

Analysis of Irregular Structure under Linear Time History

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Abstract - Earthquake is the result of sudden release of energy in the earth's crust that generates seismic waves. Ground shaking and rupture are the major effects generated by earthquakes. In order to take precaution for the loss of life and damage of structures due to the ground motion, it is important to understand the characteristics of the ground motion. The motion important dynamic characteristics of earthquake are peak ground acceleration (PGA), frequency content, and duration. These characteristics play predominant rule in studying the behavior of structures under seismic loads. The strength of ground motion is measured based on PGA, frequency content and how long the shaking continues, Ground motion has different frequency contents such as low, intermediate, and high. Present work deals with study of frequency content of ground motion on reinforced concrete (RC) buildings. Linear time history analysis is performed in structural analysis and design (ETABS 2016) software. The proposed method is study the response of low, mid, and high motions. The response of the buildings due to the ground motion in terms of story displacement, storey velocity, storey acceleration, and base shear are found. The response of each ground motion for each type of building are studied and compared. The results show that low-frequency content ground motions have significant effect on RC buildings. However, high-frequency content ground motions have very low effect on responses of the regular as well as irregular RC buildings.

Key Words: PGA, seismic loads, frequency content, displacement, Base shear

1. INTRODUCTION

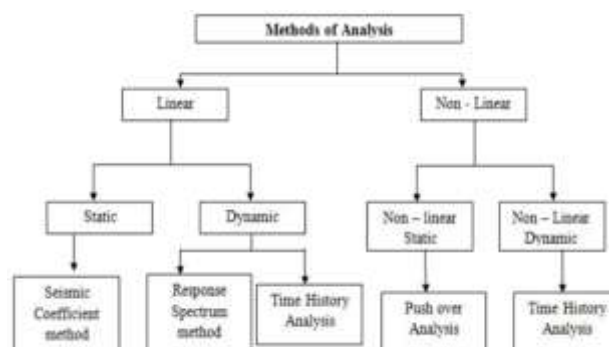
An earthquake is the disturbance of the surface of the Earth, outcome from the unexpected release of energy in the Earth's layers that creates seismic waves. Structures are vulnerable to earthquake ground motion and damage the structures. In order to take precaution for the damage of structures due to ground motion, it is important to know the characteristics of the ground motion. The main important dynamic characteristics of earthquake are huge ground acceleration, duration and frequency content. These characteristics perform predominant rule studying the behavior of structures under the seismic ground motion. The methodology, which is conducted, is briefly described as below:

1. Ground motion records are collected and then normalized.
2. Linear time history analysis is performed in ETABS 2016.
3. Building response such as story displacement, story velocity, story acceleration, and base shear are found due to the ground motions.
4. The results of the RC buildings are compared with respect to the two ground motions.

2. ASYMMETRY IN STRUCTURES

A building that loss symmetry and have discontinuity in geometrically, mass, or load resisting elements is called "irregular". These irregularities may cause disturbance of force flow and the stress concentrations on structure.

METHODS OF ANALYSIS



3. STRUCTURAL MODELLING

Most building codes prescribe the method of analysis based on whether the building is regular or irregular. Almost all the codes suggest the use of static analysis for symmetric or any regular buildings. For buildings with irregular configurations, the codes suggest the use of dynamic analysis procedures such as response spectrum method or time history analysis.

STEP BY STEP PROCEDURE OF TIME HISTORY ANALYSIS

The step by step procedure is as follows

- Defining a time history function by adding a function from file. In our case, the Bhuj earthquake record 2001 has been linked to the program.
- Defining a separate analysis case under the load type 'quake' with the appropriate analysis case type i.e. linear direct integration time history.
- Applying earthquake acceleration values from the defined time history function.
- Indicating the damping coefficients by calculating the mass and stiffness according to coefficients as per the equations mentioned above or inputting the frequency or time periods of two consecutive modes of the structure in the same direction whereby the program itself calculates the required damping coefficients.
- Indicating a direct integration method in the program. In our case, we have adopted Newark's direct integration method.

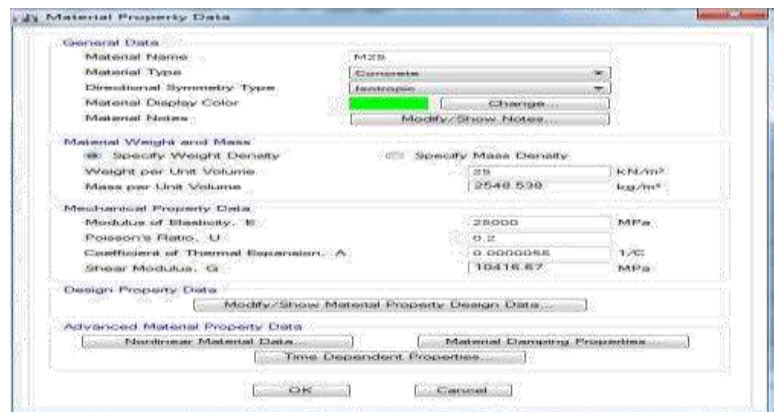


Figure 1: Material specifications for concrete grade M25

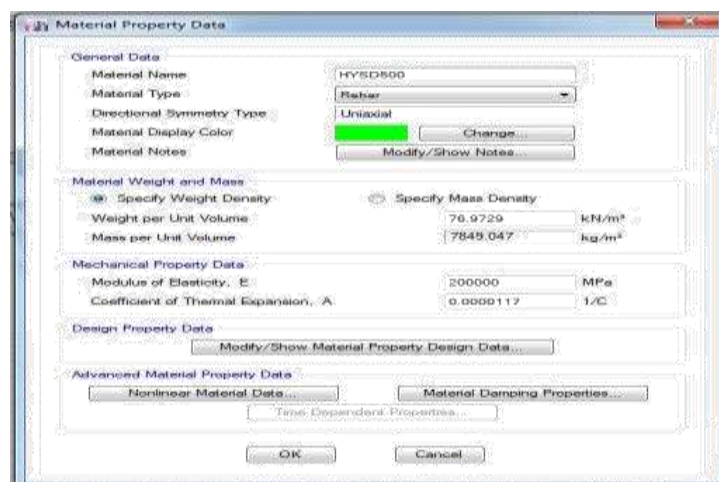


Figure 2: Reinforcement details of HYSD500

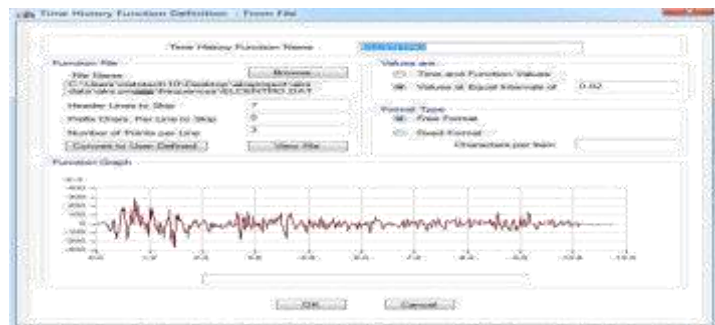


Figure 3: Elecentro time history function details

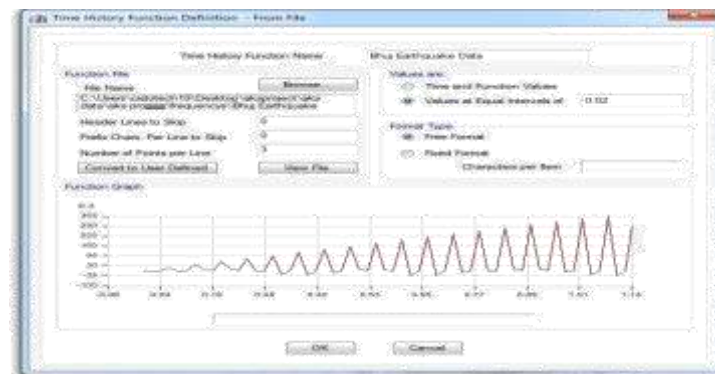


Figure 4: Bhuj earthquake time history function details.

4. RESULTS&DISCUSSIONS

The results of the three building models are presented and discussed in detail. The results are included for the two models (model 1 – Building modeled as irregular, structure model 2 – Building modeled as regular structure and the response results are computed using the Time History Analysis. The analysis and design of the models is performed by using ETABS analysis package.

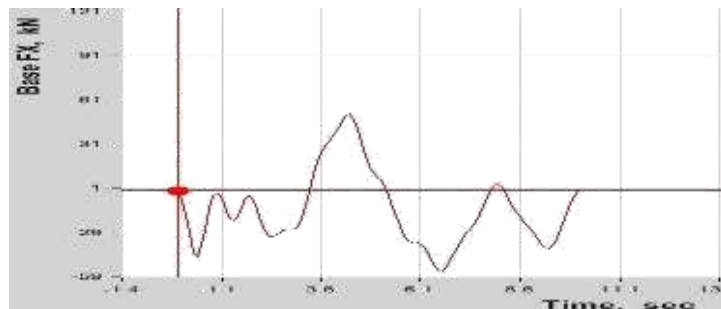


Figure 5: Bhuj, India Earthquake Result along X- Direction (Model-1)



Figure 6: Bhuj, India Earthquake Result along Y--DIRECTION (Model-1)

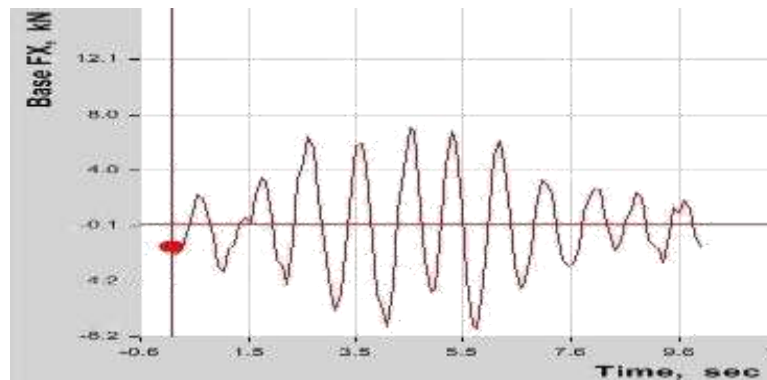


Figure 7: Centro (United States and Mexico) Earthquake Result along X-Direction (Model-1)

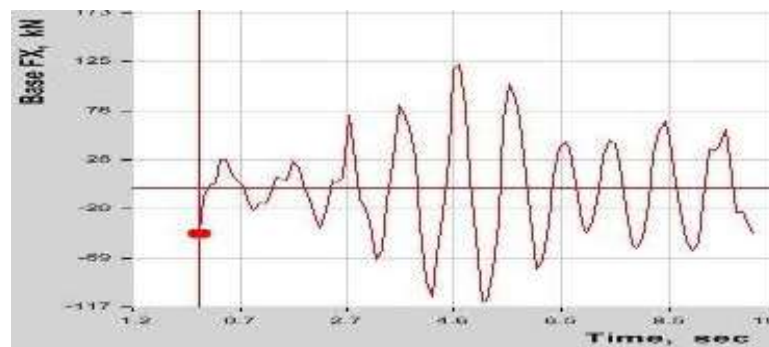


Figure 8: Centro (United States and Mexico) Earthquake Result along Y-Direction (Model-1)

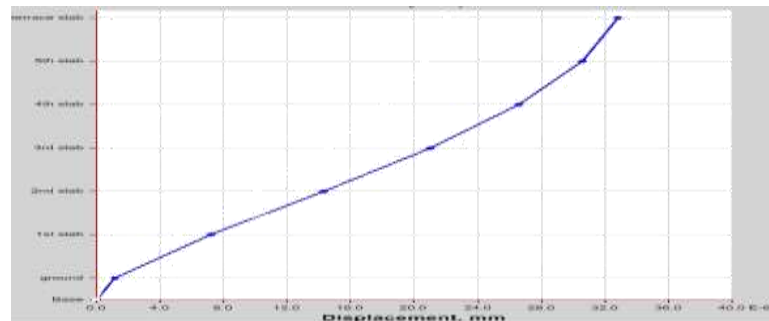


Figure 9: Maximum Story Displacement of Bhuj Earthquake (Model-1)

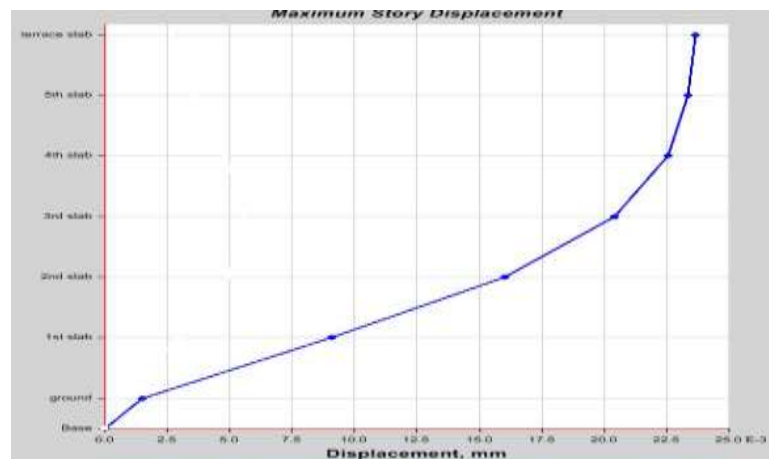


Figure 10: Maximum Story Displacement of El Centro Earthquake (Model-1)

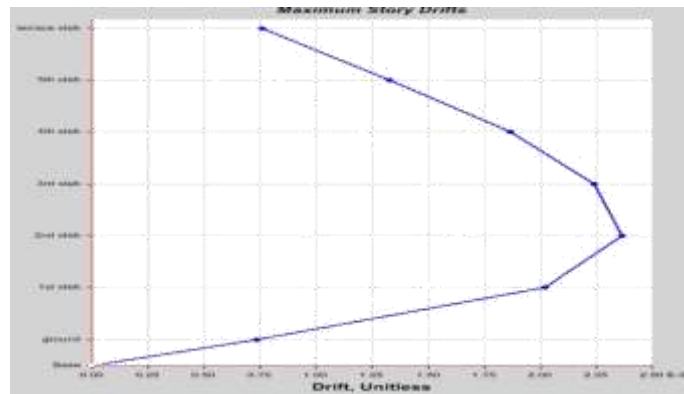


Figure 11: Maximum Story Drift of Bhuj Earthquake. (Model-1)

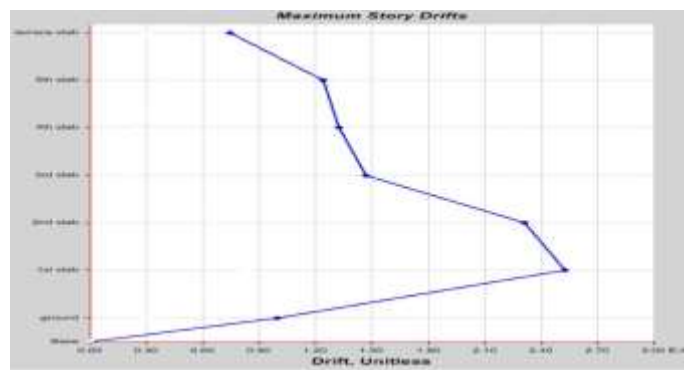


Figure 12: Maximum Story Drift of El Centro Earthquake (Model-1)

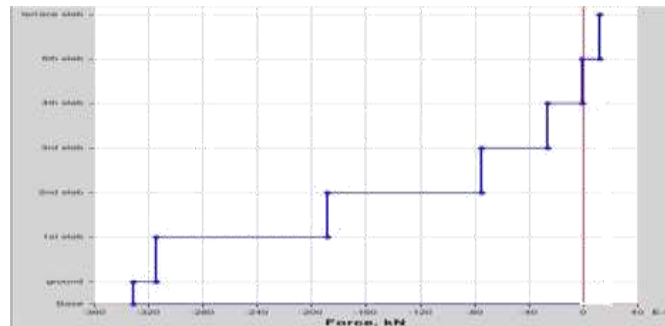


Figure 13: Maximum Story Shear of Bhuj Earthquake.-X-Direction (Model-1)

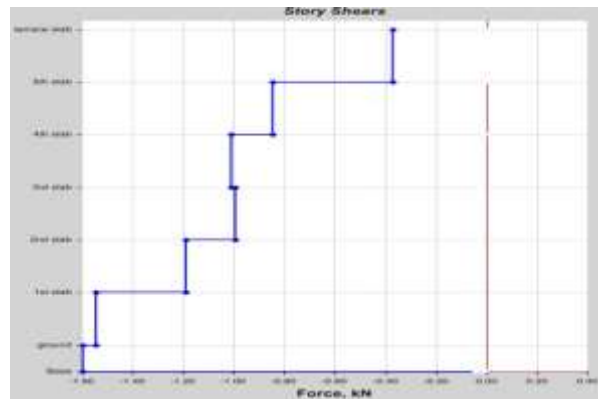


Figure 14: Maximum Story Shear of ElCentro Earthquake.-X-Direction. (Model-1)

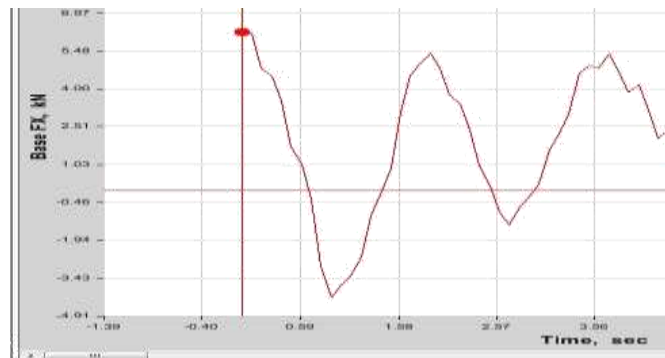


Figure 15: Bhuj, India Earthquake Result along X- Direction (Model-2)

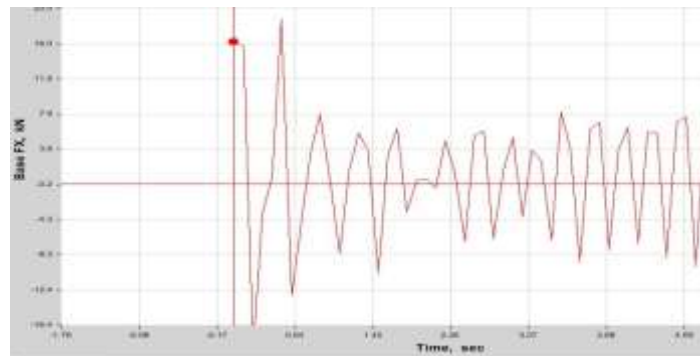


Figure 16: Bhuj, India Earthquake Result along Y--DIRECTION (Model-2)

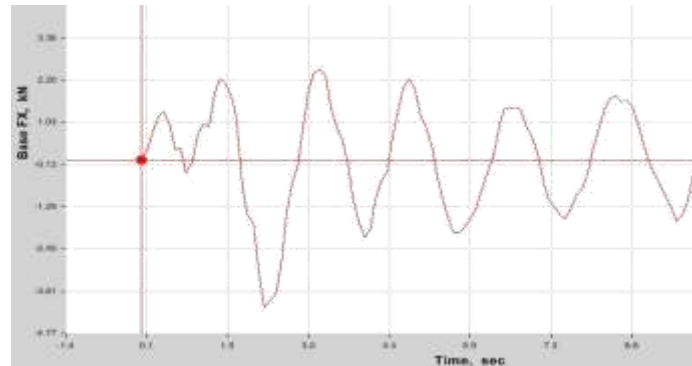


Figure 17: El Centro (United States and Mexico) Earthquake Result along X--Direction (Model-2)

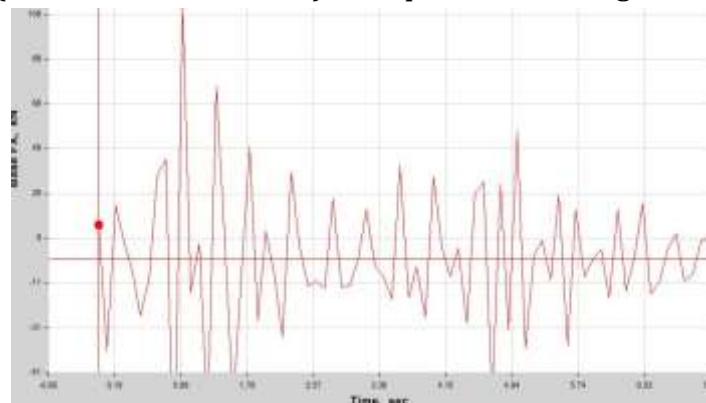


Figure 18: El Centro (United States and Mexico) Earthquake Result along Y--Direction (Model-2)

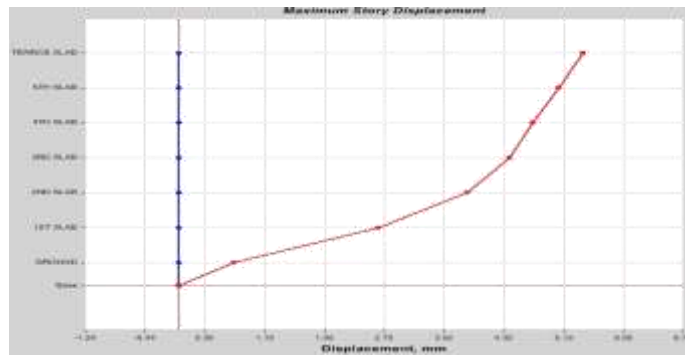


Figure 19: Maximum Story Drift of Bhuj Earthquake (Model-2)



Figure 20: Maximum Story Displacement of El Centro Earthquake (Model-2)

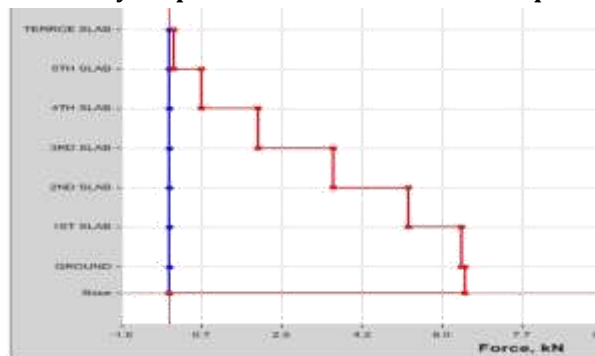


Figure 21: Maximum Story Shear of Bhuj Earthquake.-X-Direction (Model-2)

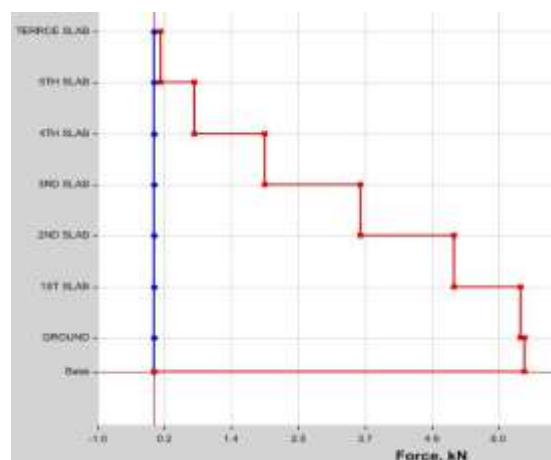


Figure 22: Maximum Story Shear of El Centro Earthquake.-X-Direction. (Model-2)

5. CONCLUSION

The Time History Response of a structure is simply the response (motion or force) of the structure evaluated as a function of time including inertial effects. Based on the limited study conducted on this work, on the seismic performance of building with and without Setbacks, it is observed that the behaviour of the building with Setbacks is critical. Hence, the work in general, hints towards standardization of limitations over the Setbacks of various types of buildings. Further, the work also hints the need for considerations of the effects of Setbacks in the design of the buildings. Although the work is limited to only three building models, the following points could be concluded in terms of the various study parameters chosen such as time period, displacements, storey drifts, bending moments and shear forces. As compared to the high rise building, low rise buildings (irregular) also required some special care in planning and in design to resist earthquake forces. The mass of the building that is effective during earthquake shaking. The seismic mass distribution in irregular building along the plan is different, so it is very effective in lateral oscillation during earthquake. The buildings with irregularities also showed unsatisfactory results in both direction of buildings. This proves that irregularities in buildings are harmful for the structures.

6. REFERENCES

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