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DYNAMIC ANALYSIS OF A RCC CHIMNEY

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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. Chimneys are development of industrial growth in any country. 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. In view of stricter control on air pollution, the trend is towards constructing taller chimneys. The paper deals with the dynamic analysis of RCC chimney having height of 275mts.This chimney serves for thermal plant located in kothagudem district, Telangana state. Paper deals with the external applied loadings that affect chimney structures namely wind, seismic and temperature with reference to the Indian codes. Modelling is done by SAP2000version 16.00 software. This paper discusses the analysis & design procedure adopted for the evaluation of RCC chimney under effect of Wind and EQ forces. 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.

Keywords: SAP2000, Finite element method, Non-Liner Static and Linear Dynamic Analysis, Reinforced Concrete Hollow Structure

I. Introduction

Chimneys are a symbol of industrial growth in any country. In recent years there has been an increased demand for tall Chimneys due to setting up several large thermal power stations in the country. With increased recognition that fuel gases from large plants such as power stations must be discharged at very high elevations in order to meet the demands of air pollution control the trend is towards constructing taller Chimneys. In early 1960 a 122-metre-high chimney was considered to be very tall and nowadays many chimneys in the range of 220 M height have been built in our country. In the USA, several chimneys in the range of 380 m already exist, and this trend toward constructing taller chimneys will continue. Construction of such tall Chimneys has been possible with the better understanding of loads acting on them and of the structural behaviour above all with the utilisation of Modern construction plant equipment and techniques such as slip form. Reinforced concrete has been the most favoured material for Chimney construction since it has the advantage to resist wind load and other forces acting on them as a self-standing structure.

II. Literature Review

B. Siva Konda Reddy, V. Rohini Padmavathi, Ch.Srkanth:"Study Of Wind Load Effects On Tall RC Chimneys", This paper give the information of along and across wind effects on 275m high reinforced concrete chimney for 1st and 6th wind zones of India and the outcome point out that in shell completed condition, for zone I across winds are foremost and for maximum wind zones VI along wind loads are leading somewhat than the across wind loads. The analysis is done using STAAD PRO and MS excel. 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 highest and most important along wind. The wind speed of zone 1 is 33m/sec and for zone 6 is 55 m/s. The zone 5 wind speed is higher than zone 1.

Doris Mehta, Nishant.J. Gandhi (2008)"Time Response Study Of Tall Chimneys, Under The Effect Of Soil Structure Interaction And Long Period Earthquake Impulse", This research is done using time history analysis allowing for Bhuj earthquake which is a time taken earthquake inclination. The vital reason of using this earthquake was, to know the affect in chimney when experienced by long time and to know how the response is done, when foundation soil affects are in use into the scenario. The analysis and results show the time period rises with raise in soil plasticity. It extremely rises up to 9% for soft soil in fundamental mode and up to 80-85% for higher modes. The behaviour of chimney is highest at 0.5h and h along the height of chimney for long duration earthquakes. The chimney response is different at different heights. The behavior changes with different heights.

Ganesh Kumar T, Shruthi.H. K (2014)"Soil Structure Interaction Effect On 200m Tall Industrial Chimney Under Seismic Load", This paper study mainly discusses on the quantity of the effect of soil plasticity on the vital design variables in the earth quake response of chimney structures. Depending results, it is accomplished that the

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affect of structure contact place important aspect to fall of the natural frequency, raft displacement, radial and tangential moments in annular raft. The paper delivers that natural frequency fall with rise in soil plasticity and percentage falls in natural frequency falls with rise in soil plasticity. The foundation plays an important role to maintain rigidity of the chimney.

Negar Sadegh Pour, Indrajit Chowdhry (2009)"Dynamic Soil-Structure Interaction Analysis Of Tall Multy-Flue Chimneys Under Aerodynamic And Seismic Force", The study results a semi methodical mathematical model depends on seismic and aerodynamic response of a high raised chimney are calculated for several soil rigidness and are compare with fixed base predictable method as per UBC 97 and CICIND. Soil Structure relations also has vital role on quake forces of high raised chimneys. Though for high chimneys based rigid soil, quake loads fall as a result of rising in specific time values, quake forces increase by using different response spectra in computation. This tells that soil structure interaction lead to dependent on characteristic of the earthquake excitation in suppliment to chimneys properties. The seismic force is main study for any high raised structures.

Anurag Jain, Behnam Arya, Charles Goddard And Jon Galsworthy:"Non-Linear Dynamic Analysis Of An Industrial Chimneys Pile Foundation System For Storm Loading", This paper presents the results of a nonlinear dynamic analysis to assess the structural show pile and mat foundation system sustaining a 350ft tall concrete chimney stack for storm force wind loads. The wind tunnel test was conducted to develop wind load time histories along the height of the chimney. A geotechnical investigation is done to acesss the nonlinear characteristics of the pile actions under perpendicular and horizontal loads. Analysis shown for a 157mph wind speed pile perpendicular forces stay below the threshold where permanent pile settlement is predictable. Therefore, no completion is predictable along the height of loading and the pile foundation should remain fully functional.

III. Methodology

A study how research is done systematically and a procedure to methodically solve the problem and by adopting various steps and there by Methodology helps to recognize products of scientific inquiry and the process aims to describe and analyze methods, clarify their assumptions relating in their potentialities.

Different methods used for methodology are as follows:

1) The Finite Difference Method
2) The Boudary Element Method

Dynamic analysis for simple structures can be carried out manually and for high rise buildings the dynamic effect on building can be analysis by software, if the building are unsymmetrical in nature the torsion will develop and it will the important parameter for the analysis , Torsional failures are seen to occur where the symmetry is not planned in the location of the lateral structural elements as for example providing the lift cores at one end of the building or at one corner of the building or unsymmetrically planned buildings in L shape at the street corners. Large torsional shears are caused in the building columns causing their torsional shear failures.

IV. Modeling and Analysis

Structural modeling is an implement step to establish three mathematical models,

1) Structural model
   a) Structural components
   b) Joints and
   c) Boundary conditions
2) A material model and
3) A load models

For designing a new structure or designing a plan, construction particulars and support conditions shall be made as close to the computational models as possible. For an existing structure estimation, structures shall be modeled as near to the actual as-built structural situations as possible. The different choice of modeling and analysis methods are

a) Reputation of the structure
b) Determination of structural analysis
c) Essential level of response accuracy

Model In 3DView

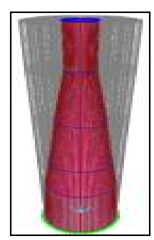

Fig 1:.The above figure shows Developed 3D model in SAP2000

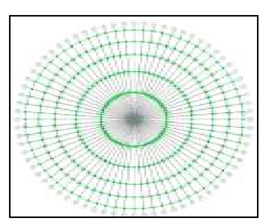

Fig 2: The above figure shows top view in SAP2000

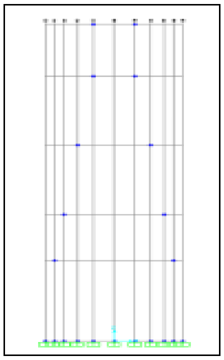

Fig 3: The above figure shows coloum layout in SAP2000

V. Results and Discussion

Table1. Different Time Period and Frequencies For The Structure

Mode Shape No	Time period(s)	Frequency(Hz)
Mode 1	1.39806	0.71528
Mode 2	1.39786	0.71538
Mode 3	0.48667	2.05479
Mode 4	0.48483	2.06260
Mode 5	0.26954	3.71000
Mode 6	0.25744	3.88435
Mode 7	0.25634	3.90107
Mode 8	0.25598	3.90653
Mode 9	0.16746	5.97146
Mode 10	0.16010	6.24595
Mode 11	0.15958	6.26648
Mode 12	0.11599	8.62158

A. Time History Analysis

INDIAN earthquake data has been considered for the structure and response to the structure was studied. In this study ELCENTRO earthquake data has been applied.

The four joints joint1601, joint611, joint620, joint622 are taken in different heights of the structure.

The time history is applied with an ELCENTRO earthquake data in X-Direction and the graph obtained is described below

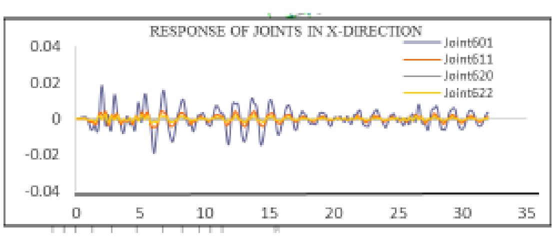

Fig 4:. Response of Building suspected to ELENTRO ground motion at the particular joints.

The time history is applied with an ELENTRO earthquake data in Y-Direction and the graph obtained is described below:

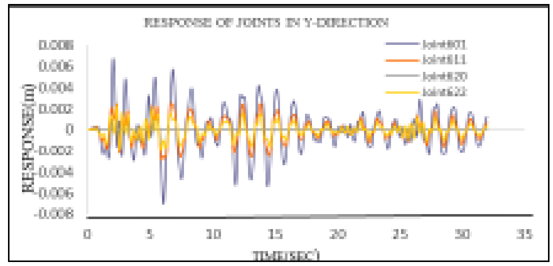

Fig 5: Response of Building suspected to ELCENTRO ground motion at the particular joints.

The time history is applied with an LOMA earthquake data in X-Direction and the graph obtained is described below:

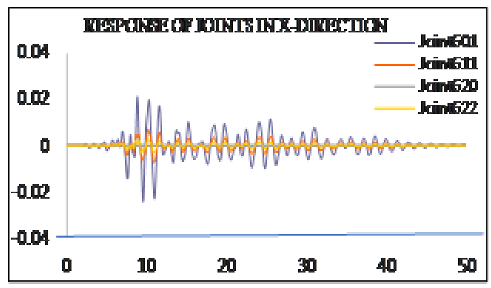

Fig 6: Response of Building suspected to LOMA ground motion at the particular joints

The time history is applied with an LOMA earthquake data in Y-Direction and the graph obtained is described below:

VI. Conclusion

1) The results which are obtained from the above analysis is safe for construction.
2) The structure is safe for the earthquake data i.e., Loma and it can resist small disturbances that during earthquake.
3) The different shell thickness is placed at different points and they shall not change their position as per the safety factor in the structure.
4) Designing using Software's like SAP2000 reduces lot of time in design work.
5) Accuracy is Improved by using software.
6) Comparison of all model shapes shows that building is more economic for all other buildings structure.
7) The maximum deflection occurred in ELCENTRO ground motion

Joint no.	Max deformation in X-Direction(m)

Joint601	0.02424
Joint no.	Max deformation in Y-Direction(m)
Joint601	0.02424

8) The maximum deflection occurred in

LOMA earthquake data is

Joint no.	Max deformation in X-Direction (m)
Joint 601	0.01919
Joint no.	Max deformation in Y-Direction (m)
Joint 601	0.00698

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