Evaluation of the Impact of Dynamic Analysis on Different Building Height

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Abstract: ***Over the past decades, earthquake resistant design of building structures has been largely based on ductility design concept worldwide. The performance of the intended ductile structures during major earthquakes (e.g. Northridge, 1994; Kobe, 1995; Chi-Chi, 1999…etc) however have proven to be unsatisfactory and indeed far below expectation. So, performance based seismic design philosophies in seismic design has become the cardinal point of interest in civil engineering structures Due to the vulnerability of Bangladesh to earthquake, dynamic analysis should be introduced in major earthquake zone to ensure the seismic performance. To see the dynamic behavior of the structure, dynamic analysis should be performed for building with varying height. Dynamic analysis can take the form of a dynamic time history analysis or a linear response spectrum analysis. In this present study, a building of 15 stories with varying floor height has been modeled using software packages SAP2000 v15 for seismic zone of Bangladesh. Dynamic response of building under actual earthquakes, chi-chi, Taiwan, 1999, El centro and Northridge have been investigated. This paper highlights the effect of varying height in high-rise building with Time History Analysis.***

Keywords: RCC building, Time history analysis, displacement, earthquake resistant design

1. Introduction

Historical seismic catalogues reveal that Bangladesh has been affected by earthquake since ancient times. Earthquakes occurred in 1664, 1828, 1852 and 1885 are shown to have Dhaka as epicentral area. Similarly cities like Rangpur, Sylhet, Mymensing, Chittagong, Saidpur, Sirajgong, Pabna etc. have been shown to be the epicentral area of some of the major earthquakes in the past. Although the ancient record do not specify the earthquake epicenter by giving coordinates in terms of latitude and longitude. It is difficult to figure out whether these cities were directly hit by earthquakes. However occurrence of earthquakes both inside and outside of the country and around major cities indicates that earthquake hazard exists for the country in general and the cities in particular. Consideration of earthquake forces in structural design, city planning and infrastructure development is therefore a prerequisite for future disaster mitigation. Several earthquake of large magnitude (Richter magnitude 7.0 or higher) with epicenters within Bangladesh and India close to Indo-Bangladesh have occurred (AM and Chowdhury, 1994). Table 1 and Table 2 provide lists of the major earthquakes that have affected Bangladesh and its surroundings. Furthermore the country is divided into three zones determined from the earthquake magnitude for various return periods and the acceleration attenuation relationship (Ali and Chowdhury, 1994) namely zones 1, 2, 3 being most to least severe gradually (BNBC, 1993).

Table 1: Lists of Major Earthquakes Affecting Bangladesh

Date of occurrence	*Name (Place)*	*Magnitude*	*Epicenter distance from Dhaka (Km)*
10 Jan 1869	Cachar Earthquake	7.5	250
14 Jul 1885	Bengal earthquake(Bogra)	7.0	170
12 Jun 1897	Great Indian Earthquake	8.7	230
08 Jul 1918	Srimangal Earthquake (Srimangal)	7.6	150
02 Jul 1930	Dhubri Earthquake	7.1	250
15 Jan 1934	Bihar-Nepal Earthquake(Bihar)	8.3	510
15 Aug 1950	Asam Earthquake (Aasm)	8.5	780

Table 2: Recent Major earthquakes in Bangladesh (Ansary, 2005)

Date of Occurrence	*Name (Place)*	*Magnitude*	*Epicentral distance from Dhaka (Km)*
08 May 1997	Sylhet Earthquake (Sylhet)	6.0	210
21 Nov 1997	Chittagong Earthquake (Chittagong)	5.5	264
22 Jul 1999	Moheskhali Earthquake (Cox's Bazar)	5.2	300
27 Jul 2003	Chittagong-Rangamati Earthquake	5.9	290

The historical seismicity data of Bangladesh and adjoining areas indicate that Bangladesh is vulnerable to earthquake hazards. As Bangladesh is the world's most densely populated area, any future earthquake shall affect more people per unit area than any other seismically active regions of the world. Both of the above factors call for evaluation of seismic hazard of Bangladesh so that proper hazard mitigation measure may be undertaken before it is too late.

The basic objective of the research is to: 1) Conduct a thorough literature survey on the base isolation principle and its suitability for use in buildings with different height. 2) Perform non linear dynamic analysis of buildings with isolated bearings and non-isolated one.

The investigation gives emphasis on the feasibility of incorporation of isolators and its structural implication on buildings is limited to the following extents: 1) Only buildings in Dhaka are considered in this work. 2) Only lead rubber bearing is considered in this Study.

2. Methodology

A 15 storied residential building is modeled to analyze under Time History method. The storey height is changing in different floors as shown in figure 2, 3, 4. For the Combination 10-12-15, the height of first five floors is 10ft. the height of fifth to tenth floor is 12ft and the height of the sixteenth to twentieth story is 15ft as shown in figure 2. Two other combinations 15-12-10 and 10-15-12 is used for modeling which is shown in figure 2 and 3. Number of Bays in X direction is five and loading which is applied to the structure is according to BNBC. Number of Bays in Y direction is four. Loading applied to the structure including dead load and live load is given according to BNBC. The section of column is used as 750mm the x750mm. and the beam section is taken as 300mmx600mm. Grade beams are taken as 300mmx750mm. For isolated structure lead rubber bearing (LRB) is used which were connected to all column and foundation of the building. Material properties are chosen as f'c=28MPa, fy=414MPa, Live load=2.4KPa, Slab thickness=150mm.

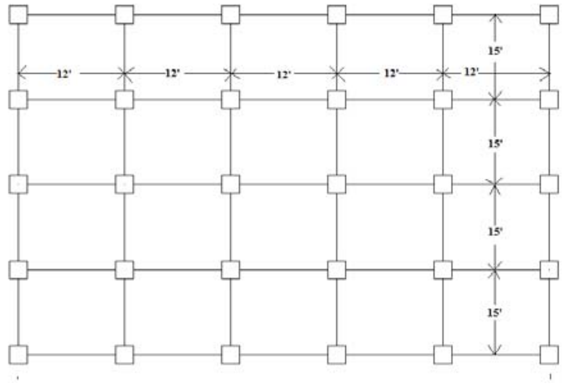

Figure 1: Building plan

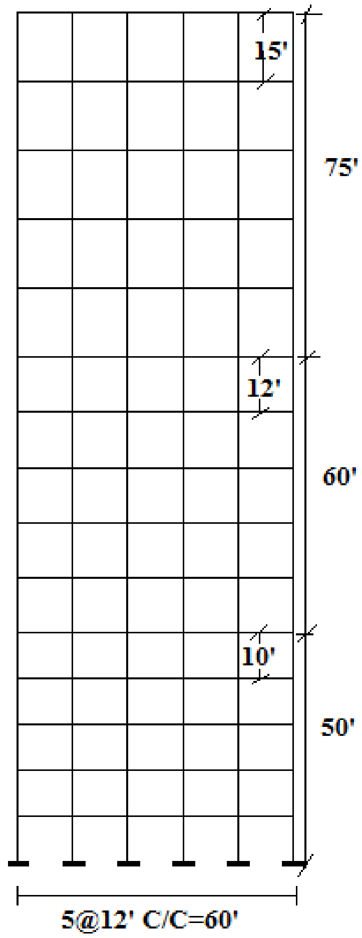

Figure 2: Elevation for the Combination 10-12-15

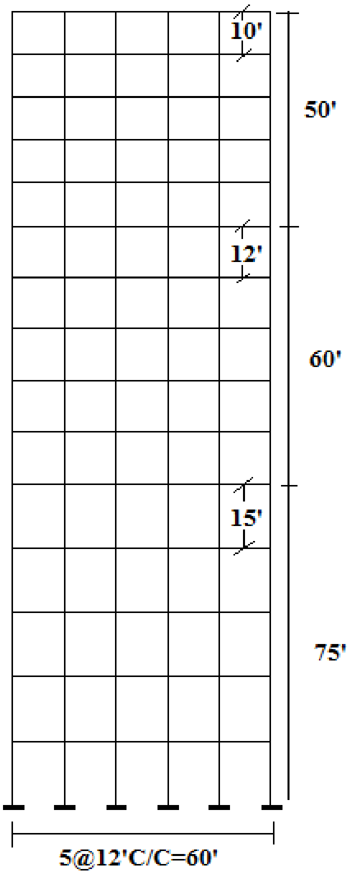

Figure 3: Elevation for the combination 15-12-10

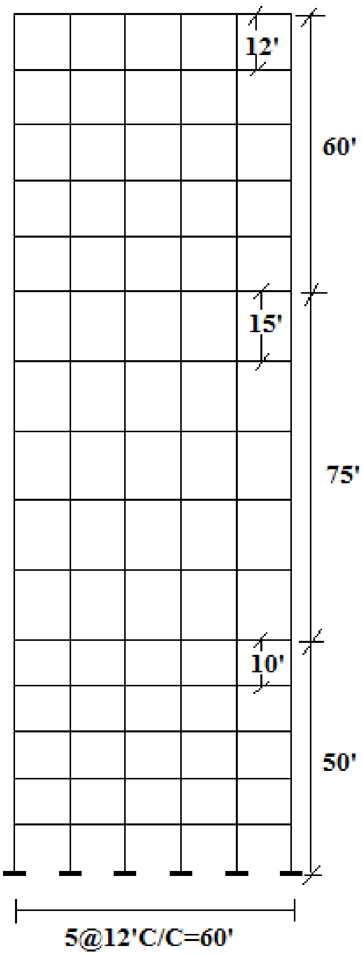

Figure 4: Elevation for the combination 10-15-12

3. Results and discussion

The maximum displacements of building in different stories in both X and Y direction for all method of analysis have been compared and shown in Figure 6-10. From the diagram below, it is observed that , displacement.

For the combination 15-12-10 is maximum and displacement for combination 10-15-12 is also significant. Combination 10-12-15 looks safer compared to other as displacement value is low for this type of height combination.From figure 5 and 6 it is observed that for the combination 15-12-10 displacement increase gradually from first story and become maximum at top floor, but for combination 10-15-12, there is an abrupt change in displacement at 5th to 6th level as storey height changed from 10 ft to 15 ft. So, this indicates an important warning when working with different storey height. Analysis data suggest that we can gradually increase the building height than irregular change.Finally, We can suggest this type of analysis before the design of buildings with different storey height.

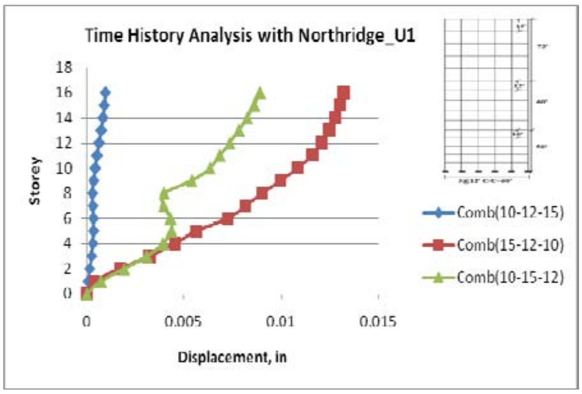

Figure 5: Maximum displacement in U1 direction

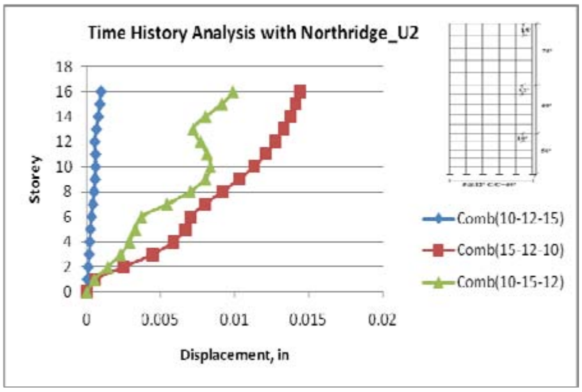

Figure 6: Maximum displacement in U2 direction

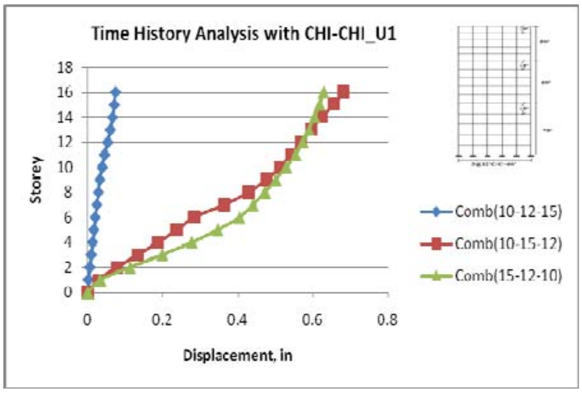

Figure 7: Maximum displacement in U1 direction

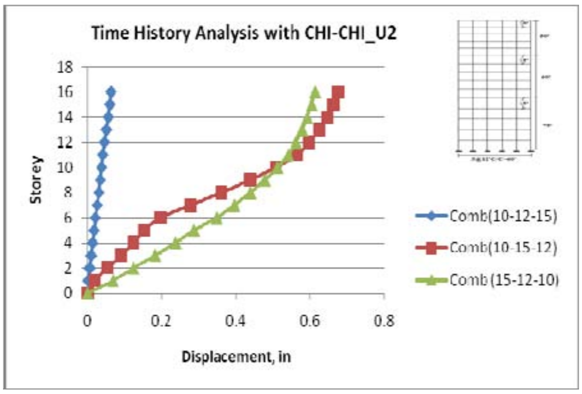

Figure 8: Maximum displacement in U2 direction

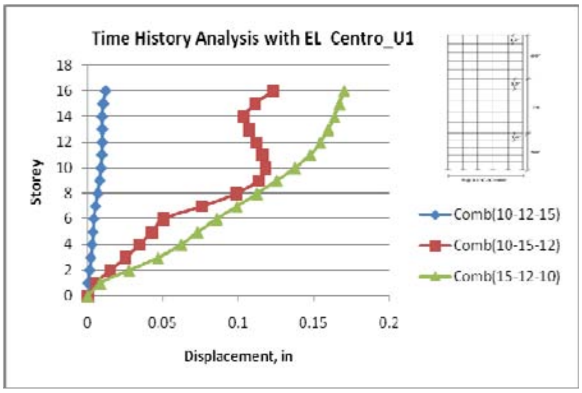

Figure 9: Maximum displacement in U1 direction

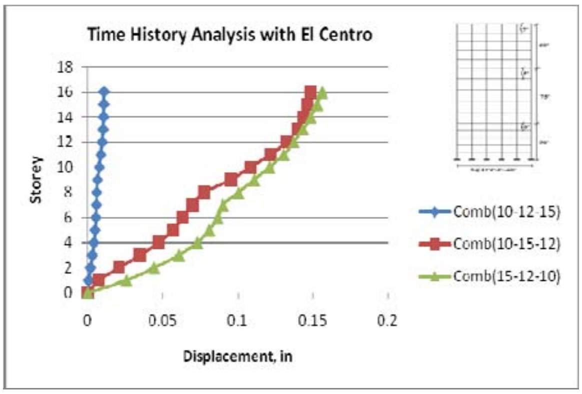

Figure 10: Maximum displacement in U2 direction

4. Conclusion

From the above work the following conclusion can be drawn out;

a. Results of comparison between different combination of heights of building under different earthquake show that the displacement obtained for the combination (10-12-15) building is minimum compared to other combination (15-12-10) and (10-15-12).
b. Time history analysis is an important and effective tool to visualize the performance level of building under different earthquake.
c. Seismic performance of structure can be obtained by selecting an adequate recorded ground motion for time history analysis.
d. Static analysis is not sufficient for high rise buildings and it is necessary to provide dynamic analysis (because of specific and non-linear distribution of force)
e. For irregular structure time history analysis should be performed to see the non-linear behavior of the structure.
f. The displacement difference between different combinations of height is significant. So, Time history analysis should be incorporated for irregular height of building and seismically active zone.

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