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Analysis of Transmission Line Tower for Different Base Width Using MATLAB

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Abstract:
Transmission tower is used for transmitting electricity from one station to another. Power lines support the conductors and earth wires in order to run the smooth functioning of daily activities The proposed work consists of design and analysis of 132kV capacity single circuit transmission line tower for different base widths that is 5.5m, 6.5m,7.5m and 8.5m.Tower is analyzed for different zones by keeping constant height, lateral forces acting on each panel joints, self-weight and maximum bending moments by considering three conditions, first is normal operating condition, second is top most conductor broken, lastly broken earth wire. The loads on the tower are calculated by IS 802-1995 part1.MATLAB software is used for the analysis of 132kV capacity transmission tower.

Keywords: Lateral loads MATLAB analysis, Panel joints, Self-weight and Transmission tower.

1. INTRODUCTION

In each country power is needed immensely, and the consumption of electricity is increasing day by day. Power towers are the structures which helps in providing power to various locations of the nation. Electricity is delivered to different parts of the country by integrated system which consists of heavy cables strung between tall towers. They allow power transmission over long distances. Towers are self-supporting and they resist all the forces, loads due to conductors, wind and ice in any direction. Towers are constructed by four legs which is spaced suitably. They are also called as electric pylons usually built to carry one or two circuits, some of the towers may carry three or four circuits. The main purpose of the tower is to support the conductors which carry the electric current to suitable distance. Hence an overhead transmission line does efficient, economical and dependable transfer of electric power and conveyance of electrical energy with the continuous increase in population and demand of energy. Tower configuration is determined by three factors

- Tower height
- Base width
- Top hamper width
- Min permissible ground clearance(H1)
- Max sagging(H2)
- Vertical spacing between the conductors(H3)
- Distance between ground wire and top conductor(H4)

2 METHODOLOGY

Design of the tower is done for different base widths and different zones. Analysis is done by using MATLAB

The main features of project are as follows.

1.Analysis of transmission line tower for 132kV by using MATLAB.

2.Analysis of power lines are done for different base widths such as

- 5.5m
- 6.5m
- 7.5m
- 8.5m

3. Different wind zones are considered

- Zone 4
- Zone 5
- Zone 6

4. Lateral loads are considered by following three conditions

- Normal operating condition
- Top most conductor broken
- Earth wire broken

2.1 Parametric details

Various parameters used are shown in table below

Table 1: Parameters for Tower

Tower voltage	132kV
tower type	Tangent type
No of circuits	Single circuit
Angle of deviation	0^0-2^0
Terrain category	1

Table 2: Wind Zones with Respect to Wind Speed

WIND ZONE	WIND SPEED
I	33
II	39
III	44
IV	47
V	55

2.2 Wind speed (V_R)

From code book IS802-1995 we will get the value of V_R for an averaging speed of 10 minutes and then calculated with the basic wind speed Vb.

$V_R=V_b/K_0$

2.3 Design wind speed (V_b)

$Vd=V_R\times K_1\times K_2$

K_1= Risk coefficient

K_2=Terrain toughness coefficient

2.4 Design wind pressure (P_d)

Design wind pressure is calculated by following relation

$P_d = 0.6 \times V_d$

P_d = design wind pressure

V_d = design wind speed

2.5 Temperature.

Usually everyday temperature is taken as 32^0C.exept some places where temperature is too low. The maximum minimum and everyday temperature ca be obtained from fig 3 ad 4 IS802.1995 part 1.

2.6 Earth wire

In this project earth wire used is of 10 mm dia galvanized steel with permissible axial tension of 25.40 kN. They provide protection against lightening

2.7 Conductors

The conductor used for this project is ACSR (Aluminum Conductor Steel Reinforced) which has a weight of 16.76 N/m and permissible axial tension of 36.50 kN. Youngs modulus of 0.842×10^5 N/mm^2.Shape factor of 0.67and coefficient of expansion(α) 0.00001992/C.

3 DESIGN DATA

- Ground clearance=6.7 m
- Vertical spacing of conductor=4m
- Height of ground wire=3.125
- Total required clearance=13.82m
- Base width= (1/4) ×Height
- Hamper width= (1/3) × Base width
- Column size: ISA130mmx130mmx10mm
- Horizontals for bottom panel: ISA 80mmx80mmx6mm
- Other members: ISA 65mmx65mmx6mm

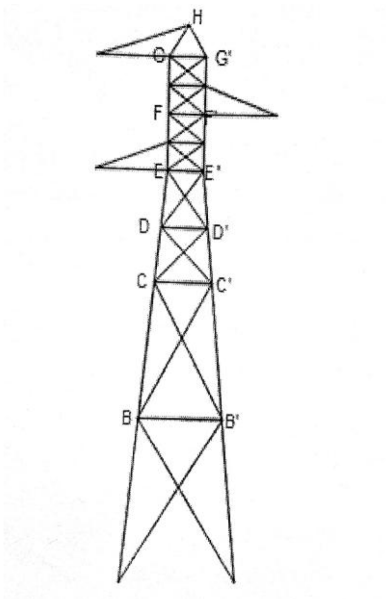

Fig.1: Tower Model

4 RESULT AND DISCUSSION

Case 1: Normal operating condition

The following table 5 shows the results obtained from MATLAB for lateral load at base width 5.5m for case 1.

Table 3: (Lateral Load at Base Width 5.5 m)

PANEL JOINT	ZONE 4	ZONE 5	ZONE 6
B	1759.2	1991.0	2409.1
C	1194.3	1351.6	1635.5
D	651.7	737.6	892.5
E	3401.9	3727.3	4314.3
F	3508.5	3847.9	4460.2
G	3508.5	3847.9	4460.2
H	1708.0	1845.4	2093.3

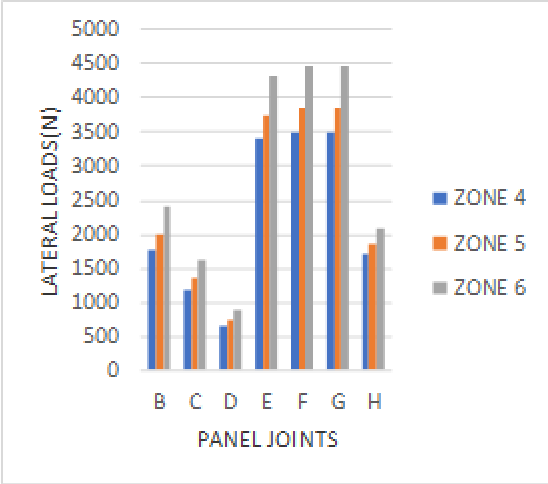

Fig.2: Lateral Loads at 5.5 m Base Width

Case 2: Top most conductors in broken condition.

The below mentioned tables gives the results obtained through MATLAB software. And graphs are plotted for the same values

Table 4: (Lateral Load at Base width 5.5 m)

PANEL JOINT	ZONE 4	ZONE 5	ZONE 6
B	1759.2	1991.0	2409.1
C	1194.3	1351.6	1635.5
D	651.7	737.6	892.5
E	3401.9	3727.3	4314.3
F	3508.5	3847.9	4460.2
G	2916.8	3178.3	3560.0
H	1708.0	1845.4	2093.3

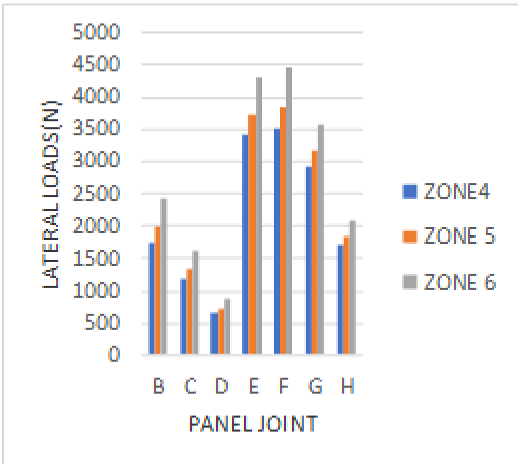

Fig.3: Lateral Loads at 5.5 m Base Width

Case 3: Ground wire broken condition
Tables shown below gives the results from MATLAB and corresponding graphs for base width.

Table 5: (Lateral Load at Base Width 5.5 m)

PANEL JOINT	ZONE 4	ZONE 5	ZONE 6
B	1759.2	1991.0	2409.1
C	1194.3	1351.6	1635.5
D	651.7	737.6	892.5
E	3401.9	3727.3	4314.3
F	3508.5	3847.9	4460.2
G	3508.5	3847.9	4460.2
H	1510.8	1622.2	1823.2

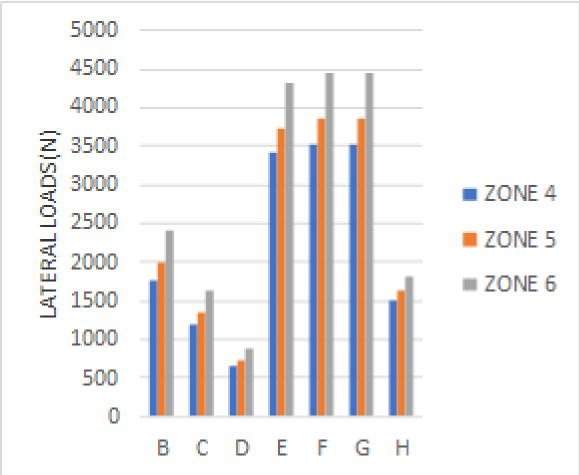

Fig.4: Lateral Loads at 5.5 m Base Width

Self-weight of the tower
By considering the following three conditions, weight of the tower is calculated
1. Normal operating condition
2. Top conductor failure
3. Ground wire failure

Table 6: Self-weight of tower

BASE WIDTH	CASE 1(kN)	CASE 2(kN)	CASE 3(kN)
5.5	56.187	54.578	55.611
6.5	58.187	56.578	57.611
7.5	60.263	58.654	59.680
8.5	62.393	60.789	61.822

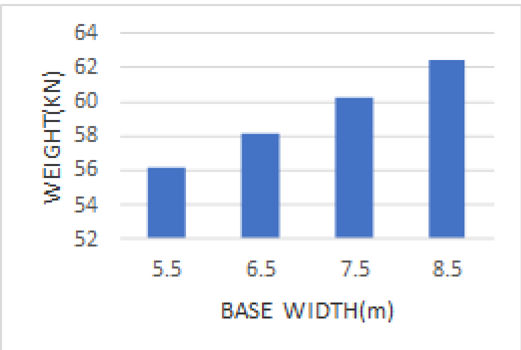

Fig.5: Self-Weight of Tower (Case 1)

Maximum bending moment
Results obtained from MATLAB for maximum bending moment are shown in table below, the graphs are plotted for the same values.

Table 7: Max BM (Case 1)

BASE WIDTH	ZONE 4	ZONE 5	ZONE 6
5.5	257.631	283.102	329.053
6.5	263.065	289.251	336.493
7.5	268.696	295.623	344.205
8.5	274.482	302.172	352.129

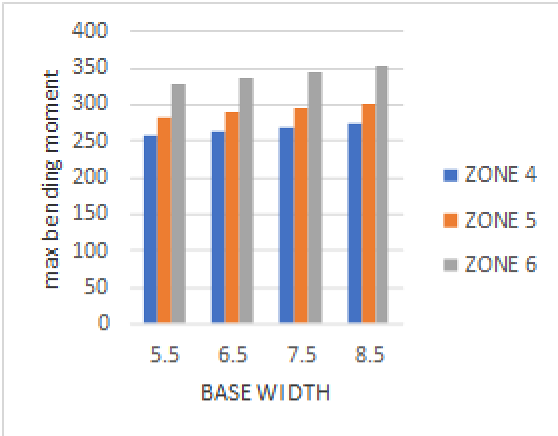

Fig. 6: Max Bending Moment (Case 1)

5. CONCLUSION

The main purpose of the work is to study transmission tower for different base widths such as 5.5, 6.5, 7.5, 8.5. By considering three wind zones i.e., zone 4, zone 5, zone 6 for three different conditions. After the analysis lateral loads self-weight and max bending moments were obtained.
Lateral forces will increase with the increase in base width, maximum lateral force was found at 8.5 m base width i.e., 3711.0 N in zone 4, 4077.1 N in zone 5 and 4737.6N in zone 6.
Maximum lateral force acts at panel joint F and G at normal operating condition.
Maximum lateral force acts at panel joint F at top most conductor broken wire condition.
Maximum lateral force acts at panel joint F and G broken wire condition.
Weight of the tower is maximum 8 .5 m base width i.e., 62.398 and minimum at 5.5 m base width. i e, 56.187.
Compared to 8.5 m base width self-weight and lateral forces are minimum at 5.5m, 6.5m, and 7.5 m base widths.
When compared with wind zones bending moment is maximum at zone 6 for 8.5 m base width for ground wire broken condition. Minimum at zone 4 for 5.5 m base width at normal operating condition. Bending moment goes on increasing with the increase in base width.

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