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Analysis and Design of RC Chimney in STAAD-PRO

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Abstract: Reinforced chimneys are used in Power plants to take the hot and poisonous flue gas to a great height designed mainly to resist the lateral forces like wind and earthquake as well the thermal stresses of the flue gas. An attempt is made to understand the variation of lateral deflection at the top of the chimney, by varying the height of chimney above 275 m. A total of five models are selected for five different heights i.e 275m, 285m, 295m, 305m & 315m and the analysis is done. All the models were analyzed and the lateral deflection regarding is calculated. Code of practice for design of reinforced concrete chimney (Third revision of IS 4998:1992 [Part I]) is used for the referance analysis. STAAD PRO software is used to do the analysis. Further an attempt is made to understand the variation of lateral deflection at the top of the chimney for different heights.
Keywords: RC Chimney, Wind Analysis, Lateral Deflection, STAAD Pro.

I. INTRODUCTION

Owing to the increase in number population and technological progress, it requires a large supply of power for the smooth running of our modern world,thus leading to the increase in the number of power plants and due to this the concentration of harmful gases in environment goes on increasing which is having diverse effect on human as well nature body.

Due to design and construction problems, lots of chimneys have failed in structure in the past few decades causing a heavy wind blow on the power production sector. RC Chimneys being tall and slender need to be treated as special structure during its design & construction phases, since their behavior under loading conditions is different from other structures. The considerations of various load combinations having static and dynamic effects make the analysis and design of RC Chimney more complicated. Each of these cases is need to be treated specifically, depending on the height of the chimney, its location, type of plant and therefore typical design are not feasible.

II. REVIEW OF LITERATURE

Amit Nagar, et al (1) discussed the effects of various profiles of chimney elevation i.e., uniform chimney, tapered chimney and uniform-tapered chimney. The dynamic behavior of chimney due to wind load in wind zone I and seismic analysis were studied. Height was varied from 150 to 300 m for this study. It was found that uniform tapered was the best section considering the wind and seismic analysis

Lokeshwran N, G. et al (1), on their research paper discussed about "Effect of Dynamic Loads on Tall RCCChimneys of different heights with Elliptical and Circular Cross sections". In this paper Chimneys with circular and elliptical cross sections of five different heights viz. 275m, 300m, 325m, 350m and 400m with two different profiles in elevation – one tapering from bottom to top and the other tapering from bottom to 2/3 H and straight afterwards - has been analyzed for seismic and vortex shedding effects caused by wind forces; further, analyses had been carried out for three R/t ratios – 15, 20 and 25. In total 120 models had been analyzed 60 for seismic forces and 60 for vortex shedding effects. Analytical results in terms of stresses induced on the structure, earthquake base shear, joint acceleration, joint displacements and vortex shedding base shear are evaluated. The results indicated that output parameters for circular and elliptical cross-sections show significant variations.

III. METHODOLOGY

A. To achieve the above objective following step-by-step procedures are followed:
B. Carry out literature study to find out the objectives of the project work.
C. Understanding the design procedure of a concrete chimney as per third revision of Indian standard code IS 4998 (part 1):1992.
D. Analyze all the selected chimney models.
E. Evaluate the analysis results.

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1) Step 1 - Modeling

Basic model is generated through structure wizard and then transfer and superimpose it on the current structure in STAAD.Pro. First of all create the geometry of the model as shown in Fig. 1 with all the nodes.

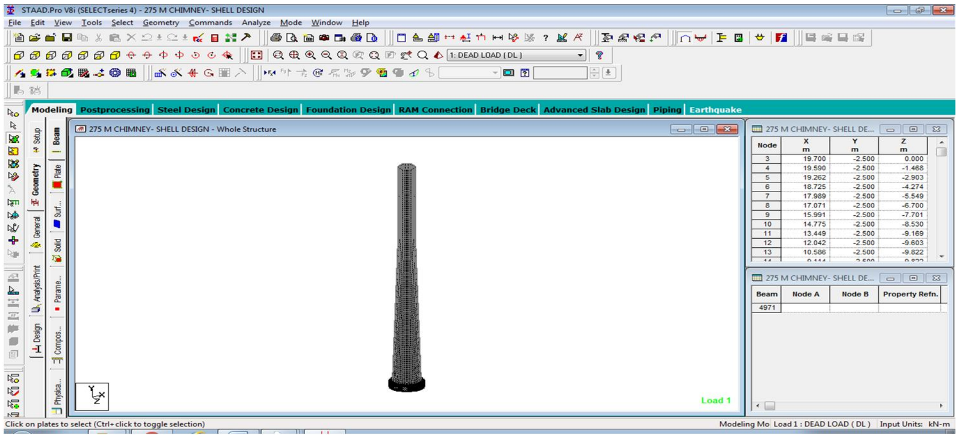


Fig 1 – Geometry Of Staad Pro

2) Step 2 – Member Properties

Once the geometry is prepared then the property is assigned to the models as shown in Fig 2.

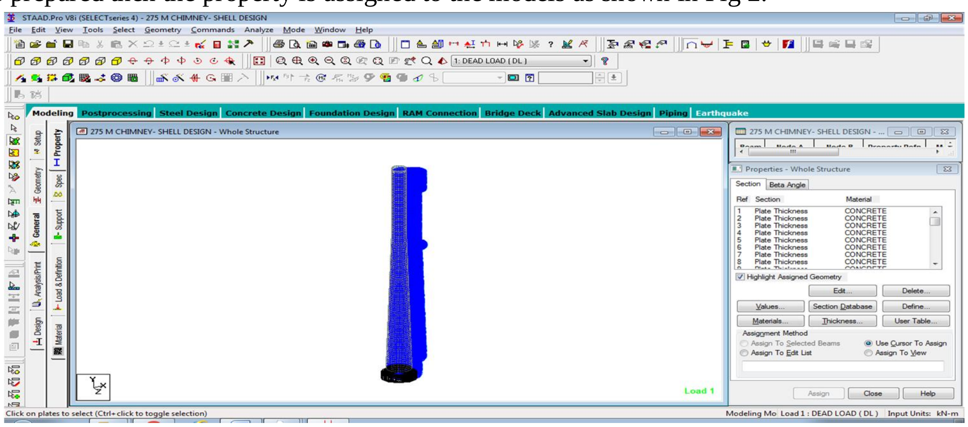


FIG 2 – Member Properties

3) Step 3 – Support Description

The support is described and assigned to the model. Fig 3 represents support reaction.

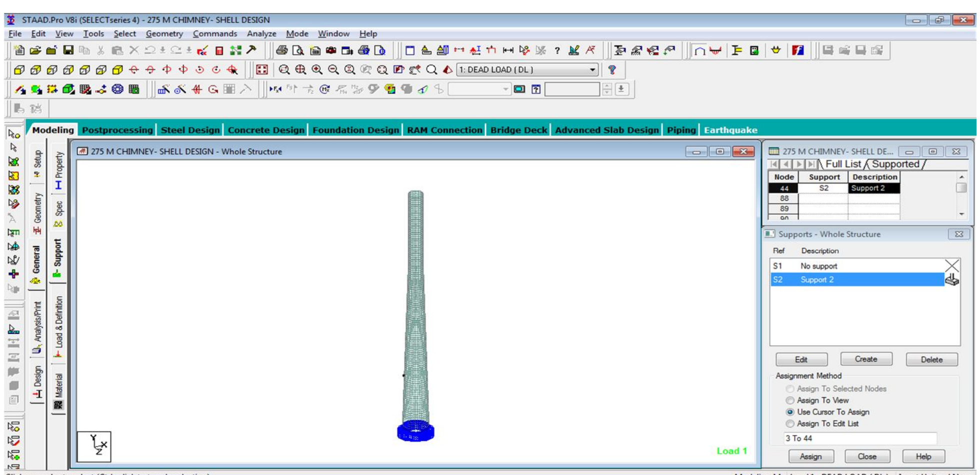


Fig 3 – Support Description

4) Step 4 – Load Definition & Load Assigned

Load are defined like dead load, wind load, earthquake load etc. Loads are assigned to the members. Load combinatins are specified. The same is illustrated in Fig 4.

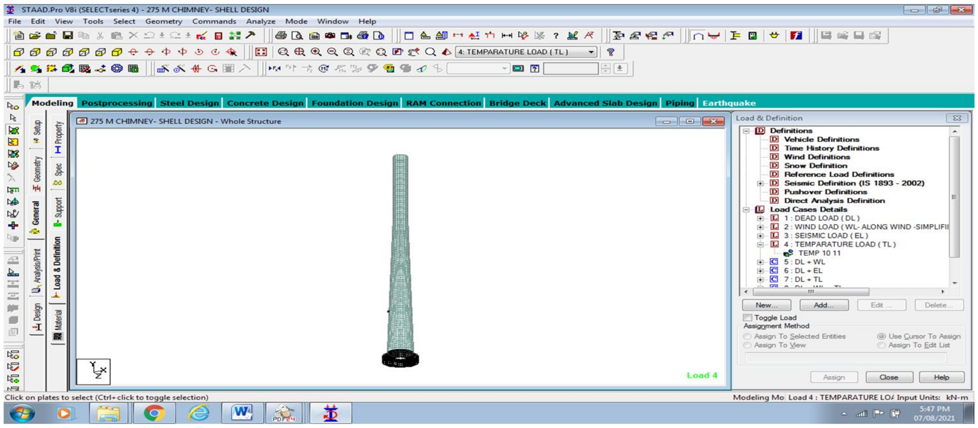


Fig 4 – Load Definition

5) Step 5 – Perform Analysis

STAAD model is now analyzed by PERFORM ANALYSIS command. Fig 5 shows the dialogue box of Perform Analysis command.

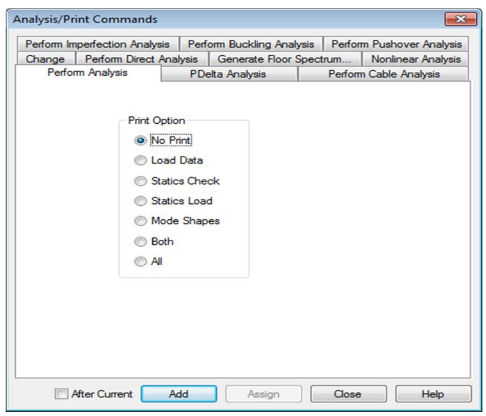


FIG 5 – PERFORM ANALYSIS

6) Step 6 – Post Processing

The post-processing command is used for the checking the analysis of the model and to check the results in terms of the different parameters. Fig 6 shows the analysed model in post processing.

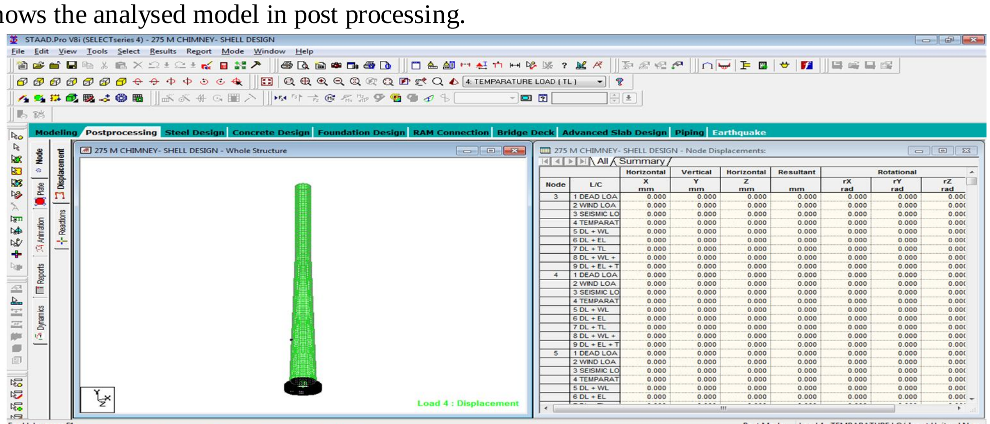


Fig 6 – Post Processing

Following figure (Fig. 7) shows the joint displacement of nodes & Fig 8 shows plate stress contour.

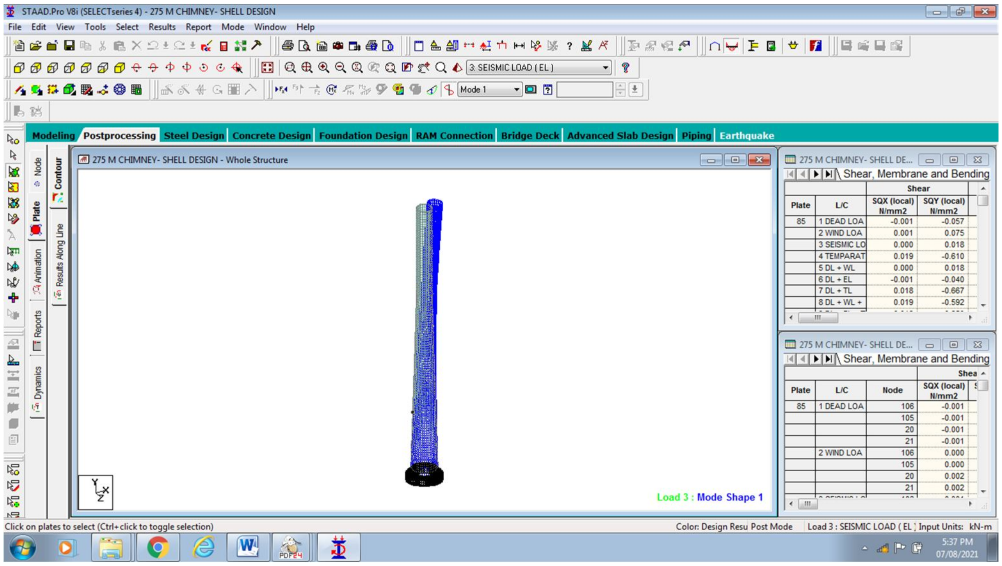


Fig 7 – Joint Displacment

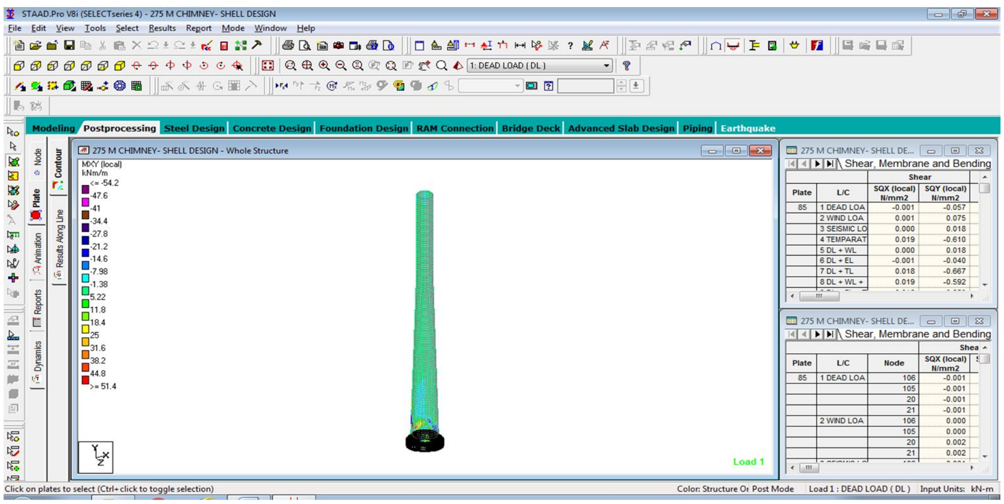


Fig 8 – Plate Stress Contour

IV. RESULT

For a particular height to base diameter ratio of 12 and slope 1in 50, the peak deflection was found to increase with increase in the height of the chimney. Following Table 4.1 shows the maximum lateral deflection at the top of chimneys for height varying from 275 m to 315 m.

	Height of chimney (m)				
	275	285	295	305	315
Limiting Deflection (m)	0.825	0.855	0.885	0.915	0.945
Max. Lateral Deflection at top (m)	0.34	0.36	0.38	0.41	0.43

From the above table, it is observed that all the maximum lateral deflections at top are well within the specified limits as stipulated in the codal provisions.

V. CONCLUSION

A. Comparing the results for a chimney profile having height to-base diameter ratio 12 and slope 1 in 50 the lateral deflection at top was found to increase by 5.48%, 11.45%, 18.62% and 25.90%, when the height is increased from 305 m to 315 m, 295 m to 315 m, 285m to 315m and 275m to 315m respectively

B. It is observed that all the maximum lateral deflections at top are well within the specified limits as stipulated in the codal provisions.

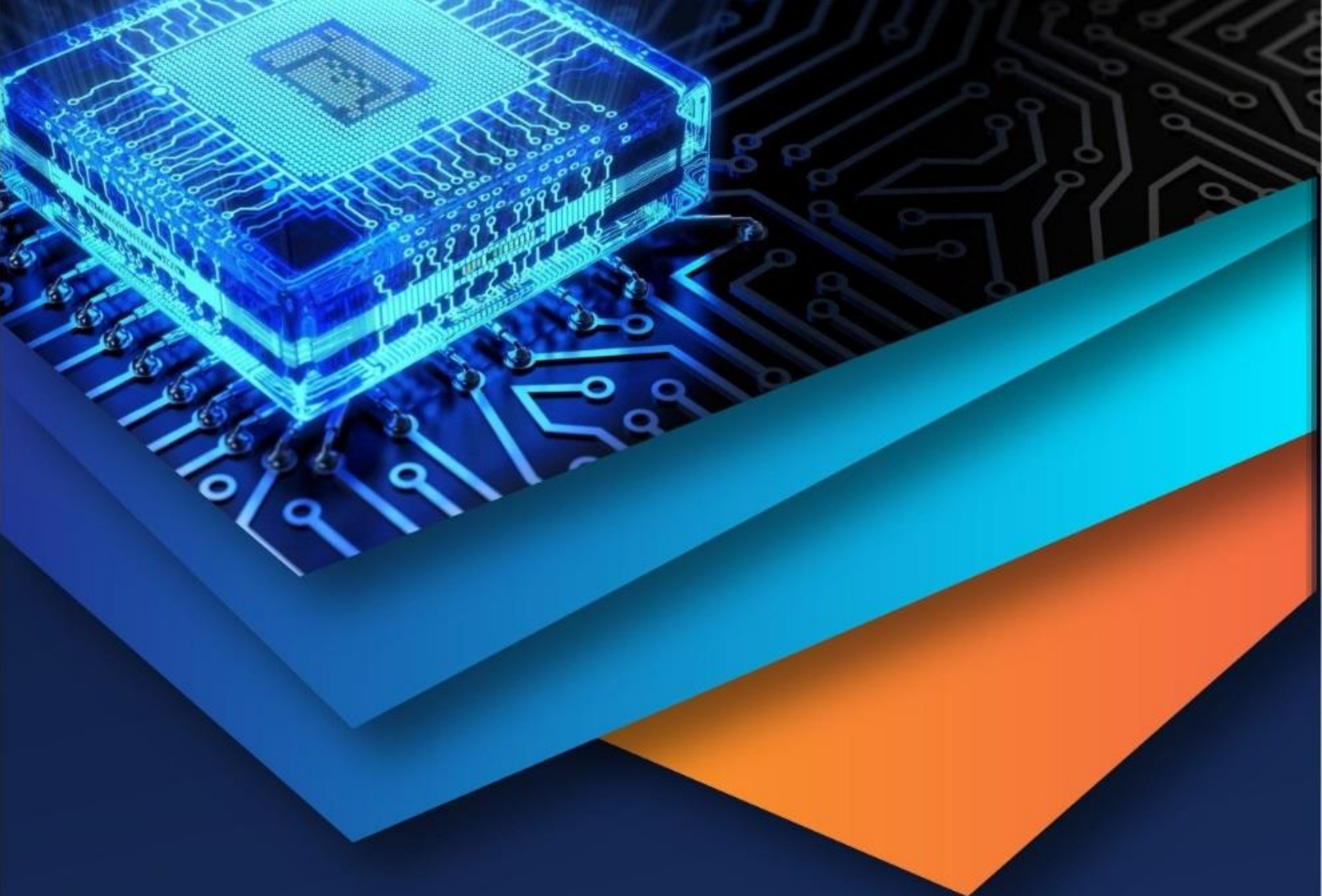
C. At small wind speed regions, along-wind effects are the governing factor for the design of RC chimney.

D. From the wind load and temperature load calculated it is clear that the wind effects are major constituent compared to Temperature effects.

E. It was also found that the lateral deflection at top of chimney increases with the increase in height of the slender structure.

REFERENCES

[1] S.N.Manohar, Tall Chimney: Design and Construction", Tata McGraw Hill Publications.
[2] IS 4998 (Part 1): 1992 "Criteria for design of reinforced concrete chimneys", part-1, Assessment of loads (Second Revision)" Bureau of Indian standards, New Delhi, 1992
[3] IS 456 : 2000 Code of practice for plain and reinforced concrete
[4] IS 1893 : 2002 Criteria for earthquake resistant design of structures
[5] IS1893 (Part 4) 2005 Criteria for earthquake resistant design of structures industrial structures including stack-like structures
[6] IS 875 Code of practice for design loads (other than earthquake) for buildings and Structures (part 1) for Dead loads , (Part 2) for Imposed loads , (Part 3) for Wind loads



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