Seismic Analysis of Regular and Irregular Building by Using Time History Method

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Abstract— The intention of this project is to evaluate (or) estimate the seismic analysis vulnerability and response of regular and irregular shaped multi-storey buildings context of India. Linear time history analysis has been performed to learn about the influence of shape of a building on its response to various loading. 10(ten) storied regular shaped (rectangular, and L-shape) and irregular shaped (Plan Irregularities, Vertical Irregularities, stiffness irregularity) buildings have been modeled using software ETABS 2016 for Hyderabad (seismic zone 2), India. Effect of dead load and live load on different shaped structure with Time history method has been meticulously analyzed considering the different shapes of building which has same mass. Comparative study on the maximum displacement of storey and centre of mass of different shaped buildings due to static loading has been explored. The base shear, displacement, response spectral acceleration and the earthquake displacement is analyzed in time history method. It is concluded that there is increase in bases shear, story displacement and story drift in irregular building than in regular building due to earthquake forces in the seismic zone ii using ETABS Software 2016.

Key words: Regular and Irregular Shaped Multi-Storey Buildings, Time History Analysis

I. INTRODUCTION

Earthquake has continually been a hazard to human civilization and all other living organisms. From the day of its existence, damaging human lives, property and man-made structures. The very latest earthquake that we confronted in our neighboring country Nepal has once more proven nature's fury, causing such a big destruction to the country and people of it. It is essential for existence to ensure the strength of the structures against seismic forces because Earthquake is such an unpredictable disaster Therefore there is continuous research work going on around the globe, revolving around development of new and better strategies that can be incorporated in structures to overcome damages of seismic forces. Obviously, buildings designed with unique strategies to resist damages for the duration of seismic activity have much higher cost of construction than normal buildings, but for the sake of safety from seismic forces it is required. Earthquake causes ground motions, in all directions spread out from the epicenter. On the other hand Vertical ground motions are rare and horizontal ground shaking earthquake always occurs. The structures resting on the ground vibrates, and develops inertial forces in the structure due to ground motions. In the structural components it causes reversal of stresses when the directions of earthquake changes that is, tension may changes to compression and compression may changes to tension. , yielding of structures and large deformations happened because Earthquake can generate high stresses, rendering the structure non-functional and unserviceable. There can be large storey drift developed in the building, making the building unsafe for the people to continue living there in India Reinforced Concrete structures are practiced more, with increasing numbers of high-rise structures adding up to the landscape. There are many important Indian cities that fall in highly prone seismic zones. So all such high-rise structures, constructed especially in highly prone seismic zones, should be analyzed and designed for ductility and extra lateral stiffening system so that their overall performance of seismic resistance improved and damage is reduced.

II. LITERATURE REVIEW

- The comparison of ductility demands between regular & irregular structures had been studied by Aranda by using different ground motions values recorded on the soft soil. During the comparision between these structures, He concluded that there is higher ductility demands for regular structures than that of irregular ones (Aranda (1984)
- A 20 storied residential building and has been Considered and modeled by Arman chowdary et.al to analyse under two methods ie Response Spectrum method and Time History method."Comparative study is done by using Dynamic Analysis of Multi-storey Irregular building". The building plan is altering in different floors because it is a irregular building. The maximum displacements of building in different storeys in both X and Y direction for the both methods of analysis ie response spectrum and time history methods have been compared. (Md. Arman Chowdhury and Wahid Hassan,(2013)
- Himanshu Bansal performed an analysis by using two methods ie Response spectrum analysis and Time history Analysis on building with vertical Irregularity.here the irregularites considered are stiffness irregularity, vertical geometry irregularity and mass irregularity,He observed that there is a maximum storey base shear force in the first storey of a building and shear force decreases in the top most storey to minimum in all the cases.(Himanshu BansaL (2014)

III. METHODOLOGY

The methodology adopted to perform the seismic analysis of Regular and Irregular
Building requires
a) An understanding of Time history method procedure
b) An in depth knowledge of E-TABS software is required as the building was modelled in ETABS.

In this study post analysis data obtained from Etabs was used in the analysis of the structure.

The demand to capacity ratio of members was calculated to analyze the seismic stability of the structure under the various load combinations in accordance with IS 1893-2002 (part 1).

Comparison of design and detailing requirement of an RC building for the earthquake zone (II), i.e, as in India. This will be done for 2 buildings with varying shapes of ten storey each respectively.

For every building, It will consist of the following steps:

1) Modelling of the building with all the requisite parameters.
2) Analysing the building for the earthquake zone (as in India)
3) Comparing of building and checked error free for earthquake zone.
4) No infill walls are considered.
5) A comparison of performance of Analysing buildings for seismic zone and provisions using computer based "TIME HISTORY" analysis method.

IV. ANALYSIS METHOD

A. Elastic Time History Analysis

This is a method of linear analysis and here nonlinear analysis is not involved and elastic time history analysis over comes all disadvantages of modal response spectrum provided in nonlinear behavior .elastic time history analysis method needs greater efforts for calculating the response at discrete times. One stimulating benefit of this is that the relative signs of response quantities are well-maintained in the response histories.

B. Regular Building Speciations

For analysis a 10 stories high building is modeled in Etabs as a space frame. The building does not represent any real existing building. The building is unsymmetrical with the span more along Z direction than along X direction. The building rises up to 31m along Y direction and spans 16m along X direction and 18 m along Z direction .The building is analyzed by Response Spectrum Analysis and Nonlinear dynamic analysis, Dynamic Analysis is adopted since it gives better results than static analysis.

The specifications of the frame are given in Table 1. And the plan and the model of the building is shown in Fig 1.

Specifications	Data
No of Storeys	10
No of bays along X direction	4
No of bays along Z direction	4
Bay Length along X direction	16 m
Bay Length along Z direction	16 m
Concrete grade used	M25
Columns	450x450 mm
Beams	450x230
Slab Thickness	125 mm
Unit Weight of Concrete	25 KN/m3
Live Load	3 KN/m3
Dead load	1.5 KN/m3
Zone	II
Soil Conditions	Hard soil
Damping Ratio	5 %

Table 1**:** Specifications of the regular building

IS 1893:2002 (part 1). The values are given for 5 % of damping of the

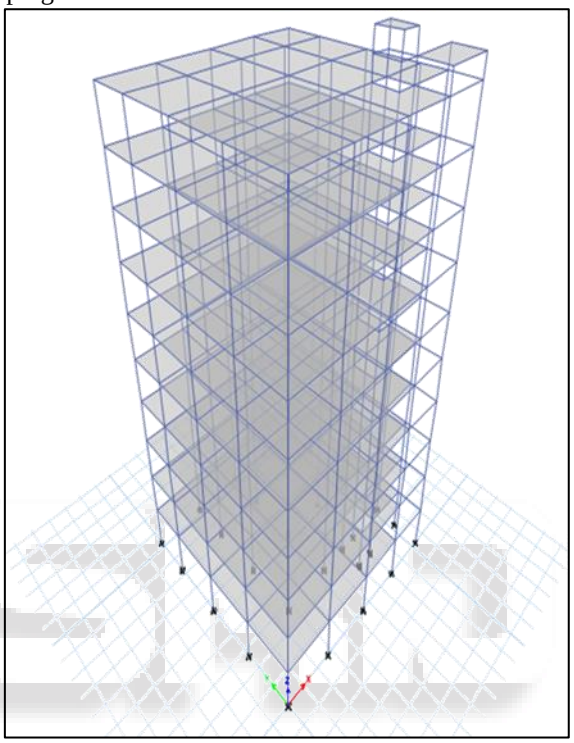

Fig. 1: Model of regular building structure

C. Irregular Building Specification

For analysis a 10 stories high building is modelled in Etabs as a space frame. The building does not represent any real existing building. The building is unsymmetrical with the span more along Z direction than along X direction. The building rises up to 15m along Y direction and spans 16m along X direction and 18m along Z direction .The building is analyzed by time history Analysis and linear dynamic analysis, Dynamic Analysis is adopted since it gives better results than static analysis.

The specifications of the frame are given in Table 2. And the plan and model of the building is shown in Fig 2.

Specifications	Data
No. of Storeys	10
No. of bays along X direction	10
No. of bays along Y direction	7
Bay Length along X direction	44 m
Bay Length along Y direction	28m
Concrete grade used	M25

Columns	450x450 mm
Beams	450x230
Slab Thickness	125 mm
Unit Weight of Concrete	25 KN/m3
Live Load	3 KN/m3
Dead load	1.5 KN/m3
Zone	II
Soil Conditions	Hard soil
Damping Ratio	5 %

Table 2: Specifications of the irregular building

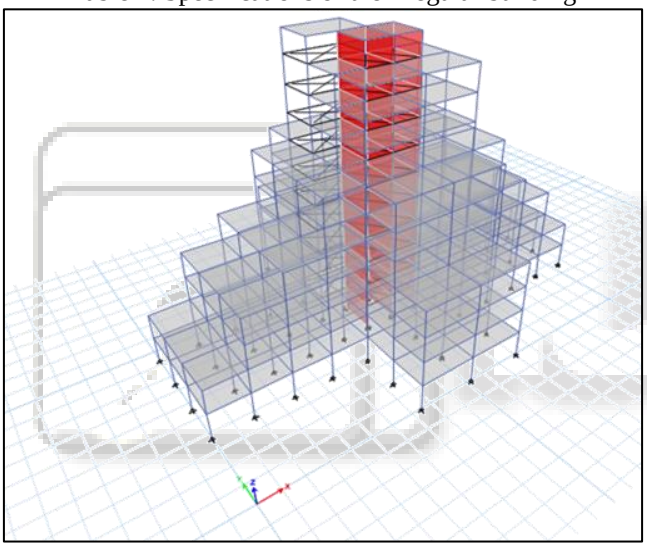

Fig. 2: Model of irregular building

V. TEST RESULTS

The following are the major conclusions that can be made based on present work carried Up on the RC buildings with different types regular and Irregular building (taken in dimensions shown above) analysed in Time history method, Earthquake forces in the seismic zone ii using ETABS Software 2016.

1) The base shear in regular building in X&Y dir is 380.67 KN where as in irregular type its value in x direction is 968.67KN and in y direction is 802.0 KN.
2) Here from the Base Shear curves that the magnitude of Base Shear decreases in regular type building.
3) Story displacement in regular building in X & Y direction is 1.22 mm and 2.05, in irregular. Building there is 1.90 mm and 0.035 mm.
4) In irregular building displacement in X and Y directions is decreasing compared to regular buildings in both X & Y directions.
5) Response Spectrum Acceleration for regular building in X & Y direction is 0.264,397.2mm/sec2 and in irregular building it is maximum 0.266, 3503.79mm/sec2 minimum 3.33, 96.12 mm/sec2.
6) Earthquake maximum displacement in regular building is 30.38 mm where as in irregular building it is 13.39 mm along X direction and 7.659 mm in y direction it means in irregular building because of variatio.n in both directions damage occurs more.
7) Time History in regular building in X direction maximum 10 min 382.56sec, and min 0, in Y direction maximum 4.5min per 480.3sec & minimum 3.2min per sec.
8) Time History in irregular building in X direction maximum 9.7 min 968.79 per sec minimum 0 per sec and in Y direction maximum 9.3min 4.8per sec & minimum 9.9 min.
9) Maximum story drift in x dirn 0.000095 and in y direction 0.000134 where as in irregular in x dirn 0.000185 and in y dirn 0.000006 which the values satisfy the max drift condition in code IS1893-2002.
10) Modal participating mass ratios are also satisfied in regular and irregular buildings.

VI. CONCLUSION

The major conclusions that can be made based on present work carried upon the RC buildings with different types Regular and Irregular building (taken in dimension) analysed in Time history method, Earthquake forces, Response spectrum in the seismic zone ii using ETABS Software 2016 is that there will be increase in the bases shear, story displacement and story drift in irregular building than in regular building.

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List of Standard Referred Codes

[9] IS: 456 – 2000 Code of practice for plain and reinforced concrete (fourth revision).

[10] IS: 1893-2002 code of practice for Earthquake resisting buildings.

