*Impact Factor (SJIF): 5.301*

**International Journal of Advance Research in Engineering, Science & Technology**

*e-ISSN: 2393-9877, p-ISSN: 2394-2444*

***Volume 5, Issue 7, July-2018***

# Analysis of 132 KV Transmission Line Suspension Tower

Naineshkumar Modi
Applied Mechanics Department
Faculty of Technology & Engineering. M. S. University,
Vadodara, India
naineshmodi99@gmail.com

Dr. M. K. Maroliya
(Associate Professor) Applied Mechanics Department
Faculty of Technology & Engineering. M. S. University,
Vadodara, India
mkmmsu@gmail.com

Ms. Krishna Nair
(Assistant Professor) Applied Mechanics Department
Faculty of Technology & Engineering. M. S. University,
Vadodara, India
krshnnair16@gmail.com

Chaitanya Joshi
Jr. Structural Engineer
Takalkar Power Engineers & Consultant PVT. LTD,
Vadodara, India
Chaitanyajoshi.civil@gmail.com

*Abstract*— **In this paper Analysis of square based 132 KV Transmission Tower is carried out keeping in view to supply optimum utilization of electric supply and increasing population in the locality, in India. Transmission line tower has a less than 50% total cost. The increasing demand for electrical energy can be met more economical by developing different light weight configurations of transmission line towers.**

**In this project, an attempt has been made to make the transmission line more cost effective keeping in view to provide optimum electric supply for the required area by considering unique transmission line tower structure. The tower is designed for wind zone IV. The objective of this research is met by choosing a 132 KV tower with square based Self Supporting Lattice Towers with a view to optimize the existing geometry. Using STAAD PRO v8i analysis has been carried out.**

**Keywords— Configuration of Tower, Design, Geometry of Tower, Transmission Tower, Self-Supporting Tower**

## I. INTRODUCTION

Transmission line is an integrated system consisting of conductor subsystem, ground wire subsystem and one subsystem for each category of support structure. Mechanical supports of transmission line represent a significant portion of the cost of the line and they play an important role in the reliable power transmission.

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 height of tower is fixed by the user and the structural designer has the task of designing the general configuration and member and joint details.

India has a large population residing all over the country and the electricity supply need of this population creates requirement of large transmission and distribution system. Transmission line is an integrated system consisting of conductor subsystem, ground wire subsystem and one subsystem for each category of support structure. They are designed and constructed in wide variety of shapes, types, sizes, configuration and materials.

The goal of every designer is to design the best (optimum) systems. But, because of the practical restrictions this has been achieved through intuition, experience and repeated trials, a process that has worked well. Power Grid Corporations of India

## II. TRANSMISSION LINE COMPONENTS

TABLE 1. TRANSMISSION LINE TOWER:

| | |
|---|---|
| Transmission Line Voltage | 132 KV |
| No. of Circuits | 2 |
| Tower Configuration | Suspension Tower |
| Angle of Line Deviation | 0 – 2 Degrees |
| Bracing Pattern | Cross Pattern System |
| Tower Type | Type " A " |
| Length of Insulator String | 2.200 mm |
| Tower Geometry | Square Base Tower |



All Rights Reserved, @IJAREST-2018

TABLE 2. CONDUCTOR

| | |
|---|---|
| Conductor material | ACSR |
| Code name | CARDINAL |
| Conductor size | 54/7/3.38 mm |
| Area of the conductor (for all strands), A | 5.4730 cm2 |
| Overall diameter of the conductor (d) | 3.042 cm |
| Weight of the conductor (w) | 1.833 kg/m |
| Bearing strength of the conductor (UTS) | 15381 kg |
| Coefficient of linear expansion (α) | 0.0000193/°C |
| Modulus of elasticity (E) | 7.04E+09 kg/m2 |

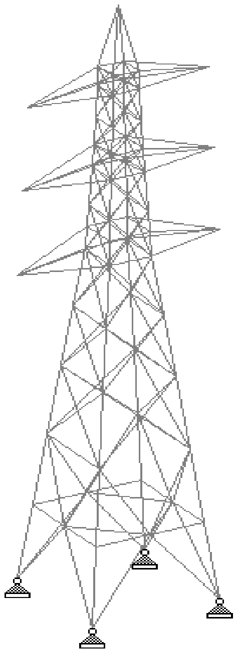

Fig. 1. Transmission Tower

TABLE 3. INSULATOR

| | |
|---|---|
| Length of Insulator String | 2.186 m |
| Minimum Ground Clearance | 6.100 m |
| Mid Span Clearance | 6.100 m |
| Electrical Clearance: Swing Angle: | |
| 15° | 1.530 m |
| 30° - | 1.370 m |
| 45° | 1.220 m |
| 60 | 1.70 |



All Rights Reserved, @IJAREST-2018

## III. SAG TENSION CALCULATION FOR CONDUCTOR AND GROUND WIRE

Indian standard codes of practice for use of structural steel in over-head transmission line towers have prescribed following Conditions for the sag tension calculations for the conductor and the ground wire:

- Maximum temperature (75°C for ASCR and 53°C for ground wire) with design wind pressure (0% and 36%).
- Every day temperature (32°C) and design wind pressure (100%, 75% and 0%).
- Minimum temperature (5°C) with design wind pressure (0% and 36%).

IS 802: part 1: sec 1: 1995 states that conductor/ ground wire tension at every day temperature and without external load should not exceed 25 % (up to 220 kV) for conductors and 20% for ground wires of their ultimate tensile strength.
Sag tensions are calculated by using the parabolic equations as discussed in the I.S. 5613: Part 2: Sec: 1: 1989 for both the conductor and ground wire. In this paper, the consideration of the sag of ground wire as 90% the sag of the conductor at 5°C and 100% wind condition. The sag tension values are mentioned in the Table given below.

From Parabolic Equation

$$F^2 (F - (K - \alpha * t * E)) = \frac{L^2 \delta^2 q^2 E}{24 F^2} \quad \ldots\ldots\ldots\ldots(1)$$

$$\text{Take, } K = f - \frac{L^2 \delta^2 q^2 E}{24 F^2} + \alpha * t * E \quad \ldots\ldots\ldots\ldots (2)$$

Tension T = UTS/FOS
Stress, f = T/A
Sag = $W*L^2/8$

TABLE 4. SAG TENSION CALCULATION

| ASCR Cardinal Conductor | | | |
|---|---|---|---|
| Temperature (°C) | Wind Factor (%) | Tension (Kg) | Sag (m) |
| 5 | 0 | 3673.43 | **7.64** |
| 32 | 75 | **6370.52** | 4.41 |
| 32 | 100 | **7670.13** | 3.66 |
| 85` | 0 | 2600.35 | **10.79** |
| **OPGW Ground Wire** | | | |
| 5 | 0 | 1140.29 | **6.11** |
| 32 | 75 | **2586.03** | 2.69 |
| 32 | 100 | **3097.31** | 2.25 |
| 53 | 0 | 929.60 | **7.49** |

## IV. Wind Loads On Tower

Wind loads on all the towers are calculated separately by developing excel programs by following Indian Standards. For finding the drag coefficients for the members of triangular tower, the solidity ratio is derived from Table 30 –IS-875 (part 3)-1987 in the similar fashion as prescribed in the IS- 826 (part 1/sec1) - 1995.

### *A. Design Wind Pressure*

To calculate design wind pressure on conductor, ground wire, insulator and panels:
$\mathbf{P_d = 0.6 \times V_d}$
$\mathbf{V_d = V_R \times K_1 \times K_2}$
Where, $P_d$ = design wind pressure in N/m2



All Rights Reserved, @IJAREST-2018

$V_d$ = design wind speed in m/s
$V_R$ = 10min wind speed (or) reduced wind speed
$V_R = V_b/k_0$
$V_b$ = basic wind speed
$K_0$ =1.375 [conversion factor]
$K_1$ = risk coefficient
$K_2$ = terrain roughness coefficient.

*B. Wind Loads on Conductor/Ground Wire*

To calculate wind loads on conductor and ground wire,
Where, $F_{wc}= P_d \times C_{dc} \times L \times D \times G_C$
Fwc = wind load on conductor
Pd = design wind pressure
Cdc = drag coefficient for ground wire=1.2 drag coefficient for conductor = 1.0
L = wind span
d = diameter of conductor/ground wire
Gc = gust response Factor

*C. Wind Load on Insulator*

To calculate wind load on insulator,
$\mathbf{Fw=Pd \times Cdi \times AI \times G_t}$
Where, $A_I$ = 50% area of insulator projected parallel to the longitudinal axis of string
$G_I$ = gust response factor for insulator
$C_{di}$ = drag coefficient, to be taken as 1.2150 mm

*D. Wind Load on Panels*

The lateral force due to wind acting at every panel joint is found as a product of intensity of wind and the exposed area of members of the tower consist of the projected area of the windward force plus fifty percent of plant of the leeward force. The sizes of the members taken are as

- *Assuming-*
-

For whole tower ISA 130x130x8 single angle back to back section.

To calculate wind load on panels, $\mathbf{F_w=P_d \times C_{dt} \times A_e \times G_T}$

$C_{dt}$ = drag coefficient for panel considered against which the wind is blowing
$A_e$ = effective area of the panel
$G_T$ = gust response factor for towers

The wind load on panels for various conditions:

*1. Normal operating conditions.*
*2. Top most power conductor in broken wire condition.*
*3. Ground wire in broken condition*.



All Rights Reserved, @IJAREST-2018

There are total 12 panels in this tower i.e. P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12

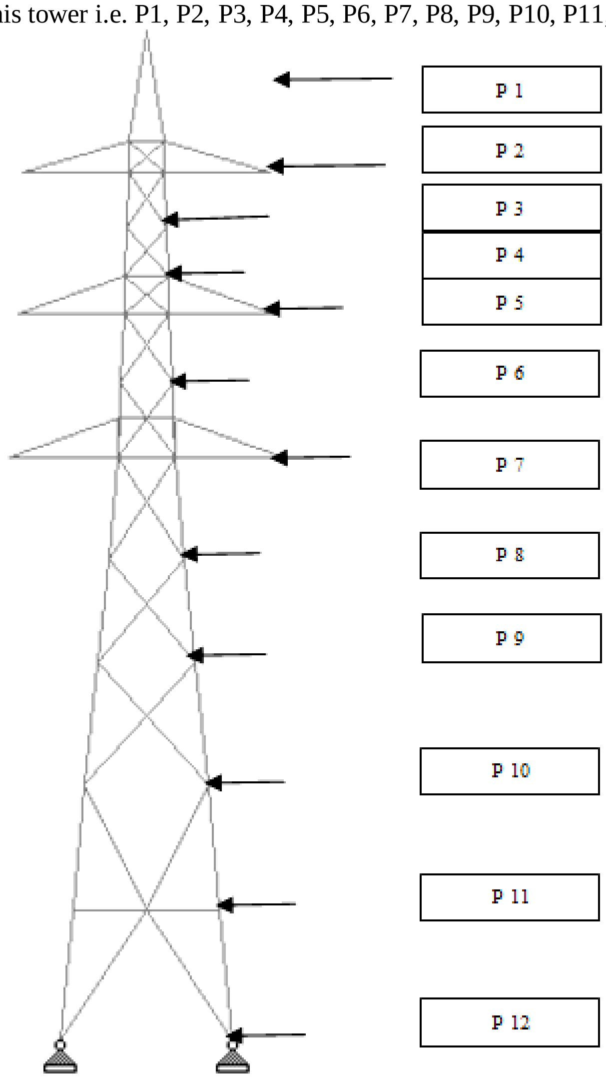


Fig. 2. wind load on Panels

## V. Stresses In The Members Of The Tower Under Various Conditions

The stresses in the various members may be found by approximate method. The tower is reduced to a determinate plane frame by neglecting the horizontal and secondary members. The stresses are determined for the following conditions:

1. Normal operation conditions.
2. Due to lateral forces under the topmost power conductor broken condition.
3. Due to longitudinal forces under the topmost power conductor broken condition.
4. Due to lateral forces under the ground wire in broken condition.
5. Due to longitudinal forces under the ground wire in broken condition.

The axial forces in column and diagonal members are determined by the method of joints and by horizontal equilibrium.

## VI. Conclusion

The transmission line tower is a statically indeterminate structure and the manual analysis of such a structure is very complex. A rigorous analysis considering three dimensional space actions is quite difficult. The vertical members are more prominent in taking the loads of the tower than the horizontal and diagonal members,

However the adopted method of analysis presented in this paper considering linear behavior with two dimensional approaches gives satisfactory results which should be further verified with advanced software like STAAD Pro, ANSYS etc.



All Rights Reserved, @IJAREST-2018

In summary, the study presented here would certainly useful for Design Engineers basically for the new learners for better understanding the behaviors and the method of analysis of the transmission tower as per Indian Standard Codes of practice.

## VII. References

1. C. Preeti; K. Jagan Mohan, (2013) Analysis of Transmission Towers with Different Configurations, Jordan Journal of Civil Engineering, Volume 7, No. 4
2. Gopi Sudam Punse, (2014) Analysis and Design of Transmission Tower, International Journal of Modern Engineering Research, ISSN: 2249-6645..
3. Y. M. Ghugal, U. S. Salunkhe "Analysis and Design of Three and Four Legged 400KV Steel Transmission Line Towers: Comparative Study " International Journal of Earth Sciences and Engineering 691 ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp 691-694
4. IS 802 (Part1/ Sec1): 1995 Use Of Structural Steel in Overhead Transmission Line Towers - Code of Practice (Part 1 Materials, Loads and Permissible Stresses Sec 1 Materials and Loads).
5. IS 5613 (Part2/ Sec1): 1985 Code of Practice for Design, Installation and Maintenance of Overhead Power Lines (Part 2 Lines above 11kv and up to and including 220kv Sec 1 Design).
6. IS 5613 (Part1/ Sec1): 1985 Code of Practice for Design, Installation and Maintenance of Overhead Power Lines (Part 1 Lines up to and including 11kv Sec 1 Design).
7. I.S 800: 2007 General Constructions in Steel - Code of Practice



All Rights Reserved, @IJAREST-2018