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TITLE: Comparative Study of Structural Response of Cooling Towers with Alternative Supporting Configurations under Wind and Earthquake Excitations

ABSTRACT

Cooling towers constitute very important component of power generation systems and also contribute to environment protection. Although cooling towers are more associated with nuclear and thermal power plants, yet they are being used in chemical and other industrial plants.

In the present study the hyperbolic cooling towers supported on alternative supporting columns, namely, I-type and Λ-type have been analyzed performing the three dimensional finite element analysis.These two groups of models are identical with respect to cross sectional geometry of their elements and materials. However inclination angle of the supporting columns have been varied. Influence of the supporting columns' configuration and inclination angle on the linear and nonlinear wind response,buckling stability, modal characteristics, linear and nonlinear earthquake response, and progressive collapse of the layered hyperbolic cooling towersare investigated.In this investigation 11 models are created for various inclination angles of the supporting columns.

The comparisons are made regarding the stresses and radial displacements in the tower shell along its height and circumference in the vicinity of the support junctions, at the throat level, and at the top. Resultant forces and moments in the columns also are compared.

The main aim of the study is to develop an efficient configuration of supporting systems which controls the response of the cooling tower under applied loads.

CONCLUSIONS

Hyperbolic cooling towers supported on alternative supporting columns, namely, I-type and Λ-type have been analyzed performing the three dimensional finite element analysis. Influence of the supporting columns' configuration and their inclination anglesin circumferential and radial directions on the linear and nonlinear wind response,buckling stability, modal characteristics, linear and nonlinear earthquake response, and progressive collapse of the layered hyperbolic cooling towersare investigated.

The main aim of the study was to develop an efficient configuration of supporting systems which controls the response of the cooling tower under applied loads. On the basis of the work presented in this work following conclusions are drawn.

1. The structural response of the hyperbolic tower is quite sensitive to the type of the supporting columns and also to the change of the inclination angles of these supporting columns.
2. From wind analysis results, it is concluded that the towers supported with tangential I-type

columns and the towers supported with Λ-type columns having tangential angle bisector to their respective meridian significantly improves the structural response. For Λ-type columns, the tower supported by the columns not joined at the foundation level (Λ-75-T type) are found to be more effective than those joined at the foundation level (Λ-J-T type) against the wind pressure but weaker against the buckling.

3. From buckling analysis results, it is concluded that the hyperbolic tower shell supported with I-type columns tangential to their respective meridian at the base of the shell provide smallest buckling stability and the towers supported with Λ-type columns having tangential angle bisector to their respective meridian provide largest buckling stability.
4. From modal analysis results, it is concluded that the dynamic response and characteristics of all circumferential, lateral, rotational and ovalling modes and the number of waves observed in mode shapes are significantly altered by supporting columns' configuration and inclination angles.
5. From earthquake analysis results, it is concluded that the hyperbolic tower shell supported with I-type columns tangential to their respective meridian at the base of the shell are not as effective as the towers supported by the columns with 15^o inclination towards the axis of the tower against earthquake excitation. The hyperbolic towers supported by the Λ-type columns having the angle bisector tangential to the respective meridian at the base of the tower shell (i.e. Λ-75-T type and Λ-J-T type) are also not effective against earthquake excitation, but the towers supported with Λ-type columns joined at the foundation level and having the angle bisector normal to the tower base are very effective.
6. From progressive collapse analysis results, it is concluded that towers supported with tangential I-type columns and the towers supported with Λ-type columns having tangential angle bisector to their respective meridian provides higher safety against the progressive collapse.

The above mentioned conclusions imply the fact that the supporting columns' configuration and inclination angle not only economizes the design of the hyperbolic cooling tower. The findings are of great consequence to the safe and economical design of the hyperbolic cooling towers and one may trade off the alternative support configurations and their inclination angles against the wind, earthquake and other types of loading.