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Comparative structural analysis of RCC cooling tower for different height and seismic zones

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Abstract
A cooling tower is a heat rejection device that removes the heat from the water stream into the atmosphere and cools the water to a lower temperature. It is difficult to design and analyze the structure of forces, because it is the structure of the shell. Earthquake and wind loads are two important parameters to consider that make things more complex. Modeling of the building involves modeling and assembly of various supporting elements. The model should ideally represent mass distribution, strength, rigidity and deformity. The first part of this chapter summarizes the various parameters, such as material properties, the basic geometry required to determine the model. The optimal model is observed as a model - 4 according to the results obtained in terms of displacement, voltage. As the height of the cooling tower increases, the results increase.

Keywords: Cooling tower, plate stress, STAAD and displacement

1. Introduction
Cooling towers are divided into two main types, the first is called natural cooling towers and the second mechanical cooling tower. In the natural cooling tower (NDCT), air circulation is induced by adding heated air to the chimney, which then contains a column of air that is lighter than the ambient atmosphere. This difference in weight leads to a continuous flow of air through the cooling tower as long as the water at a temperature above the temperature of the wet flask circulates through the cooling tower. NDCT uses the effect of the chimney stack over the package to cause air flow through the package into the water flow meter.

2. Literature Review
Priya Kulkarni *et al*., 2015 [1] this document discusses thermal analysis in cooling towers. As an example, cooling towers from the Bellari thermal power plant (BTPS) are selected. These cooling towers are analyzed using Staad software. ProV8i, assuming a free top end and fixed base. The material properties of the cooling towers are the 2.1Mpa module, Poisson Ratio 0.15 and the RCC 25kN / m3 density. The results of the analysis include moving in the direction of X, Y, Z and the maximum main stress. Option of thickness of movement v / s, maximum main voltage v / s thickness graphically constructed. The rate of heat loss is affected by atmospheric parameters such as air temperature, water temperature, relative humidity and the rate of heat loss. Due to the heat load, the movement in the upper part of the cooling tower in the X and Z direction continues with decreasing thickness and height. Due to the heat load, the movement in the Y direction continues with increasing thickness and height.
Pujaa Venkataiah *et al*., 2016 [2]. From the results of the analysis, it can be concluded that the displacement of the structural node increases by 30%, as the height of the cooling tower increases, whereas the displacement of the node can be reduced by approximately 20-25% by increasing the thickness of the plate used to model the cooling tower. Mass participation over 75% is obtained for all dominant modes. It was found that the oscillations of the plate tension are minimal (5%) with increasing model height and plate thickness. The CQC offset increased by approximately 35% as the tower height and plate thickness increased. From the above results, taking into account the cost-effectiveness, the optimal height for the cooling tower can be considered as 250 m, the optimal plate thickness - 300 mm and the optimal throat diameter - 60 m.

3. System Development
Modeling a building involves the modeling and assemblage of its various load carrying

elements. The model must ideally represent the mass distribution, strength, stiffness and deformability. The first part of this chapter gives a summary of various parameters such as material properties, basic geometry required to define the model. Accurate modeling of the nonlinear properties of various structural elements is very important in nonlinear analysis. In this study, STAAD Pro v8i is used for the modeling and analysis of the structure.

1. **Model-I:** Cooling Tower with 10 m height and seismic zone-II
2. **Model-II:** Cooling Tower with 10 m height and seismic zone-III
3. **Model-III:** Cooling Tower with 10 m height and seismic zone-IV
4. **Model-IV:** Cooling Tower with 10 m height and seismic zone-V
5. **Model-V:** Cooling Tower with 15 m height and seismic zone-II
6. **Model-VI:** Cooling Tower with 15 m height and seismic zone-III
7. **Model-VII:** Cooling Tower with 15 m height and seismic zone-IV
8. **Model-VIII:** Cooling Tower with 15 m height and seismic zone-V
9. **Model-IX:** Cooling Tower with 20 m height and seismic zone-II
10. **Model-X:** Cooling Tower with 20 m height and seismic zone-III

4. Performance analysis

The results obtained for the models in the STAAD-PRO and the obtained results are as follows.

Table 1: Displacement for all the models

	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm
Model-1	40.575	90.711	40.575	95.355
Model-2	40.575	90.711	40.575	95.355
Model-3	40.575	90.711	40.575	95.355
Model-4	40.575	90.711	40.575	95.355
Model-5	40.614	127.762	40.614	133.151
Model-6	40.614	127.762	40.614	133.151
Model-7	40.614	127.762	40.614	133.151
Model-8	40.614	127.762	40.614	133.151
Model-9	80.935	172.992	80.935	187.56
Model-10	80.935	172.992	80.935	187.56

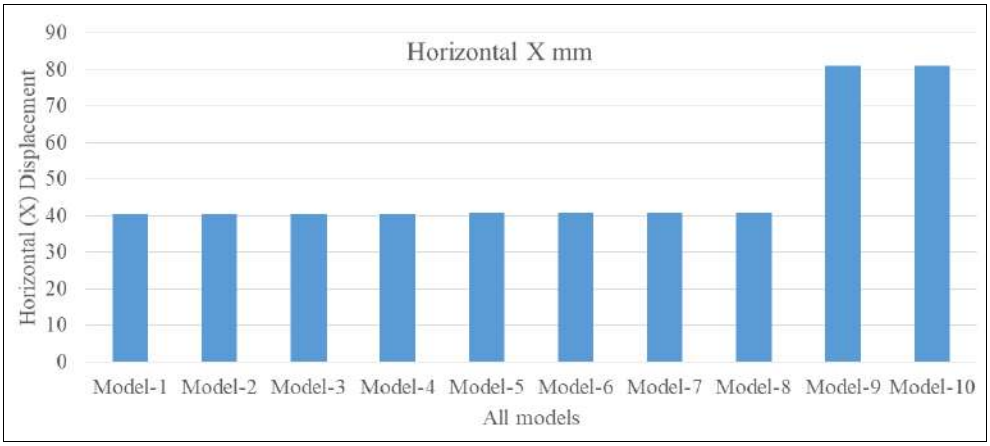

Fig 1: Horizontal Displacement (X) for all the models

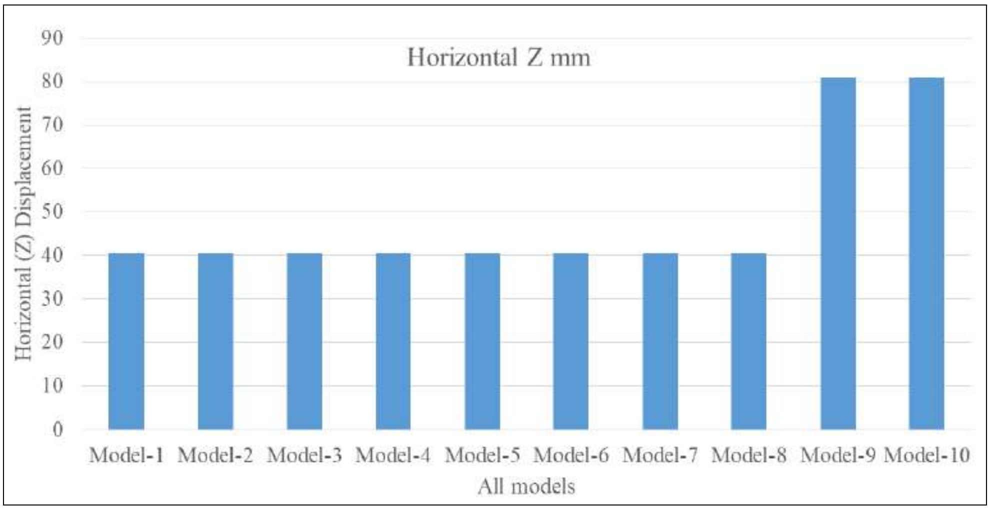

Fig 2: Horizontal Displacement (Z) for all the models

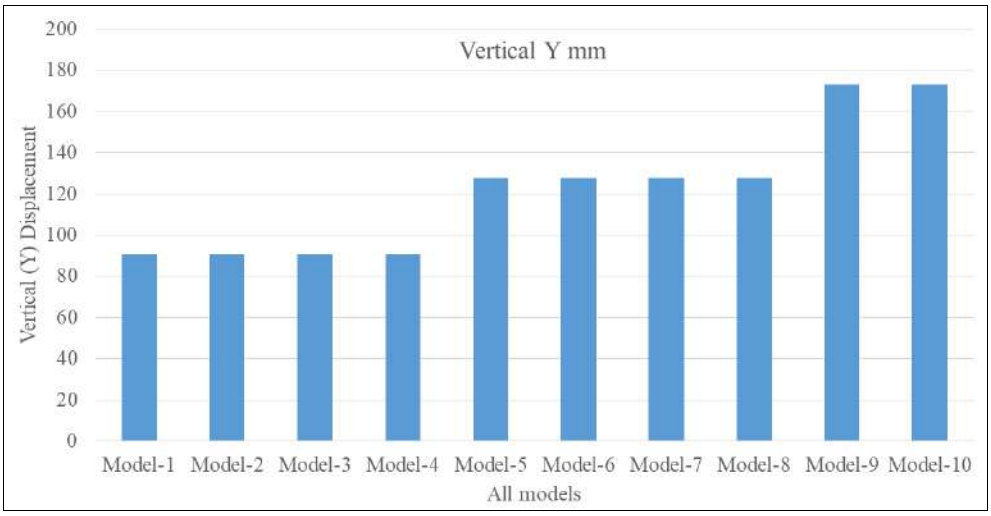

Fig 3: Vertical Displacement (Y) for all the models

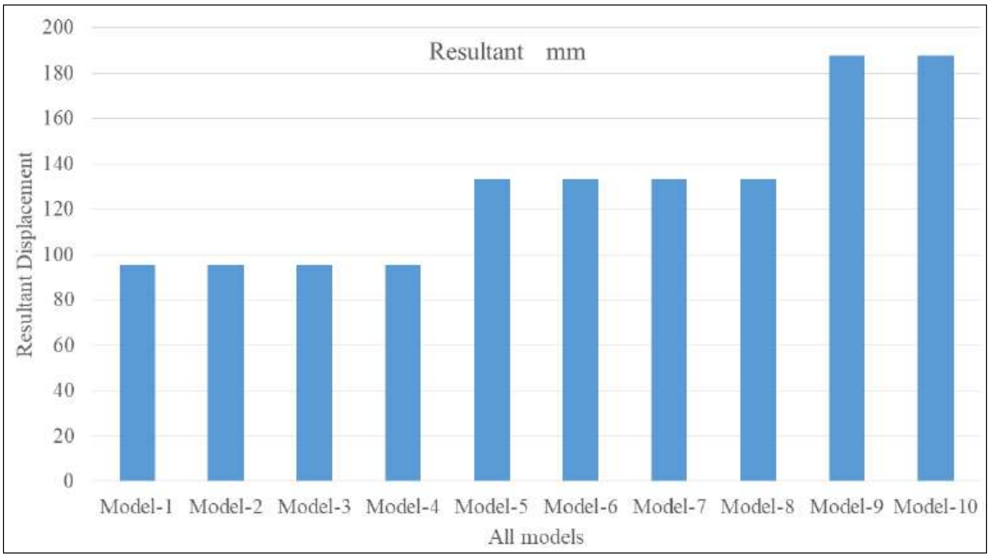

Fig 4: Resultant Displacement for all the models

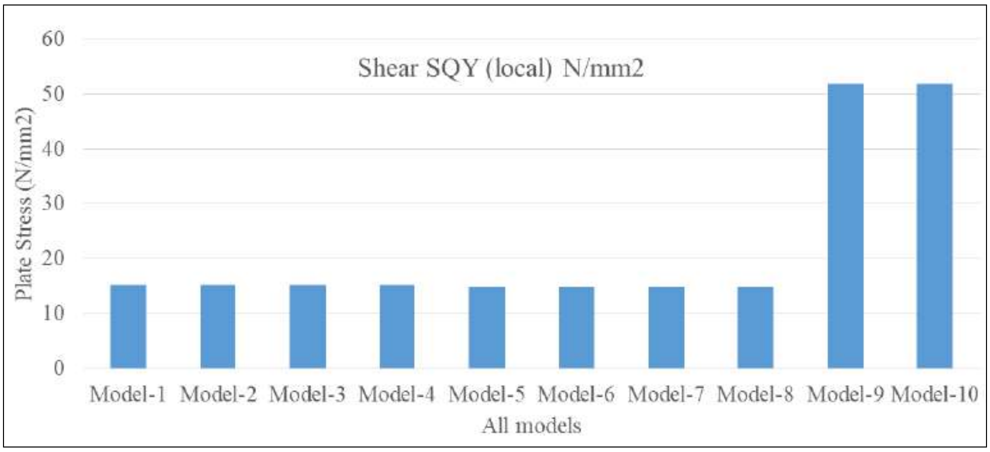

Fig 5: Shear stress (SQY) for all the models

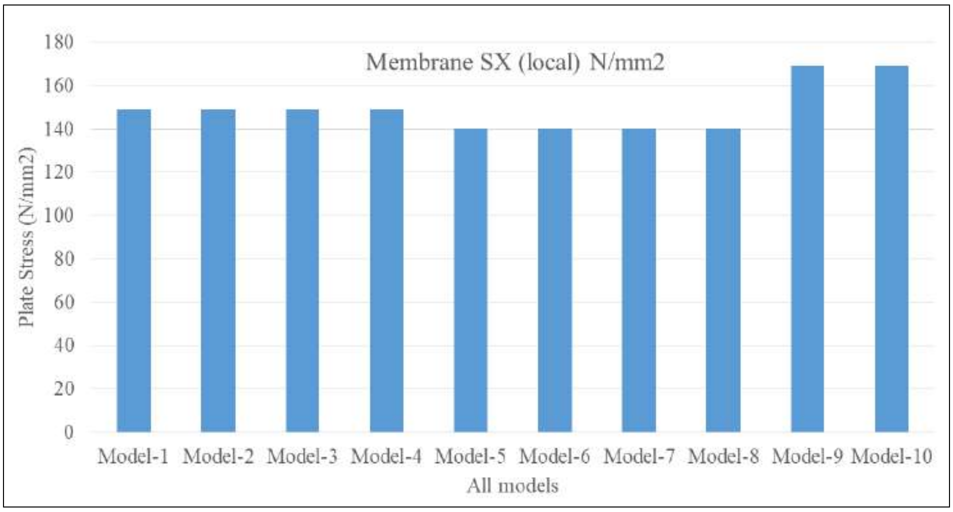

Fig 6: Membrane stress (SX) for all the models

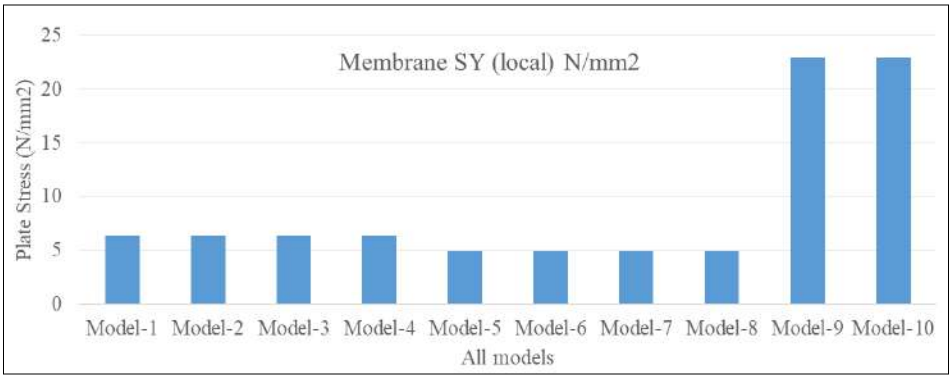

Fig 7: Membrane stress (SY) for all the models

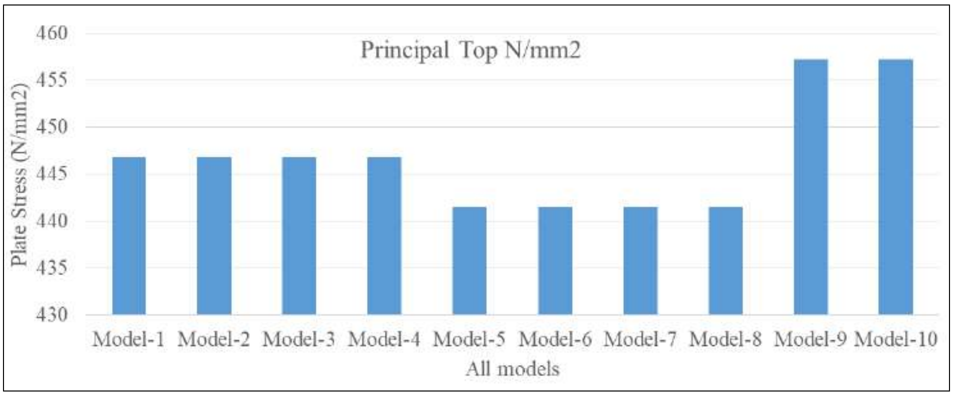

Fig 8: Principal stresses for all the models

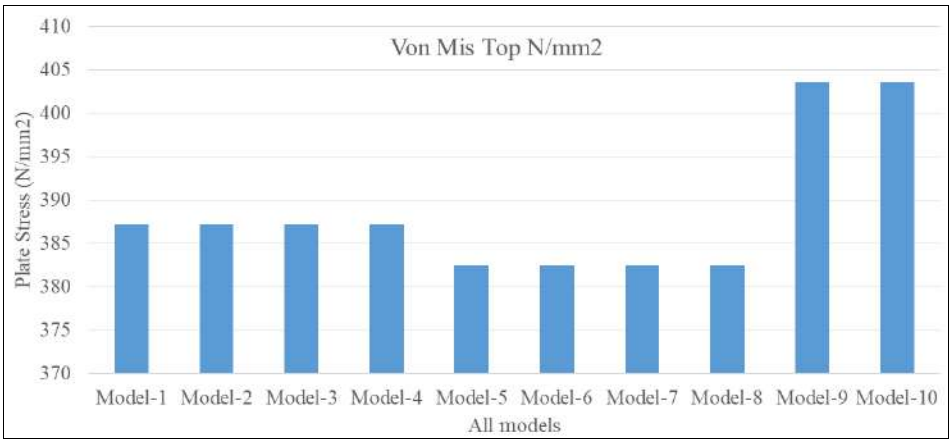

Fig 9: Von Mis stresses for all the models

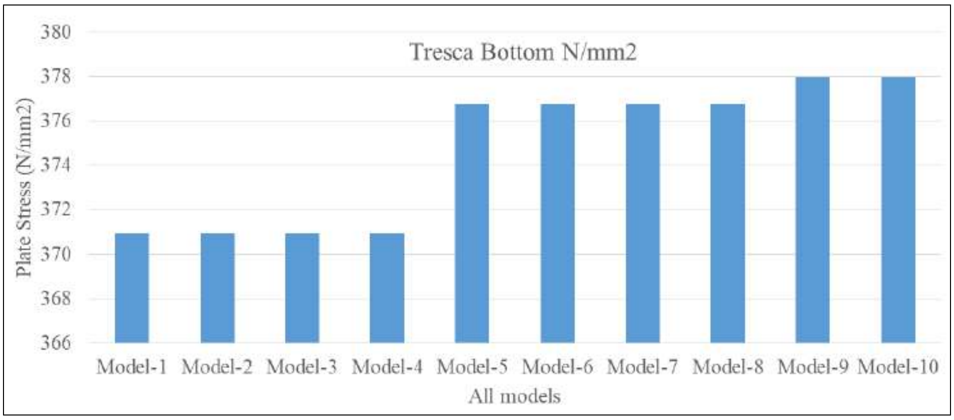

Fig 10: Tresca stresses for all the models

5. Conclusions

From the analysis carried out in the STAAD-PRO software for the different models following conclusions can be drawn:

a. The maximum displacement is observed in the model-10.
b. The maximum plate stress is observed in the model-10 while minimum plate stress in the model-4.
c. The plate stresses in terms of the principal stress, tresca stress and von mis stress have been observed.
d. The maximum tresca stress is observed in the model-10 while minimum in the model-4.
e. The optimum model is observed to be model-4 as per the results obtained in terms of the displacement, stress.
f. As the height of the cooling tower increases the results goes on increasing.

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