Analysis of Industrial Reinforced Concrete Chimney

Veerajun S Wali[1] Rajendra J Thakai[2]
[1]PG Student [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]KLS Gogte Institute of Technology, Belagavi, India

Abstract— RCC chimneys are the industrial structures which are built to the greater heights as tall slender structures. Chimneys are used in the industries as the medium to pass the poisonous and highly contaminated gases to the greater heights at the atmosphere, with sufficient velocities. Thus being tall and slender structures, chimneys are more vulnerable to the wind load and earth quake loads which may cause a severe problems specially in the sensitive organizations like nuclear power plant and major other industries. Hence this project is carried out to understand the behavior and action of the wind component i.e. along wind loads and seismic load for various zones. And also the typed of chimney cross-section, which is more efficient and stable for the particular height.

Key words: Gust Wind Factor, Wind Analysis, Seismic Analysis

I. INTRODUCTION

RCC chimneys are the industrial structures which are built to the greater heights as tall slender structures. Chimneys are used in the industries as the medium to pass the poisonous and highly contaminated gases to the greater heights at the atmosphere, with sufficient velocities. Thus being tall and slender structures, chimneys are more vulnerable to the wind load and earth quake loads which may cause a severe problems specially in the sensitive organizations like nuclear power plant and major other industries.

II. METHODOLOGY

The STAAD Pro. Software provides different ways to model the chimney structure, depending upon the results that are required to determine the strength, stability, durability, sustainability of the reinforced concrete chimney. Thus during this project, the various types of models were done to arrive for the required results. In this project we were concerned about of only of top horizontal displacement.

Thus there were totally three types of models were done viz;

1) 8-noded beam element.
2) Line element (tapered beam element).
3) Plate element.

III. MODELING AND ANALYSIS

A. Problem Statement

- Height of the chimney – 60m
- Outer diameter of chimney at bottom – 5.455m
- Outer diameter of chimney at top – 3.273m
- Thickness of shell at bottom –0.3,0.4,0.45 m
- Thickness of shell at top –0.3,0.4,0.45 m
- Thickness of air gap – 0.08m
- Thickness of fire brick lining – 0.1m
- Grade of concrete – M25
- Height to base diameter ratio – 11
- Top diameter to base diameter ratio – 0.6
- Basic wind speed – 55m/s
- Foundation type – RCC circular mat

B. 8-Noded Beam Element

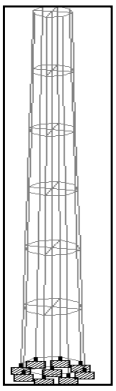

Fig. 1: 8-Noded Beam Element

C. Line Element (Tapered Beam Element)

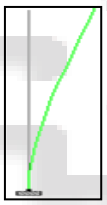

Fig. 2: Line Element

D. Plate Element

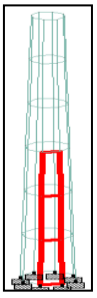

Fig. 3: Plate elements

IV. RESULTS AND DISCUSSIONS

A. Tabulations of Results

Height (m)	Intensity (KN/m)
10	3.5
20	5.2
30	7.2
40	9.5
50	12.01
60	15.12

Table 1: For tapered chimney section (along wind)

Height (m)	Intensity (KN/m)
10	3.85
20	5.48
30	7.89
40	9.90
50	13.05
60	15.65

Table 2: For cylindrical chimney section. (Along wind)

Height of chimney	(m)	60	60	60
Thickness of shell	(m)	0.30	0.40	0.45
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.073	0.062	0.054

Table 3: Deflection for tapered section (wind analysis)

Height of chimney	(m)	60	60	60
Thickness of shell	(m)	0.30	0.40	0.45
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.055	0.045	0.041

Table 4: Deflection for cylindrical section (wind analysis)

B. Tabulations of Results (Seismic Analysis)

Height of chimney	(m)	60	60	60
zone		3	4	5
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.049	0.074	0.111

Table 5: Deflection for tapered section of 0.3 m thick

Height of chimney	(m)	60	60	60
zone		3	4	5
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.051	0.077	0.116

Table 6: Deflection for tapered section of 0.4 m thick

Height of chimney	(m)	60	60	60
zone		3	4	5
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.054	0.079	0.119

Table 7: Deflection for tapered section of 0.45 m thick

Height of chimney	(m)	60	60	60
zone		3	4	5
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.043	0.064	0.097

Table 8: Deflection for cylindrical section of 0.3 m thick

Height of chimney	(m)	60	60	60
zone		3	4	5
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.044	0.067	0.100

Table 9: Deflection for cylindrical section of 0.4 m thick

Height of chimney	(m)	60	60	60
zone		3	4	5
Limiting deflection	(m)	0.18	0.18	0.18
Lateral deflection at top	(m)	0.045	0.069	0.103

Table 10: Deflection for cylindrical section of 0.45 m thick

C. Overall View

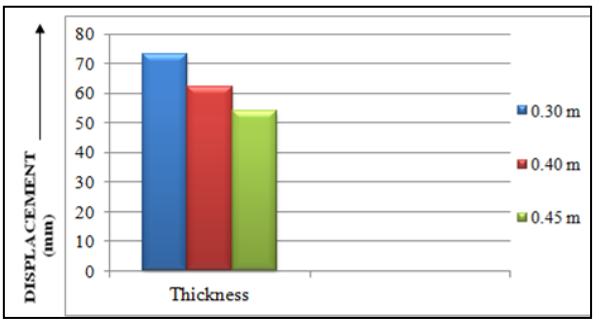

Fig. 4: For Tapered section (Along winds)

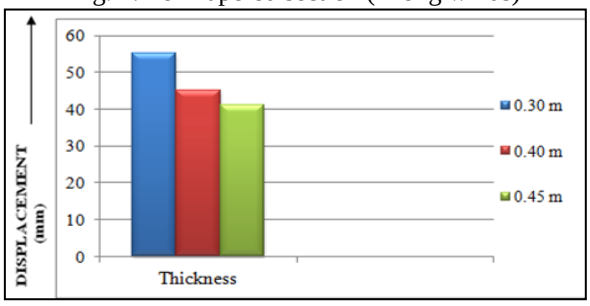

Fig. 5: For Cylindrical section (Along winds)

1) Earthquake Analysis

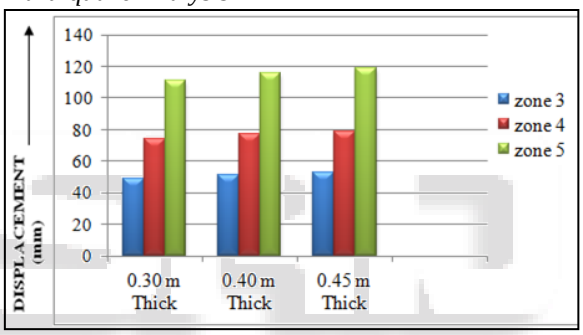

Fig. 6: For Tapered section

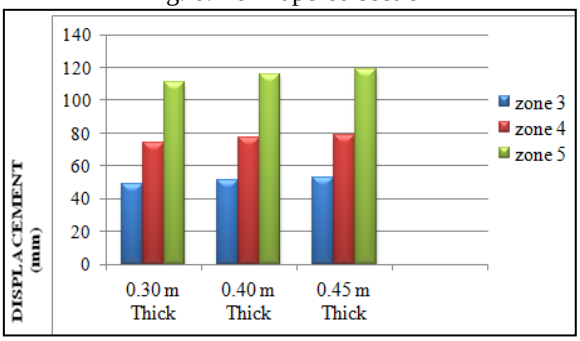

Fig. 7: For Cylindrical section

V. CONCLUSIONS

- Wind load increases as the height of the chimney increases
- Wind load increases linearly along the height of the chimney.
- As the thickness of the concrete shell increases, the deflection of the chimney reduces for the wind analysis.
- For the 60m height of the chimney, the tapered chimney section seems to be more deflecting compared to the cylindrical section.
- For seismic analysis, the deflection increases as the thickness of the concrete shell increases.

- Cylindrical section seems to be more stable or lesser deflection compared to the tapered chimney section for the height of 60m.
- When compared to both along wind load and seismic analysis, between the tapered section and cylindrical section, the cylindrical section is more efficient and stable.

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