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Analysis of building resting on plain ground with plan irregularity without infill and diaphragm opening

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ABSTRACT

In India more than 54% of the land is endangered to earthquakes. Since prevention of earthquake occurrence is not possible hence the other option is to give priority to disaster mitigation and preparedness rather than restorative measure such as. Modifying the house type, building-design and plan in the vulnerable areas and making it compulsory to follow earthquake resistant code and designs. Recently different researchers have been broadly carried out studies on building having vertical or plan irregularity. However, most of the studies have been analyzed with focus on building resting on plain ground with plan irregularity without infill and diaphragm opening or performing experiments on building model for the static and dynamic loads. In other words, structural researchers are mostly concerned with the axial or shear behavior, Lateral stiffness, local compression effect, structure on plain ground, economic study, thermal comfort, soft storey building, building with opening or building with vertical irregularity.

Therefore, the present research work is to analyze 3D numerical models of G+14 multistory infill building with different shape of diaphragm discontinuity are constructed and performed the analysis by using software SAP 2000 (ver.16.0) using static nonlinear method. This paper highlights the comparing and investigating the performance of infill building with different shape of diaphragm discontinuity subjected to seismic load at performance point. The result of the analysis for displacement, base shear at performance point, storey drift, storey displacement and base moment have been studied and compared with the help of tables and graphs for all the structure models.

Keywords: SAP2000, Open Diaphragm, Performance Based Analysis, Infill, Macro Modeling

INTRODUCTION

During the past few years several severe earthquakes are experienced by India and around 60% (44% in Zone II , 26% in Zone III , 18% in Zone IV, and 12% in Zone V,) of its land is in moderate to very severe earthquake prone area. India is spectator of various moderate earthquakes In last 25 years [The earthquake of Nepal- Bihar border (1988) of seismic magnitude 6.4, Uttarkashi earthquake(1991) of seismic magnitude 6.6, Jabalpur earthquake(1997) of seismic magnitude 6, Chamoli earthquake (1999) of seismic magnitude 6.8, Bhuj earthquake(2001) of seismic magnitude 6.9, Kashmir earthquake(2005) of seismic magnitude 7.6 and Doda earthquake(2011) of magnitude 5.2 caused more than 45,000 casualty due to destruction of structures. These seismic disasters have exposed the very less understanding of seismic hazard of the country. Sometimes, if this seismic disaster effects are known then the lack of understanding of earthquake resistant building design and practical knowledge of construction of reinforced concrete building is exposed. Therefore, the professionals should take more care about the safety and serviceability of structures during future seismic events.

Building should be regular, simple and symmetric in configuration, sufficient lateral strength, ductility and stiffness to perform well during earthquake. Building having regular or simple geometry, uniform mass and stiffness distribution in plan as well as in elevation has very less destruction during earthquake than the building with irregular plan and elevation. But nowadays irregular plan and elevation structural buildings are constructed in wide range because of aesthetic purpose and due to rapid urbanization growth. Non-uniform distributions of stiffness, strength and masses in building are due to Irregular plan and elevation. Therefore there are more chances of damage of these structures during seismic hazard. Therefore, the present analysis is performed to study the performance of high rise infill building with different shape of Diaphragm opening situated in earthquake zone v using IS 1893-2016.

OBJECTIVE OF THEWORK

The interest of this research work is to find various responses of different shape diaphragm opening infill building during earthquake. The comparison between various parameters such as base shear, storey drift, displacement or base moment would help us to select the best infill

building configuration on the existing conditions. More specifically, the main objectives of this study are:

➢ To understand interaction of different shape diaphragm opening infill structures with the vibrating ground condition under earthquake.

➢ To design, plan construct and maintain different shape of diaphragm opening infill building to perform well during earthquake and follow the building codes.

➢ Comparison between different shape diaphragm opening infill building on the basis of base shear, top displacement at performance point, storey displacement, storey drift and base moment subjected to nonlinear static loading.

➢ To select the best configuration of the building under existing condition.

This work is naturally considered as a fresh and contributively activity in terms of the development of knowledge due to evaluation and validation by available recommendations to analyse different shape diaphragm opening infill building with the help of computer-based software.

DISCUSSION ON RESULTS

• In H-Shaped open diaphragm infill building it is observed that out of 6690 assigned hinges 6178 hinges are in linear range, 507 is in B-IO (immediate occupancy) range, 4 hinges are in IO-LS range, 1 hinge in LS-CP range. Thus, the building performance is under collapse prevention level.

• In C-Shaped open diaphragm infill building it is observed that out of 6690 assigned hinges 6273 hinges are in linear range, 383 is in B-IO (immediate occupancy) range, 30 hinges are in IO-LS range, 2 hinges are in LS-CP range. 2 hinges in CP-C range Thus, the building performance is in collapse level.

• In L-Shaped open diaphragm infill building it is observed that out of 6690 assigned hinges 6259 hinges are in linear range, 402 is in B-IO (immediate occupancy) range, 19 hinges are in IO-LS range and 10 in LS-CP. Thus, the building performance is in Collapse prevention level.

• On comparing base shear of H, C and L-Shaped open diaphragm infill building at performance point it is observed that base shear of H-Shaped open diaphragm infill building (44643.543 kN) is less as compared to Base shear C-Shaped (59841.042 kN) and L-shaped (54343.575 kN) open diaphragm infill building.

• On comparing Top displacement of H, C and L-Shaped open diaphragm infill building at performance point it is observed that Top displacement of L- open diaphragm infill building (44.177 mm) is lower as compared to Top displacement of H-Shaped (46.985 mm) and C-shaped (49.419 mm) open diaphragm infill building .

• when major earthquake in x-direction base moment of H-Shaped open diaphragm infill building (21686.72 kN-m) is higher as compared to Base moment of C-Shaped (19169.55 kN) and L-shaped (18924.69 kN-m) open diaphragm infill building.

• when major earthquake in y-direction base moment of H-Shaped open diaphragm infill building (20175.27 kN-m) is higher as compared to Base moment of C-Shaped (18583.05 kN-m) and L-shaped (18791.65 kN-m) open diaphragm infill building.

Conclusion-

In this research paper, numerical models of G+14 story H, C and L-Shaped open diaphragm infill building with plan area of 21.0 m X 21.0 m having 7 bays of 3 m width in X-direction and Y-direction and story height of 3 m (floor to floor) is developed. The results obtained from the nonlinear static analysis which shows the behavior of structures in terms of base shear, displacement at performance point, storey displacement, base moment and storey drift are presented below:

➢ The performance of C-Shaped open diaphragm building is in collapse Level and numbers of hinges are also more than H and L shaped open diaphragm buildings. Hence the performance of C-Shaped open diaphragm building is critical than other two shaped building at performance point.

➢ At performance point C-shaped open diaphragm building has 34.44% more base shear then H-shaped open diaphragm building and 10% more base shear then L-shaped open diaphragm building.

➢ At performance point C-shaped open diaphragm building has 4.98% more top displacement then H-shaped open diaphragm building and 10.44% more top displacement then L-shaped open diaphragm building.

➢ When major earthquake in x-direction C-shaped open diaphragm building has higher storey displacement then H and L-shaped open diaphragm building

➢ When major earthquake in y-direction H-shaped open diaphragm building has higher storey displacement then C and L-shaped open diaphragm building

➢ Inter storey drift of C-shaped open diaphragm building is higher than H and L shaped open diaphragm building when major earthquake in x-direction

➢ Inter storey drift of H- shaped open diaphragm building is higher than C and L shaped when major earthquake in y-direction

➢ Moment at the base in H- shaped open diaphragm building is more than C and L-shaped when major earthquake is along x-direction.

➢ Moment at the base in C- shaped open diaphragm building is less then H and L-shaped open diaphragm building when major earthquake is along y-direction.

➢ Load combination 1.5[DL+ (Eqx+.3Eqy)] is more critical than all other load combination for all the three models.

➢ The storey drift and displacement for all the model within permissible limits as per IS 1893-2016.

Hence, overall Results have been concluded that at performance point C- shaped open diaphragm building has less lateral stiffness and large number of hinges been moving from collapse prevention to collapse level. It attracted more base shear and Top displacement at performance point is also high in both direction. storey displacement and storey drift is also higher than other two model .C shape open diaphragm building is more vulnerable compare to other shape building when major earthquake in x-direction.

It is also concluded that behavior of L-shaped open diaphragm building in between C and H-shaped open diaphragm building and it is most suitable configuration in earthquake prone are as in both directions.

REFERENCES

I. Raju, P. and Rao, P. (2011). Push Over Analysis of Reinforced Concrete Frame Structure, International General of Earth Sciences And Engineering, Vol.4(6), 684-690.

II. Samoila, D. M. (2012). Analytical Modelling of Masonry Infills, Acta TechnicaNapocensis: Civil Engineering & Architecture Vol.55(2), 127-136.

III. Liao, W. and Goel, S. C. (2012). Performance-Based Plastic Design and Energy-Based Evaluation of Seismic Resistant RC Moment Frame, Journal of Marine Science and Technology, Vol. 20(3), 304-310.

IV. Ahmed, S. (2013) Seismic Evaluation of Reinforced Concrete Frames Using Pushover Analysis., Al-Rafidain Engineering, Vol.21(3), 28-45.

V. Siddiqui, R. and Vidhyadhara, H. S. (2013). Seismic Analysis of Earthquake Resistant Multibay Multi Storey 3d- RC Frame, International Journal of Engineering Research & Technology Vol.2 (6), 489-495.

VI. Hirde, S. and Bhoite, D. (2013). Effect of Modeling Of Infill Walls on Performance of Multi Story RC Building, International Journal of Civil Engineering and Technology, Vol.4(4), 243-250.

VII. Niruba, S. (2014). Analysis of Masonry Infill in a Multi-Storied Building, Civil & Environmental Engineering, Vol.4(2).

VIII. Elhamed, A. and Mahmoud, S. (2015). Effect of Infill Walls on Response of Multi Storey Reinforced Concrete Structure, World Academy of Science, Engineering and Technology International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol.9(5), 578-582.

IX. Mohod, M. V. (2015). Pushover Analysis of Structures with Plan Irregularity. IOSR Journal of Mechanical and Civil Engineering, Vol.12(4), 46-55.

X. Rajesh, B., Khan, S. A., Kandan, M. and Babu, S. S. (2015), Comparison of Both Linear Static and Dynamic Analysis of Multistoryed Buildings with Plan Irregularities. International Journal of Scientific Engineering and Applied Science, Vol.1(7), 512-517.

XI. Milind V. (2015) Effect of Shape And Plan Configuration On Seismic Response Of Structure. International Journal of Scientific & Technology Research Vol.4(9),84-88.

XII. Dubal, R., Vasanwala, S. and Modhera, C. (2015) Innovative study of Performance Based Seismic Design Method for RCM R Frames with Vertical Geometric Irregularity, IOSR Journal of Mechanical and Civil Engineering, Vol.4(2), 9-14