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Analysis and research on new mechanical characteristics of narrow base steel tube tower for transmission line

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ABSTRACT

Compared with the common angle steel tower, the narrow base steel pipe tower has the advantages of simple structure, beautiful appearance, small floor area and better coordination with the urban environment. In the construction of urban high pressure transmission line, the narrow base tower has its own unique advantages and wide application prospects. It has the advantages of ordinary iron tower processing, transportation, assembly, cost saving, small occupancy of single column steel pipe rod, small line corridor and beautiful beauty. In the optimization design of the narrow tower, how to take the wind vibration coefficient of the tower, how to consider the bending moment of the rod end, the design of the narrow base tower and the structure optimization of the narrow tower tower are all the problems to be solved urgently. In this paper, the modal analysis of a single tower is carried out to determine its vibration mode, and then the wind vibration coefficient of a narrow tower is analyzed. Finally, the influence of x and y direction vibration on the frequency of the tower is obtained.

Keywords: Transmission line; Narrow base tower; Frequency; Vibration mode

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1. Introduction

Along with the development of the country's urbanization, the line corridors in urban planning areas and suburban areas are increasingly tense, and the routes are crowded through urban greening belts and sidewalks and other congested areas. Luo Yuhe studied the design of wind-induced vibration coefficient of 110kV narrow tower[1], Sun Zhigang and so on only studied the wind-induced vibration coefficient of 110kV narrow base tower, and did not analyze the higher voltage narrow tower[2], in this paper, the narrow tower of 110kV~220kV transmission line is analyzed.For 66kV and the following line projects, steel pipe rods or concrete rods are used. They have the advantages of small diameter, easy implementation and good economy, which can meet the requirements of the line corridor.; For the line engineering of 110kV to 330kV, especially the double loop and multi loop engineering, the use of steel pipe rod can meet the requirements of the corridor, but the pipe diameter is larger, the wall thickness is more increased and the economy is poor, and the use of the ordinary angle steel tower can not meet the requirements of the urban area of the transmission line. Narrow base steel tube tower is a kind of small area, compact channel, tower height and root opening ratio is usually more than 6 tower type. It is a new application of steel tube tower technology in urban planning area and suburban area line engineering.

2. Modal analysis of single tower model

It is very sensitive to the wind load and the seismic load effect, so it is necessary to analyze the dynamic characteristics of the narrow base tower, so it is necessary to analyze the dynamic characteristics of the narrow base tower. The foundation of the dynamic characteristic analysis is the modal analysis, and the modes of the narrow tower can be obtained by modal analysis. The natural frequencies are then determined according to the wind-induced vibration coefficient formula provided in the Code for Load of Building Structures. A single tower finite element model for a narrow base tower is established, as shown in Figure 2-1.

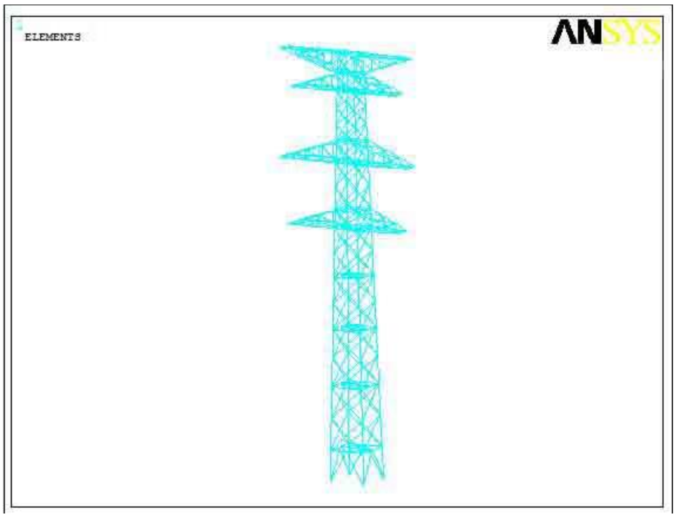


FIGURE 2-1. Single tower finite element model

The first five modes of vibration are extracted, and the results are as follows:

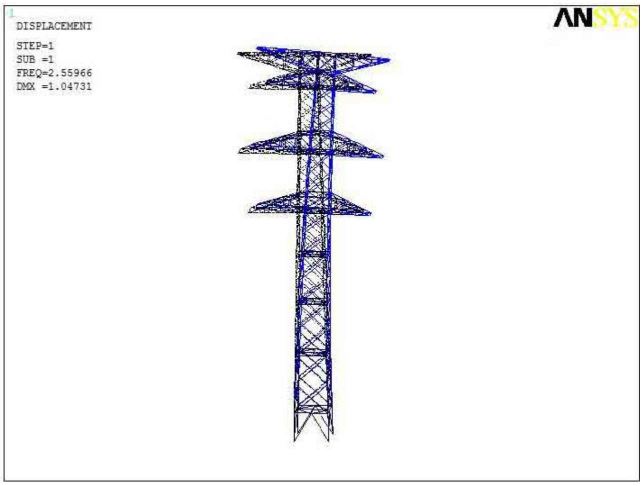


FIGURE 2-2. f_1=2.55966Hz(x direction bending)

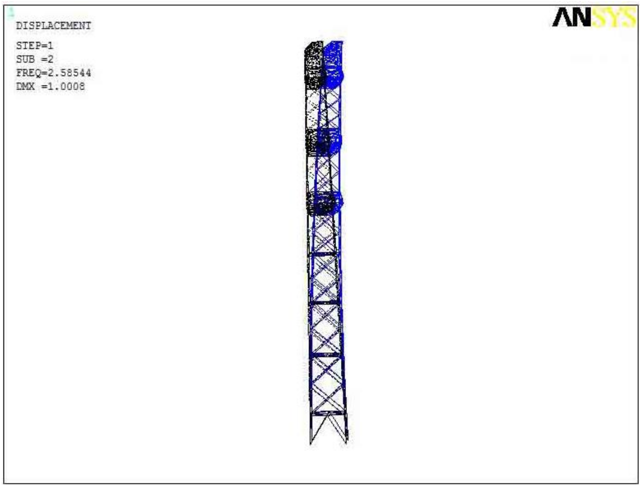


FIGURE 2-3. f_2=2.58544Hz (y direction bending)

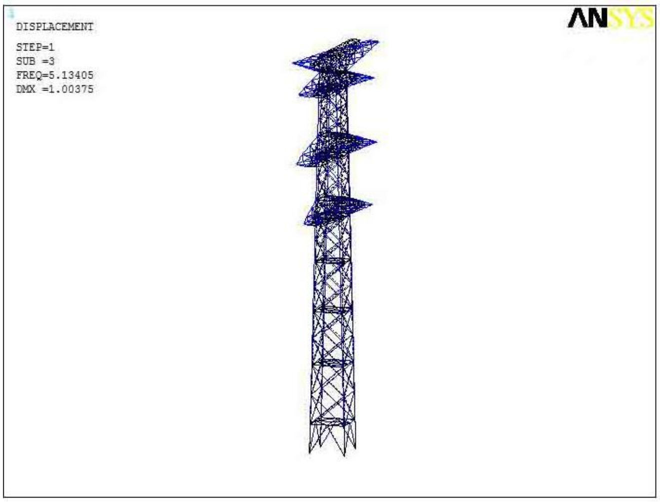


FIGURE 2-4. f_3=5.13405Hz(Reverse)

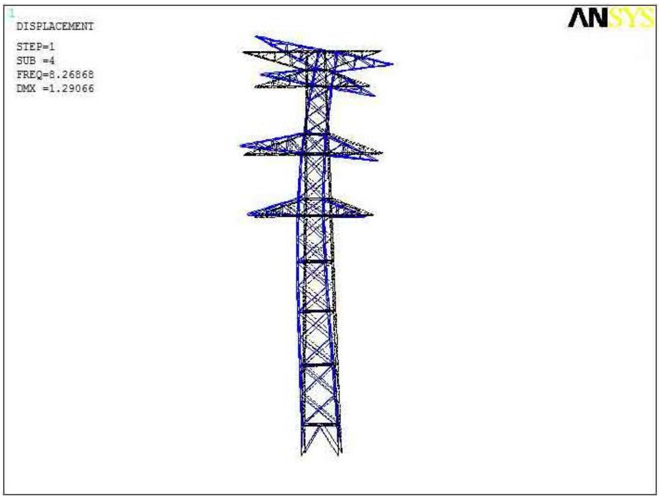
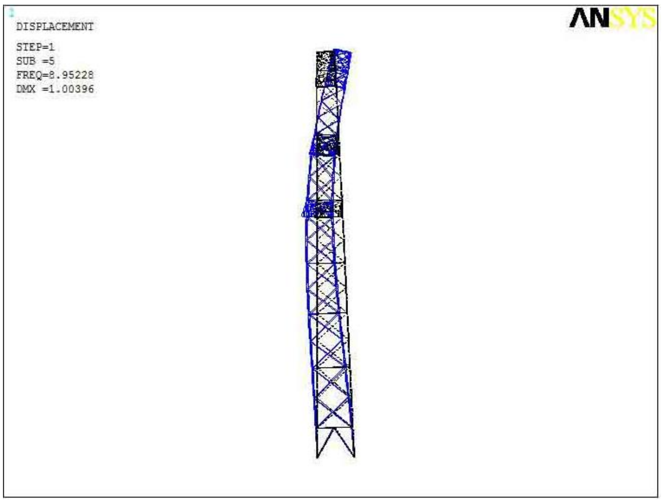


FIGURE 2-4. f_4=8.26868Hz (X direction bending)



f

FIGURE 2-5. f_5=8.95228Hz (Y direction bending)

According to the results, the first order X direction of the single tower is very close to the Y frequency, which indicates that the stiffness of the two directions of the tower is basically the same, which is more favorable for the tower, and the torsional vibration frequency is about 2 times that of the first order bending vibration frequency, reaching an ideal state.

3. Calculation of wind vibration coefficient of narrow base tower

According to the formula in the code of load for building structures, the wind-induced vibration coefficient of the narrow base tower is roughly calculated. According to the standard formula, the wind vibration coefficient is only related to the first natural frequency of the structure. According to the analysis result of Table 2.4, for the coupling model of the tower line, the calculation of the bending frequency should be taken from X to the frequency of the wind vibration, because the frequency of X is less than Y to the frequency. The curve of the wind vibration coefficient varies with the height of the tower as follows:

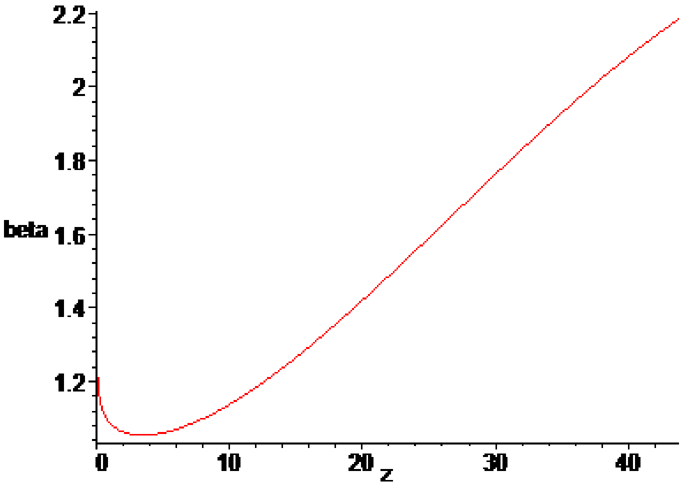


FIGURE 3-1. High variation curve of wind vibration coefficient

The above calculation results show that the wind vibration coefficient of the narrow base tower is larger than that of the conventional tower; The calculation results of the wind vibration coefficient are basically the same, which is due to the little influence of the conductor action on the first natural frequency of the tower body, and the formula provided by the standard is only related to the first order frequency. Although the conductor has great influence on the y natural frequency of the narrow base tower, it has little influence on the wind-induced vibration coefficient. However, the formula provided by the standard is only applicable to the high-rise and towering structures with uniform distribution of body shape and mass. For narrow base steel tube towers, the quality and windshield area of the structure itself are not continuously changed along the height. The width of the tower structure is much larger than the width of the tower, so the air retaining area is larger and the quality is larger. Under the action of wind load, the influence of the dynamic response at the transverse load is obvious, and the wind vibration coefficient has a sudden change at the concentrated mass, which leads to the larger wind vibration coefficient of the column and the column connected with the transverse load, and the wind vibration coefficient of the tower body below the slope is relatively small.

4. Conclusions

This paper first introduces the calculation method of the current code to the wind vibration coefficient, and then studies the influence of the traverse on the transverse and longitudinal frequency of the narrow base tower. The calculation results show that the wire has little influence on the natural frequency of the tower X and has a great influence on the natural frequency of the Y. This influence degree is calculated to be stable when the three line model of the Twin Towers is calculated. The influence of the natural frequency to the natural frequency is greater than Y to the natural frequency, so the effect of the wire on its value is almost no account when calculating the wind vibration coefficient according to the standard. The calculation shows that the wind vibration coefficient of the narrow base tower is greater than that of the conventional iron angle steel tower at the same height. Finally, the wind vibration coefficient of the narrow base tower is given in accordance with the different parts of the narrow base steel tube tower. The recommended value provides a basis for engineering design.

References

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[2] Sun Z, Huang W. Wind Vibration Coefficient Analysis of Narrow Base Transmission Tower[J]. Special Structures, 2016.