ANALYSIS AND DESIGN OF COOLING TOWER BY USING STAAD pro

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Abstract: Cooling tower are the biggest heat and mass transfer devices that are in wide spread use. It works on the temperature difference between the air inside the tower and outside the tower. In this study cooling tower in analyzed under the effect of earthquake forces using STAAD pro software. The parameters considered are top diameter and height of cooling with constant thickness under different zones of India. It is observed from the analysis that maximum displacement, support reactions support moments stresses and bending moments in plates due to seismic loading on a hyperbolic cooling tower is continuous function of geometry. Based on these results, salient conclusions are drawn.

***Index Terms* – Cooling tower, Modeling, Earthquake, Stresses, Temperature, STAAD pro.**

I.INTRODUCTION

A cooling tower is a semi closed device for evaporative cooling of water by contact with air. The main function of cooling tower is to remove waste heat into the atmosphere from condenser. It is a wooden, steel or concrete structure and corrugated surfaces or baffles or perforated trays are provided inside the tower for uniform distribution and better atomization of water in the tower. Towers are divided into two main types, the first being named natural draught cooling towers and the second mechanical draught cooling towers. In natural draught tower, the circulation of air is induced by enclosing the heated air in a chimney which then contains a column of air which is lighter than the surrounding atmosphere. This difference in weight produces a continuous flow of air through the cooling tower as long as water at a temperature above the wet bulb temperature is circulated through the cooling tower. As hot air moves upwards through the tower, fresh cool air is drawn into the tower through an air inlet at the bottom. The hyperbolic shape is made because of following reasons.

More packing can be fitted in the bigger area at the bottom of the shell, the entering air gets smoothly directed towards the centre because of the shape of the wall, producing a strong upward draft, and greater structural strength and stability of the shell is provided by this shape. The direct rejection of hot water to these reservoirs could lead however to thermal pollution problems. Where location of industrial plant is such that cooling water in large quantities is scarce, then the water must be cooled and recycled.

NATURAL DRAFT COUNTER FLOW COOLING TOWER

This study is concerned with natural draft counter flow cooling tower. This type of towers is found in large power plants. There are three zones: 1. Spray zone 2. Fill zone 3. Rain zone. The hot water is introduced into the tower through spray nozzles approximately 10 m above the basin. The main function of the spray zone is to simply distribute the water evenly across the tower. The water passes through a small spray zone as the fast moving droplets before entering the fill. There are a range of fill types. Generally they tend to be either a splash fill or film fills type. The splash fill type acts to break up water flow into smaller droplets with splash bars. A film fill is a more modern design which forces the water to flow in film over closely packed parallel plates. This significantly increases the surface area for heat and mass transfer.

II.MATERIAL AND METHODOLOGY

2.1 LOAD CASE DETAILS

2.1.1 SEISMIC LOADS (IS 1893: 2002)

When a structure is subjected to ground motion, it responds in shaking fashion. The random motion of structure is possible in all possible directions mainly in horizontal (X) and vertical (Y) directions. This motion causes the structure to vibrate in all three directions. This seismic forces must be evaluated from IS: 1893:2002.

2.1.2 DEAD LOAD (IS 875: 2007 Part 1)

These are the external loads which acts vertically downward and arises due to the self-weight of the structure. Dead loads are static forces that are relatively constant for an extended time. They can be in tension and compression. The term can refer to laboratory test method or to the normal usage of a material or structure.

2.1.3 LIVE LOAD (IS 875: 2007 Part 1)

Live loads are usually unstable or moving loads. These are dynamic loads may involve considerations such as impact, momentum, vibration, slosh dynamics of fluids, etc.

2.1.3.1 TEMPERATURE LOAD

Temperature changes leading to thermal expansion cause thermal loads.

III.TECHNICAL SPECIFICATIONS

Tower height	= 84m
Tower Top Diameter	= 45m
Tower base Diameter	= 66m
Throat Diameter	= 42m
Distance of top from throat	= 20m
Division along circumference	= 20m
Division along height	= 20m

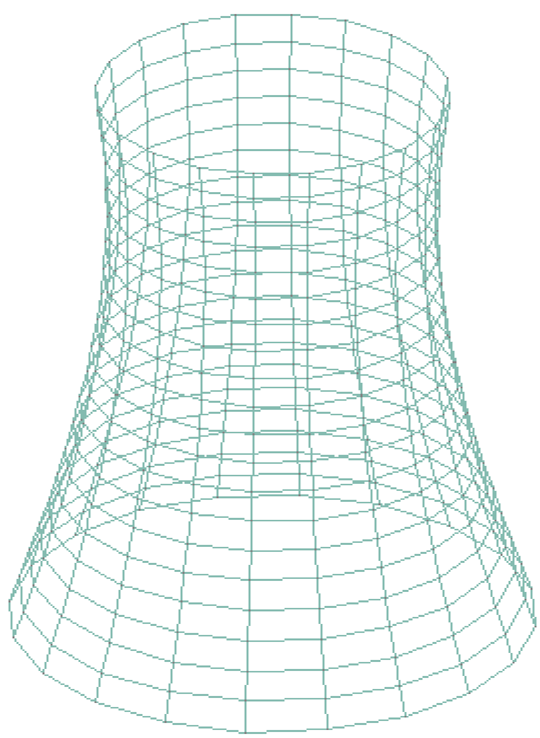

FIGURE: 3.1 MODELLING OF COOLING TOWER

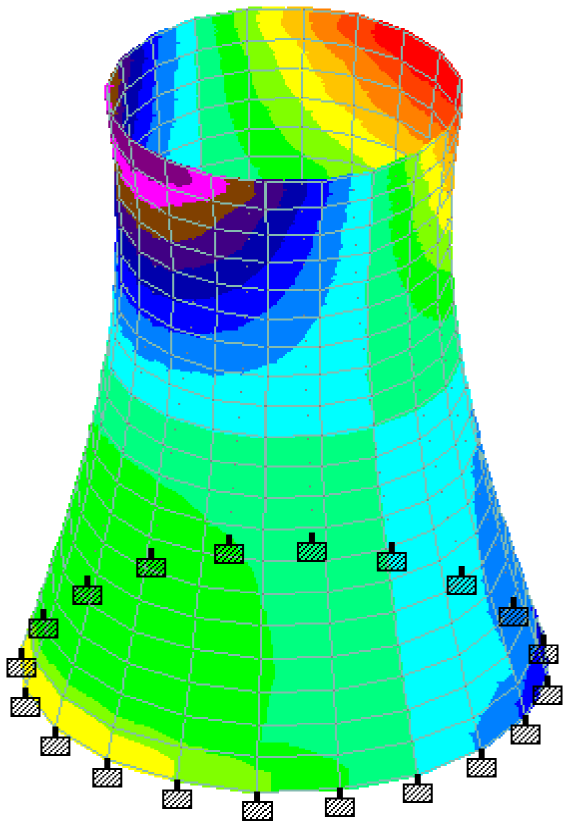

FIGURE: 3.2 PLATE LOAD

IV.RESULTS AND DISCUSSION

Table 4.1: Comparison between Thickness, shear force and bending moment of cooling tower

Thickness	Horizontal	Vertical	Horizontal		Moment	
Tk	Fx	Fy	Fz	Mx	My	Mz
mm	kN	kN	kN	kNm	kNm	kNm
300	0.023	4660.59	1400.282	1236.303	0.018	0.035
275	0.022	4272.207	1284.451	1131.339	0.017	0.034
250	0.021	3883.825	1168.466	1026.832	0.015	0.033
225	0.02	3495.443	1052.323	922.764	0.013	0.033
200	0.018	3107.062	936.017	819.112	0.012	0.032
175	0.016	2718.681	819.544	715.847	0.009	0.032
150	0.014	2330.3	702.902	612.932	0.007	0.032
125	0.012	1941.92	586.092	510.325	0.004	0.033
100	0.009	1553.539	469.118	407.972	0.001	0.035
90	0.008	1398.187	422.286	367.09	0.001	0.037
80	0.007	1242.835	375.431	326.236	0.002	0.038
70	0.005	1087.483	328.555	285.407	0.004	0.04
65	0.004	1009.806	305.109	265	0.005	0.041
60	0.004	932.13	281.658	244.598	0.006	0.043

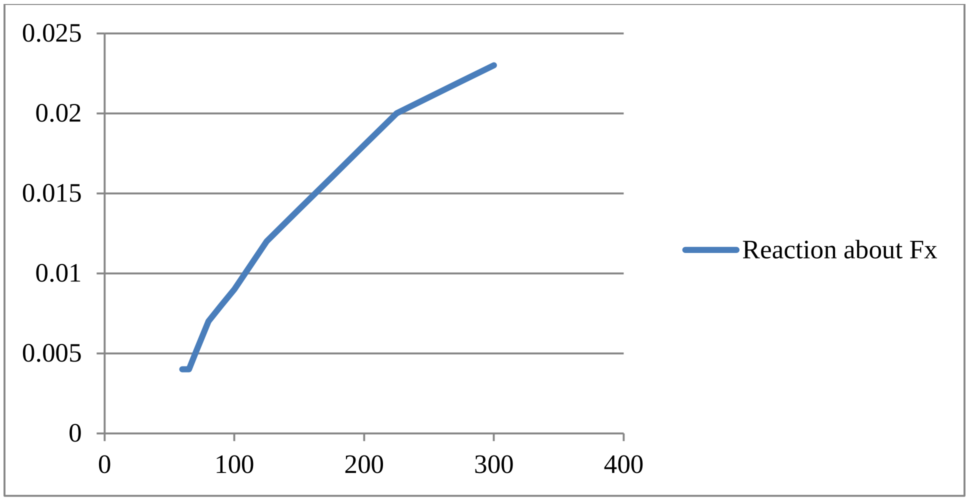

FIG: 4.1 Reaction About Fx

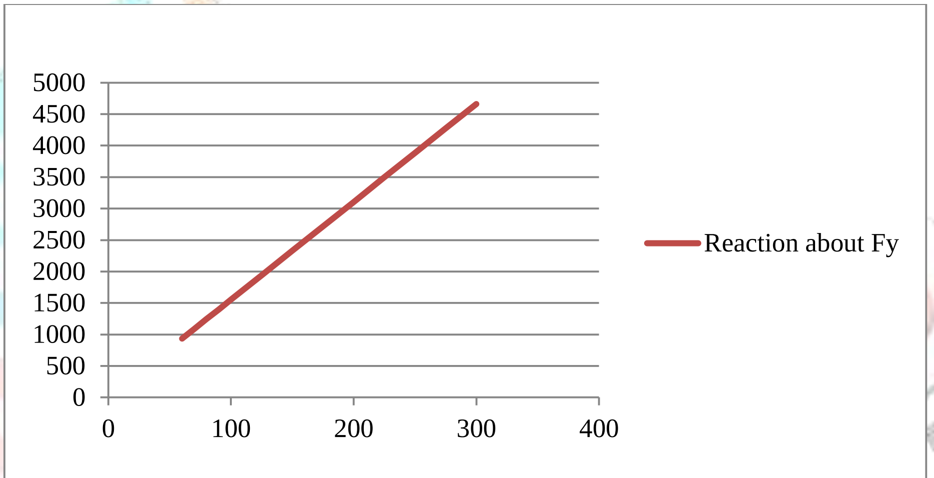

FIG: 4.2 Reaction about Fy

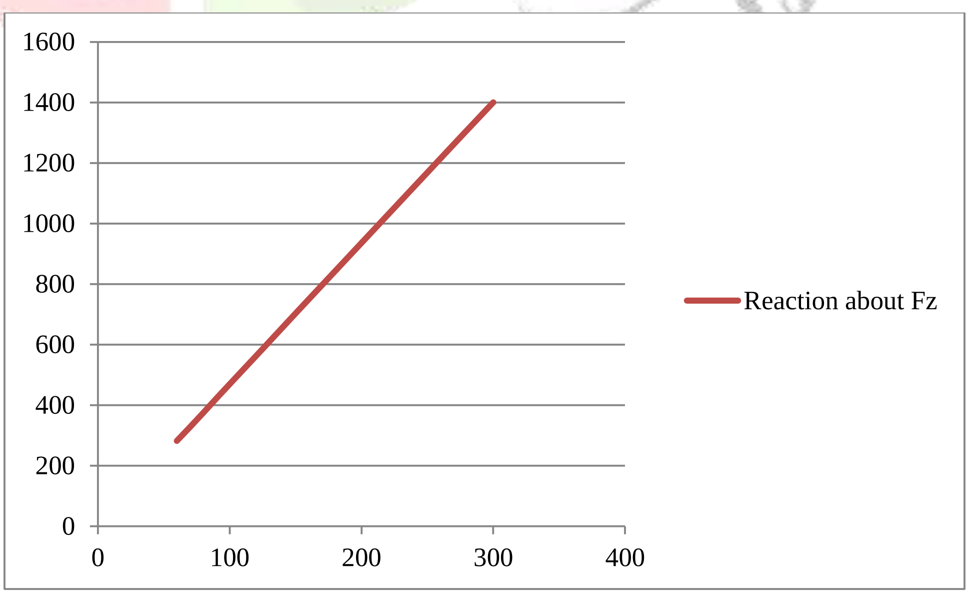

FIG: 4.3 Reaction about Fz

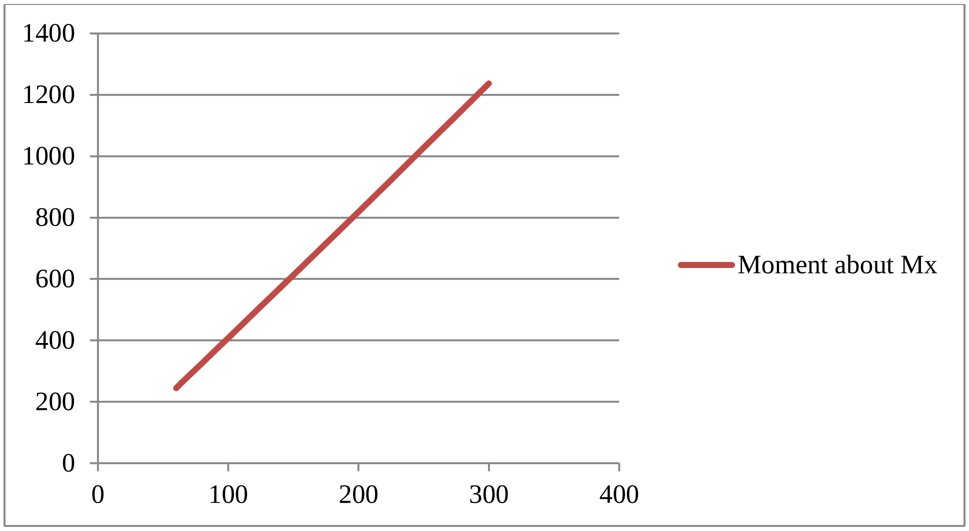

FIG: 4.4 Moment about Mx

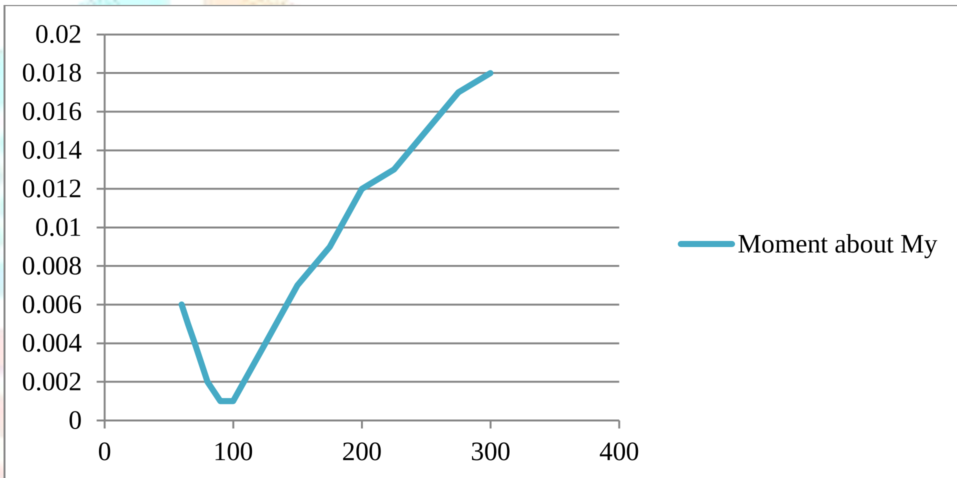

FIG: 4.5 Moment about My

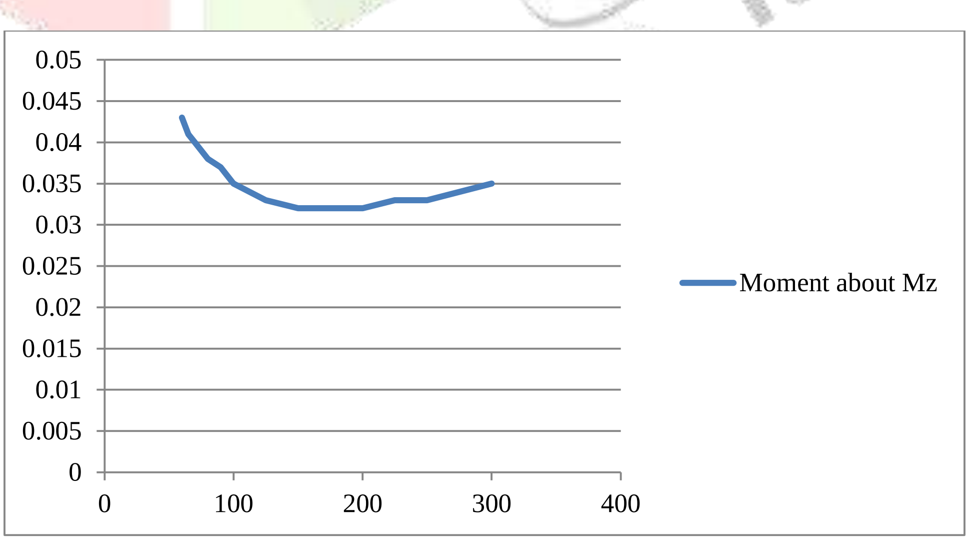

FIG: 4.6 Moment about Mz

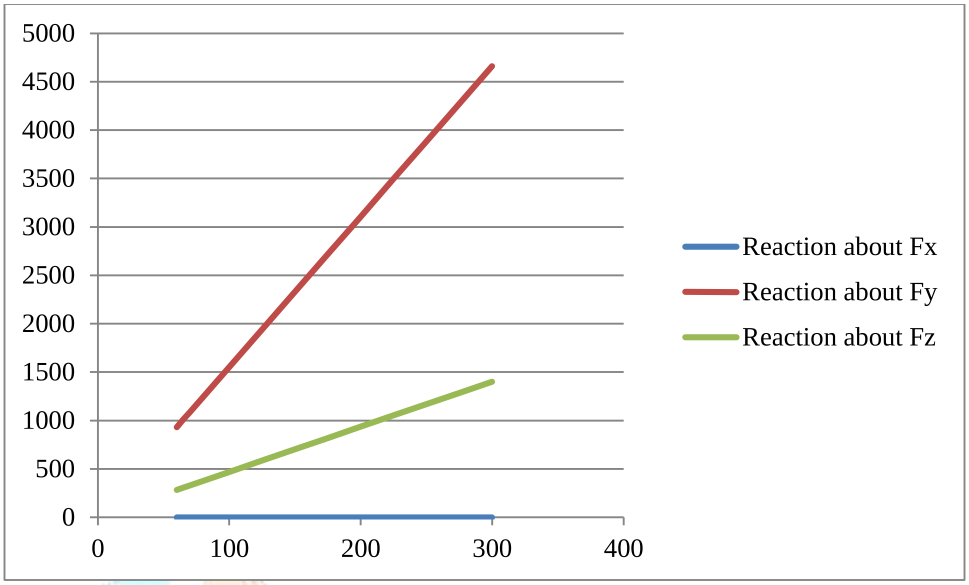

FIG: 4.7 Reactions about Fx,Fy and Fz

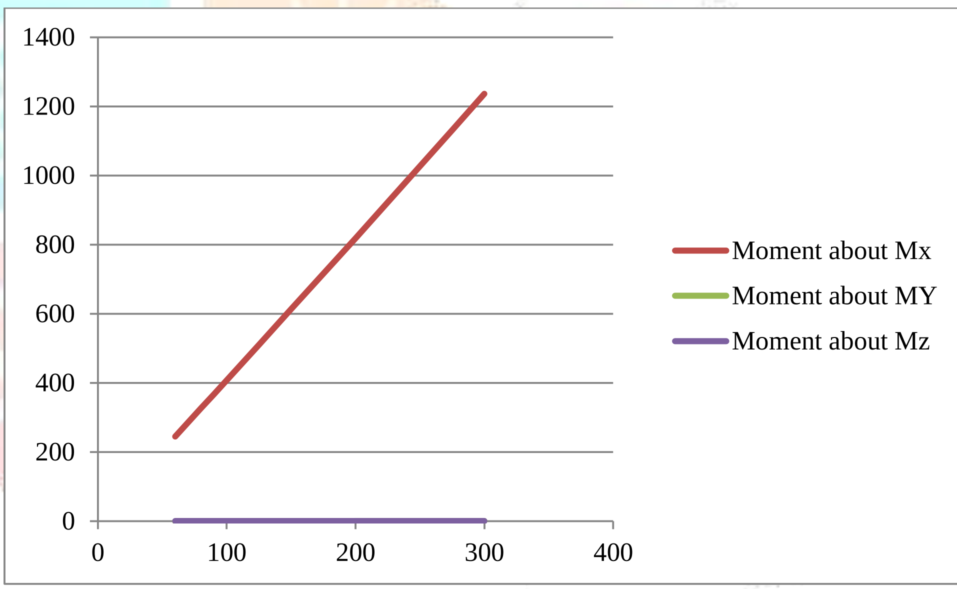

FIG: 4.8 Moments about Mx, My and Mz

V.CONCLUSIONS

1. The analysis and design of cooling tower was done using STAAD pro.
2. The dimension of plate thickness is taken between 60mm to 300mm.
3. The cooling tower was analyzed and designed for dead load, seismic load, different live loads and constant temperature of 1000degree Fahrenheit for axial elongation, 4000 degree Fahrenheit f for top to bottom and 2000 degree Fahrenheit for side to side.
4. The plate thickness having 300mm to 70mm carrying 5kN/m live load and the failure of structure occurs when the thickness of plate is 60mm.

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