International Journal of Advanced Research in Engineering Technology & Sciences ISSN: 2394-2819
April-2016 Volume 3, Issue-4
Email: editor@ijarets.org www.ijarets.org

DESIGN AND ANALYSIS OF 6M HIGH NON ANCHORED ROOF TOP POLE UNDER SPECIFIED WIND SPEED

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ABSTRACT:
The increasing trend of mobile communications has seen exponential growth in the last three years. Increased competitions among mobile operators also have contributed to the installation of many towers to enhance both coverage area and network reliability. The tower locations as specified in terms of latitudes and longitudes with the height of mounted antenna dictated by functional requirements of the network. The availability of land which satisfies ideal installation conditions in urban areas is extremely limited giving no alternative but to adopt roof top towers installing tower in roof can cause degradation in RCC slab. In the present study, the design and analysis of roof top pole which is not anchored with RCC slab has studied. The analysis is has been performed with specified wind speed using STAAD Pro V8i. The wind force is considered as governing factor of the structure.

KEYWORDS: Rooftop Pole, STAAD Pro, Connection Design.

INTRODUCTION:

Telecommunication towers has became an essential item especially in wireless telecommunication sector with the development of wireless telecommunication technologies such as CDMA (Code Division Multiple Access), GSM (Global System for Mobile),WAP (wireless Web Access), etc. In India most of telecommunication towers have been constructed with the introduction of mobile telephone networks in early 1990s, even though there are few towers which have histories over 30 years. Generally towers in India are constructed on ground, But as the demand increases the roof based poles or towers has now increased. But every solution has its own limitation like this increase the load on the building and if beam and columns are not designed well then it may lead failure. Generally towers are fixed at their base to the roof of building, this creates high nuisance to residents. The seepage may happen and the rebaring need to be done for fixing the tower on the slab. To solve this problem roof mounted telecom tower are being used which are not anchored with roof. Although this concept is very much in use for small roof mounts. In this study we are using this same concept for 6 m high tower.

The paper covers the design and analysis of 6m Non penetrating tower based on roof of RCC building. The pole is not fixed with base but supported by concrete blocks. The pole is designed as per wind governing structure and major loading is wind loading. The pole is analysed through Staad but the joints and stability is checked manually as per IS codes. The paper cover the details final drawing of the section.

LITERATURE REVIEW:

There are many literature available which has done study regarding roof based tower but no study is available for non penetrating roof mounted pole. In this study we design and analysis the tower with as

per IS code. Till now there is no literature available which clearly show with a design example for roof mount tower.

Siddesha H. (2010) [1] presented the wind analysis of microwave antenna tower with Static and Gust Factor Method (GFM). In this experimental programme comparison had been done between the tower with angle and square hollow (unfilled) section. In this the displacement at the top of the tower is well thought-out as the main factor. The analysis on different configuration had been done by removing one member as present in the regular tower at lower panels.

Nitin Bhosale et. al. (2012) [2] presented Influence of host structure characteristics on response of rooftop telecommunication towers. In this study, four-leged telecommunication tower has been studied for the seismic response under the effect of design spectrum for Zone-IV from the Indian seismic code of practice. Lying on ground tower and tower located on the rooftop of host structure has been analyzed by varying positions of tower with increase in stiffness of host structure in the both horizontal and vertical directions i.e. X and Y. Dynamic analyses has been performed by SAP2000 program. The main factors that are considered in this study are axial forces of the tower members. At last rooftop tower and ground tower members are compared at the same height from the ground.

McClure G et. al.(2004) [3] presented the two self-supporting telecommunication lattice and check the seismic response towers of height 30m and 40m, which are placed at the rooftop of two medium rise buildings (Burniside Hall), on McGill Campus, and 2020 University, located near downtown Montreal. The time history analyses had been used to analyze the relationship between the building accelerations and maximum seismic base shear and moreover between the base overturning moment of towers placed at building rooftops.

Richa Bhatt et. al. (2013) [4] have carried out study on the influence of modelling in lattice mobile towers in wind loading where in the towers are analysed for gust factor wind. Displacements, member forces and maximum stress have been compared to find out the effect on towers.

C Preeti Presented et. Al. (2015) [5] has presented a comparison between four legged self supported angular telecommunication tower on ground and mounted on roof She concluded that the presence of a normal size tower on the buildings does not have a noteworthy influence on the building frequencies and mode shapes.

OBJECTIVE:

The objective of the paper is to design and analysis of 6M high non penetrating roof top pole under specified wind speed.

METHODOLOGY:

- Create the shape of tower which can be placed over the roof without penetrating the existing slab.
- Analyse the drafted model using Staad Pro and manual calculations.
- Check against the stability of structure.
- Draw the final drawing of the Structure with all details.

CALCULATIONS AND ANALYSIS:

1. Draw the preliminary drawing with Auto CAD and Draw the same Model on STAAD Pro and assign properties to the structure and apply support to the model.

Figure 1

LOADS ON STRUCTURE:

Dead and live load is considered as

1. **Dead Load:**
   Self weight of steel structure = 7850 kg/cum
   Weight of Antenna = 40 kg (40 kg each)
2. **Live load**= 80 kg (1 man weight)

Wind load is calculated as per IS 875 Part III using below mentioned equations

$$V_z = V_b K_1 K_2 K_3$$
$$P_z = 0.6\, V_z^2$$
$$F_w = C_f A P_z$$

All these loads are applied on STAAD PRO and the structure is analysed.

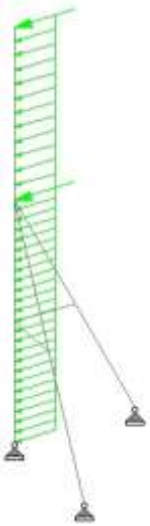
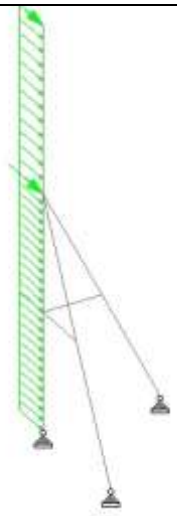
 Load 1. Dead Load	 Load 2. Live Load	 Load 3. Wind Load X Direction	 Load 4. Wind Load Z Direction

Figure 2

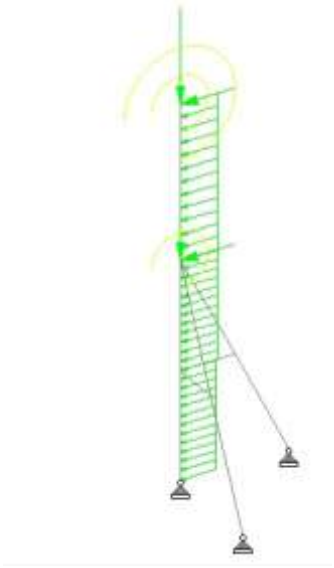
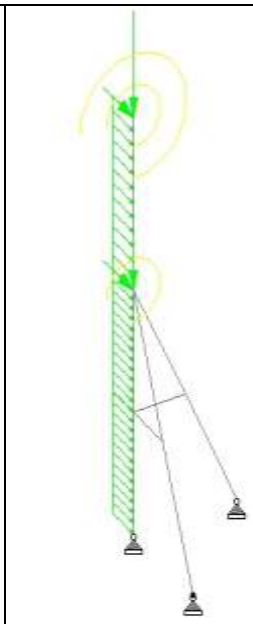
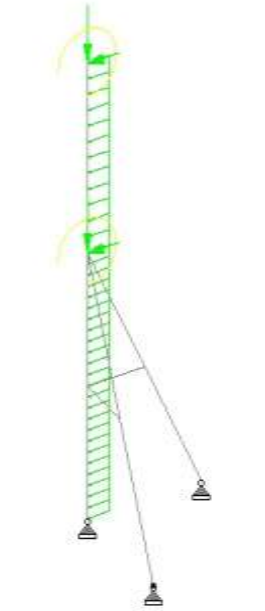
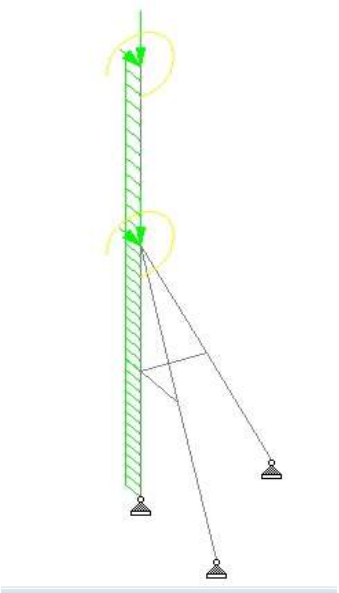
 Load 5. DL+ WL (X Direction)	 Load 6 DL + WL (Z Direction)	 Load 7. DL + 0.5625 Wind load (X Direction)	 Load 8. DL + 0.5625 Wind load (Z Direction)

Figure 3

SLAB BASES:
Columns with slab bases need not be provided with gussets, but fastenings shall be provided sufficient to retain the parts securely in plate and to resist all moments and forces, other than direct compression, including those arising during transit, unloading and erection. When the slab alone distributes the load uniformly, the minimum thickness of a rectangular slab shall be given by the following formula:

$$t = \sqrt{\frac{3w}{\sigma_{bs}}\left(a^2 - \frac{b^2}{4}\right)}$$

Where:
t= the slab thickness, in mm;
w = the pressure or loading on the underside of the base in MPa;
a = the greater projection of the plate beyond column in mm;
b = the lesser projection of the plate beyond the column in mm; and
σ_{bs}= the permissible bending stress in slab bases (for a11 steels, shall be assumed as 185

Design strength of Fillet weld, f_{wd} shall be based on its throat area and shall be given by:

$f_{wd} = f_{wn}/\gamma_{mw}$
Where
$f_{wn} = f_u/\sqrt{3}$
f_u = smaller of the ultimate stress of the weld or of the parent metal, and
γ_{mw} = partial safety factor = 1.5, as per table 5 of IS 800
The following be the result of the STAAD PRO

Support Reactions							
		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
1	5 DL + WL (X-DIRECTION)	-0.23	6.62	0.10	0	0	0
	6 DL + WL (Z-DIRECTION)	-0.14	-0.51	0.19	0	0	0
2	5 DL + WL (X-DIRECTION)	1.83	-3.82	-0.07	0	0	0
	6 DL + WL (Z-DIRECTION)	0.11	-0.25	0.03	0	0	0
3	5 DL + WL (X-DIRECTION)	-0.07	0.20	-0.03	0	0	0
	6 DL + WL (Z-DIRECTION)	0.03	3.77	-1.75	0	0	0

Table 1

Used Steel Members		
MEMBER	**SECTION**	**RESULT**
Main Leg	PIP889M	PASS
Diagonal Bracing	ISA75X75X8	PASS
Horizontal Bracing	ISA65X65X6	PASS

Table 2

Joint Connection Design: Generally Joint failure is the main cause of failure of any structure. So the design of each joint should be check. Staad Pro is not helpful to design the joint, so all the joints should be design manually.

Flange Connection		
External Applied tensile force	5.70	KN
As per IS 4000 Maximum Applied tensile force	56.7	KN
	Hence safe	

Table 3

Gusset Plate Connection		
Maximum Stress at Joint	3.82	KN
Check for tension		
Design strength of members under axial tension (AgFy/Ymo) Refer clause 6.2 from IS 800-2007	150.0	KN
Factor of safety	39.267	

Table 4

Check for Deflection		
Max Displacement		
x =	19.9	Mm
Sway (ϕ) =arctan(x/H)		
	<0.5 Degree Hence Safe	

Table 5

Steel Provided		
Profile	**Length (MMS)**	**Weight (NEWT)**
ST PIP889M	6000	495
ST ISA75X75X8	7830	685
ST ISA65X65X6	1750	100
	Total	**1290**

Table 6

Check for Stability		
Total Overturning Moment from staad out put	7.64	KNM
FOS AGAINST OVERTURNING	3.490401	>1
	Hence Safe	
Total Shear Force	1.83	KN
Coefficient of Friction	0.6	
Resistance Force (Weight of Structure + Weight of Concrete block)x0.6	12	KN
FOS AGAINST SLIDING	6.557377	>1
	Hence Safe	

Table 7

SUMMARY AND CONCLUSION:

The main objective of study is to carry out theand analysis of 6 m high non penetrating telecommunication pole. The study covers the brief introduction of communication towers where the benefits of non-penetrating roof top pole are explained. A detail literature review is carried out as part of the present study on wind engineering and design and analysis of telecommunication roof based towers. Estimation of wind effect is carried out as per IS 875 part 3. As there is no literature available for roof top base non penetrating tower, Here IS 800 is used for design the structure.

The Structure is design with STAAD Pro V8i, But the structure may fails at joints so the joints are by manual as per IS 4000, then the structure is checked for stability as per IS 456. When the structure become safe in all aspects then a final drawing is prepared on auto cad

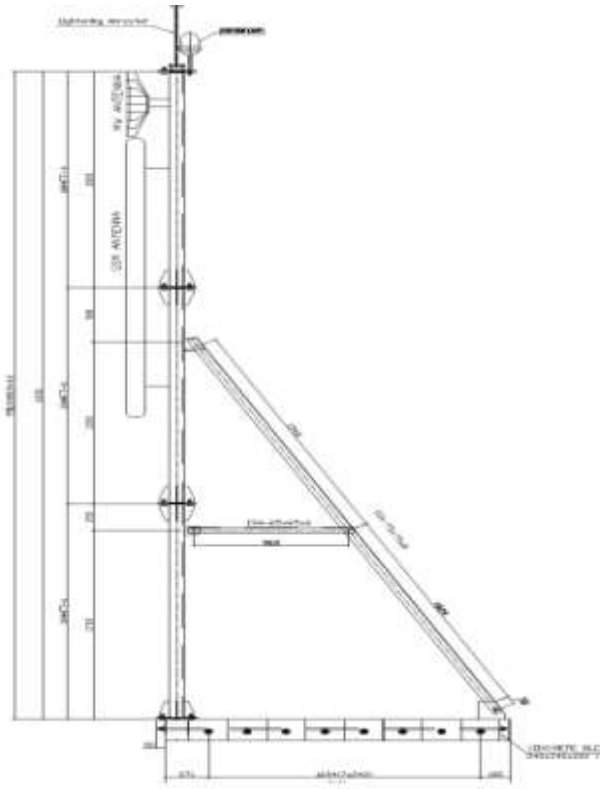


Figure 4

SCOPE OF FUTURE WORK:

1. Present study covers 6m high tower for future Long structure upto 30m high non penetrating pole can be design.
2. Non penetrating concept can be used for structure other then pole like solar panel, monkey huts on roof.

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