Wind Analysis of Three Legged Transmission Towers with Different Bracing Systems for Angle Section & Tube Section

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Abstract- *Owing to the increasing demand of electrical energy an emphasis should be given to the analysis & design of transmission line towers. Since the transmission line towers are the elevated structures, they are mostly affected by wind forces. Therefore before construction of these structures, they must be checked against wind forces. This research paper presents a study on wind analysis of three legged towers with three different bracing patterns i.e. inverted VX, V & W for angle & tube section. Wind analysis of towers is done by using STAAD Pro software & under the guidelines provided by IS: 802 (Part 1)-1995. A Comparative study has been done between different bracing systems & between the angle & tube sections in terms of parameters such as axial forces, deflections in normal and wire condition & steel take off. Study has concluded that W bracing with tube section is most suitable as it provides optimum values of all the parameters in all the conditions.*

Keywords- Three Legged Tower, Bracing, STAAD Pro, Angle Section, Tube Section, Wind Analysis.

I. INTRODUCTION

Transmission tower design is very beneficial because they are constructed to carry power lines at safe and sufficient spaces from ground level due to high voltage. Cost of tower is dependent upon its configurations and bracing patterns. Bracing members improve the stiffness and decrease the slenderness ratio of the tower. Tower is designed according to structural and electrical view point. Tower configurations, conductors, insulators, bracings, cross arms and foundations are main constituents of tower. Transmission line towers establish about 28 to 40% of the cost of the transmission line. Cost of tower is dependent upon tower configurations, cross arm, height and correct type of bracing patterns. The present study focusses on bracing patterns used along with angle & tube section & its impact on axial forces, & deflections under same loading pattern in normal & broken wire condition & steel take off. Wind analysis is carried out as par IS 802 (1995).The objective of this study is to find out most efficient bracing system for 400kV multi-circuit transmission tower.

II. OBJECTIVES OF THE STUDY

Objectives of the present study are as given below

- To carry out wind analysis on three legged transmission towers with three different types of bracing systems.
- To study the behaviour of tower structure for angle section & tube section.
- To study behaviour of three legged tower structure under wind load.
- To Study behaviour of three legged tower structure in normal & broken wire condition.
- To find out most efficient and reasonable braced transmission tower from the parametric studies on three legged transmission towers with different sections & with different types of bracing systems.

III. SCOPE OF THE STUDY

The present work is pointed to study the tower structure by using STAAD-PRO software & to check it for different bracing systems with angle & tube section.

Different bracing systems of tower structure considered for the study are:

a) Inverted VX bracing b) V bracing c) W bracing

IV. METHODOLOGY

This topic describes the method used for the analysis. It clarifies the assumptions made & description of models used for the study.

Description of the Models

All the tower models used for the study are having same height i.e.80m & same base area equal to101.88m^2. Material used for the tower is steel. All the supports are considered as fixed supports. Dead load comprises of the self-weight of all the constituents i.e. Conductors, insulators, ground wires & the weight of transmission lines. Live load on the tower is taken as 150Kg. The tower is assumed to be situated in Aurangabad region having basic wind velocity equal to 39m/s.

Models considered for the wind analysis:

a) Tower with Inverted VX bracing (model 1)
b) Tower with V bracing (model 2)
c) Tower with W bracing (model 3)

Table-1: Geometrical Parameters for Three Legged Tower

Parameters	**Dimensions**
Base Width	13.5m
Top Width	2.5m
Base Area	101.88m2
Top Area	3.49m2
Total Height	80m

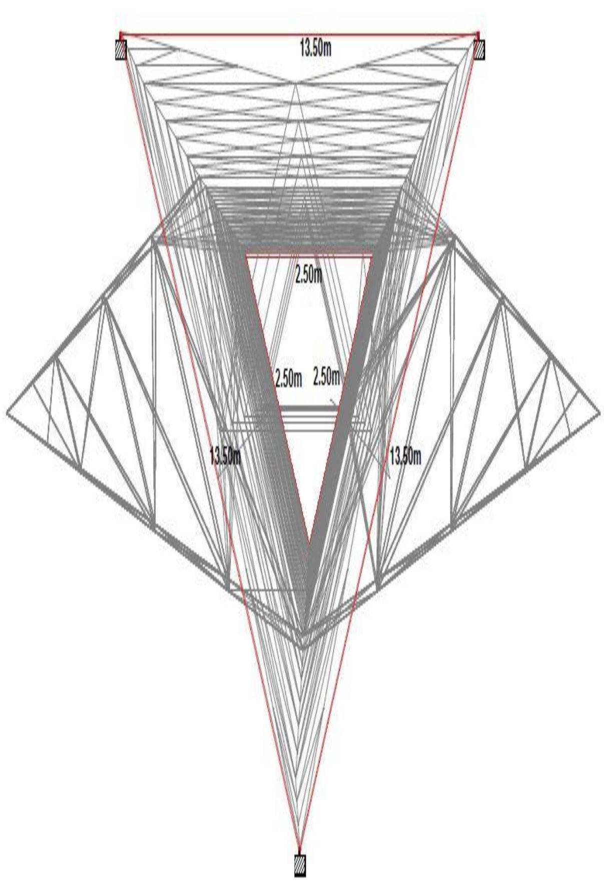


Figure 1: Plan for Three Legged Transmission Tower

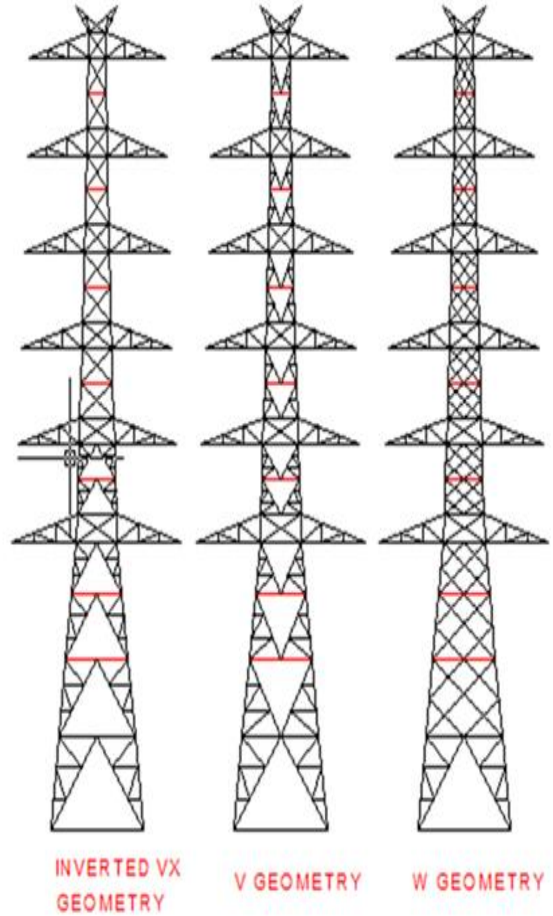


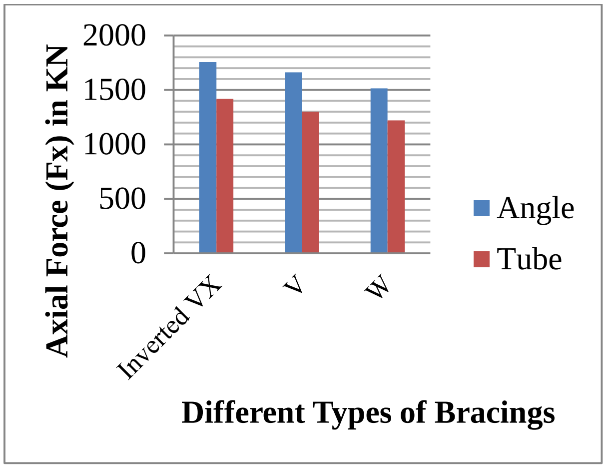
Figure 2: Configurations of Three Legged Towers in (a) Inverted VX Bracing Type (b) V Bracing Type (c) W Bracing Type

V. RESULTS AND DISCUSSION

This chapter expalains the results in the form of maximum axial force (F_X), deflection & steel take off with different types of bracing systems & for angle & tube section in normal & broken wire condition and variation of results is discussed.

Table-2: Maximum Axial Force (Fx) in Normal Condition in KN

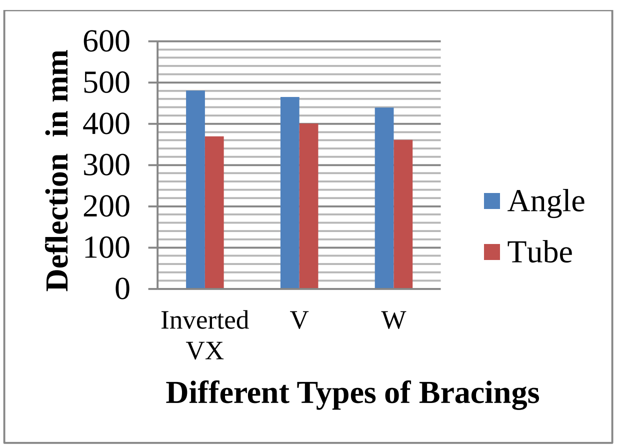
Type of Braced Tower	**Maximum Axial Forces (Fx) in three legged condition in KN**	
	For Angle Section	**For Tube Section**
Inverted VX braced tower	**1755.5**	**1417**
V braced tower	1660.4	1300
W braced tower	**1515**	**1220**



Graph-1: Axial Forces for different bracing systems

Table-3: Maximum Deflection in Normal Condition in mm

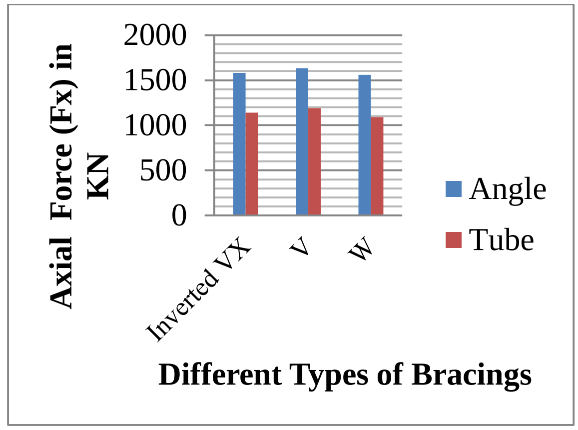
Type of Braced Tower	Maximum Deflections in three legged condition in KN	
	For Angle Section	For Tube Section
Inverted VX braced tower	**480.48**	369.83
V braced tower	465.09	**400.22**
W braced tower	**439.38**	**360.83**



Graph-2: Deflections for different bracing systems

Table -4: Maximum Axial Force (Fx) in Broken Wire Condition in KN

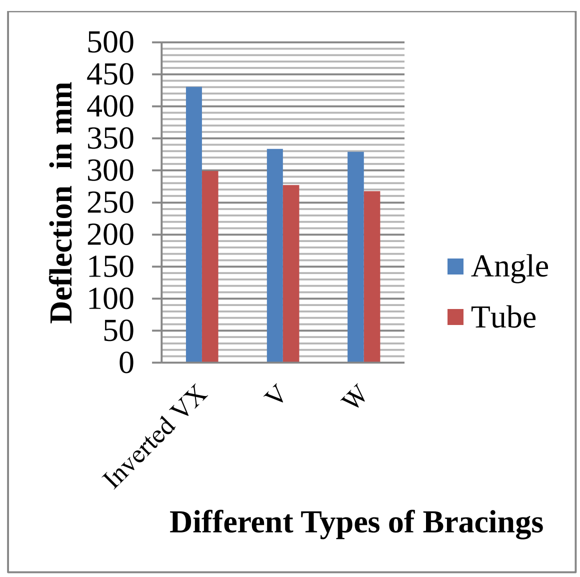
Type of Braced Tower	Maximum Axial Forces in three legged condition in KN	
	For Angle Section	For Tube Section
Inverted VX braced tower	1580.77	1140.00
V braced tower	**1632.44**	**1190.70**
W braced tower	**1557.66**	**1090.00**



Graph-3: Axial Forces (Fx) for different bracing systems

Table-5: Maximum Deflections in Broken Wire Condition in mm

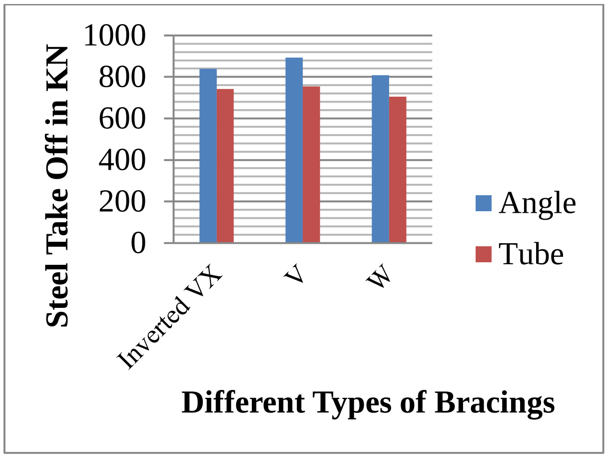
Type of Braced Tower	Maximum Deflections in three legged condition in mm	
	For Angle Section	For Tube Section
Inverted VX braced tower	**430.33**	**298.99**
V braced tower	333.44	277.37
W braced tower	**328.88**	**267.78**



Graph-4: Deflections for different bracing systems

Table-6: Steel Take Off for different Types of Bracings

Type of Braced Tower	Steel Take Off in three legged condition in mm	
	For Angle Section	For Tube Section
Inverted VX braced tower	838.91	741.42
V braced tower	**892.68**	**754.13**
W braced tower	**807.67**	**705.61**



Graph-5: Steel Take Off for different bracing systems

VI. CONCLUSION

The present study has focused on three legged transmission tower with different bracing systems in normal condition & broken wire condition against wind forces. After the analysis wind effects of three models has been compared and efficient braced tower is found. The conclusions of present study are as given below.

1. For three legged transmission tower the maximum axial force considering normal condition for angle section observed in inverted VX bracing and minimum in W bracing with percentage decrease of 13.69%. The maximum axial force considering broken wire condition for angle section is observed in V bracing and minimum in W bracing with percentage decrease of 4.58%.
2. For three legged transmission tower the maximum axial force considering normal condition for tube section observed in Inverted VX bracing and minimum in W bracing with percentage decrease of 13.90%. The maximum axial force considering broken wire condition for tube section is observed in V bracing and minimum in W bracing with percentage decrease of 8.45%.
3. Values of axial forces obtained for angle section are more than that for tube section by about 19.47% if the W braced tower is considered in normal condition. Values of axial forces obtained for angle section are more than that for tube section by about 30.02% if the W braced tower is considered in broken wire condition.
4. Deflection is minimum in W type braced tower while maximum in the inverted VX braced tower structure in normal condition. Deflections in inverted VX bracing are about 10.65% more than W type bracing. Deflections in V bracing are about 4.67% more than W type bracing.
5. Deflection is minimum in W type braced tower while maximum in the inverted VX braced tower structure in broken wire condition. Deflections in inverted VX bracing are about 12.02% more than W type bracing. Deflections in V bracing are about 2.57% more than W type bracing.
6. The tower with W bracing systems show minimum required steel quantity as compared to other braced tower. The saving in steel quantity is maximum in W braced tower.

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