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A Review on Dynamic Analysis on the High Varying Chimney for the Fix and Flexible Base

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ABSTRAT: Chimneys or stacks are very essential industrial structures used for the emission of toxic gases or smoke from a boiler, stove, furnace or fireplace to a larger elevation such that the gases should not contaminate the surrounding environment. These structures are generally tall, slender in nature and consist of circular or cylindrical cross-sections. Different types of construction materials, such as concrete, steel, brick masonry, are used to construct chimneys. Steel chimneys are preferably suited for process works where a short term heat-up period and inadequate thermal capacity are required. Chimneys are usually designed for loads produced by seismic effect and wind. So, it is inevitable to analyses the dynamic response of chimney due to effect of earthquake. The prime focus of this research is to conduct the seismic analysis of a reinforced concrete chimney. For this analysis Chimneys with fixed and flexible base subjected to seismic forces were analyzed under different soil condition like hard, soil strata for 100, 120 And 180m of height.

KEYWORDS: Chimney, Fix and Flexible Base, Response Spectrum, 100, 120 And 180m Height.

I. INTRODUCTION

During the last few decades the use of reinforced concrete chimneys in place of brick masonry and steel chimneys have become very popular due to their low cost and durability. Composite material like reinforced concrete is eminently suited for chimney stack. Brick chimneys are very heavy requiring expensive foundation. In contrast to the steel chimneys, the maintenance costs are minimum in the case of concrete stacks. Also the development silp form method of constructing cylindrical stacks as resulted in rapid construction in the case of concrete chimneys. The thickness of the concrete shell generally varying from 120 to 300mm is considerably smaller than that required in the case of brick chimneys. Concrete stacks with lesser maintenance costs are architecturally superior to masonry and steel chimneys. A reinforced concrete chimney is generally circular in shape with a rigid concrete shell cast with a rich concrete mix of M-20 to M-25 grade and provided with longitudinal vertical reinforcement and horizontal hoop reinforcement. A fire brick lining 100 to 150 mm thick is provided inside the concrete shell with an air gap to reduce the temperature gradient from the interior surface of fire brick lining to the exterior surface of the concrete shell. Reinforced concrete brackets with holes are provided at regular intervals to support the fire brick lining. At the bottom of the chimney, provision is made for a flue opening. The chimney is generally made to rest on a circular raft foundation.

A. Types of Chimneys

1. Concrete chimney

The quality of the concrete shows deterioration when there are implementation defaults. Since concrete is not as homogeneous and isotropic as steel, the static calculations depends on acceptances. The margin of error is a lot more and this causes additional high costs

2. Steel chimney

The quality of steel construction components are always under control. They are produced in factory conditions according to the standards in proper sizes and proportions. As it is a homogeneous and isotropic material it reacts as expect

3. Brick chimney

The white material which appears on brick is a powdery mass of minerals called efflorescence. Efflorescence occurs when moisture moves through concrete or other masonry

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II. STATE OF DEVELOPMENT

[1] Sushmita Tandan et. al. (2023) Different types of steel chimney models are made by varying their height, diameter and geometry. Steel chimneys are generally cylindrical. Loads acting on steel chimneys are easily transferred to the foundation by widened or flared sections, chimneys built today are often susceptible to wind due to their size, shape, flexibility, slenderness and of their lightness. Therefore, special attention should be p aid to the safety and economy of the structure when designing the steel chimney.

[2] Verma, P., (2023) Evaluated the induced pressure across the chimney with different shapes: sharp-edged, chamfered, and filleted-edged. On chimneys made of M25 concrete, FSI studies were conducted. The durability and structural stability of chimney constructions were proven at high wind speeds (i.e., 44 m/s). It was found that the induced pressure on the chimney construction could be precisely calculated using the CFD modelling tool.

[3] Singh, G., Saxena, K. and Shenai, G., (2022) Aimed at deriving standard curves with the help of which one can easily calculate the approximate wind load on a chimney in shell-completed condition. The curves have been plotted for chimneys with varied heights, top internal diameters, taper, and locations in various wind zones. These curves will determine the finalization of the chimney's starting size and the framework that will support it. They got to the conclusion that wind load increases along with the wind zone. Despite the fact that wind and height have a parabolic relationship, in very tall tapered stacks, the along wind load reduces as the diameter grows with increasing wind speed.

[4] Ahmida, K.M., Abuaisha, S.N., Allaboudi, E.G. and Abead, M.S., (2022) The maximum and average wind speeds were considered in the analysis. After performing stress and deformation evaluations, the deflection at the top of the chimney was calculated and compared to standards recognized worldwide. The plant's rising surrounding population led them to the conclusion that the chimney could still need to be taller in order to protect the neighborhood's buildings from hazardous emissions.

[5] Bhakti Soni et. al. (2022) Present work investigates the performance of self-supported steel chimney considering different shape factors for wind forces at different heights.. It has been observed that, for 60m flared chimney, induced equivalent stresses in hexagonal shape in less than the stresses induced in other shapes but total deformation was found lesser for circular as compared to other shapes. Analysis of 30m unflared chimney shows better performance towards hexagonal shape that means lesser values of induced stresses and total deformation as well.

[6] Richa Chandrakar et. al. (2022) The chimneys are tall structures which are subjected to heavy wind loads. The current research reviews various researches conducted in analyzing design and analysis of high rise chimneys using experimental and numerical techniques. The effect of material type on structural strength of tall chimney is also evaluated by various scholars. The effect of soil type, seismic zone on stability of chimney is also presented in this review.

[7] Sarvesh Kumar et. al. (2022) The industrial chimneys are tall structures used to remove gases and fumes boiler. The CAD modelling and CFD simulation is conducted using ANSYS CFX software. The critical regions of chimney which are susceptible to high stresses are determined. From the CFD analysis it is evident that the chimney mid-section region is weakest part as compared to base and top. The use of chamfered edges can significantly reduce induced pressure on chimney and is thus beneficial.

[8] Shubham Ankush Bombile et. al. (2022) The proper analysis of RCC Chimneys, are necessary so that it will create self-standing structures that will resist wind load, earthquake load Dead load and other forces acting on them. This paper aims at the detailed analysis of RC Chimneys subjected to static-dynamic wind load and seismic loading using STAAD.Pro connect edition software .Analysis is performed for two seismic zones and two different wind speed, Also height of chimney is varied and two chimney of height 60m and 80m is considered for study. Parameters like Maximum lateral displacement, maximum moments, and horizontal shear are compared.

[9] Sameer Ramteke et. al. (2022) The location selected for the study is Bellary in Karnataka. Wind load and Earthquake forces are considered for this study. The analysis is done on 250m tall RCC chimney. The main focus is to study the wind analysis result and the Earthquake forces with wind zones I, II, III, IV And EQ zones II,III,IV,V. We

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referred IS 4998 2015, IS 875:2015, IS 1893 (part 4):2005 and IS 1893(part1):2016. The analysis is carried out for 8 models by using STAAD PRO software and MS Excel.

[10] Shivraj Patidar et. al. (2021) It has been observed that most of the existing studies have focused on the load considerations for design of tall chimneys. To make a further contribution to this study, this paper presents the load parameters considered for the design of RCC chimney and focuses on one of the structural parameters of RCC chimneys viz. the effects of number of supports to the flue. A brief review on the types of supports is presented in this paper and analysis is carried out for different kinds of supports to the flue. The comparison of results is plotted. The software STAAD Pro and MS Excel sheets have been used for design.

[11] Shubham Patidar et. al. (2021) In this thesis we are considering chimney used for de-dusting system. The basic dimension of industrial self-supporting steel chimney such as height diameter at entry, diameter at exit etc. are taken hypothetically for the study purpose. For static wind load calculations reference is made of design of steel structure and dynamic wind load calculation as per the procedure given in IS 6533: 1989 (Part 2) .By comparing the three design results like self-supporting chimney stresses, thickness of shells, an effort has been made to arrive at possible/probable cost effective recommendation toward design parameters.

[12] Alqama Hasan, D.M.D.S. and Singh, G., (2020) Here, the base isolation technique included using the laminated rubber bearing as an isolator to manage the reactions. The results show that base isolation greatly minimizes seismic reactions under strong ground motion because it decouples the superstructure from the earthquake ground motion by establishing a flexible interface between the structure's foundation and base. When compared to the Landers-Baker far-field earthquake, it was discovered that the seismic responses under the El. Centro near-field earthquake were significantly higher.

[13] Yadav, B.P., Reddy, S.A., Yadav, J.G. and Prasad, C.V.S.R., (2021) Reviewed the findings of a 100-m reinforced cement concrete chimney's seismic and wind analyses. In STAAD.Pro V8i SS6, the chimney was modelled with the lumped mass modelling technique. The earthquake analysis was performed in accordance with IS 1893 (Part-4):2005, whereas the wind load assessment was performed in line with IS 4998:2015. The outcomes of seismic and wind evaluations were taken into account when determining the design values. They used the limit state method and the most recent code to construct a 100-meter RCC chimney.

[14] Zhou, C., Tian, M. and Guo, K., (2019) Twenty ground motion recordings were selected as input motions from the Next Generation Attenuation database, and the peak ground acceleration was chosen as the intensity measure. The chimney structure's reaction to multidimensional ground motions was calculated using incremental dynamic analysis. The maximum strains of concrete and steel bars were determined to be the damage limit states of the chimney structure. According to the fragility curves and surfaces generated by this research. Based on the analysis's conclusions, these weak points can be adapted to the chimney structures that are already in situ to strengthen their seismic resilience.

[15] Hermes Carvalho et. al. (2019) The aim of this paper is to present a methodology for dynamic analysis of structures under wind loading considering the geometric nonlinearity, the vibration caused by the kinetic energy of wind gusts and the aerodynamic damping due to the relative movement between this structure and the wind. The formulation proposed is applied to a 180-meter-high concrete chimney and the results were compared with those obtained through the recommendation given in the standard ABNT NBR 6123:1988 for the dynamic structural analysis.

[16] Rekha B et. al. (2019) The height of chimney influences the flow of flue gaeses to external environment. The higher the height, it is better for the environmental protection, but the reduced structural stability and increased construction cost with increasing the height. The second objective is to identify optimum height to diameter (H/D) ratio of chimney for different wind and seismic zones using Autodesk software and a parametric study.

[17] Aniruddhasinh R. Sindha et. al. (2019) In this study RC chimney configurations are selected and designed based on Indian codes and standards. The displacement-controlled method is then used for non-linear pushover analyses of the RC chimney. The pushover curve of each RC chimney is developed and the seismic response factors are evaluated. The effect of various parameters such as time period, height on the seismic response reduction factors of RC chimney is

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evaluated. Strength factor, ductility factor and response reduction factors increase with increase the height. It is recommended not to apply the same seismic response reduction factors for all RC chimney.

[18] Mohammed Elwi, et. al. (2018) However though the structures are supported on soil, most of the designers do not consider the soil structure interaction and its subsequent effect on structure during an earthquake. An attempt has been made in this paper to study the effect of Soil-structure interaction on multi storied buildings with various foundation systems. The response of building frames such as Lateral deflection, Story drift, Base shear, axial force and Column moment values for all building frames were presented in this paper.

[19] Amer Hassan, et. al. (2018) In the present paper, nonlinear time history and response spectrum analyses were carried out using Etabs-2015 software to study the influence of soil condition beneath the isolated base. The paper concluded that the hard soil and medium soil are suitable for base isolation building. In addition, analysis and design considerations for base isolated and conventional structures are suggested to enable the designer to get a better understanding at the preliminary design stage.

[20] K Rahul et. al. (2018) These structures are generally tall, slender in nature and consist of circular or cylindrical cross-sections. In recent years there has been increased demand for tall chimneys due to setting up several large thermal power stations in the country. This study examines RCC chimney is analysed and design under effect of wind and earthquake using SAAP2000. Analytical results are compared to achieve the most suitable resisting system & economic structure against the lateral forces.

III. FINDING

This study offers a comprehensive review of the research papers published in the field of dynamic analysis carried out on the chimneys. The current review article gives the latest information and developments taken place in chimney analysis and design. The paper mainly focuses on dynamic analysis, linear and non-linear analysis, soil structure interaction studies, Seismic and wind analysis etc. The paper gives a complete collection of the studies carried out on dynamic analysis and would give an updated material for researchers.

IV. PROBLEM STATEMENT

Chimneys are usually designed for loads produced by seismic effect and wind. So, it is inevitable to analyses the dynamic response of chimney due to effect of earthquake. The prime focus of this research is to conduct the seismic analysis of a reinforced concrete chimney. For this analysis Chimneys with fixed and flexible base subjected to seismic forces were analyzed under different soil condition like hard, soil strata.

MODEL	H/D = 4	H/D = 6	H/D = 8
Fix Base	100 m	120	180
Flexible Base	100 m	120	180

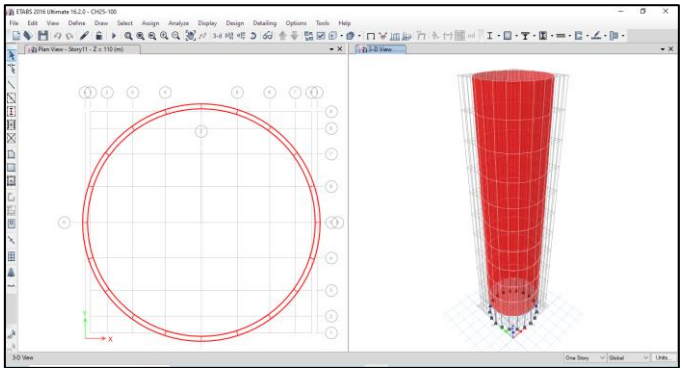

Fig 1 Chimney Model H/D – 4

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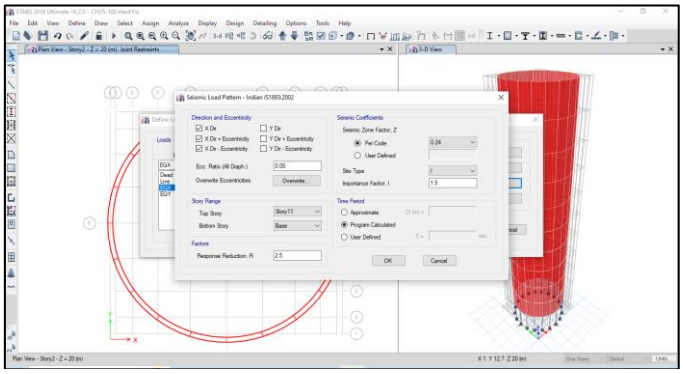

Fig 2 Chimney Model 1 H/D – 4 - Hard Soil

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