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To Study the Wind Effect on Three Legged and Four Legged Telecommunication Tower

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Abstract—*As The telecommunication towers are considered as one of the basic infrastructures in the human societies. During last few decades with the compulsion to provide efficient communication huge number of telecommunication towers has been built in India. It is an engineering discipline work that collaborates structural engineering, civil engineering, electrical engineering and electronics engineering. Failure of such structures is a major concern. it is extremely important to consider appropriate parameters for designing of these towers in order to enhance their sustainability. In this paper, a comparative analysis is being carried out for three legged and four legged telecommunication tower to install the efficient structure with more stability and economical too. It is extremely important to consider appropriate parameters for designing of these towers in order to enhance their sustainability. The wind has been taken as an elementary force for the analysis and design using STAAD pro software. The joint displacements, bending moment, shear force and axial stress have been compared to find out the serviceability of the structure.*

Keyword*: Design, Analysis, Solidity Ratio, windward, Leeward direction.*

1. INTRODUCTION

Telecommunication market is the fastest growing industry this enlarging base create challenges to mobile operators in terms of upgrading and augmenting infrastructure to offer the quality of services. A rapidly increasing subscriber base and a more rigorous spectrum allocating regime may create a higher demand for tower locations for operators to hold large subscribers. So it has increased the requirement of steel towers. Since they require less base area Self-supporting towers are generally preferred. The major loads considered in the design for these towers are self-weight, seismic load, wind load, platform load, steel ladder load, antenna load etc. Failure of this structure is generally due to high- intensity winds. Designed the telecommunication tower for a height of 50m with different types of bracings to study the effect of wind load on three and four-legged lattice tower for wind zone II uses the gust factor method. The analysis of telecommunication tower with angle section and check with Gust factor method. when compression member is designed with bracing it behave as struts. One of the most common arrangements is the cross bracing. Height is the most significant dimension of a tower. Commonly vertical dimension is many times greater than the horizontal dimensions. The tapered part of the tower is advantageous with regard to the bracing, as are reduces design forces. Bracings hold the tower stable by transferring the loads sideways down to the ground (not gravity, but wind or earthquake loads) and are used to resist horizontal loads, thereby preventing sway of the tower. Bracing increases the resistance of the tower against side drift or sway. The longer the tower, the more it is exposed to horizontal loads such as wind load, since it has more chances to drift. If the bracing is weak, the buckling of the compression member would occur which leads to failure of the tower. Diagonal braces are efficient elements for resistance to wind load and developing stiffness. Due to the probabilistic approach, there is difficulty in estimating the wind loads. The displacement at the top of the tower was considered as the main parameter. The towers with different configuration have also been analyzed by removing one member present in the tower at different places. Angle sections used in bracing along with the leg members did not show any appreciable reduction of displacement. The objective of the present work is to study the effect of wind load for three and four-legged tower structures with different possible arrangements of bracing systems for the wind zone of Jaipur with Gust factor method for wind loading.

The main objective of this research is to determine the efficient form of the structure of three legged and four legged telecommunication tower with no bracing, K bracing, Y bracing with the influence of wind load.

2. METHODOLOGY USED

Design and Analytical Approach

The STAAD.pro stands for Structural Design and Analysis. It is one of the software applications program created to help structural engineers automatics their work, to remove the slow and long process of the manual methods. It covers the means to be taken after to create the basic examination and outline of steel and concrete. STAAD Pro is the expert's decision for concrete, solid, steel timber, aluminum and cool framed steel outline of low and tall structures, courses, petrochemical plants, scaffolds, heaps and significantly more. The adaptability of STAAD Pro settles on it the decision of most driving building consultancies, plan and development experts. STAAD Pro highlights a best in class clients interface, perception apparatuses, intense examination and outline motor with cutting-edge limited component and dynamic capacities. The business adaptation of STAAD Pro is a standout amongst the most broadly utilized auxiliary investigation and outline programming. It bolsters a few steel, cement and timber configuration codes. It can make utilization of different types of examination from the conventional first request the static investigation, second request p-delta investigation, geometric non-direct investigation or a clasping examination. It can likewise make utilization of different types of dynamic investigation from modular extraction to time history and reaction range examination. Moreover STAAD Pro has added guide connects to applications, for example, RAM Connection and STAAD.

The basic three activities which are to be carried out to achieve the goal are:

1. Tower generation
2. The computation to be obtained from analysis results. 3. Check result.

2.1 The general strategy of the analysis is:

1. The fundamental building model.
2. The backings, properties, and materials for the required structures are relegated and entered.
3. The size of the member.
4. Load assign.
5. Finally, the run examination is done and created out file is taken.
6. Results are looked at.

3. MODELING OF TOWER

The Steel Communication tower is designed with the help of different Indian standard angle section for the height of 40 m from the ground level with three legged and four legged which is named as M1 and M2 (without bracing). The towers are provided with 2-different types of bracings: K type, Y-type for lower and upper portion of the tower for both type of legged structure and named as M3, M4, M5, and M6. STAAD. Pro V8i software is used for modeling, analysis, and design of this different telecommunication towers. Particular of towers used for modeling are taken according to Table-I for a different type. Fig. 1 shows 40 m high towers with different types of bracings considered in the study.

Table 1: Details of Towers.

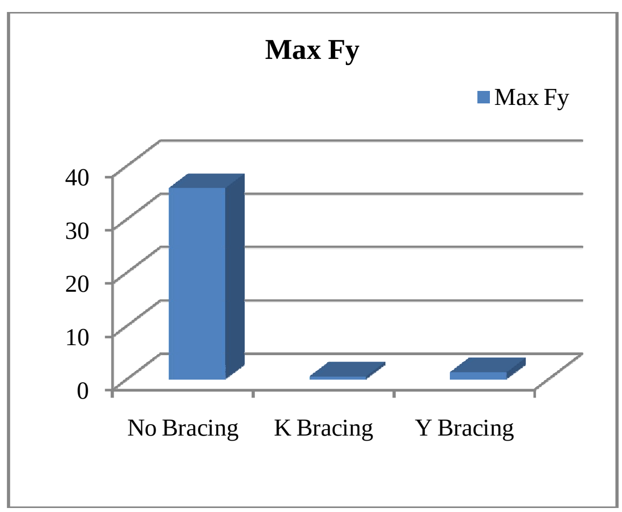
	3- legged tower	4- legged tower
Height of tower	40	40
Height of slant portion	34	34
Height of straight portion at top of tower	6	6
Base width	5.63	4.6
Top width	2.17	1.77

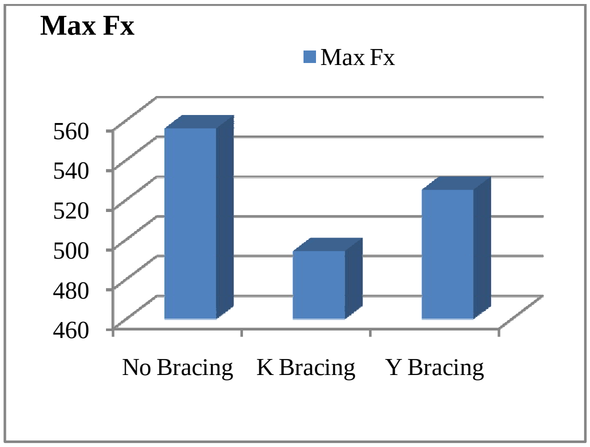
Table 2: Member Details of 40m Tower

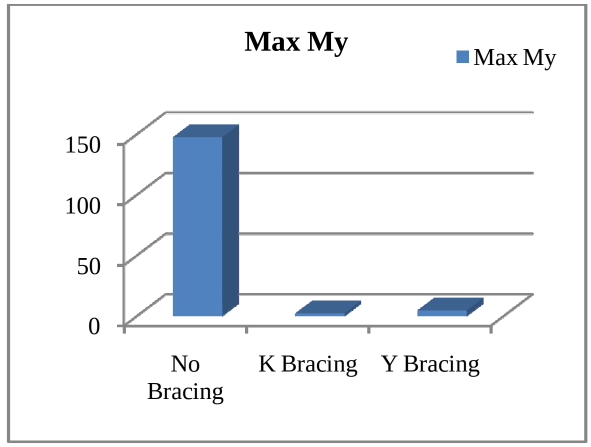
Height	0-13.5	13.5-24	24-34	34-40
	ISA section used			
Main leg bracing	130x130 x10	110x110 x10	110x110 x8	90x90 x8
Horizontal member	50x50 x8	50x50 x8	50x50 x8	50x50 x8
Primary bracing	75x75 x5	60x60 x5	60x60 x5	50x50 x5
Secondary bracing	75x75 x5	60x60 x5	60x60 x5	50x50 x5
horizontal bracing	50x50 x5	50x50 x5	50x50 x5	50x50 x5

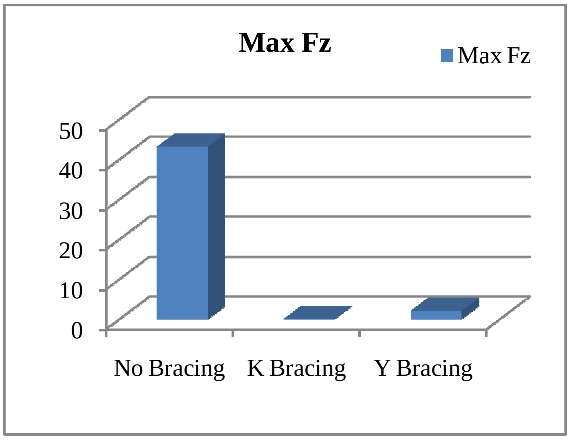
Table 3: Details of Maximum Shear Force

Maximum Shear Force(in KN)					
Max Fx	**In Kn**	**Max Fy**	**In Kn**	**Max Fz**	**In Kn**
No Bracing	555.91	No Bracing	35.827	No Bracing	43.25
K Bracing	494.204	K Bracing	0.49	K Bracing	0.146
Y Bracing	525.004	Y Bracing	1.282	Y Bracing	2.153









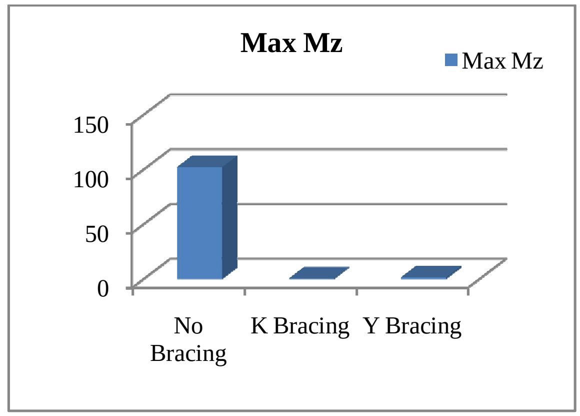


Table 4: Details of Maximum Bending Moment

Maximum Bending Moment(in KNm)					
Max Fx	**In Kn**	**Max Fy**	**In Kn**	**Max Fz**	**In Kn**
No Bracing	0.459	No Bracing	147.727	No Bracing	102.209
K Bracing	0.001	K Bracing	2.402	K Bracing	0.5
Y Bracing	0.006	Y Bracing	4.887	Y Bracing	1.456

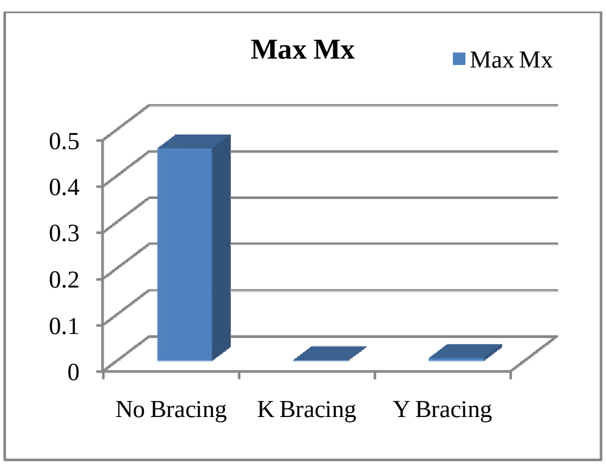
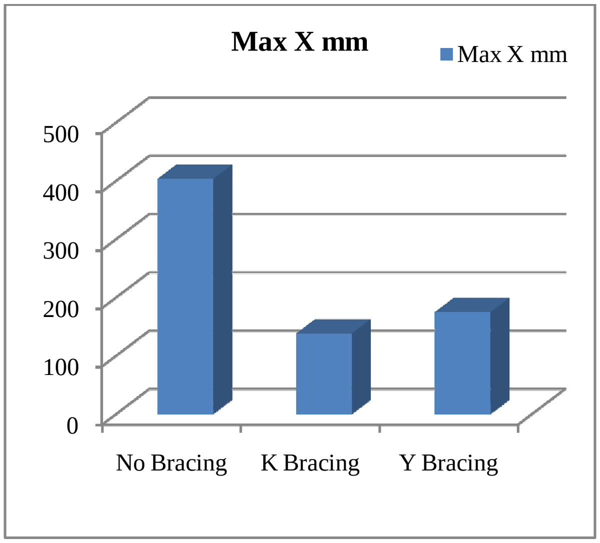
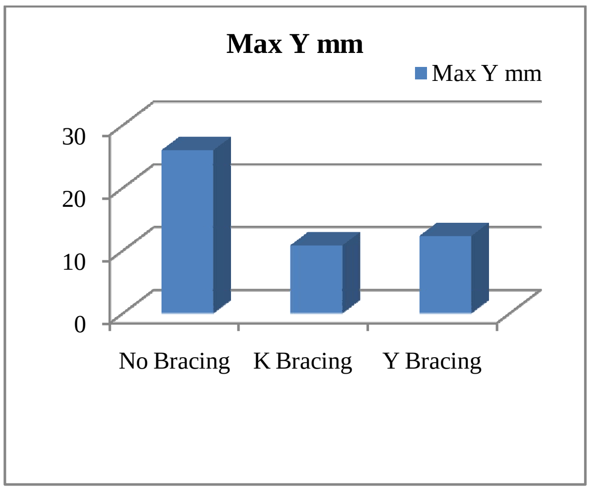


Table 5: Details of Maximum Deflection

Maximum Deflection(in mm)					
Max Fx	**In Kn**	**Max Fy**	**In Kn**	**Max Fz**	**In Kn**
No Bracing	403.305	No Bracing	25.97	No Bracing	407.058
K Bracing	137.958	K Bracing	10.812	K Bracing	79.04
Y Bracing	174.565	Y Bracing	12.302	Y Bracing	144.218





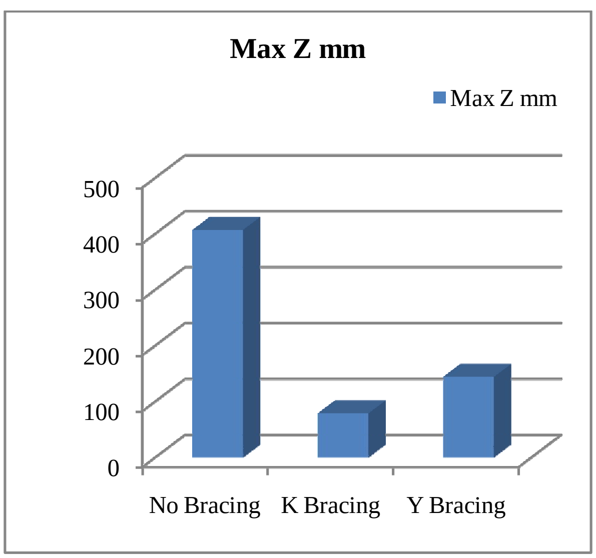
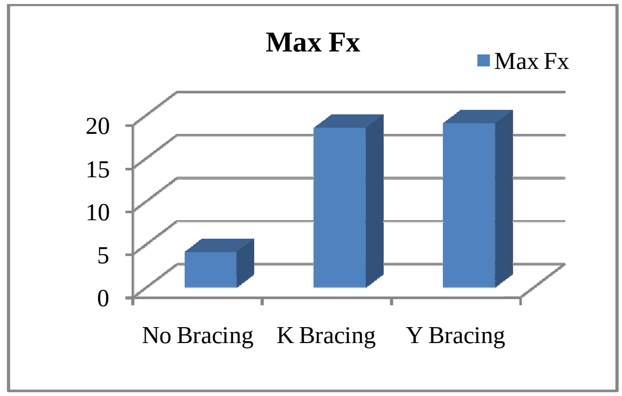
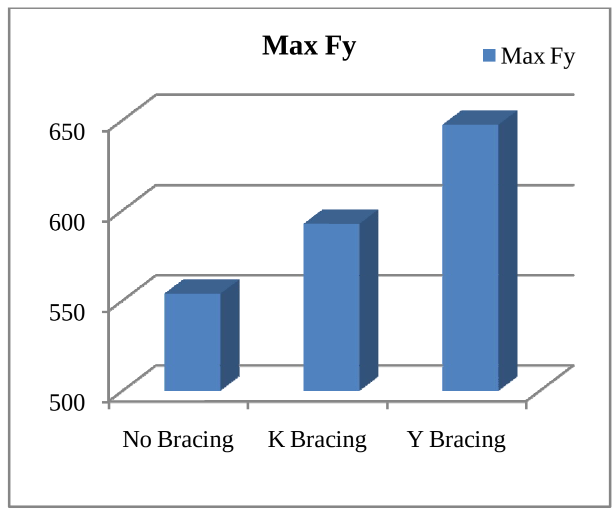
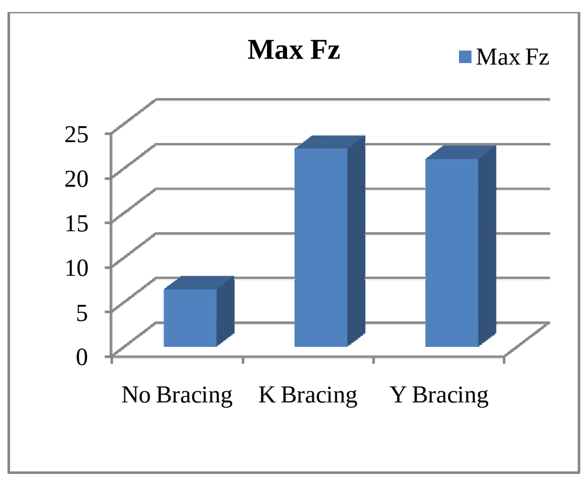


Table 6: Details of Maximum Support Reaction

Maximum Support Reaction(in KN)					
Max Fx	**In Kn**	**Max Fy**	**In Kn**	**Max Fz**	**In Kn**
No Bracing	4.132	No Bracing	553.663	No Bracing	6.375
K Bracing	18.524	K Bracing	592.338	K Bracing	22.131
Y Bracing	19.044	Y Bracing	647.334	Y Bracing	20.997







4. LOADS CONSIDERED FOR THE STUDY

4.1 DEAD LOAD -

Self-weight of the structure and telecommunication equipment mounted on top of the tower is considered as a dead load. A load of platform with 0.82 kN/m2 intensity is applied at 36m respectively for 40m tower. The weight of the cage assembly and ladder is assumed to be 10% of total weight of tower. The antenna loads are determined and distributed uniformly to the nodes at the considered heights. The details of the antenna provided on the tower are given in the table III.

4.2 WIND LOAD

The wind load at the telecommunication tower is calculated with the use IS 875 (part 3): 1987 and IS 802 (Part 1:Sec1)-1995 are look up to estimate wind loads on the structure.

Design wind speed (Vz) is stated as:

Vz=Vbk1k2k3

Where, , k1= probability factor (risk coefficient), k2= terrain, height and structure size factor, k3= topography factor, Vb=basis wind speed in m/s at height z and design wind pressure is expressed as

$P_z=0.6V_z^2$ where, P_z =design wind pressure in N/m2 at height z

Wind loads are calculated for wind zone IV for which basic wind speed is respectively 47 m/s. Following stipulations have been made. Terrain category – 2 (Open terrain with well scattered obstruction height having 1.5 to10 m), Class – B (Greatest vertical dimension between 20 to 50 m), Risk coefficient k1=1.08 (Mean probable design life of structure = 100 years) and Topographic factor k3=1 (Up-wind slope less than 30).

5. RESULTS AND DISCUSSION

5.1 FOR WIND LOAD

Wind analysis is carried out for two wind zone IV of basic wind speed 47 m/s. The gust wind factor is taken into consideration for the analysis. The combination of antenna load, dead load and wind load is the load take for the analysis of the towers. Joint displacement at the top of the both three legged and four legged tower is stated below and also the stresses in the bottom leg of tower were obtained for tower of height 40 m with different bracing arrangements No Bracing, K-Bracing and Y-Bracing for wind zones IV are tabulated in Table VIII and Table IX, respectively. The fig 3 (a-d) shows the variation in displacement at top for different towers and the fig 4 (a-d) shows the variation in stress at the bottom leg.

6. CONCLUSION

BY OBSERVING THE RESULT, WE HAVE OBSERVED THAT -

1. K bracing is more effective and economical than Y bracing as well as than No bracing.
2. The stability is-
   K Bracing> Y Bracing> No Bracing.
3. The Four Legged Telecommunication Tower has more stability than Three Legged Telecommunication Tower.

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