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Analysis of Transmission Tower with Various Bracing using Ansys

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ABSTRACT

A transmission tower supports an overhead power line. The other names of transmission towers are power transmission towers, power towers, and electricity pylons. The transmission towers carry high-voltage transmission line to transport power from the generating station to electrical substations. The electrical substations transport power to the end users through distribution lines. The distribution line uses utility poles to carry the low-voltage conductor. Transmission towers have to carry the heavy transmission conductors at a sufficient safe height from the ground. In addition to that, all towers have to sustain all kinds of natural calamities. Therefore, the transmission tower design is an important engineering job where civil, mechanical, and electrical engineering concepts are equally applicable.

A transmission tower (usually a steel lattice tower) supports the overhead power line. Transmission towers have to carry the heavy transmission conductors at a sufficient safe height from the ground depending on the voltage (132kV/220kv/400kv/765kv). Thus, the transmission towers maintain the minimum ground clearance according to the system voltage.

Keywords: Transmission Tower, Bracing, Ansys.

1. INTRODUCTION

A transmission tower supports an overhead power line. The other names of transmission towers are power transmission towers, power towers, and electricity pylons. The transmission towers carry high-voltage transmission line to transport power from the generating station to electrical substations. The electrical substations transport power to the end users through distribution lines. The distribution line uses utility poles to carry the low-voltage conductor.

Transmission towers have to carry the heavy transmission conductors at a sufficient safe height from the ground. In addition to that, all towers have to sustain all kinds of natural calamities. Therefore, the transmission tower design is an important engineering job where civil, mechanical, and electrical engineering concepts are equally applicable.

In order to decrease the transmission losses, after the generation of power, we step-up the voltage in order to transmit it over a long distance. At receiving end, we again step down the voltage value and use it for electrical loads. There are various transmission lines at various voltage levels throughout the power system network in order to transmit the bulk power.

A transmission tower (usually a steel lattice tower) supports the overhead power line. Transmission towers have to carry the heavy transmission conductors at a sufficient safe height from the ground depending on the voltage (132kV/220kv/400kv/765kv). Thus, the transmission towers maintain the minimum ground clearance according to the system voltage.

1.1 Problem Statement

A 220 kV single circuit transmission line with which is selected for the study. Modelling, design and analysis is carried out on Ansys Software.

1.1. Objective

- To analyse a structural stability of transmission tower.
- To study the different bracings of transmission tower of capacity 220kV.
- To compare the transmission towers in different bracings.

2. LITERATURE REVIEW

Literature review was conducted to investigate recent researches and current state of practice related to performance of transmission tower, its risk management and advanced alternatives. This appendix summarizes the review organized by risk management, asset data, and analytical tools and for Commerce management. Scenes industrialization and atomization has become most versatile sector in today’s modern production area, Ansys is one of the most crucial and necessary part process of it. Many research persons have dedicated their research for the betterment of this design sector.This chapter concentrates on major breakthrough topics that have created the modern image of transmission tower as a most reliable technique up until todays date.

Archana R,Aswathy S Kumar(2016) she suggested that the angular section is more economical than the other section.The angular section is found to have the lesser amount of displacement throughout the height of the tower as compared with the other sections. Tanvi G. Londhe, Prof. M.S.Kakamare(2018) implies that single web diagonal type tower behaves more rigidly than other types of tower.The weight of the diamond bracing tower is less as compared to other three type of bracing tower.

Shubham Kashyap, Prof. Sumit Pahwa(2018) On comparing all the analysis i.e. Static, Modal, Response spectrum, wind. The deformation value is maximum in case of wind analysis. Thus wind loadprove to be dominant among all loads for present existing tower.The analysis carried out using finite element analysis (ANSYS software) gives appropriate solutions including nodal, element, and member solutions

CH. Prasad Babu, N. Vikram(2017) given information about Design of transmission tower and its foundation.This work attempts to optimize the transmission line tower structure for a 132KV double circuit with respect to configuration and different materials as variable parameters. CH. Harshini, K. Sindhu Rani(2018) given information aboutA Comparative Study of Wind Analysis on 220KV Transmission Line Tower in STAAD-Pro & E-Tabs.The analysis of the transmissions line tower with X bracing for all wind zone as per IS 875- codal provision Done. BALAJI PATIL, K.S.UPASE, Prof. Hamne A. A.(2020) given information aboutDesign and analysis of transmission line tower using Staad-pro.

3. MATERIAL STUDY AND METHODOLOGY

An electrical tower is a reticular structure made of steel that functions as an aerial support for transmission lines for electrical power distribution, whether high or low voltage. Depending on its use or the voltage of the distributed energy, it can vary in shape and size. The height of an electrical tower can range from 15 meters to 55 meters, though there are some types, usually for distributing high voltage currents, that can reach 300 meters. Its height and robustness are to cope with the environmental adversities to which it is subjected without the power lines being affected, nor the safety of the people, animals, or objects around it.

It is part of an electrical grid system and is used for power distribution via transmission lines from the power stations to substations.

3.1 Material

Tubular steel: Poles made of tubular steel generally are assembled at the factory and placed on the right-of-way afterward. Because of its durability and ease of manufacturing and installation, many utilities in recent years prefer the use of monopolar steel or concrete towers over lattice steel for new power lines and tower replacements. In Germany steel tube pylons are also established predominantly for medium voltage lines, in addition, for high voltage transmission lines or two electric circuits for operating voltages by up to 110 kV. Steel tube pylons are also frequently used for 380 kV lines in France, and for 500 kV lines in the United States.In 2021 the first T-pylon, a new tubular T-shaped design, was installed in United Kingdom for a new power line to Hinkley Point C nuclear power station, carrying two high voltage 400 kV power lines. The design features electricity cables strung below a cross-arm atop a single pole which reduces the visual impact on the environment compared to lattice pylons. These 36 T-pylons were the first major UK redesign since 1927, designed by Danish company Bystrup, winner of a 2011 competition from more than 250 entries held by the Royal Institute of British Architects and Her Majesty's Government.

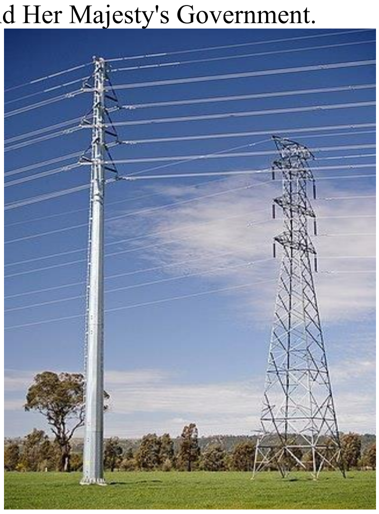


Fig.1 Tubular steel

3.2 Lattice

A lattice tower is a framework construction made of steel or aluminium sections. Lattice towers are used for power lines of all voltages, and are the most common type for high-voltage transmission lines. Lattice towers are usually made of galvanized steel. Aluminium is used for reduced weight, such as in mountainous areas where structures are placed by helicopter. Aluminium is also used in environments that would be corrosive to steel. The extra material cost of aluminium towers will be offset by lower installation cost. Design of aluminium lattice towers is similar to that for steel, but must take into account aluminium's lower Young's modulus.

A lattice tower is usually assembled at the location where it is to be erected. This makes very tall towers possible, up to 100 m (328 ft) (and in special cases even higher, as in the Elbe crossing 1 and Elbe crossing 2). Assembly of lattice steel towers can be done using a crane. Lattice steel towers are generally made of angle-profiled steel beams (L-beam or T-beams). For very tall towers, trusses are often used.

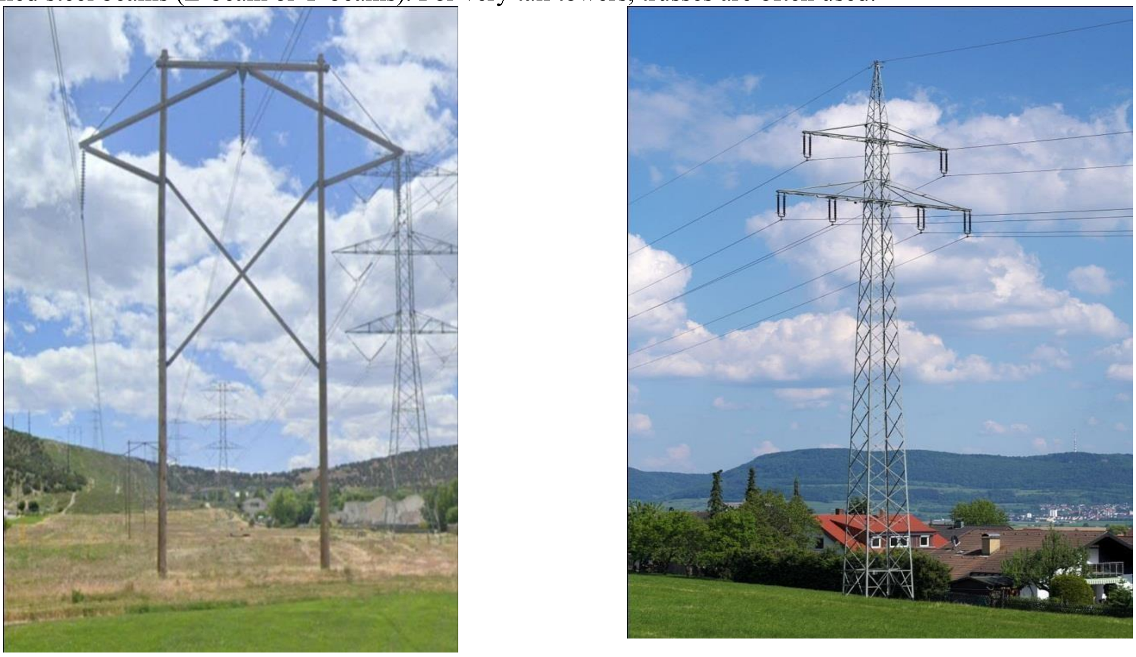
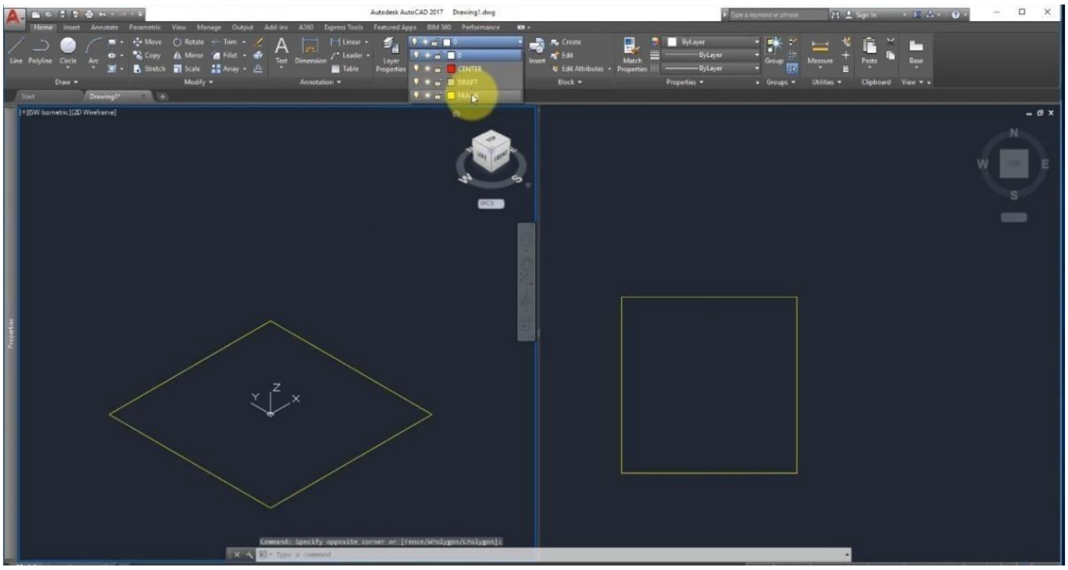


Fig 2: Lattice

4. DESIGN AND MODELING



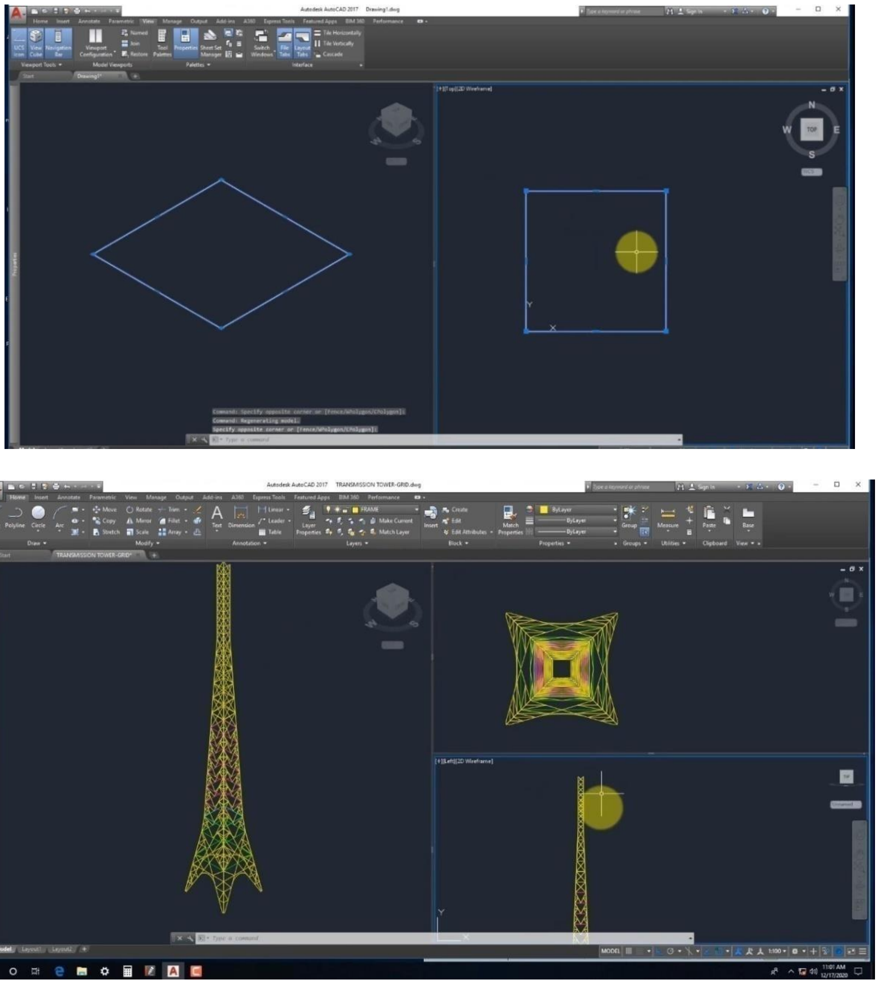


Fig. 3: CAD Model of transmission tower

Design procedure

- We have to draw only one side of transmission tower
- We have first draw the bottom of transmission tower
- Draw the square and move the centre of the of this bottom to the original zero
- Now we are going to set up a dimension to use in this AutoCAD design of transmission tower
- Then create a layer of grid name is frame
- Save the file type transmission tower grid for the file name
- Now we are going to create the first segment of transmission tower
- Segment one start from the bottom line to the height
- Now divide the right view into two small horizontal views
- Then change to the lower front view let copy the square of elevation up to the height of section 1 and then scale with based on the centre of the square and scale factor
- Now we are going to create the truncate surface square pyramid with the bottom is the square and the top is the smaller square type leaves the all centre
- Then select the smaller square first and bottom square for left cross section Change truncated surface square pyramid to the layer draft then create a central line of first segment
- We are going to split the centre into two parts
- Create inside leg from the bottom elevation then unwanted line we are going to create all the rest segment of the tower by the same procedure
- Create a diagonal bracing.
- Now finally using classical polar array to copy all members belong to the left side of the tower to the rest.

5. RESULT & DISCUSSION

- From the analysis, Total Deformation:
  For K bracing: 0.027514m (max),0 m(min).
  For X-B bracing: 0.026906m (max),0 m(min).
  For X-X bracing: 0.025166m (max),0 m(min).

- Axial Force:
  For K bracing: 1.0391e5N(max), -2.539e5N(min).
  For X-B bracing: 84501N(max),6.23774e5N(min).
  For X-X bracing: 88074N(max), -2.3298e5N(min).

  Total Bending Moment:
- For K bracing: 6707.5N.m(max),5.4527N.m(min).
  For X-B bracing: 4183.6N.m(max),2.2739N.m(min).
  For X-X bracing: 4312.9N.m(max),1.1681(min).

- Shear Force:
  For K bracing:4471.8N(max),4.3481N(min).
  For X-B bracing: 4895N(max),12.24(min).
  For X-X bracing: 5004.6N(max),9.7533(min)

6. COMPARISON

K and X-B Bracing having more deformation than another bracing.These braces attach to the columns at the middle height. Frame with these braces are more flexible and provide openings in the outer face, resulting in less bending in the floor beam. Bracings are used to interconnect the legs of transmission lines, and the framing angle of the bracing and main leg of transmission towers should not exceed more than 15 degrees. Members of transmission towers are designed to compression and tension loads.
Bracing is a structural element that provides lateral stability and resists forces that act perpendicular to the plane of a structure. Without proper bracing, a steel structure is vulnerable to collapse under the forces of wind, earthquakes, or other external factors. XX bracing having very less deformation than another K and X-B bracing. So it is reliable.

7. CONCLUSION

This report has discussed the complete design and analysis of the transmission tower,The goal of this project was to demonstrate how to use the advanced structural tool Ansys to solve complex engineering issues involving the natural conditions.Towers are tall structures, their height being much more than their lateral dimensions. These are space frames built with steel sections having generally an independent foundation under each leg. It is far more important to maintain constant structural stability.By this analysis the structural stability should be check and exact forces which comes on the tower are calculated.
The conclusion is summarized into following points. K and X-B bracing having more deformation than XX bracing so XX bracing is more reliable than another bracing. XX bracing having only 0.025166m deformation on wind and cable load.

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