

**A REVIEW OF ANALYSIS OF INDUSTRIAL STEEL CHIMNEY**Hardik D.Lapsiwala¹, Hitesh Dhameliya², Hiten Kheni³¹M.Tech (Structure) Civil Department, ChhotubhaiGopalbhai Patel Institute of Technology, hlapsi@gmail.com²Asst. Prof. Civil Department, ChhotubhaiGopalbhai Patel Institute of Technology, hitesh.dhameliya@utu.ac.in³Asst. Prof. Civil Department, ChhotubhaiGopalbhai Patel Institute of Technology, hiten.kheni@utu.ac.in

Abstract— It has been undergone a considerable development of industrial chimney in past few years in terms of structural system as well as method of analysis. Also the height of chimney has been increased for the better control of environment pollution in populated areas. With the increase in height, the wind forces have become predominant forces while analyzing and designing such structures. Here in this paper, an attempt has been made to analyses the industrial steel chimney for the prevailing wind forces and seismic force considering chimney with and without guy ropes.

Keywords- wind force, seismic force, deflection, manhole

I. INTRODUCTION

The chimney is a structure for venting hot flue gases or smoke from a boiler, stove, furnace or fireplace to the outside atmosphere. Chimneys are typically vertical, or as near as possible to vertical, to ensure that the gases flow smoothly, drawing air into the combustion in what is known as the stack, or chimney, effect. Scientific discoveries have lead to the establishment of various types of industries. These industries supply smoke and harmful gases in to the atmosphere. Due to heavy industrialization and installation of high capacity power plants together with the growing consciousness about pollution has led to the construction of tall chimneys. However, with the increment in height, the wind actions on it become important as these produce very high stresses. Although chimneys do not present as a great hazard to life and limb as buildings with high human capacity, damage to chimneys may result in shut down of plants and industries. The chimney may be self supporting or guyed chimney. In this paper, an attempt has been made to analyze the industrial steel chimney with and without guy ropes for prevailing wind conditions and forces.

II. LITERATURE REVIEW

- **KIRTIKANTA SAHOO, PRADIP SARKAR AND ROBIN DAVIS, “ANALYSIS OF SELF SUPPORTED STEEL CHIMNEY WITH THE EFFECT OF MANHOLE AND GEOMETRICAL PROPERTIES” INTERNATIONAL JOURNAL OF SCIENTIFIC & ENGINEERING, MAY 2013**

KirtikantaSahoo, PradiP Sarkar and Robin Davis presents the analysis and design of self-supported steel chimney. The chimney is considered as a cantilever column with tubular cross section for analysis. Wind load, Temperature loads, seismic load and dead loads are considered for design purpose. But apart from these load they considered wind load is most vital load due to height of the structure. The effect of wind can be divided into two components: (a) Along wind effect (b) Across wind effect. But the across wind effect is most critical and unpredictable. Design force in a chimney is very sensitive to its geometrical parameter such as base and top diameter of chimney, height of the flare, height of chimney and thickness of the chimney shell. Manholes are provided at the bottom in the chimney for inspection purposes. Two chimney models, one with the manhole and other without manhole, are analyzed using finite element software ANSYS for static wind load.

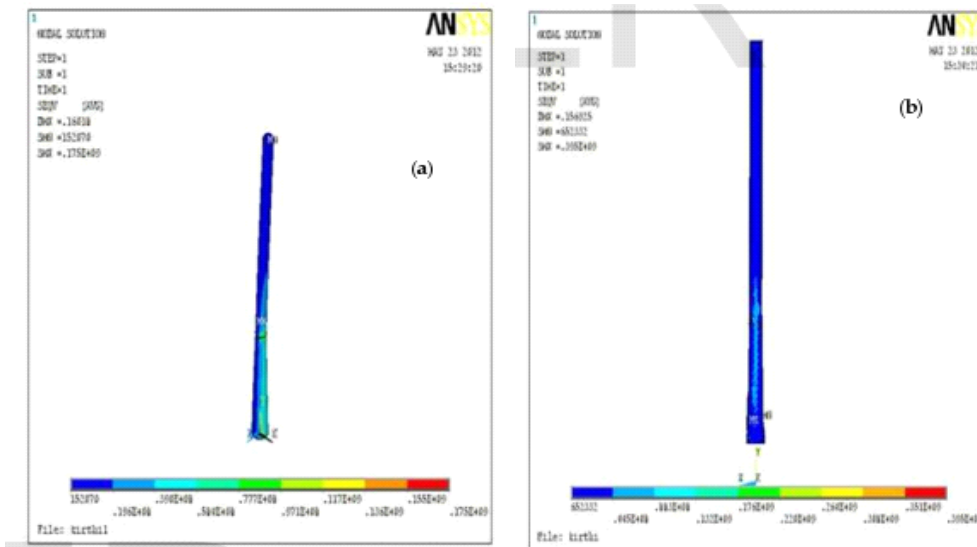


Figure 1: Comparison of Von-Mises Stress: (a) without manhole; (b) with manhole

Figure: 1 show that the maximum stress in the chimney with manhole is increased 55.6% as compared to the maximum stress in chimney without manhole.

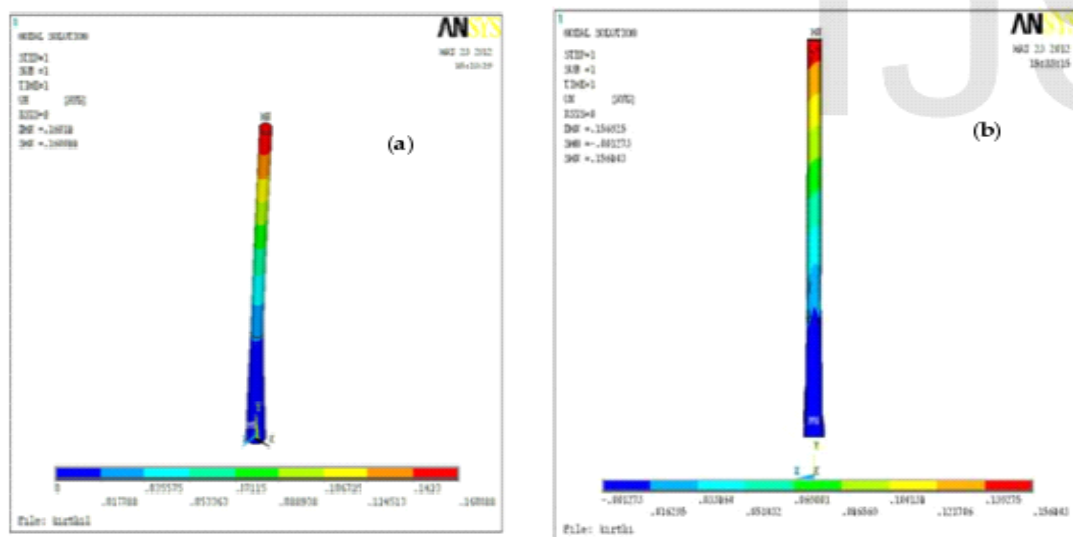


Figure 2: - Comparison of top deflection in chimney: (a) without manhole; (b) with manhole

Figure 2 shows that higher deflection is occurred at the top of chimney with the manhole as compared to chimney without manhole. Chimney without manhole is found to have higher fundamental frequency compared to the chimney with manhole.

The presence of manhole reduces the area and hence the stiffness of the chimney.

- **G. MURALI, B. MOHAN, P. SITARA AND P. JAYASREE, “RESPONSE OF MILD STEEL CHIMNEY UNDER WIND LOADS”, INTERNATIONAL JOURNAL OF ENGINEERING AND APPLICATION, MARCH-APRIL 2012**

In this paper they deal with the study of three chimney 55m high above ground level. These chimneys were designed as per **IS: 6533–1989** and wind load was calculated as per **IS: 875–1987**. Three different wind speeds were considered for the design of chimneys viz., 47m/s, 50m/s & 55m/s respectively. They considered parameter for study of static forces, the static moment, dynamic moment and thickness of chimney shell were compared to three chimney. However these three chimney are divided into six zones, the height of zone1, 2, 3, 4, 5 and 6 is to be 10m, 10m, 9m, 9m, 9m, and 8 respectively.

Table 1- Geometry of chimney

Chimney	Basic Wind Speed (m/s)	Height (m)	Top diameter (m)	Bottom diameter (m)	Flared Height (m)
1	47	55	1.6	3	20
2	50	55	1.6	3	20
3	55	55	1.6	3	20

Compare to the C1 the static force is gradually increasing for C2 and C3 is found to be 15% and 40% for zone 1, 15% and 40% for zone 2, 15% and 40% for zone 3, 15% and 40% for zone 4, 15% and 40% for zone 5, 15% and 40% for zone 6. The static forces for the C3 in all the zones are higher than the C1 and C2 due to higher basic wind speed than C1 and C2. And also compared to the C2 the static force is gradually remain same for C1 and C3 is found to be 13% and 21% for zone 1, 13% and 21% for zone 2, 13% and 21% for zone 3, and 13% and 21% for zone 4, 13% and 21% for zone 5, 13% and 21% for zone 6. Finally compared to the C3 the static force is gradually decreasing for C1 and C2 is found to be 28% and 17% for zone 1, 28% and 17% for zone 2, 28% and 17% for zone 3, and 28% and 17% for zone 4, 28% and 17% for zone 5, 28% and 17% for zone 6. The static forces for the C3 in all the zones are higher than the C1 and C2 due to higher basic wind speed than C1 and C2.

The dynamic force is increased in the range of 4% to 16% for C2 and 4% to 16% for C3 compared with C1. This indicates the basic wind speed is directly proportional to the dynamic forces on chimney. And also dynamic force is varies in the range of 4% to 10% for C1 and 12% to 20% for C3 compared with C2. The dynamic force is decreased in the range of 14% to 20% for C1 and 10% to 20% for C2 compared with C3. This indicates the basic wind speed is directly proportional to the dynamic forces on chimney.

It can be observed that, the static moment for the C2 and C3 is increased up to 15% and 40% for zone 1, zone 2, zone 3, zone 4, zone 5 and zone 6 respectively. This indicates that the static moments for the six zones are to be same even when the zone height is varying.

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Based on the results obtained from the design of chimney they observed that the static force and static moment for all the zones of C3 is 15% and 21% higher than the C1 and C2. The dynamic force and dynamic moment for all the zones of C3 is increased up to 4% and 12% than C1 and C2 respectively. The thickness is found to be same for all the chimneys even the basic wind speed is varying.

• **SULES, NWOFOR T.C, “WIND INDUCED VIBRATION OF A TALL STEEL CHIMNEY”, CANADIAN JOURNAL ON ENVIROMENTAL, CONSTRUCTION, CIVIL ENGINEERING, FEBRUARY 2012**

In this paper, the vortex induced vibration of a 50m steel chimney under wind excitation is discussed. A steel chimney of length 50m is modeled as a cantilever structure subjected to two degrees of freedom. Lumped parameter approach was employed to estimate the natural frequencies of vibration. It was shown among other findings that the intensity of wind loading varies with chimney height with maximum value at chimney top and minimum value at the base and the frequency of vortex shedding due to wind excitation was found to be greater in value than the fundamental frequency of vibration showing that the chimney may go into resonance leading to a very large and severe deflection and damage to the steel chimney in the form of fatigue during the expected lifetime of the structure.

Table 2- Wind pressure at different height of chimney

Chimney	Height (m)	Wind Pressure(KN/m ²)	Wind Load(KN)
1	10	0.208	1.17
2	20	0.304	1.70
3	30	0.390	2.18
4	40	0.467	2.62
5	50	0.519	2.91

The dynamic analysis of a 50m steel chimney modeled as a two-degree of freedom structural system under wind excitation was carried out using a lumped mass approach. The results of the analysis showed that the fundamental frequency of vibration of the chimney was much lower in value than the frequency of the vortex shedding showing the

possibility of the chimney going into resonance resulting in large displacement and stresses which may cause fatigue failure during the expected lifetime of the chimney.

Guyed cables should be provided between the top of the chimney and the ground to minimize the effect of flow induced vibration. The intensity of wind loading is a function of the height with maximum value at chimney top and minimum value at chimney base.

III. CONCLUSION

All the above reviews conclude that the wind effect on steel chimney is most critical and unpredictable as compared to earthquake loading. For Designing of steel chimney, height of chimney, base diameter, top diameter and thickness of chimney is most critical parameter.

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