COMPARATIVE STUDY OF PERFORMANCE OF RCC MULTISTORY BUILDING FOR KOYNA AND BHUJ EARTHQUAKES

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ABSTRACT

Earthquakes occurred in recent past have indicated that if the structures are not properly designed and constructed with required quality may cause great destruction of structures. This fact has resulted in to ensure safety against earthquake forces of tall structures hence, there is need to determine seismic responses of such building for designing earthquake resistant structures by carrying seismic analysis of the structure. Time history analysis is one of the important techniques for structural seismic analysis especially when the evaluated structural response is nonlinear.

In the present work dynamic analysis of G+12 multistoried practiced RCC building considering for Koyna and Bhuj earthquake is carried out by time history analysis and response spectrum analysis and seismic responses of such building are comparatively studied and modeled with the help of ETABS software. Two time histories (i.e. Koyna and Bhuj) have been used to develop different acceptable criteria (base shear, storey displacement, storey drifts).

Keywords: Time History Analysis, Response Spectrum Analysis, Seismic Responses, Etabsv9.7.2.Etc.

I. INTRODUCTION

1.1 General

The process of urbanization has been a common feature throughout the past decades, Urbanization and Growth of high rise buildings is the need of current population, earthquakes have the potential for causing the greatest damages to those tall structures. Hence, it is necessary to take in to account the seismic load for the design of high-rise structure. Earthquakes occurred in recent past, particularly in the state of Gujarat (Bhuj, Kutch, 2001) have indicated that if the structures are not properly designed and constructed with required quality may cause great destruction of structures and also loss of life. Reinforced concrete buildings have been damaged on a very large scale in Bhuj earthquake of Jan 26th 2001, Even though these buildings are analyzed and designed as per IS code. The damages are caused by inconsistence seismic response, irregularity in mass and plan, soft storey and floating columns etc. Hence it becomes necessary to evaluate actual seismic performance of building subjected to earthquake forces. Time History analysis gives more realistic seismic behavior of the building. It gives more accurately seismic responses than response spectrum analysis because of it incorporates material nonlinearity and dynamic nature of earthquake.

II. OBJECTIVES OF STUDIES

Following are the objectives of the present study

1. To analyze the RCC multistory building for seismic forces.
2. To study various responses such as base shear, lateral displacement, storey drift etc. of building for Koyna and Bhuj earthquakes.
3. To compare effect of Time history analysis and response spectrum analysis on performance of RCC multistory building.

III. METHODS OF ANALYSIS

The analysis can be performed on the basis of external action, 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.

1. Equivalent static analysis:

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings. This procedure does not require dynamic analysis, however, it account for the dynamics of building in an approximate manner. The static method is the simplest one-it requires less computational efforts and is based on formulate given in the code of practice. First, the design base shear is computed for the whole building, and it is then distributed along the height of the building. The lateral forces at each floor levels thus obtained are distributed to individual's lateral load resisting elements.

2. Response Spectrum Method:

Response spectrum method is the linear dynamic analysis method. In this method the peak responses of a structure during an earthquake is obtained directly from the earthquake responses (or design) spectrum. The representation of the maximum responses of idealized SDOF systems having 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 relative velocity or maximum relative displacement.

3. Time History Method:

Time History analysis is a step by step analysis of the dynamic response of the structure at each increment of time when its base is subjected to specific ground motion time history. To perform such an analysis a representative earthquake time history is required for a structure being evaluated. It is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

IV. STRUCTURAL MODELING AND ANALYSIS

4.1 Problem statement

The G+12 RCC multistory residential building consider for analysis building to know the realistic behavior during earthquake with the general form of plan shown in fig. Building is modeled for two time histories i.e. Bhuj and Koyna. Plan dimensions in X and Y direction are 30.40m and 20.95m respectively. The buildings are consisting of columns with dimension 230mm x1000mm for ground ,storey 1and 2,column sizes reduced by 100mm for every two floor up to 230mmx 500mm, all beam with dimension 230mm x 700mm. the floor slabs are taken as 125mm

thick. The height of all floors is 3m and foundation height is 1.5m considered soil type is hard. Modal damping 5% is considered with SMRF and I=1. The columns are assumed to be fixed at the ground level. Material concrete grade is M30 and while steel Fe500 is used.

4.2 Loading considered:

Loading which is applied in this structure includes dead load, live load and earthquake load are according to IS 875 part I, Part II and IS 1893:2002 respectively.

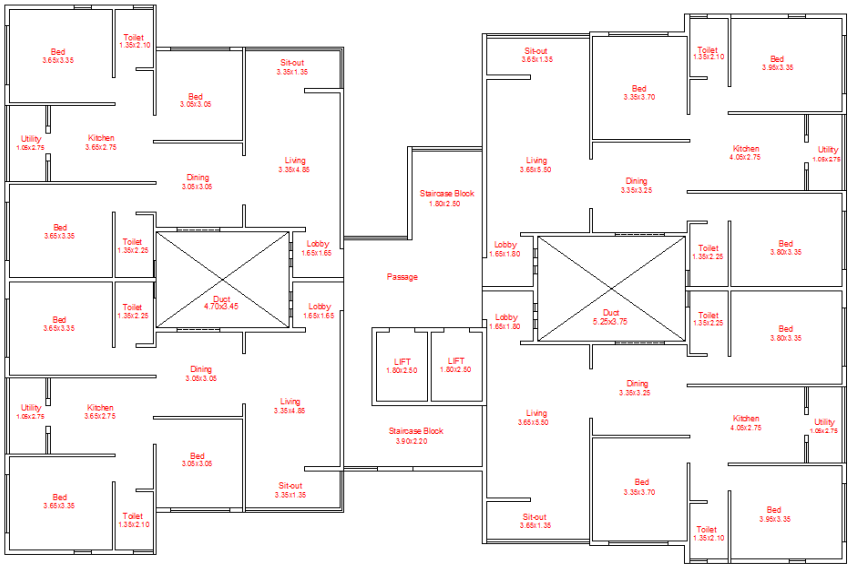

Fig.1: Plan selected for proposed work

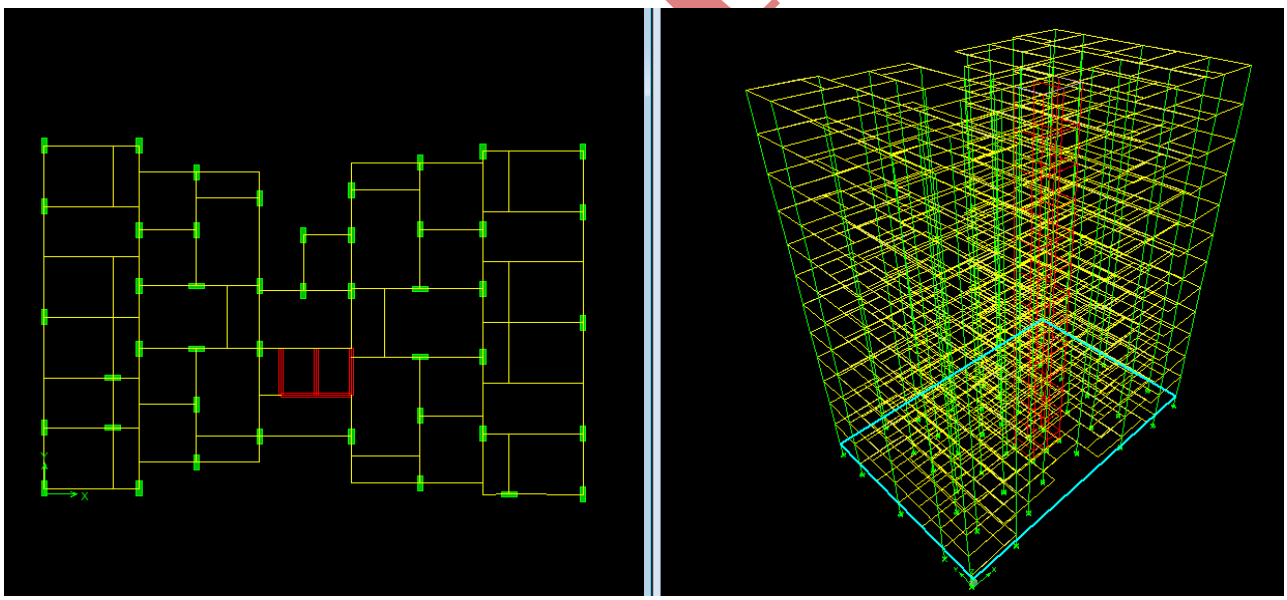

Fig.2: Plan and 3D view of G+12 RCC multistory residential building in ETABS9.7.2

V. RESULTS AND DISCUSSION

The parametric study of base shear, storey displacement and storey drift of building in different stories by time history analysis and response spectrum analysis for Koyna & Bhuj is performed here. The results obtained from analysis are listed below and compared by graphical representation.

5.1 Comparison of Base Shear

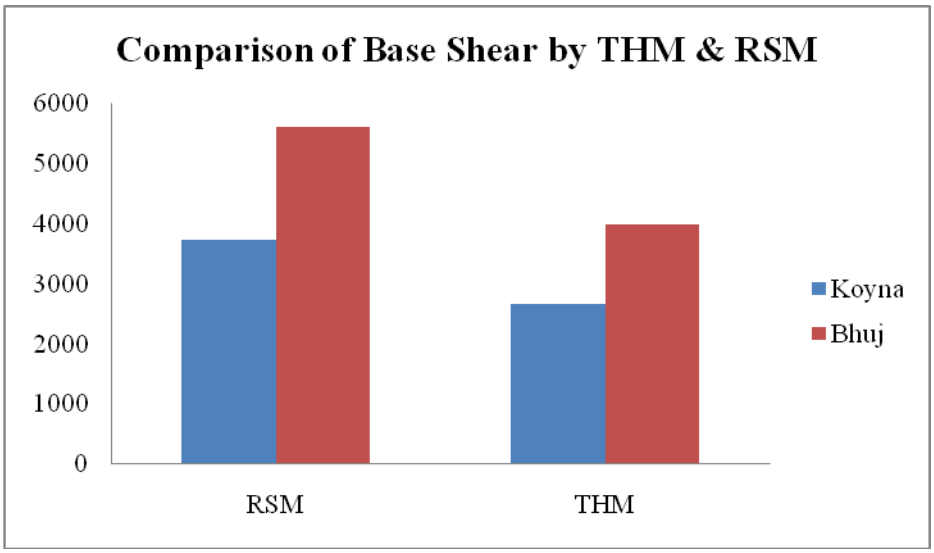

Fig.3: Comparison of Base Shear for Koyna & Bhuj Earthquake by THM&RSM

By Time History method base shear are 2667.99kN for Koyna and 3978.37kN for Bhuj and by Response Spectrum Method values of base shear are 3727.3kN for Koyna and 5590.96kN for Bhuj earthquake.

5.2 Storey Displacements:

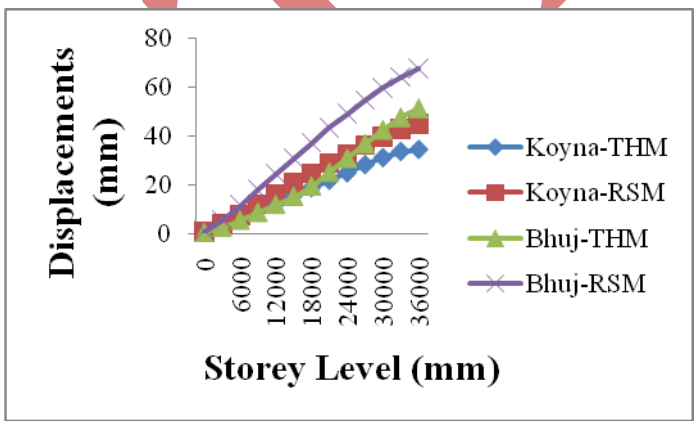

Fig.4: Comparison of storey displacement for Earthquakes in X direction using RSM&THM

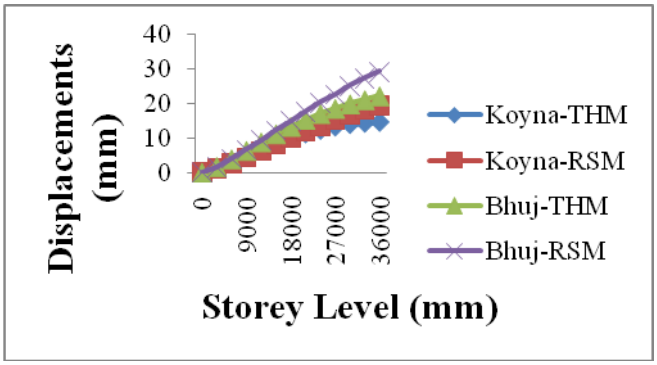

Fig.5: Comparison of storey displacement for Earthquakes in Y direction using RSM&THM

It has been observed that values of storey displacement are increases at roof level from ground. From the graphs it is observed that the value of displacements varies linearly for response spectrum analysis. The value of top storey displacements for Bhuj earthquake 49% & 50.92% more than Koyna earthquake by time history analysis for both X and Y directions.

5.3 Storey Drift:

As per clause no 7.11.1 of IS-1893 (Part-1):2002 the storey drift in any storey due to specified design lateral force with partial load factor of 1 shall not exceed 0.004 times the storey height. Maximum storey drift for building= 0.004 X h, for 3m storey height it is 0.12m.

Table 1: Variation of Maximum Storey Drift for Earthquakes in X direction by THM & RSM

Storey Level (mm)	Storey Drift			
	Koyna-THM	Koyna-RSM	Bhuj-THM	Bhuj-RSM
0	0.000178	0.000404	0.000267	0.000606
3000	0.000457	0.001053	0.000644	0.001579
6000	0.000648	0.001327	0.000905	0.001991
9000	0.000812	0.001459	0.001095	0.002188
12000	0.000845	0.001464	0.001183	0.002195
15000	0.000864	0.001511	0.001263	0.002266
18000	0.000888	0.001467	0.001261	0.0022
21000	0.000946	0.001499	0.001362	0.002249
24000	0.000887	0.001422	0.001382	0.002132
27000	0.000834	0.001438	0.001453	0.002157
30000	0.000755	0.001318	0.001362	0.001977
33000	0.000693	0.001219	0.001242	0.001829
36000	0.000632	0.000899	0.000946	0.001348

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VII. CONCLUSION

From the above results the following conclusions are drawn.

1. From the graphs it is observed that the values of base shear for Bhuj earthquake is 49.11% more than the Koyna earthquake. Response spectrum method gives 50% more results than time history analysis.

2. As a result of comparison between time history method and response spectrum method it has been observed that the values obtained by response spectrum analysis of base shear and top story displacement for Koyna earthquake 39.70% & 31.18% and for Bhuj earthquake 40.53%&31.99% are higher than time history analysis.
3. From the tabulated values it is observed that the values of the Storey drifts for all the stories are found to be within the permissible limits.
4. From the results it is recommended that time history analysis should be performed as it predicts the structural response more accurately than the response spectrum analysis.

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