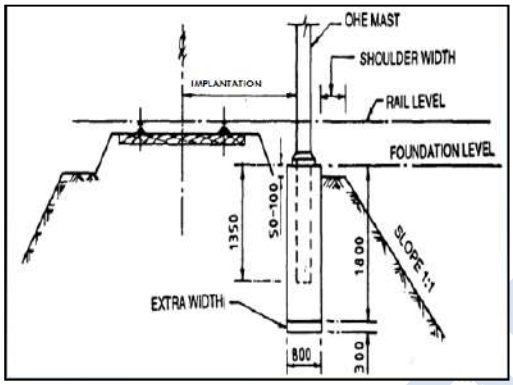
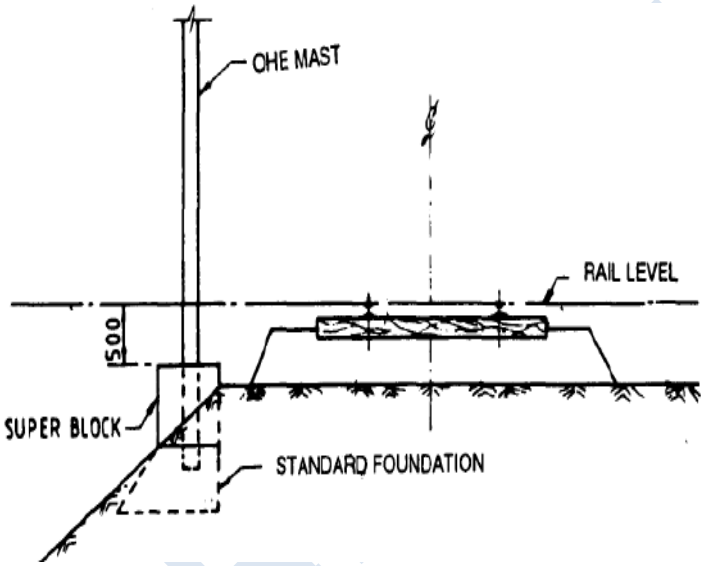
## OHE Foundation

**Introduction:** Normally foundations are provided for providing stability of structure carrying OHE equipment. OHE structures are mainly Mast, TTC and Portals. These structures are subjected to heavy overturning moment and considerably low direct load.



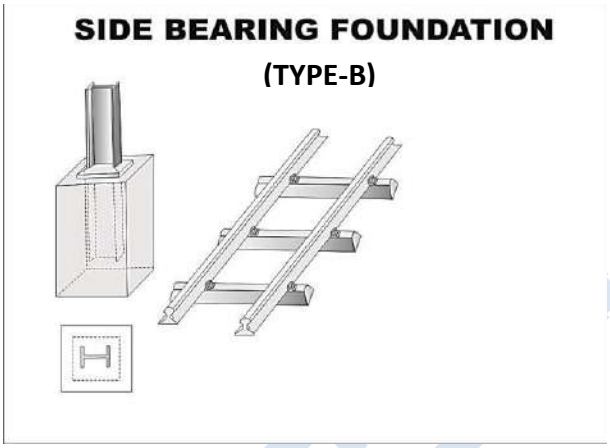

- The top of foundation should be 50-100 mm above the surrounding ground level.
- The length of mast below rail level should be minimum 1850 mm for regulated OHE and 1750 mm for un-regulated OHE.
- A 1350 mm embedment of mast in concrete is necessary. Wherever necessary, these may be achieved by providing a super block of length and width equal to the top dimension of foundation.
- Concrete cushion of 150 mm below the bottom of mast is also necessary.

- **SOIL PRESSURE**:
  The following allowable bearing pressure are generally adopted for different kinds of soils:

**SIDE BEARING FOUNDATION *(Type B)* :**

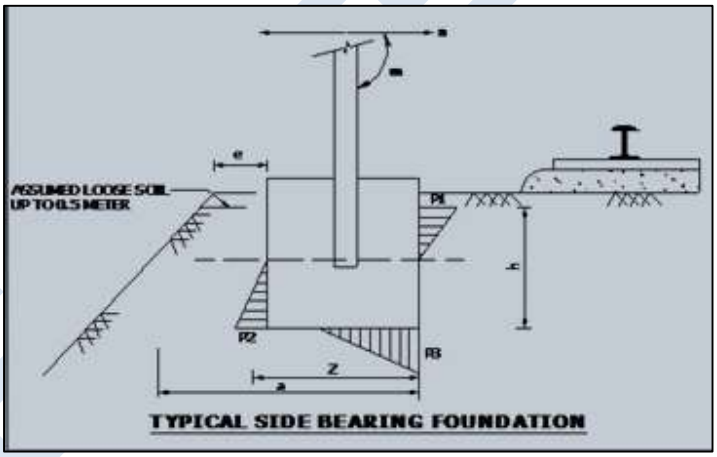
- ❖ Side bearing foundations are used for masts where the soil bearing capacity is 11,000 or 21,500 Kgf./$M^2$ and 300 mm wide shoulder is available on the bank.
- ❖ However for overlap inter masts and masts on the inside of curves, 550 mm wide shoulder is necessary.

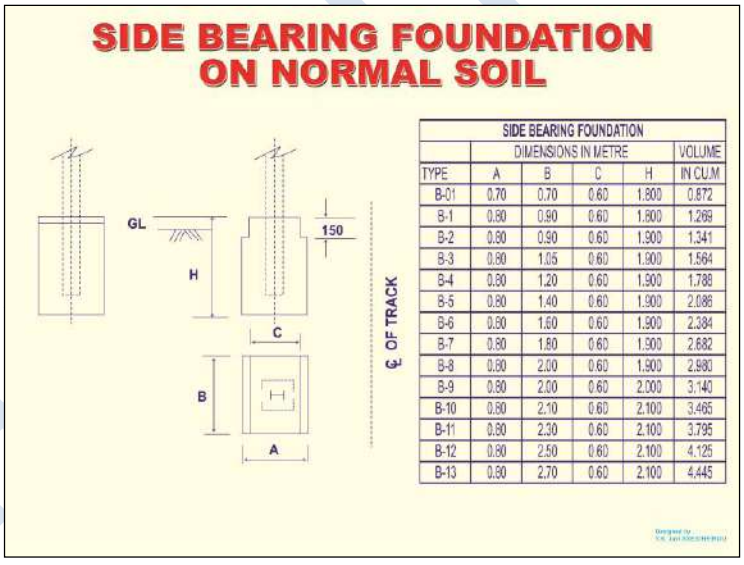
The image shows on the screen is side bearing foundation (type-B)




**SIDE BEARING FOUNDATION:**

- ❖ In case of side bearing foundation both the side as well the base pressure are supposed to resist the overturning moment and provide stability of structures.



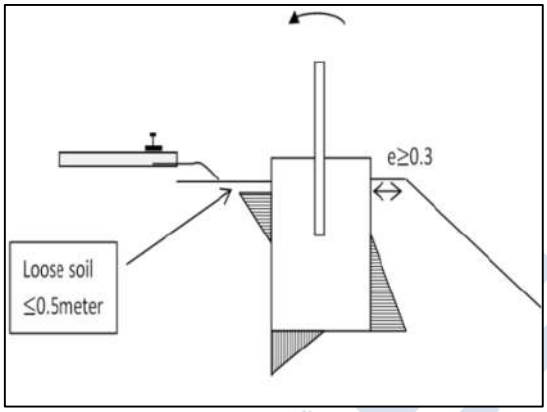



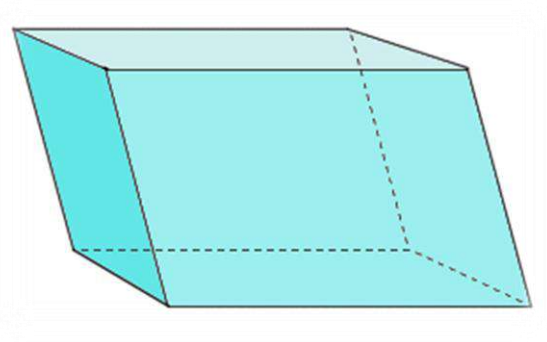


Side bearing foundation is shows on the screen is casted above the ground for better understanding.

**Side bearing foundation**

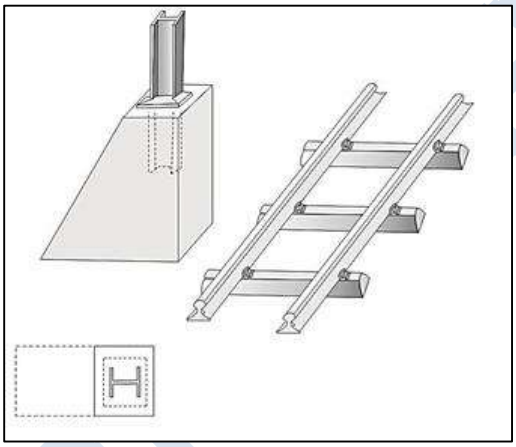
- With sufficient shoulder width used on level ground, cutting and good consolidated embankment.
- Both side as well bottom soil pressure available ≥11000 Kg. /m² and ≥21500Kg. /m²
- Side bearing foundation are of parallelepiped shape and with their use 50 to 60% volume of concrete is saved.



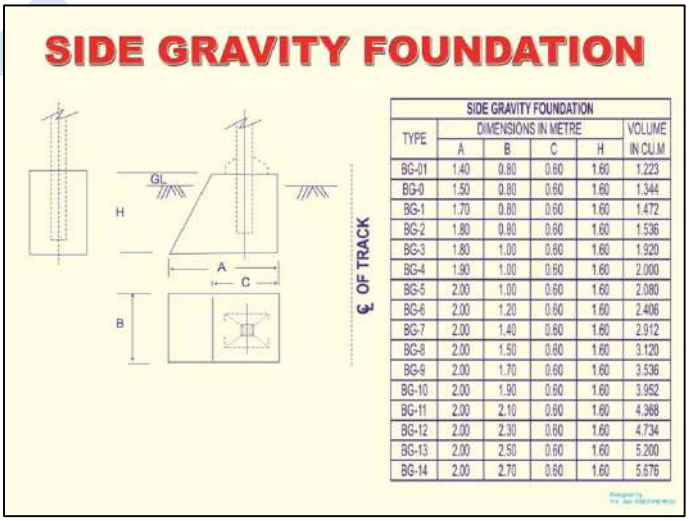



**SIDE GRAVITY FOUNDATION *(Type BG):***

- Side gravity foundations may be used for masts where soil bearing capacity is 8000 and 11000 Kgf./M$^2$, or adequate shoulder width is not available. No portion of the foundation should be exposed.



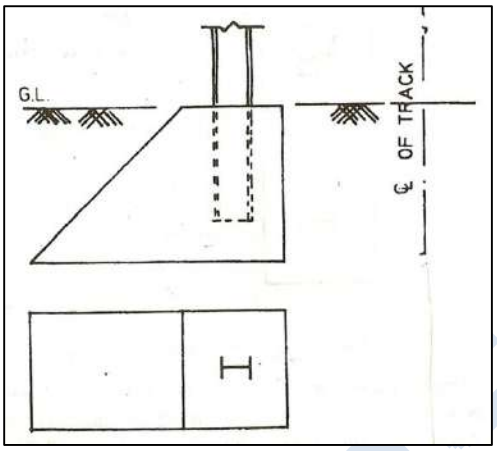

Side gravity foundation (type BG)



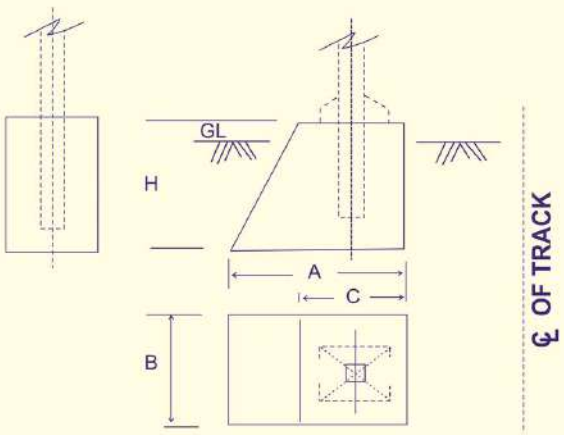

SIDE GRAVITY FOUNDATION

| TYPE | DIMENSIONS IN METRE | | | | VOLUME |
|---|---|---|---|---|---|
| | A | B | C | H | IN CU.M |
| BG-01 | 1.40 | 0.80 | 0.60 | 1.60 | 1.223 |
| BG-0 | 1.50 | 0.80 | 0.60 | 1.60 | 1.344 |
| BG-1 | 1.70 | 0.80 | 0.60 | 1.60 | 1.472 |
| BG-2 | 1.80 | 0.80 | 0.60 | 1.60 | 1.536 |
| BG-3 | 1.80 | 1.00 | 0.60 | 1.60 | 1.920 |
| BG-4 | 1.90 | 1.00 | 0.60 | 1.60 | 2.000 |
| BG-5 | 2.00 | 1.00 | 0.60 | 1.60 | 2.080 |
| BG-6 | 2.00 | 1.20 | 0.60 | 1.60 | 2.406 |
| BG-7 | 2.00 | 1.40 | 0.60 | 1.60 | 2.912 |
| BG-8 | 2.00 | 1.50 | 0.60 | 1.60 | 3.120 |
| BG-9 | 2.00 | 1.70 | 0.60 | 1.60 | 3.536 |
| BG-10 | 2.00 | 1.90 | 0.60 | 1.60 | 3.952 |
| BG-11 | 2.00 | 2.10 | 0.60 | 1.60 | 4.368 |
| BG-12 | 2.00 | 2.30 | 0.60 | 1.60 | 4.734 |
| BG-13 | 2.00 | 2.50 | 0.60 | 1.60 | 5.200 |
| BG-14 | 2.00 | 2.70 | 0.60 | 1.60 | 5.676 |

Side gravity foundation with volume chart




# SIDE GRAVITY FOUNDATION




| SIDE GRAVITY FOUNDATION | | | | | |
|---|---|---|---|---|---|
| TYPE | DIMENSIONS IN METRE | | | | VOLUME IN CU.M |
| | A | B | C | H | |
| BG-01 | 1.40 | 0.80 | 0.60 | 1.60 | 1.223 |
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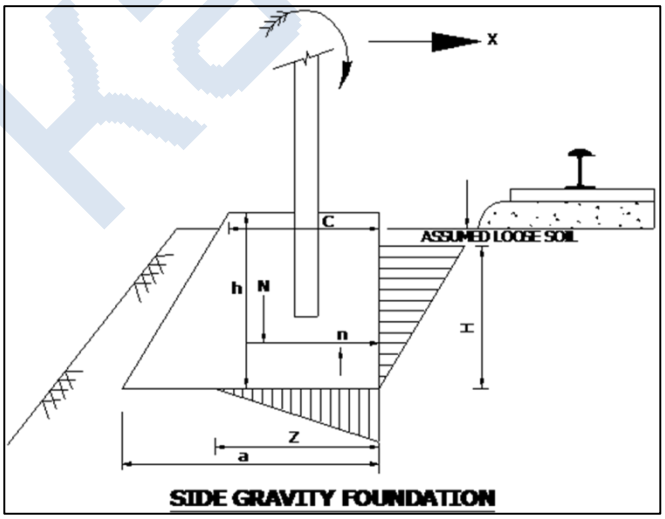
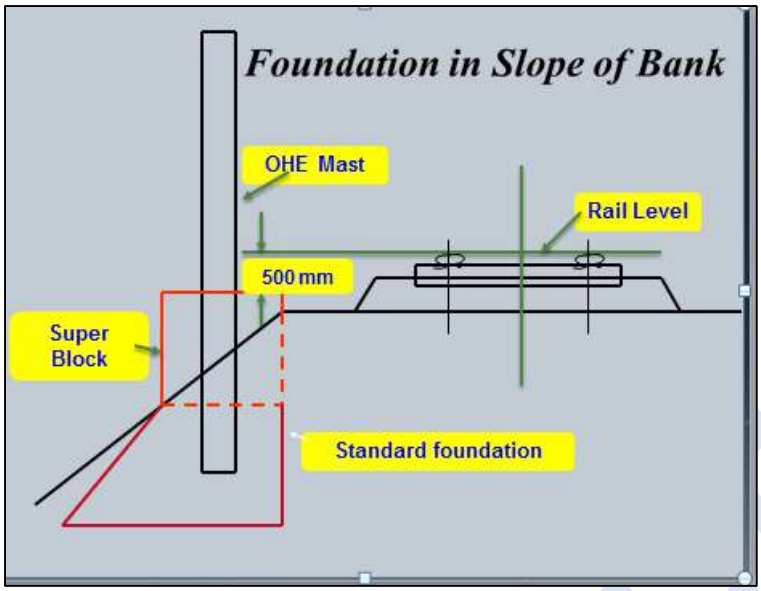
| BG-2 | 1.80 | 0.80 | 0.60 | 1.60 | 1.536 |
| BG-3 | 1.80 | 1.00 | 0.60 | 1.60 | 1.920 |
| BG-4 | 1.90 | 1.00 | 0.60 | 1.60 | 2.000 |
| BG-5 | 2.00 | 1.00 | 0.60 | 1.60 | 2.080 |
| BG-6 | 2.00 | 1.20 | 0.60 | 1.60 | 2.406 |
| BG-7 | 2.00 | 1.40 | 0.60 | 1.60 | 2.912 |
| BG-8 | 2.00 | 1.50 | 0.60 | 1.60 | 3.120 |
| BG-9 | 2.00 | 1.70 | 0.60 | 1.60 | 3.536 |
| BG-10 | 2.00 | 1.90 | 0.60 | 1.60 | 3.952 |
| BG-11 | 2.00 | 2.10 | 0.60 | 1.60 | 4.368 |
| BG-12 | 2.00 | 2.30 | 0.60 | 1.60 | 4.734 |
| BG-13 | 2.00 | 2.50 | 0.60 | 1.60 | 5.200 |
| BG-14 | 2.00 | 2.70 | 0.60 | 1.60 | 5.676 |

Designed by
V.K. Jain SSE/OHE/ROU



SIDE GRAVITY FOUNDATION

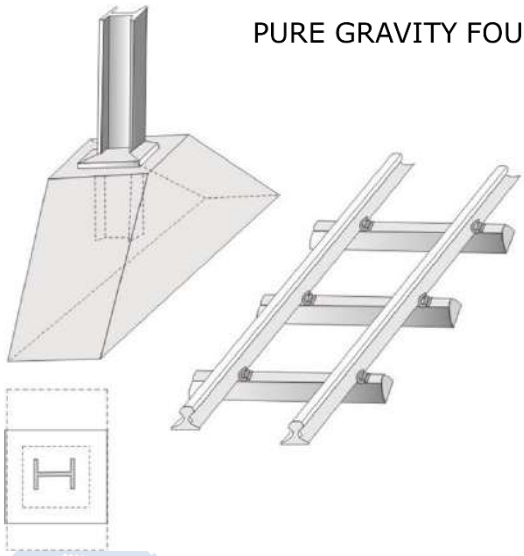
Casted above the ground for better understanding.

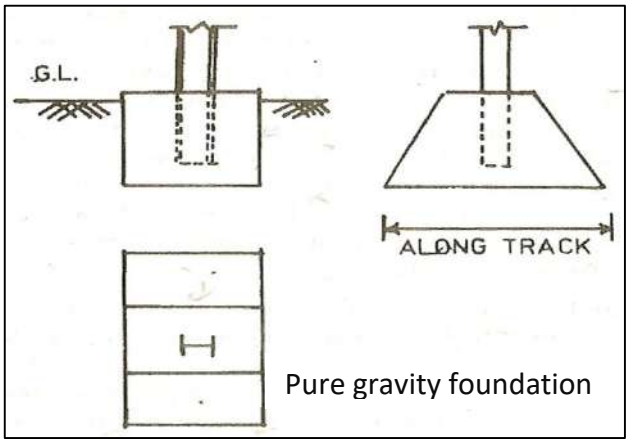



**PURE GRAVITY FOUNDATION *(type G):***

- These foundations are used for independent masts where soil surrounding the foundations is loose and cannot exert passive pressure on the foundations.
- G type foundation have been designed for soil bearing capacity of 5500, 8000 and 11000 Kgf./$M^2$.
- Pure gravity foundations (Type P) are used for portals and are designed for soil bearing capacity of 8250 and 11000 Kgf./$m^2$.

PURE GRAVITY FOUNDATION

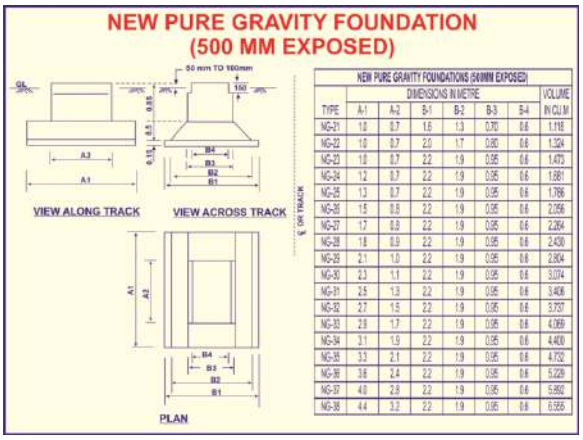




Pure gravity foundation

**New pure Gravity Foundation (NG type):**

- These foundations may be used for masts where soil bearing capacity is 5500, 8000 and 11000 Kgf./$M^2$ or where adequate shoulder width is not available.
- In such cases, it should be ensured that foundation is not exposed.



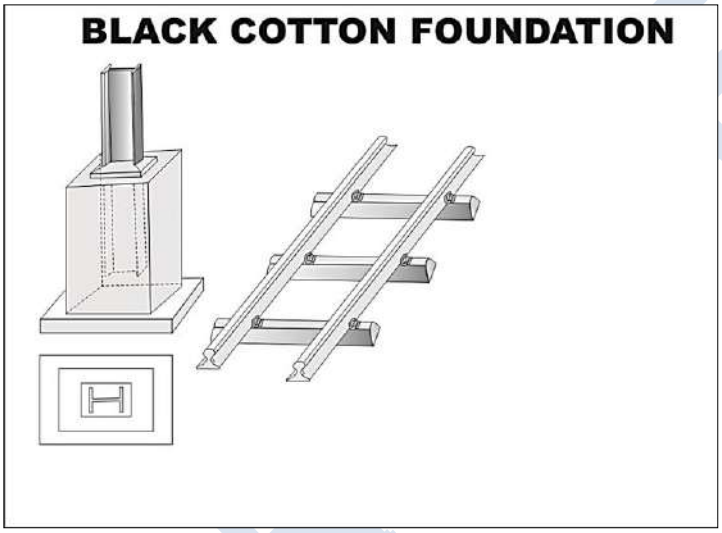


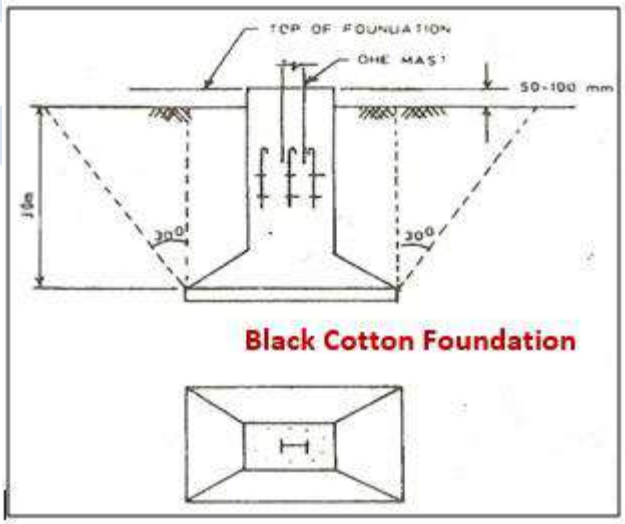
New pure gravity foundation (500 MM Exposed)

Casted above the ground for better understanding

**Foundation in black cotton soil *(Type BC):***

- In black cotton soils. WBC and NBC type of foundations are used. Primarily WBC foundations are to be adopted where swelling/shrinkage is not expected to take place at the founding level and NBC foundations have to be provided where swelling/shrinkage is expected to occur.
- When in doubt regarding classification of BC soil as to dry or wet, it is preferable to make NBC type foundation.



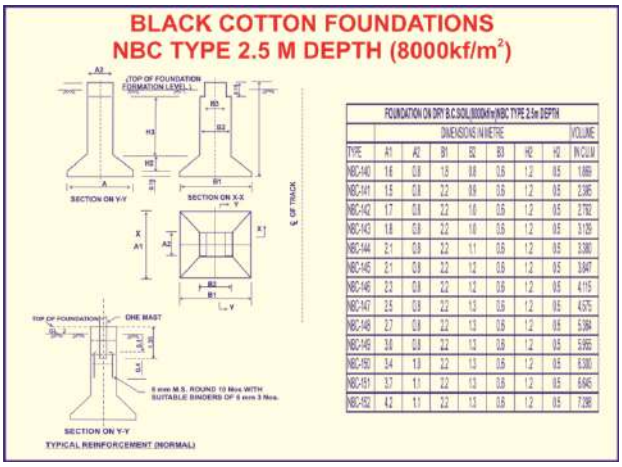




**Dry Black Cotton Foundation**

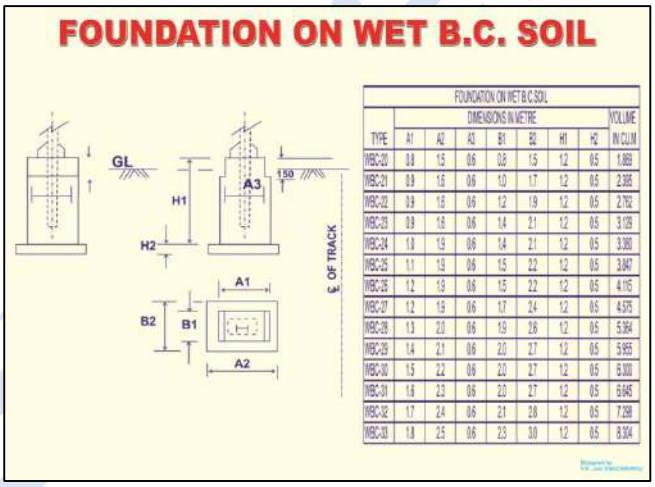
The image on the screen shows is black cotton foundation

Dry black cotton foundation shows on the screen is casted above the ground for better understanding

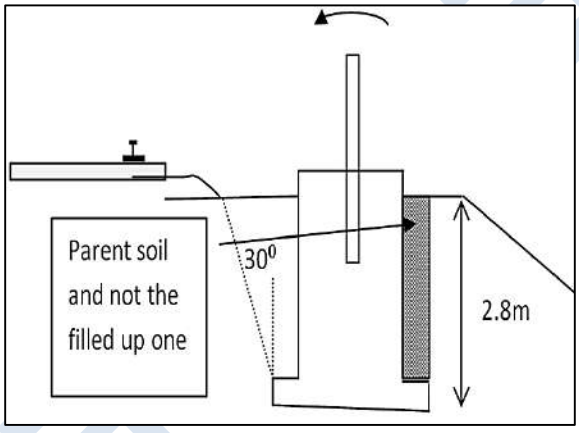
The structure shows on the screen is black cotton foundation.




Black cotton foundation NBC type 2.5 depth (800kf/m2) table shows on the screen with volume chart.




Foundation on wet B.C soil with volume chart




The structure shows on the screen is Black cotton soil.

- ❖ The foundation of the black cotton should be done preferably in dry season i.e. from November to May. Excavations should be avoided as far as possible in case of unexpected rains in dry season also.
- ❖ In black cotton areas a special type of foundation is used. The design of such a foundation is based on the following premise:

- Black cotton soil when loaded in dry condition has a bearing capacity of 16,500 kg/m$^2$,
- When black cotton soil is wet, It swells and the swelling pressure may be of the order 16,500 kg/m$^2$, When dry the soil shrinks and shrinkage cracks may extend to 3 m below ground level.
- The depth of black cotton soil foundation is therefore about 3.0 m so that the base of foundation is free from violent swelling and shrinkage. The foundation is so designed that the pressure on the base is

within 16,500 kg/$m^2$ and is checked for uplift pressure of same magnitude. In considering the uplift the weight of an Inverted frustum of a pyramid of earth making an angle of 30 with the vertical is assumed to resist uplift. A typical black cotton soil foundation is shown in Fig

**Notes on use of Sand core Foundation:**

- Sometimes the overhead equipment foundations are likely to be disturbed on a new bank due to settlement of abandoned. In such cases to facilitate removal adjustment of the mast, sand core foundations are used.
- In normal case the mast is grouted in the core hole with M 15 mix of concrete. This makes removal of mast difficult.
- In sand core foundation, the core hole is filled with perfectly dry sand and well packed with Bitumen sealing at the top. For details of sand core foundation RDSO's Drg. No. ETI/C/0012/69 may be referred.
- This type of foundation is not used for portals and location having bending moment more than 5000 kg. m. The top of sand core foundation should always be kept above ground level.

**Employment Schedule:**

- There are several types of Mast/Portal with different loading, altered by types of conductor used (copper or aluminum etc.) and also used in different wind pressure zones, with different spans and located inside or outside the curve with the degree of the curve varying from location to location.

| No. | Employment Code | Type | Description | Date |
|---|---|---|---|---|
| 1 | ETI/OHE/G/00125 SH-1 | A | Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE only. | 20.09.05 |
| 2 | ETI/OHE/G/00125 SH-2 | A | Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE + EW. | 20.09.05 |
| 3 | ETI/OHE/G/00125 SH-3 | A | Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE + RC. | 20.09.05 |
| 4 | ETI/OHE/G/00125 SH-4 | A | Employment schedule for cantilever mast regulated OHE Al caty-65and 107-cu cont wire. WP 112.5kgf/m2 -- OHE + EW + RC. | 20.09.05 |
| 5 | ETI/OHE/G/00153 SH-1 | F | Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu. WP 112.5 kgf/m2 -- OHE only. | 20.09.05 |
| 6 | ETI/OHE/G/00153 SH-2 | F | Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu. WP 112.5 kgf/m2 -- OHE + EW. | 20.09.05 |
| 7 | ETI/OHE/G/00153 SH-3 | F | Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu. WP 112.5 kgf/m2 -- OHE + RC. | 20.09.05 |
| 8 | ETI/OHE/G/00153 SH-4 | E | Employment schedule for cantilever mast regulated OHE caty 65/cu and cont 107/cu. WP 112.5 kgf/m2 -- OHE + EW + RC. | 20.09.05 |
| 9 | ETI/OHE/G/00154 | D | Employment schedule for cantilever mast unregulated OHE caty 65/cu and cont 107/cu. WP 112.5 kgf/m2 with 28 kgf/m2 at 4 degree C without (EW & RC). | 09.08.05 |

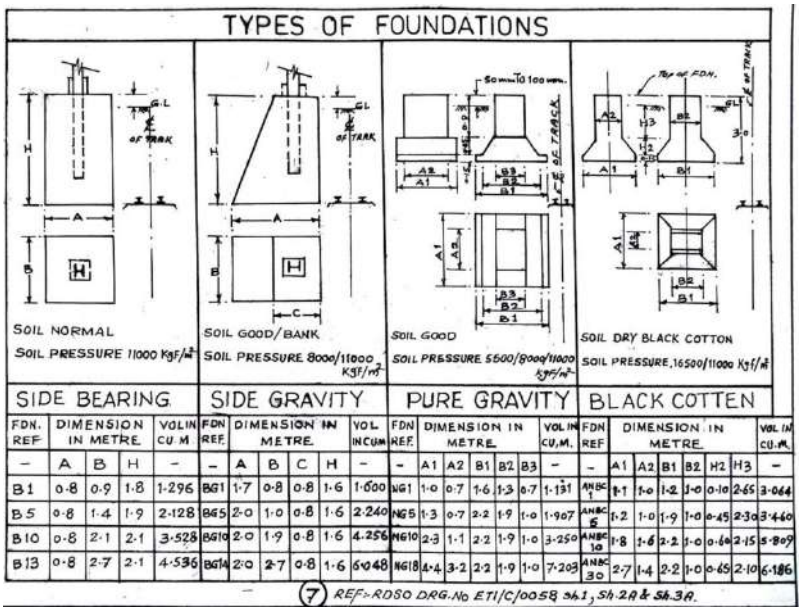
- The structure to be used for the loading at a particular location has to be decided first before deciding the foundation which also has many varieties like side bearing, side gravity, New pure gravity, black cotton soil foundation, the size depending on the safe bearing pressure to be adopted based on the site conditions. If for each one of these types met with, the calculations have to be done over and over again by each project and it would consume tremendous amount of technical man hours.
- Ultimately, the calculations themselves are the result of many assumptions like the safe bearing pressure the soil can withstand the type of soil around in different depth, maximum wind pressure to be adopted etc. Lot of time and energy could be save if an employment schedule can be prepared by the design office. In any case the masts are either rolled to standard sizes or fabricated from standard

sections. Hence, we can have a series of masts varying in strength to take the bending moment, each a little stronger than the last one so that the one that fits in best economically can be adopted.

- With this end in view, Employment schedules for Overhead equipment masts are prepared for standard conditions for particular wind zones, for single cantilever overhead equipment, overlap central mast, overlap or ant creep anchor mast etc. with standard implantations.
- The employment schedule normally contains columns for type of mast with locations, maximum span in which it can be used, radius of curvature, versine maximum, with reverse deflection and the 'FBM' i.e. Foundation Bending Moment Code. If the location under consideration fits in with the standard parameters indicated the FBM can be straight away selected without going through all the detailed calculations. The only caution to be exercised being that most economical mast is selected. If the implantation is different or the super mast is longer or it carries an isolator and such other special factors the bending moment calculations will have to be done.
- However, since most of the cases falls under the standard use of the mast the employment schedule is very useful in the site engineer/design office not having to calculate and go through the same set of calculations over and over again.
- A typical employment schedule for overhead equipment mast (9.5 m) with wind pressure of 150 kg/m$^2$ with copper overhead equipment overlap inter location with higher implantation in RDSO's Drg. No. ETI/C/0729.
- Similarly for foundations also "Volume chart and Equivalent chart of foundations" are prepared showing equivalent sizes of foundations for OHE structure to suit various common loadings for different soil and site conditions. The chart gives the foundations bending movement code, direct load, bending moment, safe soil bearing pressure assumed and the codes for different foundations like side bearing, side gravity etc. The dimensions of the foundations are also given against each code number of easy setting out at site.

**VOLUME CHARTS**

- The foundation bending moment codes (FBM) for each location are obtained from the mast employment schedules or by actual calculations. Bearing capacity of the soil is determined at the outer toe of the bottom of foundation at a representative number of locations. Where foundations are placed on the slope of banks due to increase in setting distance, the bearing capacity of the soil should be determined on the slope. Bearing capacities determined thus would be considerably less than those determined on the top of formation.
- Selection of the type and size of foundation is done from the volume chart (Drg. No. ETI/C/0058) on the basis of FBM code, type and bearing capacity of soil/shoulder width and the extent of projection above ground level.




| SIDE BEARING | | | | | SIDE GRAVITY | | | | | | PURE GRAVITY | | | | | | BLACK COTTEN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FDN. REF | DIMENSION IN METRE. | | | VOL IN CU.M | FDN REF | DIMENSION IN METRE. | | | | VOL IN CU.M | FDN REF | DIMENSION IN METRE. | | | | VOL IN CU.M. | FDN REF | DIMENSION IN METRE. | | | | | VOL IN CU.M. |
| – | A | B | H | – | – | A | B | C | H | – | – | A1 | A2 | B1 | B2 | B3 | – | – | A1 | A2 | B1 | B2 | H2 | H3 | – |
| B1 | 0·8 | 0·9 | 1·8 | 1·296 | BG1 | 1·7 | 0·8 | 0·8 | 1·6 | 1·600 | NG1 | 1·0 | 0·7 | 1·6 | 1·3 | 0·7 | 1·131 | ANBC 1 | 1·1 | 1·0 | 1·2 | 1·0 | 0·10 | 2·65 | 3·064 |
| B5 | 0·8 | 1·4 | 1·9 | 2·128 | BG5 | 2·0 | 1·0 | 0·8 | 1·6 | 2·240 | NG5 | 1·3 | 0·7 | 2·2 | 1·9 | 1·0 | 1·907 | ANBC 5 | 1·2 | 1·0 | 1·9 | 1·0 | 0·45 | 2·30 | 3·440 |
| B10 | 0·8 | 2·1 | 2·1 | 3·528 | BG10 | 2·0 | 1·9 | 0·8 | 1·6 | 4·256 | NG10 | 2·3 | 1·1 | 2·2 | 1·9 | 1·0 | 3·250 | ANBC 10 | 1·8 | 1·6 | 2·2 | 1·0 | 0·60 | 2·15 | 5·809 |
| B13 | 0·8 | 2·7 | 2·1 | 4·536 | BG13 | 2·0 | 2·7 | 0·8 | 1·6 | 6·048 | NG13 | 4·4 | 3·2 | 2·2 | 1·9 | 1·0 | 7·203 | ANBC 30 | 2·7 | 1·4 | 2·2 | 1·0 | 0·65 | 2·10 | 6·186 |

(7) REF:- RDSO DRG. No ETI/C/0058 Sh.1, Sh.2A & Sh.3A.

**THREE DIGIT CODE**

- To choose the correct size of fdn. We have to follow a three digit code system. For standard loc. the code no. can be obtained from the Employment Schedule supplied by RDSO vide Drg.no.ETI/OHE/G/0015.
- The code is a three digit no. The first no (100th place) represents the vertical load N tones. The next two digits (10th & 1st) represents the magnitude of bending moment.
- For values of vertical load up to 1000kg we take no. 1, 1000 to 2000kg we take no.2, for value above 2000 but less than 3500kg we take no.3
- The next two digits represents bending moment in hundreds.
- **Example for method of obtaining the code from loading :-**

- At a particular location we have following values
  - Vertical load - 2470kg
  - Bending Moment-5900KG
- Since the vertical load lies in the rang 2000 to 3500 the first figure is 3.As bending moment is 5900Kg,the last two digit will be 59.Therefore the full code no will be 359.
- If the code no arrived (say 359) is not available in the volume chart, the next higher no available should be chosen.
- For example in volume chart we have 355 & than 363.

**MUFF**

- Muff is an additional concreting done on top of foundation to prevent accumulation of water around the mast and thus prevents corrosion of mast at the foundation level.

**OHE ANCHOR FOUNDATION**

Anchor foundations are of two types:

- Anchor foundation In normal soil,
- Anchor foundation in black cotton soil.

- Anchor foundations have been designed for the above two types of soil irrespective of soil pressure. Hence the same foundation can be adopted in case of loose or filled up soil.

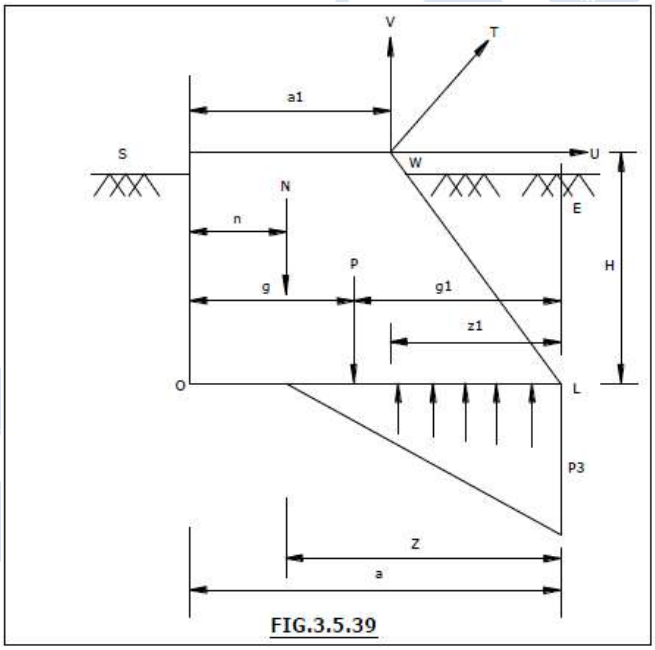
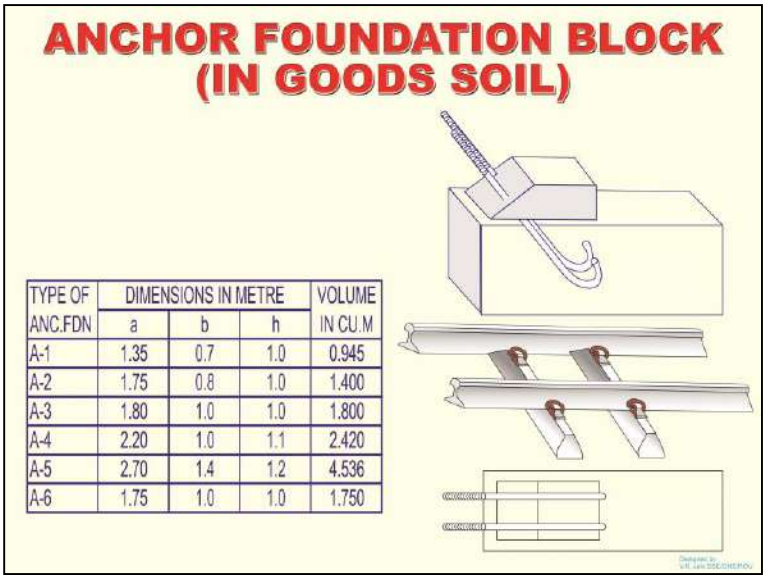
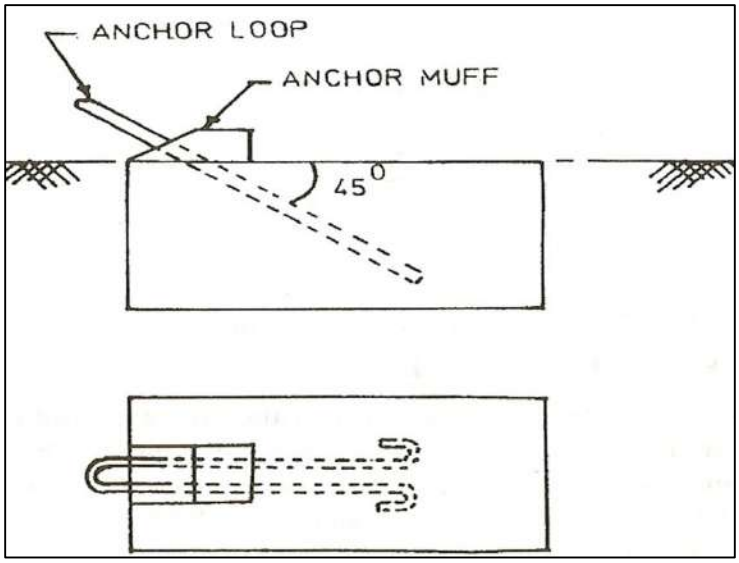


FIG.3.5.39

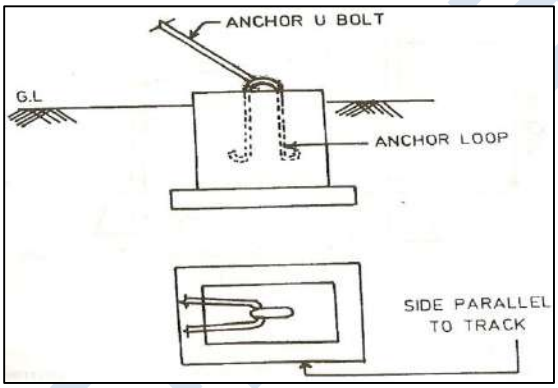



| TYPE OF ANC.FDN | DIMENSIONS IN METRE a | b | h | VOLUME IN CU.M |
|---|---|---|---|---|
| A-1 | 1.35 | 0.7 | 1.0 | 0.945 |
| A-2 | 1.75 | 0.8 | 1.0 | 1.400 |
| A-3 | 1.80 | 1.0 | 1.0 | 1.800 |
| A-4 | 2.20 | 1.0 | 1.1 | 2.420 |
| A-5 | 2.70 | 1.4 | 1.2 | 4.536 |
| A-6 | 1.75 | 1.0 | 1.0 | 1.750 |

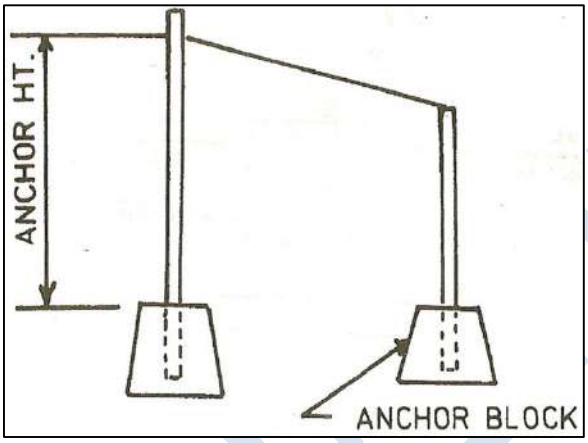
The Table shows Anchor Foundation Black (In Goods Soil)



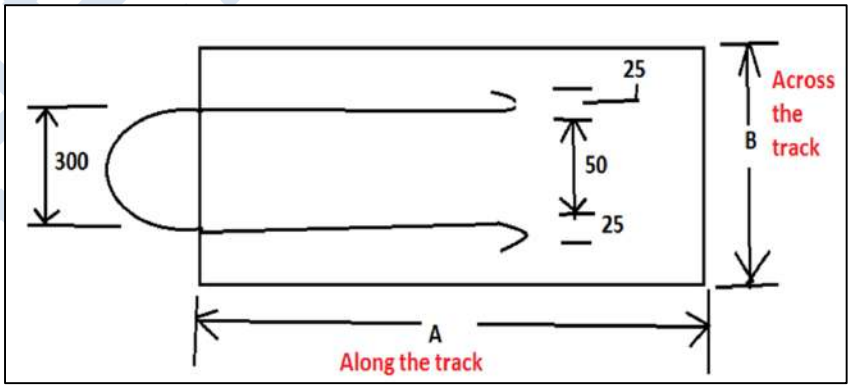

The Image Shows Anchor Foundation in Normal Soil




The Image Shows Anchor Foundation in BC Soil



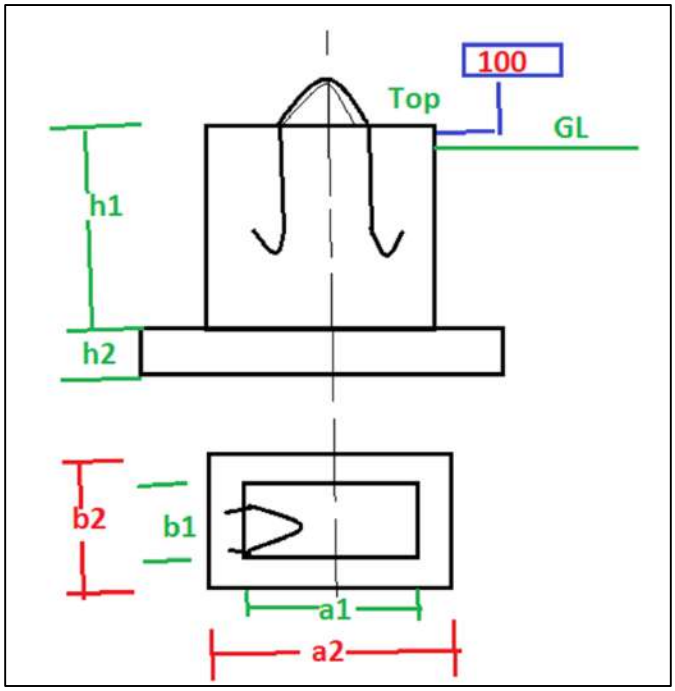

The Image Shows Dwarf Mast Anchor




Top Side View of Anchor Foundation

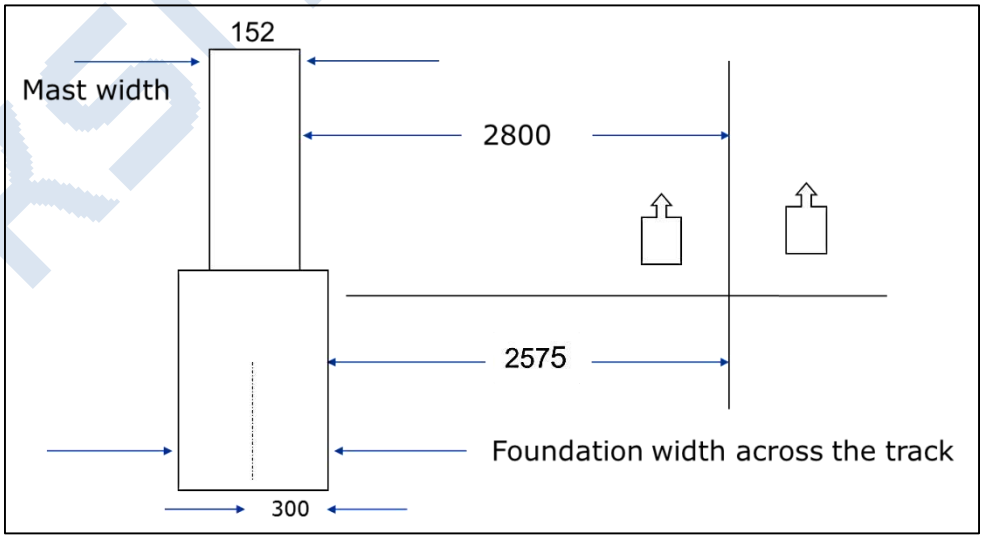
| Anchor Block | H | A | B | Uses |
|---|---|---|---|---|
| **A1** | 1.00 | 1.35 | 0.70 | For termination with max tension 800kgf (For earth wire or Short feeder) |
| **A2** | 1.00 | 1.75 | 0.80 | For termination with max tension 1500kgf (For anticreep wire /longitudinal feeder) |
| **A3** | 1.00 | 1.80 | 1.00 | For termination with max tension 2000kgf (For single regulated OHE) |
| **A4** | 1.10 | 2.20 | 1.00 | For termination with max tension 3000kgf (For single Un-regulated OHE) |

The Table shows Allocation Chart for Anchor Foundation




- Dwarfs mast anchor are used in platforms, as normal anchors infringe with the movement of staff and passengers.
- Also this type of anchor is used where the normal guy-rod infringes with the schedule of dimensions due to insufficient track canters. Normally, RSJ(200x150mm) mast of 4.3 m length is used as dwarf mast.
- OHE foundation clearance
- Railway Bd. Lr. No. 2006/RE/138/4 Dt. 26.02.2010.
- Railway Board has issued instructions to maintain 2.80m implantation.
- OHE mast implantation is arrived as follows 2575+300-75=2800mm with a view of 0.6m foundation width across the track.
- Certain type of foundations like BG, MG the width is 0.80m, thereby causing clearance problem which works out to be 2800-400+75=2475 which is less by 100mm.

| Type Of Fdn | a1 | a2 | b1 | b2 | h1 | h2 | Max Tension | Usase |
|---|---|---|---|---|---|---|---|---|
| BCA1 | 0.9 | 1.5 | 0.8 | 1.2 | 2.3 | 0.5 | 1400 | Single anticreep |
| BCA2 | 1.3 | 1.9 | 0.8 | 1.15 | 2.4 | 0.5 | 2000 | Single regulated |
| BCA3 | 1.4 | 2.0 | 0.8 | 1.5 | 2.6 | 0.5 | 3000 | Single unregulated |




**OHE Mast Implantation**

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