DESIGN AND ANALYSIS OF MULTISTOREYED BUILDING UNDER STATIC AND DYNAMIC LOADING CONDITIONS

[1]*Vaidhyula bhavani*

[1]Assistant professor, Department of Civil Engineering, Brilliant grammar school educational society group of institutions integrated campus
Near By Ramoji Filmcity, Hayathnagar, Abdullahpurmet, Hyderabad,Telangana 501505

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 seismiceffect on building and its performance under earthquake loads. A building of height G+17 RCC structureis 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+17 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.

I.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.

II.METHODOLOGY

Introduction

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 undamped 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).

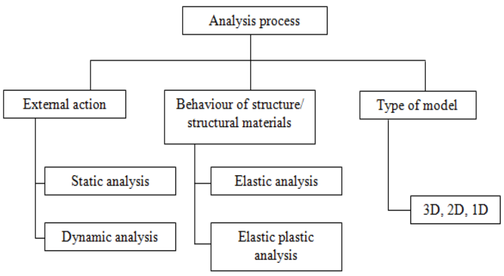

Fig : Method of Analysis Process (Syrmakezis, 1996)

III.SAMPLE RESULTS AND DISCUSSION

In this chapter analysis results of G+17 building in seismic zones III, IV and V are listed in tables and graphs. The parameters studied are storey displacements, storey drifts, storey shears, lateral loads, base reactions, bending moments, shear forces and axial forces.

Results of G+17 building in zone III

Table Storey displacements of G+17 in zone III

Story	Elevation m	Location	For EQ X		For EQ Y	
			X-Dir (mm)	Y-Dir (mm)	X-Dir (mm)	Y-Dir (mm)
Story17	51.5	Top	11.8	2.542E-02	1.369E-02	13.1
Story16	48.5	Top	11.6	2.548E-02	1.515E-02	12.8
Story15	45.5	Top	11.2	2.483E-02	1.492E-02	12.5
Story14	42.5	Top	10.8	2.398E-02	1.452E-02	12
Story13	39.5	Top	10.4	2.299E-02	1.421E-02	11.5
Story12	36.5	Top	9.8	2.184E-02	1.381E-02	10.9
Story11	33.5	Top	9.2	2.056E-02	1.329E-02	10.2

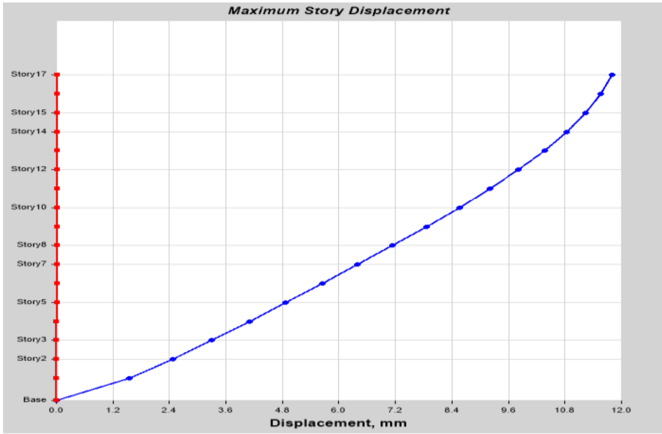

Fig: Maximum storey displacements of structure for EQ X in zone III

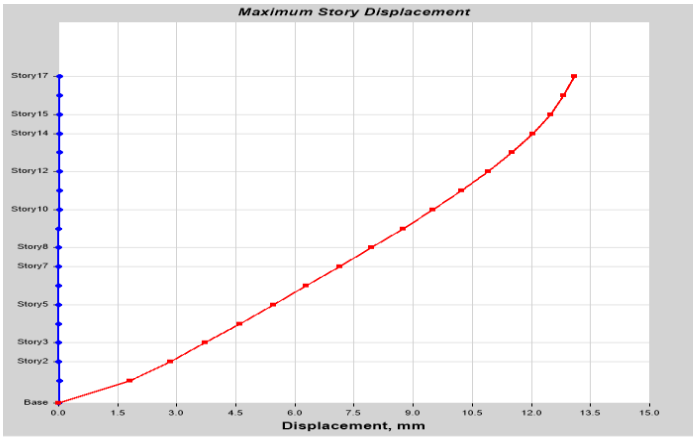

Fig: Maximum storey displacements ostructure for EQ Y in zone III

Table Storey drifts of G+17 in zone III

Story	Elevation m	Location	For EQ X		F
			X-Dir	Y-Dir	X-Dir
Story17	51.5	Top	0.00008	3.042E-07	0.00000
Story16	48.5	Top	0.000105	2.159E-07	1.792E-(
Story15	45.5	Top	0.000133	2.84E-07	1.349E-(
Story14	42.5	Top	0.000159	3.298E-07	1.033E-(
Story13	39.5	Top	0.000182	3.822E-07	1.33E-0
Story12	36.5	Top	0.000202	4.278E-07	1.741E-(
Story11	33.5	Top	0.000218	4.658E-07	2.12E-0
Story10	30.5	Top	0.000231	4.97E-07	2.458E-(
Story9	27.5	Top	0.000241	0.000001	2.769E-(
Story8	24.5	Top	0.000248	0.000001	3.068E-(
Story7	21.5	Top	0.000253	0.000001	3.373E-(
Story6	18.5	Top	0.000257	0.000001	3.887E-(
Story5	15.5	Top	0.000259	0.000001	0.00000
Story4	12.5	Top	0.000263	0.000001	0.00000
Story3	9.5	Top	0.000275	0.000001	0.00000
Story2	6.5	Top	0.000313	0.000001	0.00000
Story1	3.5	Top	0.00044	0.000001	0.00000
Base	0	Top	0	0	0

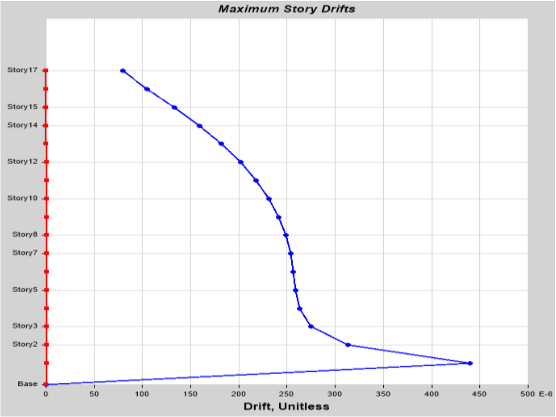

Fig: Maximum storey drifts of structure for EQ X in zone III

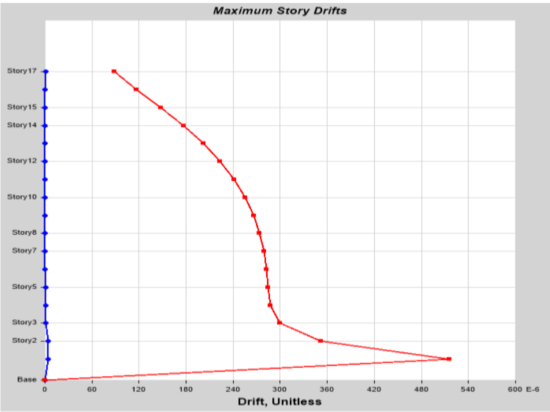

Fig: Maximum storey drifts of structure for EQ Y in zone III

Table Lateral loads on G+17 in zone III

Story	Elevation m	Location	X-Dir kN	Y-Dir kN
Story17	51.5	Top	153.2853	137.7126
Story16	48.5	Top	179.1233	160.9256
Story15	45.5	Top	157.6491	141.633
Story14	42.5	Top	137.5455	123.5719
Story13	39.5	Top	118.8127	106.7422
Story12	36.5	Top	101.4505	91.1439
Story11	33.5	Top	85.4591	76.777
Story10	30.5	Top	70.8383	63.6417
Story9	27.5	Top	57.5883	51.7377
Story8	24.5	Top	45.7089	41.0652
Story7	21.5	Top	35.2002	31.6241
Story6	18.5	Top	26.0623	23.4145
Story5	15.5	Top	18.295	16.4363
Story4	12.5	Top	11.8984	10.6896
Story3	9.5	Top	6.8725	6.1743
Story2	6.5	Top	3.2173	2.8905
Story1	3.5	Top	0.9703	0.8717
Base	0	Top	0	0

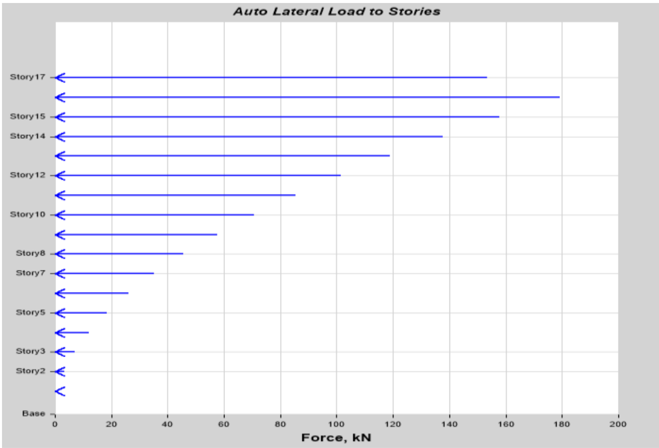

Fig: Lateral seismic load distribution in X-direction on structure in zone III

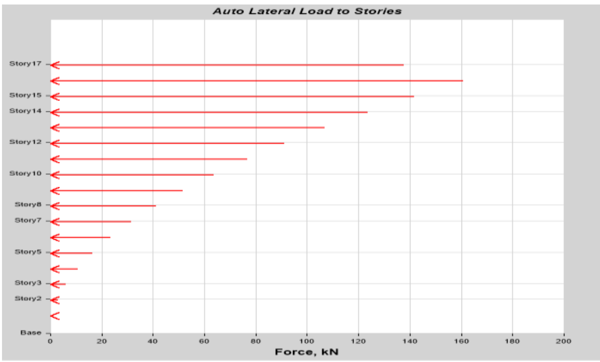

Fig: Lateral seismic load distribution in Y-direction on structure in zone III

IV.CONCLUSIONS

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.

V.REFERNCES

1. IS 1893:1984,"Criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi, India.
2. IS 1893(Part1):2002,"Criteria for earthquake resistant design of structures -General provisions and buildings", Bureau of Indian Standards, New Delhi, India.

3. IS 456: 2000,"Plain reinforced concrete-code of practice", Bureau of Indian Standards, New Delhi, India.
4. IS 13920: 1993,"Ductile detailing of reinforced concrete structures subjected to seismic forces-code of practice", Bureau of Indian Standards, New Delhi, India.
5. IS 875 Part I for Dead load calculations.
6. IS 875 Part II for live load calculations.
7. B.G. Birajdar1, S.S. Nalawade2" seismic analysis of buildings resting on sloping ground"
8. Likhitharadhya Y R1, Praveen J V2, Sanjith J3, Ranjith A4 "Seismic Analysis of Multi-Storey Building Resting On Flat Ground and Sloping Ground"
9. Dr. R. B. Khadiranaikar1 and Arif Masali2 " Seismic performance of buildings resting on sloping ground a review"
10. Manjunath C S1, SidduKarthik C S2 "seismic performance of r c buildings on sloping grounds with different types of bracing systems"
11. P. R. Patil, M. D. Pidurkar, R. H. Mohankar studied(2013) on "Comparative Study of End Moments Regarding Application of Rotation Contribution Method (Kani's Method) & Moment Distribution Method for the Analysis of Portal Frame" (Volume 7, Issue 1)IOSR-JMCE
12. Balaji.U, Mr. Selvarasan M. studied (2016) "Design and analysis of multi storied building under static and dynamic loading conditions using ETABS" (Volume 4, Issue 4) International Journal of Technical Research and Applications e-ISSN: 2320-8163.
13. Siva KiranKollimarla, ChadalawadaJagan Mohan studied (2016)"Seismic Analysis of a Multi Storey Plane Frame using Static & Dynamic Methods Comparison of Equivalent Static Force & Response Spectrum on Frame with & without Infill's" (Vol. 5 Issue 04) (IJERT)
14. DeepmalaPandey (2016) on" Analysis& Design of G+5 Residential Building with Seismic Load Using STAAD .Pro "(Vol-2, Issue-8) (IJIR)
15. Aman, ManjunathNalwadgi , Vishal T, Gajendra studied (2016) " Analysis and design of multistorey building by using STAAD Pro"(Volume: 03 Issue: 06) (IRJET)