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Analysis of High Rise (G+50) Building for Various Soil Conditions by using ETABS

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Abstract – *Most earthquakes are caused by sudden energy release at a dislocation or rupture in crustal plates occurs due to natural or artificial reason. So, soil types and earthquake parameter are very much important while planning, constructing and designing any structure. Most of the structural failures occurred in the structure due to inadequate stiffness, strength and irregularities present in it. In this project work, behavior of regular and vertically irregular high rise G+50 story building in seismic zone V for soft, medium and hard strata is studied. Regular and vertically irregular building frames are modelled & analysed in ETABS software. The results are tabulated and graphs are plotted for base shear, time period, displacement and drift. The seismic analysis is done according to IS 1893:2002 part 1 by using the dynamic analysis method. For seismic zone V & soft, medium and hard soil strata are taken for comparative study.*

***Key Words*: Regular, Vertically Irregular, Soil types, Seismic zone, ETABS, Displacement.**

1. INTRODUCTION

Buildings oscillate during earthquake shaking and inertia forces are mobilized in them. Then, these forces travel along different paths, called load paths, through different structural elements, until they are finally reach to the soil through the foundation. The generation of forces based on basic oscillatory motion and final transfer of force through the foundation are significantly influenced by overall geometry of the building. [1] Plan irregularity is due to asymmetric distributions of mass, stiffness, strength, geometric discontinuity and diaphragm discontinuity. The behaviour of a building during an earthquake depends on several factors, stiffness, and strength, and ductility, simple and regular configurations. The buildings with regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer fewer damages compared to irregular configurations. But due to increasing population and aesthetic look high rise building with irregularities are demanded. If building is irregular, then excessive stresses or forces get developed in weak portion and they cause serious damages. [2] Also building grows taller there is a change in the level of response to the seismic forces.

In present work, study of seismic analysis of high rise G+50 storey regular and vertically irregular framed building is done for various soil conditions. The structural analysis of G+50 storey reinforced concrete regular and vertically irregular framed building is done with the help of ETABS software. The building is considered as commercial building. The Response spectrum analysis of regular and vertically irregular RC building compares the results. Finally results are obtained such as base shear, modal time, drift and displacement.

1.1 STRUCTURAL IRREGULARITIES [3]

There are the types of irregularities, IS Code 1893 (Part-1):2002 classifies irregularity in two sections:

1. Plan irregularities and

2. Vertical irregularities.

2. OBJECTIVES

1. To study the seismic behavior of G+50 story regular and vertically irregular structures when subjected to Earthquake force in earthquake zone V and different soil types.
2. To perform dynamic analysis on G+50 story building i.e. performing dynamic analysis by using Response spectrum method.
3. The behavior of two models is checked for Base Shear, Time Period, Story Drift and Story Displacement at each and every story are carried out for seismic forces.

3. SYSTEM DEVELOPMENT

- To study the performance of building, two models are considered with regular and vertically irregular in seismic zone V and for soft, medium and hard soil type (I, II and III).

- For the present work G+50 storey regular and vertically irregular structure is selected.
- ETABS software is chosen for modelling and analysis of the selected structure.

3.1 MODELLING

- Site location : Bhuj
- No. of Story : G+50
- Total Height of the building : 153 m
- Floor to Floor Height : 3 m
- Inner and outer Wall thickness : 0.15m
- Slab Thickness : 150 mm
- Columns Detail (for soil type I,II and III)

Floor	Regular	Irregular
Foundation to 10th	300x750	300x750
10th to 20th	300x600	300x600
21th to 30 th	300x530	300x530
31th to 40 th	300x450	300x450
41th to 50th	300x380	300x380

- Beams Detail

Floor	Regular	Irregular
Foundation to 10th	300x600	300x750
10th to 20th	300x530	300x600
21th to 30th	300x450	300x530
31th & ABOVE	300x380	300x530

- Soil type - I,II and III
- Seismic Zone - V
- Importance factor- 1.5
- Frame Type = OMRF
- 3D modeling of G+50 regular and vertically irregular building -

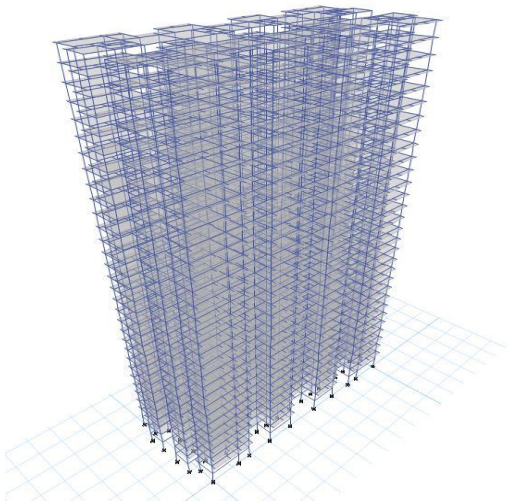

Fig.01- 3D Model of regular building

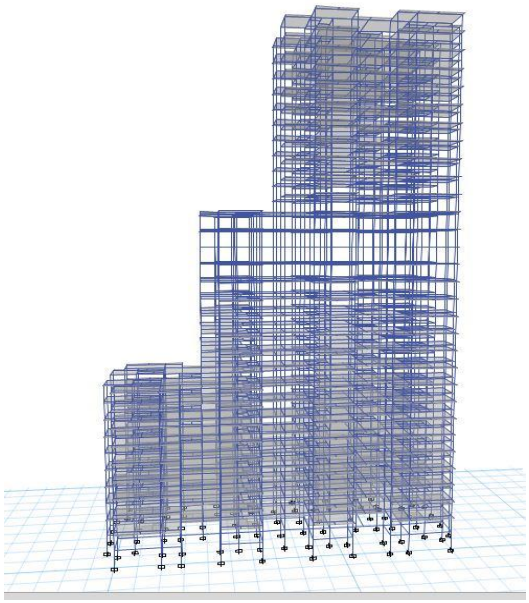

Fig.02- 3D Model of irregular building

4. RESULTS AND CONCLUSIONS

4.1.1 Modal Time Period-

Table 01 - Modal Time Period for Mode-1, 2 and 3 (FOR REGULAR)

Mode	SOIL I	SOIL II	SOIL III
Mode-1	13.327	13.327	13.327
Mode-2	10.964	10.964	10.964
Mode-3	10.334	10.334	10.334

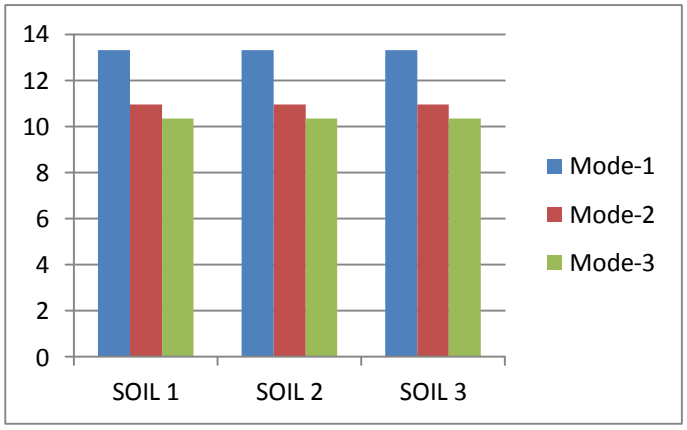

Chart. 01 Modal Time Period for Mode-1, 2 &3 (Regular)

Table 02 - Modal Time Period for Mode-1, 2 and 3 (FOR IRREGULAR)

Mode	SOIL I	SOIL II	SOIL III
Mode-1	12.531	12.531	12.531
Mode-2	9.006	9.006	9.006
Mode-3	6.645	6.645	6.645

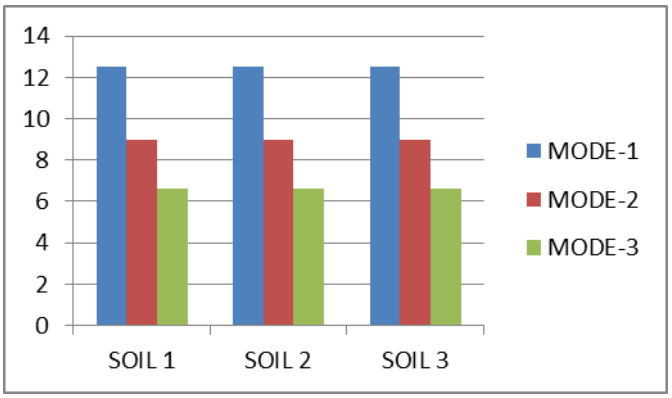

Chart. 02 Modal Time Period for Mode-1, 2 &3 (Irregular)

4.1.2 Base Shear Details:-

Table 03 – Base Shear Details for Static and Dynamic load Condition in X and Y Direction-

A-For Regular building

Base Shear	SOIL I	SOIL II	SOIL III
Static Ex	14404	19589	24054
Static Ey	22491	18324	37561
DynamicEx	5361.9241	7292.2169	8954.4134
DynamicEy	4417.6222	6007.966	7377.4215

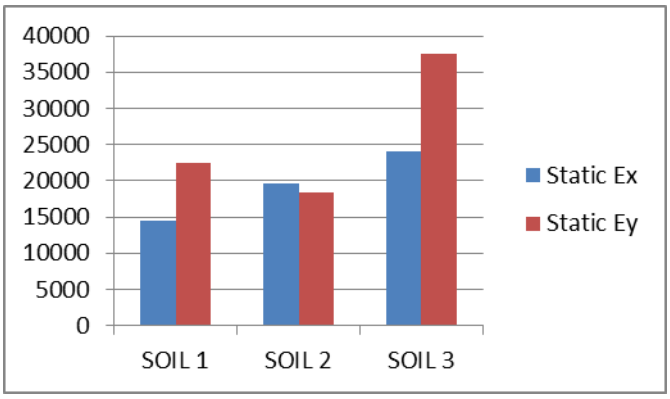

Chart. 03- Base Shear For Static Ex (Regular)

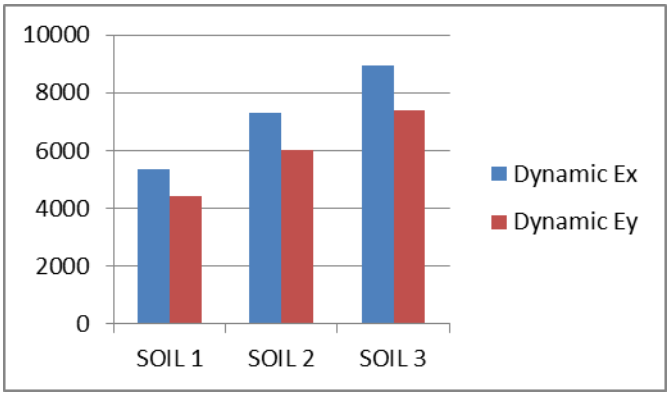

Chart. 04- Base Shear For Dynamics Ex (Regular)

Table 04 – Base Shear Details for Static and Dynamic load Condition in X and Y Direction-

B-For Irregular building

Base Shear	SOIL 1	SOIL 2	SOIL 3
Static Ex	10548	14345	17615
Static Ey	16470	22400	27506
DynamicEx	3450.31636	4692.4305	5762.028
DynamicEy	2945.33866	4005.6613	4918.715

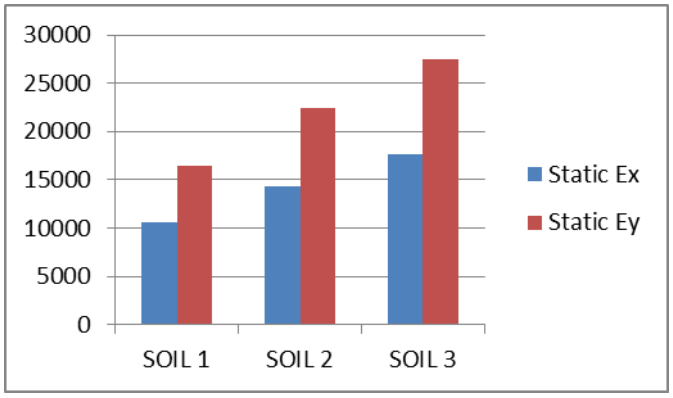

Chart. 05- Base Shear For Static Ex

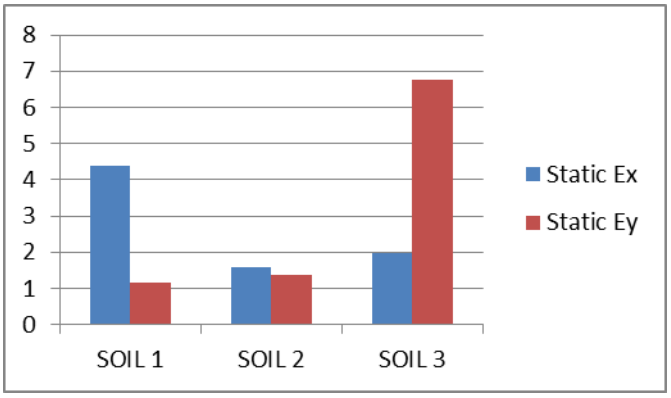

Chart. 07- Displacement Details for static (Regular)

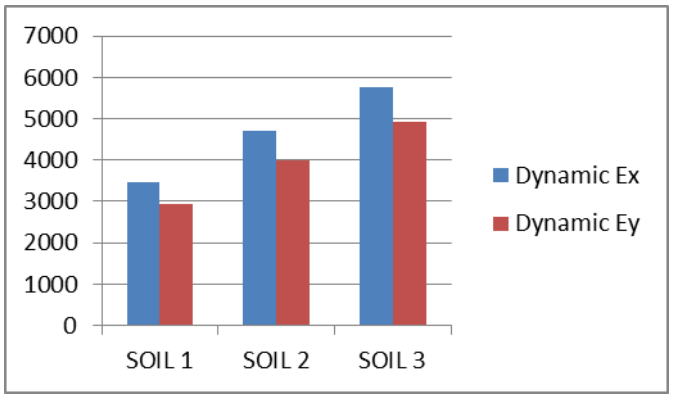

Chart. 06- Base Shear For Dynamics Ex (Irregular)

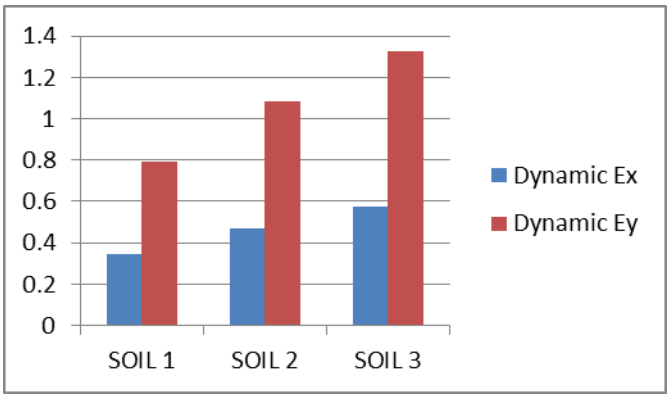

Chart. 08- Displacement Details for Dynamic (Regular)

4.1.3 Displacement Details: –

Table 05 – Displacement Details in X and Y Direction for Seismic Condition**- :-**

A-For Regular building

Displacement	**SOIL I**	**SOIL II**	**SOIL III**
Static Ex	4.3989	1.5951	1.9587
Static Ey	1.1729	1.363	6.7466
Dynamic Ex	0.3462	0.47089	0.5782
Dynamic Ey	0.7950	1.0812	1.3277

Table 06 – Displacement Details in X and Y Direction for Seismic Condition**- :-**

A-For Irregular building

Displacement	**SOIL I**	**SOIL II**	**SOIL III**
Static Ex	1.3318	1.8113	2.2242
Static Ey	4.39541	5.9777	7.34033
Dynamic Ex	0.32036	0.43569	0.53500
Dynamic Ey	0.68068	0.92572	1.1367

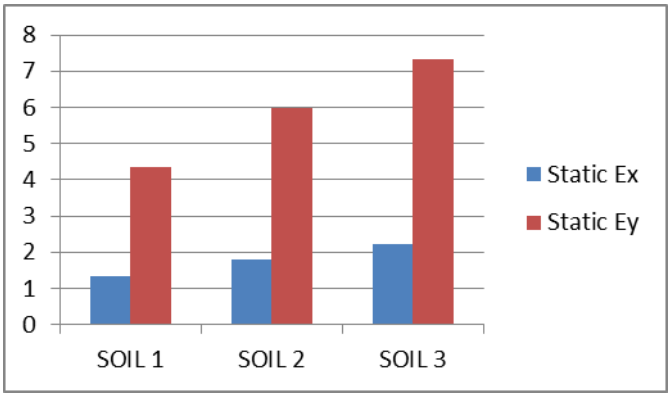

Chart. 09- Displacement Details for static Ex (Irregular)

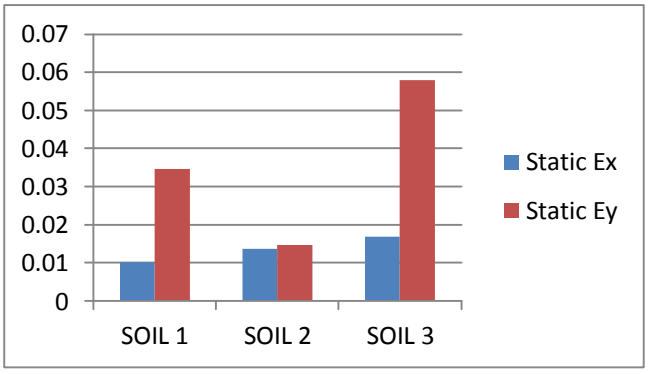

Chart. 11- Drift Details For Static (Regular)

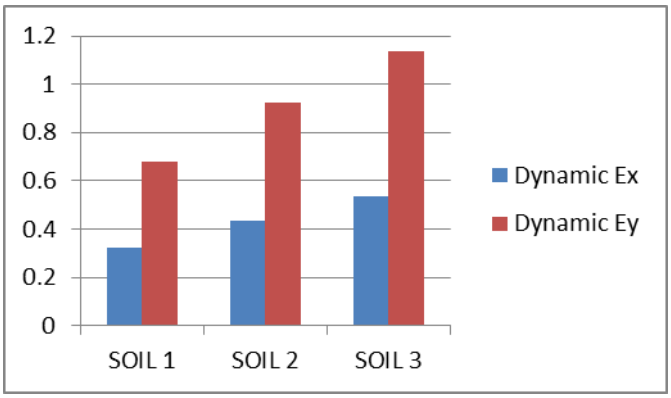

Chart. 10- Displacement Details for Dynamic (Irregular)

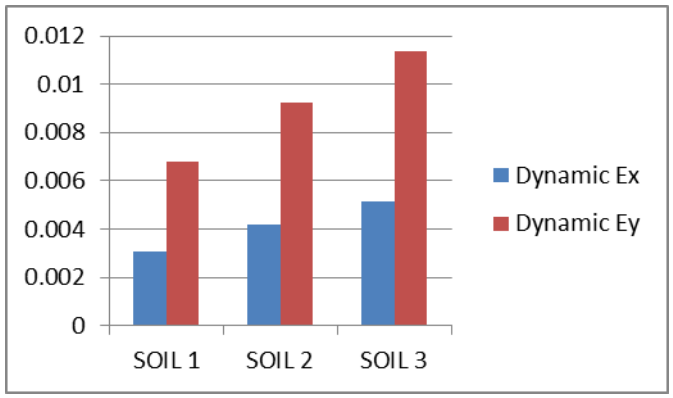

Chart. 12- Drift Details For Dynamic (Regular)

4 .1.4 . Drift Details: -

Table 07 - Drift Details in X and Y Direction for Seismic Condition-

A-For Regular building

Drift	SOIL I	SOIL II	SOIL III
Static Ex	0.010026	0.01363	0.01674
Static Ey	0.03469	0.0146	0.057939
Dynamic Ex	0.003068	0.004173	0.00512
Dynamic Ey	0.006813	0.009265	0.011377

Table 08 - Drift Details in X and Y Direction for Seismic Condition-

B-For Irregular building

Drift	SOIL I	SOIL II	SOIL III
Static Ex	0.0133	0.01822	0.022375
Static Ey	0.03831	0.05213	0.06397
Dynamic Ex	0.003228	0.00439	0.005391
Dynamic Ey	0.005907	0.008033	0.009864

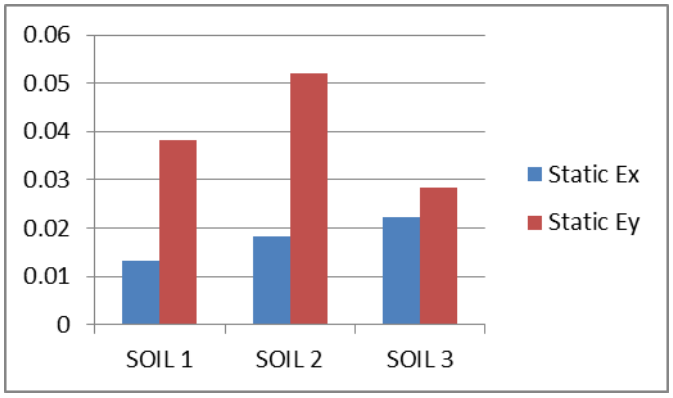

Chart. 13- Drift Details For Static (Irregular)

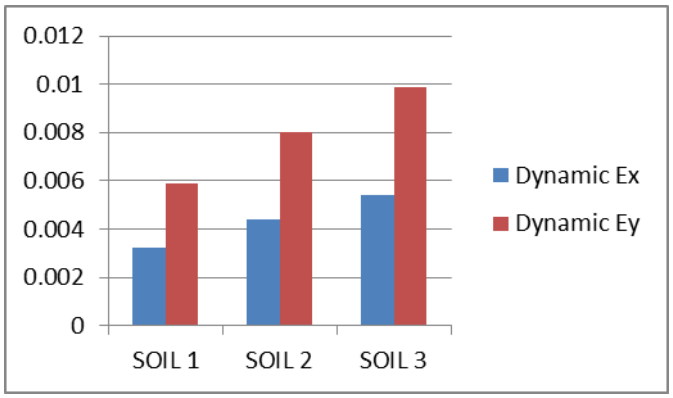

Chart. 14 - Drift Details For Dynamic (Irregular)

Following are the conclusions obtained from above analysis results are: -

1. Time period
   A] Model time period of the building is the time period in which the building takes to complete the one oscillation when earthquake will be act on the building. The model time period for the irregular building is lesser as compared with the regular building.

2. Base shear
   A] Base shear values for EX, EY and Dx and Dy which is Static and dynamic higher in case of regular building and less in case of irregular building. Similarly, it is also concluded that, the base shear values as changes as the soil type is changes. From the above table the base shear is higher in case of Soil type III when it is compared with the other 2 type of soil.

3. Displacement
   A] Displacement is increasing as the soil type is changing as shown in table. The soil type III is having higher Displacement value when compared with the soil type I and II regular as well as irregular building.
   B] In case of comparing regular with irregular building Displacement values for EX, EY , Dx , Dy are more in case of irregular building and less in case of regular building .

4. Drift
   Drift are getting higher in case of Irregular building and less in regular building but if soil effect is considered the soil III values are more when comparing with soil type II and I respectively.

   From the above conclusion it is concluded that, the model time period is more in regular building and soil property is not effect on the building only in case of time period consideration. In base shear results the base shear are more in regular building because it is depending on the mass of the structure and irregular building is having less mass.

   Also displacement and drift is getting increasing as the soil type is increasing from I to III respectively.

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