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EFFECT OF PLAN IRREGULARTIY ON SEISMIC RESPONSE OF RC BUILDING: A REVIEW

Akshay Ahirwal[1], Kirti Gupta[2], Vaibhav Singh[3]

[1]*M.Tech student, Dept. Of Civil Engineering, SVVV Indore, M.P*
[2]*Assistant Professor, Dept. Of Civil Engineering, SVVV Indore, M.P*
[3]*Assistant Professor, Dept. Of Civil Engineering, SVVV Indore, M.P*

***Abstract*— Due to the architectural demand and usage of building in present scenario many building have irregularity in plan and elevation. Such type of building having plan irregularity in terms of slab opening is more susceptible to earthquake forces. Openings in slab can be provided to fulfil purposes like staircase, architectural aspects, lighting etc. Discontinuity in slab increases stress at discontinues joints. In this paper an attempt is made to study effect of plan irregularity over seismic forces for different plan shapes and percentage of openings in slab**.

Keywords: - Seismic Analysis, Response Spectrum, Diaphragm Discontinuity, Structural Parameters*, *SAP2000

I. INTRODUCTION

Structure is subjected to seismic forces are developed during earthquake. Structure is experienced there seismic forces. Seismic forces develops the seismic waves there waves reaches the structure during earthquake. They produce ground motions in the structure. Earthquake is the rapid movement of the earth surface. It takes place naturally at or below the surface of the earth. The earthquake takes place the layers of the soil surfaces in the earth. The earthquake takes place the layers of the soil surfaces in the earth also displaced. When the structure is subjected to ground motions during earthquake the vibrations are occurred the structure will be responds. When the ground motions occurred it should effects the structure in three perpendicular directions. In the three perpendicular directions one is vertical direction (Z) and other two are off horizontal directions (X & Y).The ground motions are occurred the structure get shaking in three directions. The structure is mostly affected by the horizontal direction of shaking. All the structures are designed to satisfy the gravity loads that acted in vertical directions. In the design specifications safety factors to be considered for the design because of this most of the structures tend to be adequately protected against vertical shaking. In general building structures are not susceptible particularly to the vertical ground motions. But it effects to be considered in mind in the design of RCC structural members like RCC columns, steel column connections and beams. Acceleration in the vertical direction also considered in structures with the large span and also stability of structures also is considered in the overall stability analysis of structures. When the building structure is designed for considering only the vertical ground motions in general this design is not safe. This not satisfies the horizontal ground shaking. In generally the forces generated due to Horizontal ground motions of earth is taken as important for the design of the structures. Therefore it is important that the structure is designed to resist the forces acting horizontally due to earthquake. When the building structure is resist on soil surface. In multi-storeyed framed building, damages from earthquake generally initiates at locations of structural weaknesses. Openings present in slab are often providing discontinuities in distribution of load. But when these openings are provided at suitable locations the vulnerability of structure to damage can be avoided. Structural engineers have developed confidence in the design of buildings. In the present work openings enclosed by shear walls are placed at different locations..

II. LITERATURE REVIEW

A. Shape of Plan

Rajesh et.al. (2015) analysed static and dynamic analysis of reinforced concrete building with plan irregularity. In the study four models of G+15 storey building with one regular plan and remaining irregular plan have been taken. The analysis of R.C.C. building is carried out with the FE based software ETABS 9.5. Responses of structures have been studied for lateral forces, base shear, storey drift, storey shear. Effect of the variation of the plan on the structural response building also has been carried out.

Veena S Ravi et.al. (2015) studied the seven models of G+11 storey building with one regular plan and remaining irregular plan (C, E, H, L, T, PLUS shapes) have been taken. The static and dynamic analysis has done with the help of STAAD-Pro software.Seismic performance of different shape of structures located in severe earthquake zone (V) and minor earthquake zones (II) are evaluated and compare design lateral shear, time period, joint displacement etc. Response spectrum analysis is used for analysis.

Gaurav Kumar et.al. (2018) studied the behaviour of different irregular plan buildings during seismic excitation. The building plans, which have eccentricity between centre of mass and centre of rigidity are subjected to more severe damages in compare to building plan which have no eccentricity between centre of mass and centre of rigidity.

The buildings which have zero eccentricity perform well during earthquake. Most common shape of building plans as Square shape, 'L' shape, 'C' shape, and 'T' shape are modelled by using ETABS software. Different parameters as Story drift, Story displacement and Torsion (Ratio of max story drift to average story drift) are studied for four models. After analysis using Linear Time history method, comparison of seismic performance of different models was performed and most vulnerable building shape against earthquake forces was located in this study.

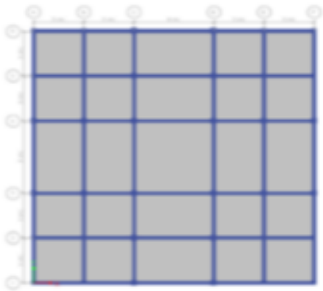

Fig. 1 Square Shape Plan[3]

Fig. 2 L Shape Plan[3]

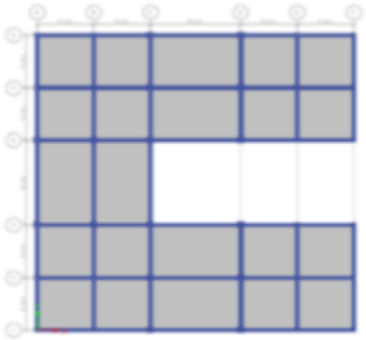

Fig.3 C Shape Plan[3]

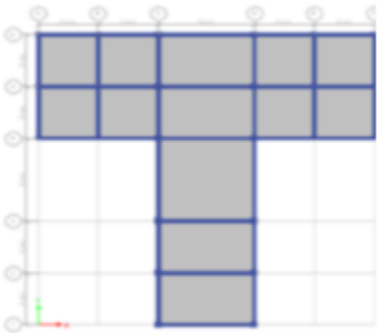

Fig. 4 T Shape Plan[3]

Atul Patane et.al. (2015) addressed asymmetry in structures makes analysis of the seismic behavior very complicated. Recent earthquakes have shown that the structure with plan irregularity results in irregular distribution of mass and stiffness. In this study an effort has been made to understand seismic behavior of building with plan irregularity and symmetric building. A G+9 storied bare RC special moment resisting framed building is considered for the response spectrum analysis using SAP 2000 v.15. It is concluded that the symmetric building performs well as compared to asymmetric building in the event of earthquake.

B. Percentage of Opening

Reena Sahu et. al. (2017) analyzed and compared various models with varying percentages of diaphragm openings for seismic parameters like base shear, maximum storey drifts, shear force, Bending Moment and Axial Force. Results shows that base shear in the buildings calculated from the earthquake static analysis is higher than the response spectrum analysis. Models with a symmetrical opening in both directions expressed similar response for all the parameters while models with change in the symmetry behaved differently. The increase in the opening percentage, increase the storey drift in all the models. It can be seen from the results that storey drift in the buildings calculated from the earthquake static analysis is higher than the response spectrum analysis. Shear force, bending moment and Axial Force obtained from the earthquake static analysis is higher as compared to response spectrum analysis.

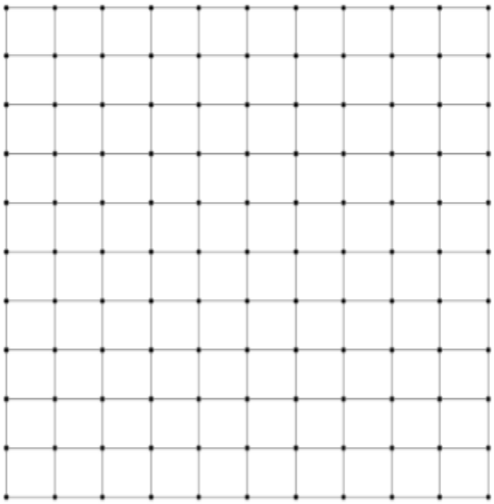

Fig. 5 0% Opening in Slab [5]

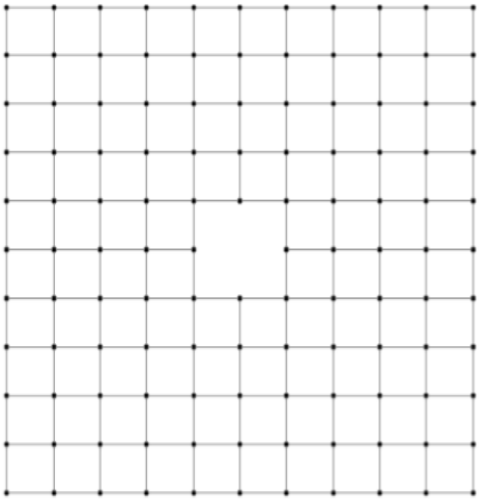

Fig. 6. 4% Opening in Slab[5]

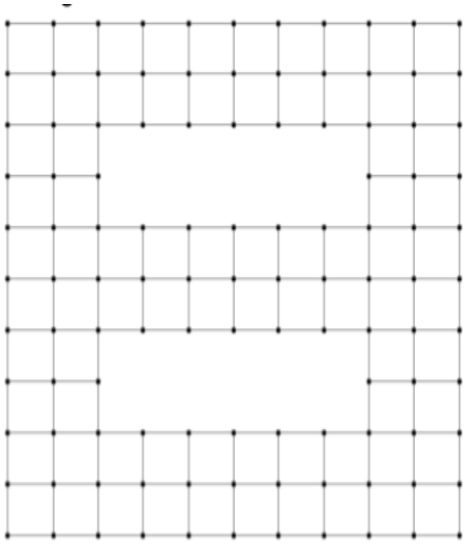

Fig. 7 16% Opening in Slab[5]

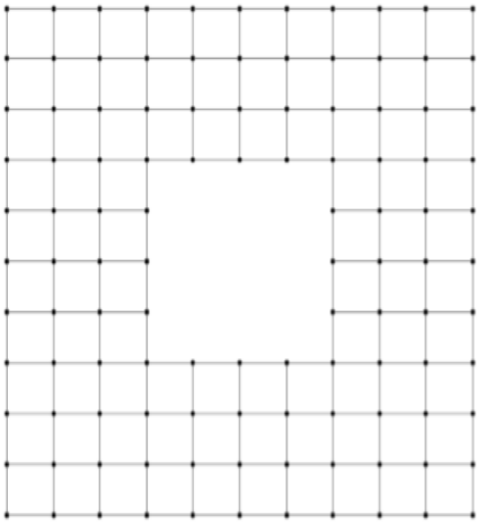

Fig. 8 24% Opening in Slab[5]

Arya v manmathan et.al. (2017) studied buildings with openings in slabs are provided at various locations such as centre, at corners and at periphery with buildings having various shaped columns. The effects of size of openings in slabs were investigated. The seismic performance of multistory regular building is determined by Response Spectrum analysis in ETABS software. As the percentage of slab opening increases, base shear also increases.

P.P. Vinod Kumar et.al. (2015) analyzed the behavior of multi storeyed buildings with diaphragm openings under non-linear static (pushover) analysis using ETABS – 2013. Various models with varying percentages of diaphragm openings were analyzed and compared for seismic parameters like maximum dead load, base shear, maximum storey drifts, modal time period and pushover results.

C. Method of Analysis

J. Sreenath et.al. (2018) studied to know the difference between a building with diaphragm discontinuity and a building without diaphragm discontinuity. Five different multi storied buildings with diaphragm openings under response spectrum analysis using ETABS v 9.7.4 To achieve this objective, various models with varying diaphragm openings were analyzed and compared.

Akhilesh rathi et.al. (2018) analyzed behavior of multi-story structures always depends on its strength, durability, stiffness and adequacy of the regular configuration of the structure. Creating the 3D building model for both linear and non-linear dynamic method of analyses. Understanding the seismic behavior of Setback buildings and Co-relating the seismic behavior of the Setback building with that of a building without Setback finally comparing the regular building behavior of building with a setback at top most 5 stories to that of the building with a setback at each floor level.

Study the influence of vertical irregularity in the building when compare to regular building. Studied the reinforced concrete framed structure designed for setback and regular building of loads (DL, LL & EL). The behavior of 20-Storied buildings with and without setbacks was studied. The buildings were analyzed using Time History Analysis and Response Spectrum Method and Novelty: The effect of Setback is studied considering the parameters such as Time Period, storey drifts, Displacements, Storey Shears, Bending Moments and Shear Forces and correlated with the building without a setback.

Reshma K Bagawan et.al. (2017) analyzed two types of diaphragm discontinuities are considered as stiffness irregularity and mass irregularity in the slab portion. The building is analyzed by Responses spectrum analysis and Time history analysis. The Response quantities like; modal period, storey shear, story displacement and storey drift are estimated and Time history quantities like base force, joint displacement and column forces are estimated and are compared for regular building and building with diaphragm discontinuity. From analysis it can be seen that building with diaphragm discontinuity has the more displacement and drift compared to regular building and regular building has greater time period and shear force then irregular building. Hence regular building is less susceptible to earthquakes.

Babita Elizabath Baby et.al. (2016) studied the slab openings that are provided as discontinuity at different locations such as at centre, at corners and at periphery. In each case linear and nonlinear analysis (push over analysis) are done in ETABS software. It can be seen that openings are more effective to be located at periphery. Comparison has been done for the linear and nonlinear analysis. Around 4% variation has been shown for linear static analysis and response spectrum analysis. 7% variation has been shown for linear static analysis and pushover analysis.

D. Ground slope

Pooja P. Dhanani et.al. (2017) studied two kinds of irregularities in the building models namely plan irregularity with geometric and diaphragm discontinuity and vertical irregularity with sloping ground and the parametric study of the structure had been carried out with analysis of different model with different diaphragm discontinuity and comparison of different structural parameters. Discontinuity in diaphragm shows that optimum percentage of opening will with stand the seismic forces in earthquake area and discontinuity diaphragm makes the building flexible. Capacity of the building may be significant but the seismic demand varies with respect to the configuration.

Ravikumar CM et.al. (2012) studied two kinds of irregularities in the building models namely plan irregularity with geometric and diaphragm discontinuity and vertical irregularity with setback and sloping ground. These irregularities are created as per clause 7.1 of IS 1893 (part1)2002 code. In Oder to identify the most vulnerable building among the models considered, the various analytical approaches are performed to identify the seismic demands in both linear and nonlinear way. It is also examined the effect of three different lateral load patterns on the performance of various irregular buildings in pushover analysis. This study creates awareness about seismic vulnerability concept on practicing engineers.

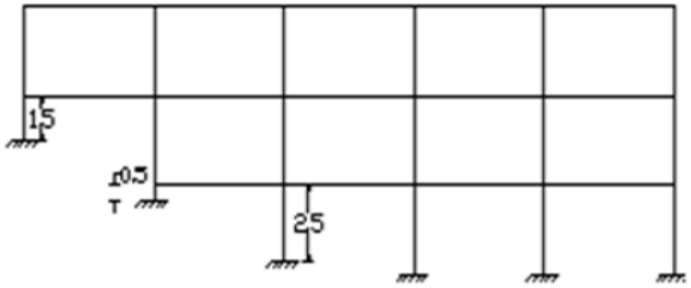

Fig.9 Model on sloping ground [12]

III. CONCLUSIONS

[1] Buildings having irregularity in plan are severely affected during earthquake for high seismic zones.
[2] After a broad comparison, it has been concluded that C and L shapes of building are more susceptible for seismic forces.
[3] With increases in opening percentage in slab, base shear and storey drift increases.
[4] It can also be concluded from the studies that static analysis produces higher base shear as compare to response spectrum analysis.
[5] Opening located near periphery of the structure produces less adverse effect as compare to centre of the plan.

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