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DESIGN AND ANALYSIS OF TRANSMISSION LINE TOWER USING STAAD-PRO

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Abstract - *Transmission line towers carry heavy electrical transmission conductors at a sufficient and safe height from ground. In addition to their self-weight they have to withstand all forces of nature like strong wind, earthquake and snow load. Therefore transmission line towers should be designed considering both structural and electrical requirements for a safe and economical design.*

This study focuses Estimation of a feasible transmission line tower for different wind speed by designing transmission line tower with hot rolled sections and compare three types of bracings. For this purpose, 220 kV double circuit self-supporting transmission towers having square base is used. Analysis of this transmission tower is carried out using STAAD PRO subjected to wind load for Zone-II, III and IV. Load calculation for the analysis is carried out according to IS 802:1995. Finally, the optimal design of transmission tower using hot-rolled steel is compared for wind speed.

***Key Words*: *Transmission tower, wind speed, analysis, design, staad-pro*.**

1. INTRODUCTION

Transmission towers are essential for the purpose of supplying electricity to various regions of the nation. That's why power stations are increased & provided at different corners where it's needed. Interconnections between systems are also increasing to improve accuracy and economy. If Transmission line is not designed carefully, they can be fail due to any natural disaster. That's why it should be stable and carefully designed so that they do not fail during natural disaster. It should also conform to the national and international standard. In the planning and design of a transmission line should be structural and electrical point of view., The most important requirement from the electrical point of view is insulation and safe clearances of the power carrying conductors from the ground.

Transmission line towers contribute nearly 40 percent of the cost to the transmission line project. The selection of an optimum outline together with right type of bracing system contributes to a large extent in developing an economical design of transmission line tower. The major source of power of industries, commercial and residential is electricity. Due to rapid growth in industrial area the need for electricity increases because of infrastructure development,. Because of lesser cost, electricity is now being used for rail transportation in place of fuel powered engines. Therefore, it is required to transmit the high voltage to the area in need, so we require installing transmission line tower to carry Extra High Voltage (EHV).

1.1 Scope of the Study

Estimation of a feasible transmission line tower for different wind speed by designing transmission line tower with hot rolled sections and compare three types of bracings.

1.2 Objectives

Following are the objectives of the proposed dissertation work:

1. To study the analysis and design of transmission tower using STADD Pro software
2. To analyze and design of self-supporting transmission line tower with different types of bracings using hot-rolled steel sections.
3. To compare different towers for its structural stability with different wind speed.

2. LITERATURE REVIEW

1. V. Lakshmi1, A. Rajagopala Rao "EFFECT OF MEDIUM WIND INTENSITY ON 21M 132kV TRANSMISSION TOWER" In this paper the performance of medium wind intensity is observed. The Recommendations of IS 875-1987, Effect of height above ground terrain and Basic wind speeds, , Design wind pressure, Design wind force, Design wind speed, is clarified in detailed. A study is administered for the tower and therefore the reform the performance of the tower and the member forces altogether the vertical, horizontal and diagonal members are evaluated. The critical elements among each of three groups are identified. In following chapters the performance of tower under abnormal

conditions like localized failures are evaluated. The small print of load calculation, modeling and analysis are discussed. The wind intensity converted into point loads and loads are applied at panel joints.

2. Gopi Sudam Punse (Analysis and Design of Transmission Tower) In this thesis Analysis and design of narrow based Transmission Tower (using Multi Voltage Multi Circuit) is administered keeping in sight to provide optimum utilization of electrical supply with available ROW and growing population within the locality, in India. Transmission Line Towers constitute about 28 to 42 per cent of the entire cost of the cables. The growing demand for electricity is often met more economical by developing different light weight configurations of transmission towers. In this project, a struggle has been made to form the cable more cost effective keeping in sight to supply optimum electric supply for the specified area by considering unique transmission tower structure. The target of this research is met by choosing a 220KV and 110KV Multi Voltage Multi Circuit with narrow based Self Supporting Lattice Towers with a view to improve the prevailing geometry. Using STAAD PRO v8i analysis and style of tower.
3. Tanvi G. Londhe, Prof. M.S.Kakamare(Comparative Study of Dynamic Analysis of Transmission Towers**)** This paper describes the estimation of possible solution to optimize transmission line tower for weight parameter. The value of transmission line towers is about 35% to 40% of the entire cost of the transmission tower. But lesser study is administered within the field of minimizing weight of transmission line tower, also less literature is out there on transmission tower with cold form sections. Analysis of cable tower administered as per standard codes, also comparative study is carried on the idea of various sorts of bracing systems (warren, horizontal, diagonal and diamond) and materials like hot rolled and cold form sections. By designing cable tower with hot rolled sections using STAAD pro, hot rolled sections gives light weight design.
4. (Qianjin Shua et al. 2018) Two 1:2 scaled substructure models for typical 110KV transmission tower were designed and fabricated. The models were tested for movements of the horizontal ground surface under different wind load conditions. The wind load speed is used in the study as 15m/s and 30m/s respectively. The finite element model was developed by using ANSYS and validated by test data. Results of the present study indicated that wind load has a significant unfavorable influence on the resistance of transmission tower subjected to ground motion.

3. Transmission Line Tower Parameters

Table -1: Parameters of Transmission Line Tower

The maximum voltage in the tower	220 KV
Type of transmission tower	Self-supporting, Type 'A'
Deviation Angle of line	0-2^{o}
Terrain type	plain
Return period	150 years
Terrain category	two
Wind zone	II,III,IV
Wind speed	39,44,47 m/s
The geometry of the tower	Square base

Table -2: steel sectional properties

single web diagonal pattern bracing	Leg members	ISA 200×200×16 LD
	Horizontal members	ISA 180×180×20
	Bracings	ISA 150×150×10
single web horizontal bracing	Leg members	ISA 200×200×16 LD
	Horizontal members	ISA 180×180×20
	Bracings	ISA 150×150×10
Warren type bracing	Leg members	ISA 200×200×16 LD
	Horizontal members	ISA 180×180×20
	Bracings	ISA 150×150×10

3.1 Loads on STAAD Pro Models of Transmission Tower

1. Self-Weight of Tower
2. Dead Load on Conductor
3. Dead Load on Ground Wire
4. Wind Load on Ground Wire
5. Broken Wire Condition on Conductor
6. Wind Load as Per IS 875 Part 3
7. Maximum Temperature Effect on Tower

3.2 Geometry of tower

Description	Length
Ground clearance	7.1m
lower conductor wire sag	8.19m
Distance between the two conductors	4.979m
Distance between the top conductor and earth wire	8.339m
The entire height of the tower	33.86m
Square base width	6m
Cross arm from edge of the lower leg	4.29m
Span length between two towers	320m

4. RESULTS AND DISCUSSION

Analysis of tower is carried out by considering all types of loading, different types of bracings systems. All loads are calculated manually as per IS 802 (part 1 and 2): 1995, IS 5613 (part 2): 1985, IS 875- 2015. The tower is analyzed and designed using STAAD Pro.

NO'S	TYPE OF STRUCTURE	FAILED MEMBERS	FEAILD SECTIONS
01)	Single web horizontal bracing	00	-
02)	Single web diagonal pattern bracing	00	-
03)	Warren type bracing	20-leg members 6-bracings	180x180x20 200x200x16 150x150x10

Table-3: For wind speed 39 m/s

NO'S	TYPE OF STRUCTURE	FAILED MEMBERS	FEAILD SECTIONS
01)	Single web horizontal bracing	00	-
02)	Single web diagonal pattern bracing	00	-
03)	Warren type bracing	13-leg members 6-bracings	180x180x20 200x200x16 150x150x10

Table-4: For wind speed 44 m/s

NO'S	TYPE OF STRUCTURE	FAILED MEMBERS	FEAILD SECTIONS
01)	Single web horizontal bracing	00	-
02)	Single web diagonal pattern bracing	01	200x200x16
03)	Warren type bracing	20-leg members 6-bracings	180x180x20 200x200x16 150x150x10

Table-5: For wind speed 47 m/s

5. CONCLUSIONS

In the present study self-supporting transmission line tower is analyzed and designed using hot-rolled steel sections. Tower is designed and compared for weight parameters and absolute displacement variation along with its height.

- Warren type bracings are not structurally stable as compare to two other types of bracings.
- Single web horizontal type bracings are structurally safe as compare to warren type and single web diagonal type bracings
- Single web diagonal type bracing transmission tower is failed at bottom leg for wind speed 47m/s.

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