DESIGN AND ANALYSIS MULTI STORIED BUILDING WITH IN DIFFERENT CONDITIONS

[*] RATHLAVATH SHIVA KUMAR, [**]A.UPENDER, ***KASI REKHA

[*]MTech student, Dept of CIVIL, AVN Institute of Engineering and Technology, Hyderabad, TS, India.

[**] Assistant Professor, Dept of CIVIL, AVN Institute of Engineering and Technology, Hyderabad, TS, India.

[***] Professor & HOD, Dept of CIVIL, AVN Institute of Engineering and Technology, Hyderabad, TS, India.

ABSTRACT:

Earthquake is the shaking of the ground caused by the sudden breaking and shifting of large sections of earth's rocky outer shell. Earthquakes are among the most powerful events on earth, and their results can be terrifying. Earthquake is general does not kill people directly. Instead, many deaths and injuries result from the collapse of buildings, bridges and other structures. We cannot prevent natural disasters from striking, but we can prevent or limit their impact by making buildings strong enough to resist their destructive forces. This can be achieved by earthquake resistant structures. In the case of earthquakes, it is possible to neutralize their harm by applying basic engineering and planning principles that are in expensive. This paper deals with the explanation of basic engineering and planning to be taken into account during the construction of earthquake resistant structures. The present study is to find the seismic effect on building and its performance under earthquake loads. A building of height G+12 RCC structure is modeled with material properties M30 grade for concrete and Fe500 for reinforcing steel and structures dimensions of length 21m, width 17.5m and height of G+12 is 51.5m from the plinth level, the support conditions are chosen to be fixed base and foundation depth is considered as 1.5m below the ground level. Structures are modeled using ETABS in seismic zones III, IV, V as per IS 1893-2002 methods by using response spectrum method. The results are shown in terms of graphs and tables.

Keywords: ETABS, M30, RCC, Earthquake.

1. INTRODUCTION:

The world's urban population is growing at very faster rate. Currently, about half of the world's population is living in urban areas. In the coming decades, urban dwellers will make up roughly 60 to 70 percent of the world's population. Though the urban population is growing at an alarming rate, the land available for construction is limited. Increasing population coupled with urbanization has made the construction of multi-storey buildings a necessity to house the millions .Housing the millions is possible only by constructing multi-storey buildings. As The height of building increases, the behavior of the structure becomes more complex, these are more sensitive to wind and earthquake loads and hence, we need to be very careful to design them. Reinforced concrete is the best suited for multi-storey buildings. It has occupied a special place in the modern construction due to its several advantages. Owing to its flexibility in form and superiority in performance, it has replaced the earlier materials like stone, timber and steel. It has helped the engineers and architects to build pleasing structures. However, its role in several straight line structural forms like, multi-storey building and bridges etc. is enormous. The unsymmetrical buildings require great attention in the analysis and design under the action of seismic excitation.

Linear static analysis

Displacements, strains, stresses, and reaction forces under the effect of applied loads are calculated..A series of **assumptions** are made with respect to a linear static analysis:

Small Deflections Determine whether the deflections obtained or predicted are small relative to the size of the structure.

Small Rotations In linear codes all rotations are assumed to be small. Any angle measured in radians should be small enough that the tangent is approximately equal to the angle.

Material Properties Linear solvers assume that all material behaves in a linear elastic manner. Some materials have a non-linear elastic behavior, and although they do not necessarily yield.

Time history method:

The usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics. In this method, the mathematical model of the building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure.

Response spectrum method:

The word spectrum in engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. This method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic analysis of steel and reinforce concrete buildings, respectively

Response Spectrum Analysis as per IS: 1893-2002

This method is also known as modal method or mode superposition method. It is based on the idea that the response of a building is the superposition of the responses of individual modes of vibration, each mode responding with its own particular deformed shape, its own frequency, and with its own modal damping. According to IS 1893(Part-l):2002, high rise and irregular buildings must be analysed by response spectrum method using design spectra Sufficient modes to capture such that at least 90% of the participating mass of the building (in each of two orthogonal principle horizontal directions) have to be considered for the analysis. However, in this method, the design base shear (V_B) shall be compared with a base shear (V_b) calculated using a fundamental period T. If V_B is less than V_b, all response quantities are (for example member forces, displacements, storey forces, storey shears and base reactions) multiplied by V_B/ V_b.

2. LITERATURE SURVEY

P. R. Patil, M. D. Pidurkar, R. H. Mohankar studied in general Analysis of portal frames involves lot of complications and tedious calculations by conventional methods. To carry out such analysis is a time consuming task. The rotation contribution method i.e. Kani's Method & Moment Distribution Method for analysis of portal frames can be handy in approximate and quick analysis so as to get the detailed estimates ready. In this work, these two methods have been applied only for vertical loading conditions. This paper presents the analysis of portal frame, considering mainly the case of single bay portal frame, which is the most common in practice. The Kani's method is self-correcting, that is, the error, if any, in a cycle is corrected automatically in the subsequent cycles. The checking is easier as only the last cycle is required to be checked. The convergence is generally fast. It leads to the solutions in just a few cycles of iterations.

Balaji.U, Mr. Selvarasan M, In this project they proposed a journal on a residential of G+13 multi-story building which is studied for earth quake loads using ETABS. .Assuming that material property is linear static and dynamic analysis is performed. These non-linear analyses are carried out by considering severe seismic zones and the behavior is assessed by taking types II soil condition. Different response like, displacements, base shear are plotted.

SivaKiranKollimarla, ChadalawadaJagan Mohan In the context of seismic analysis and design of structures, in earthquake engineering, a verity of methods are available. Standard codes provide provisions for certain methods for the analysis of wide range of structures of engineering interest. In this paper an attempt is made to present the provision of IS 1893:2002,Part-1 for the analysis of structure and its suitability.

DeepmalaPandey The principle objective of this project is to analyze and design a [G + 5 (3 dimensional frame)] residential building with seismic load and analyzing it under different earthquake zones in India using STAAD.Pro. The design involves load calculations and analyzing the whole structure by STAAD.Pro. The design methods used in STAAD.Pro analysis are Limit State Design conforming to Indian Standard Code of Practice.

Aman, ManjunathNalwadgi , Vishal T, Gajendra The main aim of structural engineer is to design the structures for a safe technology in the computing field; the structural engineer can dare to tackle much more large and complex structure subjected to various type of loading condition. Earlier the loads acting on the structure are considered as static, but strictly speaking, with the exception of the self-weight (dead load) no structure load is static one. Now a day large number of application software's are available in the civil engineering field. All these software's are developed as the basis of advanced. Finite element analysis which includes the effect of dynamic load such as wind effect, earth quake effect bets etc. in the present work, an attempt has been made to study the efficiency of certain civil engineering application software's.

B.G. Birajdar, S.S. Nalawade Made a study on seismic analysis of buildings resting on sloping ground by considering 24 RC buildings with three different configurations like, Step back building, Step back Set back building and Set back building are presented. 3 –D analysis including tensional effect has been carried out by using response spectrum method. The dynamic response properties *i.e.* fundamental time period, top storey displacement and, the base shear action induced in columns have been studied with reference to the suitability of a building configuration on sloping ground. In the present study, three groups of building (i.e. configurations) are considered, out of which two are resting on sloping ground and third one is on plain ground. The first two are step back buildings and step back-setback buildings; and third is the set back building. The slope of ground is 27 degree with horizontal, which is neither too steep or nor too flat. The height and length of building in a particular pattern are in multiple of blocks (in vertical and horizontal direction), the size of block is being maintained at 7 m x 5 m x 3.5 m. The depth of footing below ground level is taken as 1.75 m where, the hard stratum is available. The performance of STEP back building during seismic excitation could prove more vulnerable than other configurations of buildings. Hence, Step back Set back buildings are found to be less vulnerable than Step back building against seismic ground motion. In Step back buildings and Step back-Set back buildings, it is observed that extreme left column at ground level, which are short, are the worst affected. Special attention should be given to these columns in design and detailing.

Likhitharadhya Y R, Praveen J V, Sanjith J, Ranjith A performed Seismic Analysis of Multi-Storey Building Resting On Flat Ground and Sloping Ground In this study, G+ 10 storeys RCC building and the ground slope varying from 100 to 300 have been considered for the analysis. The seismic analysis was done by the response spectrum analyses have been carried out as per IS:1893(part 1): 2002. The results were obtained in the form of top storey displacement, Storey Acceleration, Base shear and Mode period. It is observed that short column is affected more during the earthquake. Base shear is maximum at 200 slope compared to other models. Period also increases. From the analysis, Storey displacement is decrease with increase in slope angle. From the analysis, Storey Acceleration is decrease with increase in slope angle. Acceleration is maximum in storey-11 when compared to storey-1 in all other models along x and y-direction.

Dr. R. B. Khadiranaikar,ArifMasali review on Seismic performance of buildings resting on sloping ground and the conclusions drawn are1. Step back buildings produce higher base shear, higher value of time period, higher value of top storey displacement compared to step back set back building. During seismic excitation Step back building could prove more vulnerable than other configuration of buildings. 2. It is observed that, short columns attracts more forces and are worst affected during seismic excitation. From design point of view, special attention should be given to the size (strength), orientation (stiffness) and ductility demand of short column. 3. The hill slope buildings are subjected to significant torsional effects; due to uneven distribution of shear force in the various frames of building suggest development of torsional moment, which is found to be higher in step back building.4. Many researchers suggested as step back set back buildings may be favored on sloping ground. 5. From the study it is concluded that the presence of infill wall and shear wall influences the behaviour of structure by reducing storey displacement and storey drifts considerably, but may increase the base shear, hence special attention should be given in design to reduce base shear.

3. METHODOLOGY

Earthquake and its occurrence and measurements, its vibration effect and structural response have been continuously studied for many years in earthquake history and thoroughly documented in literature. Since then the structural engineers have tried hard to examine the procedure, with an aim to counter the complex dynamic effect of seismically induced forces in structures, for designing of earthquake resistant structures in a refined and easy manner. This re-examination and continuous effort has resulted in several revisions of Indian Standard: 1893: (1962, 1966, 1970, 1975, 1984, and 2002) code of practice on the "Criteria for Earthquake Resistant Design of Structures" by the Bureau of Indian Standards (BIS), New Delhi. In order to properly interpret the codes and their revisions, it has become necessary; that the structural engineers must understand the basic design criteria and procedures for determining the lateral forces. Various approaches to seismic analysis have been developed to determine the lateral forces, ranging from purely linear elastic to non-linear inelastic analysis. Many of the analysis techniques are being used in design and incorporated in codes of practices of many countries. However, this chapter is restricted to the method of analysis described or employed in IS 1893 (Part I): 2002 of "Criteria for Earthquake Resistant Design of Structures" essentially to buildings although in some cases that may be applied to other types of structures as well.

General Terms

- Natural Period (T): Natural period of a structure is its time period of undamped free vibration.
- Fundamental Natural Period (T1): It is the first (longest) modal time period of vibration.

- Diaphragm: It is a horizontal or nearly horizontal system, which transmits lateral forces to the vertical resisting elements, for example, reinforced concrete floors and horizontal bracing systems.

- Seismic Mass: It is the seismic weight divided by acceleration due to gravity.

- Seismic Weight (W): It is the total dead load plus appropriate amounts of specified imposed load.

- Centre of Mass: The point through which the resultant of the masses of a system acts. This point corresponds to the centre of gravity of masses of system.

- Storey Shear: It is the sum of design lateral forces at all levels above the storey under consideration.

- Zone Factor (Z):It is a factor to obtain the design spectrum depending on the perceived maximum seismic risk characterized by Maximum Considered Earthquake (MCE) in the zone in which the structure is located. The basic zone factors included in this standard are reasonable estimate of effective peak ground acceleration.

- Response Spectrum Analysis: It is the representation of the maximum response of idealized single degree freedom system shaving certain period and damping, during earthquake ground motion. The maximum response is plotted against the un damped natural period and for various damping values, and can be expressed in terms of maximum absolute acceleration, maximum relative velocity, or maximum relative displacement.

- Time History Analysis: It is an analysis of the dynamic response of the structure at each increment of time, when its base is subjected to a specific ground motion time history.

Methods of Seismic Analysis

Once the structural model has been selected, it is possible to perform analysis to determine the seismically induced forces in the structures. There are different methods of analysis which provide different degrees of accuracy. The analysis process can be categorized on the basis of three factors: the type of the externally applied loads, the behavior of structure/or structural materials and the type of structural model selected. Based on the type of external action and behavior of structure, the analysis can be further classified as linear static analysis, linear dynamic analysis, non-linear static analysis, or non-linear dynamic analysis (Beskos and Anagnostoulos, 1997).

modeling of structures

In the present study three G+17 structure models with foundation depth of 1.5m and bay widths in length and width directions of 3m and 3.5m each respectively, support conditions are assumed to be fixed at the bottom or at the supports/footings. The structures having length = 7x3 = 21m, width = 5x3.5 = 17.5m and height = 51.5m. The structureis modeled in ETABS (structural analysis and design software) by considering various loads and load combinations by their relative occurrence are considered the material properties considered are M30 grade concrete and Fe500 reinforcing steel bars. Methods of analysis considered are response spectrum method.

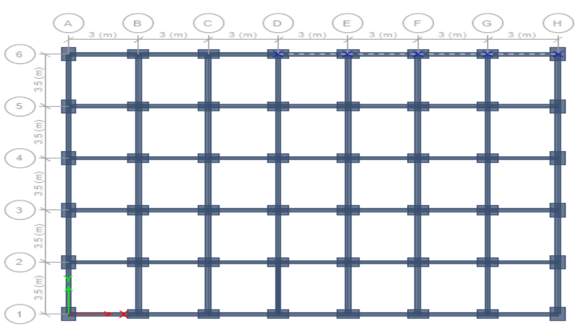

Fig.1. Floor plan of G+17 building

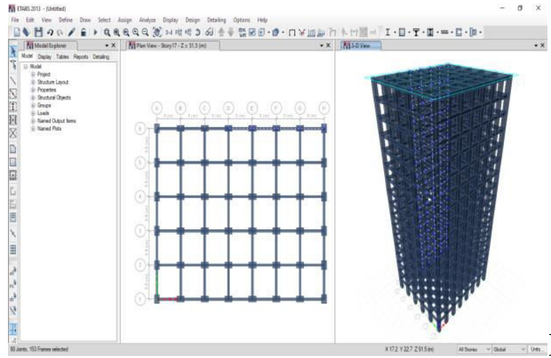

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Fig.2. Three dimensional view of G+ 15 structure.

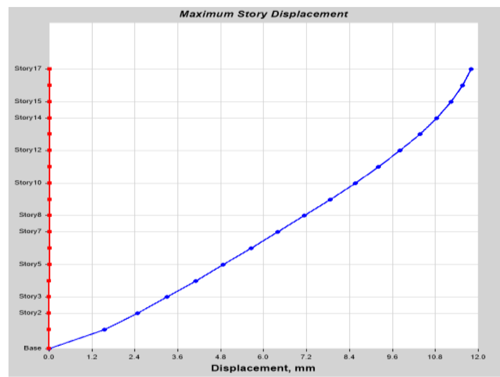

Fig.3. Maximum storey displacements of structure for EQ X in zone III.

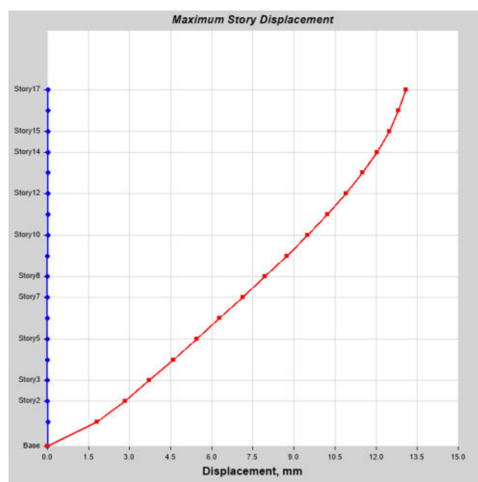

Fig.4. Maximum storey displacements of structure for EQ Y in zone III.

CONCLUSION

The following are the results drawn from the analysis of G+17 buildingin zones III, IV and V by using response spectrum under seismic loads applied parallel to x and y directions.

1. As the storey increases displacement increases, drift decreases, storey shear increases and lateral loads increases.
2. As the zone increases the storey displacement, storey drifts, lateral loads and storey shears are increasing.
3. Lateral loads in X-direction are greater than Y-direction for every zone. The max lateral load in every zone is at storey 16 and those values are as follows
   - In zone III lateral load is 179.1233 KN
   - In zone IV lateral load is 268.685 KN
   - In zone V lateral load is 403.0275 KN
4. The storey displacements, storey drifts and storey shears in X-direction increase with respect to Y-direction.
5. The storey displacement is more in Y-direction at storey 17, storey drift is more in Y-direction at storey 1 and storey shear is more in X-direction at storey 1. Those values are as follows for different zones
   - In zone III displacement is 13.1 mm, drift is 0.000515 and shear is -1209.98 KN
   - In zone IV displacement is 19.6 mm, drift is 0.000773 and shear is -1814.97 KN
   - In zone V displacement is 29.5 mm, drift is 0.001159 and shear is -2722.45KN
6. Maximum Support reactions at the base is 222957.867 KN
7. Shorter columns are observed to be stiffer than longer columns and are subjected to higher storey forces.
8. It is observed that with the increase in the seismic zonesthe parameters such as axial loads, bending moments, shear forces and deflections are increasing.

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