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Seismic Behavior of Irregular Building with and without Floating Column

Vijayanand[1], Manasa Veena[2]

[1]*PG Student, Dept. of civil Engineering, SGBIT Belgaum, Karnataka, India*
[2]*Assistant Professor, Department of civil Engineering, SGBIT Belgaum, Karnataka, India*

Abstract - Floating columns are most widely used feature in multi-storey construction in urban areas. The structures with floating column in seismically active zones are undesirable to construct. As the path of load transfer in floating column is not continuous, they are more prone to the seismic activity. Indian standard code IS 1893-2016 (Part-1) defines number of structural Irregularities, in such ir-regularities floating column is one of them.

The project studies the analysis of G+10 storey normal building, G+10 storey building with floating column at periphery and G+10 storey building with floating column at alternative floors. The present paper deals with variation in displacement of structure, base shear and Inter storey drift. The basic validation problem is carried out to cross check software results with manual calculations. The study of is to find whether the structure built in seismically active areas are safe or unsafe with floating column.

***Key Words*: Floating column building, Normal building, Storey displacement, Storey shear and Storey drift**

1. INTRODUCTION

The vertical structural member such as column, It transfer's the structural load coming from beam and slab to the ground. Floating column is defined as vertical member which is resting on beam will not directly transfer load from column to foundation. On beam floating column will act as point load, the column may be placed on any floor irrespective of position. The purpose of beam is to support column as rigid foundation.

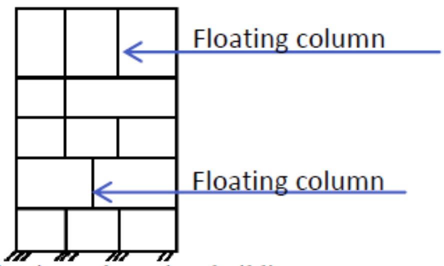
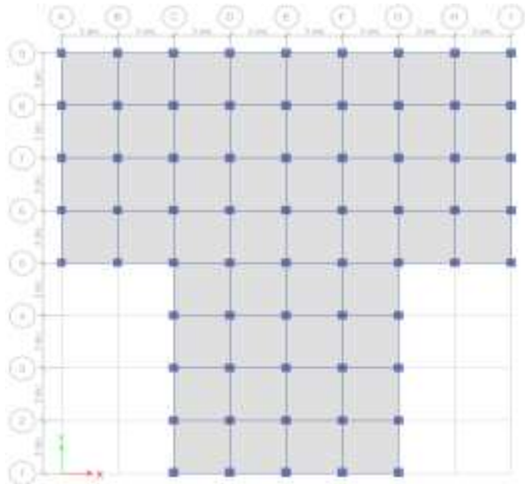


Fig -1: Floating column in a building

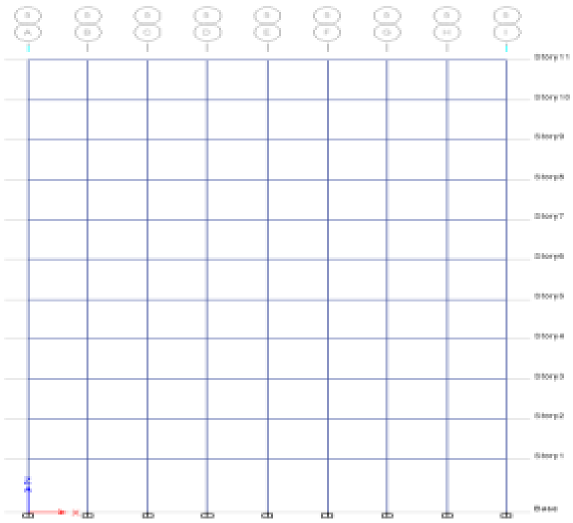
Most of high raised buildings constructed for residential, commercial and industrial purpose with a bottom storey as soft storey is most commonly used for parking.

2. MODELLING DETAILS

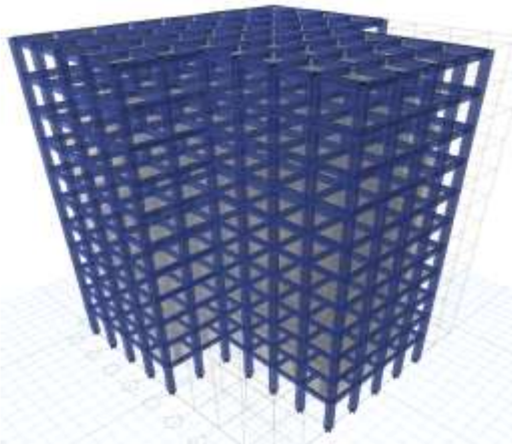
2.1 3m span 11 storey regular model (IRM)



PLAN (M1)

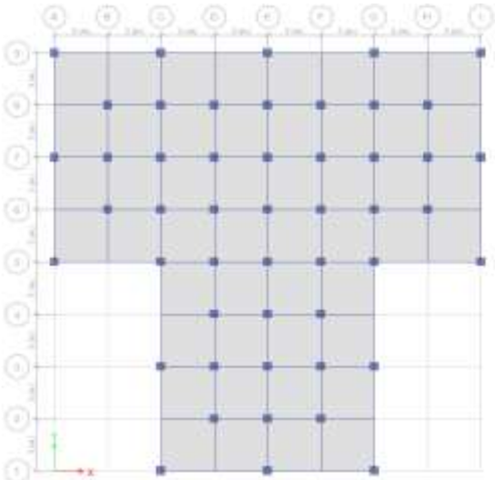


ELEVATION

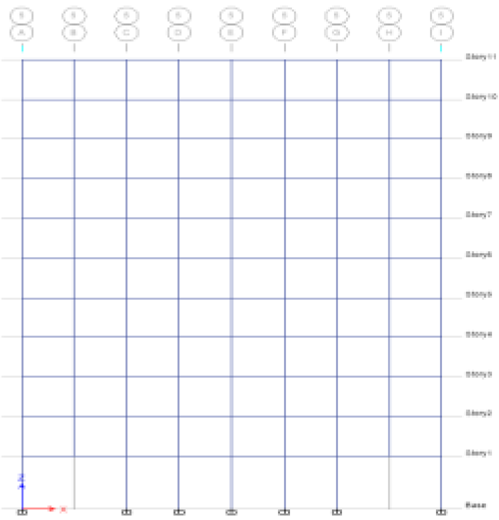


3D VIEW

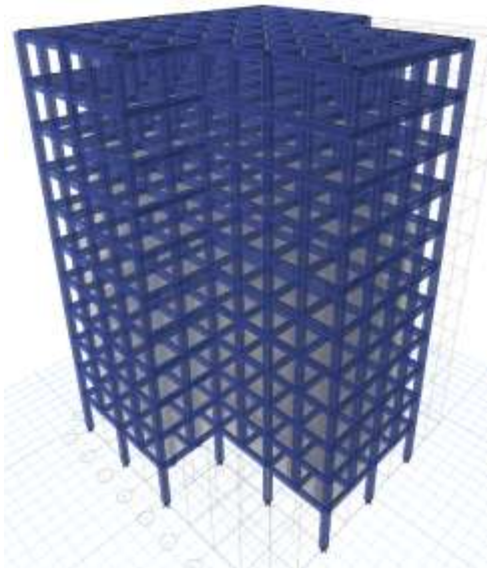
2.2 3m span 11 storey IRM+ Floating column (FC) at periphery.



PLAN (M2)

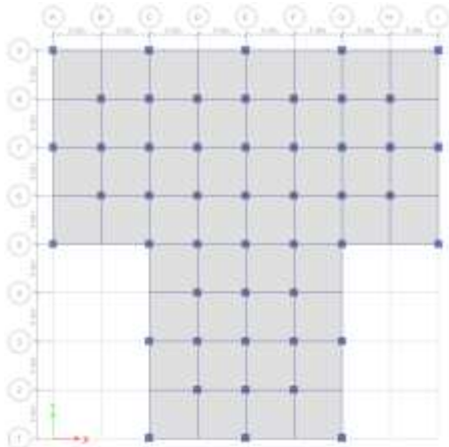


ELEVATION

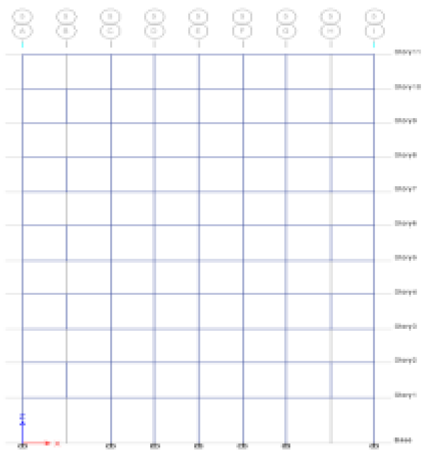


3D VIEW

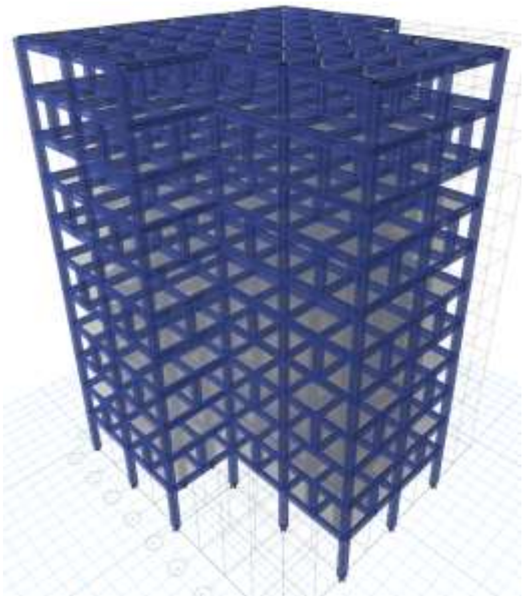
2.3 3m span 11 storey IRM+FC at periphery & alternate floor



PLAN(M3)



ELEVATION



3D VIEW

3. ANALYSIS OF SELECTED MODELS

Dimensions of structural element:

1. Size of the column- 500×500mm.
2. Size of the beam-230×525mm
3. Thickness of slab-150mm

Specifications:

1. Earthquake Zone: 5
2. Soil Type: Medium Type II
3. Structure Type SMRF: R= 5
4. Importance Factor: I =1.5

Material properties:

1. M25 Weight/Unit Volume: 25 kN/m^3
2. Modulus of elasticity E: 25000N/mm^2
3. Poisson's ratio, µ: 0.2
4. Co-efficient of thermal expansion, A: 0.0000055°/c
5. Shear modulus, G: 10416.67N/mm2
6. F_{ck} = 25N/mm^2
7. F_y = 500 N/mm^2

Loads:

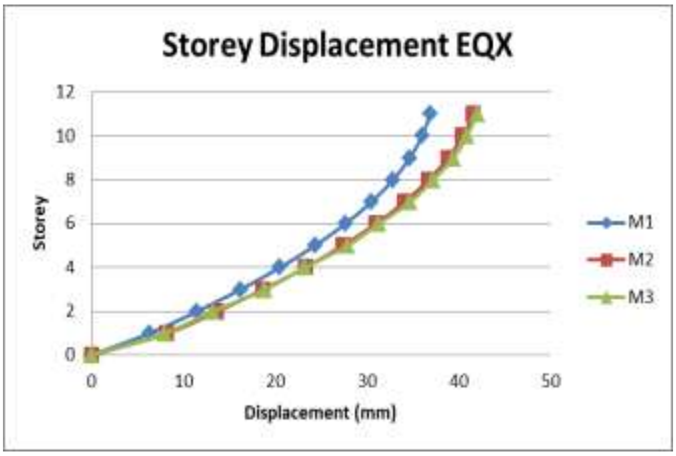
1. Live Load on Floor=4kN/m^2
2. Floor finish=1.5kN/m^2
3. Live Load on Roof =3 kN/m^2
4. Floor finish on roof=1.75kN/m^2

All models are analysed using ETAB-2017 software and results are discussed,

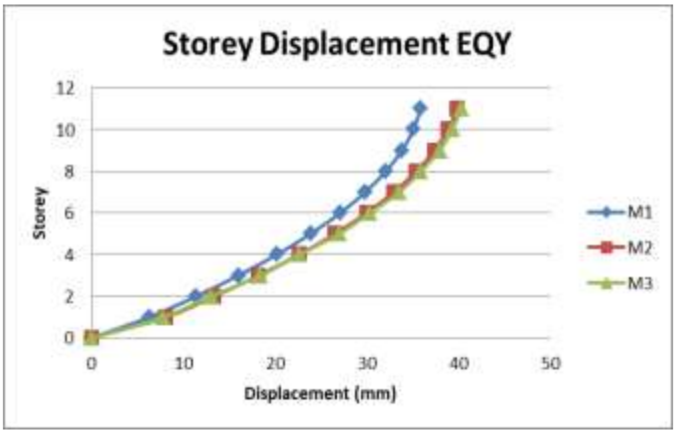
4. EQUIVALENT STATIC ANALYSIS

It deals with series of forces which are acting on high storey building to show the impact of an earthquake ground motion. This method will not show much safer results in high magnitude areas of earthquake. As whole design base shear is computed, and then along height of the building it is distributed based as some simple formulae appropriate for the regular distribution of building with stiffness and mass. Depending upon the floor diaphragm action the obtained design lateral force at each floor then shall be distributed to the individual lateral load resisting element.

4.1 EQSM-Storey displacement of M1, M2 & M3

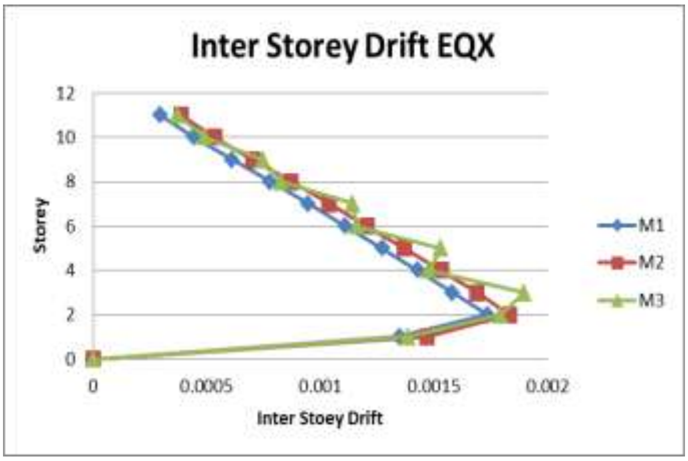


Graph.4.1a: EQX-IRM for M1, M2 & M3

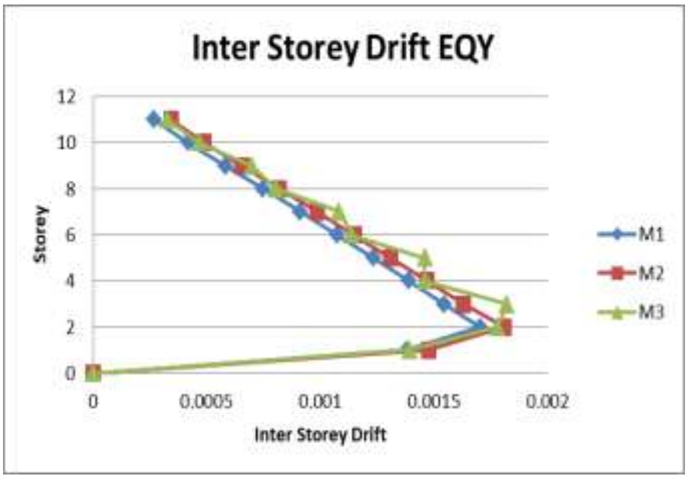


Graph.4.1b: EQY-IRM for M1, M2 & M3

4.2 EQSM-Inter Storey Drift of M1, M2 & M3

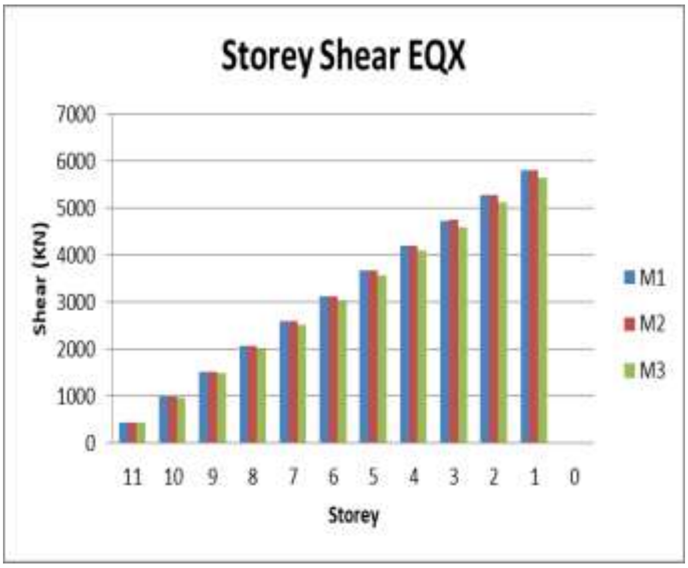


Graph.4.2a: EQX-IRM for M1, M2 & M3

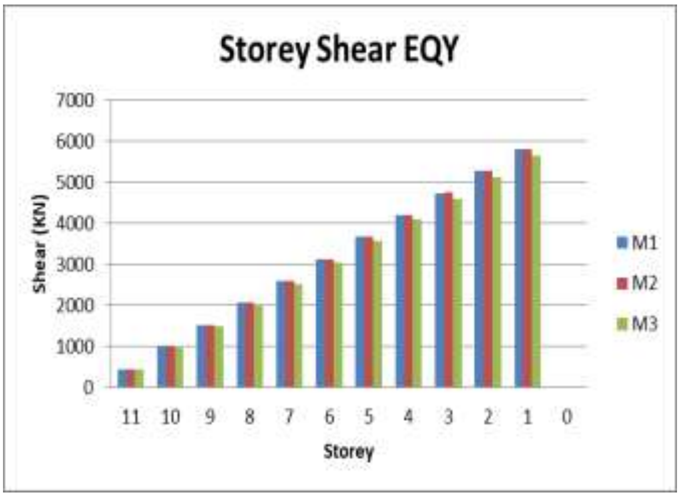


Graph.4.2b: EQY-IRM for M1, M2 & M3

4.3 EQSM- Storey Shear of M1, M2 & M3



Graph.4.3a: EQX-IRM for M1, M2 & M3

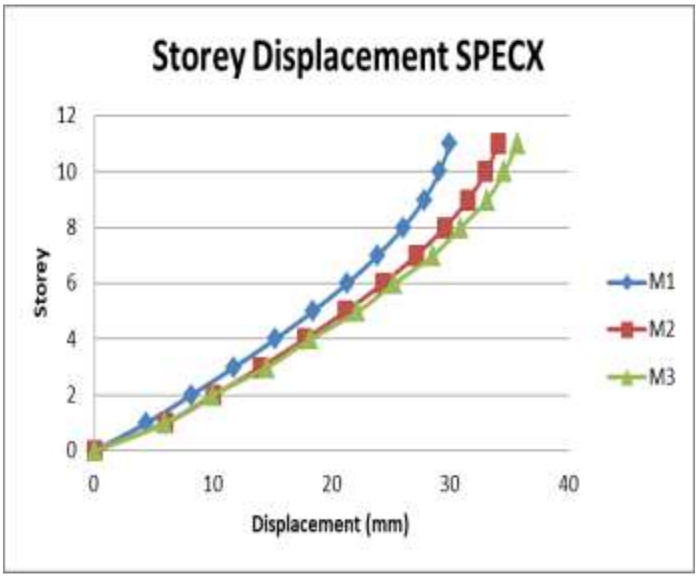


Graph.4.3b: EQY-IRM for M1, M2 & M3

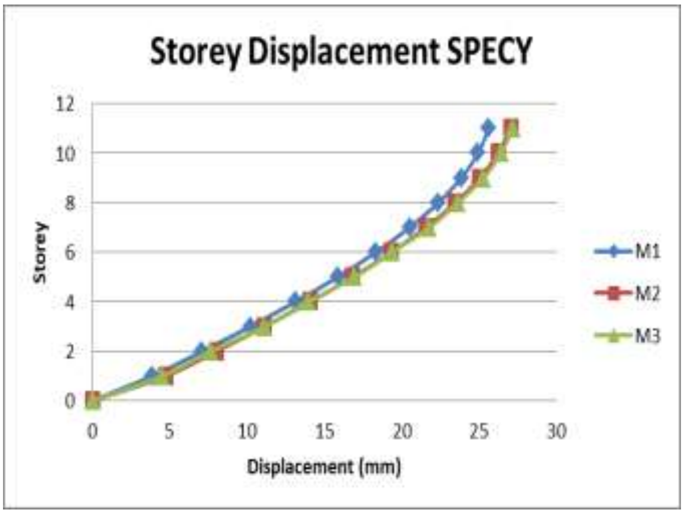
5. RESPONSE SPECTRUM ANALYSIS

It provides a technique for performing an Equilateral Static Lateral Analysis. Response Spectrum Analysis uses same principle of Time History Analysis, only the change is values obtained here are for maximum response. To find out forces, Peak displacement readings are more important. Response spectra curves are the curves plotted between maximum responses of single degree of freedom system (SDOF) subjected to specified earthquake ground motion and its time period.

5.1 RSM-Storey displacement of M1, M2 & M3

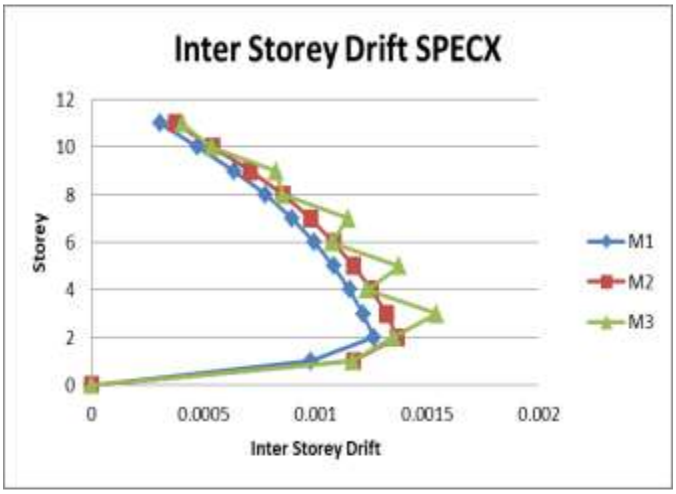


Graph.5.1a: SPECX-IRM for M1, M2 & M3

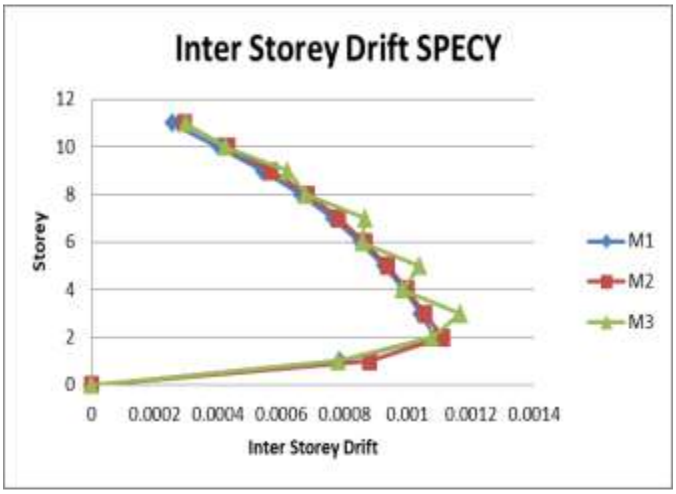


Graph.5.1b: SPECY-IRM for M1, M2 & M3

5.2 RSM-Inter Storey Drift of M1, M2 & M3



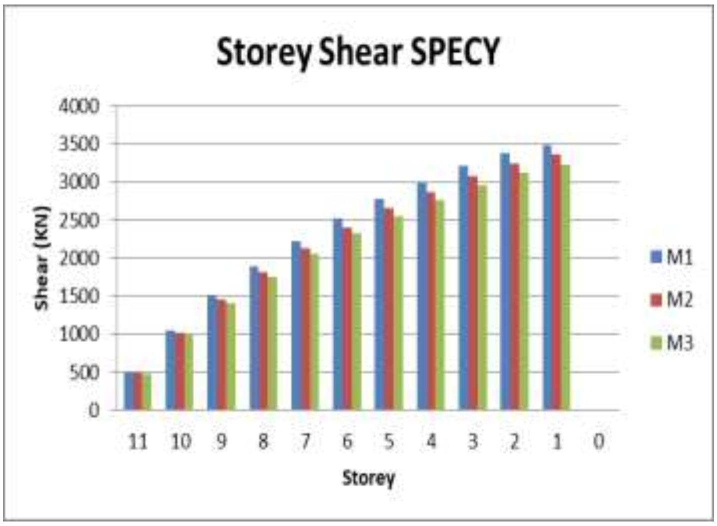
Graph.5.2a: SPECX-IRM for M1, M2 & M3



Graph.5.2b: SPECY-IRM for M1, M2 & M3

5.3 RSM-Storey Shear of M1, M2 & M3

Graph.5.3a: SPECX-IRM for M1, M2 & M3



Graph.5.3b: SPECY-IRM for M1, M2 & M3

6. CONCLUSIONS

The study of irregular multi storey building with and without floating column is carried out for Static and Response Spectrum Analysis method. The seismic parameters like Storey displacement, Inter storey drift and Storey shear are calculated and compared with different models.

Displacements, as we observed by the results model M3 shows maximum displacement in both static and response spectrum analysis, as that of M1 shows minimum displacement. Higher displacement observed in M3 because of floating column present in alternative floors.

This shows alternate floor floating column structural systems will effect much on global stiffness of the structure which results reduction in lateral load resisting capacity.

Inter Storey Drift, As result of drifts in model M3, shows maximum storey drift at storey 3 in both seismic analysis methods. And minimum values is seen in model M1 at storey 2. This shows that alternate floor floating column structural systems will effect much on global stiffness of the structure which results in soft storey effect thus result in higher drift.

Storey shear, In absence of floating column M1 shows maximum storey shear value in both static and response spectrum analysis, in presence of floating column at alternative floors model M3 shows minimum shear values.

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BIOGRAPHIES

Vijayanand
PG Student, M.Tech in Structural Engineering, Civil Department, S.G. Balekundri Institute of Technology, Belagavi - 590010

Manasa Veena
Assistant Professor, Civil Department, S.G. Balekundri Institute of Technology, Belagavi - 590010