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A Comparative Study of Wind Analysis on 220KV Transmission Line Tower in STAAD-Pro & E-Tabs

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Abstract: ***India has huge population spread all over the country. Electricity is vital for Residential, Commercial and Industrial areas. After power generation, power is transmitted through transmission line towers to distribution systems. Due to increase in power generation, there is an increase in transmission line systems. For the design of transmission line towers in different wind zone factors we have used stad-pro, ETABS. The transmission line towers which resists can be resisted by different wind factors is computed by the stad-pro and ETABS. In this project the comparative studies is carried on the transmission line towers 220KV for different wind zones in the both the software's and also progressive collapse behavior of transmission line tower with different bracing patterns namely K-bracing, X-bracing, (K-X) bracings. All the considered towers are analyzed for gravity and wind loads (IS: 875(Part-III)-2015). The tower is analyzed as space truss for different load combinations as per IS: 875(Part-V) and IS:456-2000. Based on the analysis of obtained results, a comparison between towers with different bracing patterns namely K-bracing, X-bracing, (K-X) bracings with different software.***

Keywords: Transmission line tower, Progressive collapse, Local failure, Bracings, Load combination

1. Introduction

Transmission line is and integral system consisting of Conductor subsystem, Ground wire subsystem and Insulator subsystem. Each tower consists all these systems.

Transmission line towers are modelled using different bracing patterns. Axial forces, deflection and weight of towers vary with bracing pattern. Certain bracing patterns reduce weight of tower.

Power Grid corporations of India has specified some guide0lines for transmission tower. In current study all these parameters are considered for analysis and design. Towers are analysed and designed according to code IS 802(Part-I/sec-I). Tower is designed using angle sections. Permissible stresses in members are confined to IS 802(Part-I/sec-II).

1.1 Factors affecting Transmission Line Tower

Minimum ground clearance: Minimum ground clearance is showed in accordance with all technical requirements and specifications. Normally minimum ground clearance in Electrical power_transmission line varies from country to country depending on the rules and regulations which they Patrice.

Maximum Sag of Conductor: In Maximum sag of conductor depend on several factors of the conductor. Following are the factors which taken in to account while determine maximum sag of conductor in electrical power lines

- The Size of Conductor
- Type of Conductor (ACC, ACSR, AAAC, ACAR)
- Climatic Conditions
- Length of Span

In most cases maximum sag of conductor are occurs rapidly under the maximum temperature of conductor and sill wind condition too.

The maximum sag of electrical power line also consider in the fixing the height of the Transmission line support too. In cold countries the maximum sag can occur at the minimum temperature and ice coated at power conductor.

Length of Suspension Insulators: Length of Suspension Insulators is one of the main factors to determine the height of the transmission line tower.

Following are some of the factors affect on the length of suspension insulators.

Lowest cross arm in case of delta type, vertical type suspension Power transmission tower.

Boom in case of wasp and horizontal type of suspension tower

Vertical space between conductors: Vertical space between power conductor are also play main role in spacing between the cross arms.

Ground Wire Location: Main factors which affect to determine the location of earth wire on transmission tower are the minimum difference in

- Suspension insulator length
- Drop of earth wire to Suspension claps
- Angle of shield.

Angle of Shield: The main function of ground wire of power transmission lines are to provide necessary protection on transmission lines against the direct and indirect lightening stocks.

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Function of ground wire is mainly based on the selection of angle of shields and coordinates of ground wire sages with that conductor.

Location of the ground wire consider the highest of the ground wire peak

Ground wire is also located.

1.2 Scope of the Work

The main objective of this study is to know the behavior of 220kV Double circuit Transmission Tower with X bracing system in different wind speeds.

2. Scope of the Study

1) Study was conducted for X-bracing transmission line tower.
2) Study was conducted for four wind speeds.
3) Study was conducted for Two soft ware's.

Seismic loads are not considered for the study

3. Literature Review

3.1 General

Many studies were made regarding the analysis of a 220KV transmission line tower. Earlier studies were made only for analysis considering only dead load and furthermore comparing the different analysis types and different software's. In this study the main aim is to analyze the transmission line tower in Staad pro and Etabs with dead load and wind load.

Archana Et al [1] (2013) conducted analysis on angular section is more economical and more effective section compared with other sections. The angular sections are found to have lesser amount of axial forces in comparison with the other section of tower. The angular section is found to have the lesser amount of displacement throughout the height of the tower as compared with the other sections. This implies that this section behaves more rigidly than the other section tower.

Nikolay lalkovski (2013) studied pancake type collapse energy absorption mechanisms and their influence on the final outcome. It was demonstrated that the progressive collapse of a building structure impacting the ground or the lower part of the structure after the loss of one story is not inevitable. A simplified model, neglecting secondary effects was described in several consecutive phases in which the column force reduces stepwise, provided the column survives the first most critical phase of motion. Plastic deformations in the columns are distributed along the height of the building instead of allowing them to concentrate in the lower story only.

Preeti Et al [8] (2013) studied Least weight of the tower implies greatest economy in the transmission line cost. Configuration of towers has revealed that all the three towers are having the same height but different base widths. Reliability, security and safety conditions have been kept the same for all the three towers. Wind loading is calculated for each tower.

4. Theory / Methodology

4.1 General

This chapter deals with the model specifications, element loss scenarios, modelling of the cable transmission line tower, non linear static how they were performed.

4.2 Loading Considered for the 220 KV Transmission line tower

Apart from the dead load of the conductors are considered based on IS 802part –I, part-II. Apart from the wind load of the conductors are considered based on IS 875 part-III

4.3 Geometrical Configuration of the Transmission Line Tower

Following are the geometrical parameters of transmission line tower. The 200Kv Transmission line tower geometric details are manually calculated and wind analysis is done in both Stad-Pro & Etabs comparison of defection values by both stad- pro is done

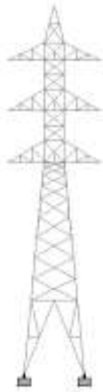

Figure 1: Front view of X-bracing tower

Tower Data Taken

As per the guidelines of Power grid co-corporation of India limited (PGCIL), the following parameters for transmission line and components are assumed from I.S. 802: Part 1: Sec: 1:1995, I.S. 5613: Part 2: Sec: 1:1989 and CBIP Manual No. "268":
1. Transmission Line Voltage: 220 KV (A. / C.)
2. Number of Circuits: Double Circuit.
3. Angle of Line Deviation: 2°
4. Insulator String configuration: Suspension.
5. Length of span considered: 350 m (IS 5613.Part-2.Sec-1-1985, cl 6.4.1).
6. Terrain Type considered: 1 (Exposed open terrain)
7. Return Period: 50years.
8. Wind Zone: III
9. Basic Wind Speed: 44 m/s
10. Basic Wind Pressure: 71.63 kg/ m^2
11. Steel used: Mild steel (IS-2062)

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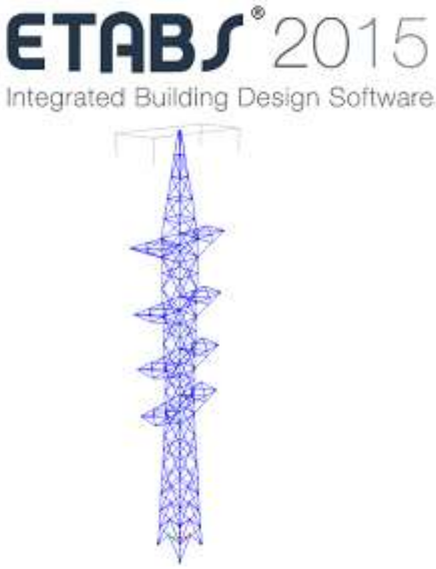
5. Experimental /Results

By the geometrical details of the 220kv transmission line tower, the model created in staadPro. &Etabs wind analysis is Performed for all the zones The transmission tower is of height 46.82m and base width of the tower is 3.882m. The transmission tower was modeled using members

The Etabs model of the 200kv transmission line tower



5.1 Joint reactions

5.1.1 (a) 120kmph in Etabs

Story	Joint Label	Unique Name	Load Case/Combo	FX tonf	FY tonf	FZ tonf	MX tonf-m	MY tonf-m	MZ tonf-m
Base	1	1	Dead	0	0	0	0	0	0
Base	1	1	Live	0	0	0	0	0	0
Base	1	1	1 <SELF$_{WEIGHT}$>	0.191	-0.1897	4.2846	0	0	0
Base	1	1	15 <EW-DEADEND--MAX-V-LOAD>	0.5874	-0.5647	13.628	0	0	0
Base	1	1	16 <EW-DEADEND--MIN-V-LOAD>	0.5874	-0.5647	13.628	0	0	0
Base	1	1	45 <CONDUCTOR-DEADEND--MAX-V-LOAD>	5.7769	-9.404	151.449	0	0	0
Base	1	1	46 <CONDUCTOR-DEADEND-X-WIND-MIN-V-LOAD>	5.7189	-9.3603	150.0932	0	0	0
Base	1	1	71 <WIND ON TOWER-X WIND>	-5.3168	2.4947	-58.17	0	0	0
Base	1	1	72 <WIND ON TOWER-Z WIND>	2.4945	-5.3169	58.1696	0	0	0
Base	1	1	85 <LOAD COMBNATION WO FOS CASE - 5 >	1.2384	-7.6637	111.1915	0	0	0
Base	1	1	86 <LOAD COMBNATION WO FOS CASE - 6 >	8.9917	-15.4316	226.1754	0	0	0
Base	2	2	Dead	0	0	0	0	0	0
Base	2	2	Live	0	0	0	0	0	0
Base	2	2	1 <SELF$_{WEIGHT}$>	0.1912	0.1897	4.2895	0	0	0
Base	2	2	15 <EW-DEADEND--MAX-V-LOAD>	-0.7356	-0.7182	-17.2053	0	0	0
Base	2	2	16 <EW-DEADEND--MIN-V-LOAD>	-0.7356	-0.7182	-17.2053	0	0	0
Base	2	2	45 <CONDUCTOR-DEADEND--MAX-V-LOAD>	-8.1458	-11.07	-190.2949	0	0	0
Base	2	2	46 <CONDUCTOR-DEADEND-X-WIND-MIN-V-LOAD>	-8.1757	-11.1143	-190.9891	0	0	0
Base	2	2	71 <WIND ON TOWER-X WIND>	-5.3168	-2.4947	-58.1702	0	0	0
Base	2	2	72 <WIND ON TOWER-Z WIND>	-2.4945	-5.3169	-58.1696	0	0	0
Base	2	2	85 <LOAD COMBNATION WO FOS CASE - 5 >	-14.0071	-14.0932	-261.3809	0	0	0
Base	4	4	72 <WIND ON TOWER-Z WIND>	-2.4948	-5.3171	58.1706	0	0	0
Base	4	4	85 <LOAD COMBNATION WO FOS CASE - 5 >	-15.5217	-14.1462	279.2744	0	0	0
Base	4	4	86 <LOAD COMBNATION WO FOS CASE - 6 >	-12.6407	-16.9245	277.9121	0	0	0

5.2 As per the analysis done the Etabs the sectional details of each member is given below

Etabs Section Details of 160kmph:

Brace ID	Section	Net Length (ft)	Numbers	Total length (ft)	Total weight (ton)
SBR1	ISA200*200*25	9’10”	31	305’8”	6.86
SBR2	ISA200*200*25	8’7”	7	60’9”	1.35
SBR3	ISA200*200*25	7’6”	7	58’5”	1.18
SBR4	ISA200*200*25	7’2”	7	50’4”	1.13
SBR5	ISA200*200*25	6’3”	743	44’0”	6.99
SBR6	ISA80*80*60	5’2”	15	283’10”	0.36
SBR7	ISA80*80*60	11’9”	15	175’11”	0.39
SBR8	ISA80*80*60	11’6”	15	172’7”	0.36
SBR9	ISA80*80*60	11’4”	15	169’5”	0.38
SBR10	ISA80*80*6	10’0”	15	150’1”	0.39
SBR11	ISA80*80*6	8’8”	15	138’5”	0.29
SBR12	ISA80*80*6	8’5”	15	126’6”	0.28
SBR13	ISA80*80*6	7’4”	15	110’6”	0.25
SBR14	ISA 90*90*8	5’8”	151	861’8”	2.16
SBR15	ISA 90*90*8	5’7”	47	264’2”	0.27
SBR16	ISA80*80*6	12’3”	15	183’7”	0.41
SBR17	ISA80*80*6	8’7”	15	128’2”	0.28
SBR18	ISA65*65*5	8’2”	7	57’4”	0.09
SBR19	ISA65*65*5	7’3”	7	50’8”	0.08
SBR20	ISA80*80*6	64”	7	44’7”	0.10
SBR21	ISA 65*65*8	5’11”	71	417’2”	0.62
SBR22	ISA65*65*8	6’0”	7	42’2”	0.06

In the same manner the 140Kmph and160Kmph is analyzed for the 200KV transmission line tower in both E-Tabs & Stad-Pro the defections are computed

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6. Conclusion

1) The analysis of the transmissions line tower with X bracing for all wind zone as per IS 875- codal provision done
2) For this analysis the major deflection is occurred in 108 member
3) The compression of the E-tabs & Stad-pro the displacement values are quite higher in the satdpro
4) The quantity of the steel is required is higher in the staad result
5) Form the sectional result in the Etabs the transmission line tower with 220kv have the major section member of 200*200*25mm section for the wind zone-III
6) Transmission tower with same bracing can be used at these two different wind zones with same seismic zone by using different steel members at different phases of the transmission tower according the effect of the load on the specific location members.
7) In staadpro self weight of structure is considered as factor 1. Etabs self weight factor is 1.1 that means 10% of self weight consideration is more in Etabs

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