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Dynamic Analysis of Multistory Structure using Linear Time History Analysis

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Abstract—Linear Time History analysis of G+12 storied RCC building considering 4 different time histories is carried out. The time history data of Bhuj earthquake, Chamba earthquake, Chamoli earthquake and NE (Myanmar) earthquake has been considered. Here, a G+12 stories building has been modelled using Etabs software for seismic analysis and time history analysis. This paper highlights the effects of different time histories of different region on the same structure. The effects under considerations are story shear, building deflection and story drift.

Index Terms—Time History Analysis, Seismic zone, Multistorey building, Seismic responses, Seismic Analysis

I. INTRODUCTION

Due to rapid infrastructural development and population increment, the need for high-rise structures in India had been increased in the past few decades. Around 60% of Indian areas are prone to seismic damages due to seismic activities. The seismic zones vary from zone II to V as per IS 1893 [2] (part 1):2016.

The earthquake causes various intensities of shocks in various places and the damage induced in the buildings in those places is also different. Thus, it is necessary to build a structure that resists earthquake to a particular degree of intensity to shake a structure, and not so much the scale of a seismic event. Although the same scale of seismic event occurs because of its variable intensity, the resulting adverse effects differs in different regions. Therefore, it is essential to consider the varieties in seismic conduct of multistorey RCC building for diverse seismic force in terms of different reactions such as horizontal relocations and base shear. It is necessary to understand the seismic behaviour of buildings having similar layout under different intensities of earthquake. For determination of seismic responses, it is necessary to carry out seismic analysis of the structure using different available methods [1].

Time history analysis is the dynamic response of the structure at each instance of time, when its base is subjected to a specific ground motion time history.

II. LITERATURE REVIEW

Gururaj B., Basavraj S. (2014) G+10 storied structure is analysed for different time histories and highlights the impacts on floors which has diverse loads (mass irregularity) in multi-storeyed building with time history analysis by ETABS software.

M.Jeelani, B.Venkatrao (2016) G+2, G+4, G+6, G+8, G+10 storied structure are analysed for different zones and soil conditions and showed the importance soil supporting at the base of structure during different earthquake intensities.

Patil A.S., Kumbhar P.D. (2013) G+10 storied structure is analysed for different time histories for establishment of relationship between seismic intensities and seismic responses and recommended that analysis of multi-storeyed RCC building using Time History method becomes necessary to ensure safety against earthquake force.

Phadnis, Punashri (2013) G+3 & G+10 storied structures were analysed with static equivalent method, response spectrum method and linear time history analysis and concluded that the presence of shear wall in the structure decreases fundamental natural period, percentage of reinforcements in the columns and increases the lateral stiffness of the building, thus performing effectively in resisting lateral forces induced by an earthquake.

Mehta *et al.* (2017) G+25 storied structure is been analysed using time history analysis in staad.pro software to check displacement and story drift of the structure.

Mahmood Hosseini *et al.* (2017) A set of multi-story buildings upto 16 stories were considered in the highest seismic hazard zone of Tehran and showed that some earthquakes the buildings performance exceed LS PL, and even in some cases they reach collapse level.

Jelena Pejovic, Srdjan Jankovic (2015) G+8 reinforced concrete building with frame structural system in one direction and wall system in the other direction. The nonlinear time history analysis used to present analysis of different ground motion intensity measures can be used in assessing the behaviour of reinforced concrete structure.

Chetan P., Amey R. (2018) G+15 story building with symmetrical and asymmetrical configurations analysed for seismic zone 4 and medium soil conditions and maximum storey displacement, maximum storey drift, storey shear, and maximum overturning moment are plotted for linear and nonlinear dynamic analysis [3].

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III. OBJECTIVES

a) To analyse G+12 story RC building for seismic intensity V, by using distinctive methods such as Equivalent static method, Response spectrum method and Time history analysis.

b) To compare seismic behaviour of G+12 story RC building for specific time history acceleration data in terms of reactions [4].

c) To study the impacts of distinctive time history information on performance of G+12 story RC building in terms of seismic reactions such as base shear, storey displacement and story drift [6].

d) To know the relationship between distinctive methods of earthquake analysis and time history analysis.

IV. METHODS

In this study, (G+12) story RC building is modelled and analysed in ETABS software. (G+12) storied RC building is analysed under different time history data of different earthquakes such as Bhuj earthquake, Chamba earthquake, Chamoli earthquake and NE (Myanmar) earthquake.

The (G+12) RC building with different time history data is taken and their corresponding responses are determined [7].

This work involves here is modelling of (G+12) story RC building, assigning material properties to frames sections and giving support conditions to the base of model and assigning various loads as per IS 875. And then analysis of the modelled structure with response spectrum method and different time histories of different earthquakes [5].

Problem Statement

The (G+12) RC multi storied structure considered for the analysis [8]. The general form of plan shown in fig.1 & fig.1A. Building is modelled for Indian seismic zone V as per IS:1893(Part 1)-2016.

Table 1 The considered structure has following dimensions

Plan(m^2)	25m X 25m
Story height(m)	3m
Material	M30 & FE500
Column size (mm)	750X750
Beam size (mm)	230X750
Slab thickness (mm)	150

Loading considered
At typical floor,
Floor finish = 1.5 kN/m^2
Live load = 2.0 kN/m^2
Wall load (outer, 230 thk) = 13.6 kN/m
Wall load (inner, 150 thk) = 9.5 kN/m

At terrace floor,
Floor finish = 1.5kN/m^2
Live load = 3.0 kN/m^2
Water proofing (200 thk) = 4 kN/m^2
Wall load (parapet, 230 thk) = 6.25 kN/m

Seismic parameters
(As per IS1893:2016)
Soil type = II (medium)
Importance factor = 1.0
Response reduction factor = 5
Zone factor (for zone V) = 0.36
Time period (in X & Y dir) = 0.702 sec.

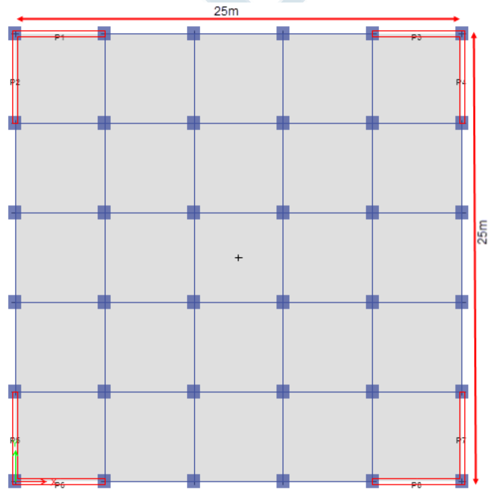

Fig. 1 Plan

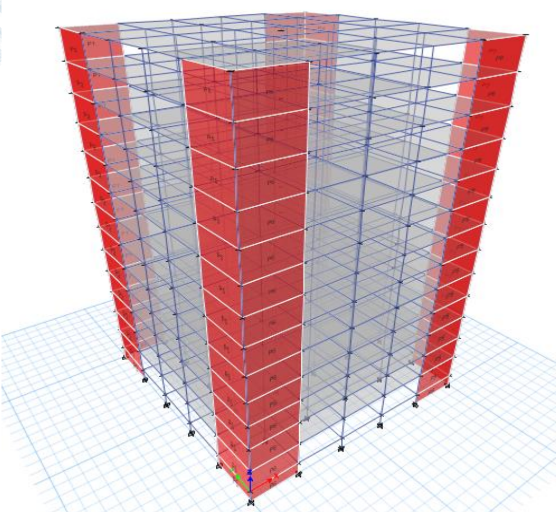

Fig. 1a 3D Elevation

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Table 2 Time histories considered for study

Sr no.	Earthquake	Date	Magnitude Richter scale
01	Bhuj earthquake	26th Jan'01	7.7
02	Chamba	24th Mar'95	4.9
03	Chamoli	29th Mar'99	6.8
04	NE (Myanmar)	06th Aug'88	7.3

The following figures show the time vs acceleration graphs, (refer fig. 2 to fig. 5)

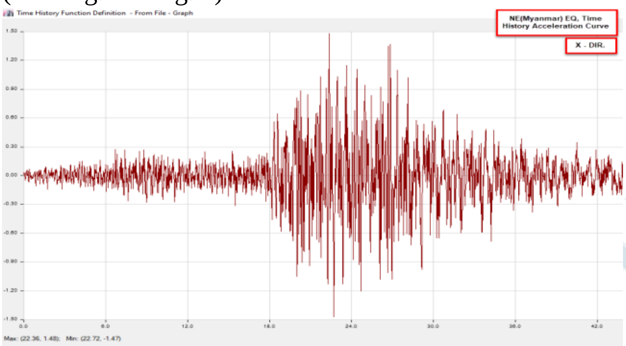

Fig. 2 – Bhuj EQ, X-Dir.

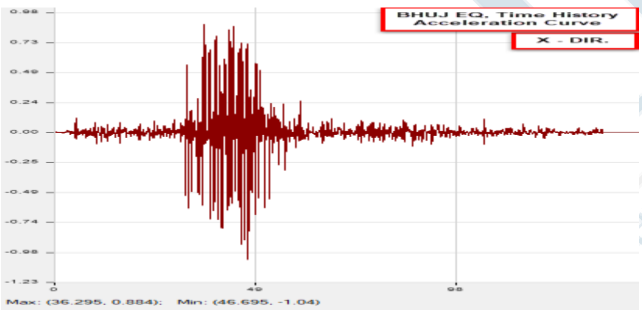

Fig. 2A – Bhuj EQ, Y-Dir

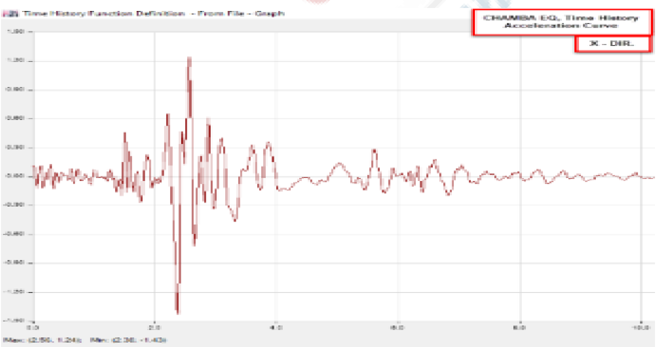

Fig. 3 – Chamba EQ, X-Dir

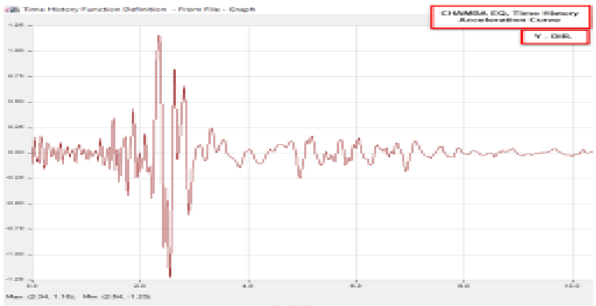

Fig. 3A – Chamba EQ, Y-Dir.

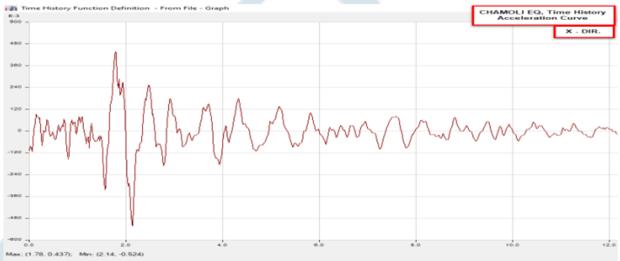

Fig. 4 – Chamoli, X-Dir

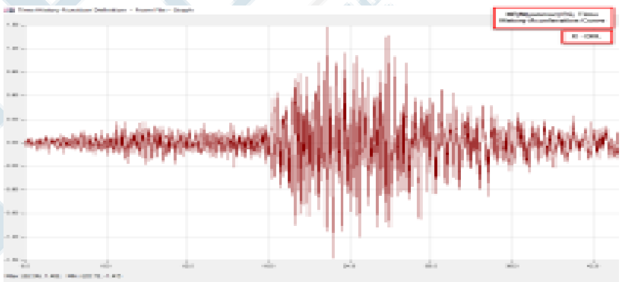

Fig. 4A – Chamoli, Y-Dir

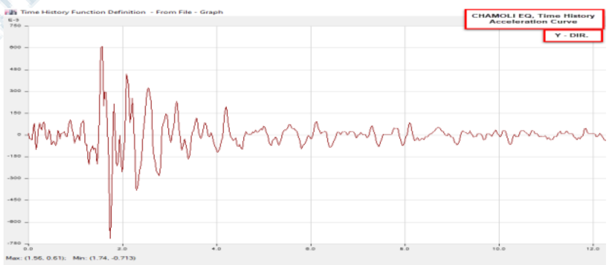

Fig. 5 – NE, X-Dir.

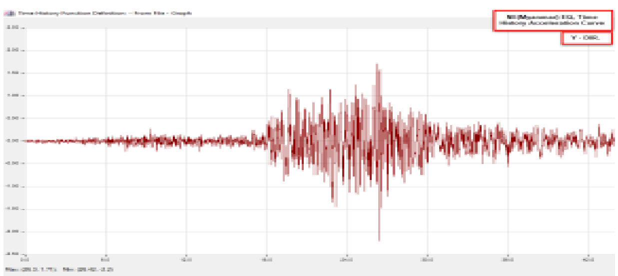

Fig. 5A – NE, Y-Dir.

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V. RESULTS

Results obtained from above analysis is presented below in fig. 6 to fig. 11

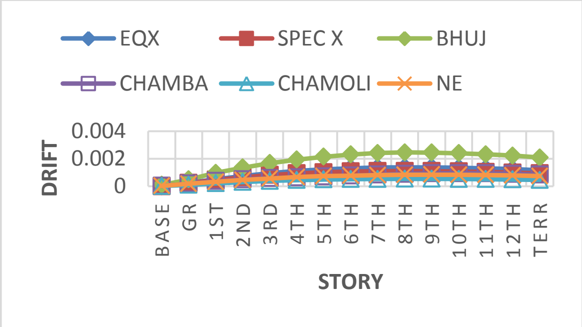

Fig. 6 - X-direction Building deflection

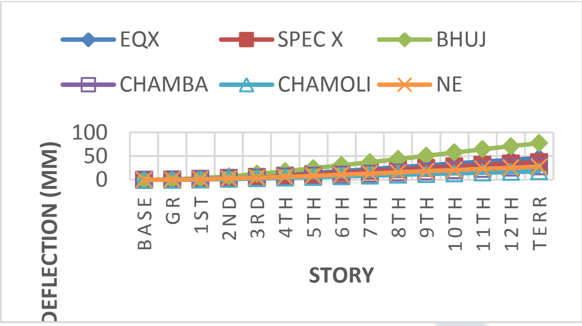

Fig. 7 - Y-direction Building deflection

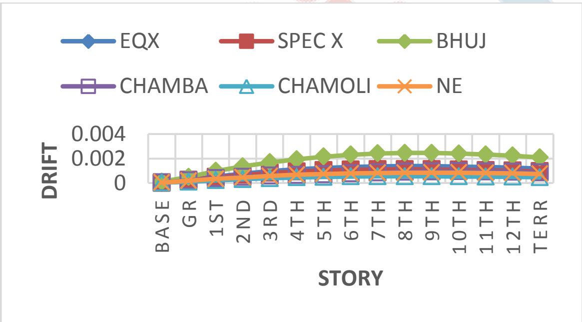

Fig. 8 - X-direction story drift

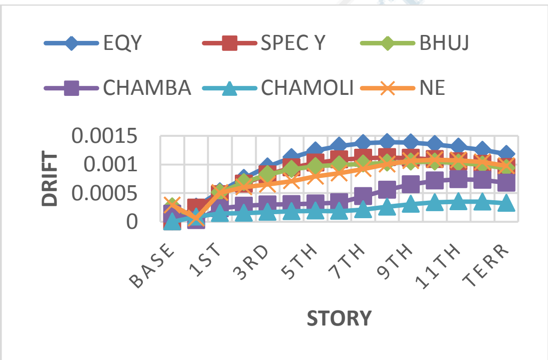

Fig. 9 - Y-direction story drift

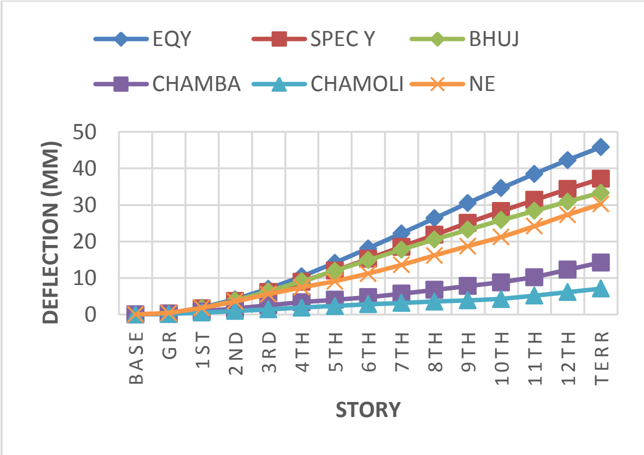

Fig. 10 - X-direction story shear

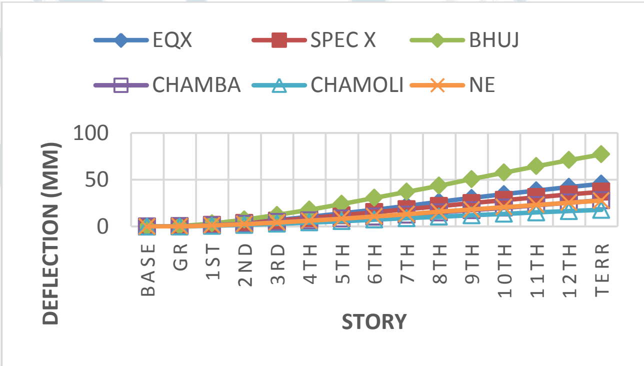

Fig. 11 - Y-direction story shear

Above graphs (fig.6 – fig11) shows variation in the results in X-dir and Y-dir for Building deflection, Story drift & Story shear.

VI. DISCUSSION

The analysis of the G+12 RC building model was carried out with equivalent static method, response spectrum method and time history method.

The structure was modelled in ETABS software with different earthquake time histories [9].

For Building deflection, in X-dir. the Bhuj EQ deflection values are highest i.e., 70% more than static EQ in same dir. (fig. 6) and in Y-dir., the equivalent static method values are highest i.e., 37.4% more than the Bhuj EQ time history (fig. 7). This shows that the time history analysis gives more accurate results as it is based on actual earthquake data.

For Story drift, in X-dir. the Bhuj EQ drift values are highest (fig. 8) and in Y-dir., the equivalent static method values are highest (fig. 9)

For Story shear, the time history analysis gives the worst-case results. For e.g., Bhuj EQ time history analysis, the base shear in X-dir. is increased by 100.6% (fig. 10) and in Y-dir. is

increased by 10.5% (fig. 11). The difference in values of building deflection for time history analysis and static equivalent method is mainly due to the huge difference in ground motion in case of actual seismic activity [10].
The equivalent static method and response spectrum analysis are approximate methods which fails to match the actual behaviour of ground motion as seen in case of Bhuj earthquake (refer fig. 6, fig. 8 & fig.10)

VII. CONCLUSION

This study shows that the time history analysis procedure leads to good estimates of the trends of building response.
Equivalent static method and response spectrum analysis are not sufficient for structures in higher seismically active regions (i.e., for zone V).
Time history analysis represents a seismic design method which avoids the approximations of other linear seismic analysis methods, which leads to conservative results and can be applied to any structure.

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