Dynamic Analysis of RCC Chimney- A Review

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Abstract— 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. Also steel chimneys are more economical up to a height of 40m-45m. Usually chimneys are almost vertical in order to ensure that the hot gases should flow smoothly. The present paper comprises of literature review of latest papers published in the field of industrial chimneys. 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.

Key words: Chimney, Dynamic, Stacks, linear, seismic, soil-structure interaction

I. INTRODUCTION

Chimneys are the structures which are built to greater heights as tall slender structures. In early days, as household vents and over the years; they are popularly known as chimneys. Chimneys or stacks are used as a medium to transfer highly contaminated polluted gases to atmosphere at greater heights.

Over the years due to development of large scale industries, a large number of tall slender chimneys are required to be designed every year. Chimneys are answerable for industrial growth in any country and changes in the various parameters in any country and changes in the various parameters or dimensions such as increasing the height of the chimneys is more independent on the structural analysis such as response to earthquake is become more critical criteria. Diameter of the top the chimney and height of the chimney, exit velocity at the top, dispersion of gases are within the allowable limits. Mainly bottom diameter is also controlling by the various structural requirements of the both the concrete shell and foundation base of the chimney. For the development of large scale industries all over the country, enormous numbers of tall structures all over the design every year and proper care is to be taken for the design of chimneys.

Fig. 1: Industrial Chimney

The present review article gives collection of literature papers carried on dynamic analysis of chimneys. The linear and non-linear behaviour, soil structure interaction studies and seismic and wind analysis are brought briefly into picture.

II. LINEAR & NONLINEAR DYNAMIC ANALYSIS

Many researchers have carried out the analysis on linear and non-linear dynamic analysis. Below mentioned literature papers gives a survey of this dynamic analysis.

M.R.TABESHPOUR (2012) [1], "NONLINEAR DYNAMIC ANALYSIS OF CHIMNEY-LIKE TOWERS" In this study the most important problem i.e. earthquake behaviour of the structures, hysteric behaviour of material and section properties are studied. The significance of this study is mainly concentrated on model simplification that provides sufficient accuracy based on a nonlinear discrete model. Tous power plant chimney is investigated numerically as an example. The nonlinear dynamic analysis essentially needed for seismic assessment in evaluation of actual performance of complicated structures during earthquakes than the damage indices of structure had to be calculated using appropriate damage models. VICTOR BOCHICCHIO, [2] "DESIGN OF CHIMNEY WITH GRP LINER FOR LOW AND HIGH TEMPERATURE OPERATION", The design of this chimney presented several interesting and challenging aspects related to the high temperature By-Pass operation. The use a highly ventilated annulus added in addressing concerns regarding access into the annular space and in the thermal design of the GRP liner. A large construction opening, reinforced by pilasters, provided structural performance equivalent to that of a similar chimney with a normal sized openings, at a significant cost savings. M. SHIVAJI, AND V.S.N.RAJU

[3], "DYNAMIC ANALYSIS RCC CHIMNEYS" This paper discusses the dynamic analysis of 220m high RCC chimney for free vibration analysis and response spectrum analysis using MSC/Nastran. Analysis has been carried out for fixed base case and base soil structure interaction case. The coupling between structure and its supporting soil generally results in system which has a longer fundamental period than the same structure fixed to a rigid base. It has also been observed from this study that the effect of considering soil structure interaction on the stresses originating from earthquake response analysis in the reinforced concrete chimney structure is highly beneficial. ANURAG JAIN, BEHNAM ARYA, CHARLES GODDARD AND JON GALSWORTHY, [4] "NON LINEAR DYNAMIC ANALYSIS OF AN INDUSTRIAL CHIMNEYS PILE FOUNDATION SYSTEM FOR HURRICANE LOADING", This paper presents the results of a nonlinear dynamic analysis to evaluate the structural performance pile and mat foundation system supporting a 350ft tall concrete chimney stack for hurricane force wind loads. The wind tunnel testing was conducted to develop wind load time histories along the height of the chimney. A geotechnical investigation was performed to determine the nonlinear characteristics of the pile behaviour under lateral and vertical loads. Analysis showed that for a 157mph wind sped pile axial forces remain below the threshold where permanent pile settlement is expected. Therefore, no settlement is expected at this level of loading and the pile foundation should remain fully functional.

III. SOIL STRUCTURE INTERACTION STUDIES

Soil structure interaction defines in which the response of the soil influences the motion of the structure and the motion of the structure influences the response of the soil. Neither the structural displacements nor the ground displacements are independent from each other in this case. Many researchers have carried out SSI on chimneys considering soil-flexibility and brought into various literatures explained below.

K.S.BABU NARAYAN, SUBHAS .C. YARAGAL, AND YUKIO TAMURA, [5] "INTERACTION ENVELOPS FOR LIMIT STATE DESIGN CHIMNEYS", Chimneys as an indirect and effective means of air pollution control is popular from time immemorial. Environmental protection agencies have been forced frame, implement and monitor stringent pollution control policies. From the study the following conclusions are obtained i.e. Availability of interaction envelops and computer algorithm immensely helps the designer in expeditiously solving the design problem. The program developed can be used in structural optimization exercise where in the total cost can be minimized and the ratio of cost to strength or cost to efficiency can be minimized. B.R JAYALAXMI, S.V. JISHA, R. SHIVASHANKAR, [6], "WIND LOAD ANALYSIS OF TALL CHIMNEYS WITH PILED RAFT FOUNDATION CONSIDERING THE FLEXIBILITY OF SOIL", Soil-structure interaction (SSI) analysis was carried out for tall reinforced concrete chimneys with piled raft foundation subjected to wind loads. The present SSI study would be helpful to the design engineers for the optimum selection of geometrical parameters of chimney and foundation. Estimation of the response of slender chimneys due to SSI is very important. The variation in maximum tangential moment of chimney is double for a chimney with thin raft as compared to that with thick raft. When founded on loose sand. Similar variation occurs in radial moment also. NEGAR SADEGH POUR, INDRAJIT CHOWDHRY (2009) [7], "DYNAMIC SOIL-STRUCTURE INTERACTION ANALYSIS OF TALL MULTY-FLUE CHIMNEYS UNDER AERODYNAMIC AND SEISMIC FORCE", The present paper proposes a semi analytic mathematical model based on which both seismic and aerodynamic response of such a tall chimneys are studied for various soil stiffness and are compared with fixed base conventional method as per UBC 97(for seismic load) and CICIND (for wind loading). Soil Structure interaction also has an important effect on seismic forces of tall chimneys. Although for tall chimneys rested on firm soil, earthquake loads decreased as a result of increasing in period values, seismic forces may amplify by using different response spectra in calculation. This means that the soil structure interaction effects are reliant on characteristic of the seismic excitation in addition to chimneys properties. JEEVAN T, SOWJANYA G. V (2014) [8], "SOIL STRUCTURE INTERACTION ON 100m TALL INDUSTRIAL CHIMNEY UNDER SEISMIC LOAD", The thesis attempts to study the effect of soil structure interaction under transient loading for tall chimneys with annular raft. This study has been mainly carried out to determine the change in various seismic response quantities due to consideration of flexibility of soil, slenderness ratio of chimney and thickness of annular raft. The study shows that natural frequency decreases with increase in soil flexibility, and also shows that increase in slenderness ratio of chimney decreases tangential and radial moment of annular raft. GANESH KUMAR T, SHRUTHI.H.K (2014) [9], "SOIL STRUCTURE INTERACTION EFFECT ON 200m TALL INDUSTRIAL CHIMNEY UNDER SEISMIC LOAD", The present paper focuses on the quantification of the effect of soil flexibility on the most important design variables in the seismic response of chimney structures with raft footing. Based on the analysis results, it has been concluded that the effect of soil structure interaction place significant role to decrease the natural frequency, raft displacement, radial and tangential moments in annular raft. The study shows that natural frequency decreases with increase in soil flexibility and percentage decrease in natural frequency decreases with increase in soil flexibility. DORIS MEHTA, NISHANT.J.GANDHI (2008) [10], "TIME RESPONSE STUDY OF TALL CHIMNEYS, UNDER THE EFFECT OF SOIL STRUCTURE INTERACTION AND LONG PERIOD EARTHQUAKE IMPULSE", This study is carried out using time history analysis considering Bhuj earthquake which is a long duration earthquake impulse. The main objective in using this earthquake was, to find out the effect on structure when hit by long duration and see how the response is modified, when soil effects are taken into the consideration. The analysis and results shows that the time period increases with increase in soil flexibility. It remarkably increases up to 9% for soft soil in fundamental mode and up to 80-85% for higher modes. The response of chimney is maximum at section 0.5h and h along the height of chimney for long duration earthquakes. JISHA S. V, DR B.R JAYALAXMI, DR R SHIVASHANKAR (2012) [11]

"ACROSS WIND RESPONSE OF TALL REINFORCED CONCRETE CHIMNEYS CONSIDERING THE FLEXIBILITY OF SOIL", In this experiment a three dimensional soil structure interaction (SSI) analysis of tall slender reinforced concrete chimneys with annular raft foundation subjected to across wind load is carried in the present study. Different ratios of external diameter to thickness of the annular raft and different ranges of height of the chimneys were selected for the parametric study. The integrated chimney foundation soil system was analyzed by finite element software ANSYS based on direct method of SSI assuming linear behaviour. In this study the maximum deflection in chimney increase with increase in raft-thickness ratio and the base moment of chimney decreases due to the effect of soil structure interaction.

III. SEISMIC AND WIND ANALYSIS

SREERATH S, ANOOJA BASHEER, [12], "COMPARISON OF WIND AND SEISMIC EFFECTS ON A REINFORCED CONCRETE CHIMNEYS", when designing any high rise structure, wind and seismic forces are the major lateral forces that have to be dealt with. As by the code recommendations, it is very unlikely that maximum wind accompanying maximum earthquake activity, we just have to design the structure for the maximum load which is induced by either wind or seismic. A comparison study of wind and earthquake forces on reinforced concrete chimney is discussed. The chimney is analyzed individually for wind and earthquake induced lateral forces in order to determine the governing factor on stack design. The slenderness of the structure demanded to investigate the along and across wind behaviours of the structure. STEVEN REID, [13], "WIND ACTIONS AND RESPONSES OF STEEL CHIMNEYS", this paper intended to introduce or simplify the basic concepts of wind engineering and particularly dynamic responses to wind. Understanding some of the basic wind engineering concepts helps one understand the chimneys response. The circular cross section of the steel chimney characteristically provides aerodynamic lift perpendicular to wind direction. Knowing how to predict and prevent these adverse responses is of critical importance in steel chimney design. T SARAN KUMAR, R. NAGAVINOTHINI (2015) [14], " WIND ANALYSIS AND ANALYTICAL STUDY ON VORTEX SHEDDING EFFECT ON STEEL CHIMNEY USING CFD", The present paper study of vortex shedding effect on steel chimney. Vortex shedding means at certain velocities air or fluid past a cylindrical body forms an oscillating flow, which depends on the size and shape of the body. Reynolds number used to predict fluid flow pattern fast a body is steady are turbulent. In this study, five models of chimneys with different heights and diameters at top and bottom, were designed as per IS 6533-1989(part 2) and wind load was calculated as per IS 875 (part 3)-1987.The study on the vortex shedding effect on different chimney models reveals that the wind induced vibration in the tall chimneys varies with respect to height. Dr. D. K. RAGHUPRASAD, NITIN SHEPOR, Dr. AMARNATH.K, (2014) [15], "PENDULUM DAMPERS FOR TALL RC CHIMNEY SUBJECTED TO WIND", The paper discusses the dynamic analysis of 150m high RCC chimney subjected to wind. Analysis has been carried out for fixed base case. In the present work pendulum dampers of different natural frequencies have been tried the one which have largest equivalent logarithmic decrement is found to reduce the response significantly. The response is compared with that of chimney with a tip mass. The natural frequency of the chimney decrease due to pendulum damper and mass at the chimney top and also the displacement, velocity and acceleration decreases for the chimney with pendulum damper. K.R.C. REDDY [16], "ALONG WIND ANALYSIS OF REINFORCED CONCRETE CHIMNEYS", the analysis is done by random vibration approach and codal methods of India, America are presented in this paper. For the analysis based on random vibration approach the RC chimney is modelled as multi degree of freedom system subjected to static load due to mean component of wind velocity and dynamic load due to fluctuating component of velocity. The fluctuating component of wind velocity at a point is considered as temporal random process. Present codal methods of a long - wind analysis are found simplistic and are not equipped to estimate the deflection of chimneys. Different codes are giving different results though basic parameters are same. ALOK DAVID JOHN, AJAY GAIROLA, ESHAN GANJU AND ANANTH GUPTHA (2011) [17], "DESIGN WIND LOADS ON REINFORCED CONCRETE CHIMNEY-AN EXPERIMENTAL CASE STUDY", The present paper is aimed at providing a better understanding of effect of interference and influence of streaks for wind load on TPS chimneys. In the present study, particular attention has been given to bending moment due to across-wind vibration, because it has been found that across-wind vibration is more predominant for the case of interference at an angle of wind incidence. Bending moment due to across wind vibration for interference is found to be approximately double compared to that of stand-alone condition. In this paper the amplification of wind loads on 100m tall chimney due to interference of surrounding structures and influence of streakes has been studied. K.S RAHANE, M. R. WAKCHAURE (2012) [18] "EFFECT OF THE SUPPORTING STRATA ON DESIGN OF WIND MILL TOWER", In this paper the attempt show the effect of wind and earthquake load on tubular type wind mill and its foundation considering hard, medium and soft soil strata. The modelling of wind mill tower was done in computer software by finite element modelling technique. The effect of wind is significant as compared to earthquake and has to be considered in the analysis of wind mill. The foundation sizes, concrete material, reinforcement material increases with respect to hard, medium and soft strata. And therefore cost of structure also increases. JOHN .L. WILSON, (2003) [19] "EARTHQUAKE RESPONSE OF TALL REINFORCED CONCRETE CHIMNEYS", The results from an experimental program have been used to develop a nonlinear dynamic analysis procedure for evaluating the inelastic response of tall reinforced concrete chimney structures. The procedure is used to study the inelastic response 10 chimneys, ranging in height from 115m to 301m subjected to earthquake excitation. Based on study, a series of code design recommendation have been prepared and incorporated into the 2001 CICIND code to encourage reliance on the development of ductility in reinforced concrete chimneys and to prevent the formation of brittle failure modes. G. MURALI, B. MOHAN, P. SITARA

AND P. JAYASREE, (2012) [20] "RESPONSE OF MILD STEEL CHIMNEY UNDER WIND LOADS", This paper deals with the study of 3 chimneys of 55m high above ground level were designed as per IS:6533-1989 (1) and wind load was calculated as per IS:875-1987(3). Three different wind speeds were considered for the design of chimneys. The force exerted by wind on the chimney varies with the wind speed and its associated turbulence. The thickness is found to be same for all the chimneys. YOGANATHAM .C, HELEN SANTHI .M (2013) [21] "MODAL ANALYSIS OF RCC CHIMNEY", the analysis and design of chimneys are normally governed by wind or earthquake load. In this paper modal analysis of a RCC chimney in a cement factory is carried out using the FEM software package ANSYS. The effects changes in the dimensions of the chimney on the modal parameters such as fundamental frequency, displacement etc are evaluated. The displacement of chimney is found to decrease with increase in all geometric parameter ratios. SAGAR .S, BASAWARAJ GUDADAPPANAVAR, (2015) [22] "PERFORMANCE BASED SEISMIC EVALUATION OF INDUSTRIAL CHIMNEYS BY STATIC AND DYNAMIC ANALYSIS", This paper mainly deals with the linear static and dynamic analysis of RC and steel chimney having height of 65m and chimneys were modelled with the help of SAP2000 version 12.00 software, the main purpose of studying this chimney includes effect of base shear, maximum lateral displacement, fundamental time period and frequency of all the zones from zone II to zone V and their comparison of the results of all the zones. Deflection at the free end of chimney should be within the permissible limits of 0.003h for the both the RC and steel chimney, is more economical in all aspects compared to RC chimney. K.R.C.REDDY, O. R. JAISWAL. P.N. GODBOLE, (2011) [23] "WIND AND EARTHQUAKE ANALYSIS OF TALL RC CHIMNEYS", In this paper two RC chimneys are analyzed for earthquake and wind loads. Earthquake analysis is done as per IS1893 (part 4): 2005 and wind analysis is performed as per IS:875-1987 (3) & IS 4998 (part1):1992.This paper presents the comparison of wind loads that of earthquake loads to decide the most critical loads for the design of chimney shell. The wind load is obtained by combination of along and across-wind response of chimney. The wind loads are always governing the design of chimney shell. For the design of chimney shell, the combined design wind loads are used. J.L.WILSON, (2000) [24] "CODE RECOMMENDATIONS FOR THE ASEISMIC DESIGN OF TALL REINFORCED CONCRETE CHIMNEYS", This paper presents results of recent experimental tests which indicate that reinforced concrete chimneys possess some ductility when subjected to cyclic loads. Based on these tests an inelastic procedure has been established for assessing the performance of reinforced concrete chimneys subject to severe earthquake ground shaking. This procedure has been used to analyses a number of chimneys, develop design recommendations and establish appropriate ductility factors. Tall reinforced concrete chimneys being highly tuned, profiled cantilevers respond in a complex manner to earthquake excitation, with the response dominated by higher mode effects, in both the elastic and inelastic range. RAJKUMAR, VISHWANATH.B.PATIL (2013) [25] "ANALYSIS OF SELF-SUPPORTING CHIMNEY", in this paper an RC chimney is designed considering dead load, wind load and earthquake load. The BIS design codal procedures will be used for design of the chimney. The present paper discusses the parametric study of RC chimney which is made by obtaining the results from software for different heights, diameter, earthquake zones, wind zones, types of soils and various load conditions. Because of changes in the dimensions of chimney, structural analysis such as response to earthquake and wind oscillations have become more critical to influence on response design of chimney. The minimum grade of concrete to be used for chimney should be greater than M25 since lower grades fail in permissible stresses. M.G.SHAIKH, MIE, H.A.M.I.KHAN, [26] "GOVERNING LOADS FOR DESIGN OF A TALL RCC CHIMNEY", the present paper discuses governing loads acting on reinforced concrete tall chimney. The main focus is to compare the wind analysis result with that due to seismic one. Wind analysis is done for along wind by peak factor method as well as by gust factor method and for across wind by simplified method as well as by random response method. The results obtain in above cases are compared. The seismic analysis is performed using response spectrum method. Finally, the maximum value obtained in wind analysis and seismic analyses are then compared for deciding the design value. The effect of wind forces is quite significant as compared to earthquake forces over 220m height RCC chimney. The geometry of chimney has to be so chosen that deflection of chimney at the top is within permissible limits. B. SIVA KONDA REDDY, V.ROHINI PADMAVATHI, CH.SRKANTH [27], "STUDY OF WIND LOAD EFFECTS ON TALL RC CHIMNEYS", This paper presents the study of along and across wind effects on a 275m tall RCC lined chimneys for first and sixth wind zones of India and the results indicate that in shell completed condition, for zone I (i.e. basic wind speed 33m/s) across winds are governing and for highest wind zones of VIth (i.e. basic wind speed 55m/s), along wind loads are governing rather than the across wind loads. The analysis is carried out using STAAD PRO and MS excel spread sheets. For zone I, the shear force bending moment and deflection are maximum and governing in across wind. For zone VI, along wind methods are increased with increasing wind speed. The shear force bending moment and deflection are maximum and governing along wind. M.GACZEK, JKAWECKI (1996) [28] "ANALYSIS OF CROSS WIND RESPONSE OF STEEL CHIMNEYS WITH SPOILERS", The method for prediction for vortex-induced response of steel chimneys with spoilers is presented. A 3-start helical strake system with straight pitch 5D was analyzed. The dependence of the displacement of the top of chimney on the parameter of excitation Cv was proved. LEONARDO E CARRION, RODRIGO A DUNNER AND IVAN FERNANDEZ-DAVILA (2000) [29] "SEISMIC ANALYSIS AND DESIGN OF INDUSTRIAL CHIMNEYS" This paper describes a simplified method that allow obtaining the fundamental period of vibration, lateral displacement, shear force and bending moment through a set of equations, obtaining for all cases studied an error below 10% the results obtained in this study were applied to a total of 9 real chimneys built in Chile, with the objective of calibrating founded expressions. When chimney is analyzed by the

three effects (flex ion, shear and rotational inertia), the number of elements to be discretized no longer influences the estimated responses because the height of the element is controlled by shear if h/D < 2 ,and by flex ion if h/D > 2, h the height of the element. R.D.SHARPE, R.I.SKINNER [30] "THE SEISMIC DESIGN OF AN INDUSTRIAL CHIMNEY WITH ROCKING BASE", this paper discusses the advantages in the adoption of this revolutionary design and describes the dynamic analysis carried out during the design process. Subsequent time-history computer analysis carried out to confirm the design method is reported on. An industrial reinforced concrete chimney, of cruciform cross section and 35m tall, has been designed and built with the high degree of seismic protection afforded by allowing the base to rock during large earth quakes .A simple analytical rocking model has been presented which is compatible with available in elastic time history analysis computer programs. Such a model may be used to make parametric studies of the rocking response of a proposed structure during the design process. ALOK DAVID JOHN, AJAY GAIROLA, ESHAN GANJU AND ANANT GUPTA (2011) [31] "DESIGN WIND LOADS ON REINFORCED CONCRETE CHIMNEY-AN EXPERIMENTAL CASE STUDY". The present paper aimed at providing a better understanding the effect of interference and influence streaks for wind load on thermal power station (TPS) chimneys. Measurements of across and along vibration have been made on scale model of panipat power station chimney, India .In the present study particular attention has been given to bending moment due to across wind vibration, because it has been found that across wind vibration is more predominant for the case of interference is found to be approximately double compare to that of standalone condition. In this paper, the amplification of wind loads on 100m tall chimney due to interference of surrounding structures and influence of streakes has been studied. RAJESH M.N AND S.K PRASAD (2014) [32] "SEISMIC PERFORMANCE STUDY ON RC CHIMNEYS FROM PUSH OVER ANALYSIS". Rapid growth of industrialization and increasing need for air pollution control has made long RC chimneys a common structure in modern scenario. Owing to their long and narrow structure, earthquake forces are one of the important loads to be considered for the design of chimneys. Present paper aims to study the effect of various geometric and material properties of the chimney on the fundamental time period of the chimney and to compare it with that obtained as per IS codal provision. In the present study performance study on chimneys is carried out considering a 160m tall chimney. From push over analysis it was found that the presence of openings significantly reduces the base shear capacity and slightly decreases displacement ductility of the chimneys. Openings of size above 1.2% should possibly be avoided in chimneys. T SUBRAMANI , P.SHANMUGAM (2012), [33] "SEISMIC ANALYSIS AND DESIGN OF INDUSTRIAL CHIMNEYS BY USING STAAD PRO" This study explain the simplified method that allows obtaining fundamental period of vibration, lateral displacement, shear force and bending moment through a set of equations, boating for all cases studied an error below 10%. The results obtained in this study were applied to a total of 9 chimneys, in this the 4 chimneys are steel and 5 are reinforced. Through our problem we conclude that the seismic effect will cause more damages to the structure which will stabilize when it will analysis and constructed based on the stress condition which is highlighted in the diagram. It is possible to carry out an analysis of a chimney parametrically, finding a factor that will transfer these dimensional values into responses of the structure. The maximum error obtained considering the 4 responses studied i.e. period of vibration, lateral displacement, shear force and bending moment is 3.5%. K.ANIL PRADEEP, C.V.SIVARAMA PRASAD, (2014) [34] "GOVERNING LOADS FOR DESIGN OF A 60m INDUSTRIAL RCC CHIMNEY "in his experiment he described that industrial chimneys are generally intended to support critical loads produced by seismic activity. So it is essential to evaluate the dynamic response of chimney to seismic activity and wind loads. As per draft code the deflection at the free end of the chimney should be well within the permissible limit. The effect of wind force for 55m/s wind speed is quite significant as compared with the earthquake forces in zone II and III. Moment due to earthquake in zone III is almost equal to the combined moment due to wind speed of 55m/s.

IV. SUMMARY & CONCLUSION

The present paper focuses on dynamic analysis of industrial chimney which includes linear and non linear analysis, soil structure interaction studies and seismic and wind analysis. From the review article following conclusions could be drawn Soil structure interaction has an important effect on seismic forces of tall chimneys. Although for tall chimneys rested on firm soil, earthquake loads decreased as a result of increasing in period values, seismic forces may amplify by using different response spectra in calculation. The soil structure interaction effects are reliant on the characteristic of the seismic excitation in addition to chimneys properties. Thus earthquake and wind forces are dominant on these industrial structures. Consideration of SSI effect must be done for these structures. The effect of foundation flexibility on the reinforcement concrete chimneys to wind excitation can be significant and should be addressed in design stage. None of the present codes present any method for estimation of influence of soil structure interaction. It might be advisable to take soil structure interaction effects into account for calculation of wind load in different codes.

It is thus concluded that seismic response of tall chimneys is influenced greatly by soil supporting its base and nature of earthquake excitations striking the base. Ignoring any one of them, can significantly affect the performance of chimney during earthquake and lead to devastating effects. So one should take care of these effects during the analysis and design stage to avoid future damages and destruction. For engineering purposes, the Time variation of ground acceleration is the most useful way of defining the shaking of ground during earthquake. This ground acceleration is descritized by numerical values at discrete time intervals. Integration of this time acceleration history gives velocity history, integration of which in turn gives displacement history.

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