STATIC PUSHOVER ANALYSIS FOR REGULAR AND IRREGULAR STRUCTURES IN ALL ZONES

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Abstract

In many earthquake-prone countries, structures may be suffers to various seismic loads in any stage of structures life. For this situation it is expected that the structures designed will show ductile behaviour under the various loads like vertical loads and lateral loads and also shows a stable behaviour without any major damage. Most of Indian lands behave insecure owing to the vibrations which are caused by the seismic effects. Also, it's not possible to stop earthquake or vibrations on the structures but it may be controlled by some effective seismic techniques. Pushover analysis is a simply nonlinear analysis to estimate the static and dynamic demand imposed on any structures under earthquake excitation. In now days for design purpose, irregularity in structures is under highly demand. In this paper regular and irregular building structures are taken to study the behaviour during under seismic zone. Here various type high-rise buildings are analyzed; behaviour of high rise building during earthquake depends on their structural design. In this study a G+8 rugular structure and multi-storeyed irregular structures are analyzed by nonlinear static pushover analysis. Zone factor for analysis is taken as zone III & zone V. This concerned work all building are designed as per IS 456:2000 and IS1893:2002. The aim of this work is to compare the result of symmetrical and unsymmetrical structure behaviour after applying pushover analysis in behalf of storey drift, storey displacement, base shear and storey shear.

Keywords- Pushover analysis, seismic loads, lateral loads, regular and irregular building, nonlinear analysis, storey drift, storey displacement, base shear.

1. Introduction

During an earthquake, its generates a large enough shaking intensity, which severely damage the building structure, dams & bridges. Earthquakes are taken into one of the most dangerous natural menace. Earthquake poses various menaces to economic, population and property loss. To reduce this threat in property or structure loss, measures use is through the seismic problem analysis of present structures. To reduce or prevent structural hazards from earthquake menaces, here are some procedures have been developed, one such method is developed to determine that which building structures are tolerate at the earthquake condition. At many condition large amount of structures are take place so it can be consider a specific amount of time and recourses to compute the details.

Due to highly growth in population, building development & design is in demand. Population increases day by day but the land area is limited in our earth, so as per our land requirement design parameters & comfort ability vertical development is take place at the horizontal development. Due to successfully techniques development in construction field, it is easy to construct a skyscraper structure but in earthquake zone prone area it is risky to maintain stability of structure. So in this type of area it is necessary to check the possible damage due to earthquake effect for this pushover analysis method is adopted which can easily calculate and evaluate the possible damage after seismic effect.

In firstly seismic risk assessments, here various parameters are taken such as seismic zone area, structural system, height of structure, type of building and type of irregularity in building. From the various study and research it is found that most of the structure shows a nonlinear behaviour under earthquake excitations and result as a nonlinear displacement. So displacement- based methods are taken for performance assessment of structures. On this displacement nonlinear method plastic hinges are provided in the structure that provides a nonlinear behave and it is accepted that earthquake input energy is dissipated in the plastic region.

1.1 Pushover Analysis

Pushover analysis is simply a static nonlinear procedure method to analyse seismic structural deformation. In this procedure structures redesign themselves during earthquakes. Pushover analysis is one of the methods to evaluating structures during earthquake loads. After 1970, Pushover analysis has come into use in structural design work. In a nonlinear static pushover analysis, a structure is under a gravity load and continuously increasing vertical forces during seismic program is analyzed until a target displacement is obtained. In pushover analysis a performance point is take place which represent a maximum inelastic capacity state of the structure. A pushover analysis works on this principle where loads applying until the weak link of the structure is identify and then revising the structure model to keep the changes in the structure which is due to weak section. The objected outcome result from the pushover analysis

is in the curve form which is state as force displacement curve. Pushover analysis defined in following performance level:

- Immediate Occupancy (IO): Damage is minor and structure is almost in its original strength and stiffness.
- Life Safety (LS): shows more than minor damage to the structure and in this stage structure would loss its original strength and stiffness in large amount.
- Collapse Prevention (CP): At this stage severe damage take place and a little amount of stiffness and strength remains.

1.2 Types of Structure

For the comparison of structure, there are two types of building are consider.

1. Regular Building

Regular structures consist no purposeful discontinuity in plan or in lateral configurations. Regular structure is symmetrical in principle direction in plan. In regular building it is compulsory that all elements (column) should run without any interruption from setback of top to bottom foundations. In this all lateral stiffness and mass should remain constant or reduce.

2. Irregular Building

Irregular building is kept unsymmetrical property in one of the principle direction. It contains sudden physical discontinuities which may be either in elevation or in plan or sometimes it may be in both which affect the result of the structure subjected vertical loads. Its geometric shape is different which shows stiffness and mass discontinuities. The irregularity in any structure may be due to its diversion of mass, shape, strength and stiffness along to the height.

There are two types of irregularities of structure-
a.) Plan Irregularity: uncertainty in plan or asymmetry in plan shows result irregularity in mass and stiffness.
b.) Vertical Irregularity: vertical discontinuity in mass, stiffness and strength distribution shows a irregular outcome from structure. It may be generate a sudden change in structure property.

2. Significance of work

- To understand the behaviour of high-rise building ongoing seismic effect with regular and irregular plan.
- Evaluate the level of displacement and damage difference between regular and irregular structure.

3. Structure Design

3.1 Structure detail

This study is to deal with the stable and unstable effects caused by the regular and irregular building having constant buildup space. Compared the outcome of structural behaviour in different- zones are according to IS 1893(Part1):2002 codal provision. Here we are taking G+8, G+9 and G+14 building with different shapes for behaviour analysis in zone III and zone V. It offers the wide scope of the feature for nonlinear static pushover analysis. Table below shows the details of structure

Table No 3.1 Building Plan and Dimension Details

Size of beams	225X300mm
Size of column	350X350mm
Thickness of slab	125mm
Grade of concrete	M30
Grade of Steel	Fe 415
Total height of the structure	24m,30m,45m
No. of stories	9,10,15
Height of each storey	3m

3.2 Structure models with different shapes-

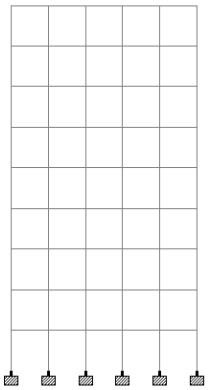


Fig.3.1 Front view of regular structure

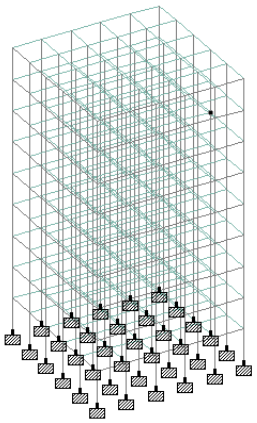


Fig.3.2 3D view of regular structure

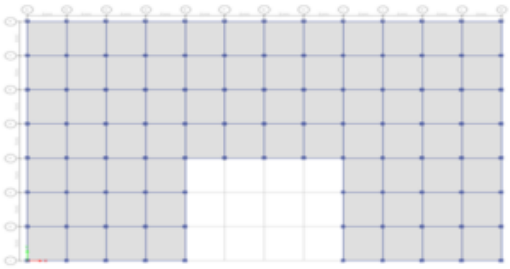


Fig.3.3 Plan view of C shape RCC structure

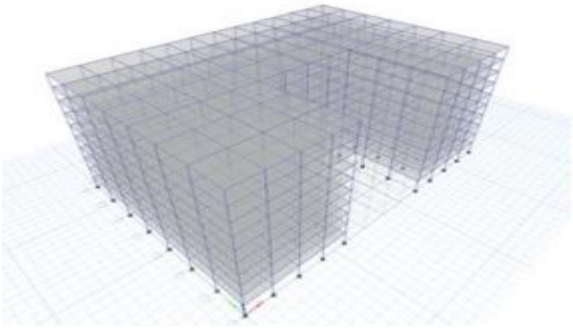


Fig.3.4 3D view of C shape RCC structure

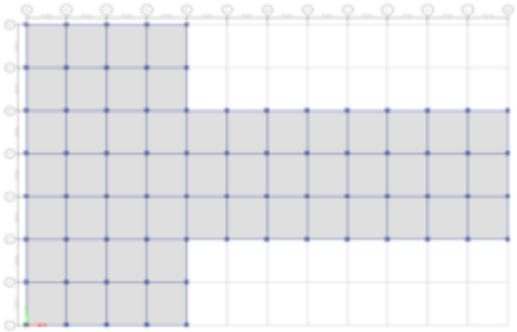


Fig.3.6 3D view of T shape structure

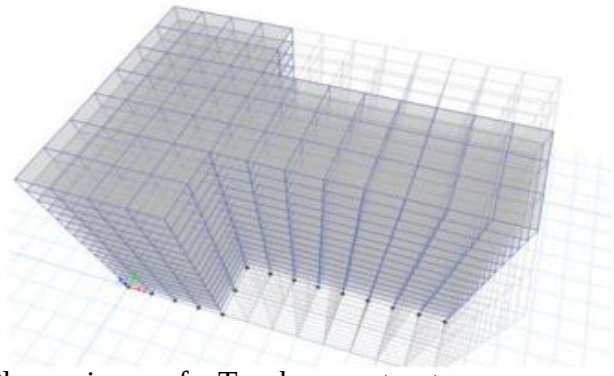


Fig.3.5 Plan view of T shape structure

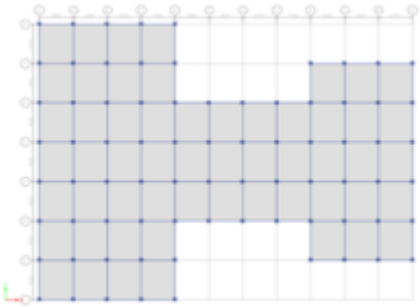


Fig.3.7 Plan view of I shape structure

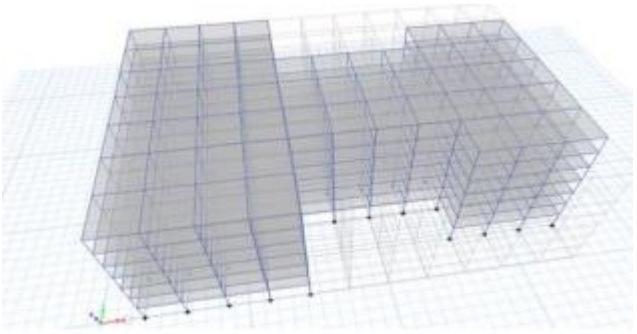
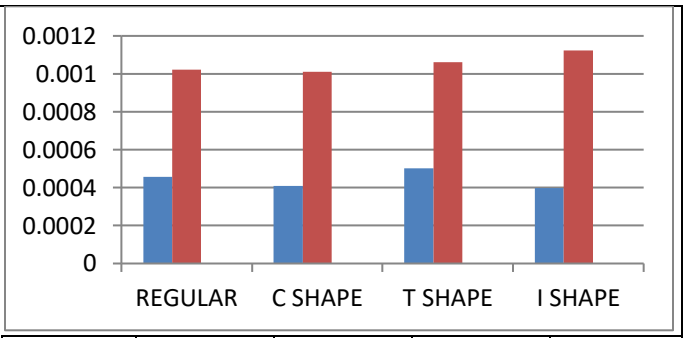


Fig.3.8 3D view of I shape structure

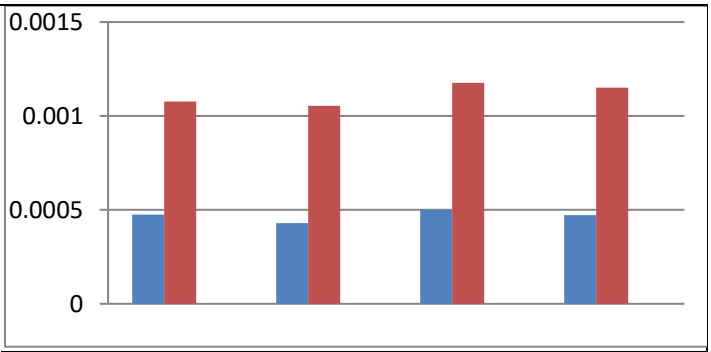
4. Results

A] Storey Drift



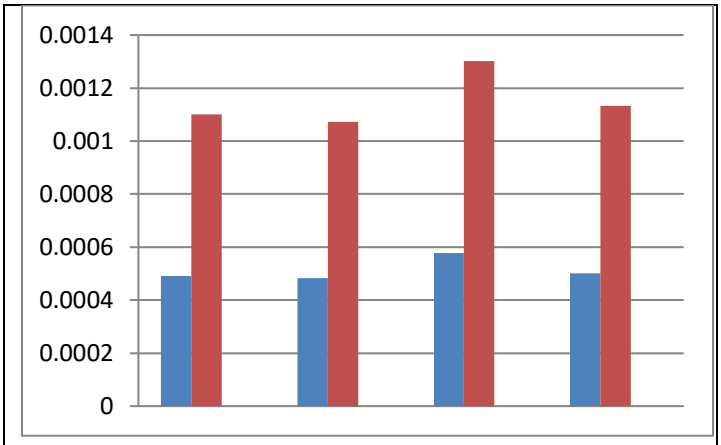
ZoneIII	0.00452	0.00041	0.000503	0.000436
Zone V	0.001021	0.001012	0.001062	0.001054

Fig. No.4.1: Storey Drift in Different Zones in G+8



	Regular	*C SHAPE*	*T SHAPE*	*I SHAPE*
ZoneIII	0.000474	0.00043	0.000501	0.000472
Zone V	0.001076	0.001055	0.001176	0.001151

Fig. No. 4.2: Storey Drift in Different Zones in G+9

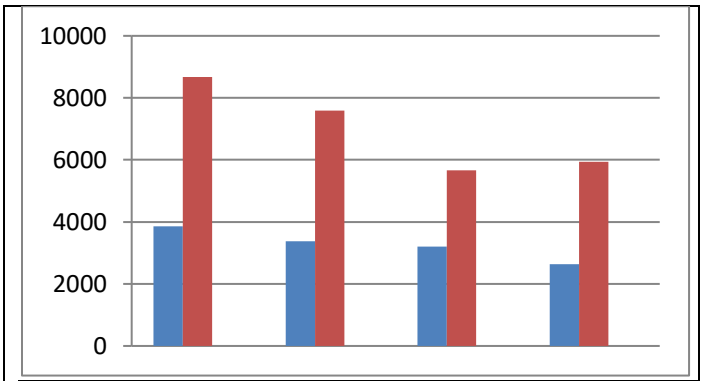


	Regular	C SHAPE	T SHAPE	I SHAPE
ZoneII I	0.00049 1	0.000482	0.000578	0.000502
ZoneV	0.00110	0.001072	0.001301	0.001132

Fig.No.4.3: Storey Drift in Different Zones in G+14

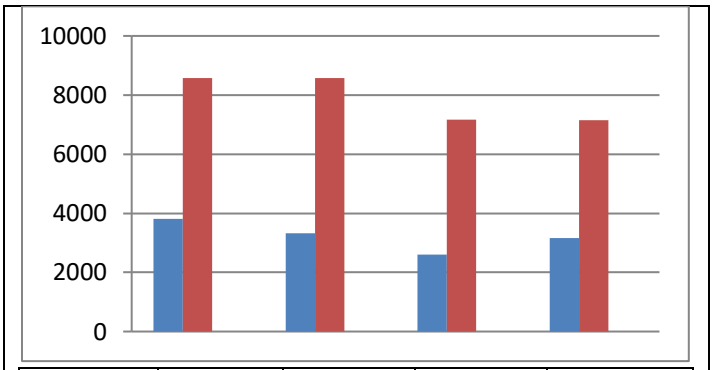
From the above data and graphs it is observed that T shaped Structure has the highest Storey Drift values and the C shaped structure has the least values for storey drift when it is compared with other two I Shaped and Regular structure where stories are G+8,G+9 and G+14.

B] Base Shear



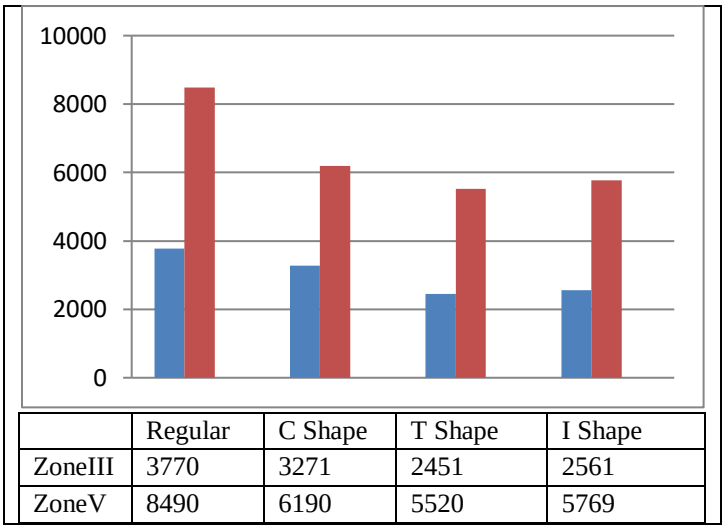
	Regular	C shape	T shape	I shape
ZoneIII	3851	3372	3201	2643
ZoneV	8672	7591	5659	5940

Fig.No. 4.4: Base shear for different zone in G+8



	Regular	C shape	T shape	I shape
ZoneIII	3815	3325	2601	3156
ZoneV	8578	7485	7170	7155

Fig.No. 4.5:Base Shear for different zones in G+9



	Regular	C Shape	T Shape	I Shape
ZoneIII	3770	3271	2451	2561
ZoneV	8490	6190	5520	5769

Fig.No.4.6: Base shear for different zones in G+14

From the above base shear graph it is observed that the regular structure has the highest base shear values and least value is in T shaped structure when it is compared to other two I shaped and C shaped structure in G+8, G+9 and G+ 14 structures.

5. Conclusion

- Base shear is highest for Regular structure as compared to other irregular structure.
- As height to weight ratio increases, drift and displacement decreases in vise-versa.
- Storey displacement and storey drift for irregular building as compared to regular in Y-direction is greater than the X-direction

- The story drifts variation for irregular case increases and decreases for the asymmetrical case when compared to the regular structure.
- After comparison of all the cases it can be admit that the asymmetrical structure has max drift and displacement values where as max story shear is observed in regular structure.

6. References

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