Earthquake Analysis Of A Residential Building Using Response Spectrum Method

Lohar Kishan lal
Research Scholar
Department of Civil Engineering
Mewar University, Chittorgarh Rajasthan

Abstract-Earthquake occurred in multistoried building shows that if the structures are not well designed and constructed with and adequate strength it leads to the complete collapse of the structures. To ensure safety against seismic forces of multi-storied building hence, there is need to study of seismic analysis to design earthquake resistance structures. In seismic analysis the response reduction was considered for two cases both Ordinary moment resisting frame and Special moment resisting frame. The main objective this paper is to study the seismic analysis of structure for static and dynamic analysis in ordinary moment resisting frame and special moment resisting frame. Equivalent static analysis and response spectrum analysis are the method subsiding structural seismic analyst planning and management. Building are subjected to various loads suchasdead load, live load, wind load and seismic load .seismic load has extreme adverse effect on building so it is necessary to perform seismic a This paper describe about the response of building when it is subjected to seismic load , this response can bash own by story drift and base shear. Seismic analysis has been performed on (G+8) building which is located in zone 2&4 using STAAD Pro software. Analysis has been performed according toIS1893 PART 1 (2002).

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I. INTRODUCTION

The traditionally built buildings and other structures of India includes small structures which are constructed in bricks, mud, stone or combination of these. The masonry structures which are brittle are proved to be the most susceptible to strong seismic forces. This building construction system generally built by local masons, without the direction of any professional experts is known as non-engineered construction. These usually built structures have underwent extensive destruction during earthquakes. The main reason of the irfailure may be recognized to the negligible tensile strength of materials which are used in the irheavy mass. In most of the cases Them according to the necessities of the owners and prevailing the environmental conditions. But recent performance of earthquakes have explained that seismic efficiency of this kind of constructions is very low and traditionally built houses collapse at a large scale is the single biggest factor contributing to the weighty losses and large number of casualties which happens during earthquakes, for example Bhuj Earthquake which occur in 2001.So it is very much important to progress the seismic behavior of these traditionally build constructions by introducing number of earthquake resistant measures and features.

1. Moment Resisting Frame:

The frame whose member and joints resist the forces primarily caused by flexures Moment resisting frame.

1.1 Ordinary Moment Resisting Frame: The moment resisting frame which are designed without any special attention towards ductile nature of the frame are called ordinary moment resisting frames.

1.2 Special Moment Resisting Frame: The moment resisting frame which are designed to have ductile nature are called as special moment resisting frames. The design is done according to the requirementsspecifiedinIS-13920.Theearthquake resistant designs of structures are considering the following magnitudes of a earthquake.

1.3 Design Basis Earthquake (DBE):

The earthquake whose probability of occurrence is at least one during the structure design life is called design basis earthquake.

2. Maximum Considered Earthquake (MCE):

The earth quake whose expected intensity is maximum that can occur in a particular area or region is called maximum considered earthquake. The maximum values are considered as per code. The design approachrecommendedbyIS:1893-2002isbasedon the following principles (clause 6.1).

- The structure should have the strength to withstand minor earthquakes less than DBE without any damage.
- The structure should be able to resist earthquakes equal to DBE without significant structural damage though some non-structural damage may occur.
- The structure should withstand an earthquake equal to MCE without collapse.

II. RESEARCH REVIEW

Study of some of the past earthquakes in the recent years (Gujarat 2001), Chamoli (Uttaranchal 1999), Jabalpur-1997,Latur-1993haveclearlystatedthatthe seismic response of all traditionally built structures is very low and poor. The main cause of this large scale destruction is the improper seismic design of these traditionally constructions. Some of the most important factors which contributes to wards poor seismic efficiency of masonry buildings are explained below:

1. Large size of openings:

The size of windows and doors openings must be remain small so that there is increase in resistance of wall towards seismic shocks.

2. Failure of connection between walls:

All the walls which have the weakest link in the masonry buildings should be tied together like box to get good seismic performance. Too long walls:

3. The height to thickness and length:

To thickness ratio of walls are must be according to the definite seismic design codes.

4. Absence of proper bonding between perpendicular walls in the junction:

In order to get proper bonding there should be good interlocking between the brick courses at the corner and junctions would be ensured.

5. Irregular or asymmetric plans of masonry buildings:

The buildings which are rectangle in shape suffer less damage in earthquakes as compared to irregular structures. Irregular buildings are those buildings which lacks symmetry and are discontinuous in geometry and mass. It also be noted that focus of great number of mass at a one place attracts large number of torsional and horizontal forces during vibration of grounds i.e ground shaking .So whenever we have to design a building then adopt suitable structural configuration with complete distribution of mass.

6. Poor tensile strength and porosity of bricks: The seismic performance of masonry walls depends on the relative strength between mortar and bricks. As we all know that both concrete and masonry can carry all compressive loads safely but their both behavior in tension is very poor .Therefore, proper grades and standard recommended bricks should be used in construction of masonry structures situated in the specified seismic zone as per Indian standards.

7. Large number construction of non-structural components:

Structures like gables, parapets, projections, unanchored walls etc are the incorrectly tied non-structural components in earthquake is the one of the major cause of injuries and lives. This loss can be lessened by constructing lesser number of these elements and by giving proper design specification.

III. COMMON TYPES OF FAILURE

The most common types or modes of failure of masonry structures subjected to seismic action areas under:

- Non-structural components failure
- Diaphragm failure
- In-plane failure
- Out of plane failure
- Connection failure

As the world moves towards the fulfillment of Performance Based Engineering studies in Seismic Design of Civil Engineering Structures. Structural Design of buildings for seismic loads is primarily concerned with structural 'safety with ground motions but serviceability and potential for economic loss are also of concern. Seismic loading requires an understanding of the structural performance under various factors such as elastic deformations, floating columns, spectrum analysis and static analysis, many more.

IV. RESULTS & DISCUSSIONS

The structure is 32m in x-direction & 24m in y-direction with columns spaced at 4m from centre to centre. The storey height is kept as 3m. Basically model consist s of multiple bay fifteen storey building, each bay having width of 4m.

Table1.The material properties and geometry of the model.

Dimensions	Values
Length X width	32mX24m
Number of stories	15
Support conditions	Fixed
Storey height	3m
Grade of concrete	30 Mpa
Grade of steel	Fe415
Sizeofcolumnsfrom1-5storey	650mmx650mm
Sizeofcolumnsfrom6-15storey	500mmx500mm
Size of beams	450mmx450mm
Height of parapet wall	0.9m
Thickness of main wall	230mm
Thickness of parapet wall	115mm

The storey height between two floors is3.0m with beam and column sizes of 0.45x0.45m respectively and also the slab thickness is taken as0.125m.Shape Of the building for all the cases is shown in figure. The material properties and geometry of the model are described below in table1.

Load details for the model is given in the below table 2.

Table2. Load details of the model.

Loads	Values
Wall load	13.8 KN/m
Wall load (of Parapet wall at top floor):	2.07 KN/m
Live load:	
Floor load	4KN/m2
Roof load	2KN/m2
Seismic Load:	
Seismic zone	V (Z=0.36)
Soil type	II
Import acne factor	1
Response reduction factor	5
Damping	5%

All the results are given below. We have selected rectangular section from the paper [1]. And the comparison of results is also given below.

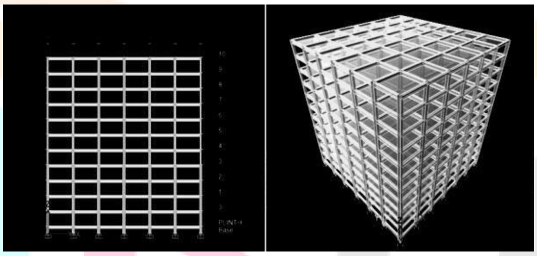

Fig1.Softwar rendered model of regular structure.

Data from dynamic analysis perform edits given in the table 3 and the data from dynamic analysis from
[1]is given in the table4.

Table3 .Data from dynamic analysis performed.

Modes	Time period	Frequency	Mass participation ratios	
			X trans	Y trans
1	1.57	0.637	0	75.5
2	1.524	0.656	75.82	0
3	1.372	0.729	0	0
Sumof12modes			93.32	93.28

Table-4.Data from dynamic analysis.

Modes	Time period	Frequency	Mass participation ratios	
			X trans	Y trans
1	1.332729	0.75034	0	77.0963
2	1.303713	0.767039	77.3483	0
3	1.200129	0.833243	0	0
Sumof12modes			94.6027	94.5829

The below Fig 4.2 and Fig 4.3 is the graph plotted for the Storey displacement. The graph is plotted for displacement vs. Storey. The results for storey displacement are given in the table 4.5.

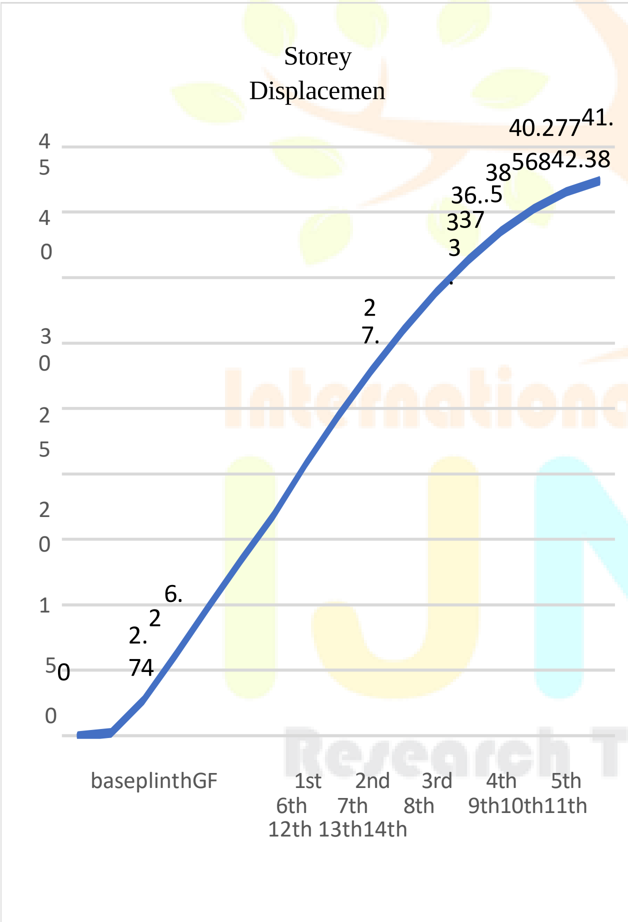

Fig2.Graph plotted for the Storey displacement.

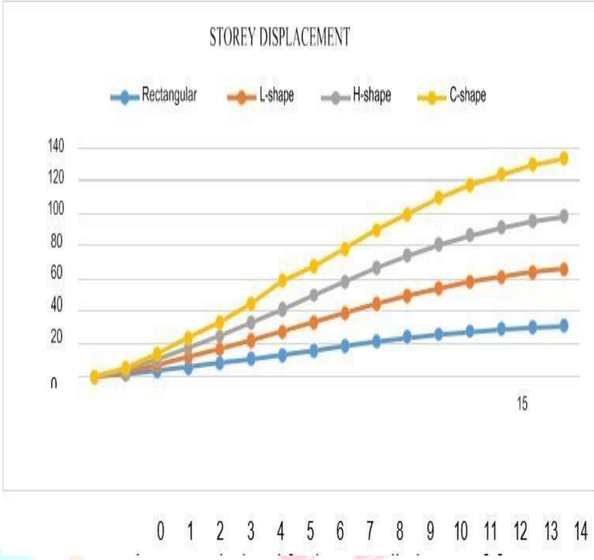

Fig3.Graph plotted for the Storey displacement.

The below Fig 5 is the graph plotted for the Storey drift. The graph is plotted for storey drift vs. Storey.

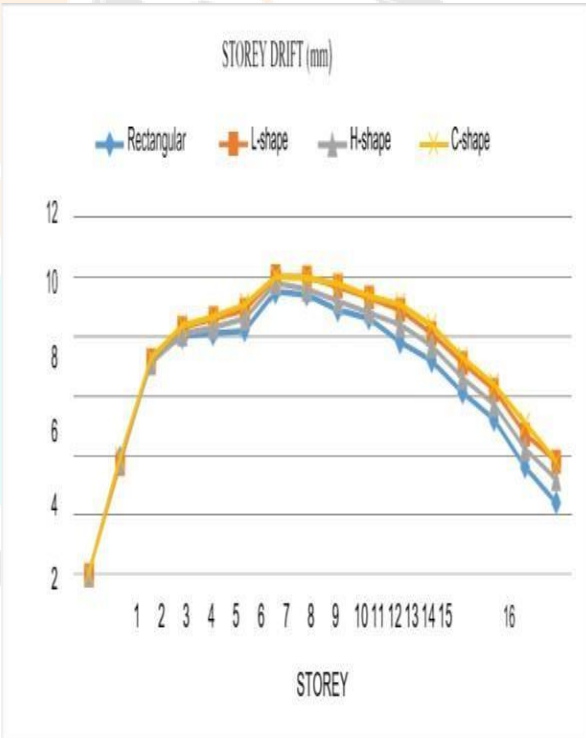

Fig4.Graph plotted for the Storey drift.

The below Fig 6 is the bar graph plotted for the Storey Shear. The graph is plotted for storey Shear vs. Storey. The results for storey Shear are given in the table 5.

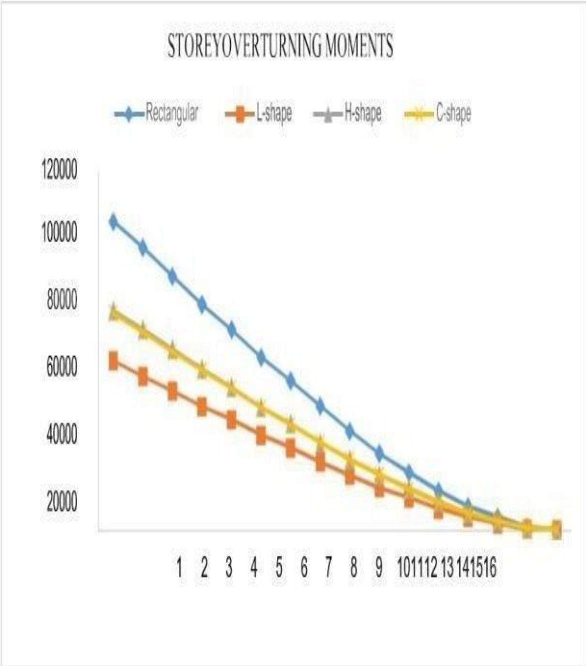

Fig5.Graph plotted for the Storey overturning moment.

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Table5.TheresultsforstoreyShear.

Storey	Storey shear Obtained	Storey shear
1ststorey	4166.3	3000
5thstorey	3294.6	2800
10thstorey	2351.61	2000
15thstorey	633.19	500

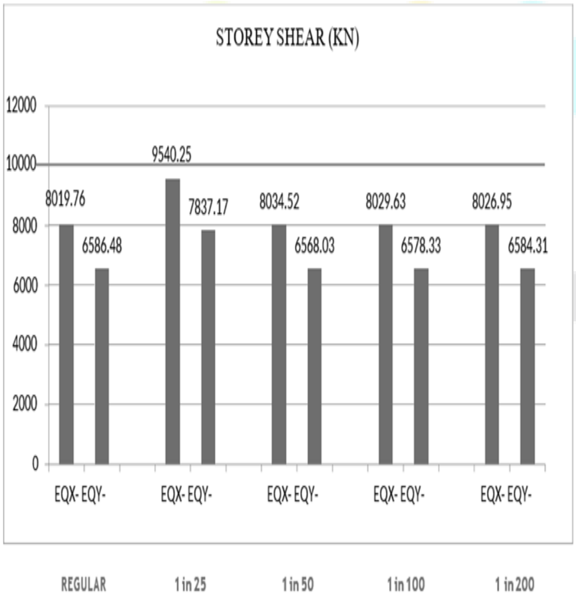

Fig6.Bar graph for Storey Shear.

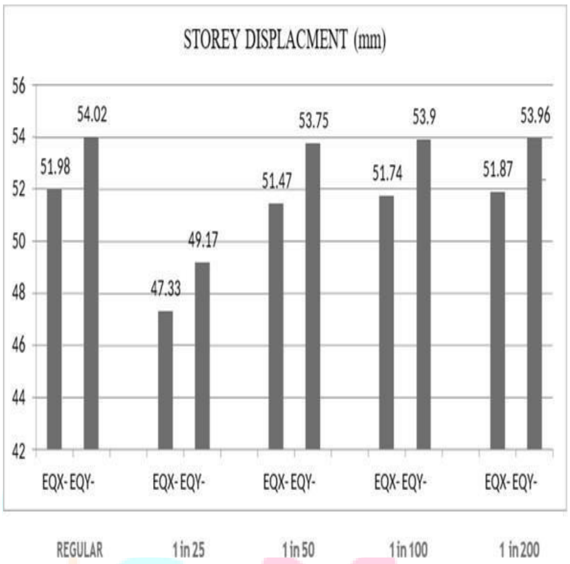

Fig7.Bar graph for Storey Displacement.

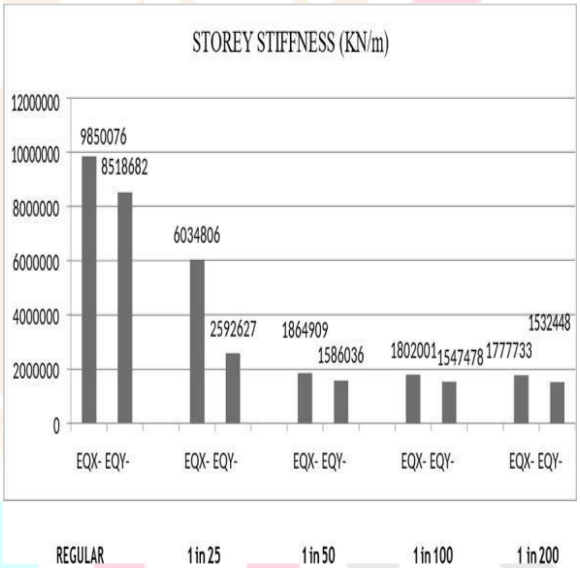

Fig8.Bar graph for Storey Stiffness.

- The centre of area for remains constant for all the structures.
- The centre of mass and centre of stiffness varies with the sloping ground and vertical irregularity creating enormous eccentricity in the structure.
- The centre of load for the regular structure without any irregularity was found to be.
- 15.36m where as for the vertically irregular structure in a flat ground was16.45mfor which the eccentricity is1.09,Similarly, the eccentricity of the structure on the sloping terrain condition without vertical irregularities for thesl

ope1:25,1:50, 1:100,1:200 are

- 1.13 m,1.05 m, 0.36mand0.45m respectively.
- The centre of load for the vertical ir regular in flat ground was16.45m.theeccentricityof the structure on the sloping terrain condition without vertical irregularities for the slope 1:25, 1:50, 1:100, 1:200 are2.57m, 1.66 m, 2.39m and 0.82m respectively.
- Comparing the above results we come to know that for the terrain slope of 1:100 the structure without any irregularity can be constructed.

IV.CONCLUSION

The obtained results of static and dynamic analysis in OMRF & SMRF are compared for different columns under axial, torsion, bending moment and displacementforces.Theresultsingraph-1showsthat there is equal values obtained of axial forces in static and dynamic analysis of OMRF structure. The results in graph-2 shows that the values are obtained for torsion in static analysis are negative and dynamic analysis values are positive.

The results in graph-3 here we can observe that the values for bending moment at dynamic analysis values are high initially for other columns it decreased gradually as compared to that of static analysis. The results in graph-4 we can observe that the values for displacement in static analysis of OMRF values are more compared to that of dynamic analysis values of same columns.

The results in graph shows that the values obtained of axial forces in dynamic analysis of SMRF structure values are high compare to static analysis. The results in graph-6 shows that the values are obtained for torsion in static analysis are negative and dynamic analysis values are positive with more difference.

In theresultsgraph-7, we can observe at the values for bending moment at dynamic analysis values are more as compared to that of static analysis SMRF structure. In the results graph-8, we can observe that the values for displacement in dynamic analysis of SMRF values are gradually increased compared to that of static analysis values of same columns.

The static and dynamic analysis of OMRF & SMRF values is observed. Finally it can conclude that the results of static analysis in OMRF & SMRF values are low when comparing to that of dynamic analysis in OMRF & SMRF values. Hence the performance of Dynamic analysis SMRF structure is quiet good in resisting the earthquake forces compared to that of the static analysis OMRF & SMRF.

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