International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 2, Mar-Apr-2019, ISSN (Online): 2395-566X

A Comparative Study on Multistoried Building by Time History Analysis Method for Nepal Earthquake

Anu Shekhar annushekhar23@gmail.com
Subhankar Manna subhankarmanna7221@gmail.com
Dona Chatterjee donajdvu@gmail.com
Dept. of Civil Engineering
Heritage Institute of Technology
Kolkata, India

Abstract- **Nonlinear time history analysis is known for simulating structural behaviour under severe earthquake more proper than other methods. The present paper mainly studies seismic response of four building models of variable heights with constant base dimensions under ground motion records of Nepal earthquake 2015 which are modelled and analysed using STAAD software. The results of the study are discussed and compared in terms of accelerations and displacements versus time plots and seismic response such as base shear, bending moment, storey drift shows a similar trend of variation with increase in height of the building.**

***Keywords* – Time History Analysis, Seismic Responses, Multistoried Buildings, Nepal Earthquake.**

I. INTRODUCTION

Ground motion due to earthquake can cause severe damage to the structures thus a threatening to the mankind. In order to take precaution against the damage of structures due to strong ground motion, it is important to know its characteristics. The most important dynamic characteristics of an earthquake are peak ground acceleration, frequency and duration. These characteristics play an important role in studying the behavior of structures under the earthquake ground motion.

There are different techniques of seismic analysis of structure. Among them time history analysis is one of the most important techniques for structural seismic analysis generally when the evaluated structural response is nonlinear in nature. In this paper seismic analysis of multistoried building of varying heights has been carried out. Authors mainly focuses on the study of the response of four different models during earthquake. The main parameters considered in this study are to compare the seismic response in terms of base shear, storey drift and base bending moments.

II. LITERATURE REVIEW

Tehrani P. equated the nonlinear static (pushover) and nonlinear dynamic processes in the purpose of maximum displacements of a steel structure retrofitted with different methods.[1]

Khan Q.Z. studied the response spectrum analysis of 20 storied building which has been conferred in detail and comparison has been drawn between static and dynamic analysis and design results of buildings up to 400 feet height (40story) in terms of percentage decrease in bending moments and shear force of beams, bending moments of columns, top story deflection and support reaction was conferred.[2]

Mohan R. studied the exactness of time history analysis in comparison with the utmost commonly adopted response spectrum analysis and equivalent static analysis considering different shape of shear walls.[3]

Patil S. and Kumbhar P.D. carried out the nonlinear dynamic analysis of ten storied RCC building considering different seismic intensities and seismic responses of such building were reported.[4]

III. METHODOLOGY

Time history is basically a method of seismic analysis for the simulation of an earthquake motion. It is an ultimate tool to study the dynamic response of a structure. This paper gives time history analysis by using time - acceleration data as input function and then performance of the structure is evaluated with various mode shapes and time-acceleration results.The ground motion records of Nepal earthquake, 2015 has been considered for analysis. These records are obtained from USGS (United State Geological Survey) database.

The duration of ground motion is considered here is 60s. Ten, fifteen, sixteen and twenty-story RC buildings which are considered as low, mid- and high-rise reinforced buildings, are modelled as three-dimension regular reinforced concrete buildings in STAAD Pro. Then the ground motions are introduced to the software and time history analysis is performed The basis of the present work is to study the behaviour of reinforced concrete buildings under varying acceleration contents. Here, the story displacement, story velocity, story acceleration and base shear of regular reinforced concrete buildings are obtained.

The methodology, which is conducted, is briefly described as below: -

- Ground motion records are collected and then normalized.
- Linear time history analysis is performed in STAAD Pro.[5]
- Building response such as story displacement, story velocity, story acceleration and base shear are found due to the applied ground motion.
- The results of four regular RC buildings are compared with respect to ground motions.

Self-weight of structure is applied. The live load of 3.0 kN/m^2 is applied as per IS 875 (Part 2): 1987.

IV. PROBLEM DEFINITION

In this paper, the four different models (RC frame building) which has been considered for time history analysis. The geometrical & member properties of all the models have been shown in Table I & II. Figure 1 shows the typical STAAD model of the building.

Table 1 Geometrical Properties.

Model	Length (meter)	Breadth (meter)	Height (meter)
I	12	12	60
II	12	12	48
III	12	12	45
IV	12	12	30

Table 2 Member Properties.

Model	Beam dimension (cm²)	Column dimension on (cm²)	Slab thickness (cm)	Brick wall thickness (cm)
I	25*40	50*40	15	23
II	25*40	50*40	15	23
III	25*40	50*40	15	23
IV	25*40	50*40	15	23

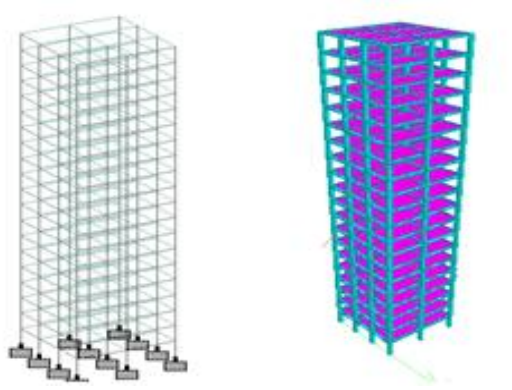

Fig.1.A Typical STAAD Model

V. RESULTS & DISCUSSION

From analysis of four models by time history method using STAAD Pro, the following results are obtained and are presented in Table III and Table IV Figure 2 to Figure 9 shows the time versus displacement and time versus acceleration plot of all the models in both X and Z direction respectively at roof level. The maximum base shear, bending moment and story drift at roof level are presented in Table III below.

Table 3 Base Shear, Moment & Story Drift at Roof Level

Model	Base Shear (kN)	Base Bending Moment (kN-m)	Story Drift in X Direction (mm)
I	41.90	2514	24.91
II	34.60	1660	20.97
III	32.36	1456	12.94
IV	25.00	750	7.83

The first three modes of natural frequencies for all models are presented in Table IV below.

Table 4 Natural Frequencies of Four Models.

Model	Frequency in First Mode,(ω_1)	Frequency in Second Mode, (ω_2)	Frequency in Third mode, (ω_3)
I	0.218	0.667	1.168
II	0.271	0.827	1.449
III	0.314	0.969	1.710
IV	0.446	1.371	2.399

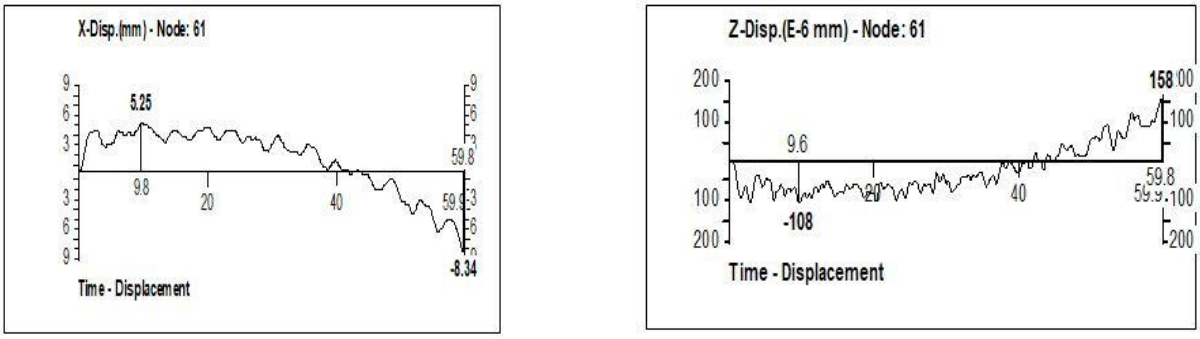

Fig. 2 Time vs. Displacement Plot for Model I at Roof Level for Both X and Z Direction Respectively

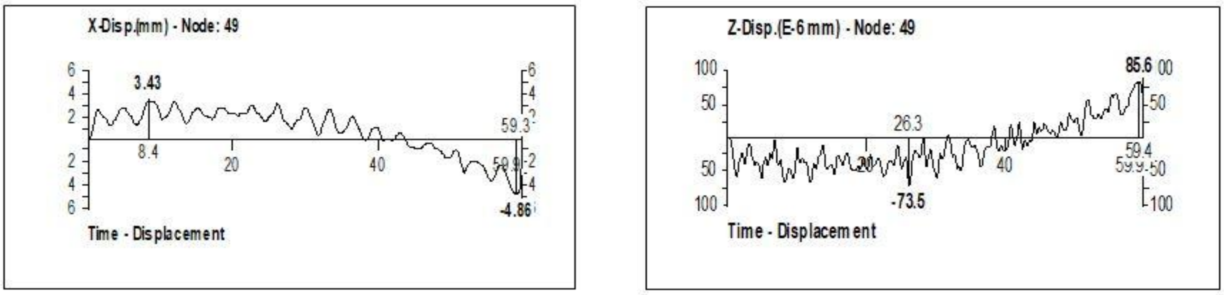

Fig. 3 Time vs. Displacement Plot for Model II at Roof Level for Both X and Z Direction Respectively

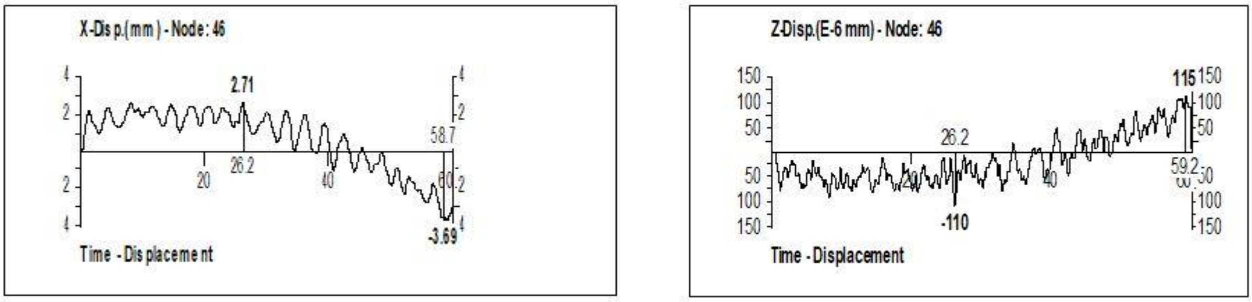

Fig. 4 Time vs. Displacement Plot for Model III at Roof Level for Both X and Z Direction Respectively

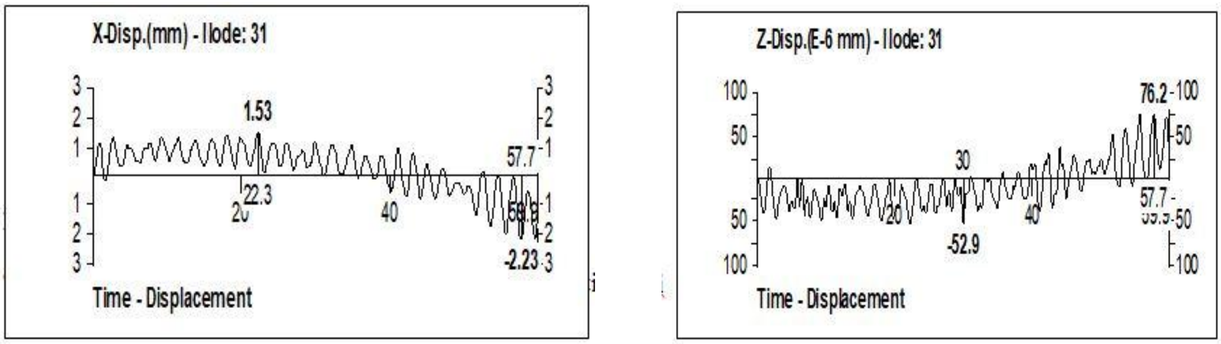

Fig. 5 Time vs. Displacement Plot for Model IV at Roof Level for Both X and Z Direction Respectively

International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 2, Mar-Apr-2019, ISSN (Online): 2395-566X

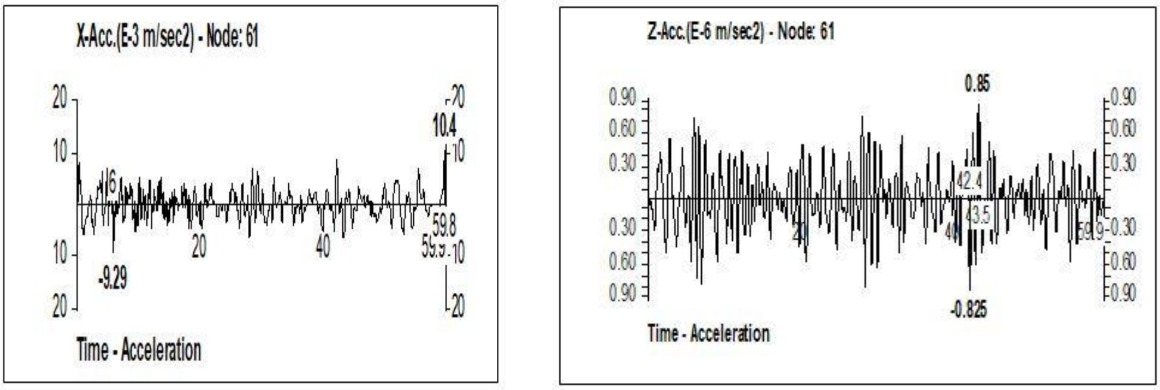

Fig. 6 Time vs. Acceleration Plot for Model I at Roof Level for Both X and Z Direction Respectively.

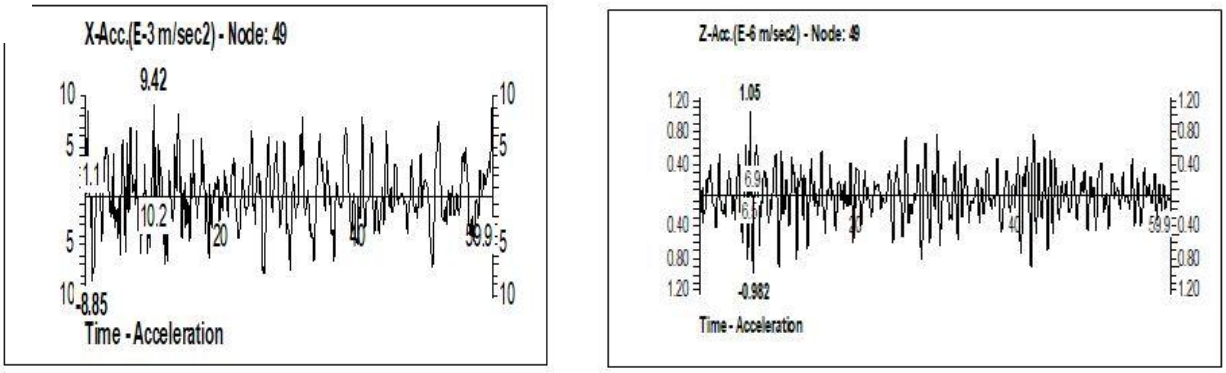

Fig. 7 Time vs. Acceleration Plot for Model II at Roof Level for Both X and Z Direction Respectively

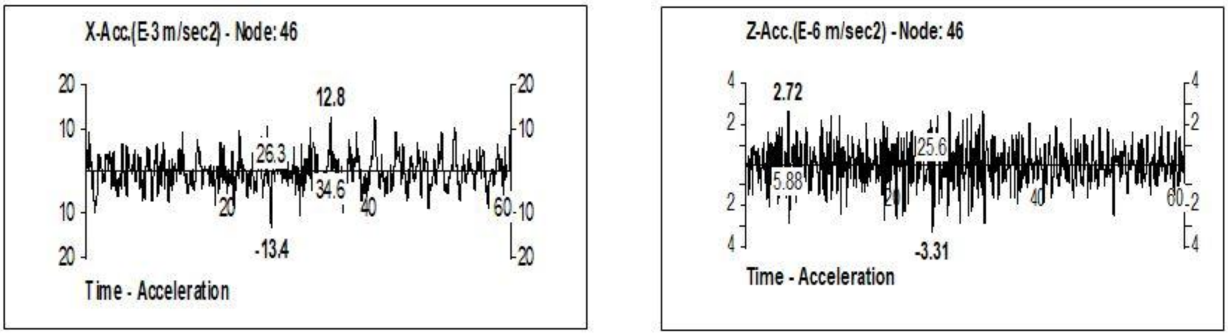

Fig. 8 Time vs. Acceleration Plot for Model III at Roof Level for Both X and Z Direction Respectively

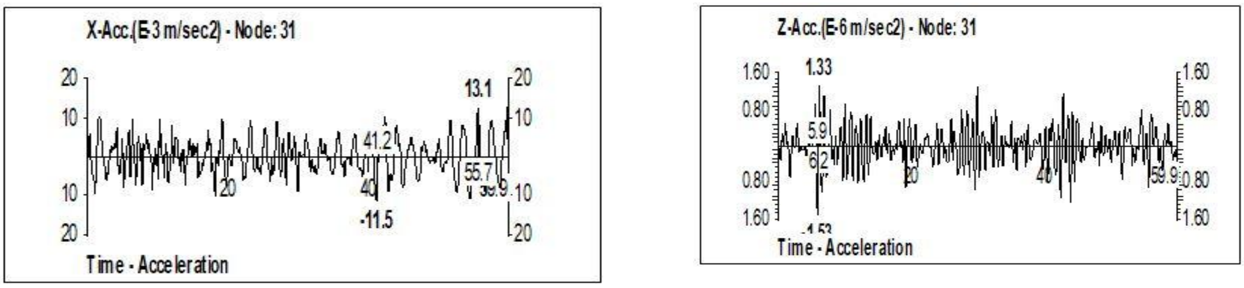

Fig. 9 Time vs. Acceleration Plot for Model IV at Roof Level for Both X and Z Direction Respectively

The variation of inter story drift with the story height is presented below in figure 10.

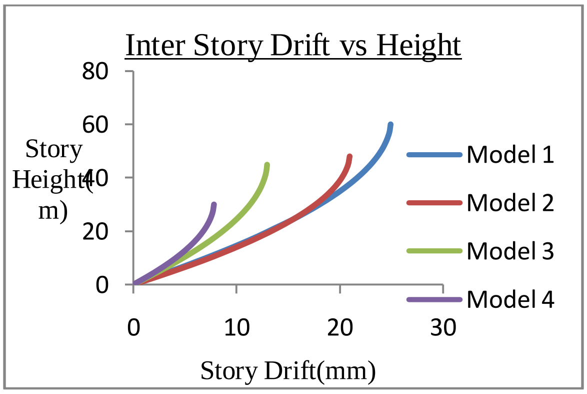

Fig.10. Inter Story drift vs. Story Height

The above figure shows that inter story drift increases with the increasing of story height. For model I, inter story drift is maximum because it has the maximum height. The variation of base shear for different models are presented below in Figure 11.

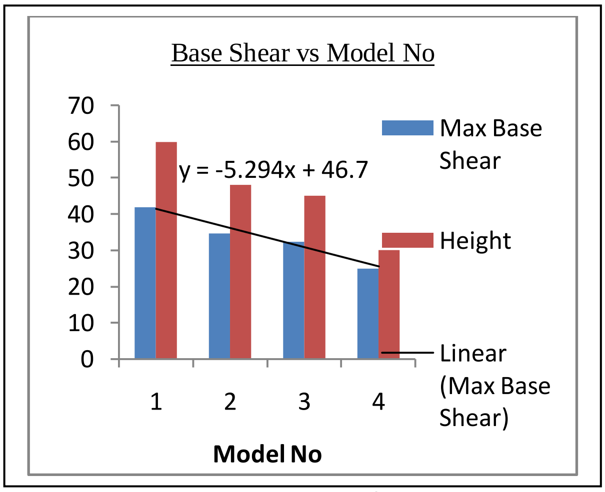

Fig.11 Base Shear Plot of Four Models.

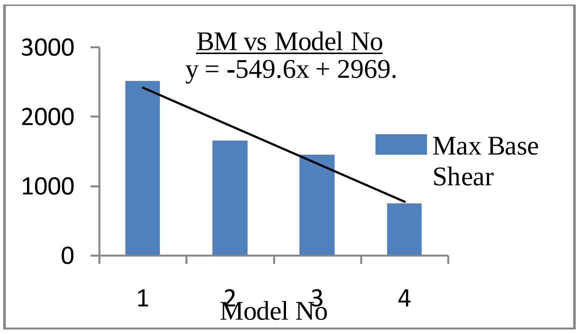

Fig.12. Base Bending Moment for Four Models.

Base shear is maximum for Model I and minimum for model IV. Therefore, building with lesser height experiences lower shear force whereas high rise building experiences high shear force. Maximum base Shear changes with the height of model as per this equation y = -5.294x +46.7 (obtained by plotting the results in excel) where y=maximum base shear & x=model no._The variation of base bending moment with the different models are presented below in figure 12. Bending moment is maximum for model I and minimum for model IV. Bending moment changes with the height of model as per this equation y= -5.294x+46.7 (obtained by plotting the results in excel) where y=B.M. & x=model no._The variation of natural frequencies of first three modes for all models is presented below in Figure 13.

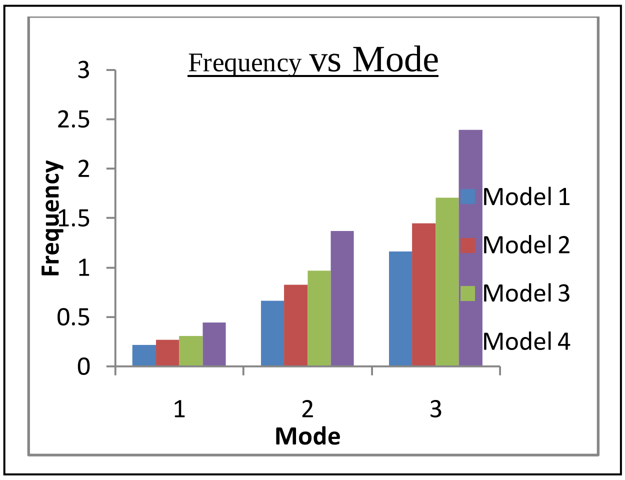

Fig.13 First three modes of natural frequencies for all models.

The frequency for model I is minimum and the frequency for model IV is maximum. So it is seen that the natural frequency of the model is inversely proportional to height of model. Thus time period of structure increases with the increase in height of the model.

VI. CONCLUSION

1. From the above results, it can be concluded that Among all the models, model IV is subjected to least displacement, bending moment & base shear. Building with less height shows minimum response when subjected to seismic force.
2. The time period of the model is directly proportional to height of model.
3. Story drift is maximum at roof level and minimum at ground level for each model.
4. Time history method is more suitable because the real data of ground motion is taken as input.
5. So the structure experiences actual seismic load and we can predict weather structure can resist earthquake or not.

REFERENCES

[1] Payam Tehrani and Shahrokh Maalek, “Comparison of non-linear static and non-linear dynamic analyses in the estimation of the maximum displacement for structures equipped with various damping device” 4th International Conference On Earthquake Engineering, Taipei, Taiwan, October 12-13, 2006, paper No. 129

[2] Prof. Dr. Qaiseruz Zaman Khan (2010), “Evaluation Of Effects Of Response Spectrum Analysis On Height Of Building” International Conference on Sustainable Built Environment (ICSBE-2010) Kandy, 13-14 December 2010

[3] Romy Mohan, C Prabha (2011), “Dynamic Analysis of RCC Buildings with Shear Wall” International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp 659-662

[4] A S Patil and P D Kumbhar “Time History Analysis of Multistoried RCC Building for Different Seismic Inntensities’’ Intenational Journal for Structural and Civil Engineering Research” Vol. 2, No. 3, August 2013

[5] "Structural Analysis And Design (STAAD Pro) software," Bentley Systems, Inc

[6] IS 875 (Part 2): 1987, Bureau of Indian Standards

[7] IS 1893 (Part 1):2016, Bureau of Indian Standards

[8] SP22(IS:1893-1975 and IS:4326-1976), Bureau of Indian Standards