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RESEARCH ARTICLE

ECONOMICAL BRACING SYSTEM FOR TELECOMMUNICATION TOWERS WITH LATERAL LOAD IN ETHIOPIA

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ABSTRACT

The major system providing lateral load resistance in steel telecommunication towers is bracing system. There are different types of bracing systems for steel towers. The heights of these towers in Ethiopia vary from 20 to 102 meters, based on the practical requirements. This study has focused on identifying the economical bracing system for a given range of tower heights. Towers of height 35m, 45m and 50m have been analyzed and designed with different types of bracing systems under seismic and wind loads. Based on the seismic zones and worst wind speed of Ethiopia the optimal bracing system has been identified and reported.

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INTRODUCTION

Telecommunication towers are tall structure usually designed for supporting parabolic antennas which are normally used for microwave transmission for communication, also used for sending radio, television signals to remote places and they are installed at a specific height. These towers are self-supporting structures and categorized as three-legged and four-legged space trussed structures. The self-supporting towers are normally square or triangular in plan and are supported on ground or on buildings. There are different types of bracing systems hold the structure stable by transferring the loads sideways (not gravity, but wind or earthquake loads) down to the ground and are used to resist lateral loads, thereby preventing sway of the structure. Bracing increases, the resistance of the structure against side sway or drift. The higher the structure, the more it is exposed to lateral loads such as wind load, since it has higher tendency to sway. If the bracing is weak, the compression member would buckle which leads to failure of the tower. Diagonal braces are efficient elements for developing stiffness and resistance to wind Analysis of Telecommunication Tower with Different Bracing System loads. There are different types of bracing systems in common use such as Single diagonal bracing, double diagonal X bracing, X-B bracing, K- bracing and W-bracing system.

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In Ethiopia the only telecommunication company is Ethio-Telecom. These company has over 1100 towers. Based on the company data the most of the towers used for microwave transmission. To transmit these microwave Ethio-Telecom mostly uses 35m, 45m and 50m towers in all regions of Ethiopia. The bracing type of these towers is not concerned because of the tower full design and section materials directly import from different international companies. Only the foundation design is carried by the company Engineers. So these thesis is focused on economical bracing system of towers with respect to lateral load in Ethiopia.

Literature Review

A. Jesumi (2013) have investigated on Optimal Bracing System for Steel Towers. The study has focused on identifying the economical bracing system for a given range of tower heights. Towers of height 40m and 50m have beenanalyzed with different types of bracing systems under wind loads. Thediagonal wind has been found to be the maximum for towers. The optimal bracing system has been identified and reported. Jithesh Rajasekharan (2014) In this paper Analysis of telecommunication tower subjected to seismic and wind loading. In this dissertation, studies are being carried out on models of varying heights with different bracing for seismic along with the wind effect. The wind effect on the structure is studied by using the gust factor method and the seismic effect on the structure is studied by carrying out the modal analysis

and response spectrum analysis. The results obtained from the above analysis are tabulated, compared and conclusions are drawn. Vellingiri Anusuya (2016) have studied the lateral load behavior of towers with various types of bracings. The primary objective of this project is to analyze the towers with different heights and different bracing configurations to show the optimal solution. Hence, this research project is aimed to suggest the efficient bracing system for a lateral load on towers using STAAD analysis. The research work will be limited to the analysis of steel towers only. It is found from the existing literature that considerable work has been carried out on static and dynamic response of towers, strengthening and upgrading of existing towers and optimization of towers. But to the Author's knowledge, no work appears to have been reported on the economical bracing suitable for a particular type of tower. Ms. Puja S. Jotawar (2017) have investigated on Seismic Analysis of Tubular Telecommunication Tower with Bracing Systems. This research paper consists of effects of earthquake force on tubular tower Structure with different bracing system. The Indian standard code of practice IS- 1893 (Part I: 2002), IS-800-2007 guidelines and methodology are used to analyze the tower structure. Etab2015 structural analysis software is used to analyze the tower under the effect of earthquake forces in zone III. Seismic analysis done by Response Spectrum Analysis. The behavior of tower was examined and compared on the basis of displacement and base shear.

Objectives of study

General objectives

- To find an Economical Bracing System for Telecommunication Towers with Lateral Load in Ethiopia.
- Specific Objectives
- To analyze lateral loads on a tower.
- To select appropriate bracing system for seismic zones of Ethiopia.
- To select appropriate bracing system for Ethiopian wind characteristics.
- To recommend the economical bracing type for telecommunication companies.

MATERIALS AND METHODS

The Steel telecommunication towers are designed for heights of 35 m, 45 m and 50 m. The towers are 3-leged provided with 4-different types of bracings: X-type, XB-type, K-type and W-type used. SAP2000 has been used for modeling, analysis and design of towers. EUROCODE has been used as a design code for the towers. The 35 m, 45m and 50m high towers with different types of bracings considered in the study.

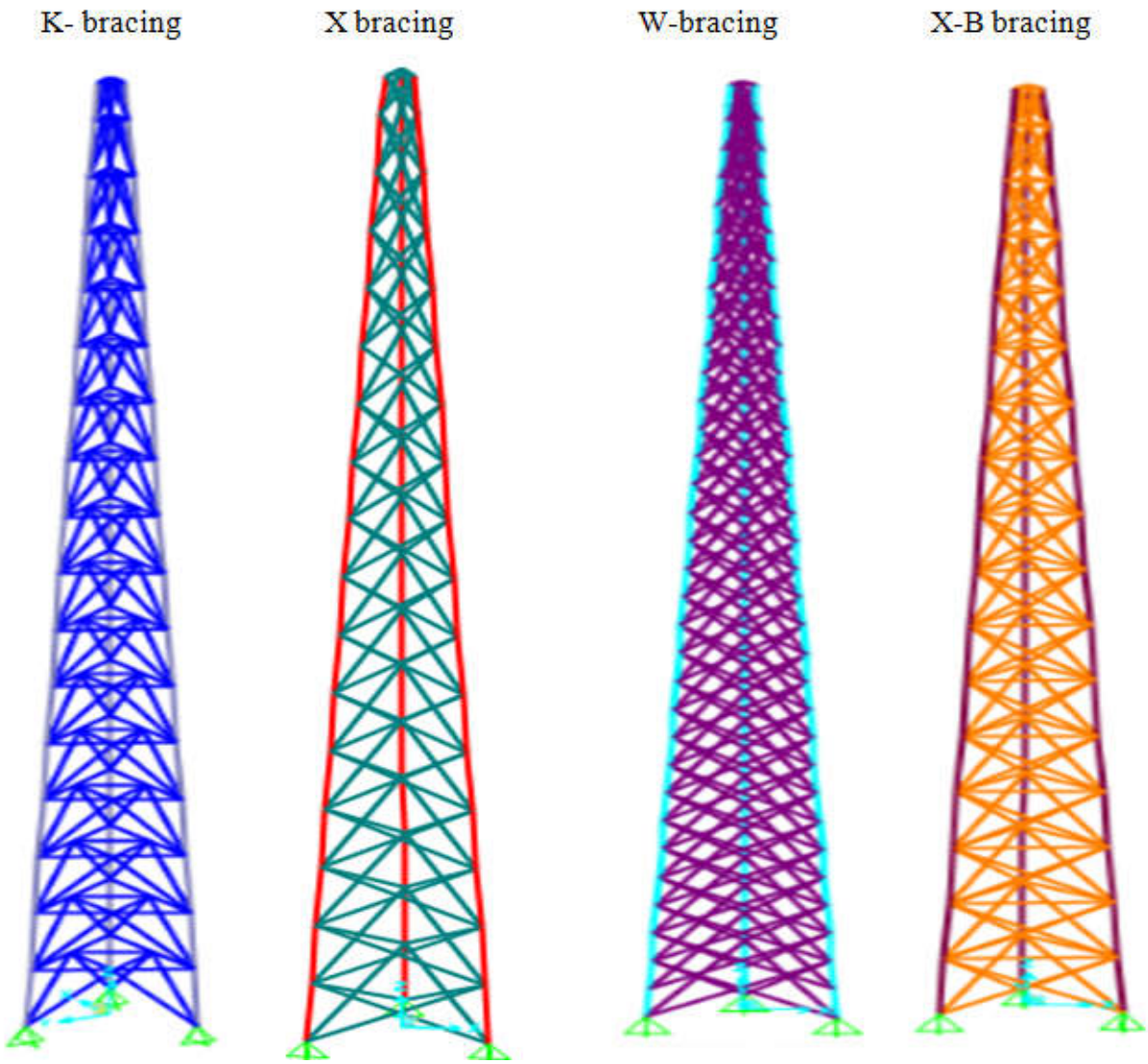

Figure 1. The diagram shows the models with various types of bracing in 50m height towers

Table 1. Weights of 35m towers in different type

	35m Towers	Weight in KN		
Zones	W- bracing(KN)	X- bracing(KN)	XB- bracing(KN)	K- bracing(KN)
1	107.279	73.438	83.893	88.216
2	107.279	73.438	83.893	88.216
3	107.279	73.438	83.893	88.216
4	107.279	73.438	83.893	88.216
5	107.279	73.438	83.893	88.216

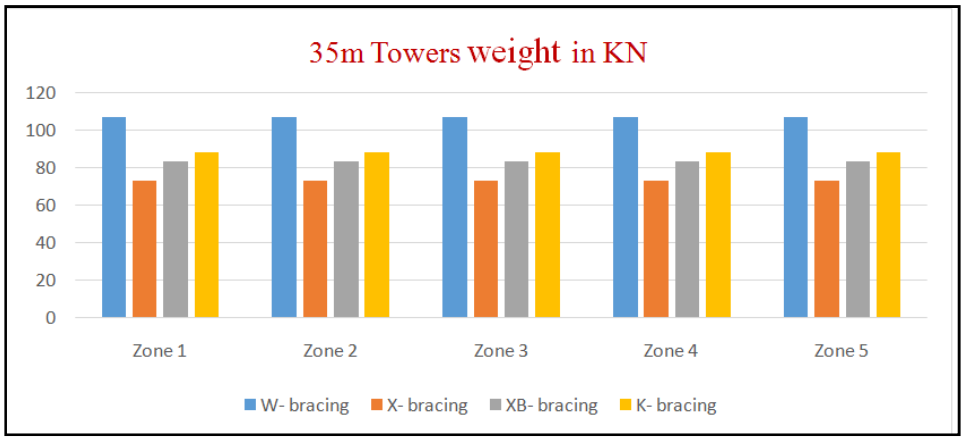

Figure 2. 35m towers weight

Analysis

The analysis was carried by SAP2000 vision 20. For analysis 35m, 45m and 50m used in four different bracing types. The loadings applied to the towers are dead load, live load, wind load and earthquake. After applying the loads, combinations were checked according to the codes.

RESULTS

The aim of these Thesis is to find Economical Bracing System for Telecommunication Towers with Lateral Load in Ethiopia. The selection criteria of the economical bracing system for these Thesis is weight. By comparing the weight of the towers for different seismic zones of Ethiopia to find economical bracing system.

DISCUSSION

It can be seen from the results in figures that the X- bracing type is the economical bracing system for Ethiopia lateral load. For 35m, 45m and 50m telecommunication towers using the other bracing types in Ethiopia in an economical. The weight of the X- bracing system is less than the W- bracing system, K- bracing system, XB- bracing system. So based on self- weight of the tower the X- bracing system is perfect for all zones of earthquake and wind pressure in Ethiopia.

Conclusions

As per the objective of this research, the lateral loads on the tower were analyzed considering different earthquake and wind loading as Eurocode 3- 2005 and EBCS EN 1998-1:2014. The design done by Eurocode 3- 2005 but the coefficient of seismic action taken from EBCS EN 1998-1:2014 and the wind velocity taken from Ethio- telecom. Again the other objective of this research is select appropriate bracing system for seismic zones of Ethiopia. Based on these objective all bracing system ware checked with different height and seismic zones.

The result which happed to use in all zones is X- bracing system is the best option from the other bracing systems. From the results obtained, X- bracing system has been found to be the most economical bracing system for 35m, 45m and 50m height telecommunication towers. The weight of the X- bracing system is less than the other bracing systems. So the X- bracing system is the economical bracing system for Ethiopia lateral loads.

Recommendations

- Further studies are recommended to determine the design of the tower using L- section in Ethiopia like China, Italy and Korea.
- I recommend further study on other bracing systems which don't conclude on these thesis regarding lateral load in Ethiopia.
- I suggest Ethio- telecom to design the towers by its own Civil Engineering staffs and do further studies on how to design towers.

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