PERFORMANCE BASED EVALUATION OF MULTISTORY FLAT SLAB COMPARED WITH CONVENTIONAL RC FRAMED STRUCTURE

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Abstract :- In the present world of construction the study of different structural analysis of building plays a major role in the construction work, Here the study of compative analysis of performance of RC conventional structure is done with structure having flat slab with and without drop this analysis is carried out for base shear , wind load , storey displacement , Natural time period, Best location of shear wall ,storey stiffness, bending moment, for G+10 storey building having both RC conventional frame and flat slab structure, this is studied under zone III also under the soft soil condition ,the structural is analysed for equivalent static force , linear dynamic response spectrum analysis , Push over analysis as per IS code, this study aim for the getting best performance results for different model conditions using Etabs.

Keywords:- Flat slab, Base shear, wind load, storey displacement, Natural time period, shear wall, Linear dynamic response spectrum, Equivalent static force.

1. INTRODUCTION

A flat slab is typical type of construction in which a reinforced slab is built monolatically with the supporting columns and is reinforced in two or more directions, without any provision of beams. The flat slab thus transfers the load directly to the supporting columns suitably spaced below the slab ,Because of exclusion of beam system in this type of construction , a plain ceiling is obtained, thus giving attractive appearance from architectural point of view. The plain ceiling diffuses the light better and is considered less vulnerable in the case of fire than the usual beam slab construction. The flat slab is easier to construct and requires cheaper form work .concrete is more logically used in this types of construction, and hence in the case of large spans and heavy load, the total cost is considerably less compared to the normal slab.

1.1 COMPONENTS OF FLAT SLAB CONSTRUCTION

1. **Drop of flat slab** :- The slab in a flat slab construction may be either with drop or with out drop. Drop is that part of the slab around the column , which is of greater thickness than the rest of the slab,
2. **Capital or column head**:- Some times the diameter of a supporting column is increased below the slab . this part of column this part of column with increased diameter is called column head the
3. **Panel** :- A panel of a flat slab construction is the area enclosed between the center line connecting adjacent columns in two directions and out line of the column heads.

2. OBJECTIVES

1. To analyze seismic performance of G+10 story multistory flat slab with the conventional RC frame on sloping and plain grounds.
2. To study the behavior of structure under equivalent static and response spectrum method.
3. To study the behavior of structure under Non linear static analysis (Pushover).
4. To compare the flat slab and RC structure.

3. METHODOLOGY

MODELLING

In this project, A 10 story building having each story height 3 meters is modeled. The buildings are fixed at the base. In this project including the ground story each story heights of buildings are same. The dimensions of building considered along X & Y directions are 30m by 30m in plain.It has 5 at 6m bay along X direction and 5 at 6m bay along Y direction. Thus 4 models were modeled out of which two models are on the plain ground and other two model are on the sloping ground all four model include both Rcc frame and Flat slab building .which are subjected to seismic analysis and wind analysis and various structural loads.

3.1 INPUT DATA

1. **For RCC frame structure on plain ground.**

Material properties

Yield stress for steel, Fy= 500 MPa

Characteristic strength, fck = 20MPa

Unit weight of concrete = 20 KN/m^3

Modulus of Elasticity of concrete, E_c =20000 MPa

Modulus of elasticity of steel, Es = 2x10^5

Sectional properties

Floor to floor height = 3 m

Size of beam = 400x600 mm

Size of column = 400x1000 mm

Thickness of slab = 125 mm

2. **For Flat slab structure on plain ground.**

Material properties

Yield stress for steel, Fy= 500 MPa

Characteristic strength, fck = 30MPa

Unit weight of concrete = 30 KN/m^3

Modulus of Elasticity of concrete, E_c =2768.13 MPa

Modulus of elasticity of steel, Es = 2x10^5

Sectional properties

Floor to floor height = 3 m

Size of column = 800x800 mm

Thickness of slab = 250 mm

Thickness of drop = 550 mm

3. **For RCC frame structure on plain ground.**

Material properties

Yield stress for steel, Fy= 500 MPa

Characteristic strength, fck = 20MPa

Unit weight of concrete = 20 KN/m^3

Modulus of Elasticity of concrete, E_c =20000 MPa

Modulus of elasticity of steel, Es = 2x10^5

Sectional properties

Floor to floor height = 3 m

Size of beam = 450x700 mm

Size of column = 450x1100 mm

Thickness of slab = 125 mm

4. **For Flat slab structure on sloping ground.**

Material properties

Yield stress for steel, Fy= 500 MPa

Characteristic strength, fck = 30MPa

Unit weight of concrete = 30 KN/m^3

Modulus of Elasticity of concrete, E_c =27386.13 MPa

Modulus of elasticity of steel, Es = 2x10^5

Sectional properties

Floor to floor height = 3 m

Size of column = 800x800 mm

Thickness of slab = 250 mm

Thickness of drop = 700 mm

Loads considered

1) **Dead load**

Column load = 0.8 x 0.8 x 25=16 KN/m

Slab load = 0.23 x 25 = 5.75 KN/m^2

Drop slab load = 0.7 x 25 = 17.5 KN/m^2

Main wall = 0.23 x 3 x 18 = 12.42 KN/m^2

Partition wall = 0.15 x 3 x 18 = 8.1 KN/m^2

Parapet load = 0.23 x 1.2 x 18 = 4.968 KN/m^2

2) **Live load**

The live load of 2 KN/m^3 is considered. (As per IS 875- Part 2)

Seismic load

Seismic zones of values zone 3 are considered

Seismic zone Z = 3

Importance factor = I =1

Response reduction factor = R = 3

Soil type = Medium soil

Total height of building = 33 m

3) **Materials**

The modulus of elasticity of RCC as per IS 456 2000 is given by Ec = 5000 $fck^{1/2}$ High yield strength deformed bars (HYSD) having yield strength 500 N/mm^2 widely used in design practice and for the present study.

4) Load combinations

Load combinations considered are 1.5(DL+LL) according to IS 1893:2002,

For equivalent static analysis, Response spectrum and Pushover analysis the loads :

Gravity load, (DL+LL) the percentage of imposed load was selected from the table 8.IS 1893:2002. It is 25% of imposed load less than 3KN/m².Lateral load in X direction.Lateral load in Y direction.The beam and column sizes are selected and modeled in ETAB software then its material properties and section properties are assigned. Then the various loads are assigned which includes dead load, live load and earthquake load. Then 4 models are modeled as RCC conventional building on the sloping and plane ground , and also flat slab building on the sloping and plane ground, These models are analysed for Equivalent static method ,Response spectrum method ,Pushover analysis. The results and conclusions are shown in the next chapter.

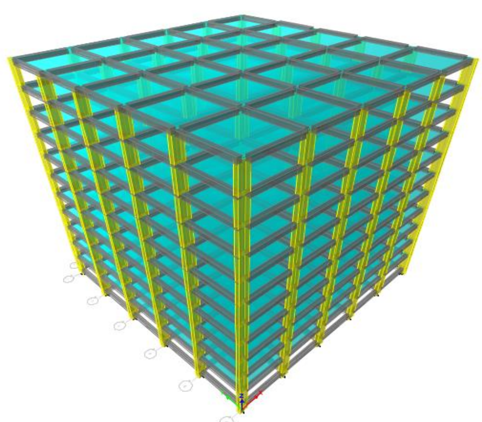


Fig 1 shows 3D model of RC building on plain ground

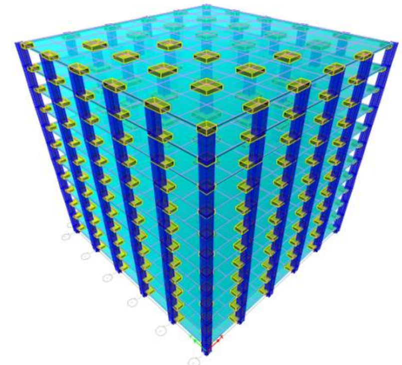


Fig 2 shows the 3D elevation of flat slab building

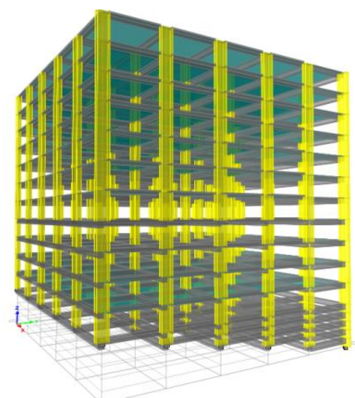


Fig 3 shows 3D elevation of RC frame building on sloping ground

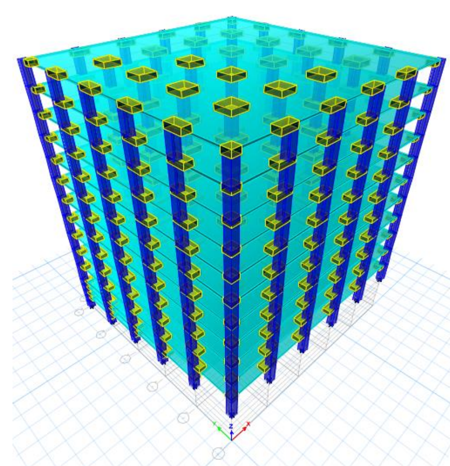


Fig 4 shows 3D elevation of flat slab on sloping ground

4. RESULTS AND DISCUSSIONS

Results from the analysis are storey stiffness, storey displacement, base shear and time period are known from both static and response spectrum analysis for both conventional RC and flat slab buildings are known. The main difference can be found between the storey stiffness, storey displacement, time period and base shear, Results of push over analysis are also shown.

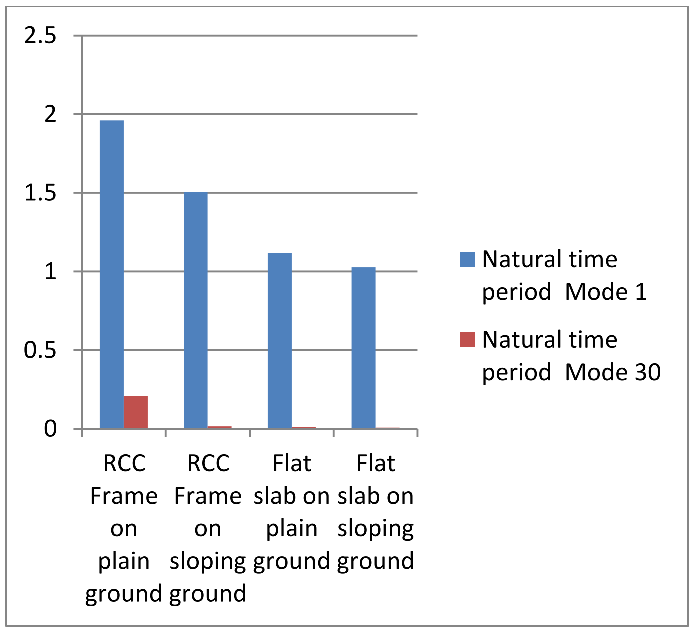
RESULTS AND GRAPHS FROM EQUIVALENT STATIC METHOD AND RESPONSE SPECTRUM METHOD

a. NATURAL TIME PERIOD:

The time required for undamped system to complete one cycle of free vibration is the natural period of vibration of the system in units of seconds. Table shows different values of natural time period for rc conventional slab and flat slab building. Graphs for variation of natural time period for RC conventional and flat slab building for 10 storey building is shown

		RCC Frame on plain ground	RCC Frame on sloping ground	Flat slab on plain ground	Flat slab on sloping ground
Natural time period	Mode 1	1.961	1.504	1.117	1.026
Natural time period	Mode 30	0.21	0.016	0.012	0.008

Results of Natural Time Period for RC conventional slab and flat slab



b. BASE SHEAR

Base shear is the estimated of maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. The total lateral force (V_b) can be calculated from the formula

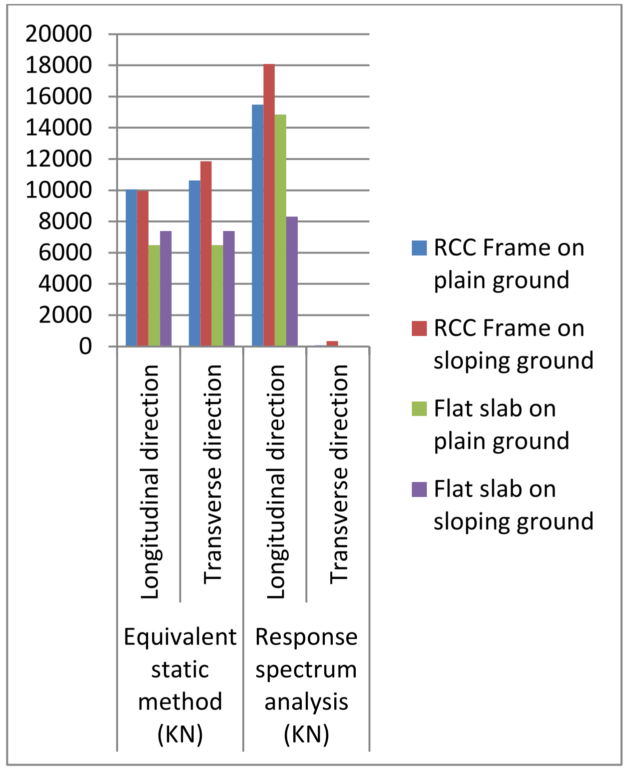
$$V_b = A_h\, w$$

Table 5.3 :- Analysis of base shear with respect to equivalent static method.

Base shear	Equivalent static method (KN)	
RCC Frame on plain ground	Longitudinal direction	Transverse direction
	10043.0106	10629.8943
RCC Frame on sloping ground	Longitudinal direction	Transverse direction
	9957.105	11863.7382
Flat slab on plain ground	Longitudinal direction	Transverse direction
	6480.4858	6480.4858
Flat slab on sloping ground	Longitudinal direction	Transverse direction
	7389.3374	7389.3374

Table 5.4 :- Analysis of base shear with respect to Response spectrum method.

Base shear	Response spectrum analysis (KN)	
RCC Frame on plain ground	Longitudinal direction	Transverse direction
	15484.0058	77.5822
RCC Frame on sloping ground	Longitudinal direction	Transverse direction
	18094.773	339.6316
Flat slab on plain ground	Longitudinal direction	Transverse direction
	14853.9136	0.0225
Flat slab on sloping ground	Longitudinal direction	Transverse direction
	8305.9412	22.9176



Graph showing Base shear comparision

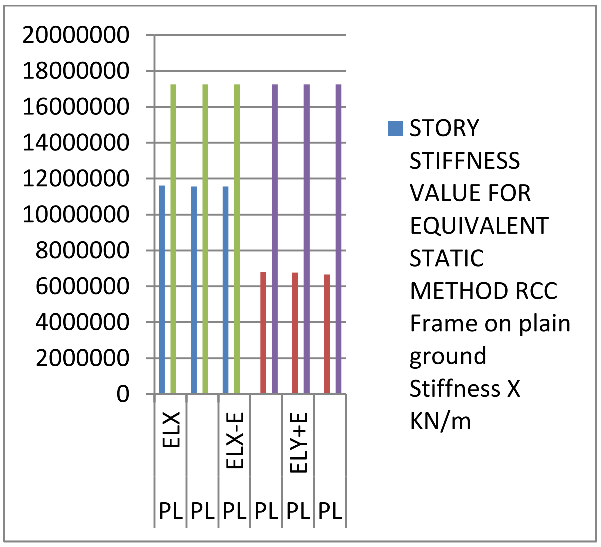
c. STOREY STIFFNESS

"The lateral stiffness of storey is generally defined as the ratio of story shear to story displacement". Structure have vertical stiffness or strength variations for many reasons thus change in story stiffness results change in strength for the same story.

d. STORY STIFFNESS VALUE FOR EQUIVALENT STATIC METHOD

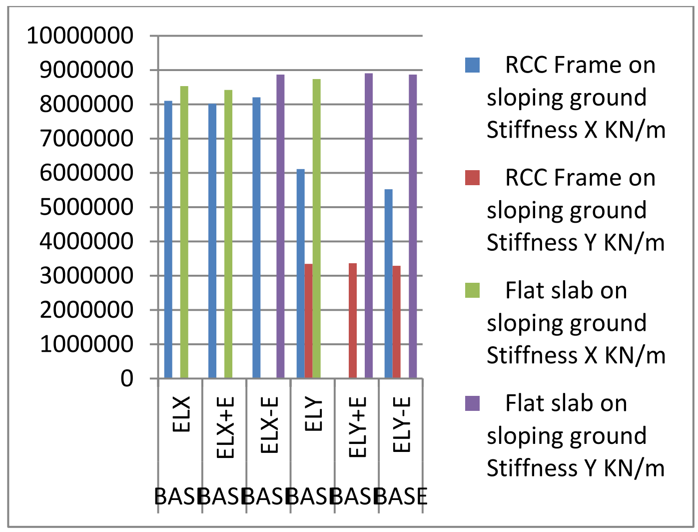
		RCC Frame on plain ground		Flat slab on plain ground	
Story no		Stiffness X KN/m	Stiffness Y KN/m	Stiffness X KN/m	Stiffness Y KN/m
PL	ELX	11608101	0	17243326	0
PL	ELX +E	11560700	0	17243326	0

PL	ELX-E	11565548	0	17243326	0
PL	ELY	0	6796467.715	0	17243326
PL	ELY+E	0	6759183.244	0	17243326
PL	ELY-E	0	6655933.289	0	17243326



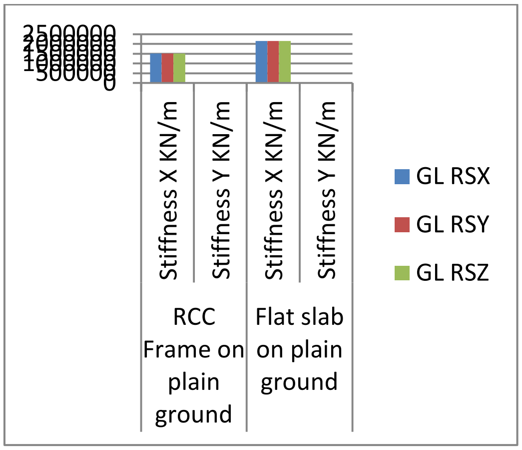
STORY STIFFNESS VALUE FOR EQUIVALENT STATIC METHOD

		RCC Frame on sloping ground		Flat slab on sloping ground	
Story no		Stiffness X KN/m	Stiffness Y KN/m	Stiffness X KN/m	Stiffness Y KN/m
BASE	ELX	8103430.389	0	8527745.854	0
BASE	ELX+E	8019569.974	0	8417832.52	0
BASE	ELX-E	8198156.702	0	0	8867307.316
BASE	ELY	6105504.903	3343640.08	8735085.694	0
BASE	ELY+E	0	3362988.698	0	8902949.835
BASE	ELY-E	5520825.182	3284249.525	0	8865804.952



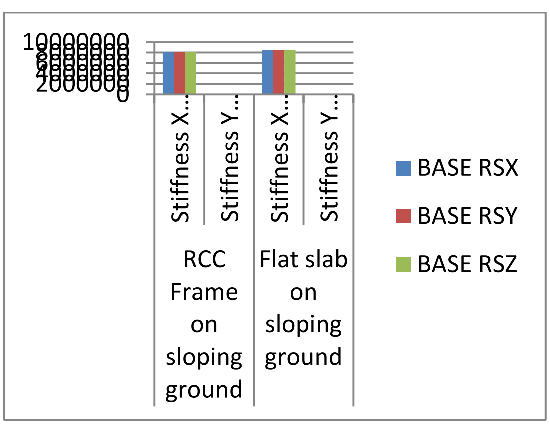
e. STORY STIFFNESS VALUE FOR RESPONSE SPECTRUM METHOD

		RCC Frame on plain ground		Flat slab on plain ground	
Story no		Stiffness X KN/m	Stiffness Y KN/m	Stiffness X KN/m	Stiffness Y KN/m
GL	RSX	1503656.412	0	2143367.904	0
GL	RSY	1503656.412	0	2143367.904	0
GL	RSZ	1503656.412	0	2143367.904	0



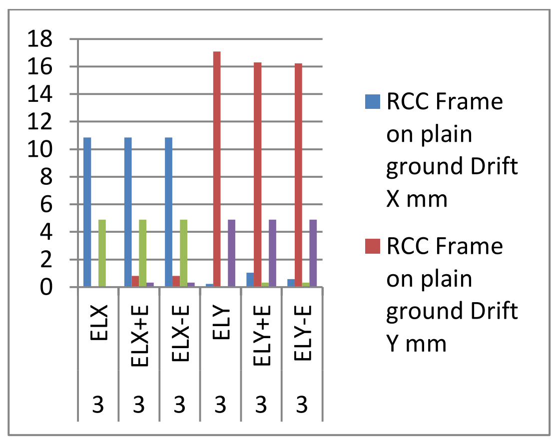
STORY STIFFNESS VALUE FOR RESPONSE SPECTRUM METHOD

		RCC Frame on sloping ground		Flat slab on sloping ground	
Story no		Stiffness X KN/m	Stiffness Y KN/m	Stiffness X KN/m	Stiffness Y KN/m
BASE	RSX	8090415.874	0	8521507.167	0
BASE	RSY	8090415.874	0	8521507.167	0
BASE	RSZ	8090415.874	0	8455106.381	0



f. STORY DRIFT VALUE FOR EQUIVALENT STATIC METHOD

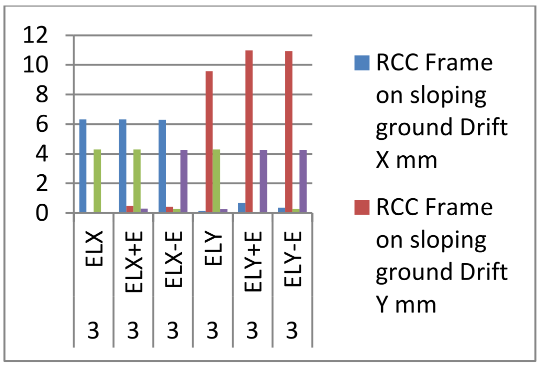
		RCC Frame on plain ground		Flat slab on plain ground	
Story no		Drift X mm	Drift Y mm	Drift X mm	Drift Y mm
3	ELX	10.843	0.001	4.887	1.47E-11
3	ELX+E	10.843	0.807	4.887	0.328
3	ELX-E	10.843	0.808	4.887	0.328
3	ELY	0.238	17.079	2.37E-11	4.887
3	ELY+E	1.035	16.304	0.328	4.887
3	ELY-E	0.58	16.226	0.328	4.887



STORY DRIFT VALUE FOR EQUIVALENT STATIC METHOD

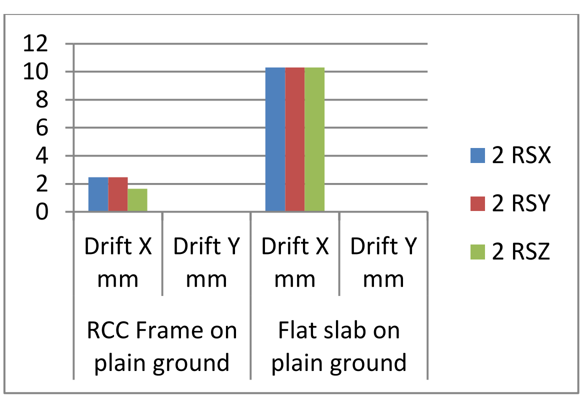
		RCC Frame on sloping ground		Flat slab on sloping ground	
Story no		Drift X mm	Drift Y mm	Drift X mm	Drift Y mm
3	ELX	6.314	0.026	4.286	0.013
3	ELX+E	6.318	0.492	4.289	0.3

3	ELX-E	6.309	0.446	0.289	4.282
3	ELY	0.145	9.566	4.284	0.273
3	ELY+E	0.703	10.987	6.06E-06	4.282
3	ELY-E	0.372	10.93	0.289	4.282



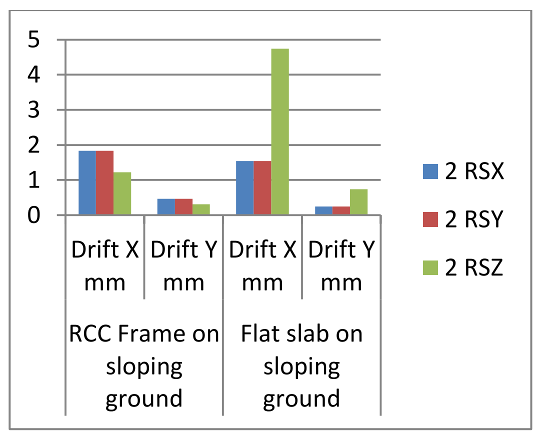
g. STORY DRIFT VALUE FOR RESPONSE SPECTRUM METHOD

		RCC Frame on plain ground		Flat slab on plain ground	
Story no		Drift X mm	Drift Y mm	Drift X mm	Drift Y mm
2	RSX	2.462	0.002	10.299	2.39E-07
2	RSY	2.462	0.002	10.299	2.39E-07
2	RSZ	1.641	0.001	10.299	2.39E-07



STORY DRIFT VALUE FOR RESPONSE SPECTRUM METHOD

		RCC Frame on sloping ground		Flat slab on sloping ground	
Story no		Drift X mm	Drift Y mm	Drift X mm	Drift Y mm
2	RSX	1.834	0.467	1.537	0.243
2	RSY	1.834	0.467	1.537	0.243
2	RSZ	1.223	0.312	4.742	0.74



5. CONCLUSIONS

RC conventional slab compared with Flat slab

1. From the results it is evident that natural time period is more for RC conventional than for flat slab (irrespective of the building located in plain ground or sloping ground).
2. From the results we can say that, base shear for RC conventional is more than flat slab.
3. Storey stiffness at the bottom storey is more compared with top storey ,thus as

the storey height increases stiffness value decreases gradually.

4. Storey displacement increases as there is an increases in storey height for all the models irrespective of all the conditions.
5. With comparisions of both methods Response spectrum analysis has given more accuracy than equivalent static method.
6. For more accurate results of structure Pushover analysis is performed as it gives structural accuracy compared with the other two methods.
7. Performance point of RC conventional and flat slab were observed before the collapse of building, and its concluded that building is safe.

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