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Comparative Analysis and Study the Behavior of Transmission Line Tower with using Eccentric and Concentric Bracing System with using STAAD Pro Software

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Abstract: The principle objective of this project is to “Model, Analysis and Study the behavior of transmission line tower with Concentric and Eccentric type of bracing system by using STAAD Pro software”. The Model methods used in STAAD Pro analysis are limit state Design conforming to Indian Standard Code of Practice. STAAD Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities from model generation, analysis and design to visualization and result verification, STAAD Pro is the professional’s choice. Our Final work was the “Comparative Analysis and study the behavior of transmission line tower with Concentric and Eccentric type of bracing system” under various load combinations. Using Indian equal angle section, wind zone II and seismic zone III. And considering the plane terrain.

Key words: transmission line tower, STAAD Pro V8i, Bracing System, load combinations

I. INTRODUCTION

Transmission line is an integral system consisting of conductor subsystem, ground wire subsystem and insulator subsystem. Transmission line tower are modeled using different bracing pattern, axial systems, deflection and weight of towers are used to pass signals wires and electric current from place to place. They are usually made of galvanized steel and run at times for long distances. Transmission line tower are most often used when there is large amount of electric current to be distributed, between 11500 to 76500 volt. Several different Model of transmission line tower are in wide use in the world today. There are generally types in transmission line tower from 11KV to 1200KV. The Model is made using software of structural analysis and Model STAAD Pro. The transmission line tower is subjected to both the vertical and horizontal loading. The vertical load consists of the dead load and live of the tower and horizontal load consist of the wind forces thus the tower is Modeled as per IS-875 and IS 1893. Based on the analysis of the obtained result a comparison between towers with the different type of bracing patterns namely concentric and eccentric such as x- bracing k- bracing etc.

II. LITERATURE REVIEW

Bharath Kumar Reddy et al. [1] author designed the tower for the wind zone V carrying 132 KV DC. Tower is modeled using constant parameters such as height, bracing system, angle sections, base widths, wind zone, common clearances, span, and conductor and ground wire specifications. The loads are calculated using IS: 802(1995). After completing the analysis, the study is done with respect to deflections, stresses, axial forces, slenderness effect, critical sections and weight of tower. Using STAAD PRO v8i analysis and design of tower has been carried out as a three dimensional structure. Then, the tower members are designed.

Anshu Kumar Pal et al. [2] they use 220 KV suspension type, square based self-supporting transmission tower having double circuit is taken for scrutinization. Two bracing systems viz. XX and XBX are being compared in all the six wind zones of India using seven different load conditions as per IS 802 (Part-1 / Sec-I):1995. The structural behavior of tower for both bracing systems are modelled and analyzed in STAAD Pro V8i software. They used following loading conditions: Reliability Consideration Normal Condition, Security Consideration Normal Condition, Safety Consideration Normal Condition, Security Consideration Top Conductor Broken Wire Condition, Safety Consideration Top Conductor Broken Wire Condition, Security Consideration Ground-wire Broken Wire Condition, Safety Consideration Ground-wire Broken Wire Condition. Supriya Khedkar et al. [3] they try to use the cold formed steel section either using hot rolled steel section. Due to lack of availability of hot rolled steel section in thin section they preferred use cold formed steel section. They use the cold formed steel section for 220KV transmission line tower with different types of wind zones. They used mainly four types of the wind zones from II to V. The towers are modelled using constant parameters such as height, bracing system and base width and the loads are calculated from IS: 802 (1995).

Hot rolled sections are design according to IS 800: 2007 using limit state method whereas cold formed sections are design according to IS 801:1975 using working state method.

Rambabu Dadi [4] he try to work on the collapse of the transmission line tower which causes major accidents in real life. An increase in transmission line systems. Progressive collapse is one of the most devastating types of structural failures, most often leading to expensive damages, multiple injuries and possible loss of life. Factors such as unexpected accidental loads, construction errors, miscommunication, poor inspections, or design flaws contribute to these progressive collapses that have led to many changes in building codes throughout the nation. To study the local failure, progressive collapse behaviour of the structure is to be analysed.

P. Markandeya Raju et al. [6] they analysed for 6 different basic wind speeds that are considered according to IS 875: 2015 (PART 3). This project is aimed at comparing a four legged communication towers with different bracing systems for different wind zones in India. Towers are designed as per IS: 800-2007 using STAAD Pro and the wind forces are calculated as per IS: 875 Part-III. From this study, it can be concluded that for a 24m height four legged tele-communication tower, angular cross section with K bracing pattern is found to be most effective and economical among all considered basic wind speeds (33, 39, 44, 47, 50 and 55 m/sec).

III. OBJECTIVE

- A. To model and analysis the steel framed transmission line tower for eccentric and concentric types of bracing system using STAAD pro.
- B. To study the behavior of the transmission line tower for eccentric and concentric types of bracing system.
- C. To differentiate between eccentric and concentric types of bracing system used on transmission tower.
- D. To determine a suitable bracing system for various conditions.

IV. METHODOLOGY

In this work we are taking 220 KV suspension type, square based self-supporting transmission tower is taken for analysis. The overall height of the transmission tower is about to be 36 m as per our data collected. Total two tower models having Concentric K-bracing and Eccentric K-Bracing systems are modelled and analyzed in STAAD Pro.V8i software. All the loads and design calculation were performed accordingly mentioned in IS-802 (Part 1/Sec- 1):1995. Using wind zone II and seismic zone III from IS 875(part 3)-1987 and IS 1893-2002 respectively.

V. TRANSMISSION LINE TOWER PARAMETERS

The following parameters for transmission line and its components are assumed as follows:

Transmission line voltage = 220kv
 Tower type = Suspension tower
 Angle of line deviation = 0° - 2°
 Bracing Pattern = K
 Cross arm = Pointed
 Terrain category = 2

Parameters of Transmission line tower

Max. Temperature = 42°
 Every day temperature = 32°
 Min. Temperature = 0°
 Insulator type = I- string
 Height of tower = 34008 mm
 Base width of tower = 6600 mm

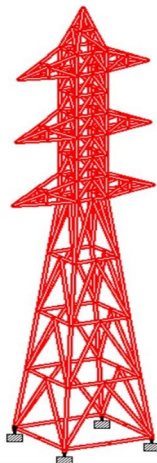


Fig. No. 1 Concentric Bracing K



Fig. No. 2 Eccentric Bracing K

VI. RESULT

In this present work, the nodal displacements due to five different load cases, were computed for two different types of bracing system as said above at specified points: base of leg, first, second & third cross-arm points and topmost point of the transmission tower using the software STAAD Pro. V8i. Since seventeen different load combinations give different nodal displacements. Displacements are calculated at selected specified points. Notations for the specified points are given, base for base, I for first arm cross point, II for second cross arm point, III for third cross arm point and ridge for topmost point of the transmission tower. Maximum values of the displacements are presented with respect to Seismic Zone III, Dead load, live load and wind load II.

Table No. 1 Node Displacement for Seismic Zone III in X Direction

Points	Concentric Bracing K			Eccentric Bracing K		
	X	Y	Z	X	Y	Z
Base Point	0	0	0	0	0	0
I	0.849	0.657	0	2.812	0.148	0
II	1.625	0.738	0	3.175	0.112	0
III	2.494	0.748	0	3.38	0.05	0
Ridge Point	3.368	0	0	3.252	0	0

Table No. 2 Node Displacement for Seismic Zone III in Z Direction

Points	Concentric Bracing K			Eccentric Bracing K		
	X	Y	Z	X	Y	Z
Base Point	0	0	0	0	0	0
I	0	0	0.841	0	0	2.827
II	0	0	1.621	0	0	2.647
III	0	0	2.49	0	0	3.001
Ridge Point	0	0	3.359	0	0	2.857

Table No. 3 Node Displacement for Dead Load

Points	Concentric Bracing K			Eccentric Bracing K		
	X	Y	Z	X	Y	Z
Base Point	0	0	0	0	0	0
I	0.013	1.128	0	0.013	1.186	0
II	0.008	1.23	0	0.009	1.283	0
III	0.008	1.278	0.001	0.008	1.328	0.001
Ridge Point	0	1.233	0	0	1.284	0

Table No. 4 Node Displacement for Live Load

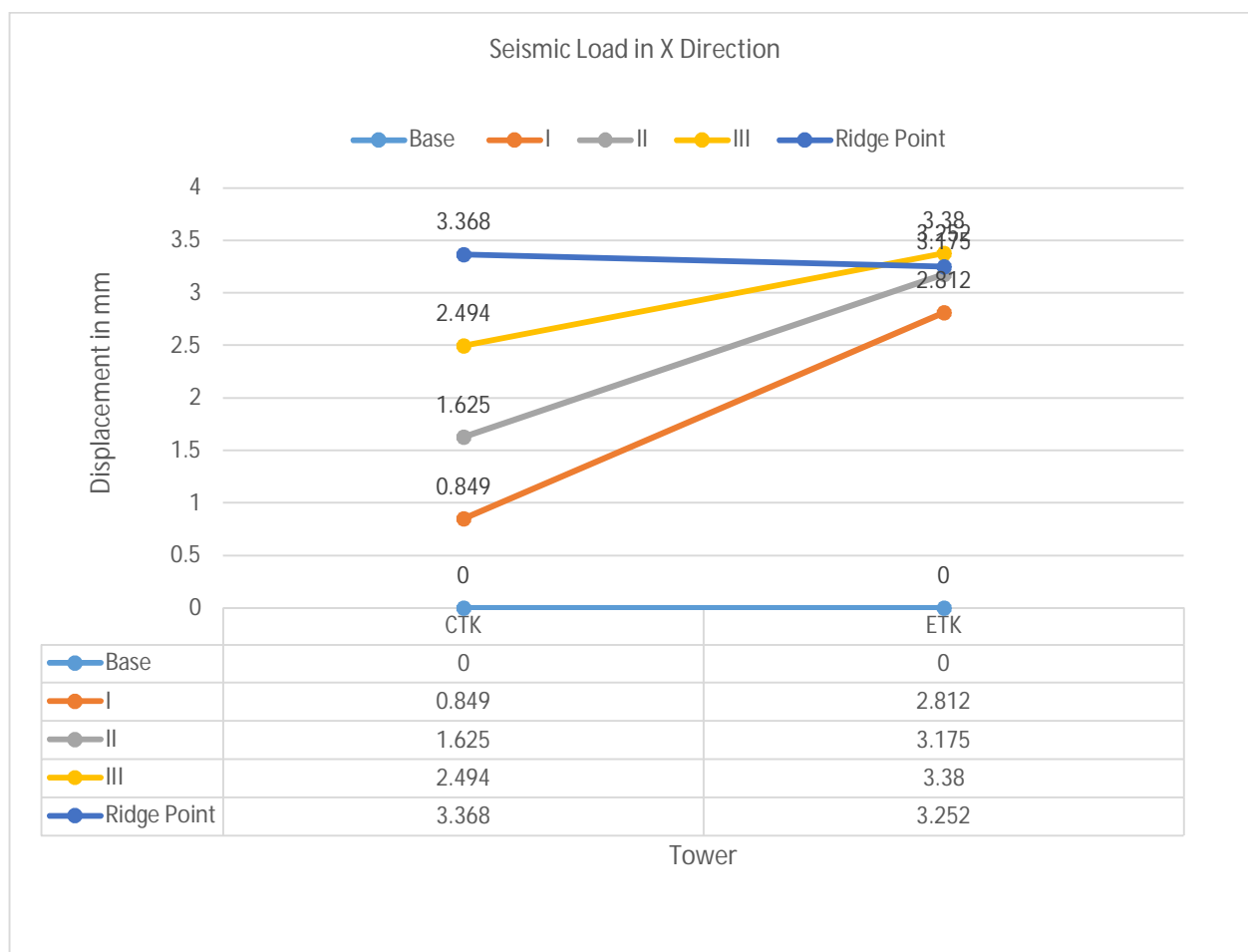
Points	Concentric Bracing K			Eccentric Bracing K		
	X	Y	Z	X	Y	Z
Base Point	0	0	0	0	0	0
I	0.049	0.523	0	0.049	0.516	0
II	0.043	0.529	0	0.043	0.521	0
III	0.042	0.54	0.001	0.042	0.531	0.002
Ridge Point	0	0.352	0	0	0.343	0

Table no. 5 node displacement for wind load in zone II

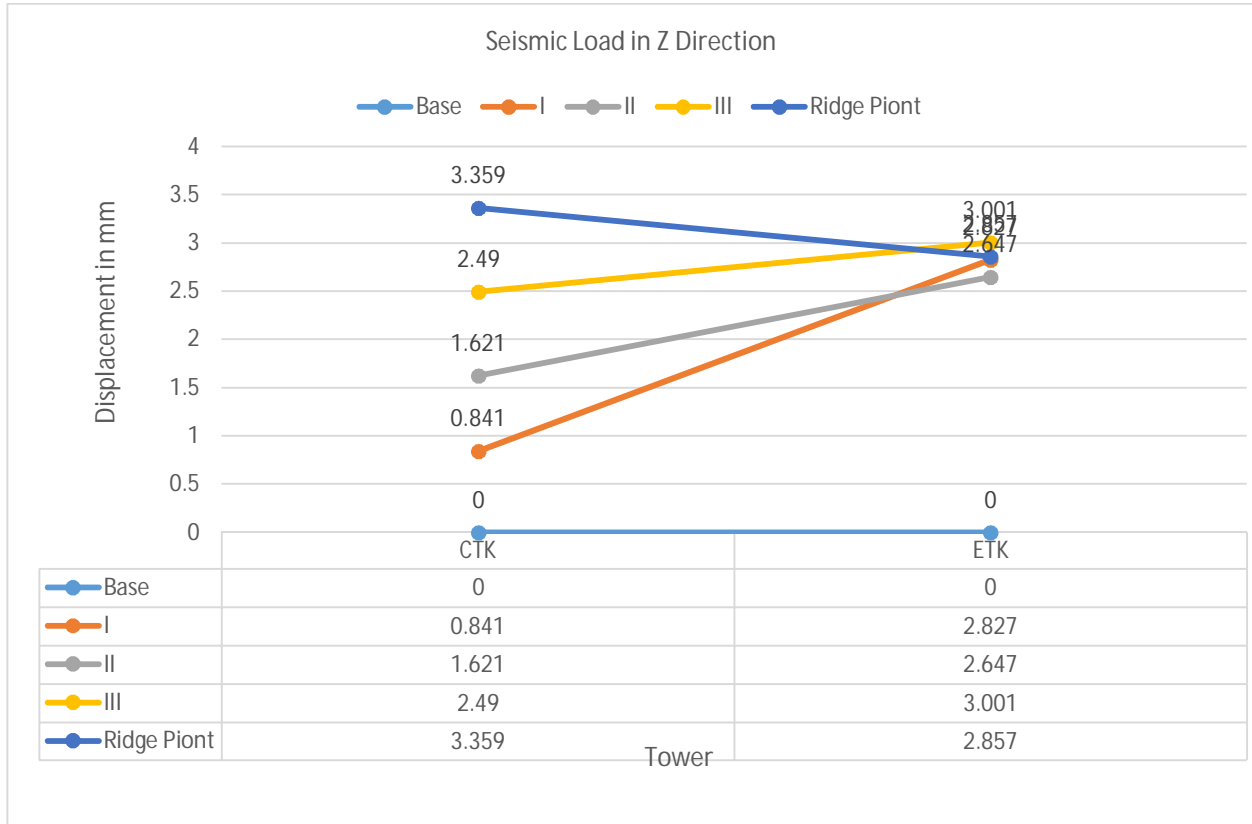
Points	Concentric Bracing K			Eccentric Bracing K		
	X	Y	Z	X	Y	Z
Base Point	0	0	0	0	0	0
I	0	0	0	0	0	0
II	0	0	0	0	0	0
III	0	0	0	0	0	0
Ridge Point	0	0	0	0	0	0

Table No. 6 Weight of the Tower

Steel angle section	Concentric bracing K		Eccentric bracing K	
	Length (m)	Weight (KN)	Length (m)	Weight (KN)
ISA 100x100x10	728.2	106.846	705.38	103.497



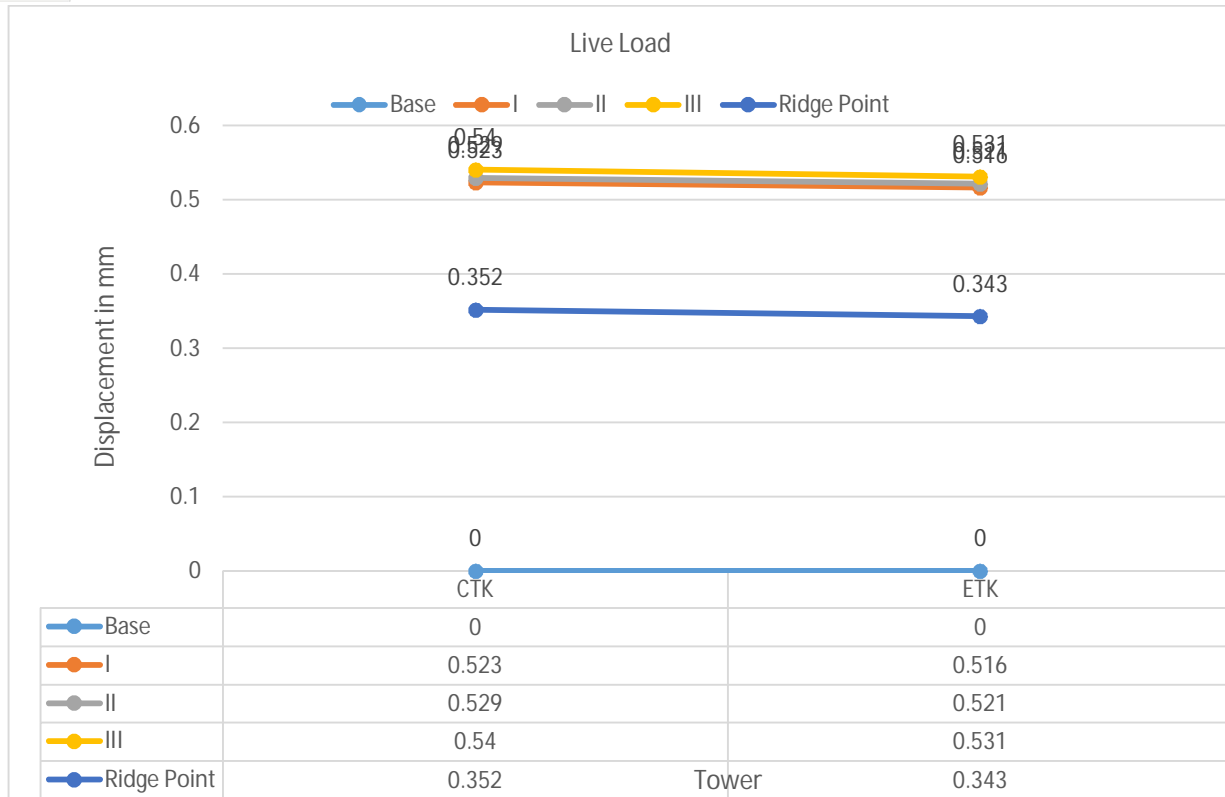
Graph no. 1 displacement in seismic load in X direction



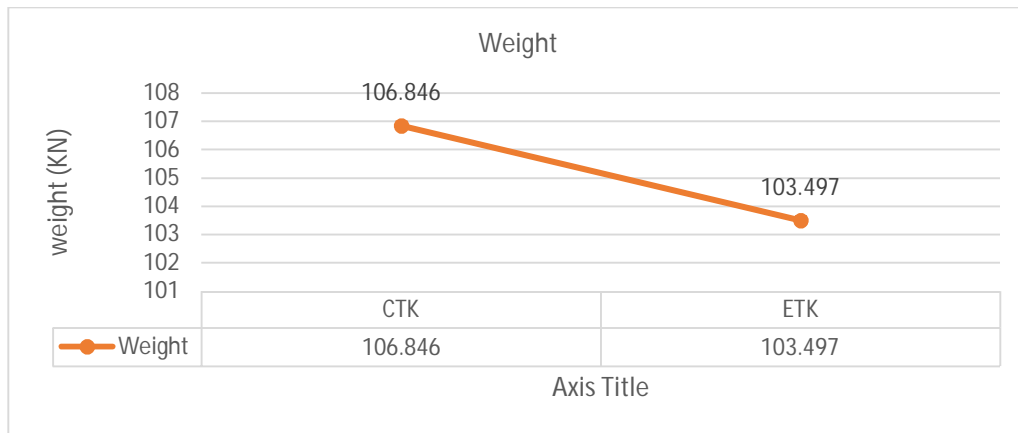
Graph no. 2 displacement in seismic load in Z direction



Graph no. 3 displacement in dead load



Graph no. 4 displacement in live load



Graph no. 5 weight of the tower

VII. CONCLUSION

From the above results we can draw some conclusion as follows

- A. From the above results given by STAAD Pro software, we can clearly see for seismic zone III in X and Z direction, for all bracing there are increasing in displacement as height increases in their respective directions.
- B. For seismic loading eccentric bracing system shows the 150 % more displacement than the concentric bracing system.
- C. For dead loading condition eccentric bracing shows 104 % more displacement than the concentric bracing system.
- D. For live loading condition concentric bracing systems are showing 101 % more displacement as compare to eccentric bracing.
- E. There are no any significant displacement for wind loading for zone II at any point of tower.
- F. As per table no. 6 we can clearly say that concentric bracing are required more steel hence it increases the self-weight of the tower compare to eccentric bracing system.
- G. From the above stated results we can determine that concentric bracing are more suitable bracings for transmission line tower.



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IS Code

- [1] IS 875-1987 Part 1
- [2] IS 875-1987 Part 2
- [3] IS 875-1987 Part 3
- [4] Is 875-1987 Part 5
- [5] IS 800-2007

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