Experimental Investigation on Comparison of Lattice Tower and Monopole

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***Abstract*: In telecommunication industry, lattice towers are the most commonly used structure. But in this new era, Monopoles are also being used in place of lattice towers. This paper presents a comparative study between Monopole and Lattice type Towers with different heights, keeping other parameters constant. The tower heights taken into consideration for this investigation are 30 m, 40 m and 50 m. Dead loads and Wind loads are considered for analysis of the tower using STAAD Pro software which is made for analyzing different structures. Basic wind speed taken is 44 m/s. Designing and analysis of towers is done on STAAD Pro keeping its height and loading constant and later comparison is carried out from the results obtained after analysis on STAAD. Monopole is a advance structure which requires less material and less space for installation than compared to conventional lattice towers. In this era, as population is increasing, requirement of land and its cost is continuously increasing and hence modification in traditional lattice towers is essential. During this paper work, past research supporting analysis of towers and monopole has been studied.**

***Index Terms*: Monopole, Lattice tower, Telecommunication tower, antenna, load, STAAD Pro.**

I. INTRODUCTION

Lattice towers are the vertical truss on ground act as cantilever beam, fixed on one end and free on the other end. These towers are used to support the antennas and electronic wires, at the elevated height from the ground. There are two types of lattice towers - a) Telecommunication Tower b) Transmission Tower. Telecommunication tower is used to support antennas of mobile and communication industry. Transmission towers are used to support electric transmission wires for the supply of electricity. This investigation work concentrates on study and design of telecommunication tower structure.

Data transmission technologies are one of the fastest-growing divisions of the technological industry in the modern period, as evidenced by both new technologies and the expanding number of network users. The latter component results in a constant need to expand network coverage, necessitating the installation of new equipment. High-rise supporting structures are inextricably linked to the technical network since telecommunication network efficiency plainly necessitates suitable receiver elevation. Due to economic constraints or the inability of building a new structure in densely populated metropolitan regions, adaption or modification of existing structures is frequently the only option for expanding the network.

Telecommunication towers are made up of a variety of mechanical constructions and electrical signal processing units that are used to link people via cell phones. These towers connect all of the telephone lines and mobile phone services. These towers are also utilized by the military for radar systems and other functions. Towers of various heights are utilized in various locations and for various purposes. They can range from 15 to 60 meters in length, and even more if necessary. For example, towers are higher in land areas than in hill areas, therefore 15 to 30 meters high towers can be used in hill areas, but 30 to 60 meters high towers can be used in land locations. Telecommunication towers are categorized into many types based on structural action, cross-section, the sort of sections used, as well as the location of the tower Based on their structural activity, they are classed as Monopole, Self-Support, or Guyed Towers. The focus of this thesis is on a comparison of the self-supporting tower and the monopole. Aesthetical, statistical, and economic approaches are taken into account in the comparison.

MONOPOLE

The importance of modern telecommunications structures in society cannot be overstated. As new technologies emerge, there is a demand for more facilities and the introduction of new features into urban areas. Our extensive range of communications poles is built for long-term use, wear and corrosion resistance, and aesthetic appeal. Monopoles are hollow steel structures with tubular polygonal sections and are hot dip galvanized. Single self-supporting or free-standing poles are the most popular in the cellular sector. It necessitates a smaller lease area, lower prices, and a shorter building period, allowing for faster time to market and cost savings. The monopole structures are aesthetically beautiful and blend in nicely with their surroundings, needing minimal installation space. They are typically constructed of different diameter steel sections either tubular or polygonal in shape. The maximum length of shaft is generally 13 m and polygonal shafts have 6, 8, 12, 16, 18 sides. The individual sections are bolted or welded together with the largest diameter sections at base and each successive section is smaller in diameter. The joint between the different sections are either slip or flanged connection. Base plates and accessories are welded to the sections. Generally, climbing accessories and antennas are the only visible additions.

II. MATERIAL

The material used for designing is steel. The material properties adopted are discussed below.

Material Properties

1. The density = 7870 kg/m^3
2. Tensile strength of steel (Fu) = 500 N/mm^2
3. Yield stress (Fyld) = 450 N/mm^2
4. The modulus of elasticity (E) = 2 x 10^5 N/mm^2
5. Poisson's ratio = 0.3

III. LOADING

Loads taken into consideration for the analysis of the communication tower are dead load, live load and wind load.

1. Dead Load : It consists self weight, antenna load and platform load

a) Self Weight - It include the self-weight of the structural elements that depends on the type of structural steel used.

b) Antenna Load -

CDMA type antenna, 4 in quantity, of 20 Kg each
GSM1 type antenna, 4 in quantity, of 25 Kg each
GSM2 type antenna, 4 in quantity, of 30 Kg each

c) Platform Load - 0.82 KN/m^2 is adopted

2. Live Load : It include weight of a person for maintenance purpose including equipments. It is taken as 1KN.

3. Wind Load : Basic wind speed taken for the investigation is 44 m/s.

IV. MODELING OF TOWER

Modeling of 3D lattice telecommunication tower and monopole structure is done using the STAAD Pro software for three Different tower heightsof 30 m, 40 m and 50 m. The model descriptions are given below.

A. Geometry of Lattice Telecommunication Tower:

The lattice tower is designed for three different heights of 30m, 40 and 50m with the base width 6.5m, 7m and 8m respectively. The towers are provided with XBX type of bracings and straight portion having X bracing. All the support conditions applied to the model are fixed.

Table 1: Details of Towers

Height of Tower	30 m	40 m	50 m
Height of slant portion	20 m	28 m	36 m
Height of straight portion at top of tower	10 m	12 m	14 m
Base width	6.5 m	7 m	8 m
Top width	1.5 m	2 m	2 m
No. of Panels	10	12	15

The member details and the ISA section used for designing of Lattice telecommunication tower are given below

Table 2: Member Details of 30 m Lattice Tower

Height (30 m)	0 - 9 m	9 - 20 m	20 - 30 m
	ISA section used		
Main leg	130 x 130 x 16	110 x 110 x 10	80 x 80 x 8
Horizontal members	110 x 110 x 10	100 x 100 x 10	60 x 60 x 8
Primary bracing	110 x 110 x 10	100 x 100 x 10	80 x 80 x 8
Secondary bracing	100 x 75 x 12	60 x 60 x 8	-
Horizontal bracing	80 x 80 x 8	60 x 60 x 8	-

Table 3: Member Details of 40 m Lattice Tower

Height (40 m)	0 - 10 m	11 - 22 m	23 - 28 m	29 - 40 m
	ISA section used			
Main leg	150 x 150 x 18	150 x 115 x 16	130 x 130 x 12	110 x 110 x 10
Horizontal members	150 x 115 x 16	130 x 130 x 12	110 x 110 x 10	90 x 90 x 10
Primary bracing	130 x 130 x 12	130 x 130 x 12	110 x 110 x 10	90 x 90 x 10
Secondary bracing	110 x 110 x 10	110 x 110 x 10	90 x 90 x 10	-
Horizontal bracing	90 x 90 x 10	90 x 90 x 10	90 x 90 x 10	-

Table 4: Member Details of 50 m Lattice Tower

Height (50m)	0 - 15 m	16 - 27 m	28 - 36 m	37 - 42 m	43 - 50 m
	ISA section used				
Main leg	200 x150 x18	150 x115 x16	120 x120 x15	100 x100 x12	90 x90 x10
Horizontal members	150 x 115 x16	120 x120 x15	100 x100 x12	90 x90 x10	80 x80 x8
Primary bracing	120 x120 x15	120 x120 x15	100 x100 x12	90 x90 x10	80 x80 x8
Secondary bracing	100 x100 x12	100 x100 x12	90 x90 x10	-	-
Horizontal bracing	90 x 90 x10	90 x90 x10	90 x90 x10	-	-

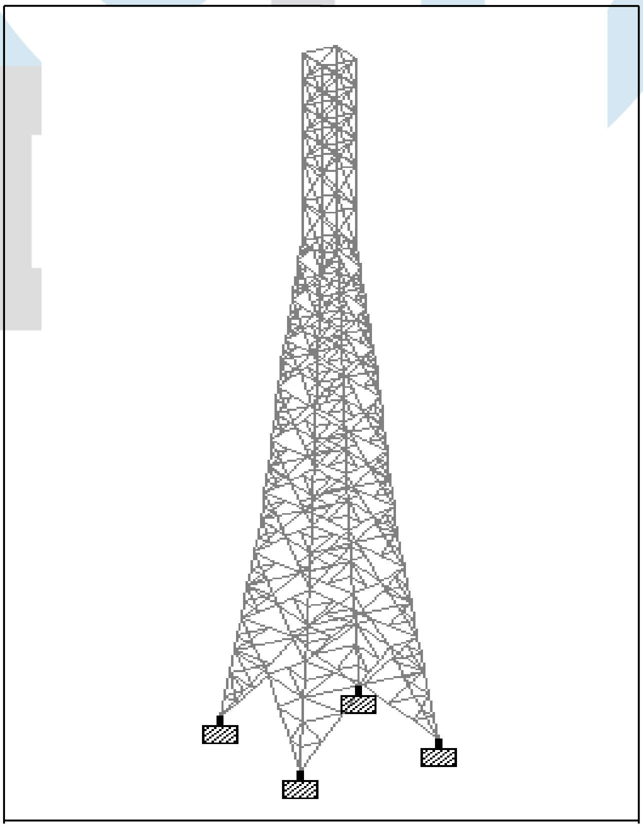

Fig 1 : Lattice Telecommunication Tower of 50 m height

B. Geometry of Monopole Tower :

The flanged joint tapered steel pipe is selected for designing the monopole telecommunication tower of height 30m, 40m and 50m. The section used are polygonal 16 sided shaft. The required number of tubular shafts are taken according to the design. The tapered tubular sections are given required thickness. The material properties are adopted from IS 800-2007 and IS 1161 -1998. Tapered circular tubular sections of monopole tower models for three heights were modeled for STAAD Pro software.

The member details and the polygonal section used for designing of Monopole telecommunication tower of are given below

Table 5 : Section Details of 30 m Monopole

Sr. No.	Elevation (m)	Height (m)	Top (mm)	Base (mm)	Thickness (mm)
1	30	10	450	700	6
2	20	10	570	850	9
3	10	10	690	1000	12

Table 6 : Section Details of 40 m Monopole

Sr. No.	Elevation (m)	Height (m)	Top (mm)	Base (mm)	Thickness (mm)
1	40	10	450	720	7
2	30	10	620	870	9
3	20	10	790	1040	11
4	10	10	950	1250	13

Table 7 : Section Details of 50 m Monopole

Sr. No.	Elevation (m)	Height (m)	Top (mm)	Base (mm)	Thickness (mm)
1	50	10	460	710	7
2	40	10	625	875	9
3	30	10	790	1040	11
4	20	10	955	1205	13
5	10	10	1120	1370	15

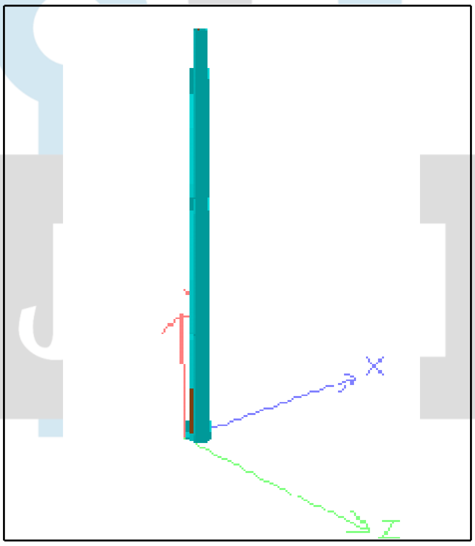

Fig. 2 : Monopole Tower of 50 m height

V. RESULT AND DISCUSSION

The designing of Lattice towers and monopole was done on STAAD software. Parameters such as total weight of material, maximum joint displacement were compared and the following results were obtained from the analysis

Table 8 : Weight of steel

Sr. no.	Tower	Lattice Tower	Monopole
1	30 m	99.74	49.82
2	40 m	202.70	87.33
3	50 m	285.43	132.77

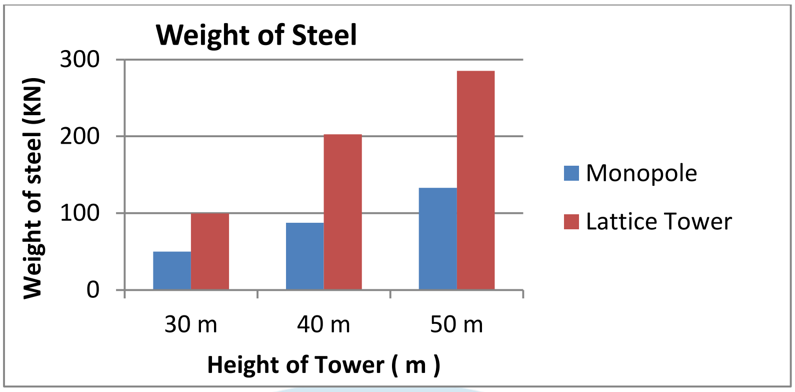

Fig. 3: Weight of Steel required

Table 9: Joint Displacement

Sr. no.	Tower	Lattice Tower	Monopole
1	30 m	0.65	0.12
2	40 m	1.39	0.2
3	50 m	2.32	0.29

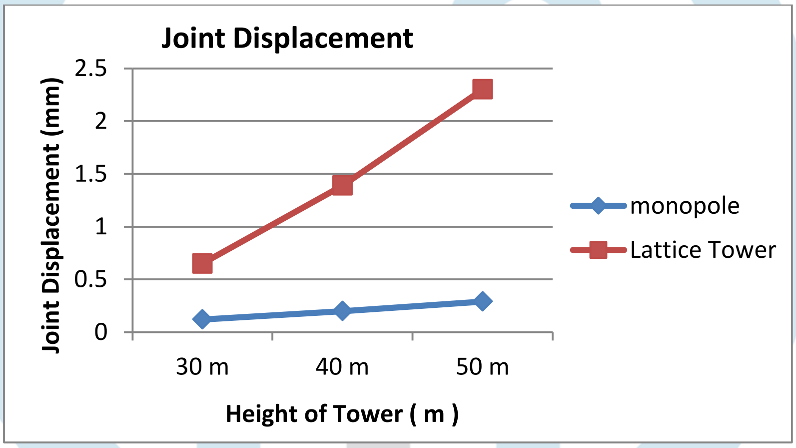

Fig. 4: Joint Displacement of tower

VI. CONCLUSION

The present work attempt has been made to analysis and design of lattice telecommunication tower and monopole by using STAAD software. Based on the results obtained following conclusion are drawn :

1) The percentage of steel quantity required for Lattice telecommunication Towers is approximately 50% more than the Monopole Towers for a given tower height.
2) The average displacement for telecommunication tower is more as compared to monopole. Bracing used for the telecommunication tower is XBX type and for monopole tapered section is used, here we conclude, monopole showing minimum displacement.
3) Through above values we can conclude that the monopole is more effective as compared to lattice telecommunication tower.
4) From results of analysis the monopole required lesser percentage of steel when compared to lattice tower. From this it reveals that monopole gets economical and lighter structure as compared to lattice tower.
5) Through calculations telecommunication tower requires the more right of way (ROW) than monopole. To overcome these problems monopole suggests the best option for crowded area.

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