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"STUDY ON REGULAR AND IRREGULAR BUILDING STRUCTURES DURING AN EARTHQUAKE"

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Abstract: Multi-storeystructures construction by Reinforced Concrete are Subjected to most dangerous seismic waves during earthquakes .The main reason found that RCC building failure is caused due to Irregularity in its plan dimension and lateral force distribution. In this paper study is made to find the Response of the Regular and Irregular Structures having plan Irregularity located in Seismic zone V.In the Present Study, Analysis has been made by taking 10 storey building by Response Spectrum Method using ETABS 2015 and IS Code 1893:2002 (part 1).Analysis can be performed for Regular and Irregular Buildings and a height of 35.5 m in zone V by using Response Spectrum Analysis method. Behavior of structures will be found by comparing the responses in the form of maximum storey displacement, storey drift, storey stiffness, periods and frequencies of modes during earthquake. Presently there are six models. One is Regular structure and remaining are Irregular structural models, all models have different shape but having same area. An attempt is made to study the structural behavior of 3Dimensional (3D) 10 storeys RC frame building considering the primary loads and their Combinations with appropriate load factor.

Keywords: Horizontal irregularity,Soft storey, Earthquake load, storey shear, maximum storey displacement, maximum storey drift.

I. INTRODUCTION

Structure is subjected to Earthquake 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. The ground surface is displaced or move due to earthquake the structure base is also moves with it but roof has tendency to stay with its original position. Since the roofs and foundations are connected with the columns and walls. During the designing of the building according to the codes the lateral force is considered in two orthogonal horizontal directions of the structure. Many of the building structure have irregularities in both the plan and elevation. Buildings consisting of asymmetrical distribution of strength, stiffness and mass suffer severe damage during earthquakes.

II. OBJECTIVES OF THE STUDY

- In this study focus on the behavior of structures during earthquake having irregularities in plan and having same area.

- To study the parameters of storey shear, storey displacements, Maximum storey drift of all models during earthquake.
- To study the frequencies and periods in different modes.

III. MODEL OF THE STRUCTURES

3.1 Parameters consider

In the present study three different buildings, regular and irregular buildings in whichsoft storey is provided at bottom storey level are modeled using ETABS (9.7.4) package and analyzed. The properties of the considered building configurations in the present study are summarized below.

Table 1. Parameters Considered For The Building Design

Parameter	**Type\Value**
Structure Type	RCC Building Structure
Number of Stories	10
Bottom Storey Height	4m
Top Storey Height	3.5m
Type of Structure	Regular , Irregular Building Structure
Area of Structure	1600 m^2
Bay Width in both direction	5m
Beam Size	0.2mX0.45m
Grade of Concrete	M_{20}
Column Size	0.3mX0.9m
Grade of Concrete	M_{25}
Thickness of Slab	0.12m
Concrete Brick Thickness	0.2m
Live Load	4 KN\m^2
Seismic Zone	V (Z=0.36)
Importance Factor	1.5
Response Reduction Factor	5
Soil Type	II

3.2 Analysis of the structures

Following models are analyzed as special moment resisting frame using response spectrum analysis

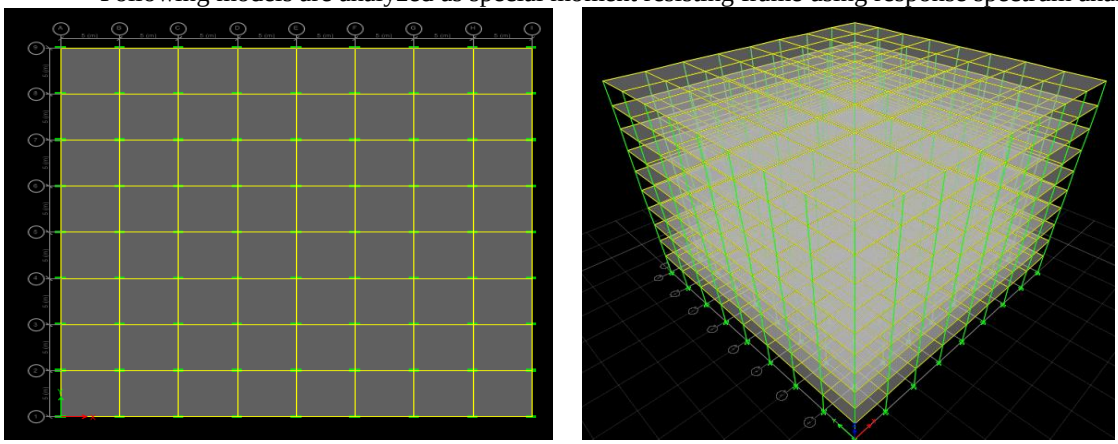

Fig1: Plan& 3d view of model 1

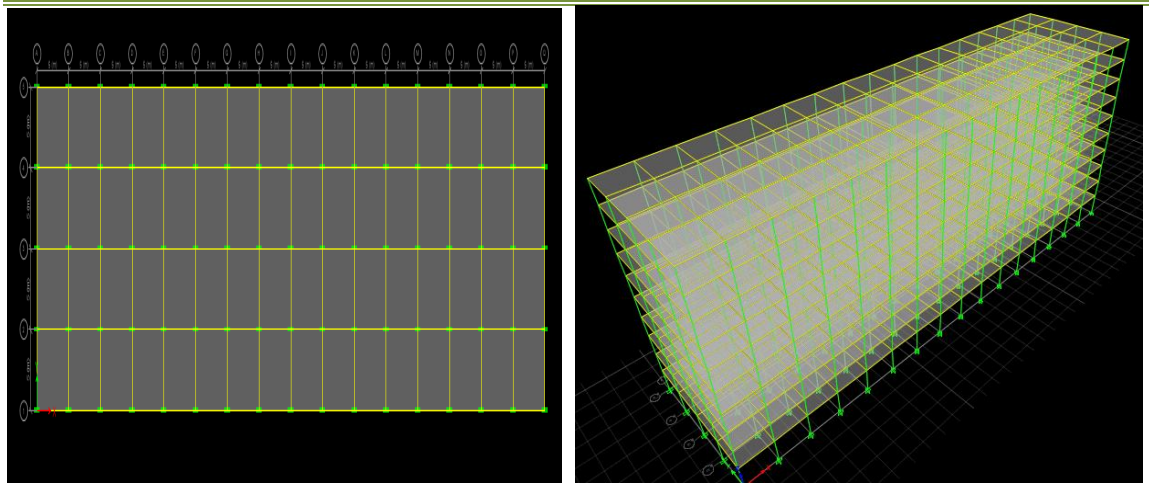

Fig 2: Plan &3d view of model 2

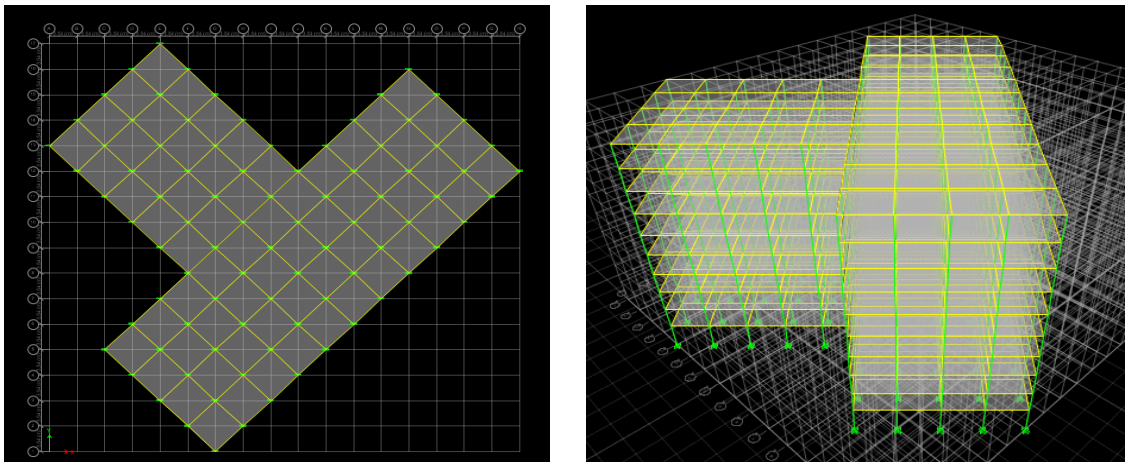

Fig 3: Plan & 3d view of model 3(Irregular building)

3.2 LOAD COMBINATIONS

Analysis can be done for all the loads of 20 combinations by using ETABS out of which the maximum load can be considered for result comparison is

- (1.2DL+1.2LL+1.2EQY)

IV. RESULTS AND DISCUSIONS

The results are presented by plotting the graph for each models considered in the study. The analysis carried out by the Response spectrum analysis. The result of periods and frequencies, maximum storey drift, storey maximum displacements, storey shear is presented for all models. In this study regular building is compared with irregular building the performance of the models is observed in high seismic zone V.

4.1 PERIODS OF MODES OF VIBRATION

Table 2. Periods of modes of vibration

mode no	model 1	model 2	model 3
1	2.794	2.864	2.766
2	2.212	2.622	2.283
3	2.139	2.052	2.133
4	0.914	0.935	0.905
5	0.686	0.846	0.706
6	0.643	0.62	0.64

7	0.53	0.539	0.524
8	0.366	0.479	0.376
9	0.363	0.367	0.359
10	0.329	0.319	0.327
11	0.27	0.319	0.267
12	0.23	0.272	0.235

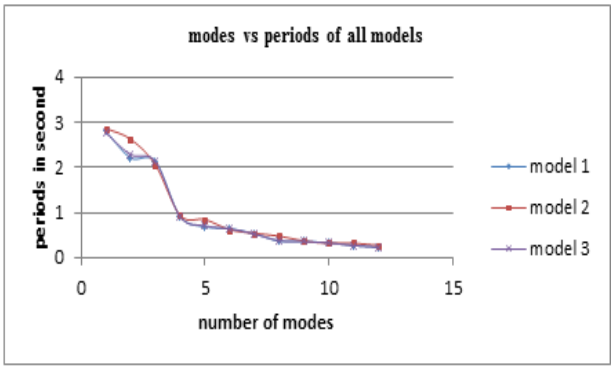

Fig 4: variation of periods

In the fig 4 shows the variations of models for different periods in different number of modes. It is observed that periods of vibrations are decreases with increases in number of modes. Model 2 has greater period of vibrations as compared to other two models.

- **FREQUENCIES OF ALL MODELS**

Table 3. Frequencies of models

mode no	model 1	model 2	model 3
1	0.358	0.349	0.361
2	0.452	0.381	0.438
3	0.468	0.487	0.469
4	1.094	1.07	1.105
5	1.458	1.182	1.416
6	1.555	1.614	1.562
7	1.888	1.857	1.909
8	2.73	2.089	2.661
9	2.755	2.723	2.789
10	3.039	3.131	3.062
11	3.704	3.134	3.752
12	4.354	3.678	4.254

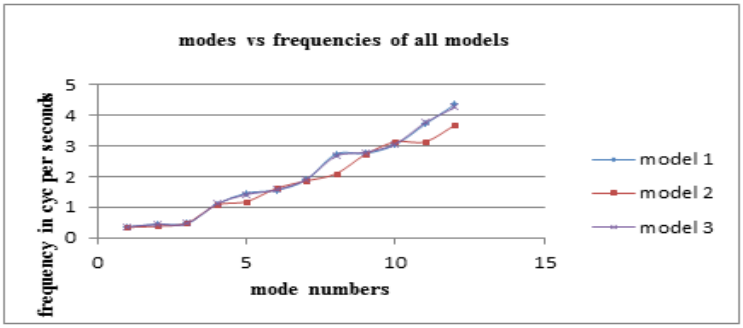

Fig 5: Frequencies of vibrations

From the fig 5 it is observed that frequency is increases with increases in modes number. In the beginning of vibrations the frequency is more in model 4 (Irregular building) and in model 2 the frequency is greater in model 1(Regularbuilding).

- **MAXIMUM STOREY DRIFT OF ALLMODELS OF (1.2DL+1.2LL+1.2EQY)**

Table 4. Maximum storey drift of all models of (1.2dl+1.2ll+1.2eqy)

Storey	model 1	model 2	model 3
10	0.000935	0.001014	0.00095
9	0.00176	0.001848	0.001774
8	0.002506	0.002609	0.00252
7	0.003093	0.00321	0.003109
6	0.003529	0.003656	0.003547
5	0.003835	0.003966	0.003855
4	0.004031	0.004163	0.00405
3	0.004128	0.004251	0.004142
2	0.004066	0.004158	0.004064
1	0.002968	0.002947	0.002939

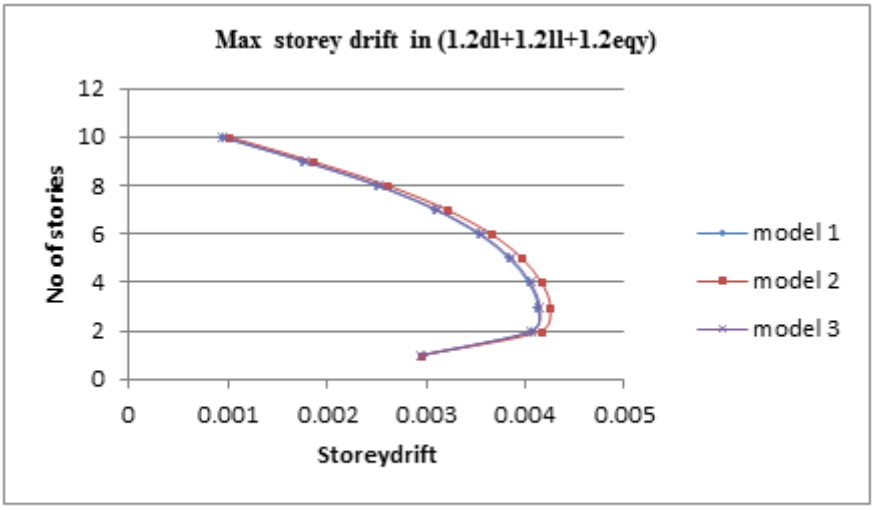

Fig 6: Variation of storeydrift

Figure 6 shows the variation of storey drift. It is less in storey 1 after that storey drift is increases up to storey 6. From storey 7 it is again decreases up to last storey. Only in the middle portion of the building model 2 has greater storey drift.

- **STOREY DISPLACEMENT IN (1.2DL+1.2LL+1.2EQY)**

Table 5.Storey displacement in (1.2dl+1.2ll+1.2eqy)

storey	model 1	model 2	model 3
10	109.5	112.8	109.8
9	106.2	109.3	106.5
8	100	102.8	100.3
7	91.3	93.7	91.4

6	80.4	82.5	80.6
5	68.1	69.7	68.1
4	54.7	55.8	54.7
3	40.5	41.2	40.5
2	26.1	26.3	26
1	11.9	11.8	11.8
0	0	0	0

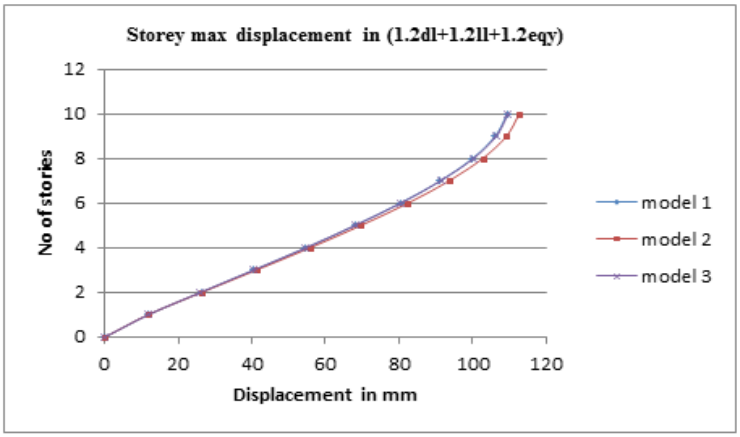

Fig 7: Variation of displacement of stories

Displacement can be done from the base point means from bottom stories. From the fig 7 we observe that displacement is increases with increases in number of stories. Model 1 and 3 has the similar displacement. And here model 2 has greater displacement because earthquake load is affected more in Y direction.

- **STOREY SHEAR IN KN OF ALL MODELS IN (1.2DL+1.2LL+1.2EQY)**

Table 6.Storey shear in kn of all models in (1.2dl+1.2ll+1.2eqy)

storey	model 1	model 2	model 3
10	-914.154	-905.092	-939.635
9	-2006	-1987	-2062
8	-2872	-2845	-2953
7	-3538	-3506	-3638
6	-4031	-3994	-4145
5	-4377	-4337	-4500
4	-4601	-4559	-4731
3	-4730	-4687	-4863
2	-4790	-4746	-4925
1	-4790	-4763	-4943
0	-4807	-4763	-4943

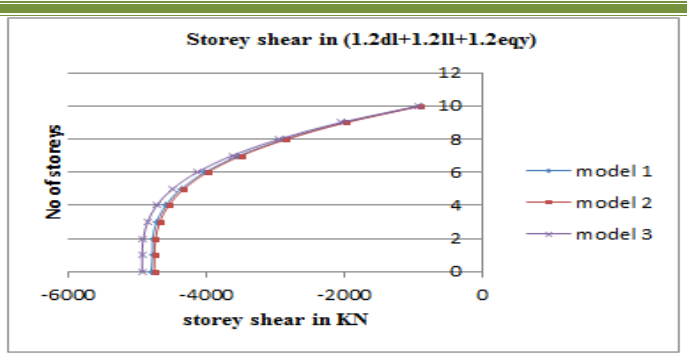

Fig 8: Storey shear along number of stories

Storey shear is increases with decreases in number of stories. Shear force is maximum at the base storey. From the fig 8 it is observed that irregular building has greater shear effect at the base as compared to regular models

V. CONCLUSION

- In general it is observed that periods of modes of vibrations are decreases with increases in number of mode. Model 2 has greater values among all other models.
- Frequencies of modes are increases with increasing in number of modes. Model 3 has greater value. Frequency is higher in irregular shape building.
- Maximum storey drift is decreases with increases in number of storey. Storey drift has maximum values in regular shape building as compared to irregular buildings. Storey drift is less in bottom storey and increases up to 4^{th} storey and from 4^{th} storey it is decreases up to top storey. Storey drift is maximum in the middle portion of the building.
- Storey maximum displacement is increases with increase in storey height. Here the storey displacement is maximum in the model 2 means its length is maximum. Hence the building structures which having greater length in the direction of earthquake motion directions are morely affected.
- Storey shear increases with decreases in storey height. Storey shear is maximum in the irregular building structure as compared to regular.

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