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Seismic optimization of horizontally irregular buildings with floating column using dampers

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Abstract – *Nowadays multistory buildings are constructed for the purpose of residential, commercial, etc with open ground story. For the purpose of parking, usually ground story is kept open. Buildings which have discontinuity of columns and buildings having columns which transfer load to the beam in lateral direction are called as floating column.*

Here, the seismic analysis of horizontally irregular buildings with floating column is done. It is then optimized using dampers.

***Key Words*: Seismic optimisation, Floating columns, Diaphragm discontinuity, Re-entrant corners, Etabs, Viscous dampers, Time history analysis**

1. INTRODUCTION

India is a developing country, where urbanization is at the faster rate in the country. As a part of urbanization multi-story buildings with architectural provisions are constructed. These necessities are nothing but soft story, floating column, hefty load, the lessening in stiffness, etc. most of the multi storied buildings having open ground story as an obligatory feature to afford parking area, reception lobbies and for other architectural needs. Nowadays multi-story building construction for residential, industrial or commercial purpose has become a common feature. These multi-story building need more parking or open spaces below. This open ground story concept leads to interruption of columns called floating columns. These are more advantageous in urban areas where space is an issue.

In this paper, effect of floating column on multi-story building has been studied and optimized by viscous dampers. The results on structures with floating column having horizontal irregularities have been compared. Various parameters such as displacement, base shear and time period are discussed. The material properties and section properties considered for analysis are shown in Table 1 & 2.

1.1 Floating Column

In floating column transfer of load to the column below it by the beam. The transfer of load in floating column changes from vertical to horizontal within the intermittent frame. In many cases these columns are chosen specially above bottom floor. Thus more open spaces is offered within ground floor which can be used for auditorium or parking intention. Thus floating column is additionally used in construction practice and it is avoided due to excess of beams. To maintain the stability of building the joint among beam and floating column are treated as critical. Main cause of collapse of this type of structure is the failure of large beam column specimens occurs in the joint in concrete moment resisting frame. The geometry of the considered model is shown in table 3.

2. SCOPE

The study is limited to improving the seismic performance of horizontally irregular structures such as plan irregular, diaphragm discontinuity and re-entrant corner irregularity with floating column using viscous dampers. ETABS software is used.

3. METHODOLOGY

The main objective of this research is to study the seismic performance of a regular and irregular multi-storey building with floating column with parameters like displacement, time period and base shear and to optimize floating column buildings with viscous dampers. Three-dimensional mathematical modelling of floating column buildings with ETABS software. Non-linear dynamic analysis (time history analysis) was carried out to study the seismic performance of the building.

4. MODELLING

Nine building models having G+9 story are created and analyzed.

MODEL 1- Regular building with floating column in the middle and the ends of story 1 in both direction.

MODEL 2- Irregular building having diaphragm discontinuity with floating column in the middle and the ends of story 1 in both direction.

MODEL 3- Irregular building having diaphragm discontinuity with floating column in the middle and the ends of story 1 in both direction with strut introduced at story 2.

MODEL 4- Irregular building having diaphragm discontinuity with floating column in the middle and the ends of story 1 in both direction with damper introduced at story 2.

MODEL 5- Irregular building having diaphragm discontinuity with floating column in the middle and the ends of story 1 in both direction with strut introduced at story 2 and damper introduced at all other stories except 1 and 2.

MODEL 6- Irregular building having reentrant corner with floating column in the middle and the ends of story 1 in both direction.

MODEL 7- Irregular building having reentrant corners with floating column in the middle and the ends of story 1 in both direction with strut introduced at story 2.

MODEL 8- Irregular building having reentrant corners with floating column in the middle and the ends of story 1 in both direction with damper introduced at story 2.

MODEL 9- Irregular building having reentrant corners with floating column in the middle and the ends of story 1 in both direction with strut introduced at story 2 and damper introduced at all other stories except 1 and 2.

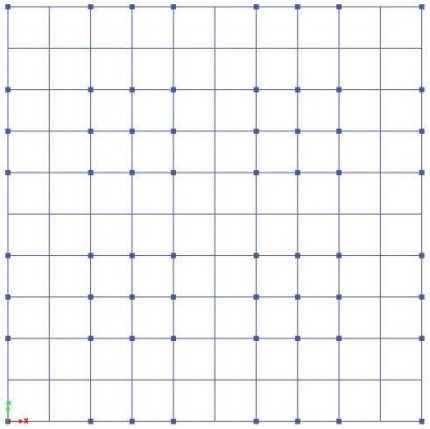

Fig -1: Plan by floating column in the middle and the ends of story 1 in both direction. (Model 1)

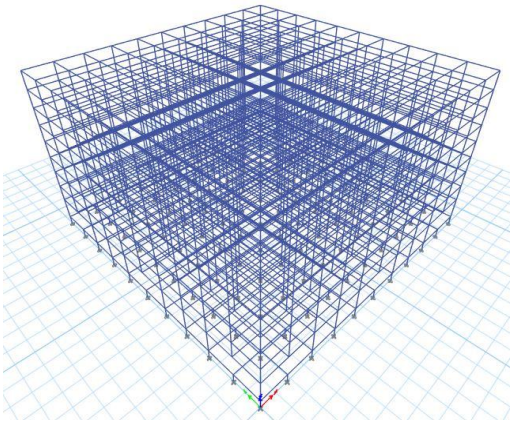

Fig -2: 3D view by floating column in the middle and the ends of story 1 in both direction. (Model 1)

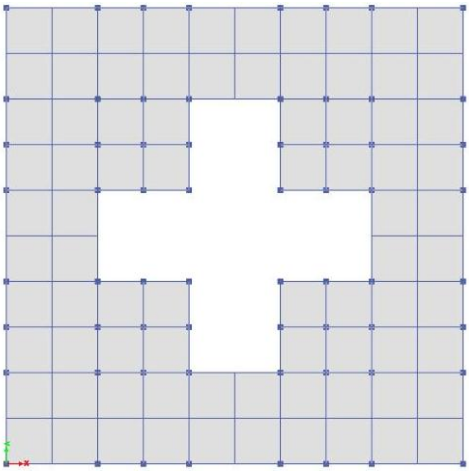

Fig -3: Plan by floating column in the middle and the ends of story 1 in both direction having diaphragm discontinuity (Model 2)

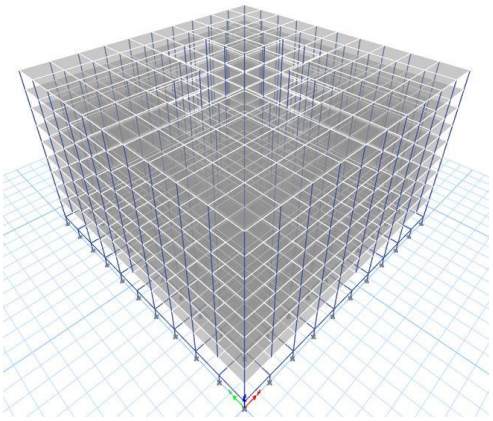

Fig -4: 3D by floating column in the middle and the ends of story 1 in both direction having diaphragm discontinuity (Model 2)

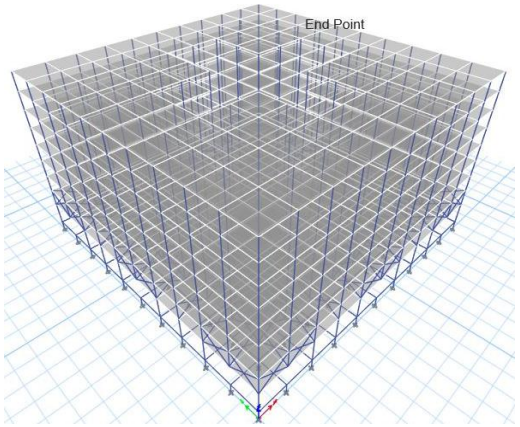

Fig -5: 3D view by floating column in the middle and the ends of story 1 in both direction having diaphragm discontinuity with strut. (Model 3)

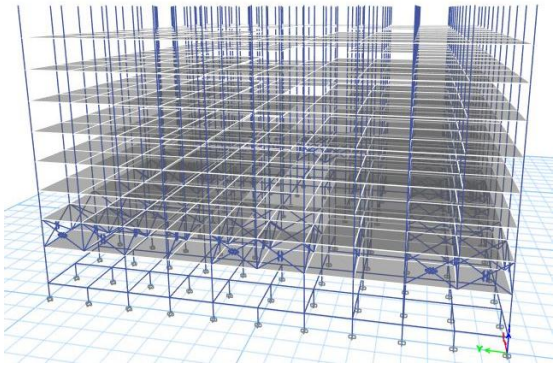

Fig -6: 3D view by floating column in the middle and the ends of story 1 in both direction having diaphragm discontinuity with damper. (Model 4)

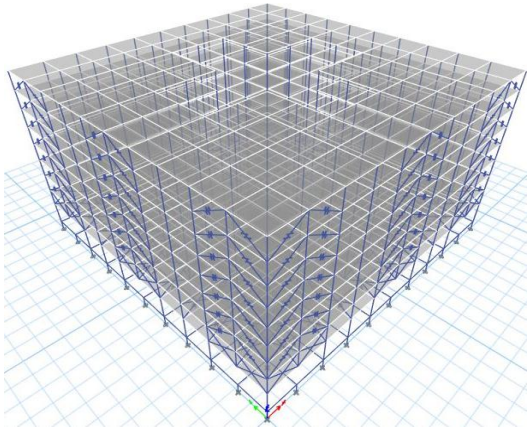

Fig -7: 3D view by floating column in the middle and the ends of story 1 in both direction with strut and damper. (Model 5)

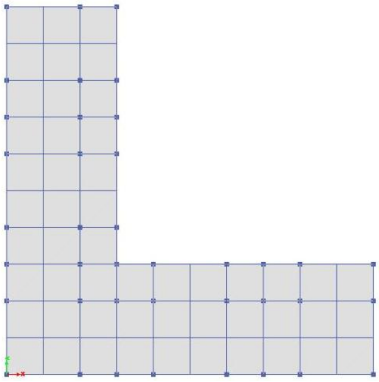

Fig -8: Plan by floating column in the middle and the ends of story 1 in both direction having reentrant corners (Model 6)

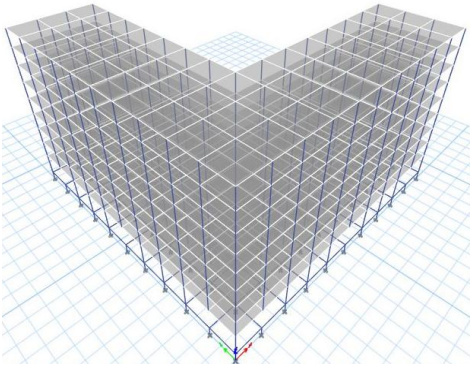

Fig -9: 3D by floating column in the middle and the ends of story 1 in both direction having reentrant corners (Model 6)

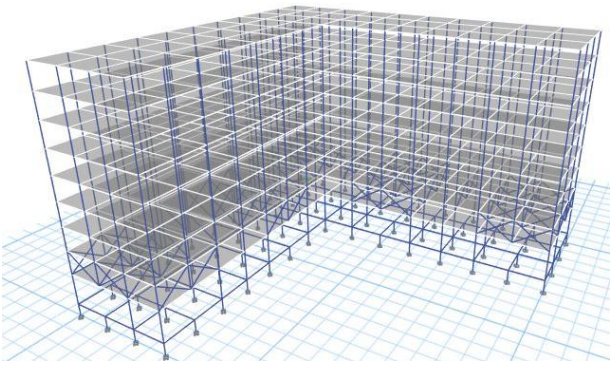

Fig -10: 3D by floating column in the middle and the ends of story 1 in both direction having reentrant corners with strut (Model 7)

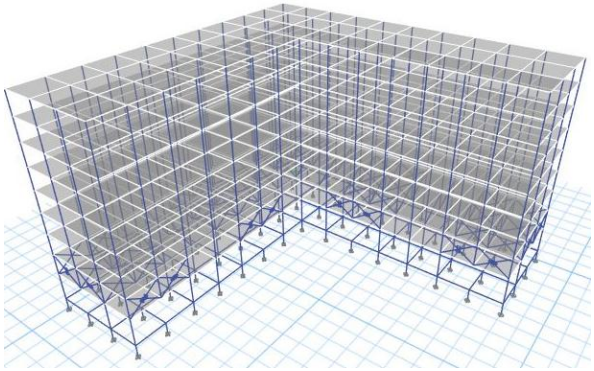

Fig -11: 3D by floating column in the middle and the ends of story 1 in both direction having reentrant corners with damper (Model 8)

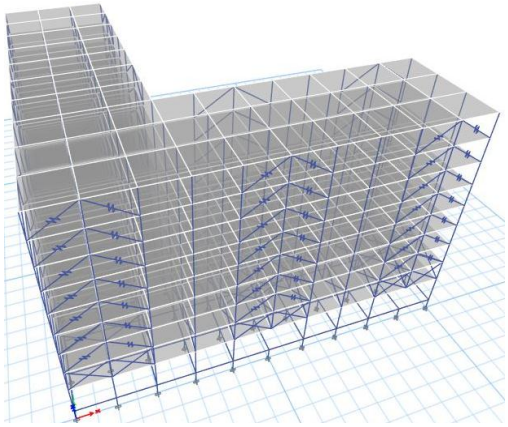

Fig -11: 3D by floating column in the middle and the ends of story 1 in both direction having reentrant corners with strut and damper (Model 9)

Table -1: Material properties of models

Properties	Values
Characteristic compressive strength of concrete, f_{ck}	25 MPa
Yield stress for steel, f_y	415 MPa
Elastic modulus of steel, E_s	20,0000 MPa
Elasticity modulus of concrete, E_c	25000 MPa

Table -2: Section properties of models

Parameters	Structure with floating column at 1st floor
Length in X-direction	45
Length inY-direction	45
No. of storeys	Ten (G+9)
Beam	400 × 350 mm
	M20 grade concrete
Column (1F – 3F) Column (4F – 6F)	550×550 mm M25 grade concrete 450×450 mm M25 grade concrete
Column (7F – 9F)	350×350 mm M25 grade concrete
Slab	130mm M20 grade concrete
Dead load	1.5 kN/m²
Live load	2.5 kN/m²
Roof live	1kN/m²

Table -3: Geomtry of models

No. of storeys	X direction bay width	Y direction bay width	Height of bottom storey	Height of storey
9	4.5	4.5	4	3

4. RESULTS AND DISCUSSION

Table -3: Comparison values of displacement, base shear and time period

	Displacement		Base shear		Time period	
	X	Y	X	Y	X	Y
FC M&E	200.31	200.31	38863.9	38863.9	1.8	1.8
DC FC M&E	188.6	188.6	30624.5	30624.5	1.7	1.7
DC FC M&E S	121.5	121.5	33533.2	33533.2	1.4	1.4
DC FC M&E D	120.3	120.07	33279.7	33364.7	1.4	1.4
DC FC M&E S+D	145.8	145.8	35444.4	35444.4	1.3	1.4
RE FC M&E	211.4	211.4	19508.5	19508.5	1.7	1.8
RE FC M&E S	124.1	124.1	21182.1	21182.1	1.4	1.4
RE FC M&E D	119.8	120.7	20727.4	20774.2	1.4	1.4
RE FC M&E S+D	168.9	168.9	25120.8	25120.8	1.2	1.3

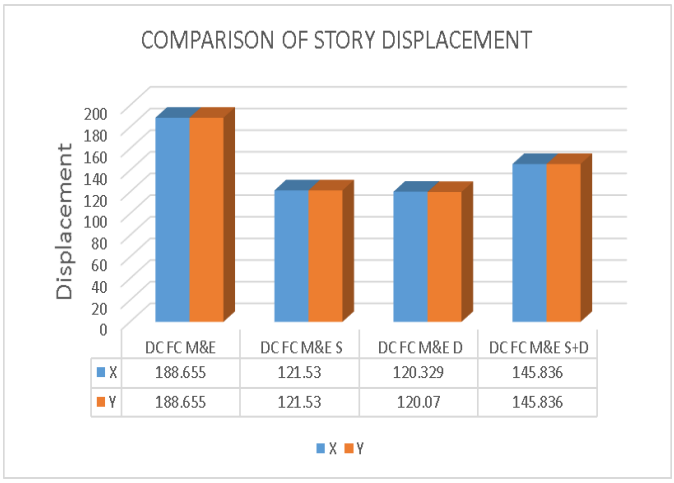

Fig -11: Comparison values of displacement of model 1,2,3,4

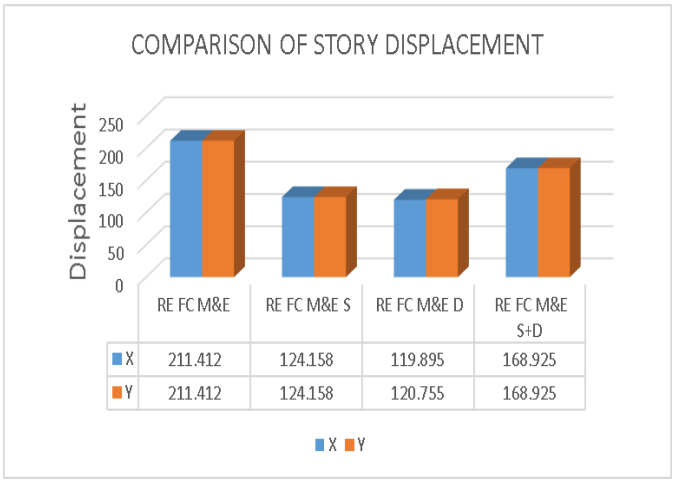

Fig -14: Comparison values of displacement of model 6,7,8,9

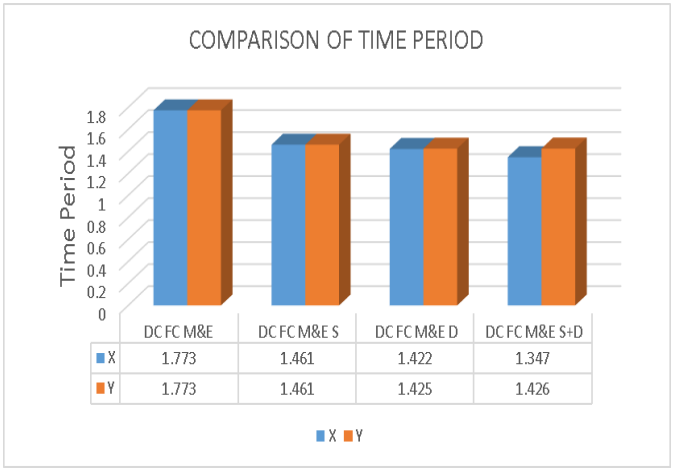

Fig -12: Comparison values of time period of model 1,2,3,4

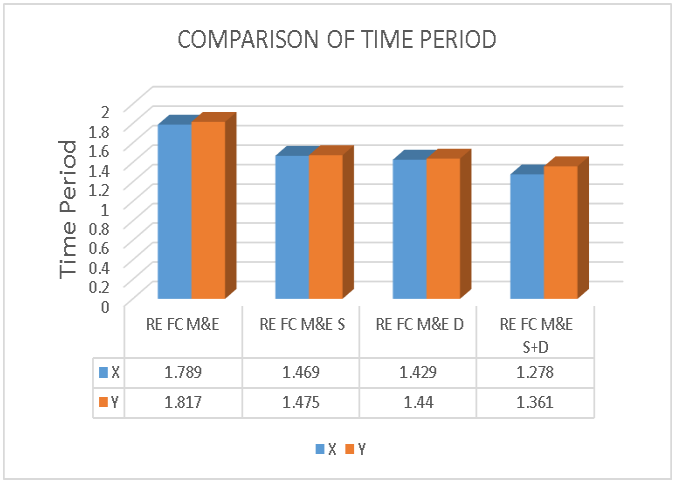

Fig -15: Comparison values of time period of model 6,7,8,9

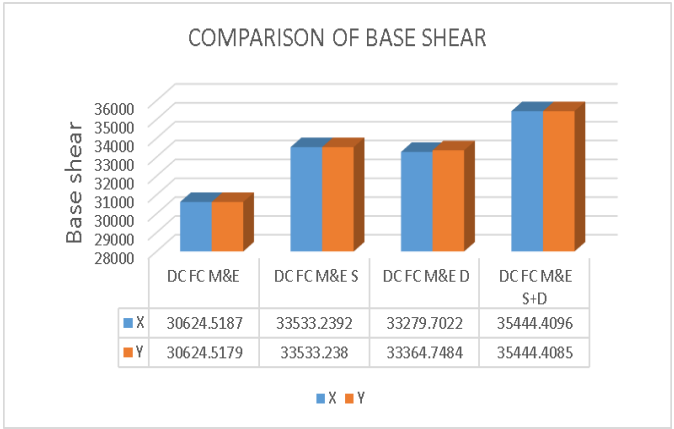

Fig -13: Comparison values of base shear of model 1,2,3,4

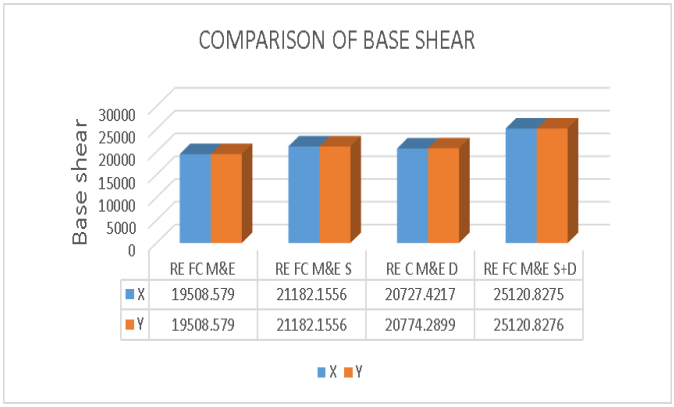

Fig -16: Comparison values of base shear of model 6,7,8,9

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3. CONCLUSIONS

This research studied the effect of floating column in horizontally irregular buildings and the optimization by viscous dampers. A time history analysis has been carried out to study the seismic performance. As a result of the investigation following results were made:

- There is a decrease in displacement and increase in base shear of models having strut and damper.
- Model with damper only shows lower displacement values in the case of diaphragm discontinuity and reentrant corner.

From overall research it can be concluded that to make the building safe from seismic effect, viscous dampers can be provided which reduce the displacement of buildings caused by floating column. By this way we can increase the use of floating column.

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