 is the avg permissible shear stress of the section

Hence OK

iv) ***Design of 10 mm dia Round Bar :***

For 250 x 400 mm2 section , Round Bar is inclined at ǿ with the axis of the column

where ǿ tan-1(400/250)
= 57.9946



Bar is inclined at 45˚ with the axis of the column

Hzl Span of the bar	=	400 - 2 x 40	mm
	=	170	mm
Ver Span of the bar	=	250 -2 x 0 mm	
		210	mm
Length of the bar	=	$\sqrt{170^2 + 210^2}$	
	=	270.19	mm
Le of the bar	=	0.7 x 270.19	mm
where Le = Effective Length			
	=	189.133	mm

Now, for 10 mm Dia rod

Area = $\frac{PI() \times 10 \times 10}{4}$

= 78.54 mm2

Ixx = Iyy $\frac{PI() \times 10^4}{64}$

= 490.87 mm4

$r_{yy} = \sqrt{\frac{490.87}{78.54}}$

= 2.5 mm

hence, $Le/r_{yy} = \frac{189.133}{2.5}$

= 75.65 < 180

Hence OK

Checking the permissible compressive capacity of the section,

Therefore, fcd = 142.96 N/mm2 **… from Table 9(c) of IS 800- 2007**

Hence Permissible Axial Load in the column = 11.23 KN

Since 11.23 > 5.445

Hence OK

Checking the permissible tensile capacity of the section,

Tensile Force in the lacing = 3.96 KN

Area of bar = 78.54 mm2

Tensile Stress = 50.42 **<** **f_y/γ_{mo}** **… from 6.2 pg 32**

< **227.25** N/mm2

Hence OK

CONNECTIONS:

a). At the Ring Angles :

			load case	member no
Maximum Axial force in the ring angle =	7.575	kN	3	804
Factored load =	11.3625	KN		

This Axial force will be transferred as a Shear force to the Bolts

No. of Bolts provided = 12 of 12mm Dia

Shear Area of Each Bolt = $\dfrac{\text{pi() x } 12^2}{4}$

Shear Area = 113.10 mm2

Shear force in Each Bolt = 113.1 x100

where, 100 N/mm2 is the permissible shear & Axial Tension stress for shop driven power rivets

= 113.1 kN

Shear Force of 12 Bolts = 1357.2 kN > 11.363 kN

Hence OK

Maximum Tension in the column = 0 kN

No. of bolts provided to resist tension 4

Tensile Area = = 113.10 mm2

Tensile capacity of Each Bolt = 113.1 kN

Tensile Force of 12 Bolts = 452.4 > 0 kN

Hence OK

b). For 10 mm Dia Rod :

Maximum Axial force in the ring/brace 10 mm dia bar = 5.445 kN

This Axial force will be transferred as a Shear force to the Weld

Effective Length of the Weld = 20 mm ….. Assumed

Thickness of the Throat = 0.7 x s

where, s is the size of weld

Assuming 6 mm Weld Size

Therefore, Throat thickness = 4.2 mm

Safe Load P = 108 x 20 x 4.2 kN
where 108 kN/mm^2 is the permissible stress in the fillet wel as per IS 816- 1969

Safe Load P = 9.072 kN > 5.445

Hence OK

<u>Gusset Connection Between cable and plate:</u>

				L/C	Member no
Maximum Tension in the cable	=	27.478	kN	5	5801
Factored load	=	41.217	KN		

Assuming 22.63 kN Tension will be present in the gusset plate

The plate may fail at the connection by tearing between rivet holes

<u>Checking of tearing of plate between rivet holes</u>

Area resisting the tension = (70-22) x 10
= 480 mm2

Tensile Stress = $\frac{27478}{480}$ = **57.25** < **fy/γ_{mo}** **… from 6.2 pg 32**
< **227.25** N/mm2

DESIGN OF CABLE ELEMENT

Wirerope Properties for proposed 120 M Latticed Wind Mast as under :

Diameter of wire rope	=	8	mm
Construction	=	6 x 19 (12 / 6 / 1)	
Main Core	=	steel	
Lay	=	Right Hand Ordinary	
Finish	=	Galvanised	
Tensile Designation	=	1570	
Governing Specification	=	IS 3459 / 1977	

Minimum Breaking Load (Fo) = 36 KN **….IS 2266 : 2002**

Permissible tension (cable) = **0.909 x 36**

= **32.724** KN

Actual. Axial Tnsn In the Cable = **27.478** KN

Since 32.724 > 27.478

Hence OK

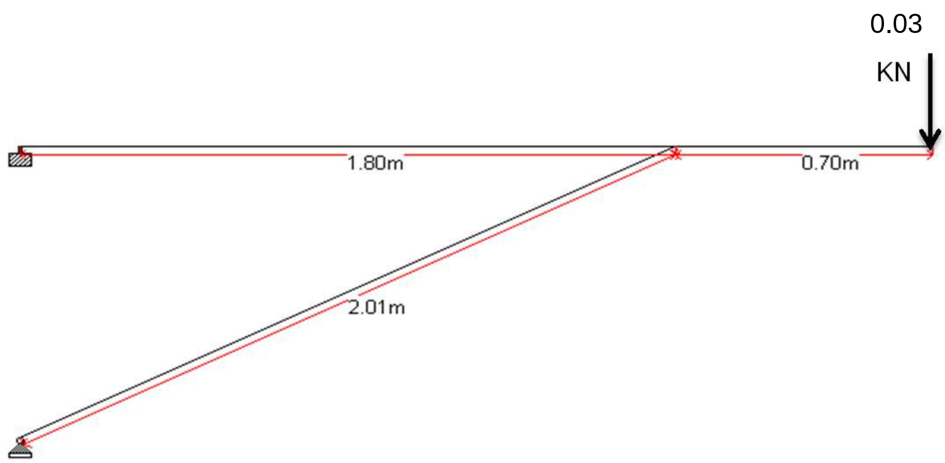
Design of bracket for side mounted wind sensor

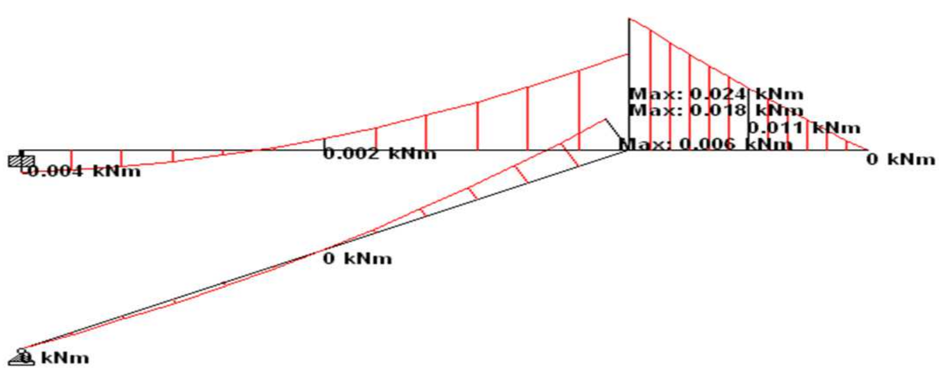
Design data

Weight of wind sensor = 3 Kg

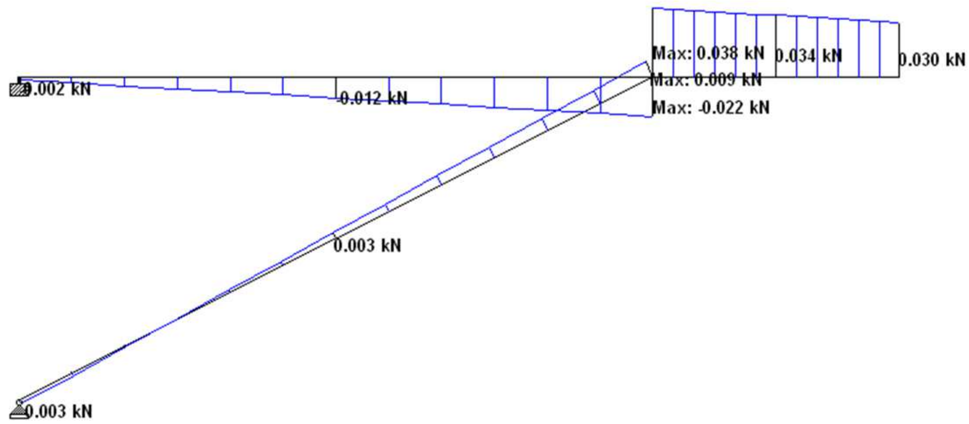
Using pipe having properties

OD	=	25.4	mm
Thickness	=	2	mm
C/S Area (A	=	147.03	mm^2
Ze	=	798.17	mm^3
Zp	=	1,097.79	mm^3
r_{min}	=	8.30	mm
Self-weight	=	1.15	Kg/m
Length	=	2,500	mm

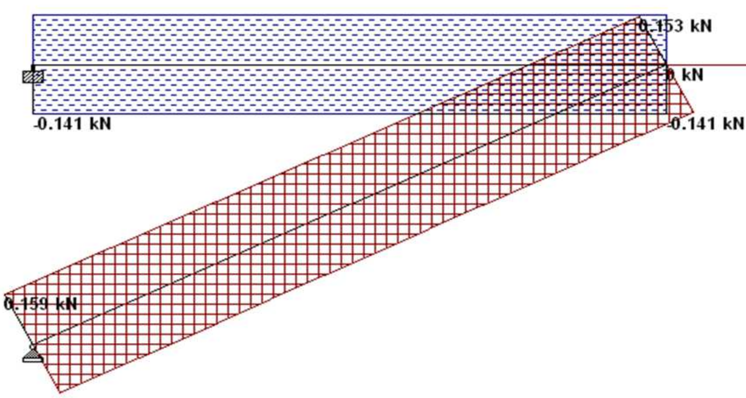




BMD



SFD



AFD

Design

Bending capacity of pipe

$$= \frac{\beta_b \times Z_p \times f_y}{\gamma_{mo}}$$

$$= \frac{1 \times 1097.79 \times 250}{1.1}$$

$$\mathbf{= 249497.73 \ N.mm}$$

Tension capacity of pipe

$$= \frac{A_g \times f_y}{\gamma_{mo}}$$

$$= \frac{147.03 \times 250}{1.1}$$

$$\mathbf{= 33415.909\ N}$$

Compression capacity of pipe

$$= A_e \times f_{cd}$$

$$l/r = 1800/8.3$$

$$= 216.87$$

Buckling class b

f_{cd} = 33.099 N/mm^2 …..from table 9(b) pg 41 of IS 800 : 2007

$$\mathbf{C = 147.03 \times 33.099}$$

$$\mathbf{= 4866.546\ N}$$

Shear capacity of pipe

$$= \frac{A_v \times f_{yw}}{\sqrt{3} \times \gamma_{mo}}$$

$$A_v = \frac{2 \times A}{\pi}$$

$$= 93.7\ mm^2$$

$$S = \frac{93.7 \times 250}{1.73 \times 1.1}$$

$$\mathbf{= 12294.942\ N}$$

Check for combined stresses

* Axial compression

$$\frac{238.5}{4866.5} = 0.05$$

* Axial Tension + Bending

$$\frac{211.5}{33416} + \frac{36000}{249498} = 0.15$$

FOUNDATION DESIGN

Data :-

1)	The unit weight of concrete used	=	25	kN / m^3			
2)	Net Safe Bearing Capacity of Soil	=	100	kN/m^2			
2)	Coefficient of friction μ,	=	0.5				
3)	Plan dimensions of the foundation block	=	3.8	x	2.0	m	
			L	x	W		
4)	Depth of the foundation block	=	1.5	m			
5)	Depth of foundation	=	1.0	m			

Design :-

Bouyant force = 0*3.8*2*10
= 0 KN Considering dry soil

The support numbered 1933 in the STAAD geometry becomes critical w.r.t uplift & shear when the wind flows in the X-direction.

Refering to analysis result (support reactions),

Forces in X-direction,

F_x = 55.83 KN
= Total shear (F_h)

Forces in Y-direction,

F_y = 92.649 KN
= Total uplift (P_u)

Dead weight of the foundation block, \ = 285 KN

effective downward weight (W) = 285 - 0
285 KN

Check for stability against uplift :-

Minimum factor of safety against uplift = 1.5

.'. Actual factor of safety = $\frac{0.9 \times W}{P_u}$

= 2.77

Hence **SAFE**

Check for stability against sliding :-

Minimum factor of safety against sliding = 1.4

.'. Actual factor of safety = $\frac{\mu\ (0.9 \times W - P_u)}{F_h}$

= 1.47

Hence **SAFE**

Check for stability against overturning :-

Minimum factor of safety against overturning 1.2

Stabilizing downward force (P_s) = $0.9 \times W - P_u$

= 163.851 KN

Lever arm for restoring moment due to weight only = 1.9 m

Lever arm for overturning moment = 1.5 m

Restoring moment due to dead weight = 163.851 x 1.9

M_{RD} = 311.317 KN-m

Overturning moment, M_O = 55.83 x 1.5

= 83.745 KN-m

.'. Actual factor of safety against overturning = $\frac{\text{Restoring moment}}{\text{Overturning moment}}$

= 3.717

Hence **SAFE**

Design Calculation for blocks where cables are anchored:

Maximum Tension At the support = 92.649 kN

Taking the moment from the centre of the block

Moment @ centre = 92.649 x 1.9
= 176.1 kN-m
= 176.1 x 1.5
= 264.2 kN-m

Ast,reqd. = 0.5 x 20 / 415 · 1 - 1 - 4.6x1.5x264.2x10^6 / 20x2000x1417^2 · 2000x1417

= 517.604 mm2

Ast,min. = 0.06% x 2000 x 1500
= 1800 mm^2

Top & Bottom Reinforcement :

Provide 12 Dia bars Area of one Bar = 113.15 mm^2

Spacing Reqd. = $\frac{2000 \times 113.15}{1800}$
= 125.72

Provide 12 Dia. Bars @ 125 mm c/c Both ways

Side Face Reinforcement :

Provide 12 Dia bars Area of one Bar = 113.15 mm^2

Area Required @ each face = $\frac{0.1 \times 2000 \times 1500}{2 \times 100}$

= 1500 mm2

Spacing Reqd. = $\frac{113.15 \times 1500}{1500}$
= 113.15

Provide 12 Dia. Bars @ 100 mm c/c Both ways

Check for Development Length :

Ldt = Diameter of bar x Stress in the bar considered at deisgn load / 4 x Design Bond Stress

where, Diameter of bar = 12 mm

Stress in the bar = 361.05 N/mm2

Design Bond Stress= 1.2 **… for M20, IS 456:2000, Pg no. 43)**

$$= \frac{16 \times 0.87 \times 415}{4 \times 1.2}$$

= 902.625 < 2 x 760 mm … (Provided)

1520 mm

Hence Safe in Development Length

<u>Design Calculation of block below mast:</u>

				L/C	Node no
Maximum Compression =	94.733	kN		3	4

Area Assumed = 1.2 x 1.2 m²

Depth = 0.5 m

Self Weight of footing = 1.2 x 1.2 x 0.5 x 25

= 18 kN

Pressure Check:

Total Vertical Load = 94.733 + 18

= 112.733 kN

Gross Safe Bearing Capacity Of Soil = $\frac{112.73}{1.2 \times 1.2}$

= 78.287 kN/m^2 < 100 kN/m2

Hence ok

Provide 12 Dia bars Area of one Bar = 113.15 mm^2

Ast,min. = 0.06% x 1200 x 500

= 360 mm^2

Spacing Reqd. = $\frac{1200 \times 113.15}{360}$

= 377.17

Provide 12 Dia. Bars @ 300 mm c/c Both ways

Side Face Reinforcement :

Provide 12 Dia bars Area of one Bar = 113.15 mm^2

Area Required @ each face = $\frac{0.1 \times 1200 \times 500}{2 \times 100}$

= 300 mm2

Spacing Reqd. = $\frac{113.15 \times 500}{300}$

= 188.58

Provide 2 bars of 12 Dia (Both ways)

Check for two way shear:

Force to be resisted by = (0.4 + 2 x 0.25) x 4 x 0.5

= 1.8 m^2

= 2E+06 mm^2

τ_v = $\frac{P}{A}$

= $\frac{94.733 \times 1.5 \times 1000}{1800000}$

= 0.0939

τ_c = 0.25 f_{ck}

= 1.118 N/mm^2 > 0.0939442 N/mm^2

Hence Ok

Base Plate Design :

Area Assumed = 0.65 x 0.65 m^2

Bearing Pressure = $\frac{142.0995}{0.65 \times 0.65}$

= 336.33 kN/m2 < σ_{cc}

where, σ_{cc} = Permissible stress in Concrete due to direct compression

= $(0.67 \times f_{ck}) / \gamma_m$

= 8933.3 kN/m2

Hence safe

$$\text{Thk. Reqd.} = \frac{2.5 \times w \ (a^2 - 0.3\, b^2) \times \gamma_{mo}}{f_y}$$

w	=	336.33	kN/m^2	=	0.3363	N/mm^2
a = b	=	$\frac{650 - 400}{2}$		=	125	mm
γ_{mo}	=	1.1				
f_y	=	250	N/mm^2			

Thk. Reqd. = 6.3612

Thk. provided = 16 mm

Hence Safe

SUPPORT REACTIONS

Node	L/C	Force-X kN	Force-Y kN	Force-Z kN	Moment-X kNm	Moment-Y kNm	Moment-Z kNm
1	1	0.261	49.653	0.104	0	0	0
	2	0.387	62.713	0.198	0	0	0
	3	-0.646	52.725	1.137	0	0	0
2	1	0.103	49.444	0.258	0	0	0
	2	-1.065	62.361	-0.86	0	0	0
	3	-0.752	73.413	-0.599	0	0	0
3	1	-0.108	49.87	-0.262	0	0	0
	2	-1.369	89.393	-1.636	0	0	0
	3	-1.054	74.075	-1.359	0	0	0
4	1	-0.255	49.64	-0.108	0	0	0
	2	-0.381	89.011	-0.145	0	0	0
	3	-1.399	94.733	0.809	0	0	0
1925	1	-15.413	-11.821	0	0	0	0
	2	-26.096	-21.823	-1.032	0	0	0
	3	-38.363	-34.144	0	0	0	0
1926	1	0	-11.818	-15.408	0	0	0
	2	-1.032	-21.817	-26.087	0	0	0
	3	-1.447	-8.873	-12.738	0	0	0
1927	1	15.412	-11.82	0	0	0	0
	2	3.117	-1.403	-1.01	0	0	0
	3	0.686	-0.502	0	0	0	0
1928	1	0	-11.823	15.416	0	0	0
	2	-1.01	-1.407	3.123	0	0	0
	3	-1.447	-8.881	12.751	0	0	0
1929	1	-9.016	-12.137	0	0	0	0
	2	-33.371	-44.154	-2.547	0	0	0
	3	-53.244	-71.234	0	0	0	0
1930	1	0	-12.137	-9.016	0	0	0
	2	-2.547	-44.162	-33.377	0	0	0
	3	-3.488	-6.789	-5.315	0	0	0
1931	1	9.016	-12.137	0	0	0	0
	2	-2.445	0.611	-2.445	0	0	0
	3	-3.459	0.611	0	0	0	0
1932	1	0	-12.137	9.016	0	0	0
	2	-2.445	0.611	-2.445	0	0	0
	3	-3.487	-6.722	5.273	0	0	0
1933	1	-7.01	-12.37	0	0	0	0
	2	-36.084	-59.245	-4.221	0	0	0
	3	-55.83	-92.649	-0.001	0	0	0
1934	1	0	-12.371	-7.01	0	0	0
	2	-4.219	-59.237	-36.078	0	0	0
	3	-5.746	-6.779	-4.051	0	0	0
1935	1	7.01	-12.37	0	0	0	0
	2	-4.026	0.912	-4.026	0	0	0
	3	-5.705	0.912	0	0	0	0
1936	1	0	-12.371	7.01	0	0	0
	2	-4.026	0.912	-4.026	0	0	0
	3	-5.746	-6.631	3.973	0	0	0

	4	-4.214	-72.426	-43.029	0	0	0
	5	-5.753	-21.315	-11.723	0	0	0
1935	1	6.956	-12.269	0	0	0	0
	2	-4.026	0	-4.026	0	0	0
	3	-5.705	0	0	0	0	0
	4	2.93	-12.269	-4.026	0	0	0
	5	1.251	-12.269	0	0	0	0
1936	1	0	-12.271	6.957	0	0	0
	2	-4.026	0	-4.026	0	0	0
	3	-5.753	-9.05	4.771	0	0	0
	4	-4.026	-12.271	2.93	0	0	0
	5	-5.753	-21.32	11.727	0	0	0

CABLE FORCES

Beam	L/C	Node	Axial Force kN	Shear-Y kN	Shear-Z kN	Torsion kNm	Moment-Y kNm	Moment-Z kNm
5765	1	1925	-6.327	0	0	0	0	0
		161	6.327	0	0	0	0	0
	2	1925	-8.028	0	0	0	0	0
		161	8.028	0	0	0	0	0
	3	1925	-9.500	0	0	0	0	0
		161	9.500	0	0	0	0	0
5766	1	1928	-6.328	0	0	0	0	0
		164	6.328	0	0	0	0	0
	2	1928	-3.985	0	0	0	0	0
		164	3.985	0	0	0	0	0
	3	1928	-6.084	0	0	0	0	0
		164	6.084	0	0	0	0	0
5767	1	1926	-6.323	0	0	0	0	0
		162	6.323	0	0	0	0	0
	2	1926	-8.023	0	0	0	0	0
		162	8.023	0	0	0	0	0
	3	1926	-6.077	0	0	0	0	0
		162	6.077	0	0	0	0	0
5768	1	1927	-6.326	0	0	0	0	0
		163	6.326	0	0	0	0	0
	2	1927	-3.980	0	0	0	0	0
		163	3.980	0	0	0	0	0
	3	1927	-2.261	0	0	0	0	0
		163	2.261	0	0	0	0	0
5769	1	1925	-5.317	0	0	0	0	0
		321	5.317	0	0	0	0	0
	2	1925	-7.892	0	0	0	0	0
		321	7.892	0	0	0	0	0
	3	1925	-11.858	0	0	0	0	0
		321	11.858	0	0	0	0	0
5770	1	1928	-5.320	0	0	0	0	0
		324	5.320	0	0	0	0	0
	2	1928	-0.501	0	0	0	0	0
		324	0.501	0	0	0	0	0
	3	1928	-4.540	0	0	0	0	0
		324	4.540	0	0	0	0	0
5771	1	1926	-5.315	0	0	0	0	0
		322	5.315	0	0	0	0	0
	2	1926	-7.889	0	0	0	0	0
		322	7.889	0	0	0	0	0
	3	1926	-4.532	0	0	0	0	0
		322	4.532	0	0	0	0	0
5772	1	1927	-5.317	0	0	0	0	0
		323	5.317	0	0	0	0	0
	2	1927	-0.498	0	0	0	0	0
		323	0.498	0	0	0	0	0
	3	1927	0.000	0	0	0	0	0
		323	0.000	0	0	0	0	0

5773	1	1925	-4.504	0	0	0	0	0	
		481	4.504	0	0	0	0	0	
	2	1925	-8.962	0	0	0	0	0	
		481	8.962	0	0	0	0	0	
	3	1925	-14.672	0	0	0	0	0	
		481	14.672	0	0	0	0	0	
5774	1	1926	-4.504	0	0	0	0	0	
		482	4.504	0	0	0	0	0	
	2	1926	-8.962	0	0	0	0	0	
		482	8.962	0	0	0	0	0	
	3	1926	-3.198	0	0	0	0	0	
		482	3.198	0	0	0	0	0	
5775	1	1928	-4.504	0	0	0	0	0	
		484	4.504	0	0	0	0	0	
	2	1928	0.000	0	0	0	0	0	
		484	0.000	0	0	0	0	0	
	3	1928	-3.199	0	0	0	0	0	
		484	3.199	0	0	0	0	0	
5776	1	1927	-4.504	0	0	0	0	0	
		483	4.504	0	0	0	0	0	
	2	1927	0.000	0	0	0	0	0	
		483	0.000	0	0	0	0	0	
	3	1927	0.000	0	0	0	0	0	
		483	0.000	0	0	0	0	0	
5777	1	1925	-4.022	0	0	0	0	0	
		641	4.022	0	0	0	0	0	
	2	1925	-9.491	0	0	0	0	0	
		641	9.491	0	0	0	0	0	
	3	1925	-15.730	0	0	0	0	0	
		641	15.730	0	0	0	0	0	
5778	1	1928	-4.022	0	0	0	0	0	
		644	4.022	0	0	0	0	0	
	2	1928	0.000	0	0	0	0	0	
		644	0.000	0	0	0	0	0	
	3	1928	-2.322	0	0	0	0	0	
		644	2.322	0	0	0	0	0	
5779	1	1926	-4.022	0	0	0	0	0	
		642	4.022	0	0	0	0	0	
	2	1926	-9.488	0	0	0	0	0	
		642	9.488	0	0	0	0	0	
	3	1926	-2.322	0	0	0	0	0	
		642	2.322	0	0	0	0	0	
5780	1	1927	-4.022	0	0	0	0	0	
		643	4.022	0	0	0	0	0	
	2	1927	0.000	0	0	0	0	0	
		643	0.000	0	0	0	0	0	
	3	1927	0.000	0	0	0	0	0	
		643	0.000	0	0	0	0	0	
5781	1	1929	-4.190	0	0	0	0	0	
		801	4.190	0	0	0	0	0	
	2	1929	-11.574	0	0	0	0	0	
		801	11.574	0	0	0	0	0	
	3	1929	-18.649	0	0	0	0	0	
		801	18.649	0	0	0	0	0	
5782	1	1932	-4.190	0	0	0	0	0	
		804	4.190	0	0	0	0	0	
	2	1932	0.000	0	0	0	0	0	
		804	0.000	0	0	0	0	0	

	3	1932	-2.771	0	0	0	0	0
		804	2.771	0	0	0	0	0
5783	1	1931	-4.190	0	0	0	0	0
		803	4.190	0	0	0	0	0
	2	1931	0.000	0	0	0	0	0
		803	0.000	0	0	0	0	0
	3	1931	0.000	0	0	0	0	0
		803	0.000	0	0	0	0	0
5784	1	1930	-4.190	0	0	0	0	0
		802	4.190	0	0	0	0	0
	2	1930	-11.576	0	0	0	0	0
		802	11.576	0	0	0	0	0
	3	1930	-2.773	0	0	0	0	0
		802	2.773	0	0	0	0	0
5785	1	1929	-3.932	0	0	0	0	0
		961	3.932	0	0	0	0	0
	2	1929	-12.892	0	0	0	0	0
		961	12.892	0	0	0	0	0
	3	1929	-20.798	0	0	0	0	0
		961	20.798	0	0	0	0	0
5786	1	1932	-3.932	0	0	0	0	0
		964	3.932	0	0	0	0	0
	2	1932	0.000	0	0	0	0	0
		964	0.000	0	0	0	0	0
	3	1932	-2.299	0	0	0	0	0
		964	2.299	0	0	0	0	0
5787	1	1931	-3.932	0	0	0	0	0
		963	3.932	0	0	0	0	0
	2	1931	0.000	0	0	0	0	0
		963	0.000	0	0	0	0	0
	3	1931	0.000	0	0	0	0	0
		963	0.000	0	0	0	0	0
5788	1	1930	-3.932	0	0	0	0	0
		962	3.932	0	0	0	0	0
	2	1930	-12.895	0	0	0	0	0
		962	12.895	0	0	0	0	0
	3	1930	-2.310	0	0	0	0	0
		962	2.310	0	0	0	0	0
5789	1	1929	-3.795	0	0	0	0	0
		1121	3.795	0	0	0	0	0
	2	1929	-14.592	0	0	0	0	0
		1121	14.592	0	0	0	0	0
	3	1929	-23.443	0	0	0	0	0
		1121	23.443	0	0	0	0	0
5790	1	1932	-3.796	0	0	0	0	0
		1124	3.796	0	0	0	0	0
	2	1932	0.000	0	0	0	0	0
		1124	0.000	0	0	0	0	0
	3	1932	-2.044	0	0	0	0	0
		1124	2.044	0	0	0	0	0
5791	1	1931	-3.796	0	0	0	0	0
		1123	3.796	0	0	0	0	0
	2	1931	0.000	0	0	0	0	0
		1123	0.000	0	0	0	0	0
	3	1931	0.000	0	0	0	0	0
		1123	0.000	0	0	0	0	0
5792	1	1930	-3.796	0	0	0	0	0
		1122	3.796	0	0	0	0	0

	2	1930	-14.595	0	0	0	0	0
		1122	14.595	0	0	0	0	0
	3	1930	-2.070	0	0	0	0	0
		1122	2.070	0	0	0	0	0
5793	1	1929	-3.751	0	0	0	0	0
		1281	3.751	0	0	0	0	0
	2	1929	-15.527	0	0	0	0	0
		1281	15.527	0	0	0	0	0
	3	1929	-24.799	0	0	0	0	0
		1281	24.799	0	0	0	0	0
5794	1	1932	-3.751	0	0	0	0	0
		1284	3.751	0	0	0	0	0
	2	1932	0.000	0	0	0	0	0
		1284	0.000	0	0	0	0	0
	3	1932	-1.951	0	0	0	0	0
		1284	1.951	0	0	0	0	0
5795	1	1930	-3.751	0	0	0	0	0
		1282	3.751	0	0	0	0	0
	2	1930	-15.528	0	0	0	0	0
		1282	15.528	0	0	0	0	0
	3	1930	-1.990	0	0	0	0	0
		1282	1.990	0	0	0	0	0
5796	1	1931	-3.751	0	0	0	0	0
		1283	3.751	0	0	0	0	0
	2	1931	0.000	0	0	0	0	0
		1283	0.000	0	0	0	0	0
	3	1931	0.000	0	0	0	0	0
		1283	0.000	0	0	0	0	0
5797	1	1933	-3.709	0	0	0	0	0
		1441	3.709	0	0	0	0	0
	2	1933	-17.248	0	0	0	0	0
		1441	17.248	0	0	0	0	0
	3	1933	-27.291	0	0	0	0	0
		1441	27.291	0	0	0	0	0
5798	1	1936	-3.710	0	0	0	0	0
		1444	3.710	0	0	0	0	0
	2	1936	0.000	0	0	0	0	0
		1444	0.000	0	0	0	0	0
	3	1936	-2.062	0	0	0	0	0
		1444	2.062	0	0	0	0	0
5799	1	1934	-3.710	0	0	0	0	0
		1442	3.710	0	0	0	0	0
	2	1934	-17.244	0	0	0	0	0
		1442	17.244	0	0	0	0	0
	3	1934	-2.105	0	0	0	0	0
		1442	2.105	0	0	0	0	0
5800	1	1935	-3.709	0	0	0	0	0
		1443	3.709	0	0	0	0	0
	2	1935	0.000	0	0	0	0	0
		1443	0.000	0	0	0	0	0
	3	1935	0.000	0	0	0	0	0
		1443	0.000	0	0	0	0	0
5801	1	1933	-3.710	0	0	0	0	0
		1601	3.710	0	0	0	0	0
	2	1933	-17.514	0	0	0	0	0
		1601	17.514	0	0	0	0	0
	3	1933	-27.478	0	0	0	0	0
		1601	27.478	0	0	0	0	0

5802	1	1934	-3.709	0	0	0	0	0
		1602	3.709	0	0	0	0	0
	2	1934	-17.499	0	0	0	0	0
		1602	17.499	0	0	0	0	0
	3	1934	-2.092	0	0	0	0	0
		1602	2.092	0	0	0	0	0
5803	1	1936	-3.709	0	0	0	0	0
		1604	3.709	0	0	0	0	0
	2	1936	0.000	0	0	0	0	0
		1604	0.000	0	0	0	0	0
	3	1936	-2.061	0	0	0	0	0
		1604	2.061	0	0	0	0	0
5804	1	1935	-3.710	0	0	0	0	0
		1603	3.710	0	0	0	0	0
	2	1935	0.000	0	0	0	0	0
		1603	0.000	0	0	0	0	0
	3	1935	0.000	0	0	0	0	0
		1603	0.000	0	0	0	0	0
5805	1	1933	-3.766	0	0	0	0	0
		1761	3.766	0	0	0	0	0
	2	1933	-17.331	0	0	0	0	0
		1761	17.331	0	0	0	0	0
	3	1933	-26.839	0	0	0	0	0
		1761	26.839	0	0	0	0	0
5806	1	1936	-3.766	0	0	0	0	0
		1764	3.766	0	0	0	0	0
	2	1936	0.000	0	0	0	0	0
		1764	0.000	0	0	0	0	0
	3	1936	-2.148	0	0	0	0	0
		1764	2.148	0	0	0	0	0
5807	1	1934	-3.766	0	0	0	0	0
		1762	3.766	0	0	0	0	0
	2	1934	-17.328	0	0	0	0	0
		1762	17.328	0	0	0	0	0
	3	1934	-2.192	0	0	0	0	0
		1762	2.192	0	0	0	0	0
5808	1	1935	-3.766	0	0	0	0	0
		1763	3.766	0	0	0	0	0
	2	1935	0.000	0	0	0	0	0
		1763	0.000	0	0	0	0	0
	3	1935	0.000	0	0	0	0	0
		1763	0.000	0	0	0	0	0
5809	1	1933	-3.847	0	0	0	0	0
		1889	3.847	0	0	0	0	0
	2	1933	-16.132	0	0	0	0	0
		1889	16.132	0	0	0	0	0
	3	1933	-24.626	0	0	0	0	0
		1889	24.626	0	0	0	0	0
5810	1	1936	-3.847	0	0	0	0	0
		1892	3.847	0	0	0	0	0
	2	1936	0.000	0	0	0	0	0
		1892	0.000	0	0	0	0	0
	3	1936	-2.262	0	0	0	0	0
		1892	2.262	0	0	0	0	0
5811	1	1934	-3.847	0	0	0	0	0
		1890	3.847	0	0	0	0	0
	2	1934	-16.144	0	0	0	0	0
		1890	16.144	0	0	0	0	0

	3	1934	-2.311	0	0	0	0	0
		1890	2.311	0	0	0	0	0
5812	1	1935	-3.847	0	0	0	0	0
		1891	3.847	0	0	0	0	0
	2	1935	0.000	0	0	0	0	0
		1891	0.000	0	0	0	0	0
	3	1935	0.000	0	0	0	0	0
		1891	0.000	0	0	0	0	0