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SEISMIC BEHAVIOUR OF MULTISTOREY BUILDINGS HAVING HORIZONTAL IRREGULARITIES

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***Abstract*— During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. Irregular structures contribute a large portion of urban infrastructure. The object of the present work is to compare the seismic behaviour of regular building with horizontally irregular buildings. For this purpose five multistorey buildings are considered. Building 1 is regular plan, building 2 is of C shape, building 3 is of inverted C shape, building 4 is of L shape and building 5 is of T shape in plan. To study the behaviour the response parameters selected are lateral displacement and storey drift. All the buildings are assumed to be located in zone III, zone IV and zone V. For analysis STAAD.Pro software is used.**

Observation shows that for all the buildings considered, drift values follow a similar path along storey height with maximum value lying somewhere near the middle storey and displacement values follow around similar gradually increasing straight path along storey height with maximum value at top storey and least value at base of the structure. From all the observations it may be concluded that, regular building perform well as compared to irregular buildings. Although comparing irregular buildings to each other it shows that T shape building is performing well.

Present work provides a good source of information on the parameters lateral displacement and storey drift.

***Keywords*— Horizontal Irregularity, Stiffness, Grid Slab, Seismic Forces, Lateral Displacement, Storey Drift.**

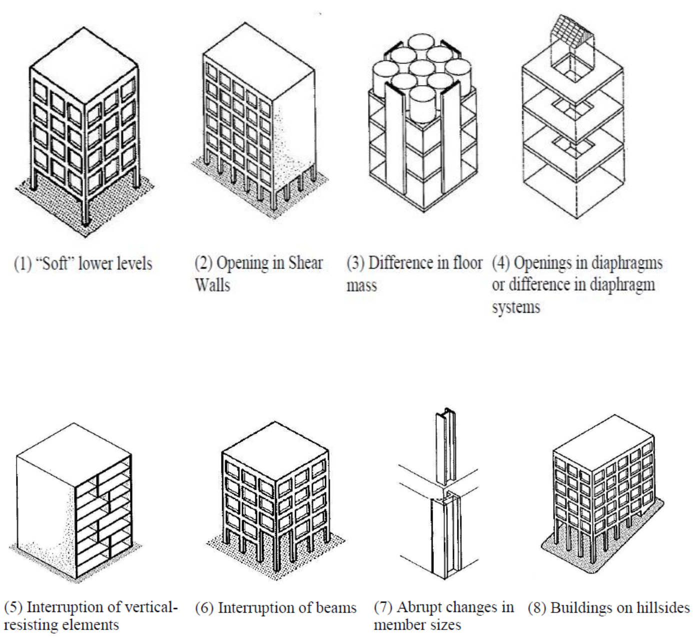
I. INTRODUCTION

When the Dynamic Loads such as Earthquake and Wind loads are applied on a building major structural collapses occurred. In the present time, mostly the structures are constructed with consideration of architectural importance and become highly impossible to plan with regular shapes. Due to these irregularities structural collapse of buildings under the action of dynamic loads happens. Hence, a broad research is required for achieving ultimate performance even with a poor configuration.

A regular building is that building whose configuration is almost symmetrical about the axis whereas, it is said to be the irregular building when it is not symmetrical and discontinuity in geometry, mass or load resisting elements.

At the time of an earthquake, structure starts to fail at points of weakness. This weakness causes due to discontinuity in mass, stiffness and geometry of the structure. This discontinuity of the structure is termed as structural irregularity. These type of structures contribute a vast portion of urban infrastructure.

Irregular buildings make up a large portion of the urban infrastructure and development. These irregularities can be due to architectural, functional, and economical reasons. The most important objective of this work is to improve the understanding of the seismic behaviour of building structures with horizontal irregularities. This is done by quantifying the effects of horizontal irregularities in plan, or strength on seismic demands.



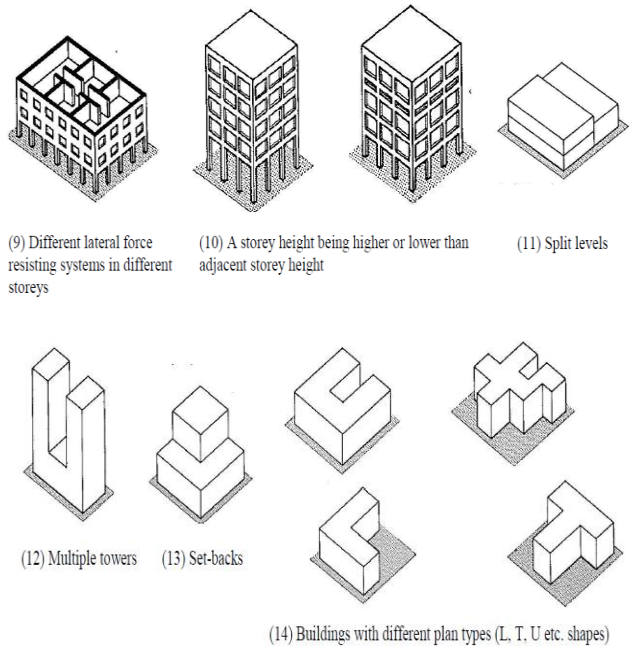


Fig. 1 Types of irregularities

As per seismic code IS 1893, Part 1 Linear static analysis of structures can be used for regular structures of restricted height, as in this process lateral loads are considered as per code based fundamental time period of the structure. Linear dynamic analysis can be used for the improvement of linear static analysis, as this analysis produces the performance of the higher modes of vibration and the actual distribution of forces in the elastic range in a better way.

Buildings are designed according to Design based earthquake, but the real forces acting on the structure is far more than that of DBE. So, for higher seismic zones Ductility based design approach is chosen as ductility of the structure narrows the gap. The primary aim in designing an earthquake resistant structure is to make sure that the building has sufficient ductility to resist the earthquake forces, which it will be subjected to during an earthquake.

II. Problem Formulation & Analysis

The object of the present work is to compare the seismic behavior of multi-storey buildings having horizontal irregularity at different positions with that to regular buildings of similar properties. For this purpose five frames of multi-storey buildings are considered. For the comparison, parameters taken are lateral displacement and storey drift. All the five frames are analyzed for zone III, IV and V. The five frames considered are:

a. Regular building (Building Frame 1)
b. C-shape building (Building Frame 2)
c. Inverted C-shape building (Building Frame 3)
d. L-shape building (Building Frame 4)
e. T-shape building (Building Frame 5)

Structural details in all the buildings are as follows:
Size of beam : 300 mm x 500 mm
Size of column : 800 mm x 800 mm
Slab thickness : 125 mm
Storey height : 4 m
No. of bays : 9 in both directions (4 m x 4 m grid)
No. of storeys : 25 and 30

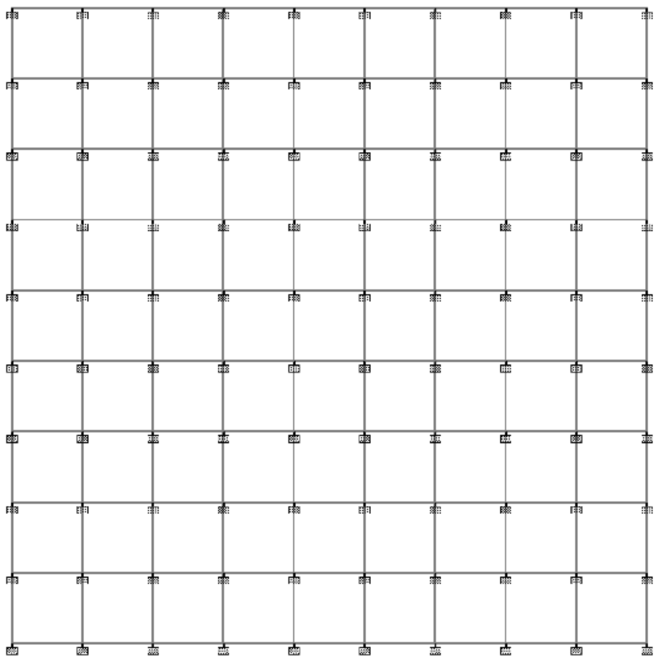


Fig. 2 Building frame1

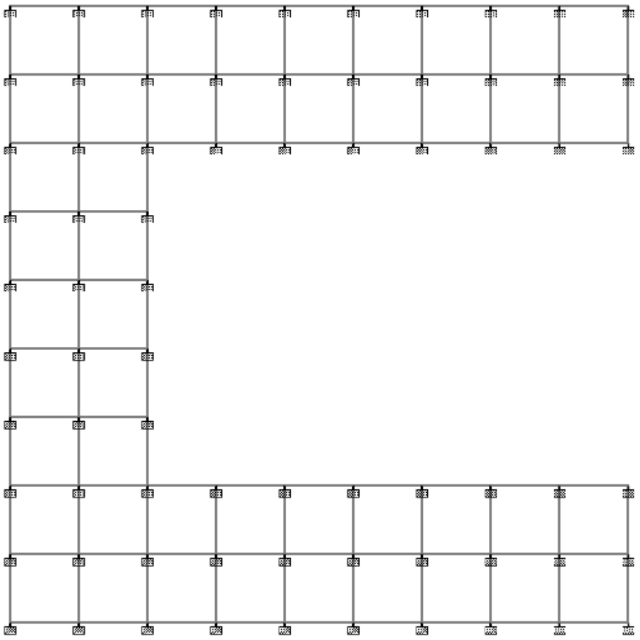


Fig. 3 Building frame 2

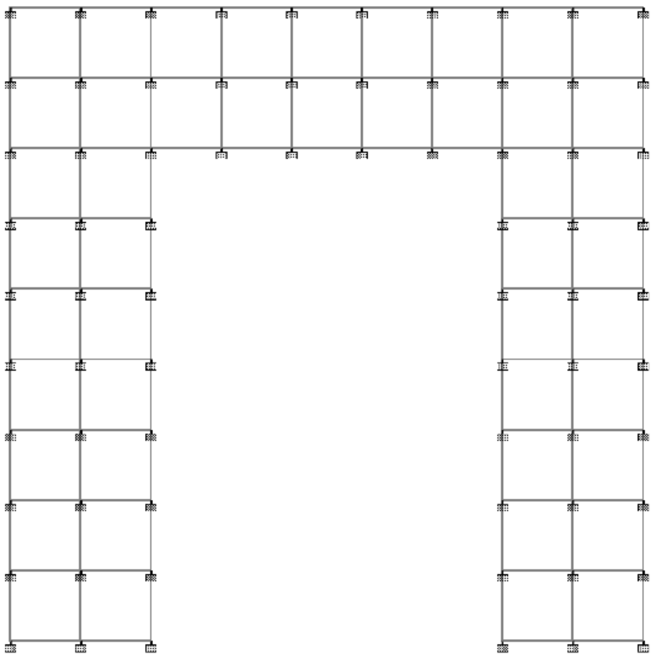


Fig. 4 Building frame 3

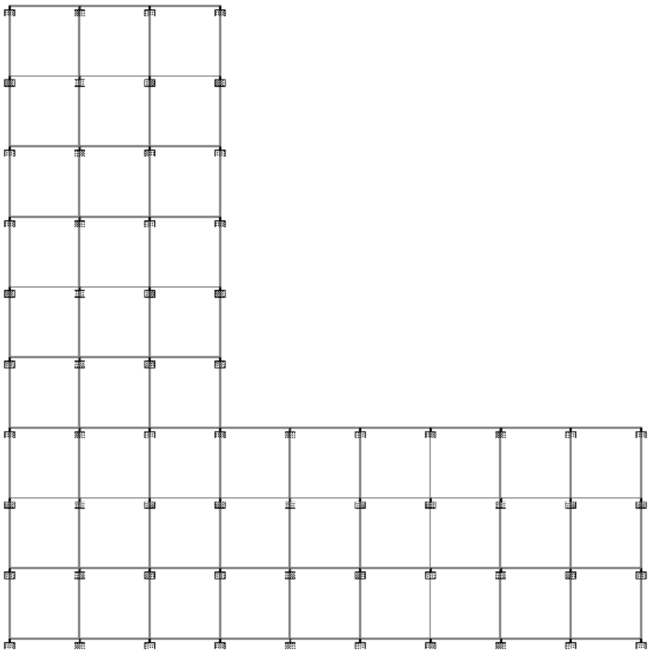


Fig. 5 Building frame 4

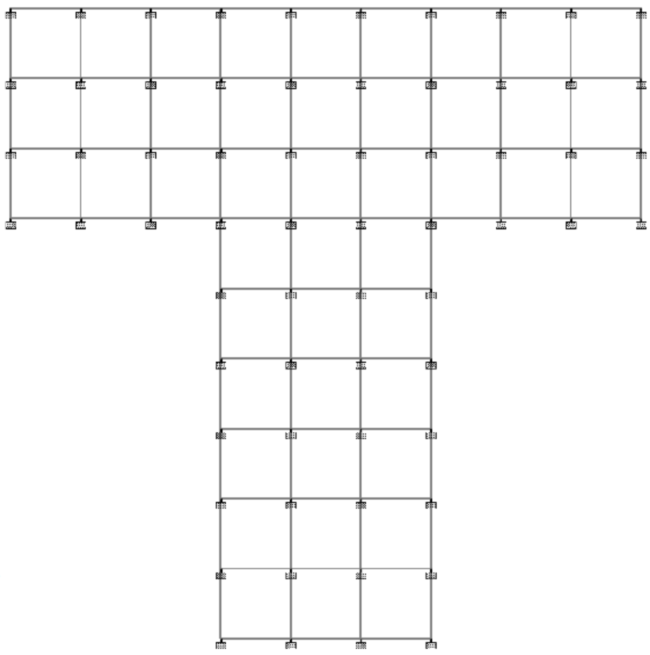


Fig. 6 Building frame 5

Details of all the cases:

1. Storey height provided in all the cases is 3.6m.
2. Sizes of beams are taken as 300mm x 500mm in all the cases.
3. Thickness of slab is 125mm.
4. Thickness of flat slab and grid slab without drop is 150mm.

5. Thickness of flat slab with drop is 150mm throughout and 300mm at drops.
6. Size of columns in case-I is 600mm x 600mm, in case-II is 700mm x 700mm and in case-III is 800mm x 800mm.
7. Loadings considered are:
a). Dead Load- It is taken by software itself.
b). Live Load- 4 KN/m2 on all the floors.
c). Earthquake Load- As per IS 1893 (part-I):2002.
8. Load combinations considered are:
a). 1.5(DL + LL)
b). 1.5(DL + EQL)
c). 1.2(DL + LL + EQL)

For the analysis purpose, these structures are assumed to be located in zone-II, zone-III, zone-IV and zone-V on site with medium soil and Sa/g value taken from the figure 2 of IS-1893: 2002 i.e., Response spectra for rock and soil sites for 5% damping. These structures are taken as general building and hence Importance factor is taken as 1 and the frames are proposed to have ordinary RC moment resisting frames and hence the Reduction factor is taken as 3. Response of the building frame structures is studied mainly for the dominated load combination i.e. 1.5DL ±1.5EL in X-direction for the selected columns at different levels including roof displacement.

III. Results And Discussions

The study evaluates the seismic effect of multi-storey buildings having horizontal irregularity at different positions. Five building frames are analyzed for zone III, zone IV and zone V. To study the effectiveness of all these frames, the storey drift and lateral displacement are worked out and are presented here.

A. EFFECT OF PARAMETERS STUDIED ON STOREY DRIFT:

1. According to IS:1893:2002 (part I), maximum limit for storey drift with partial load factor 1.0 is 0.004 times of storey height. Here, for 4 m height and load factor of 1.5, though maximum drift will be 24 mm.
2. It is observed from the results that for all the frames considered drift values follow a similar parabolic path along storey height with maximum value lying somewhere near the middle storey.
3. It is observed here that in all the building models drift values are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones.
4. As compared to regular building with C-shape building it is observed that drift value in C-shape building increases with 0.6 mm to 3.1 mm in 25 storey building, whereas in 30 storey building it increases with 2.36 mm to 5.07 mm.
5. As compared to regular building with inverted C-shape building it is observed that drift value in C-shape building increases with 1.38 mm to 3.12 mm in 25 storey building, whereas in 30 storey building it increases with 2.39 mm to 5.1 mm.
6. As compared to regular building with L-shape building it is observed that drift value in C-shape building increases with 0.59 mm to 1.37 mm in 25 storey building, whereas in 30 storey building it increases with 1.04 mm to 2.28 mm.
7. As compared to regular building with T-shape building it is observed that drift value in C-shape building increases with 0.06 mm to 0.23 mm in 25 storey building, whereas in 30 storey building it increases with 0.18 mm to 0.51 mm.
8. Hence it can be said that, regular building performs well as compared to irregular buildings. Although comparing irregular buildings to each other it shows that T-shape building is performing well.

B. EFFECT OF PARAMETERS STUDIED ON LATERAL DISPLACEMENT:

1. According to IS:456:2000, maximum limit for lateral displacement is H/500, where H is building height. Here for building height 100 m maximum limit for displacement is 200mm and for building height 120 m it will be 240 mm. Results for lateral displacement are tabulated in the result tables.
2. It is observed from the results that for all the models considered lateral displacement follows a similar path by increasing its value along almost a straight line.

3. It is observed here that in all the building models values of lateral displacement are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones.
4. The lateral displacement is maximum at the top storey and least at the base of structure.
5. As compared to regular building with C-shape building it is observed that lateral displacement in C-shape building increases with 0.03 mm to 18.98 mm in 25 storey building, whereas in 30 storey building it increases with 0.13 mm to 66.6 mm.
6. As compared to regular building with inverted C-shape building it is observed that lateral displacement in C-shape building increases with 0.15 mm to 42.64 mm in 25 storey building, whereas in 30 storey building it increases with 0.12 mm to 67.68 mm.
7. As compared to regular building with L-shape building it is observed that lateral displacement in C-shape building increases with 0.01 mm to 19 mm in 25 storey building, whereas in 30 storey building it increases with 0.04 mm to 29.97 mm.
8. As compared to regular building with T-shape building it is observed that lateral displacement in C-shape building increases with 0.25 mm to 4.84 mm in 25 storey building, whereas in 30 storey building it increases with 0.28 mm to 7.09 mm.
9. Hence it can be said that, regular building performs well as compared to irregular buildings. Although comparing irregular buildings to each other it shows that T-shape building is performing well.

IV. CONCLUSIONS

Within the scope of present work following conclusions are drawn:

1. For all the cases considered drift values follow approximately a parabolic path along floor height with maximum value lying somewhere near the middle storey and displacement values follow around similar gradually increasing straight path along storey height.
2. For all the models drift values and lateral displacements are less for lower zones and it goes on increases for higher zones.
3. In all the models maximum drift values are near about middle storey and lateral displacement is maximum at top storey and least at the base of structure.
4. From all the observations it may be concluded that, regular building perform well as compared to irregular buildings. Although comparing irregular buildings to each other it shows that T-shape building is performing well.

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