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Dynamic Analysis on Conventional Structure and Geo-polymer Concrete Structure Using Response Spectrum Method

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ABSTRACT:
This project describes seismic analysis of high raised using E-tabs, the model of residential G+11 building is prepared and analysis is done using response spectra method considering building location in zone III, this analysis will produce the effect of higher modes of vibration and actual distribution of forces in elastic range in a better way. Test results include lateral loads on diaphragm, lateral loads on story, diaphragm center of mass displacement, diaphragm drifts, maximum story displacements, maximum story drifts, story shears, overturning moments, and story stiffness and get effective lateral load resisting system and helps in finding out whether geo-polymer concrete can be used in the construction of high raised building as we include the dynamic loads in the high raised structure's.

I. INTRODUCTION

1.1 Introduction

These days earthquakes has become very frequent in the nature due to several reasons, here we don't discuss about the reasons of earthquake rather our subject is how to with stand the earthquake loads on the structures or buildings. This becomes the major criteria for us, as the earthquakes are becoming quite common to us designing the building or analyzing the buildings in general regular format using the static loads such as live load, dead load etc., we can't design a safer building especially in the case of high raised building it is because in high raised building there will be wind pressure on the building at greater magnitude which varies time to time depending upon the intensity, velocity and direction of wind i.e., dynamic in nature similarly to earth quake loads so as to withstand these type of loads, static methods are not enough and hence we go for dynamic analysis and we model the required structure using ETABS software and analyse the structure in the ETABS using the response spectra method.

1.2 Dynamic Analysis

Structures on the earth are generally subjected to two types of loads i.e. static and dynamic. Static loads are constant with time while dynamic loads are time varying. In general, the majority of the civil structures we design assuming only the static loads. The effect of dynamic load is not actually considered in many cases it is because, in India the structures are rarely effected by the earthquake and more over its considerations in the analysis makes the solution more complicated and time consuming. This negligence is the reason for the cause of disaster in most of the cases, particularly, in case of earthquake the negligence of dynamic forces are only the reason for the disaster. Nowadays, there is a growing interest in the process of designing civil engineering structures capable to withstand dynamic loads, particularly, earth quake induced load. The present project is the analysis of a multi-storey structure by considering the dynamic loads on the structure depending up on the zone as per IS code.

India is divided into multiple zones based upon the intensity of the earthquakes depending upon the local circumstances and this division is shown in the Indian map below.

1.3 Response Spectra

It is defined as the plot between the peak state response i.e., displacement, velocity and acceleration to a series of oscillators of varying natural frequency, which are forced into motion by the same base vibrations.

1.4 Geo- Polymer Concrete

Geopolymer concrete is an innovative and eco-friendly construction material and an alternative to Portland cement concrete. Use of geopolymer reduces the demand of Portland cement which is responsible for high CO_2 emission. Geopolymer was the name given by Daidovits in 1978 to materials which are characterized by chains or networks or inorganic molecules.Geopolymer cement concrete is made from utilization of waste materials such as fly ash and ground granulated blast furnace slag(GGBS). Fly ash is the waste product generated from thermal power plant and ground granulate blast furnace slag is generated as waste material in steel plant.Both fly ash and GGBS are processed by appropriate technology and used for concrete works in the form of geopolymer concrete. The use of this concrete helps to reduce the stock of wastes and also reduces carbon emission by reducing Portland cement demand.The main constituent of geopolymers source of silicon and aluminium which are provided by thermally activated natural materials (e.g. kaolinite) or industrial byproducts (e.g. fly ash or slab) and an alkaline activating solution which polymerizes these materials into molecular chains and networks to create hardened binder. It is also called as alkali-activated cement or inorganic polymer cement.

II.LITERATURE REVIEW

2.1 Introduction

The chapter involves the discussion of various research papers reviewed for achieving the aim of the project. The following research papers have discussed about the dynamic analysis, response spectra analysis and design of different multi-storey structures in different loading conditions such as static forces and dynamic forces using software's such as E-tabs, Stadd Pro etc. This in turn helps us in archiving our aim of the project.

2.2 Literature review

2.2.1 Dynamic Analysis on Multistoried Regular Building – Dr. Savita Maru, Mohit Sharma

In this paper the results are obtained using STADD PRO for the structure in zone II and zone III for both static and dynamic analysis

- There is no much difference in the values of axial forces between the values obtained by static and dynamic analysis.
- The values for torsion at different points in the beam are negative and for dynamic analysis the torsion values are positive.
- The values for moment at different points in the beam 10-15% higher for dynamic analysis than the values obtained for static analysis for the moment at the same points.
- The values for displacements at different points in the beam are 17 –

28% higher for dynamic analysis than the values obtained for static analysis at the same point.

2.2.2 Dynamic Analysis on Multistorey RCC Building – Alhamd Farqaleet

In this case we can observe that storey drift increases from base to top floor. Maximum storey drift is found to be within the permissible storey drift range as per IS 1893:2002. The max drift obtained at 10^{th} storey is 0.106m while permissible drift is approximately 0.124m. The max base shear in x and y direction are 2528.2 KN and 184.59 KN hence we can conclude that time history analysis should be performed as it predicts the structural response more accurately than response spectrum analysis.

III. METHODS OF ANALYSIS

3.1 General

All the structures are designed for the combined effects of gravity loads and seismic loads to verify that adequate vertical and lateral strength and stiffness are achieved to satisfy the structural performance and acceptance deformation levels prescribed in the governing building code. Because of the inherent factor of safety used in the design specification, most structures tend to adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans, those in which stability for design, or for overall stability analysis of structures.

In general, most earthquake code provisions implicitly require the structures be able to resist:-

- Minor earthquake without any damage.
- Moderate earthquake with negligible structural damage and some non-structural damage.
- Major earthquake with some structural damage and non-structural damage without collapse.
- The structure is expected to undergo fairly large deformation by yielding in some structural members.

Seismic codes are unique to a particular region or country. In India, IS 1893:2002 (part-1) is the main code that provided outline for calculation of seismic design force. This force depends on the mass and seismic coefficient of the structure and later in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests and ductility. IS 1893:2002 (part-1) deals with assessment of seismic loads on various structures and buildings.

The whole centers on the calculation of base shear and its distribution over height. The analysis can be performed on the basis of external action, the behavior of the structure or structural materials and the type of structural mode selected. In all that treated as discrete system having concentrated mass at floor levels, which include half the column and walls above and below the floor. In addition, appropriate of live load at this floor is also lumped with it.

3.2 Linear static analysis

This method of finding lateral force is also known as the static method or equivalent static method or seismic coefficient method. The static method is the simplest one and it required less computational effort and it is based on formula given in the code of practice IS 1893:2002 (part-1). The design against seismic loads must consider the

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equivalent linear static methods. It is to be done with an estimation of base shear load and its distribution on each story calculated by using formula given in the code.

3.3 Linear dynamic analysis

Response spectrum method is the linear dynamic analysis method. In that method the peak response of structure during an earthquake is obtained directly from the earthquake response, but this is quite accurate for structural design applications.

In **linear time history analysis** overcomes all the disadvantages of modal response spectrum analysis, provide non-linear behavior is not involved, the support points of the model are oscillated back and forth in accordance to a recoded ground motion of an actually occurred earthquake (as recorded by a seismograph and available in tabular form of time vs acceleration).

3.4 Non linear static analysis

It is practical method in which analysis is carried out under permanent vertical loads and gradually increasing lateral loads to estimate deformation and damage pattern of structure. Non linear static analysis is the method of seismic analysis in which behavior of the structure is characterized by capacity curve that represents the relation between the base shear force and the displacement of the roof. It is also known as **Pushover Analysis.**

3.5 Non linear dynamic analysis

It is known as **Non-Linear Time history analysis**. It is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear. To perform such an analysis, a representative earthquake time history is required for a structure being evaluated. Time history analysis is a step-by-step analysis of the dynamic response of a structure to a specified loading that may vary with time. Time history analysis is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

IV. MODELING AND ANALYSIS

4.1 General

This chapter deals with the modeling and analysis of the structure under various loads. The finite element package ETABS V16.2.1.0 has been used for the analysis. A three dimensional model of the structure have been created to undertake static and dynamic analysis. The model ideally represents the complete three dimensions (3D) characterizes of the building, including its mass distribution, strength, stiffness deformability. Modeling of the material properties, structural elements, load patterns, load cases and combinations and response spectrum and time history functions are discussed in this chapter.

4.2 ETABS Software

ETABS is an engineering software product that caters to multi-story building analysis and design. Modeling tools and templates, code-based load prescriptions, analysis methods and solution techniques, all coordinate with the grid-like geometry unique to this class of structure. Basic or advanced systems under static or dynamic conditions may be evaluated using ETABS. For a sophisticated assessment of seismic performance, modal and direct-integration time-history analyses may couple with P-Delta and Large Displacement effects.

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Nonlinear links and concentrated PMM or fiber hinges may capture material nonlinearity under monotonic or hysteretic behavior. Intuitive and integrated features make applications of any complexity practical to implement. Interoperability with a series of design and documentation platforms makes ETABS a coordinated and productive tool for designs which range from simple 2D frames to elaborate modern high-rises.

4.3 Problem Formulation

Two tall buildings of 10 storey's with plan area 10.5 mx14.5 m is analyzed in ETABS V16.2.1.0 package to determine dynamic control of the those buildings. Wind and Earthquake parameters for analysis are taken and dynamic analysis is performed as per IS: 1893-2002 code. Analysis is performed to find Time History, Time Period, Storey Displacement, Storey Drift and base shear for the two structures. General description of the Building is tabulated in table 5.1

V. RESULTS AND DISCUSSIONS

5.1 General

The seismic analysis of the modeled structures with shear walls and diagrids spanning in two directions are carried out by using ETABS software and the results are given in the following sections. The parameters studied are story displacement, story drifts, base shear and storey stiffness in seismic zones III. Comparison of seismic behavior is made between the structures with conventional concrete and geo-polymer concrete . The comparison has done in Response Spectrum method.

5.2 Story displacement

It is the total displacement of i^th story with respect to ground. The story displacements of the modeled structures located in zone III using response spectrum method and time history analysis in X – direction are shown in Table

Table 5.1 Story displacements of the structures in zone III in X-direction

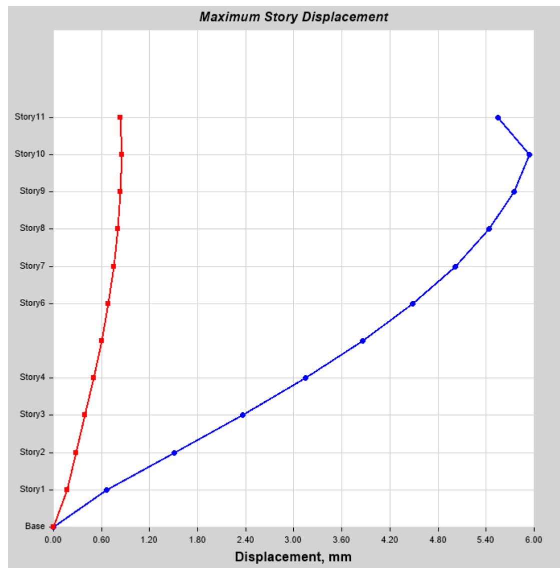

Figure 5.1 Story displacement of conventional concrete in zone III in X-direction using Response Spectrum method

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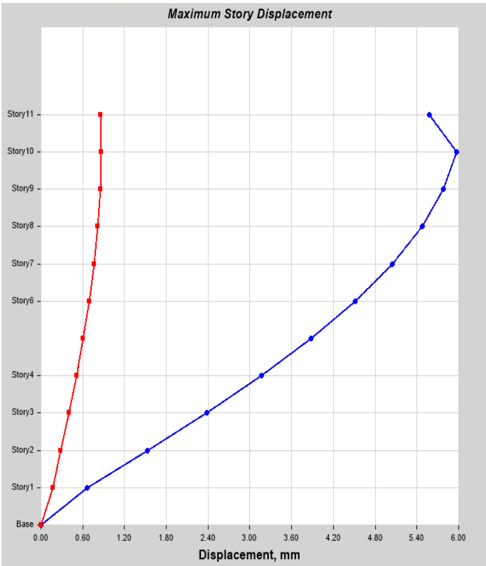

Figure 5.2 Story displacement of geo-polymer concrete in zone III in X- direction using Response Spectrum method

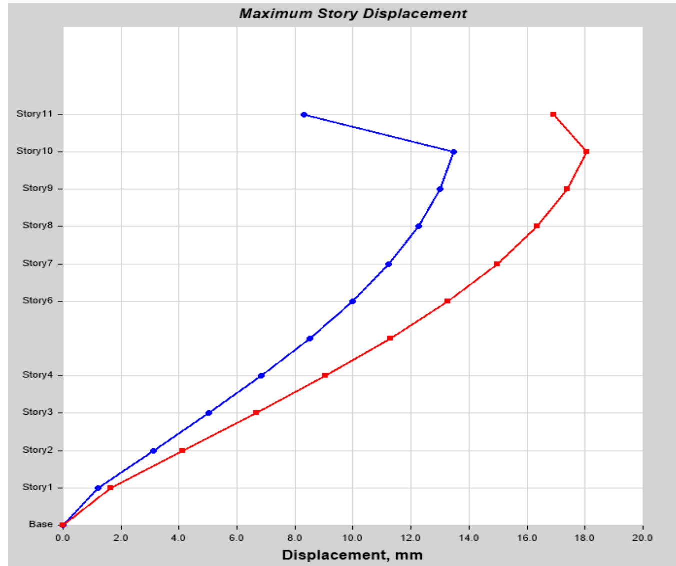

Figure 5.4 Story displacement of geo-polymer concrete in zone III in Y- direction using Response Spectrum method

Figure 5.3 Story displacement of conventional concrete in zone III in Y- direction using Response Spectrum method

5.3 Story drifts

Story Drift is defined as ratio of displacement of two consecutive floors to the height of that floor. Drifts in frame structure are due to the result of flexure and shear mode contributions. In high rise structures, higher axial forces and deformations in columns and accumulations of their effects over greater heights cause flexure component displacement to become dominant.

The story drifts of the modeled structures in Zone III using response spectrum method and time history analysis in X – direction is shown in Table

VI. CONCLUSIONS

6.1 General

In the previous chapter, the seismic behavior of the modeled structures i.e. story displacement, story drifts, base shear and natural time period in seismic zones are discussed and comparison of seismic behavior is made between structure with conventional concrete and geo-polymer concrete structure in response spectrum method. In this chapter, the conclusions of the obtained results are discussed in detail.

- The maximum story displacement between conventional concrete structure and the geo-polymer concrete structure is 3.22% but we can observe that even the displacement is higher when compared with conventional concrete the displacement is with the limits as per is code.
- The maximum story drift between conventional concrete structure and the geo-polymer concrete structure is 2.7% .
- The maximum story shear between conventional concrete structure and the geo-polymer concrete structure is 2.2%, the storey shear is also increasing in the structure when compared with conventional concrete this resembles the resistance towards the seismic loads is higher for concrete when compared with geo-polymer concrete, but we can observe we can also use the geo-polymer concrete but the only thing is the structure becomes little uneconomical but we can use this in the low seismic prone area, so as to be environmental friendly.
- The maximum story stiffness between conventional concrete structure and the geo-polymer concrete structure is 1.64%.
- With the above observations we conclude that both conventional concrete and geo-polymer concrete can be used in the high-raised structure even when the seismic loads and wind loads play major role in the design, but by using the geo-polymer concrete the structure may become uneconomical but at the same time by encouraging these types of constructions we can make the environmental friendly structures.

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