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DYNAMIC ANALYSIS OF RCC MULTI-STOREY FRAMED STRUCTURE WITH DIFFERENT PLAN CONFIGURATIONS

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Abstract*— Nowadays, Architects challenging Engineers by proposing Irregular Shaped Buildings. Design and Analysis of Irregular shaped building is more complex than the regular shaped building. Hence Structural engineer should have a complete understanding of the behavior of the irregular shaped building. In the present work, an analytical study is performed to evaluate the effect of plan irregularity on the seismic behavior of the conventional RC framed building. Six models of G+14 storey building with one regular and remaining irregular plan(Hexagonal, Circular, Elliptical, Sector and Y-shape) have been taken. The Plan area for each structure is same. The performance of these building models under Seismic loading is examined by carrying out Response Spectrum analysis using structural analysis software ETABS 2016 v16.2.1. The comparison is made between the regular model and irregular model for various parameters.

Keywords*— Plan irregularity, conventional RC framed, Seismic loading, Response Spectrum analysis**, **ETABS 2016 v16.2.1.

I. INTRODUCTION

With the advancement of Technology and for the aesthetic requirement, buildings with irregular structural forms are widely constructed. Past Earthquake studies have shown that the dynamic behavior of the structure is affected by its shape, dimensions, and locations of structural elements. Many codes on seismic design provide specifications on irregularities. Moreover to design and analyze an irregular building high accuracy is required.

In the present study G+14 storied R.C. frame building with different geometrical irregularities subjected to seismic load considered. In this study Plan area of all building kept same. Response spectrum analysis is carried out using ETABS 2016 v16.2.1 to determine the effect of irregularity.

In this study six models considered, the first one is regular and the other five are irregular in plan. In that irregular in plan with Hexagonal shape, irregular in plan with Circular shape, irregular in plan with Elliptical shape, irregular in plan with Sector shape irregular in plan with Y- shape. Gravity loads and laterals loads as per IS 1893-2002 are applied on the structure and it is designed using IS 456-2000.

II. LITERATURE REVIEW

Suravase et al. (2017) studied the Effect of Geometrical plan irregularities on RCC multi-framed structure. In this study 4 models have been considered i.e. Rectangular, L shape, H shape and Rectangle with core shape of G+10 storied R.C frame building subjected to earthquake load. Displacement control pushover analysis is carried out by using ETABS software. The author concludes that L-shaped building collapse before all other buildings and rectangular building model will collapse after all other building models.

Ullas et al. (2017) investigated the Response of buildings of different plan shapes subjected to wind vibrations. Buildings of plan shapes Y, plus and V are modeled in ETABS 2016 and analyzed. It is observed that storey force is same for all the buildings i.e. storey forces does not change with the shapes. Lateral displacement is found maximum for Y shape as compared to that of other shapes and the lateral displacement and the storey drift is observed minimum for plus shape buildings and hence it is the most stable shape among the selected shapes.

Hallale et al. (2016) worked on the Seismic Behavior of Buildings with Plan Irregularity with and Without Structural Infill Action. In this study seismic behaviour of three irregular buildings which have the same area as that of the regular building, two are symmetrical about X-axis (‘C’ shaped buildings in plan) and one has no axis of symmetry (‘L’ shaped building in plan) are considered. Both regular and irregular buildings are assumed to be located in zone III. Response spectrum analysis is carried out in ETABS 2013. It is found that plan irregularity of buildings leads to an increase in displacement, drift, storey acceleration, time period and member forces, but reduces the base shear. Infilled frame action develops additional lateral stiffness so that the quantities such as displacement, drift, storey acceleration, time period and member forces are reduced, while the base shear increases.

Ravi et al. (2016) worked on the Effect of Shape and Plan Configuration on Seismic Response of Structure (ZONE II & V). Seven models of G+11 storey building with one regular plan and remaining irregular plans such as E, H, T, L, C, and plus (+) shape plan have been taken for study. The plan area for each structure is same. STAAD-Pro V8i is used for analyzing the response of the structure. Response Spectrum method is used for analysis. Response parameters such as base shear, Time period and joint displacement have evaluated and compared. The investigation shows that building with regular square plan have the same maximum base shear value compared with other plan shapes and least base shear value for "L" shaped plan configuration in zone II & V. Regular shaped building have minimum displacement and "L" shaped have maximum compared to other shapes and hence it can be avoided. Irregular shape building is severely affected undergo more deformation during earthquake especially in high seismic zones.

Sultan et al. (2015) carried out the Dynamic Analysis of Multi-storey Building for Different Shape. Four models of 15 storeys having a plan of Rectangular, L-shape, H-shape, and c-shape are modeled in ETABS 9.7.1 version. Equivalent static force and Response spectrum method have used for analysis. The Results indicate that irregular shapes are severely affected during an earthquake, especially in high seismic zones. Base shear is more for L-shape building and C-shape building is more vulnerable compare to all other shapes.

III. MODEL AND ANALYSIS

Modeling of buildings is done in ETABS. Plan area of all the buildings is kept constant. Plan area considered is 720m2.

Table 1 Preliminary Data Considered in the Analysis of the Framed Structure For Seismic Load

S.no.	Variable	Data
1.	Type of structure	Special Moment Resisting Frame
2.	Number of stories	G+14
3.	Total height of the building	48.1m
4.	Base story height	4m
5.	Typical story height	3.15m
6.	Live Load	4 KN/m^2
7.	Floor finish	1.5 KN/m^2
8.	Wall Load	11.73 KN/m
9.	Materials	Concrete(M40) and Reinforced with HYSD bars (Fe 500)
10.	Size of columns	600*600 mm(for models 1 to 5) 750*750 mm(for model 6)
11.	Size of Beams	300*600 mm
12.	Depth of slab	150mm
13.	Size of Shear wall	400mm
14.	Specific weight of RCC	25 KN/m^2
15.	Zone	V
16.	Importance Factor	1.5
17.	Response Reduction Factor	5
18.	Type of soil	Medium

Table 2 Modeling

S.no	Model ID	Model Description
1	Model_1	Rectangular shape building
2	Model_2	Hexagonal shape building
3	Model_3	Circular shape building
4	Model_4	Elliptical shape building
5	Model_5	Sector shape building
6	Model_6	Y- shape building

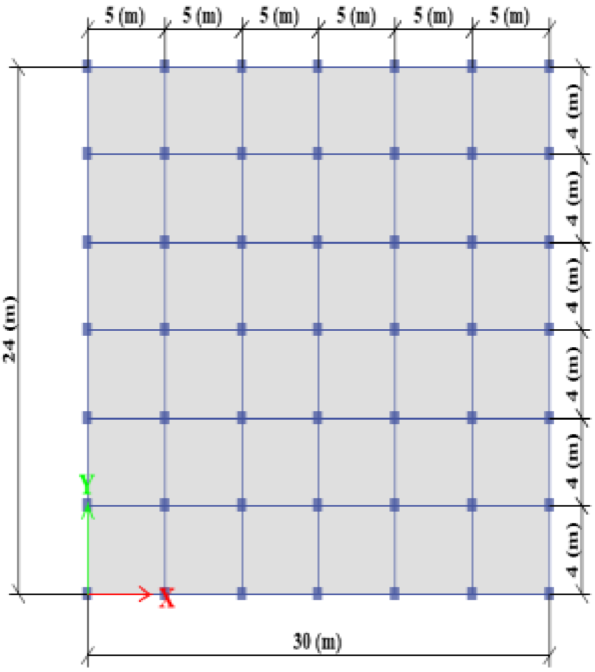


Fig 1: Plan Layout of Model_1

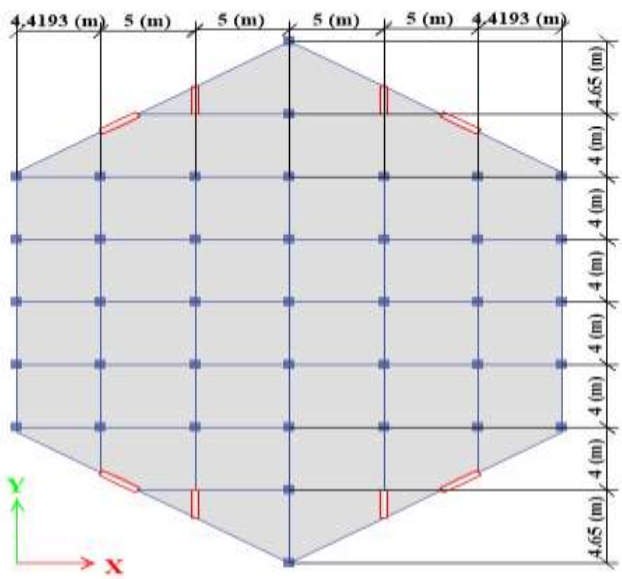


Fig 2: Plan Layout of Model_2

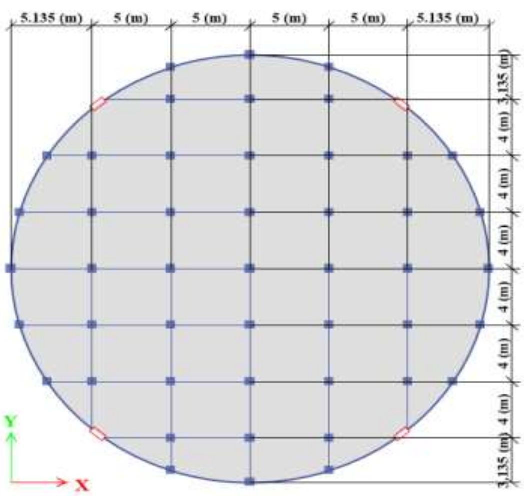


Fig 3: Plan Layout of Model_3

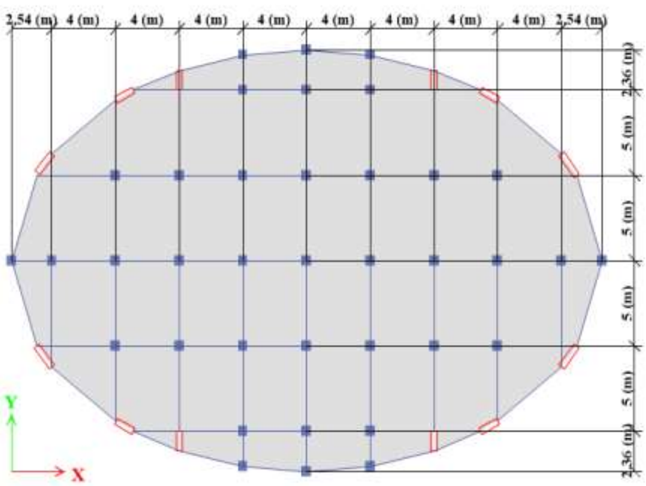


Fig 4: Plan Layout of Model_4

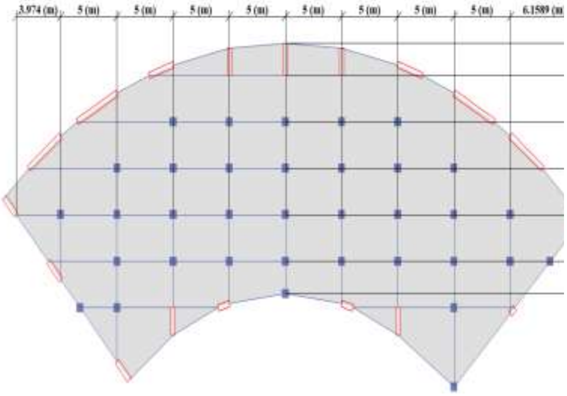


Fig 5: Plan Layout of Model_5

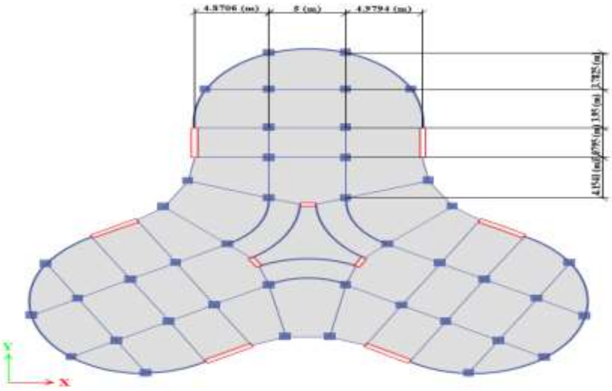


Fig 6: Plan Layout of Model_6

Fig 7: 3D Rendered View of MODEL_1

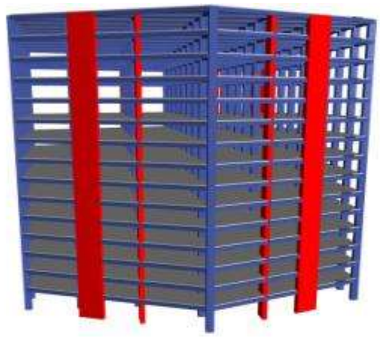


Fig 8: 3D Rendered View of MODEL_2

Fig 9: 3D Rendered View of MODEL_3

Fig 10: 3D Rendered View of MODEL_4

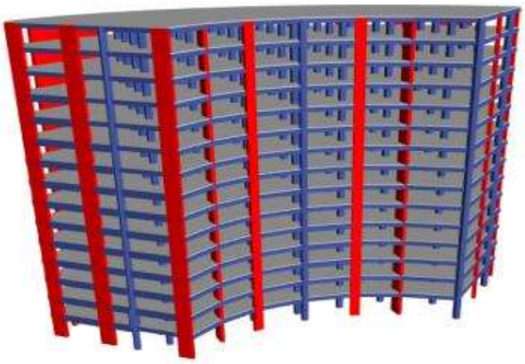
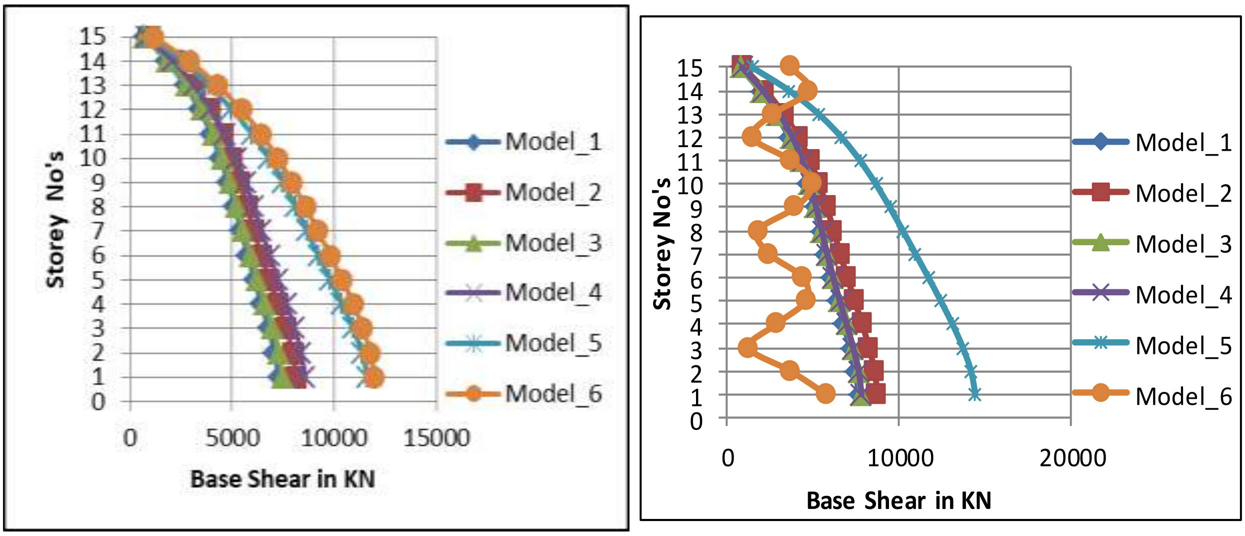


Fig 11: 3D Rendered View of MODEL_5

Fig 12: 3D Rendered view of MODEL_6

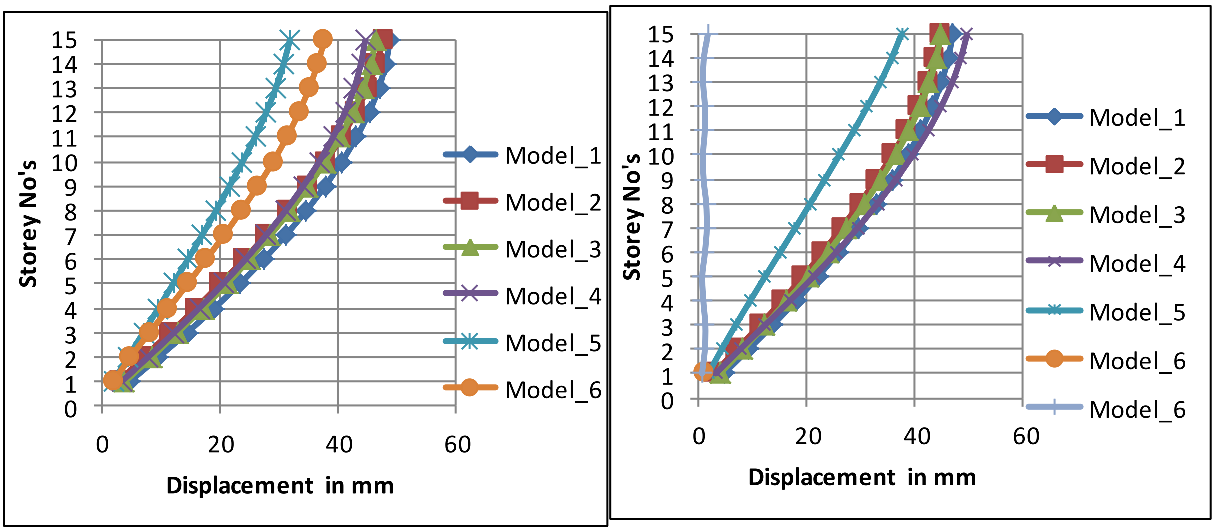
IV. RESULTS AND DISCUSSIONS

In the present study, Response Spectrum Analysis is carried out and the behaviour of each model under seismic loading can be obtained by studying various response parameters.



(a) (b)

Fig 13: Variation of Base Shear under Seismic Load (a) In X-Direction, (b) In Y-Direction



(a) (b)

Fig 14: Variation of Storey Displacement due to Seismic Load (a) In X-Direction, (b) In Y-Direction

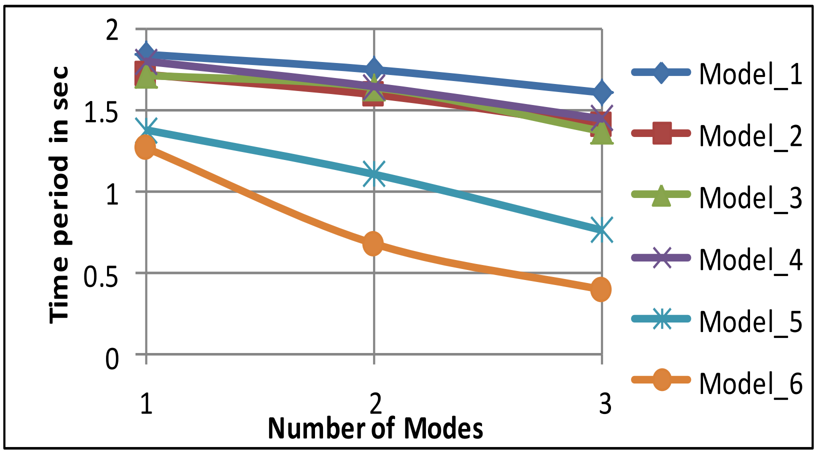


Fig 15: Variation of Time period for first 3 Modes

Table 3 Centre of Mass and Centre of Rigidity of Building Models

MODELS	XCM	YCM	XCR	YCR	ex	ey
	m	m	m	m	mm	mm
Model_1	15	12	15	12	0	0
Model_2	14.43	16.66	14.42	16.71	-10	50
Model_3	15.11	15.12	15.33	14.87	220	-250
Model_4	18.58	12.35	19.23	12.67	650	320
Model_5	25.6	26.24	22.36	37.04	-3240	10800
Model_6	19.76	14.63	19.33	14.73	-430	100

Table 4 Maximum Drift / Average Drift Ratio for Building models

MODELS	Max Drift	Avg Drift	Ratio
	mm	mm	
MODEL_1	4.91	4.91	1.00
MODEL_2	4.77	4.74	1.01
MODEL_3	4.95	4.58	1.08
MODEL_4	4.50	4.43	1.02
MODEL_5	4.47	2.95	1.51
MODEL_6	1.36	1.01	1.35

V. CONCLUSIONS

On the basis of the results of the analytical investigation carried out on the building models the following conclusions are drawn:

1. Rectangular shape model have less base shear and more displacement in X- direction when compared with other models.
2. Y-shape model have very less base shear and displacement in Y- direction when compared with other models.
3. Among all the models Y-shape model is having very less Time period.
4. Maximum Drift / Average Drift Ratio exceeds the limit of 1.2 for sector and Y-shape models which indicate that they are Torsionally irregular structure.
5. Sector shape models have maximum eccentricity compared to all other models.
6. Y-shape model is more stable and Sector shape model is more critical.

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