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A CASE STUDY ON STEEL CHIMNEY

Mohammad Imran Shah
Assistant Professor (Civil Engineering)
GVIET Chandigarh, India

Pervaiz Ul Hassan
B. Tech (4th year)
GVIET Chandigarh, India

Redwana Shujat
B. Tech (4th year)
GVIET Chandigarh, India

Abstract - Steel chimney, also known as steel stacks is an important industrial structure that must be constructed quickly and must be taller than all the other structures in the surrounding region. A steel chimney is chosen to satisfy this purpose, as a steel chimney can be constructed relatively faster and is more durable, and requires lower maintenance after construction. A self-supporting steel chimney is tall and cylindrical industrial structure which is extremely important for the emission of poisonous and toxic gases into the earth's atmosphere; hence it should be designed to withstand forces by extreme winds and also withstand seismic forces. The construction of tall steel stacks have been on the increase in the last couple of decades, due to primarily increasing demand for air pollution control. This work investigates only the behavior of a self-supporting steel chimney of height 100m in different wind zones in India in accordance with Indian standard codes. Also the comparison effects of loads due to wind and earthquake loads have also been performed.

I. INTRODUCTION:

A chimney is a structure which provides ventilation for 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. The space inside a chimney is called a flue. The height of a chimney influences its ability to transfer flue gases to the external environment via stack effect. Additionally, the dispersion of pollutants at higher altitudes can reduce their impact on the immediate surroundings. In the case of chemically aggressive output, a sufficiently tall chimney can allow for partial or complete self-neutralization of airborne chemicals before they reach ground level. The dispersion of pollutants over a greater area can reduce their concentrations and facilitate compliance with regulatory limits. Stacks are very important industrial structures for emission of poisonous gases to a higher elevation such that the gases do not contaminate surrounding atmosphere. These structures are tall, slender and generally with circular cross-sections. Different Construction materials, such as concrete, steel or masonry, are used to build chimneys. Steel chimneys are ideally suited for process work where a short heat-up period and low thermal capacity are required. Also, steel chimneys are economical for height up to 45m. There are many standards available for designing self-supporting industrial steel chimneys: Indian Standard IS 6533: 1989 (Part-1 and Part-2), Standards of International Committee on Industrial Chimneys CICIND 1999 (Rev 1), etc. Steel Chimneys are gaining more popularity as more and more tall steel chimneys are being demanded. The time of construction is greatly reduced, and also the chimney is robust and reliable in tough conditions. This allows a steel chimney to put in to use as sooner in comparison to the reinforced concrete chimney. However taller steel chimneys have their own set of problems as designing a steel chimney becomes a difficult task as tall chimneys are subjected to higher wind speeds and higher vibrations due to seismic loads. Also a steel chimney can be really expensive. The present study is a report on the design and analysis of a steel chimney in different wind zones of India and their behaviour due to the corresponding Wind Load due the wind speed in that particular region or city. The moments due the wind load, and the moments due to seismic loads is compared. Also the base shear due to the corresponding Wind Load and the Base shear due to seismic load are compared, to find out which load has greater effect on the design parameter of a steel chimney. The present study is performed on a steel chimney of height 100m with welded joints, only one flue opening and with cylindrical block type foundation.

II. METHODOLOGY

A study on the various parts of a chimney, Understand the procedure of design of a steel chimney as per IS 6533:1989., Select various points and following the various limitations as per the Indian Standard Code., Compare the various forces and moments acting upon the chimney analyzed and designed for different wind zones.

III. RESULTS & DISCUSSION

Table1.1: Total weights of chimney in three wind zones

Wind Zone	City	Wind speed	Segment of steel selected (mm)										Total weight of steel Stack (Ws)kN	Total weight of Lining (W_l)kN	Total weight of chimney (W_s+W_l) kN	Total weight of the Chimney (W_t)kN
			1	2	3	4	5	6	7	8	9	10				
IV.	**Hyderabad**	**44**	**14**	**14**	**14**	**14**	**14**	**16**	**18**	**20**	**22**	**22**	1256.81	2048.3	3299.124	3465
VI.	**Bangalore**	**33**	**14**	**14**	**14**	**14**	**14**	**14**	**16**	**18**	**20**	**20**	1340.31	2048.3	3388.622	3560

Table1.2: Wind moments, seismic moments, wind forces and base shears at base

Wind Zone	Seismic Zone	City	Wind Speed (m/s)	Wind Moment at the Base (kN-m)	Seismic Moment at Base (kN-m)	Wind Force at the Base kN	Base shear (Seismic) kN
IV.	2	Hyderabad	44	16123.36	1256.81	319.1	59.4
VI.	2	Bangalore	33	8867.3	1913.856	179.44	60.99

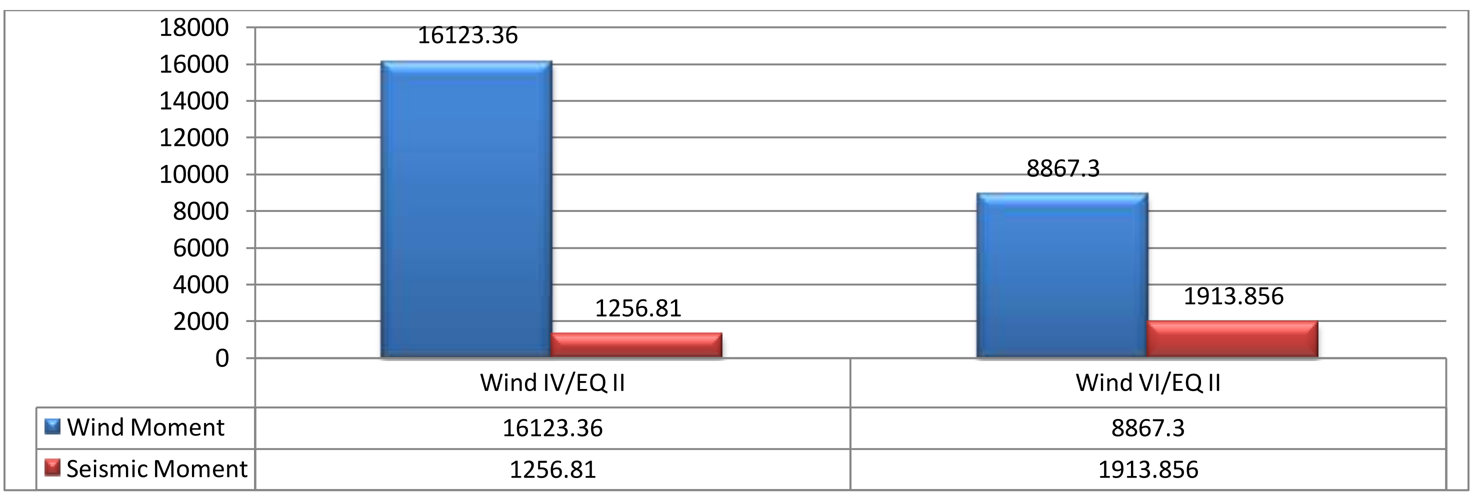

Fig 1.1 Moments at the base of the chimney

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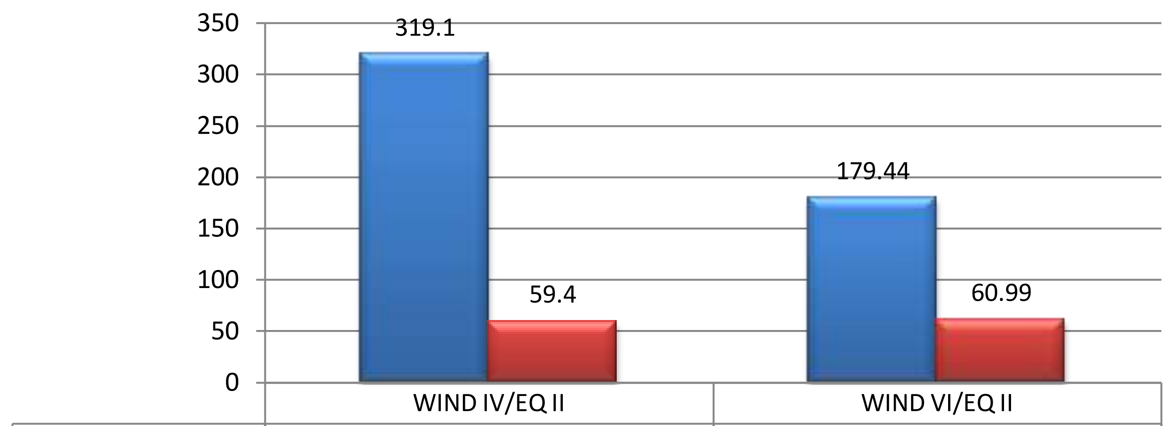

	WIND IV/EQ II	WIND VI/EQ II
Base shear(wind)	319.1	179.44
Base Shear(Seismic)	59.4	60.99

Fig. 1.2 Forces at the base of the chimney

IV. DISCUSSIONS

From the above Tables and graph we begin our discussions about the effect of different wind speeds on the weight and the thickness of the steel chimney. As the wind speed increases on the chimney, the thickness of the chimney sections also has to be increased so as to withstand the force exerted by the wind and also the consequent moment produced in each section. Due to this increase in thickness of each section, the total weight of the chimney also increases. This increase in weight not only helps in resisting moments, also helps in maintaining the stability of chimney. The next point of discussion is the effect of wind loads and seismic loads on the base of the chimney. As the chimney is designed for different wind zones which have different wind speeds. The Table 1.1 clearly shows , as we move from Wind zone IV (Hyderabad,44 m/s)to Wind zone VI(Banglore,33 m/s), there is a considerable decrease in the speed of the wind, and also there is a sharp decrease in the consequent moment at the base due the wind load. Also the shear force at the base of the chimney also decreases from Wind Zone I to Wind Zone III.

A graphical comparison is performed between the moment due to Wind Load at the base and the moment due to Seismic Load at the base. From the graph it is clearly visible that in all cases, the moment at the base due to wind load is very high in comparison to the moment due to seismic load. Also a graphical comparison has been performed between the base shear due to wind load and base shear due to seismic load. Even in this case, the base shear due to Wind Load is very large in comparison to base shear due to Seismic Load in that particular region.

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