Corelative Study of Regular and Geometric-Irregular Multistorey Building in Seismic Zone 4

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Abstract - The performance of a multi-story framed building during sturdy earthquake motions depends on the distribution of mass, stiffness, and strength in both the horizontal and vertical planes of the building. Many structures in the modern era feature odd elevation and plan arrangements. These structures are more vulnerable to earthquake forces. The more significant elements that reduce a structure's seismic behavior are structural imperfections. Reduced base shear, which attracted fewer seismic forces, was mostly caused by the effect of diaphragm openings just on the seismic response of multi-story buildings. The structure can benefit from efficient strength & serviceability thanks to the placement of apertures. It is important to determine how well the structures can survive disasters. Gaps in the floors are common for a variety of reasons, including stairs, illumination, and architectural purposes. These openings in the diaphragms result in tensions at the joints where the building elements terminate. Discontinuous diaphragms are made without considering the effects of gaps and are assumed to be adequate. In this work, an effort has been made to determine the differences between the seismic responses of two buildings with and without irregularities. Using E.TABS 2017 software, the seismic response of an existing building having diaphragm irregularity will be compared to a building with diaphragm discontinuity in the current study. There has been a linear dynamic analysis done. For the modal base shear, story drift, stiffness, and displacement the results of two buildings have been compared.

Key Words: geometrical irregularity, ETABS 2017, Response spectrum analysis , Regular building

1. INTRODUCTION

The behavior of the building is significantly influenced by the structural configuration or placement of structural components. Buildings with a straightforward and consistent layout have been demonstrated to sustain less damage in previous earthquakes. Inertia forces are created in a building when it is subjected to a seismic dynamic stress, and they concentrate at the building's Centre of mass [1]. A place known as the Centre of stiffness of the building is where the lateral resisting pressures of vertical structural elements, such as columns and shear walls, resist the seismic inertia forces. The building will become eccentric if the Centre of mass and the Centre of stiffness are not in alignment. A building develops eccentricity due to its atypical configuration, which causes torsion in the structure [2]. A building develops eccentricity due to its atypical configuration, which causes torsion in the structure. The torsion that causes a building to be damaged is significantly influenced by the location, size, the orientation of structural members [3].

In vertical or horizontal planes, regular buildings don't have any noticeable discontinuities in mass, stiffness, or strength. Contrarily, irregular structures have these discontinuities that concentrate stresses and deformities in the area of the discontinuity [4]. This could cause structural components to fail at their joints and cause the structure to collapse. Vertical irregularity is the unequal distribution of stiffness, mass, & geometry along the length of the building, while horizontal irregularity is the discontinuity in the building's plan. Usually, the buildings have these imperfections for both aesthetic and practical reasons [5]. The position, kind, and degree of abnormalities present in that mostly determine the size of the building's response. Buildings' performance under the effect of seismic load could be ensured if all these factors are wisely taken into account throughout the design process [6].

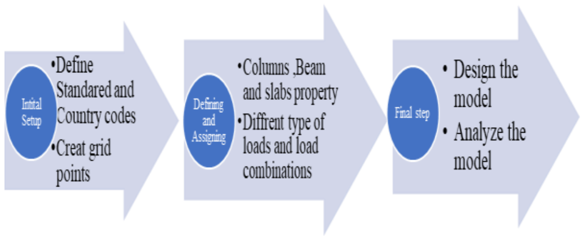
A multi-story building is one that has more than four levels and can have up to twelve or more. In towns and cities with a higher population density, multi-story buildings are frequently found. Engineering can do very little to protect people and property from earthquakes, which are the most destructive and unpredictable of all-natural disasters. There are a number of regulations that have been updated frequently on this subject. Stiffness, appropriate lateral strength, ductility, simple and regular configurations, and other elements all affect how a building responds to an earthquake [7].

In comparison to irregular structures, buildings with regular geometry and evenly distributed mass and stiffness in plan and elevation sustain substantially less damage. The modern generation's needs and demands, however, as well as the expanding population, have forced architects and engineers to build irregular arrangements. Because of this, understanding the role of building configurations has become one of the main problems in earthquake engineering [8].

Definition of Irregularity in IS 1893, An irregular distribution of their mass, strength, and rigidity along the height of the building may be the cause of the irregularities in the building structures. The design and analysis are more difficult when certain buildings are built in high seismic zones. The aim of this paper to study the seismic behavior of g+8 multistorey vertical irregular building in seismic zone IV under medium soil conditions using ETABS [9]. Vertical Irregularities define as the lateral force resisting system in a storey has a horizontal dimension that is more than 150 percent larger than that of the storey directly below. Vertical Geometric Irregularity is thus thought to apply to the construction. Here we had to study the parameters like storey drift, displacement, overturning moment [10].

2. METHODOLOGY-

A G+8 structure is built in ETABS v16 with a storeys height of 3 m, a structure length of 25.6 m in one direction and 14.3 m in the other, and member sizes that vary depending on design specifications. To finish the model and analysis, take the following actions:



3.BUILDING DESCRIPTION-

(G+8) Storey Residential building situated in Zone IV is considered for the analysis and their geometric parameters are given in table

3.1 MATERIAL PROPERTIES-

3.2 SEISMIC DATA (IS-1893:2016 PART-1)-

3.3 LOADING DATA-

3.4 MODEL PARAMETERS-

For dead loads, we get IS 875 Part 1, for live loads, IS 875 part 2, and seismic analysis is carried out in accordance with the 2016 edition of IS 1893 part 1.

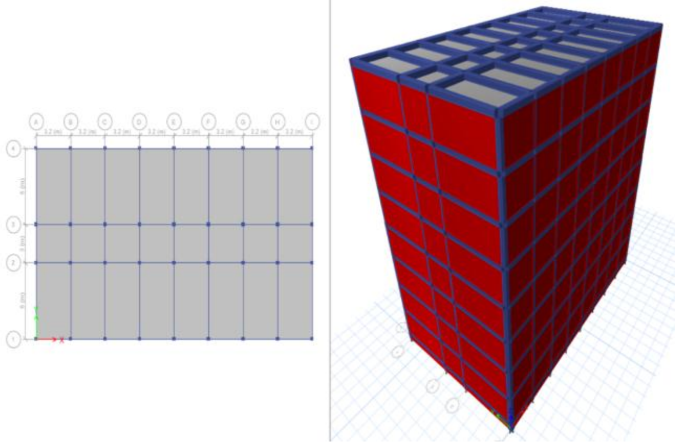
S. N	Parameters	Dimension
1	Model type	3D
2	Plan Dimension	25.6*14.3m (X*Y)
3	No of stories	G+8
4	Floor to Floor height	3m
5	Total Height of building	24m
6	Slab Thickness	150mm
7	Column size	350*350mm
8	Irregular building Column size	300*300
9	Beam size	300*400mm
10	Grade of concrete (slab)	M30
11	Grade of concrete (column, Beam)	M30
12	Rebar	Fe 415
13	Earthquake Zone	1V

S. No	Material	Grade
1.	Concrete (beam, slab)	M30
2.	Concrete (Column)	M30
3.	Rebar	FE 415

1.	Earthquake Zone	IV
2.	Zone factor (Z)	0.24 (Table 3, clause 6.4.2)
3.	Damping Ratio	5% (clause 7.2.4)
4.	Important Factor	1.2 (Table 8, clause 7.2.3)
5.	Type of soil	Medium soil (clause 6.4.2.1)
6.	Response Reduction Factor	5 (SMRF) (Table-9, clause 7.2.6)

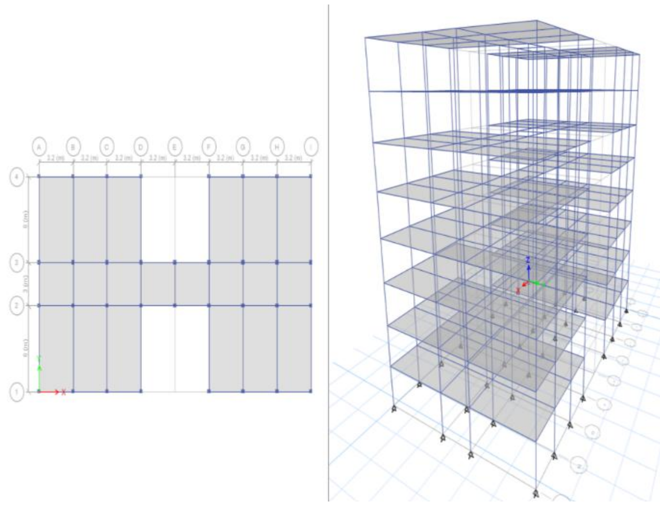
1.	Live load	3.5 KN/m^2 as per IS 875 Part II
2.	Earthquake load	as per IS 1893:2016Part-I
3.	Dead load	4.75 kN/m

3.5 MODELLING OF STRUCTURE-



2D Plan 3D Plan

Fig 1: Regular building (MODEL – 1)

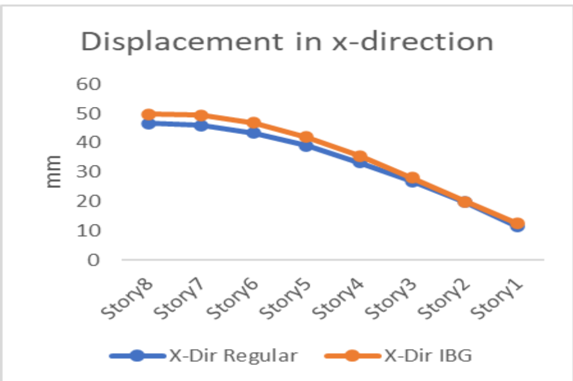


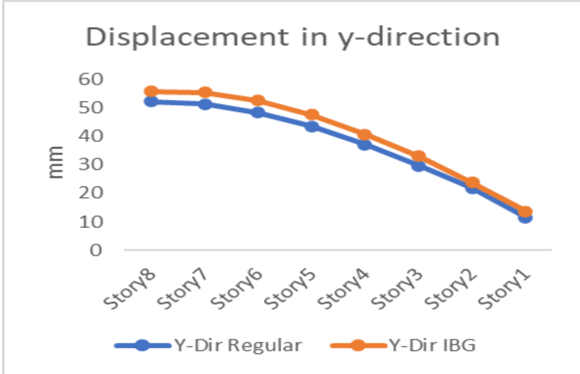
2D Plan 3D Plan

Fig 2: Irregular building (MODEL- 2)

4.ANALYSIS AND RESULTS-

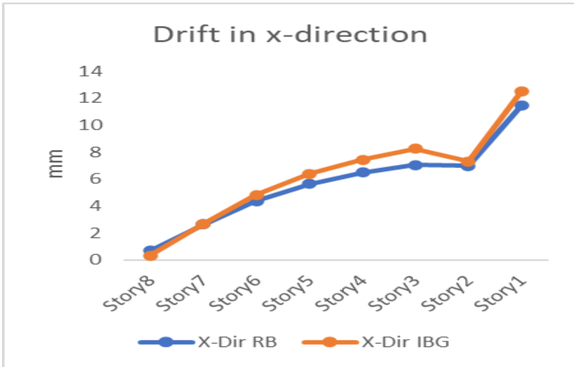
4.1 STOREY DISPLACEMENT:

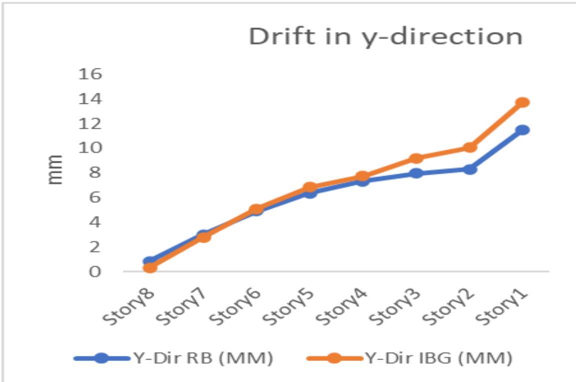




The graph shows, the displacement of building with geometrical irregularity has more displacement in both X and Y Direction which is approximately 7% more than the regular RCC building.

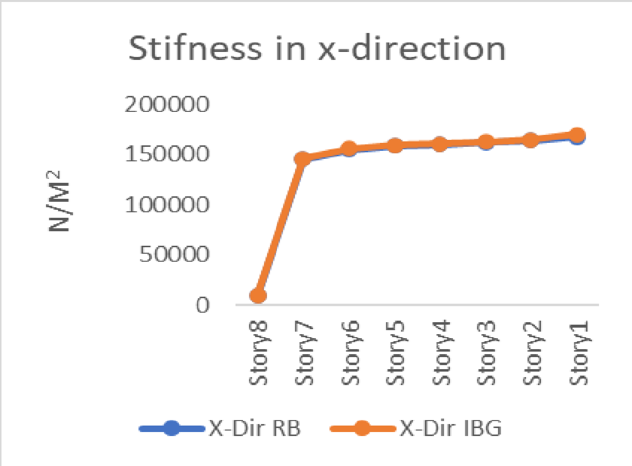
4.2 STOREY DRIFT:

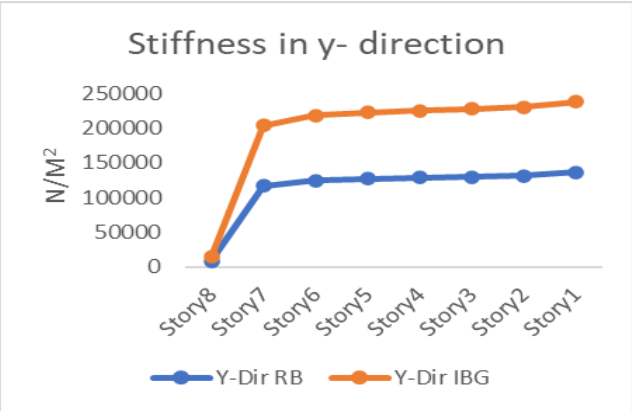




The graph shows the drift in regular RCC building is less than the story drift in building with geometrical irregularity in all story in x- direction and the max story drift in regular Building is 8% less than the max drift in IBG building where as in y-direction the story drift in building with geometrical irregularity is observe less than the regular building in 7th story due to geometrical irregularity which is approximately 7% less than the regular building but both are within permissible limits and the max story drift in y-direction in regular building is approximately 16.36% less than the Geometrical irregular building.

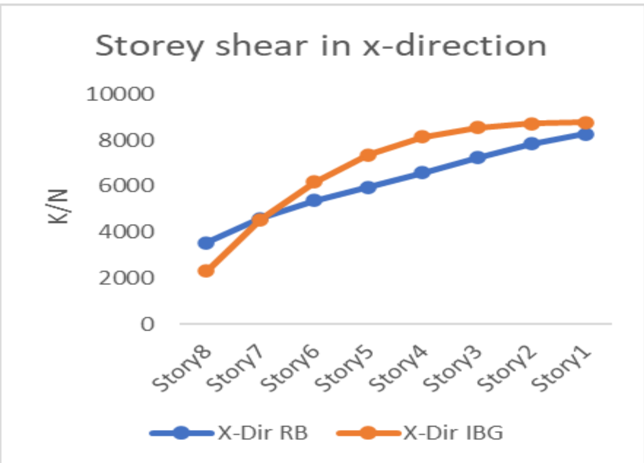
4.3 STIFFNESS:

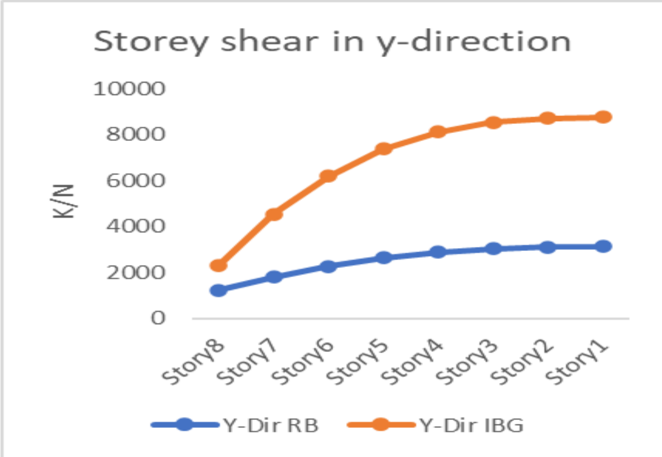




The graph shows, the stiffness of building with geometrical irregularity has almost same stiffness in X-direction as it is in regular building. In Y-direction maximum story stiffness of Geometrical irregular building is approximately 42% more than the regular RCC buildings

4.5 STOREY SHEAR:





The graph shows, the storey shear of building with geometrical irregularity has more in X- direction and less in Y-direction and maximum storey shear of geometrical irregular building is approximately 6% more in x-direction and 64% more in y- direction than the regular RCC buildings.

5.CONCLUSION:

The purpose of this study was to analyze and compare the seismic performance of the G+8 Story H Shape irregular buildings for different models at varying location. THE RESPONSE SPECTRUM method was used, and results were found in terms of base shear, story displacement, story drift, story stiffness and maximum story drift. The results of analysis for the models following conclusions can be drawn. The maximum values of STOREY DRIFT of Model 2 observed in x and y-direction are approximately 7% & 16.34% more than the values observed in Model 1 in the respective direction. Similarly the maximum values of STIFFNESS of Model 2 observed in y-directions is approximately 42 percent more than the values observed in Model 1 in the respective direction. . In this study maximum value of base shear is observed in Model 1(REGULAR) building and minimum value is seen in Model 2 (IRREGGULAR). The value of base shear in Model 1 building is more than Model 2. The story displacement remains constant but with increase geometrical irregularity in story height of building there is an exponential rise in top most storey which is approximately 7% more than the regular building. The maximum value of story displacement observed at top most story of building for both the models increases gradually and exponentially. Hence it is concluded that regular building perform best when it is subjected to seismic loading.

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