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Comparative Analysis and Design of Cooling Tower with STAAD-PRO and Manual Calculations

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Abstract: The cooling tower is a device that transforms hot water into cold water through direct air contact. It runs on the temperature difference between the air inside the tower and outside the tower. The natural cooling Tower project is one of the most widely used cooling towers. The hyperbolic shape of the cooling tower is usually preferred due to its durability and stability and a large available area based on the shape. Since it is a very important structure in atomic and chemical plants, it should be continuously assessed for its stability under its own weight, and lateral loads like wind load and E. Rthquake load. For this, cooling towers were tests for the wind load, suggesting that the fixity-based shell. Wind loads on these cooling towers were designed as pressure using distributed design of Wind pressu Re coefficients, as is given: 11504-1985 code along with wind pressure design on various. The present study deals with the analysis of cooling tower maximum displacement, support reactions, support moments, stresses and bending moments in plates due to seismic loading, wind loading and dead load i.e. its self weight on a hyperbolic cooling tower is continuous function of geometry.
Keywords: Cooling Tower, wind load, stresses and moments

I. INTRODUCTION

The cooling tower is a thermal device failure that pulls out heat waste from the water stream into the atmosphere and cools the water to the lower temperature. It is difficult to design and analyze the structure for the forces, as it is the structure of the shell. The quake and wind loads are two important parameters that should be dealt with, making things more complex. There have been many attempts to formulate methods of design and analysis for the cooling tower and many model studies have also occurred even from very early times. The cooling tower is a thermal device failure that pulls out heat waste from the water stream into the atmosphere and cools the water to the lower temperature. It is difficult to design and analyze the structure for the forces, as it is the structure of the shell. The quake and wind loads are two important parameters that should be dealt with, making things more complex. There have been many attempts to formulate methods of design and analysis for the cooling tower and many model studies have also occurred even from very early times.

II. REVIEW OF LITERATURE

The cooling tower's reaction is governed by both vertical and circumferential wind distribution. The ultimate bearing capacity of the cooling tower housing is obtained by 1.925 times, that of the construction of wind pressure, corresponding to wind speed of 40.2 m/s (90 mph). Nonlinear behaviour began due to formation of cracks of horizontal tensions in Meridian Meridian by 43% The height of the cooling Tower Corps. A free vibration analysis method may be used in seismic analysis using violent needs of the seismic design of the NDKT. The stress state in the cooling tower occupies a full range of F ro m tension in the domain compression. When the height increases, wind vibration coefficients increase first, then decrease and reach the maximum at the top of the(Parth.R.Chhaya et al 2014).

This document considers the study of thermal analysis of cooling towers. In the case of research of the cooling towers from Bellary thermal Power plant (BTES) are selected. These cooling towers are analyzed using software staffs. ProV8i, assuming top-end free and fixity-based. The material properties of the cooling towers are included in the young Mpa module, the Poisson coefficient 0.15 and the density of 25kN/m3. The results of the analysis are obtained: displacement in X, Y, Z directions and maximum main stress. Variations on the thickness of V/s, Max's main stress v/s thickness built graphically. The rate of heat loss depends on the atmospheric parameters such as air temperature, water temperature, relative humidity and the rate of heat loss. Due to the thermal imaging, the displacement at the top of the cooling tower in the direction of X and Z goes to increase with a decrease in thickness and height. Due to the thermal imager, the shift towards Y goes to increase (Priya Kulkarni et al, 2015).

The study is engaged in a modal analysis of the hyperbolic cooling towers. Two existing cooling towers are selected from Bellary Thermal Power Plant (BTPS) as a case study. The analysis uses the software based on FOREIGN trade. Marginal conditions conside Red upper end free and lower end fixed.

The material properties of the cooling tower are the module young 31Gpa, the Poisson coefficient 0.15 and the density of RCC 25 Kn/m3. The performed analysis is carried out by means of 8-foot body of 93 element. Natural frequencies, maximum number, maximum load, voltage, max voltage background, do not get the load. Variations of the Max main stress v/s thickness, the maximum deviation of V/s thickness is built graphically (Sachin Ku Lkarni et al., 2014).

III. MODELING

The modeling is carried out for the plate thickness of 0.25, 0.3, 0.4 & 0.5 (with and without Earthquake Loading). The analysis carried out in STAAD-PRO as follows

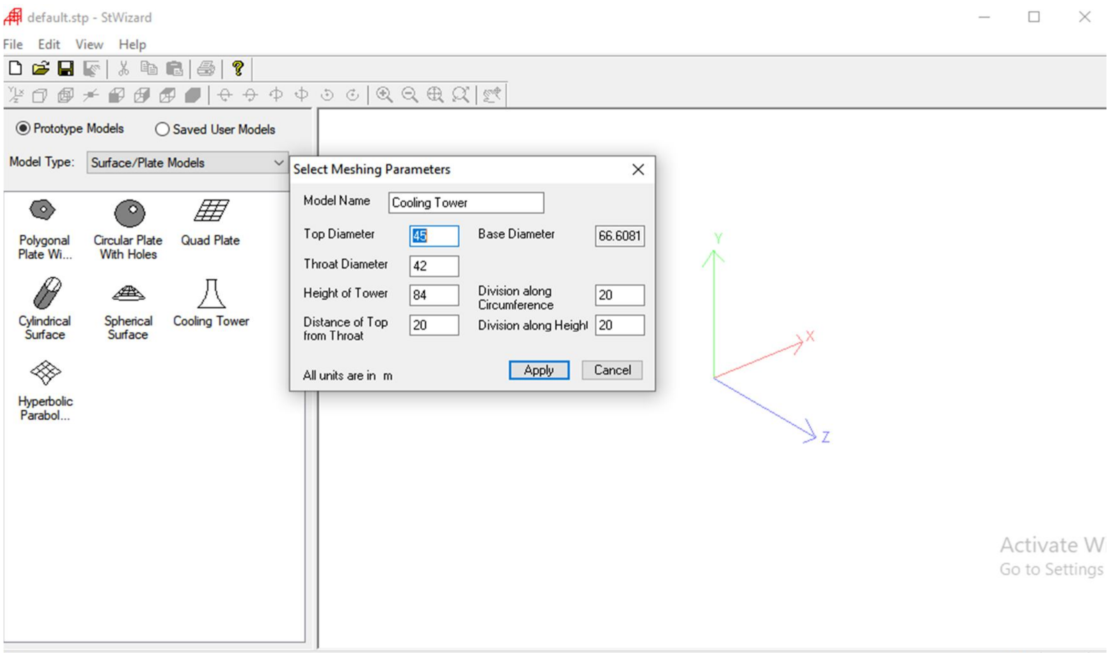

Fig.1: Properties considered for Cooling Tower

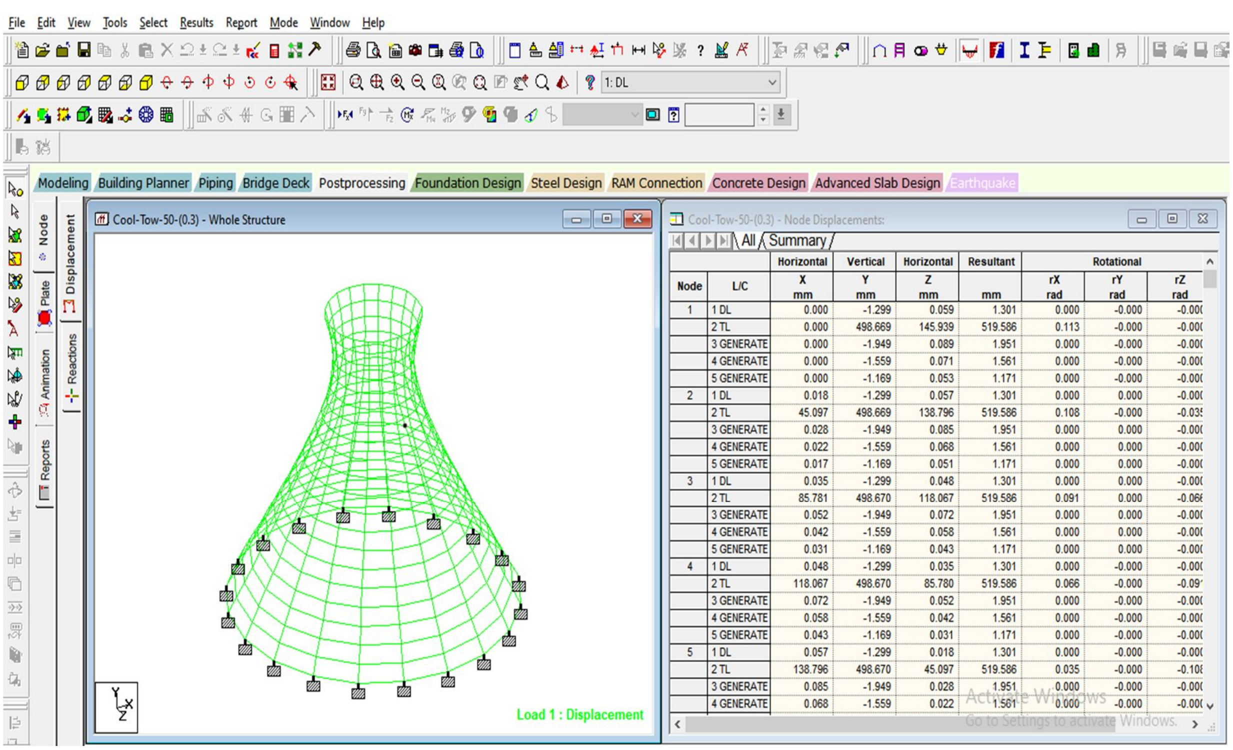

Fig 2. Modeling of Cooling Tower

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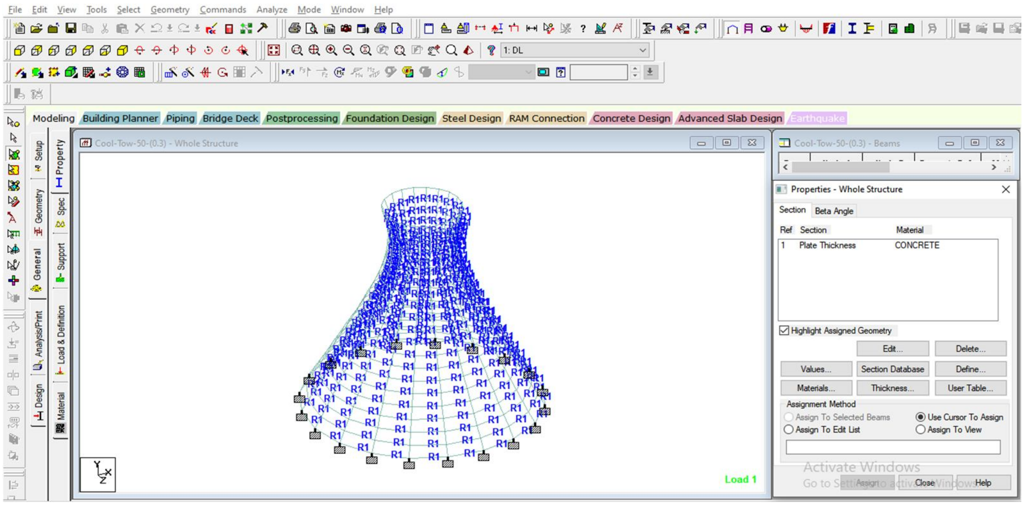


Fig.3: Assigning properties to Cooling Tower

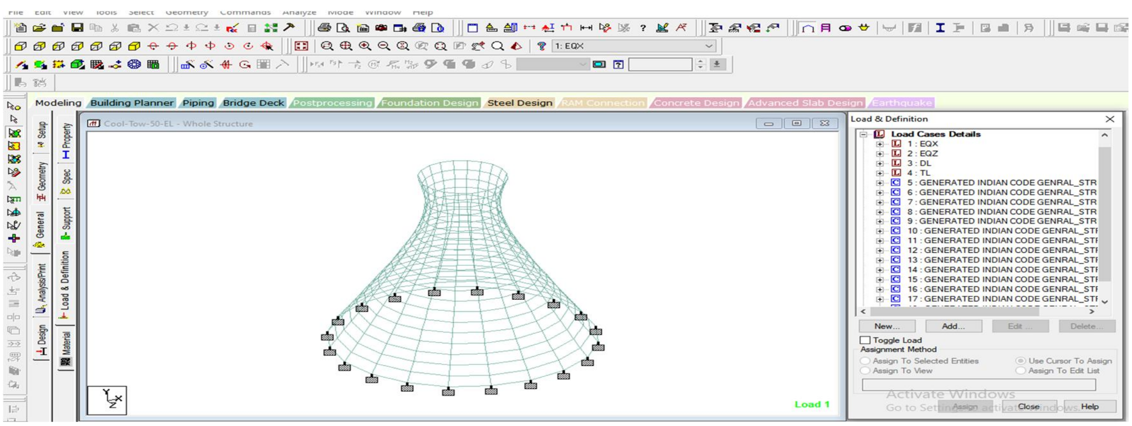
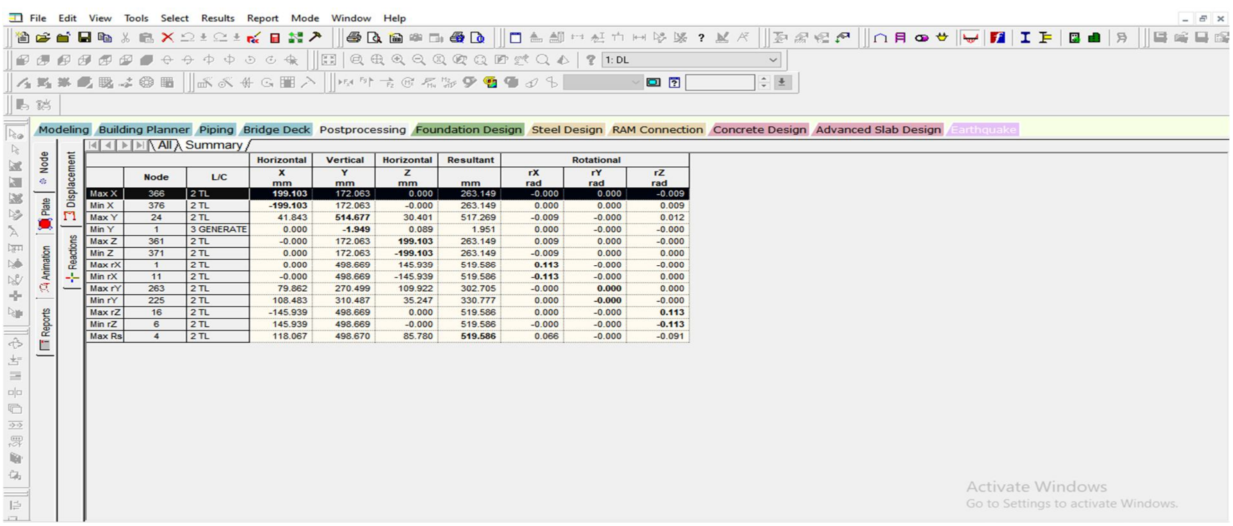


Fig.4: Assigning load to Cooling Tower

The analysis of the cooling tower models are completed using Indian standard code and accordingly the results are obtained

IV. RESULTS

The results for the cooling tower models are mentioned as follows:



			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	366	2 TL	199.103	172.063	0.000	263.149	-0.000	0.000	-0.009
Min X	376	2 TL	-199.103	172.063	-0.000	263.149	0.000	0.000	0.009
Max Y	24	2 TL	41.843	514.677	30.401	517.269	-0.009	-0.000	0.012
Min Y	1	3 GENERATE	0.000	-1.949	0.089	1.951	0.000	-0.000	-0.000
Max Z	361	2 TL	-0.000	172.063	199.103	263.149	0.009	0.000	-0.000
Min Z	371	2 TL	0.000	172.063	-199.103	263.149	-0.009	0.000	0.000
Max rX	1	2 TL	0.000	498.669	145.939	519.586	0.113	-0.000	-0.000
Min rX	11	2 TL	-0.000	498.669	-145.939	519.586	-0.113	-0.000	0.000
Max rY	263	2 TL	79.862	270.499	109.922	302.705	-0.000	0.000	0.000
Min rY	225	2 TL	108.483	310.487	35.247	330.777	0.000	-0.000	-0.000
Max rZ	16	2 TL	-145.939	498.669	0.000	519.586	0.000	-0.000	0.113
Min rZ	6	2 TL	145.939	498.669	-0.000	519.586	-0.000	-0.000	-0.113
Max Rs	4	2 TL	118.067	498.670	85.780	519.586	0.066	-0.000	-0.091

Fig.5: Results in STAAD-PRO

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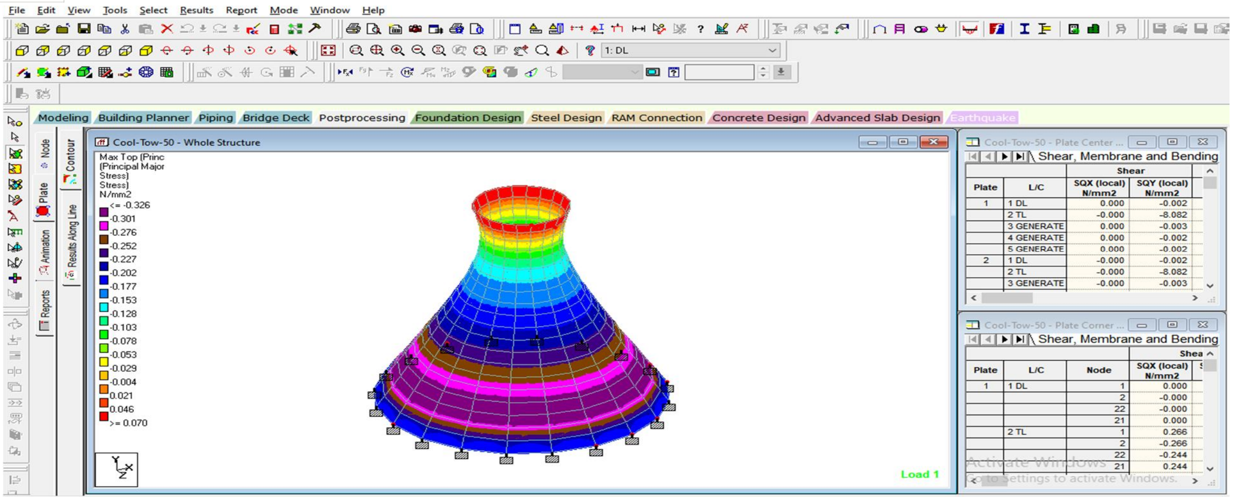

Fig.6: Principal Major Stress(N/mm^2)

Table 1: Plate bending analysis

			Shear		Membrane			Bending Moment	
	Plate	L/C	SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm 2	Mx kNm/m	My kNm/m
Max Qx	381	2 TL	0	9.624	-145.515	-5.653	0	-12477.301	-8871.974
Min Qx	382	2 TL	0	9.624	-145.513	-5.65	-0.001	-12477.308	-8871.974
Max Qy	384	2 TL	0	9.624	-145.514	-5.654	0.001	-12477.31	-8871.985
Min Qy	3	2 TL	0	-8.082	21.11	-2.81	0	-11321.005	-4693.195
Max Sx	3	2 TL	0	-8.082	21.11	-2.81	0	-11321.005	-4693.195
Min Sx	381	2 TL	0	9.624	-145.515	-5.653	0	-12477.301	-8871.974
Max Sy	341	2 TL	0	-1.182	1.422	0.712	0	-13426.519	-14767.958
Min Sy	384	2 TL	0	9.624	-145.514	-5.654	0.001	-12477.31	-8871.985
Max Sxy	384	2 TL	0	9.624	-145.514	-5.654	0.001	-12477.31	-8871.985
Min Sxy	382	2 TL	0	9.624	-145.513	-5.65	-0.001	-12477.308	-8871.974
Max Mx	363	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	0	-0.005	-0.427	-1.141	0	1.336	5.568
Min Mx	362	2 TL	0	0.82	-49.687	-0.424	0	-13697.573	-15676.215
Max My	361	3 GENERATED INDIAN CODE GENRAL_STRUCTURES 1	0	-0.005	-0.427	-1.141	0	1.336	5.569
Min My	365	2 TL	0	0.82	-49.687	-0.424	0	-13697.563	-15676.234
Max Mxy	145	2 TL	0	0	0	0	0	-13083.428	-13083.36
Min Mxy	325	2 TL	0	-0.584	7.542	0.337	0	-13125.606	-13351.221

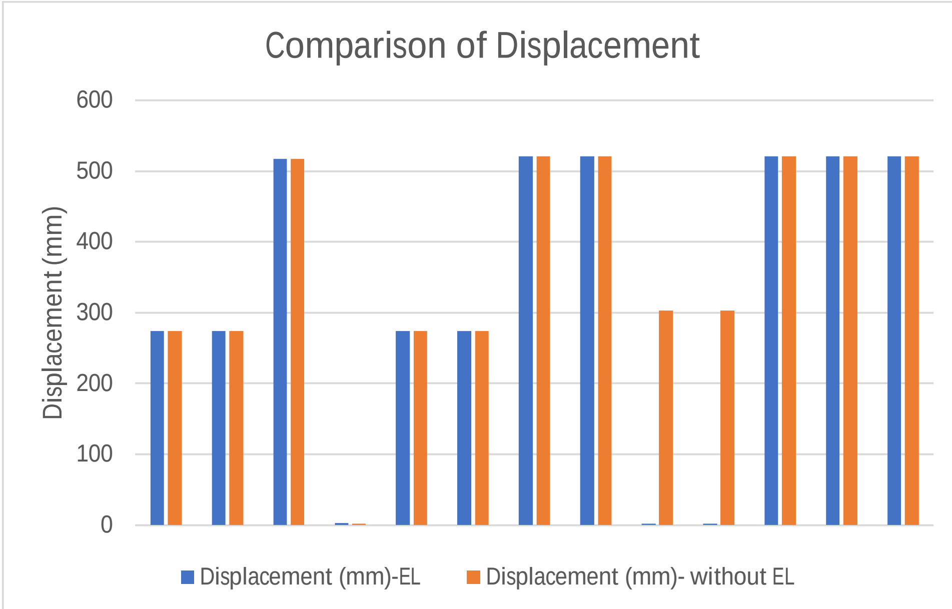

Fig.7: Comparison of Displacement for Cooling Tower with and without Earthquake load (EL)

Table 2: Stresses in plate of Cooling Tower

Cooling tower-50 (EL)

			Principal		Von Mis		Tresca	
	Plate	L/C	Top N/mm2	Bottom N/mm2	Top N/mm2	Bottom N/mm2	Top N/mm2	Bottom N/mm2
Max Principal (top)	6	11 GENERATED INDIAN CODE GENRAL_STRUCTURES 7	0.197	0.152	0.178	0.266	0.197	0.308
Min Principal (top)	381	4 TL	-444.97	153.941	385.375	186.42	444.97	207.275
Max Principal (bottom)	361	4 TL	-376.654	375.805	377.543	337.981	378.426	375.805
Min Principal (bottom)	366	11 GENERATED INDIAN CODE GENRAL_STRUCTURES 7	-1.21	-1.464	1.066	1.295	1.21	1.464
Max Von Mis (Top)	381	4 TL	-218.58	207.275	385.375	186.42	444.97	207.275
Min Von Mis (top)	16	7 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-0.017	-0.058	0.025	0.057	0.029	0.058
Max Von Mis (Bottom)	341	4 TL	-320.814	355.143	338.468	340.494	353.719	355.143
Min Von Mis (bottom)	10	1 EQX	-0.018	-0.015	0.042	0.028	0.048	0.033
Max Tresca (top)	381	4 TL	-218.58	207.275	385.375	186.42	444.97	207.275
Min Tresca (top)	16	7 GENERATED INDIAN CODE GENRAL_STRUCTURES 3	-0.017	-0.058	0.025	0.057	0.029	0.058
Max Tresca (bottom)	361	4 TL	-376.654	375.805	377.543	337.981	378.426	375.805
Min Tresca (bottom)	10	1 EQX	-0.018	-0.015	0.042	0.028	0.048	0.033

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V. CONCLUSION

From the above study following conclusions can be drawn:

A. Principal stresses, Von Mis stresses are maximum in cooling tower considering with Earthquake analysis
B. Top combined stress and bottom combined stresses are found to be more in case of cooling tower without EL.
C. Displacement is maximum as the height goes on increasing
D. Reactions found to be more in case of more height of cooling tower

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