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COMPARATIVE STUDY OF PERFORMANCE OF RCC MULTI-STOREY BUILDING

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ABSTRACT

Recent history of earthquakes has shown that if structures are not properly designed and built, they can cause serious damage to structures. This fact led to ensure the safety of tall buildings from earthquake forces, so the seismic reactions of such a building must be determined in the design of earthquake-resistant structures through seismic analysis of the structure. In this work, dynamic analysis of G+12 RC multi-story frame building considering Koyna and Bhuj earthquakes is carried out through response spectrum analysis and history analysis and the responses of such building are comparatively studied using SAP2000 software.

Two histories (ie, koyna and Bhuj) were used to develop different acceptance criteria (base displacement, layer displacement, layer drift). Based on the results, historical analysis is recommended because it predicts the structural response more accurately than response spectrum analysis. Pushover analysis is also performed on the same building and the results show that the building is seismically safe.

Keywords- Response Spectrum Analysis, Seismic Responses, Time History Analysis,

1. INTRODUCTION

THE process of urbanization has been a common feature throughout the centuries, Globalization 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 important 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,

2001) have indicated that if the structures are not properly designed and constructed with required quality may cause great damage to structures and also loss of life. Reinforced concrete buildings have been destructed 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 inconsistent seismic response, irregularity in mass and plan, soft storey and floating column etc. Hence it becomes necessary to determine actual seismic performance of building subjected to seismic forces. Time history analysis gives more realistic behavior of the building. It gives more accurately seismic responses than response spectrum analysis because of it includes material nonlinearity and dynamic nature of earthquake.

Patil A. S. and Kumbhar P. D. [1] analyzed ten storied RC building considering different seismic intensities and seismic responses of such building are evaluated with the help of SAP2000 software. Five different time histories have been used considering seismic intensities V, VI, VII, VIII, IX and X for establishment of relationship between seismic intensities and seismic responses. From the study it is recommended that, to ensure safety against earthquake force, analysis of multistoried RC building using Time History method becomes necessary.

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[2] designed multi storey buildings with regular and irregular plan (as per IS 1893) using STAAD Pro and ETABS software separately. From the design results of beams, we may conclude that ETABS gave lesser area of required steel as compared to STAAD Pro. Form the design results of column; since the required steel for the column forces in this particular problem is less than the minimum steel limit of column (i.e., 0.8%), the amount of steel calculated by both the software is equal.

Wakchaure M. R. and Ped S. P. [3] studied the effect of masonry walls on high rise building. Linear dynamic analysis on high rise building with different arrangement was carried out. Earthquake time history is applied to the models. The width of strut was calculated by using equivalent strut method. All analysis was carried out by software ETABS. Base shear, storey displacement, story drift was calculated and compared for all models. The results showed that infill walls reduce displacements, time period and increases base shear.

Parvathaneni S. and Elavenil S. [4] done the three dimensional RC frames analysis for gravity loads and lateral loads and the response spectrum analysis and time history analysis carried out to evaluate seismic performance of frame. The response spectrum analysis and time-history analysis is done by using ETABS with compatible accelograms, and results obtained from analysis are verified. Nonlinear time history analysis is done for studying the inelastic behavior of the structures.

Bahador et al. [5] studied Multi-storey irregular buildings with 20 stories using software packages ETABS and SAP 2000 for seismic zone V in India. The investigation of dynamic responses of building under actual earthquakes considering EL-CENTRO 1949 and CHI-CHI Taiwan 1999 were done. They highlighted the exactness and accuracy of Time History analysis in comparison with the most commonly adopted Response Spectrum Analysis and Equivalent Static Analysis.

N.M.Nikam [20]considered G+15and G+20 storied building with provision of shear wall at different position and pushover analysisis carried out.They found that fundamental time period is increased due to provision of shear wall as well as global stiffness is increases.

Mohommad Azoz and Anshul R.Nikhade [21] studied pushover analysis on reinforced concrete structure in which G+10 building was subjected to push in X direction and push in Y direction. Analysis was done in sap2000 15.They found that slope of pushover curve is gradually changed with increase of the lateral displacement of the building. From results the concluded that the building considered for analysis not requires retrofitting.

2. OBJECTIVES

1. To analyze the RCC multistory building for seismic forces.
2. To evaluate various responses such as base shear, lateral displacement, storey drift etc. of building for Koyna and Bhuj earthquakes.
3. To compare effect of Koyna and Bhuj earthquakes on performance of RCC multistory building.
4. To compare software results with current practices.
5. To investigate material non-linearity behaviour considering plastic analysis.

3. METHODS OF ANALYSIS

A. 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 insufficient. This is permitted in most codes of practice for regular, low-to medium-rise buildings. This procedure takes into account the dynamic behavior of building in an approximate manner; it does not require dynamic analysis. The static method is based on the formulation given in IS codes thus it is easiest one and requires less computational efforts. 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.[3,5]

B. Response Spectrum Method

Response spectrum method is the linear dynamic analysis method. In this method the peak structural response can be obtained directly during an earthquake using the earthquake responses (or design) spectrum. It represents the maximum responses of idealized SDOF systems with certain time period and modal damping, during earthquake ground motion. The maximum response curve is plotted for various damping values and against the undamped natural period, and can be represented in terms of maximum relative displacement or maximum relative velocity.[5,9,10,11,15,16]

C. Time History Method

Time History method is step by step analysis of the dynamic response of the structure at each time increment when its base is subjected to ground motion time history record.

To perform such an analysis a representative earthquake time history is essential for a structure being evaluated. It is used to determine the seismic response of a structure under dynamic loading of considered earthquake. [1,4,14,18]

STRUCTURAL MODELING AND ANALYSIS

The G+12 RC multistory framed building considered for analysis to know the realistic behavior during

earthquake with the general form of plan shown in fig 1. RC multi-storey framed building is modeled for two time histories i.e.

Bhuj and Koyna. Plan dimensions in X and Y direction are 20m and 20m respectively. The buildings are consisting of columns with dimension 600mm x 600mm for all stories and beam with dimension 300mm x 700mm. the floor slabs are taken as 150mm thick.

The height of all floors is 3.2m and height of plinth is 2m. soil type is Medium. Modal damping 5% is assumed with SMRF and I=1. The columns are assumed to be fixed at the base. Material concrete grade is M30 and while steel Fe415 is used.

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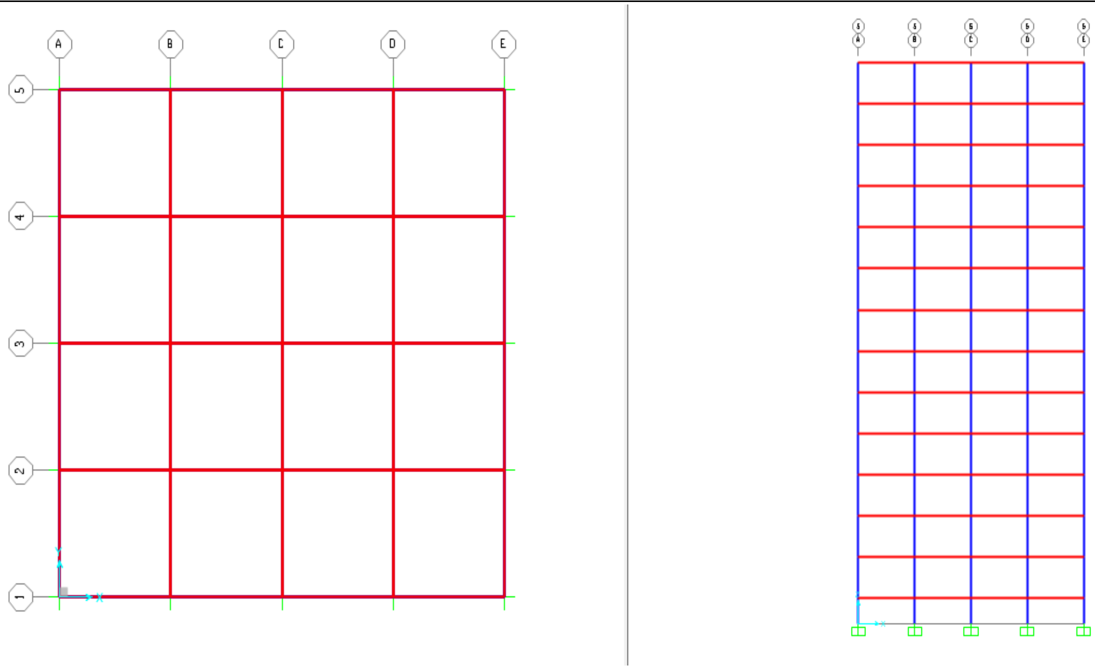

Fig. 1 Plan and Elevation of G+12 RC multistoried framed Building in SAP2000

4. RESULT AND DISCUSSION

The Comparative Study Of Storey Displacement, Base Shear And Storey Drift Of Building In Different Stories By Response Spectrum Analysis And Time History Analysis For Koyna & Bhuj Is Performed Here.

The Results Obtained From Analysis Are Given Below And Comparative Study Is Carried Out By As Following Comparison of Base Shear **Table 1:** comparison of story shear for earthquake by RSM and THM

Story level (mm)	Story shear (kN)			
	Koyna-THM	Koyna-RSM	Bhuj-THM	Bhuj-RSM
43600	275.137	340.344	377.016	510.517
40400	611.824	759.264	819.801	1138.897
37200	893.170	1114.448	1283.648	1671.674
Story level (mm)	Story shear (kN)			
	Koyna-THM	Koyna-RSM	Bhuj-THM	Bhuj-RSM
34000	1254.304	1441.154	1650.849	2116.733
30800	1504.689	1654.638	1910.848	2481.958
27600	1830.732	1850.156	2022.298	2775.235
24400	2138.652	2002.965	2394.417	3004.448
21200	2315.940	2118.321	2777.447	3177.482
18000	2432.479	2201.481	2968.719	3302.222
14800	2508.256	2257.701	2956.351	3386.552
11600	2366.272	2292.238	2818.154	3438.357
8400	1962.451	2310.348	2646.438	3465.523
5200	1566.039	2317.288	2508.267	3475.933
2000	1691.523	2317.387	2460.222	3476.294
0	1691.523	2317.387	2460.222	3476.294

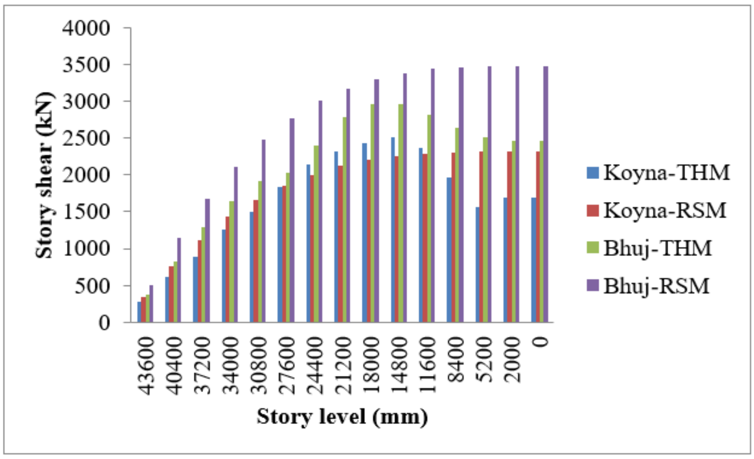

Fig. 2 Comparison of Base Shear for Koyna & Bhuj Earthquake by THM&RSM

By Time History method base shear are 1691.523 kN for Koyna and for Bhuj 2460.222kN and by Response Spectrum Method values of base shear are 2317.387kN for Koyna and 3476.294kN for Bhuj earthquake

Storey Displacements

Table 2: Comparison of story displacement for earthquake by RSM and THM

Story level (mm)	Story displacement (mm)			
	Koyna-THM	Koyna-RSM	Bhuj-THM	Bhuj-RSM
0	0	0	0	0
2000	0.681	0.734	0.492	1.102
5200	3.077	3.527	2.451	5.291
8400	5.497	6.653	4.732	9.982
11600	7.714	9.707	7.038	14.562
14800	9.415	12.623	9.252	18.901
18000	11.589	15.304	11.291	22.957
21200	13.503	17.819	14.017	26.717
24400	15.198	20.115	17.484	30.174
27600	16.898	22.209	20.939	33.315
34000	20.063	25.691	27.404	38.538
37200	21.187	27.012	29.980	40.521
40400	21.347	28.004	31.827	42.009
43600	21.528	28.665	32.026	43.001

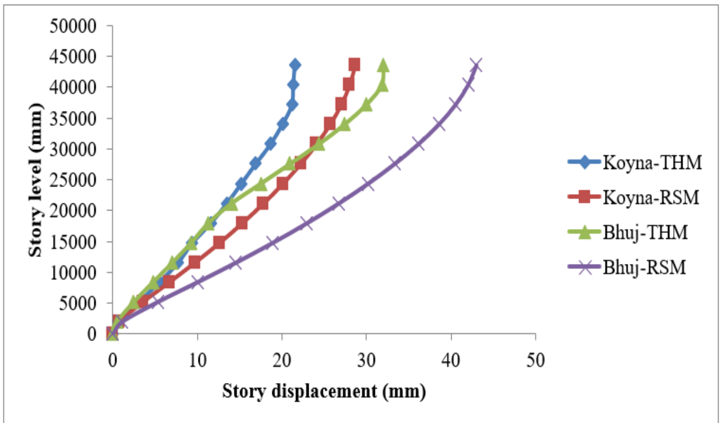

Fig. 3 Comparison of storey displacement for Earthquakes using RSM & THM

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It has been observed that values of storey displacement are increases at top level from ground. From the graph it is observed that the value of displacements varies linearly for response spectrum analysis.

The value of top storey displacements for Bhuj earthquake is 32.026mm and for Koyna earthquake it is 21.528mm by time history analysis.

Storey Drift :

As per clause no 7.11.1 of IS-1893 (Part-1) 2002 [7]: 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 3.2m storey height it is 0.0128m.

Table 3: Variation of story drift for earthquake by RSM and THM

Story level (mm)	Story drift (m)			
	Koyna-THM	Koyna-RSM	Bhuj-THM	Bhuj-RSM
0	0	0	0	0
2000	0.000323	0.000734	0.000486	0.001102
5200	0.001212	0.002793	0.001708	0.004189
8400	0.001526	0.003126	0.002131	0.004689
11600	0.001700	0.003054	0.002293	0.004582
14800	0.001670	0.002893	0.002339	0.004339
18000	0.001546	0.002704	0.002261	0.004056
21200	0.001517	0.002506	0.002157	0.003763
24400	0.001455	0.002305	0.002094	0.003457
27600	0.001306	0.002094	0.002036	0.003141
30800	0.001083	0.001868	0.001887	0.002802
34000	0.000924	0.001613	0.001668	0.002421
37200	0.000752	0.001322	0.001347	0.001983
40400	0.000697	0.000992	0.001044	0.001488
43600	0.000470	0.000661	0.000717	0.000992

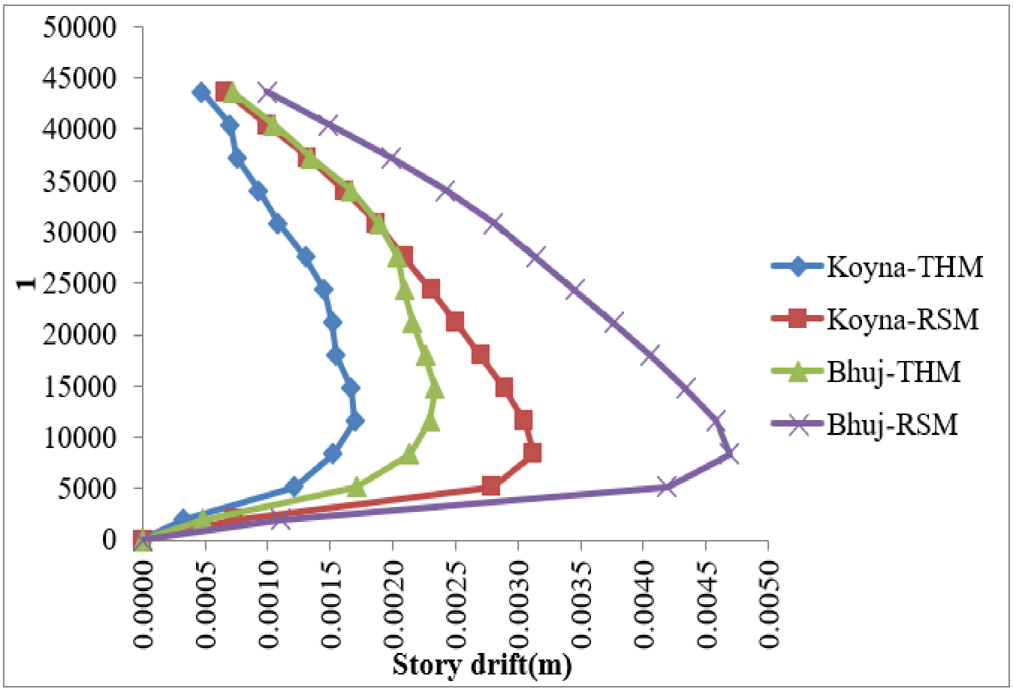

Fig. 4 Comparison of storey Drifts for Earthquakes using RSM &THM

5. CONCLUSION

From the above results it is concluded that;

1] The seismic response such as base shear for Bhuj earthquake are found to be more by 45.44% than Koyna earthquake by using time history analysis.

2] The base shear of Koyna and Bhuj earthquake by response spectrum method is found to be 37.01% and 41.30% higher than time history method.

3] The top story displacement of Koyna and Bhuj earthquake by response spectrum method is found to

be 33.15% and 34.26% higher than time history method.

4] The values of the storey drifts for all the stories for all the effects are found to be within the permissible limits specified as per IS: 1893-2002 (Part I).

5] 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.

6. REFERENCES

[1] Patil A. S. and Kumbhar P. D. (2013), "Time History Analysis of Multistoried RCC Buildings for Different Seismic Intensities", International Journal of structural and civil engineering research, ISSN 2319 – 6009, Vol. 2, No. 3 pp. 194- 201.

[2] Prashanth.P, Anshuman.S, Pandey.R.K, Arpan Herbert (2012), "Comparison of design results of a Structure designed using STAAD and ETABS Software", International Journal of Civil and Structural Engineering, ISSN 0976 – 4399, Volume 2, No 3.

[3] Wakchaure M.R, Ped S. P (2012), "Earthquake Analysis of High Rise Building with and Without In filled Walls", International Journal of Engineering and Innovative Technology. ISSN: 2277-3754, Vol. 2, Issue 2. Page No. 89-94.

[4] Mr.Parvathaneni Subash, Mr.S.Elavenil (2012), "Time History Response Prediction for Multi-Storey Buildings under Earthquake Ground Motions", Journal of Civil, Structural, Environmental, Water resources and Infrastructure Engineering Research Vol.2 ,Issue (2) pp 16-23

[5] Bahador Bagheri, Ehsan Salimi Firoozabad, and Mohammadreza Yahyaei (2012), "Comparative Study of the Static and Dynamic Analysis of Multi-Storey Irregular Building", World Academy of Science, Engineering and Technology. Vol.6 . pp 1847-1851.

[6] Bureau of Indian Standards (BIS). Plane and Reinforced Concrete Code of Practice, IS 456-2000 (Fourth Revision), New Delhi.

[7] Bureau of Indian Standards (BIS). Criteria for Earthquake Resistant Design of Structures, IS 1893(Part I)-2002 (Fifth Revision), New Delhi.

[8] Shrikhande M. and Agrawal P (2006), "Earthquake Resistant Design of Structures", First Revised Edition, PHI Learning Private Limited, New Delhi.

[9] Md. Arman Chowdhury1, Wahid Hassan, "Comparative study of the Dynamic Analysis of Multi-storey Irregular building with or without Base Isolator", International Journal of Scientific Engineering and Technology, ISSN: 2277-1581, Volume No.2, Issue No.9, pp: 909-912, Sept 2013.

[10] Mahammed Yousuf and R.M.Shimpale "Dynamic analysis of Reinforced concrete buildings with plan irregularities".International Journal of Emerging technology and Advanced Engg.ISSN 2250-2459 ISO 9001:2008

[11] Prof.Dr.Qaiser uz, Zaman khan "Evaluation of effect of Response spectrum Analysis on Height of Building"International conference (ICSBE-2010).

[12] Bhavin H.Zaveri Jasmin A.Gadhiya "Comparative study of steel, RCC and composite building´"International Journal of Innovative Resarch in science Volume 05,1Jan2016 ISSN-2319-8753

[13] Mahesh N. Patil, Yogesh N. Sonawane, "Seismic Analysis of Multistoried Building" from International Journal of Engineering and Innovative Technology (IJEIT), Volume 4, Issue 9, March 2015 ISSN: 2277-3754.

[14] Wilkinson S and Hiley R (2006), "A Non Linear Response History Model for theSeismic Analysis of High-Rise FramedBuildings", Computers and Structures,Vol. 84.

[15] Pravin B. Waghmare, P.S.Pajgade and N. M. Kanhe, Response spectrum analysis of a shear frame structure by using MATLAB, Int. Journal of Applied Sciences and Engineering Research, Vol. 1, No. 2, 20124

[16] Patnala V S Neelima, Ramancharla Pradeep Kumar, "Seismic Behaviour of RC Frame with URM Infill: A Case Study", International Journal of Education and applied research (IJEAR), Vol. 4, Issue Spl-2, Jan - June 2014 ISSN: 2348 -0033 (Online) ISSN : 2249-4944 (IJERA), Vol. 3, Issue 4, Jul-Aug 2013, pp.176-185 ISSN: 2248-9622..

[17] Sagar R Padol1, Rajashekhar S. Talikoti2 "Review paper on seismic responses of multistored rcc building with mass irregularity review paper on seismic responses of multistored rcc building with mass irregularity" IJRET: International Journal of Research in Engineering and Technology ISSN: 2319-1163 | ISSN: 2321-7308

[18] Romy Mohan, C Prabha, "Dynamic Analysis of RCC Buildings with Shear Wall", International Journal of Earth Sciences and Engineering ISSN 0974-5904, .

[19] Bhakti Narayan Harne1, Prof. R. R. Shinde, "Seismic Performance of Multi-Storied RC Building with Soft Storey International Journal of Emerging Technology and Advanced Engineering, Volume 5, Issue 8, August 2015 ISSN 22

[20] N.M .Nikam , L.G.Kulkarnix "Pushover analysis of building with shear wall " IJESC Volume -6 Issue no.6.

[21] Mohammad Azoz, Anshul R Nikhade "Pushover analysis of G+10 Reinforced concrete structures for zone II and zone III as per IS1893(2002)".

[22] Jyoti patil, dr.D.K Kulkarni "Performance based evaluation of framed reinforced shear wall by pushover analysis"International journal of engineering and technology ISSN2395-0056