2/2

16/08/12

N/16/8'

## TECHNICAL GUARANTEED PARTICULARS FOR 30 M HIGH MAST SUITABLE FOR 25 NOS. LUMINAIRES ASSYMMETRICAL

| | |
|---|---|
| CLIENT | : MORMUGAO PORT TRUST |
| PROJECT | : GOA |
| DOCUMENT | : Data Sheet |
| OFFER NO. | : TLL/12-13/RP/0067 |
| OFFER DT. | : 14.08.2012 |
| REV. NO. | : |
| REV. DT. | : |

TRANSRAIL LIGHTING GAMMON GROUP

| | | | | |
|---|---|---|---|---|
| Manufacturer | : | Transrail Lighting Limited | | |
| Max.wind speed | : | 39 m/s as per IS : 875 (Part - III) | | |
| **HIGH MAST SHAFT** | | | | |
| Height of mast (M) | - | 30 Meter | | |
| No. of sections (Nos.) | - | Three | | |
| Material construction | - | S 355 grade as per BS-EN10 025 | | |
| Bottom A/F (MM) | - | 630 mm | | |
| Top A/F (MM) | - | 180 mm | | |
| | | Top | Middle | Bottom |
| Plate thickness (MM) | - | 4 | 5 | 6 |
| Section length (MM) | - | 9490 | 10980 | 10980 |
| Cross section of Mast (Nos.) | - | 20 side polygon. | | |
| Standard for of galvanisation | - | As per BS EN ISO 1461 | | |
| Size of opening and door at base (MM) | - | 1200 x 300 mm | | |
| Diameter of base plate (MM) | - | 850 mm | | |
| Thickness of base plate (MM) | - | 30 mm | | |
| Lightning protection finial | - | G.I single spike of length 1200 mm | | |
| **LANTERN CARRIAGE** | | | | |
| Material of construction | - | 50 NB ERW Class B - M. S. Pipe | | |
| Diameter of carriage ring (MM) | - | 711 mm (ID) | | |
| Construction | - | As per design | | |
| Load carrying capacity | - | 25 Luminaire | | |
| **TRAILING CABLE** | | | | |
| Conductor | - | Copper, 8 core, 4 sq mm | | |
| Insulation | - | EPR insulated PCP scheathed | | |
| No. of circuits per mast | - | One | | |
| **WINCH / POWER TOOL** | | | | |
| Type | - | Double drum | | |
| SWL of winch (KGS.) | - | SWL 1000 Kg | | |
| Method of operation | - | Integral Motor | | |
| Motor capacity | - | 3 HP | | |
| No of speeds | - | 6 Pole, Single speed | | |
| Torque limitor | - | With mechanical tripping facility | | |
| **STAINLESS STEEL WIRE ROPE** | | | | |
| Grade | - | AISI 316 | | |
| Construction | - | 7/19 construction | | |
| Number of ropes | - | Two continuous | | |
| Diameter (MM) | - | 8 mm | | |
| Braking load capacity | - | 2350 kg x 2 | | |
| **FOUNDATION BOLTS** | | | | |
| Number of foundation bolts | - | 16 nos. | | |
| PCD of foundation bolts (MM) | - | 740 mm | | |
| Type | - | TS 600 | | |
| Diameter | - | 30 mm dia | | |
| Length of foundation bolts | - | 850 mm long | | |

PRABHA ELECTRICALS & COMMUNICATIONS

2/2

16/08/12

1618.

**Transrail Lighting limited**
Gammon Group

# STRUCTURAL DESIGN OF 30 M LIGHTING MAST
**M/s- MORMUGAO PORT TRUST @ GOA.**

## Input Details for Lighting Mast Design

### Mast Details

| | | |
|---|---|---|
| 1 | Height of mast (Ht) | 30 m |
| 2 | Top Dia (A/F) | 180 mm |
| 3 | Bottom Dia (A/F) | 630 mm |
| 4 | Section 1 Thk ( Top ) | 5 mm |
| 5 | Section 2 Thk ( Middle ) | 5 mm |
| 6 | Section 3 Thk (Bottom) | 6 mm |
| 7 | No of Sides | 20 Nos |

### Load Details

| | | |
|---|---|---|
| 1 | Number of luminaries | 25 + 6 Nos |
| 2 | Orientation of luminaries | **Asymmetrical loading** |
| 3 | Projected Area of luminaries | 6.20 Sqm |
| 4 | Weight of Lantern Carriage & Luminaries. | 1084 Kg |

### Wind Data

| | | |
|---|---|---|
| 1 | Basic Wind Speed (Vb) | 39 m/sec |
| 2 | Terrain Category & Structure Class | 1B |
| 3 | Statistical Probablity factor (K1) | 0.92 |
| 4 | Terrain, height & structure size factor (K2) | As per Table 2, IS.875 |
| 5 | Topography Factor (K3) | 1 |

### Material Details

1 High Tensile Plates of S355JO as per BS EN 10025 Or Equivalent
2 Other structural steel Fe-410 conforming to IS-2062
3 Foundation Bolts shall be Conforming to IS-1367 Part III :2002
4 Hot dip galvanisation Conforming to BSEN 1461:1991.

### Design factors

| | | |
|---|---|---|
| 1 | Safety factor for dead load for Ultimate & Serviceability limit state | 1 |
| 2 | Safety factor for wind load for Ultimate limit state | 1.25 |
| 3 | Safety factorfor wind load in Serviceability limit state | 1 |
| 4 | Safety factor for materials | 1.15 |

### Various Standards Reffered :

1 IS.875 -Part 3 -1987 for wind load on Structure
2 ILE Technical Report -7 for Lighting mast design.
3 IS-800:1984 for steel design
4 BS 5649 ( Part-7) for Design of Lighting mast
5 SABS – 0225:1991 (Code for design of lighting mast)

**Transrail Lighting limited**
Gammon Group

## 1. SECTION PROPERTIES

| Node No | Height H | Member length | Outer dia D | Thick T | Moment of inertia I | Elastic Modulus | D / T |
|---|---|---|---|---|---|---|---|
| | ( m) | ( m) | (mm ) | ( mm ) | ( cm^4) | Z (cm^3) | |
| 15 | 30 | | 180 | 5.0 | 1053.4 | 117.0 | 36.0 |
| | | 2.00 | 195 | 5.0 | | | 39.0 |
| 14 | 28 | | 210 | 5.0 | 1693.0 | 161.2 | 42.0 |
| | | 2.00 | 225 | 5.0 | | | 45.0 |
| 13 | 26 | | 240 | 5.0 | 2550.0 | 212.5 | 48.0 |
| | | 2.00 | 255 | 5.0 | | | 51.0 |
| 12 | 24 | | 270 | 5.0 | 3656.2 | 270.8 | 54.0 |
| | | 2.50 | 289 | 5.0 | | | 57.8 |
| 11 | 21.5 | | 308 | 5.0 | 5438.0 | 353.7 | 61.5 |
| | | 2.00 | 323 | 5.0 | | | 64.5 |
| 10 | 19.5 | | 338 | 5.0 | 7221.3 | 427.9 | 67.5 |
| | | 2.00 | 353 | 5.0 | | | 70.5 |
| 9 | 17.5 | | 368 | 5.0 | 9357.2 | 509.2 | 73.5 |
| | | 2.50 | 386 | 5.0 | | | 77.3 |
| 8 | 15 | | 405 | 5.0 | 12571.6 | 620.8 | 81.0 |
| | | 2.00 | 420 | 5.0 | | | 84.0 |
| 7 | 13 | | 435 | 5.0 | 15617.3 | 718.0 | 87.0 |
| | | 2.00 | 450 | 5.0 | | | 90.0 |
| 6 | 11 | | 465 | 5.0 | 19119.0 | 822.3 | 93.0 |
| | | 2.00 | 480 | 6.0 | | | 80.0 |
| 5 | 9 | | 495 | 6.0 | 27562.3 | 1113.6 | 82.5 |
| | | 2.50 | 514 | 6.0 | | | 85.6 |
| 4 | 6.5 | | 533 | 6.0 | 34401.3 | 1292.1 | 88.8 |
| | | 2.00 | 548 | 6.0 | | | 91.3 |
| 3 | 4.5 | | 563 | 6.0 | 40622.7 | 1444.4 | 93.8 |
| | | 2.00 | 578 | 6.0 | | | 96.3 |
| 2 | 2.5 | | 593 | 6.0 | 47552.4 | 1605.1 | 98.8 |
| | | 2.50 | 611 | 6.0 | | | 101.9 |
| 1 | 0 | | 630 | 6.0 | 57268.6 | 1818.1 | 105.0 |
| | | | | | | Max. D/T = | 105 |

Moment of Inertia M.I = PI()/64*($Do^4$-$Di^4$)
where, Do= Outer Dia
Di= Inner Dia

Elastic Modulus Z = M.I/(D/2)

Gross Weight of Lighting Mast Assembly **W** = 1802 Kg

**Transrail Lighting limited**
Gammon Group

***Reference for frequency calculation:***

Both TR-7 as well as BS-5649 requires structural Dynamic Safety.
As per SABS – 0225:1991 (Code for design of lighting mast)

**Natural frequency of mast is**

$f^2oc = ((12.4 \text{ X } EI)/(m*H^4)) =$ 2.56 radian/sec

Where,

| | | | |
|---|---|---|---|
| E - Elastic modulus of steel | = | 205 Kn/Sqmm | |
| I - Moment of Inertia at Mid | = | 12571.6 $Cm^4$ | (As per above table) |
| m -Weight of Mast (Kg/m) =(**W/H**) | = | 60.1 Kg/m | |
| H - Height of mast | = | 30 m | |

**Natural frequency of mast due to wt.of Luminaires**

$f^2oc\ 1 = ((3 \text{ X } EI)/(m*H^3)) =$ 1.63 radian/sec

Where,

| | | | |
|---|---|---|---|
| m -Weight headframe assembly | = | 1084.0 Kg | |

Rayleigh quotient

$\frac{1}{f^2 o} = \frac{1}{f^2 oc} + \frac{1}{f^2 ol}$ = 0.531

$(fo)$ = = 1.373 Hz

Combined Natural frequency (**no**) = 0.219 Hz
(**no**) = $(fo / 2 * 3.141)$

## 2. CALCULATION OF MULTIPLICATION FACTOR

**As per TR-7 ( Multiplication Factor is based on mean hourly wind speed )**

Calculate the K1,K2, & K3 as per IS 875 ( Part-III)

K1- Depend on Probable design life of structure & wind speed. Thus, for 25 years design life and 39m/Sec wind speed. As per IS 875, table 3, K1 = 0.92

K2- Depends on Terrain category & Structure height.We consider category 1 & as per Structure Ht. = 30m, so Class B & by using table 33, at 10 m Height K2 = 0.67

K3- Is the factor which is depend on Topography of ground, here we generally assume the upwind slope is less than or equal to $3^{\circ}$, so we get the K3 = 1.0

Vb- Basic wind speed = 39 M/sec

| | | | |
|---|---|---|---|
| k2 factor for mean hourly | = | 0.78 | |
| Mean hourly speed(V10) | = | 27.99 **m /s** | |
| Natural frequency (**no**) / Mean hourly wind speed ( **V10** ) | = | 0.008 | |
| Assume log decrement | = | 0.2 | |
| Response factor ( **b** ) | = | 1.53 | **Refer- Fig-1 of TR-7** |
| Size reduction factor ( **d** ) | = | 1-0.006*(mast **ht** - 3) | |
| | = | 0.838 | |
| Multiplication factor= ( b*d) | = | 1.28 | |

PRABHA ELECTRICALS & COMMUNICATIONS

## 3. CALCULATION OF WIND PRESSURE

**V=** 39 m / s **K1=** 0.92 **K3=** 1

**K2=** As per Table 2, IS.875 ( Depends on Terrain & Height of Structure)

| Node No | Height H | Member length | Outer D | Factor K2 | Design speed | Pressure $Qh = 0.6*Vd^2$ | Reynolds No | Force Coefficient |
|---|---|---|---|---|---|---|---|---|
| | ( m) | ( m) | (mm ) | | Vd in m/s | N / sq.m | Re $x10^{+5}$ | Cf |
| | | | | 1.13 | 40.54 | 986.31 | | |
| 15 | 30 | | 180 | | | | 5.00 | 0.73 |
| | | 2.00 | 195 | 1.13 | 40.44 | 981.08 | | |
| 14 | 28 | | 210 | | | | 5.82 | 0.73 |
| | | 2.00 | 225 | 1.12 | 40.22 | 970.66 | | |
| 13 | 26 | | 240 | | | | 6.61 | 0.73 |
| | | 2.00 | 255 | 1.12 | 40.01 | 960.30 | | |
| 12 | 24 | | 270 | | | | 7.40 | 0.73 |
| | | 2.50 | 289 | 1.11 | 39.76 | 948.71 | | |
| 11 | 21.5 | | 308 | | | | 8.37 | 0.73 |
| | | 2.00 | 323 | 1.10 | 39.52 | 937.18 | | |
| 10 | 19.5 | | 338 | | | | 9.14 | 0.73 |
| | | 2.00 | 353 | 1.09 | 39.15 | 919.40 | | |
| 9 | 17.5 | | 368 | | | | 9.85 | 0.73 |
| | | 2.50 | 386 | 1.08 | 38.66 | 896.79 | | |
| 8 | 15 | | 405 | | | | 10.72 | 0.73 |
| | | 2.00 | 420 | 1.06 | 38.10 | 871.17 | | |
| 7 | 13 | | 435 | | | | 11.35 | 0.73 |
| | | 2.00 | 450 | 1.05 | 37.53 | 845.12 | | |
| 6 | 11 | | 465 | | | | 11.95 | 0.73 |
| | | 2.00 | 480 | 1.03 | 36.96 | 819.47 | | |
| 5 | 9 | | 495 | | | | 12.53 | 0.73 |
| | | 2.50 | 514 | 1.03 | 36.96 | 819.47 | | |
| 4 | 6.5 | | 533 | | | | 13.48 | 0.73 |
| | | 2.00 | 548 | 1.03 | 36.96 | 819.47 | | |
| 3 | 4.5 | | 563 | | | | 14.24 | 0.73 |
| | | 2.00 | 578 | 1.03 | 36.96 | 819.47 | | |
| 2 | 2.5 | | 593 | | | | 15.00 | 0.73 |
| | | 2.50 | 611 | 1.03 | 36.96 | 819.47 | | |
| 1 | 0 | | 630 | | | | | |

Design wind speed Vd= Vb*k1*k2*k3

Wind pressure Qh = 0.6 *Vd*Vd

Force coefficient for Shaft is based on Reynolds No Re = $DxVd/1.46*10^{-5}$

6.1 E+5 < Re < 21.14 E+5 From wind tunnel test results Carried at IIT Kanpur

Cd = 0.73

2/2
16/05/12
16/8.

## 4. CALCULATION FORCES (ULTIMATE LIMIT STATE )

Safety factor for wind Load γwf 1.25
Safety factor for Dead Load 1

| Node No | Effect. Eqh=Qh*M.F | Total shear | Horizontal Moment | Direct load | Deflection D | M due to P-Delta | Total Moment |
|---|---|---|---|---|---|---|---|
| | N / sq.m | KN | KN.m | KN | mm | KN.m | KN.m |
| | 1264.6 | 9.80 | **Mh** | 10.84 | | **ML** | **M** |
| 15 | | 9.80 | 0.00 | 10.84 | 2752 | 0.00 | 0.000 |
| | 1257.9 | | | | | | |
| 14 | | 10.25 | 19.60 | 11.32 | 2476 | 3.06 | 22.66 |
| | 1244.5 | | | | | | |
| 13 | | 10.76 | 40.09 | 11.88 | 1969 | 8.95 | 49.04 |
| | 1231.2 | | | | | | |
| 12 | | 11.33 | 61.61 | 12.50 | 1626 | 13.13 | 74.73 |
| | 1216.4 | | | | | | |
| 11 | | 12.13 | 89.93 | 13.39 | 1250 | 17.99 | 107.92 |
| | 1201.6 | | | | | | |
| 10 | | 12.84 | 114.20 | 14.19 | 993 | 21.53 | 135.73 |
| | 1178.8 | | | | | | |
| 9 | | 13.60 | 139.87 | 15.06 | 772 | 24.77 | 164.64 |
| | 1149.8 | | | | | | |
| 8 | | 14.61 | 173.87 | 16.25 | 542 | 28.37 | 202.24 |
| | 1117.0 | | | | | | |
| 7 | | 15.47 | 203.09 | 17.29 | 393 | 30.87 | 233.96 |
| | 1083.6 | | | | | | |
| 6 | | 16.36 | 234.02 | 18.40 | 273 | 33.01 | 267.03 |
| | 1050.7 | | | | | | |
| 5 | | 17.28 | 266.74 | 19.82 | 179 | 34.81 | 301.55 |
| | 1050.7 | | | | | | |
| 4 | | 18.51 | 309.93 | 21.72 | 91 | 36.63 | 346.56 |
| | 1050.7 | | | | | | |
| 3 | | 19.56 | 346.95 | 23.34 | 43 | 37.71 | 384.66 |
| | 1050.7 | | | | | | |
| 2 | | 20.67 | 386.06 | 25.80 | 13 | 38.45 | 424.51 |
| | 1050.7 | | | | | | |
| 1 | | 22.13 | 437.73 | 28.86 | | 38.81 | 476.53 |

PRABHA ELECTRICALS & COMMUNICATIONS

## 5. STRENGTH CHECK

**Grade of Steel : S355JO** **Yield Strength Fy=** 355 Mpa

| Node No | Plastic modulus | Plastic restoring M | Constant for | Bending Strength | Stress Ratio |
|---|---|---|---|---|---|
| | cm^3 | KN.m | M* | N m | M |
| | | Mp | | MU | MU |
| 15 | 153.13 | 47.27 | 1.00 | 47.27 | 0.00 |
| 14 | 210.13 | 64.86 | 1.00 | 64.86 | 0.35 |
| 13 | 276.13 | 85.24 | 1.00 | 85.24 | 0.58 |
| 12 | 351.13 | 108.39 | 1.00 | 108.39 | 0.69 |
| 11 | 457.53 | 141.24 | 1.00 | 141.24 | 0.76 |
| 10 | 552.78 | 170.64 | 0.98 | 167.87 | 0.81 |
| 9 | 657.03 | 202.82 | 0.96 | 194.11 | 0.85 |
| 8 | 800.00 | 246.96 | 0.93 | 229.02 | 0.88 |
| 7 | 924.50 | 285.39 | 0.91 | 258.58 | 0.90 |
| 6 | 1058.00 | 326.60 | 0.89 | 289.55 | 0.92 |
| 5 | 1434.73 | 442.89 | 0.92 | 408.29 | 0.74 |
| 4 | 1663.21 | 513.43 | 0.90 | 462.19 | 0.75 |
| 3 | 1858.15 | 573.60 | 0.88 | 507.21 | 0.76 |
| 2 | 2063.89 | 637.11 | 0.87 | 553.87 | 0.77 |
| 1 | 2336.26 | 721.19 | 0.85 | 614.48 | 0.78 |

Max. A.F = 0.92 should be < 1

SAFE

**Transrail Lighting limited**
Gammon Group

## 6. FORCES ( SERVICEABILITY LIMIT STATE)

| Node No | Total shear | Horizo-moment | Direct load | Deflection D | M due to P-Delta | Total Moment |
|---|---|---|---|---|---|---|
| | KN | KN.m | KN | mm | KN.m | KN.m |
| | 7.84 | **Mh** | 10.84 | | **ML** | **M** |
| 15 | 7.84 | 0.00 | 10.84 | 2202 | 0.00 | 0 |
| 14 | 8.20 | 15.68 | 11.32 | 1878 | 3.59 | 19 |
| 13 | 8.61 | 32.07 | 11.88 | 1575 | 7.10 | 39 |
| 12 | 9.06 | 49.29 | 12.50 | 1301 | 10.45 | 60 |
| 11 | 9.71 | 71.95 | 13.39 | 1000 | 14.34 | 86 |
| 10 | 10.27 | 91.36 | 14.19 | 795 | 17.17 | 109 |
| 9 | 10.88 | 111.90 | 15.06 | 618 | 19.76 | 132 |
| 8 | 11.69 | 139.09 | 16.25 | 434 | 22.64 | 162 |
| 7 | 12.37 | 162.47 | 17.29 | 315 | 24.64 | 187 |
| 6 | 13.09 | 187.22 | 18.40 | 218 | 26.35 | 214 |
| 5 | 13.82 | 213.39 | 19.82 | 143 | 27.80 | 241 |
| 4 | 14.81 | 247.94 | 21.72 | 73 | 29.25 | 277 |
| 3 | 15.65 | 277.56 | 23.34 | 34 | 30.12 | 308 |
| 2 | 16.53 | 308.85 | 25.80 | 11 | 30.70 | 340 |
| 1 | 17.70 | 350.18 | 28.86 | 0 | 30.99 | 381 |

PRABHA ELECTRICALS & COMMUNICATIONS

7 **DEFLECTION CHECK AT 2/3 of Design Wind Speed**
**( Serviceabilty limit state )**

| Node No | Height in | 2/3 rd Design wind **Vd** | Design **qh** | Wind load | Total shear | Horizon. moment | Deflection **D** |
|---|---|---|---|---|---|---|---|
| | m | m/s | N /sq.m | KN / m | KN | KN.m | mm |
| | | 27.0 | 438.80 | | 2.72 | **Mh** | |
| 15 | 30 | | | | 2.72 | 0.0 | 697 |
| | | 27.0 | 436.5 | 0.06 | | | |
| 14 | 28 | | | | 2.84 | 5.6 | 596 |
| | | 26.8 | 431.8 | 0.07 | | | |
| 13 | 26 | | | | 2.99 | 11.4 | 502 |
| | | 26.7 | 427.2 | 0.08 | | | |
| 12 | 24 | | | | 3.15 | 17.5 | 416 |
| | | 26.5 | 422.1 | 0.09 | | | |
| 11 | 21.5 | | | | 3.37 | 25.7 | 321 |
| | | 26.4 | 416.9 | 0.10 | | | |
| 10 | 19.5 | | | | 3.56 | 32.6 | 256 |
| | | 26.1 | 409.0 | 0.11 | | | |
| 9 | 17.5 | | | | 3.77 | 39.9 | 200 |
| | | 25.8 | 399.0 | 0.11 | | | |
| 8 | 15 | | | | 4.06 | 49.7 | 141 |
| | | 25.4 | 387.6 | 0.12 | | | |
| 7 | 13 | | | | 4.29 | 58.1 | 102 |
| | | 25.0 | 376.0 | 0.12 | | | |
| 6 | 11 | | | | 4.54 | 66.9 | 71 |
| | | 24.6 | 364.6 | 0.13 | | | |
| 5 | 9 | | | | 4.80 | 76.2 | 47 |
| | | 24.6 | 364.6 | 0.14 | | | |
| 4 | 6.5 | | | | 5.14 | 88.7 | 24 |
| | | 24.6 | 364.6 | 0.15 | | | |
| 3 | 4.5 | | | | 5.43 | 99.2 | 11 |
| | | 24.6 | 372.5 | 0.16 | | | |
| 2 | 2.5 | | | | 5.74 | 110.4 | 3.50 |
| | | 24.6 | 364.6 | 0.16 | | | |
| 1 | 0 | | | | 6.15 | 125.3 | 0 |

Deflection at the top of mast = 697 mm

SAFE

< 750

**Reference : Technical Report-7 (from Institute of lighting Engg.)**
**Clause ; 2.3.2.2**

Here deflection is checked at 2/3 of design wind speed
Deflection at the top most point is found to be less than 1/ 40 of mast height.

**FOUNDATION LOADING**

Forces at serviceability without Multiplication Factor .

1 Vertical Load **Fv** = 28.86 Kn

2 Horizontal Shear Force **Fh** = 13.81 Kn

3 Overturning Moment **Mo** = 297.29 Kn.m

As recommended in Technical Report-7 Clause 2.9.1, due to differnce in the dynamic behaviour of soil & mast the forces at the bottom of mast can be reduced to 1/Multiplication factor.

2/2

RD 16/05/12

RD/1618

**Transrail Lighting limited**
Gammon Group

## FOUNDATION BOLT DESIGN

Properties of foundation bolt

| | | |
|---|---|---|
| Property Class | = | **TS-600** Grade |
| Min.Tensile Strength | = | 600 **N** / sq.mm |
| Lower Yield Strength | = | 405 **N** / sq.mm |
| Bolt Diameter(**D**) | = | **30** mm |
| Number of Bolts equally spaced (**N**) | = | **16** nos. |
| Pitch Circle diameter(**p.c.d**) | = | **740** mm |
| Pitch of bolt (**p**) | = | **3.5** mm |
| Nominal Area **An** of bolt<br>**Pi()*(Dia -Pitch)^2/4** | = | 551.48 mm^2 |

## WORKING STRESS METHOD

| | | | |
|---|---|---|---|
| Max. Tension in one bolt T | = | **4 x M**<br>**N x P.C.D** | **W**<br>**N** |
| Max. Tension in one bolt<br>( Moment **M** @ serviceability condition ) | = | **100414** N | |
| Bolt Dia **D** | = | 30 mm | |
| Embedment Length Le | = | 700 mm | |
| Threaded length | = | 150 mm | |
| Total length of bolt | = | 850 mm | |

PRABHA ELECTRICALS & COMMUNICATIONS

## FOUNDATION BOLT DESIGN

| | | | |
|---|---|---|---|
| Grade of concrete | = | M-20 | |
| Permissible bond stress **Tbd** ( As per Is-456-2000) | = | 0.8 Mpa | |
| Permissible bearing stress σb | = | 5 Mpa | **(0.25 x Fck)** |
| Tensile force resisted by bolt through bond stress **(pi * Tbd *Le * D)** | = | **52752** N | |

REQ. ANCHOR PLATE

Anchorplate is to be designed for the remaining tensile force.

Anchor bolt Design **( working stress method )**

**For bolts of property class greater than 4.6 Grade permissible stresses in the bolts as per clause 8.9.4 of IS 800-1984 is as follows**

| | | | | |
|---|---|---|---|---|
| Yield stress | = | 405 | N/Sq.mm | |
| 0.7 x Tensile strength = | | 420 | N/Sq.mm | **Clause 8.9.4.3** |

Factor = $\frac{\min(420, 405)}{235}$ = **1.72**

Hence permissible stresses in class 6.8 bolts are as follows

| | | |
|---|---|---|
| In Tension = ( σt ) =120 x 1.72 x 1.25 | = | 259 N/Sq.mm |
| In shear = ( σv ) = 80 x 1.72 x 1.25 | = | 172.3 N/Sq.mm |

**As per Clause 3.9.2.1 of IS 800-1984 ,for wind loads permissible stresses in bolt may be exceeded by 25%**

Maximum Tension in Bolt (**σtf cal**) = 100.41 Kn

Permissble Tension in bolt **(σtf perm)** = An x σt /1000
142.56 Kn
**SAFE**

Actual shear in bolt **( τvf cal )** = 17.704 Kn
( Total shear at serviceability / Number of bolt)

Permissible shear in bolt **(τvf perm)** = An x σv /1000
95.0 Kn
**SAFE**

**Check for Combined Shear and Tension:(Refer Cl. No.-8.9.4.5 of IS-800-1984)**

**Tvf cal/T vf perm + σ tf cal/σ tf perm=** = **0.89** < 1.4
**SAFE**

**Transrail Lighting limited**
Gammon Group

## FOUNDATION BOLT DESIGN

### ANCHOR PLATE ( ANNULAR)

Tension **T2** to be carried by Anchor plate = 47661.7 N
( Max tension in Bolt - Tensile force resisted through Bond stress)

| | | |
|---|---|---|
| Size of anchor plate | = | 840.00 mm |
| Opening in anchor plate | = | 640.00 mm |
| Width of plate -b | = | 100.00 mm |
| Length of plate - l | = | 145 mm |
| Bearing pressure **σb** | = | 3.28 N/mm^2 |
| **T2 / ( l x b)** | | O.K |
| Cantilever span **lc** | = | (b-hole dia)/2 |
| | = | 34.00 mm |
| Max.moment | = | 1896.0 KN mm |
| **Max.moment =( σb * lc^2)/2** | | |
| Permisssible bending stress | = | 240 N/ mm^2 |
| in the plate (**s bs**) | | **As per IS-800-1984** |
| Thickness of anchor plate Req | = | 6.88 mm |
| **t = Sqrt (6 x M / Permissible stress)** | | 8.0 mm Provided |

**To maintain the position of the Bolt, we recommend to provide the annular plate.**

## BASE PLATE DESIGN

| | | |
|---|---|---|
| Steel material | = | Fe-410 |
| Yeild strength | = | 240 Mpa |
| Max.compressive force / unit length of base plate | = | (4 M/ p.c.d +W)/ (p* p.c.d) |
| | = | 1121.0 N / mm |
| | = | 840 mm circular |
| Max.bearing pressure ( **w** ) P / ( Base plate dia- Mast bottom) | = | 5.34 N/ mm^2 |
| Cantilever span ( Base plate - PCD) / 2 | = | 105 mm |
| Max. cantilever bending moment Mmax = w x /^2 /2 | = | 29426 Nmm /m |
| Permisssible bending stress in the plate (**σbs**) | = | 240 N/ mm^2 |
| Thickeness of plate required | = | 27.1 mm |
| Thickness provided | = | 30 mm |

2/2 16/05/12

Transrail Lighting Ltd
Gammon Group

# FOUNDATION DESIGN CALCULATIONS OF 30 HIGH MAST FOR M/s- MORMUGAO PORT TRUST @ GOA.

16/8.

## DESIGN PARAMETERS:

| | | |
|---|---|---|
| SAFE. BEARING CAPACITY OF SOIL ----------SBC---------- | 100 | kn/Sq.m |
| GROUND WATER TABLE----------GWT---------- | LOW | |
| GRADE OF CONCRETE ---------- | M-20 | |

## FOUNDATION FORCES AT BOTTOM OF MAST (AT SERVICEABILITY CONDITION)

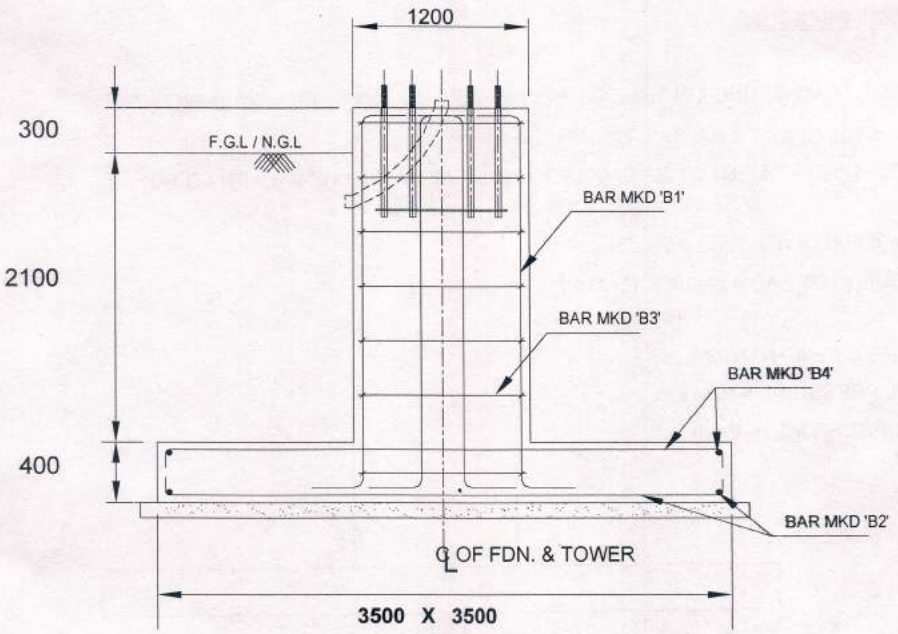
| | | |
|---|---|---|
| DOWNWARD / VERTICAL LOAD OF HIGH MAST SYSTEM----(Wm) | 28.9 | KN |
| TOTAL HORIZONTAL SHEAR ON COMPLETE MAST ----(Hz) | 13.8 | KN |
| OVERTURNING MOMENT AT BASE OF MAST----(Mo) | 297 | KN.m |

## PROPERTIES OF SOIL & CONCRETE

| | | |
|---|---|---|
| DENSITY OF SOIL ----------DS1----------kn/cu.m | 16.5 | kn/cu.m |
| DENSITY OF CONCRETE ------- DC1----------Kn/cu.m | 25 | kn/cu.m |
| CONCRETE GRADE = M-20 | | |
| STRENGTH OF CONCRETE IN COMPRESSION = Fck | 20 | Mpa |

## REINFORCEMENT DETAILS FOR FOUNDATION

| | |
|---|---|
| REINFORCEMENT STEEL GRADE USED ----Fy----------N/sq.mm | 415 |
| MINIMUM COVER FOR REINFORCEMENT ----------mm. | 50 |




PRABHA ELECTRICALS & COMMUNICATIONS

Transrail Lighting Ltd
Gammon Group

# FOUNDATION DESIGN CALCULATIONS OF 30 HIGH MAST FOR M/s- MORMUGAO PORT TRUST @ GOA.

## CONCRETE DIMENSION FOR FOUNDATION:-

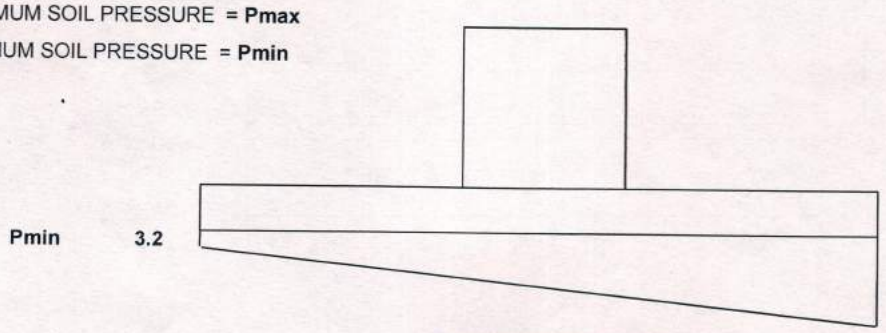
| | | | | |
|---|---|---|---|---|
| BASE WIDTH OF PAD IN TRANSVERSE DIRECTION | **TB** | - | m | 3.500 |
| BASE WIDTH OF PAD IN LONGITUDINAL DIRECTION | **LB** | - | m | **3.500** |
| TOTAL HEIGHT OF FOUNDATION | **H** | - | m | 2.500 |
| DEPTH OF BOTTOM PAD | **PD** | - | m | 0.400 |
| DEPTH OF LEAN CONCRETE PAD BELOW FOUNDATION | **LD** | - | m | **0.100** |
| WIDTH OF PEDESTAL | **B** | - | m | 1.200 |
| HEIGHT OF PEDESTAL ABOVE GROUND LVL. | **PH** | - | m | 0.300 |

## VOLUME & WEIGHT CALCULATION :-

| | | | |
|---|---|---|---|
| VOLUME OF LEAN PAD | VLD = ( TB x LB ) x LD | 1.369 | $M^3$ |
| VOLUME OF BOTTOM PAD | VC1 = ( TB x LB ) x PD | 4.900 | $M^3$ |
| VOLUME OF PEDESTAL BELOW GL | VC2 = (B x B) x ( H - PD ) | 3.456 | $M^3$ |
| TOTAL CONCRETE VOLUME | VC = (VC1 +VC2 ) | 8.356 | $M^3$ |
| AREA AT RAFT----------**A1**---------- | TB X LB | 12.250 | $M^2$ |
| VOLUME OF SOIL = **VS1** = A1 X (H-PD)- VC2 | | 22.27 | $M^3$ |
| WEIGHT OF EARTH = S**WT** = VS1 X DS1 | | 367.44 | KN. |
| WEIGHT OF CONCRETE = **CWT** = VC * DC1 | | 209 | KN. |

## CHECK FOR SOIL PRESSURE

| | | |
|---|---|---|
| TOTAL VERTICAL LOAD ACTING ON THE SOIL BELOW FOUNDATION = **FV = (Wm+SWT+CWT)** | 605.20 | KN. |
| TOTAL HORIZONTAL SHEAR = **HZ** | 13.809 | KN. |
| TOTAL OVERTURNING MOMENT AT BASE OF FOOTING = **MO = Mo + HZ X (H+PH-LD-PD)** | 330.43 | KN.M |
| GROSS AREA OF PAD = **A** | 12 | SQ.M |
| SECTION MODULUS OF PAD = **Z =1/6 X TB XLB$^2$** | 7.15 | $MM^3$ |
| SOIL PRESSURE = **FV/A +/- MO/Z** | | |
| MAXIMUM SOIL PRESSURE = **Pmax** | 95.65 | KN/SQ.M |
| MINIMUM SOIL PRESSURE = **Pmin** | 3.16 | KN/SQ.M |




**PRESSURE DIAGRAM**

Transrail Lighting Ltd
Gammon Group

**FOUNDATION DESIGN CALCULATIONS OF 30 HIGH MAST FOR M/s- MORMUGAO PORT TRUST @ GOA.**

## CALCULATION FOR REINFORCEMENT OF BASE ( BOTTOM STEEL )

| | | | | | |
|---|---|---|---|---|---|
| EFFECTIVE CANTILEVER SPAN = **Le** = (LB-PW) | | | | 1.15 | M |
| SOIL PRESSURE AT FACE OF PEDESTAL = **Pcr** | | | | 65.26 | KN/SQ.M |
| PRESSURE DUE TO EARTH WEIGHT = **P1** = DS1 X (H-SB1-PD) | | | | 33 | KN/SQ.M |
| DIA OF BARS PROVIDED ---------- DIA1 ---------BAR MKD " **B2**" | | | | 12 | MM |
| MOMENT AT FACE OF PEDESTAL (AT X-X) = **MU1** = | | | | 52.1 | KN.M |
| EFFECTIVE DEPTH = D1 = (SB1X 1000 - 50 - DIA1/2 ) | | | | 344 | MM |
| PERCENTAGE STEEL REQUIRED = Pt | Mu/b*D1^2 | = | 0.44 | 0.132 | % Steel |
| PERCENTAGE STEEL PROVIDED = **Pt act** = | | | | 0.17 | %Steel |
| BENDING STRENGTH OF REINFORCED SETION =**MRxx** | | | | 70.058 | KN.M |
| | | | | | **SAFE** |
| AREA OF STEEL PROVIDED = Ast = | | | | 584.8 | $MM^2$ |
| SPACING OF BARS = S = | | | | 200 | MM |
| NOS OF BARS = | | | | 17 | NOS |

## CALCULATION FOR TOP REINFORCEMENT ( TOP STEEL )

| | | | | | |
|---|---|---|---|---|---|
| EFFECTIVE CANTILEVER SPAN = **Le** = (LB-PW) | | | | 1.15 | M |
| PRESSURE DUE TO EARTH WEIGHT = **P1** = DS1 X (H-SB1-PD) | | | | 33 | KN/SQ.M |
| DIA OF BARS PROVIDED ---------- DIA1 ---------BAR MKD " **B4**" | | | | 10 | MM |
| MOMENT AT FACE OF PEDESTAL (AT X-X) = **MU1** = | | | | 32.7 | KN.M |
| EFFECTIVE DEPTH = D1 = (SB1X 1000 - 50 - DIA1/2 ) | | | | 344 | MM |
| PERCENTAGE STEEL REQUIRED = Pt | Mu/b*D1^2 | = | 0.277 | 0.12 | % Steel |
| PERCENTAGE STEEL PROVIDED = **Pt act** = | | | | 0.120 | %Steel |
| BENDING STRENGTH OF REINFORCED SETION =**MRxx** | | | | 49.987 | KN.M |
| | | | | | **SAFE** |
| AREA OF STEEL PROVIDED = Ast = | | | | 412.8 | $MM^2$ |
| SPACING OF BARS = S = | | | | 200 | MM |
| NOS OF BARS = | | | | 17 | NOS |

Transrail Lighting Ltd
Gammon Group

# FOUNDATION DESIGN CALCULATIONS OF 30 HIGH MAST FOR M/s- MORMUGAO PORT TRUST @ GOA.

## CHECK FOR OVERTURNING

| | | |
|---|---|---|
| TOTAL OVERTURNING MOMENT = MO | 330.43 | KN.M |
| RESTORING MOMENT DUE TO DEAD WEIGHT = MR | 663.8 | KN.M |
| FACTOR OF SAFETY AGAINST OVERTURNING = F.O.S = MO/MR | 2.0 | > 1.4 |
| | | **SAFE** |

## CHECK FOR SLIDING

| | | | |
|---|---|---|---|
| SLIDING FORCE = HZ = | | 13.8 | KN |
| COEFFICIENT OF FRICTION = CF = TAN (θ) | θ = 10 | 0.2 | |
| FRICTION CAPACITY = HF = FV X CF | | 106.7 | KN |
| FACTOR OF SAFETY AGAINST SLIDING = F.O.S = HZ /HF | | 7.73 | >1.75 |
| | | | **SAFE** |

## CHECK FOR ONE WAY SHEAR

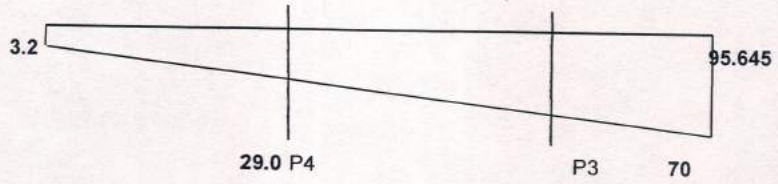
CRITICAL SECTION IS AT DIST 'D' FROM FACE OF PEDESTAL

| | | |
|---|---|---|
| DISTANCE OF CRITICAL SHEAR FROM THE EDGE = LC = Le - D1 | 0.806 | M |
| PRESSURE AT CRITICAL SECTION I.E AT DIST D1 FROM FACE OF PEDESTAL=**P2** | 74.348 | KN/SQM |
| CRITICAL SHEAR = VCR = | 68.507 | KN |
| SHEAR STRESS = Tv = VCR*1.5 / B*D1 | 0.2987 | Mpa |
| PERMISSIBLE SHEAR =Tv per $\beta$ = 0.8*fck/6.89*Pt = 13.66 | 0.3039 | Mpa |
| | | **SAFE** |

## CHECK FOR TWO WAY SHEAR

CRITICAL SECTION IS 'D/2' FROM FACE OF PEDESTAL

| | | |
|---|---|---|
| DISTANCE OF CRITICAL SHEAR FROM THE EDGE = LC = Le - D1/2 | 0.9780 | M |
| B0 = ( W + D1 ) | 1.54 | M |
| PRESSURE AT CRITICAL SECTION i.e AT DIST 'D1/2' FROM FACE OF PEDESTAL=**P3** | 69.80 | KN/SQM |
| PRESSURE AT CRITICAL SECTION i.e AT DIST 'D1/2' FROM FACE OF PEDESTAL=**P4** | 29.00 | KN/SQM |
| MAXIMUM SHEAR FORCE = Vmax = | 487.42 | KN |
| MAXIMUM SHEAR STRESS = Vmax *1.5 / 4 xB0 x D1 | 0.34 | Mpa |
| PERMISSIBLE SHEAR STRESS = 0.25 x Fck $^{0.5}$ | 1.12 | Mpa |
| | | **SAFE** |




PRABHA ELECTRICALS & COMMUNICATIONS

2/2

16/08/12

D/1618

Transrail Lighting Ltd
Gammon Group

**FOUNDATION DESIGN CALCULATIONS OF 30 HIGH MAST FOR M/s- MORMUGAO PORT TRUST @ GOA.**

**DESIGN OF PEDESTAL**

| | | | | |
|---|---|---|---|---|
| SIZE OF PEDESTAL -------- B -------- | 1.200 | X | 1.200 | M |
| LENGTH OF PEDESTAL ----------PL------- | | | 2.400 | M |
| L/D RATIO | | | 2.000 | <3.0 |

ULTIMATE FORCES ON PEDESTAL

| | |
|---|---|
| VERTICAL FORCES = Pu = | 43.29 KN |
| HORIZONTAL FORCE =Hz = | 20.71 KN |
| MOMENT = Mu= | 523.6 KN.M |

CHECK FOR CONCRETE SECTION ONLY

| | | |
|---|---|---|
| SECTIONAL MODULUS OF PEDESTAL = Z = | $1/6 \times B^3$ | 3E+08 $MM^3$ |
| SECTIONAL AREA OF PEDESTAL = Ap = | | 1E+06 $MM^2$ |

| | |
|---|---|
| STRESS IN COMP =$\sigma_{cc, cal}$ | 0.03 Mpa |
| STRESS IN BENDING =$\sigma_{bc, cal}$ | 1.818 Mpa |

PERMISSIBLE STRESS IN CONCRETE:

| | | |
|---|---|---|
| STRESS IN COMP =$\sigma_{cc, per}$ | 5 | Mpa |
| STRESS IN BENDING =$\sigma_{bc, per}$ | 7 | Mpa |

COMBINED STRESS RATIO = ($\sigma_{cc,cal}/\sigma_{cc,per} + \sigma_{bc,cal} / \sigma_{bc,per}$) 0.266 < 1.0

**SAFE**

| | |
|---|---|
| Pu / (Fck x B x d) | 0.002 |
| Mu / (Fck x B x $d^2$) | 0.016 |
| d' / D REFER DESIGN AIDS OF CONCRETE, CHART-43 | 0.042 |

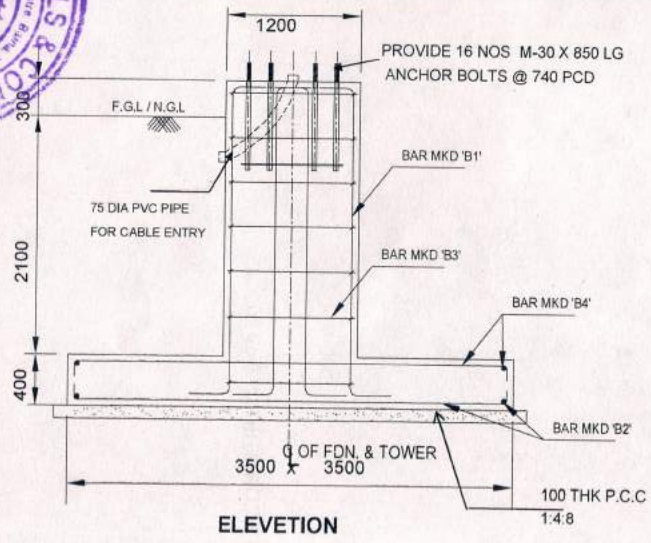
P/Fck IS VERY SMALL, THEREFORE PROVIDE MIN 0.15% OF STEEL.

| | |
|---|---|
| Pt,act ( ACTUAL % OF STEEL PROVIDED) | 0.275 % |
| DIA OF BARS PROVIDED ---------- DIA1 ---------BAR MKD " **B1"** | 12 MM |
| NOS OF BARS PROVIDED ---------- | 36 NOS |
| 8 TOR STIRRUPS -----BAR MKD "**B3**" @ C/C | 200 MM |

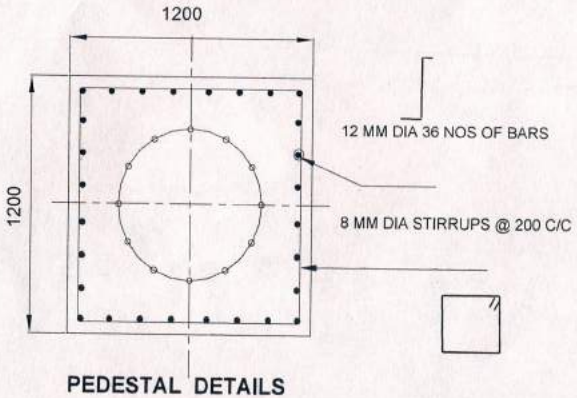
**PROVIDE 12 TOR- 36 NOS OF LONGITUDINAL REINFORCEMENT & 8 TOR STIRRUPS @ 200C/C.**

PRABHA ELECTRICALS & COMMUNICATIONS

PRABHA ELECTRICALS & COMMUNICATIONS




ELEVETION

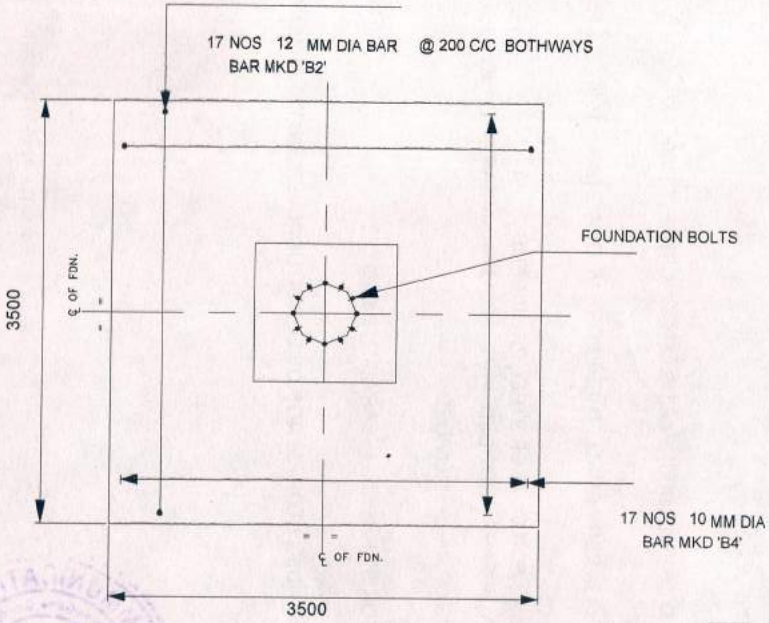



PEDESTAL DETAILS

| FOUNDATION LOADINGS AT THE BASE OF MAST | | |
|---|---|---|
| WIND SPEED | M/SEC | 39 |
| BENDING MOMENT..... | KN-M | 297.3 |
| HORIZONTAL SHEAR..... | KN | 13.81 |
| VERTICAL LOAD..... | KN | 28.9 |
| S.B.C OF SOIL ..... | T/SQM | 10.0 |

SCHEDULE OF REINFORCEMENT

| MK | DIA | SHAPE | NOS | LENGTH |
|---|---|---|---|---|
| B1 | 12 | 100, 2650, 320 | 36 | 3070 |
| B2 | 12 | 120, 3400 | 34 | 3640 |
| B3 | 8 | 1100, 1100 | 14 | 4592 |
| B4 | 10 | 3400, 100 | 34 | 3600 |




FOUNDATION PLAN

| SCHEDULE OF QUANTITIES | | |
|---|---|---|
| EXCAVATION | 37.5 | CU.M |
| P.C.C | 1.37 | CU.M |
| R.C.C | 8.36 | CU.M |
| STEEL Fe 415 | 324.7 | Kg |

SUITABLE FOR 31 LUMINARIES

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MM.
2. MATERIAL OF CONSTRUCTION : CONCRETE GRADE - M-20
   REINFORCEMENT - Fe-415.
   P.C.C - 1:4:8
3. COVER TO ALL REINFORCEMENT - 50MM
4. MINIMUM LAP LENGTH OF BARS SHALL BE 50 X DIA, UNLESS OTHERWISE STATED.
5. FOUNDATION SHOULD REST ON VIRIGIN SOIL, IF SAID S.B.C IS NOT AVAILABLE AT SPECIFIED FOUNDATION LEVEL, IT SHOULD BE TAKEN DEEPER.
6. MAST FLANGE SHOULD REMAIN UNGROUTED FOR DRAINAGE & VENTILATION.
7. IF MAST FLANGE IS GROUTED MIN- 4 NOS OF 25MM DIA DUCTS SHALL BE PLACED AROUND IT TO ALLOW DRANAGE & VENTILATION.
8. FOUNDATION IS DESIGNED CONSIDERING S.B.C- 10 T/SQM AT 2.0 M DEPTH.
9. PLEASE VERIFY THE BOLT DETAILS BEFORE CASTING THE FOUNDATION.
10. PROVIDE 300THK RUBBLE SOLING BELOW THE P.C.C.

| REV | DATE | REVISION | DRWN | CHK | APPD |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

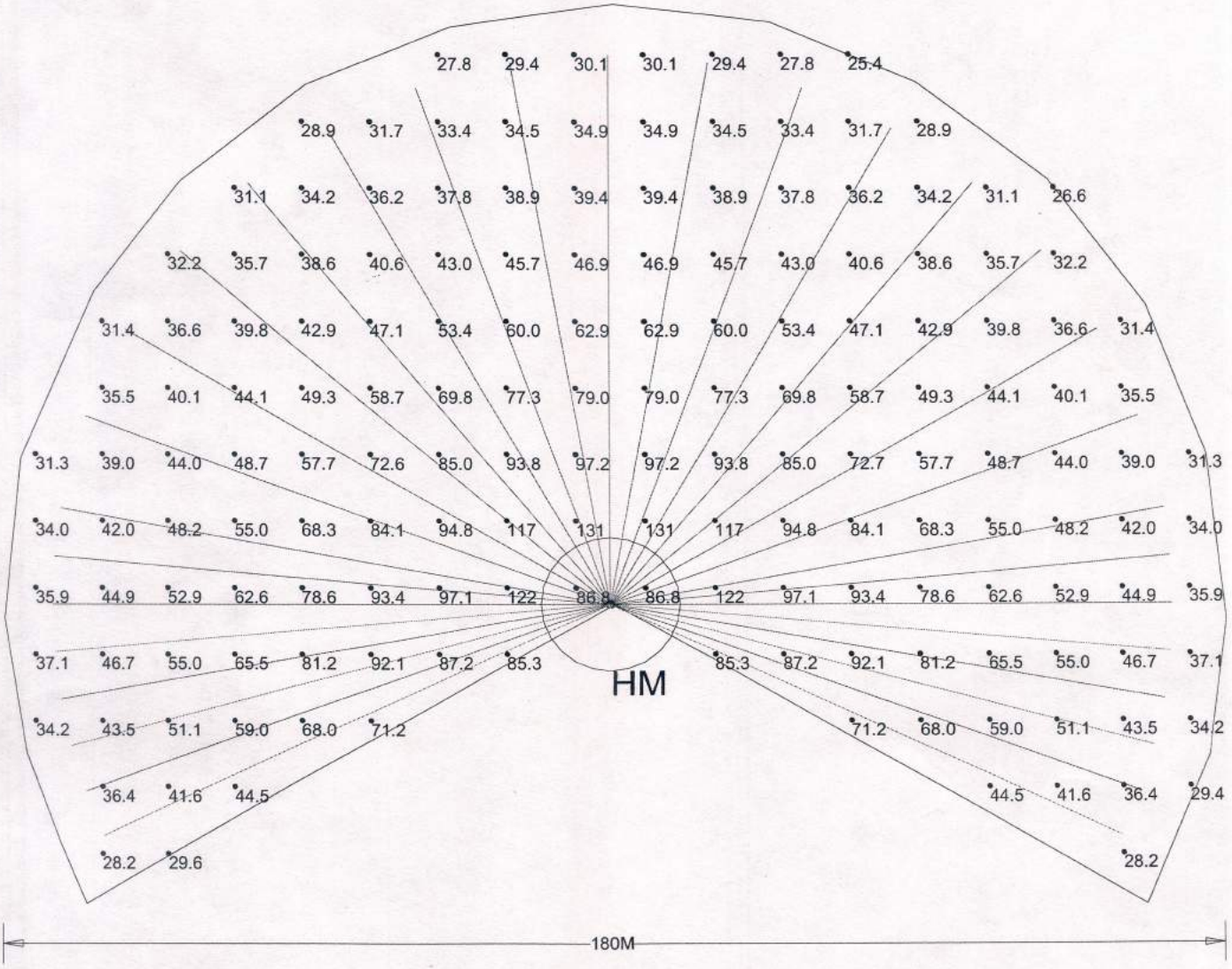
This is a property of **Transrail Lighting Ltd.**It can not be copied /used for any purpose wihout the permission of appropriate authority. It is submitted as confidential information in connection with enquiry, tender & must be returned on request. It is not to be used for any other purpose or order.

| | |
|---|---|
| | Transrail Lighting Limited |
| CLIENT | M/s- MORMUGAO PORT TRUST @ GOA. |
| TITLE | FOUNDATION DRG FOR 30 M HIGH MAST SYSTEM |
| FILE PATH | D:\D_DRIVE\1.project 2012-2013\High Mast\[D009-TLL-1213-30HM-MPT-GOA-R0-31FTG.x |
| DWG. NO | -[D009-TLL-1213-30HM-MPT-GOA-R0-31FTG]- |

| DRAWN BY | AUTO | CHECKED BY | C.S.M | DATE | Sheet No | Rev No |
|---|---|---|---|---|---|---|
| DESIGN BY | CA | APPD BY | H.K.J | 8/13/2012 | 1 OF 1 | R0 |

2/2

# TYPICAL AREA LIGHTING WITH 30M HM OPTION:2(FOR 240 DEG)




HM: 30M HM WITH 31 NOS FIXTURE(25 NOS SIRUS & 6 NOS ORION FIXTURE)

| Luminaire Schedule | | | | | |
|---|---|---|---|---|---|
| Symbol | Qty | Label | LLF | Total Lamp Lumens | Description |
| | 25 | A | 0.750 | 130000 | SIRIUS 2.0(1X1KW HPSV T) |
| | 6 | B | 0.750 | 130000 | ORION(1X1KW HPSV T) |

HORIZONTAL ILLUMINANCE LEVEL AT EL 0M FROM G/L:

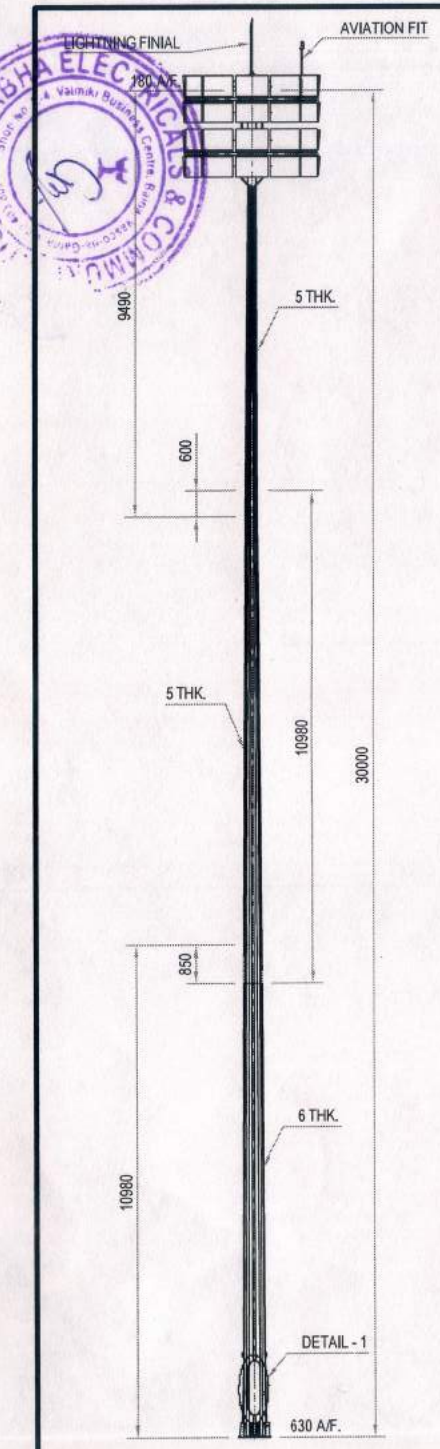
| Calculation Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| Label | CalcType | Units | Avg | Max | Min | Min/Avg | Min/Max |
| TYPICAL AREA | Illuminance | Lux | 54.53 | 131 | 25.4 | 0.47 | 0.19 |

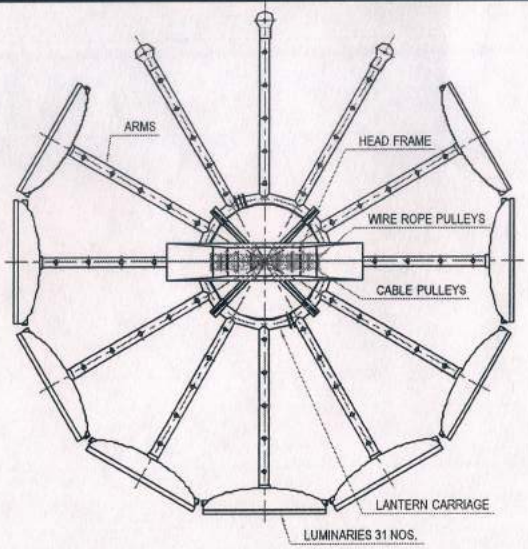
D:\Design\AUGUST '12\TYPICAL AREA LIGHTING 240 DEG AS PER REQU.AGI
Date:8/9/2012

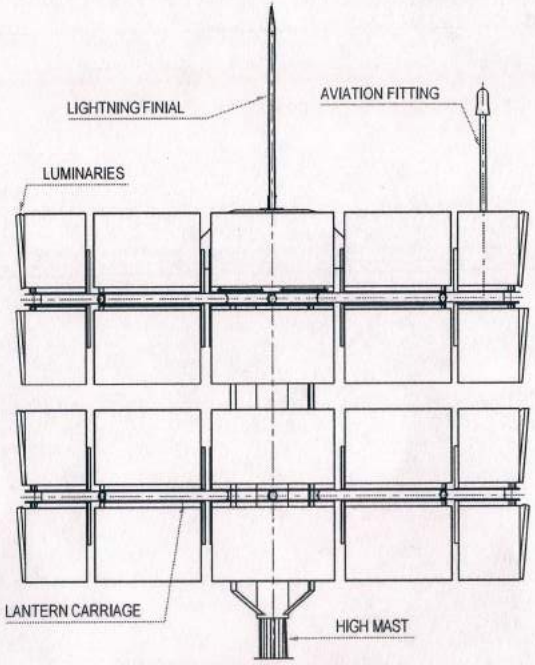
FRABTHA ELECTRICALS & COMMUNICATIONS

AGI32 lighting software

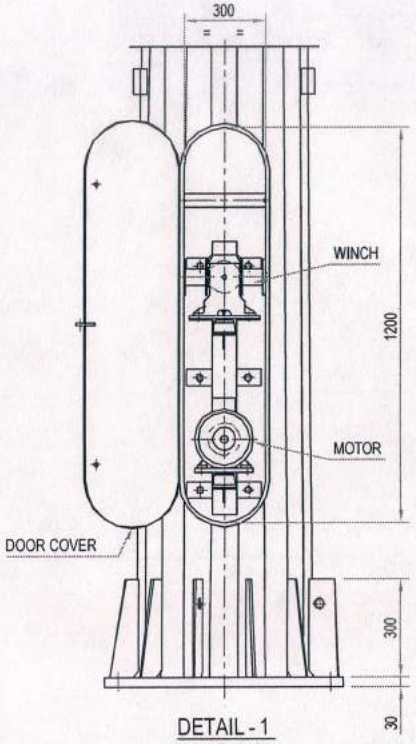
TRANSRAIL LIGHTING GAMMON GROUP



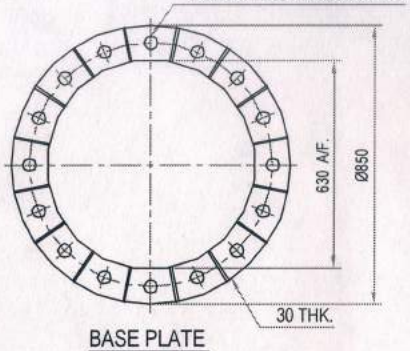



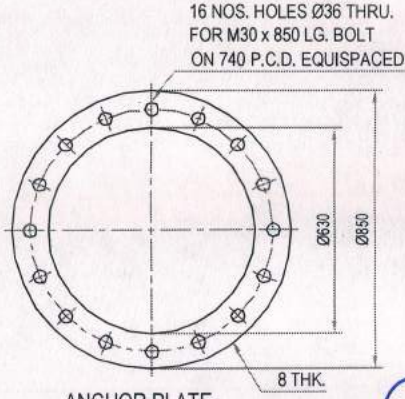

DISTRIBUTION OF LUMINARIES




DETAIL - 1
SCALE - 1 : 15




BASE PLATE
SCALE - 1 : 15




ANCHOR PLATE
SCALE - 1 : 15

NOTES:

1. ALL DIMENSION ARE IN MM
2. DESIGN STANDARD : ILE TECHNICAL REPORT - 7
3. MATERIALS :
   - 3.1 SHAFT : S355 JO AS PER BSEN 10025
   - 3.2 DOOR & FLANGE : AS PER IS : 2062.
4. FINISH :
   - 4.1 HOT DIP GALVANISED TO BSEN 1461.
5. DESIGN WIND SPEED : 39 m/sec.
6. WELDING : SUBMERGED ARC WELDING FOR SHAFT.
7. FOUNDATION BOLTS SHALL BE OF TS600 GRADE CONFIRMING TO IS : 1367 PART III 2002.
8. LIGHTNING ROD (1.5M) FIXED TO THE TOP OF THE STRUCTURE. ELECTRICAL CONTINUITY SHALL BE MAINTAINED FOR THE LENGTH OF THE MAST USING FLEXIBLE CONNECTOR.

| | | | | | | |
|---|---|---|---|---|---|---|
| | Transrail Lighting Limited<br>GAMMON Group | | | | | |
| TITLE | 30M HIGH MAST GA DRAWING | | | | | |
| CLIENT | M/s- MORMUGAO PORT TRUST AT GOA. | | | | | |
| PROJECT | | | | | | |
| DWG. NO. | 1015-TLL-HM-30-630-180-GA-DRAWING-1 | | | | SCALE | AS SHOWN |
| FILE PATH | D:\TLL\1015-HM-GA DRAWING | | | | DATE | 13-08-2012 |
| DRAWN BY | V.R.D. | SHEET NO. | 1 OF 1 | REV. NO. | 0 | This is a property of T.L.L. it cannot be copied / used for any purpose without the permission of appropriate authority. |
| DESIGN BY | C.A. | CHECKED BY | C.A. | APPD. BY | H.K.J. | |