"Optimization of Power Transmission Tower" – A Critical Review

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Abstract:- **In this paper, an attempt has been made to study the possibilities to make the transmission line more cost effective by changing the bracings, configuration and type of transmission line structure for optimizing the weight of transmission tower. Due to the increasing demand of electrical energy, the tower should be made economical by developing different light weight structures. The present literature study has been carried out for optimizing the geometry for different sections; type of bracings, different configurations and for different supply of voltage and necessary conclusions for optimizing the geometry has been drawn out.**

Keywords: optimization of weight, wind load, displacement, configuration, bracing.

I. TRANSMISSION TOWER

Towers are tall structures having height much more compared to their lateral dimensions. The main purpose of transmission line tower is to support conductors and earth wires. They are space frames or truss made up of steel having foundation under each leg. Transmission line towers constitute about 28 to 42 percent of the cost of the transmission line. The increasing demand for electrical energy can be met more economically by developing different light weight configurations of transmission line towers that is optimization of transmission tower. The selection of an optimum outline together with right type of bracing system, height, cross arm type, configuration and other parameters contributes to a large extent in developing an economical design of transmission line tower. As a goal of every designer are to design the best (optimum) systems. As transmission towers are tall structures, they are more susceptible to wind load compared to earthquake load. Generally four legged lattice towers are most commonly used as a transmission line towers and three legged towers only used as telecommunication, microwaves, radio and guyed towers but not used in power sectors as a transmission line towers.

II. REVIEW ON OPTIMIZATION OF TOWER

Gopi Sudam Punse carried out analysis and design of narrow based four legged Transmission Tower (using Multi Voltage Multi Circuit). Narrow based steel lattice transmission tower structure plays a vital role in its performance especially while considering eccentric loading conditions for high altitude as compared to other normal tower. The bottom tier members have more roles in performance of the tower in taking axial forces. The vertical members are more prominent in taking the loads of the tower than the horizontal and diagonal members. Tube section is not economic to use in this type of transmission tower.

C. Preeti and K. Jagan Mohan carried out comparison between square and triangular sections. The self - weight for the triangular tower is found to be 9.23% less than square tower. The triangular tower is found to have the lesser amount of node deflection throughout the height of the tower as compared with the square tower; this implies that the triangular tower is behaving more rigidly than the square tower. Y. M. Ghugal , U. S. Salunkhe describes the analysis and design of two self-supporting towers: three legged and four legged models using common parameters. A saving in steel weight up to 21.2% resulted when a three legged tower is compared with a four legged type. He also shows that the triangular tower is having the heaviest member section for the legs, because of reduced number of legs. He also concluded that a saving in steel of 20.6% in weight resulted in using three legged tube section compared to three legged angle section.

Sudheer, K.Rajashekar, P.P.Reddy, and Y.B.Gopi Krishna designed tower for two wind zones I & V with three different base widths 1/4, 1/5 &1/6 of total height of tower for 220KV. The maximum axial deflection is least at base width of 1/5 of height for all direction for both zones.

Alaa C. Galeb and Ahmed Mohammed Khayoon carried out study for 132KV under angle and pipe sections with X and K bracing. The transmission tower with X-bracing is lighter than that with K-bracing for both angle and pipe sections under wind and seismic load conditions.

WEI Chunming, SU Tingting, MA Bin, Gong Jing studied application of high-strength steel in transmission tower. The main goal of optimization design is minimum cost and minimum displacement and the design variable is bar cross-sectional area. Because of merely optimization of the section, the cost of steel may be saved by 4-16%.

G. Visweswara Rao describes method for the development of optimized tower designs for extra high-voltage transmission lines. The optimization is with reference to both tower weight and geometry. A derivative free method of nonlinear optimization is incorporated in the program, specially developed for the configuration, analysis and design of transmission line towers. A few interesting result of both crisp and fuzzy optimization, relevant to the design of a typical double circuit transmission line tower under multiple loading condition, are presented.

A. Jesumi, M.G. Rajendran describes lateral load resistant bracing system. He describes different types of bracing systems like X-B, single diagonal, X-X, K and Y for steel lattice towers. This study has focused on identifying the

economical bracing system for40 and 50 m tower heights. The diagonal wind has been found to be the maximum for towers. The optimal bracing system obtained from he analysis is Y bracings for both 40 and 50 m height.

CONCLUSION

The following conclusions are made from above study:-

- The bottom tier members have more roles in performance of the tower in taking axial forces for all supply of voltage.
- The triangular configuration of tower has maximum axial forces as compared to square tower for both normal and broken wire loading condition.
- The deflection is more in three legged transmission tower compared to four legged transmission tower but it is within permissible limit.
- In triangular tower, the one leg away from cross tip has more axial forces compared with other two legs nearer to cross tip.
- A saving in steel weight up to 21.2% resulted when a three legged tower is compared with a four legged type of transmission tower. Hence optimization is achieved by changing its configuration.
- A saving in steel of 20.6% in weight resulted in using three legged tube section compared to angle section. Thus, optimization in terms of cost is achieved by using different section.
- The self - weight for the triangular tower is found to be 9.23% less than square tower. Hence, the triangular tower is more economical than the square tower.
- For 220 KV, the triangular tower is found to have the lesser amount of node deflection throughout the height of the tower as compared with the square tower. This implies that the triangular tower is behaving more rigidly than the square tower.
- The main goal of optimization design are the minimum cost of the tower structure and the minimum displacement of a control point, and the design variables are bar cross-sectional area and bar materials, thus the integrated material and structure optimization model of transmission towers is established.
- The application of high-strength steel in transmission tower leads to saving in cost of steel by 4-16%.

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