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Effect of Circular, Square and Rectangular Column in Building

Samir Dalal[1], Swati Ambadkar[2],
[1]P.G Student G.H.R. University, Amravati,
[2]Professor. G.H.R. University, Amravati,

***Abstract:** While designing any structural building, the only distress of the designer is the stability of the building and its performance under internal and external forces & Loads. These forces & loads mostly comprise of dead load of the structure, superimposed load, snow load, or some other loads due earthquake, wind etc. Increase in height more force will be generated in taller building. So, for repelling developed forces, high strength members of the structure are required. Column, being the vertical member, is the most important member in a structure as it transfers the whole loads & forces from all the other structural members to the foundations. Its shape, cross-section and the area of reinforcement will change with the total load acting on the structure. Shape & Size of column can change for any structure according to its purpose. In the present study various models were analyzed considering individual and combinations of various geometric and from results various conclusions were draft.*

***Keywords:** Circular, Square, Rectangular, Staad pro. Cost*

I. INTRODUCTION

While designing any structural building, the only distress of the designer is the stability of the building and its performance under internal and external forces & Loads. These forces & loads mostly comprise of dead load of the structure, superimposed load, snow load, or some other loads due earthquake, wind etc. Increase in height more force will be generated in taller building. So, for repelling developed forces, high strength members of the structure are required. Column, being the vertical member, is the most important member in a structure as it transfers the whole loads & forces from all the other structural members to the foundations. Its shape, cross-section and the area of reinforcement will change with the total load acting on the structure. Shape & Size of column can change for any structure according to its purpose. After analysing the total load acting on it, column size and area of reinforcement shall be calculated. Unlike shapes behave differently under similar loading circumstances and other similar structural parameters, consequently, shape of a column should be chosen cleverly.II Objectives of present work

A. *Objectives*

1) To study Behavior of building during earthquake with varying shape of column.
2) To compare various structural parameters for various combinations of column shapes.
3) To effect of column shape combination on economy of structure.
4) To study variation in time period for buildings with varying column shapes.
5) To find the most efficient model amongst all others.

II. METHODOLOGY AND CASE CONSIDERATION

A. *Methodology*

For ease and fruitfully work flow during project work it is divided into some simple steps to monitor and perform the work as per methodology

1) Collection of basic information related to topic so that it will be easy to decide the parameter to be consider, Significance of various factors related to structural framing
2) Searching various research papers, journals and Codes related to present work, from various papers it was found that shape of column have significant effect of the seismic behavior of building or framing. Also, it was observed that shape of columns and their combinations or orientations leads to reduce or increase the load carrying capacity and seismic response.
3) From the various literatures it is decided that various combinations for Column shapes will be analyzed to get the most efficient column shape or column shape combinations. Such as whole building will be firstly analyzed with only one identical shape i.e with Square, Circular and Rectangular. After this various Combinations such as Circular column with combinations of square or rectangular and then interchanging will be analyzed.

4) After deciding combination martial for columns and their characteristics will be finalized along with the Seismic zone, Storey height and number of storey. Also the geometry will be finalized. For obtaining effective results a simple geometry with regular structural framing system will be adopted.
5) From various models which will be analyzed on Staad pro. The most efficient column shape or column combination will be find out.

B. Case Consideration

1) *Structural Parameters:* The sizes of column are so selected that Shape of column will not have any effect on cross sectional area of column

Table 1 Structural Parameters

Sr. No.	Structural Component	Value
01	Concrete	M40
02	Structural Steel	FE-500
03	Zone	V
04	Response Reduction Factor	5 (SMRF)
05	Importance factor	1.0
06	Type of Soil	Medium Stiff
07	Size of Beam	300mm x 500mm
08	Size of column	-
	Circular Shape	650mm (dia.)
	Square shape	600mm x 600mm
	Rectangular shape	450mm x 750mm
09	Thickness of Interior wall	100 mm
10	Thickness of Exterior wall	230mm
11	Thickness of Slab	150mm
12	Storey Height	3.35m (Floor to Floor)
13	Depth of Foundation	1.5m
14	Live Load	3 Kn/m2
15	Floor finish load	1 Kn/m2
16	Number of stories	09 (G+8)

2) *Model Nomenclature*

Table 2 Model Nomenclature

Sr. No	Model Details	Labels
01	Building with all Circular columns	M1
02	Building with all Square columns	M2
03	Building with all Rectangular columns	M3
04	Building with Circular column at corner and all other Rectangular columns	M4
05	Building with Circular column at corner and all other Square columns	M5
06	Building with Square column at corner and all other Circular columns	M6
07	Building with Square column at corner and all other Rectangular columns	M7
08	Building with Square Column at Corner, Interior column circular and all side column rectangular	M8
09	Building with Rectangular Column at Corner, Interior column circular and all side column Square	M9

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C. Modeling

1) Plan of Model

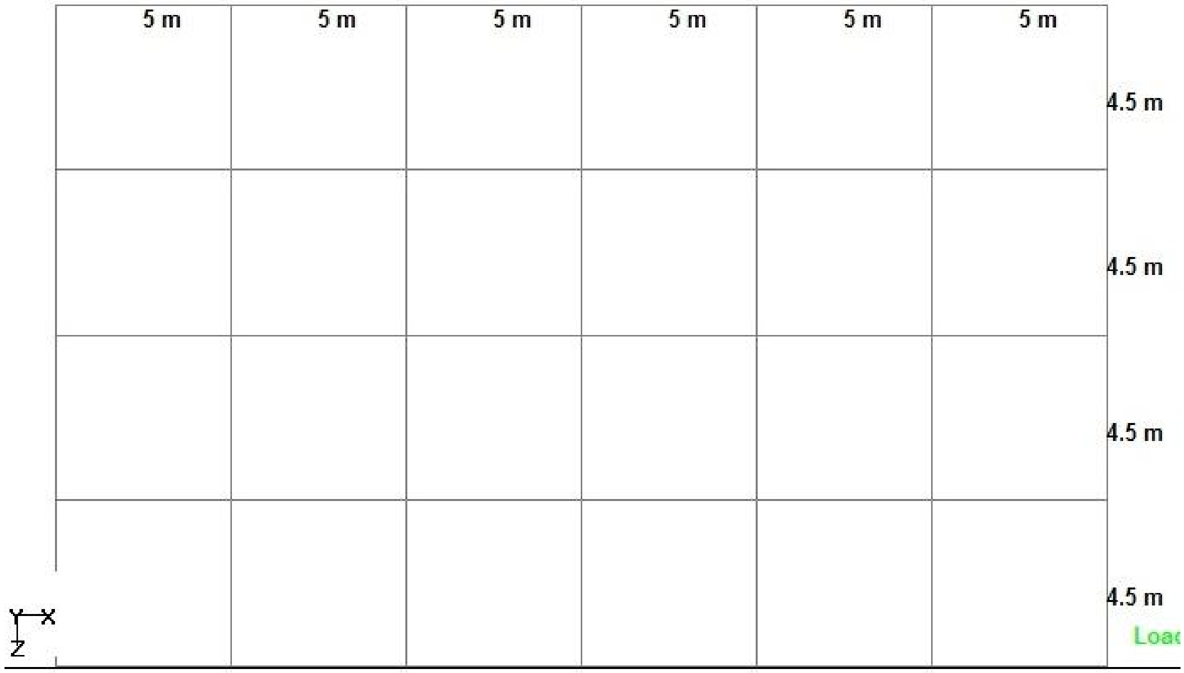

Fig. 1 plan for all models

2) Section of Models

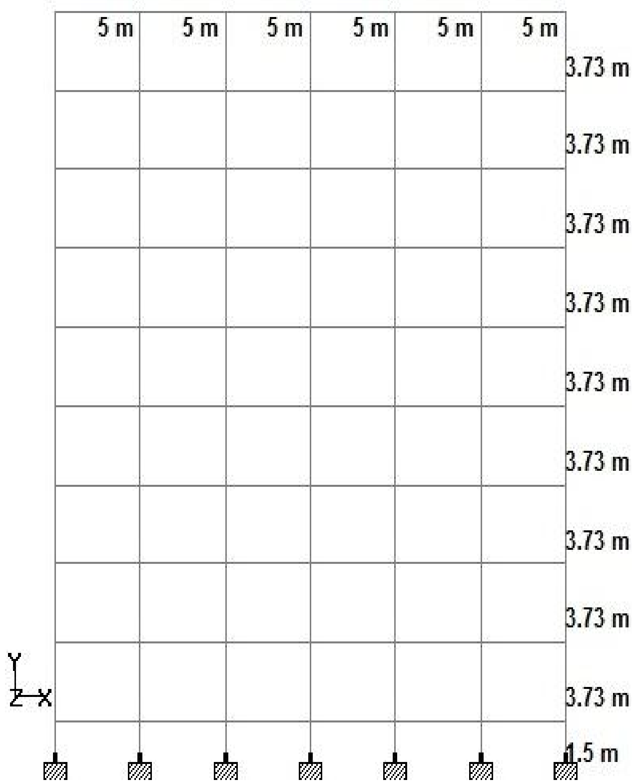

Fig. 2 Section in X-direction

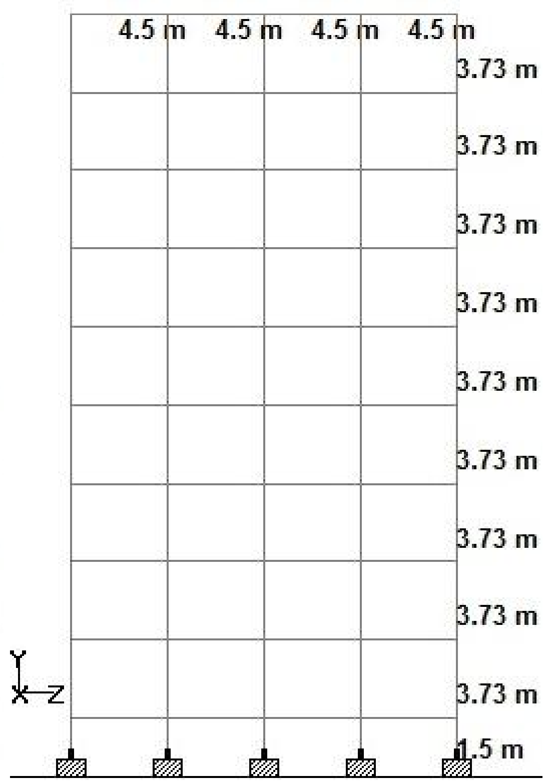

Fig. 3 Section in Z-direction

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III. 3D VIEWS OF ALL MODELS

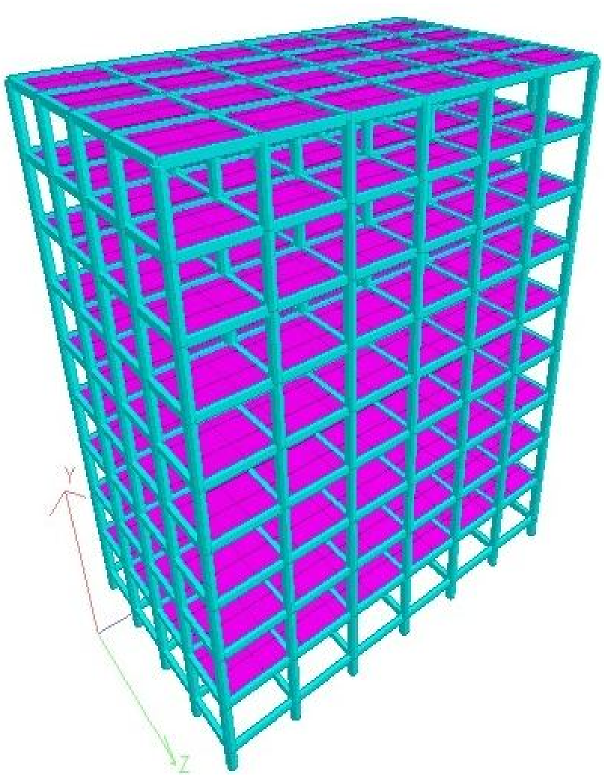

Fig. 4 3D view of model M1

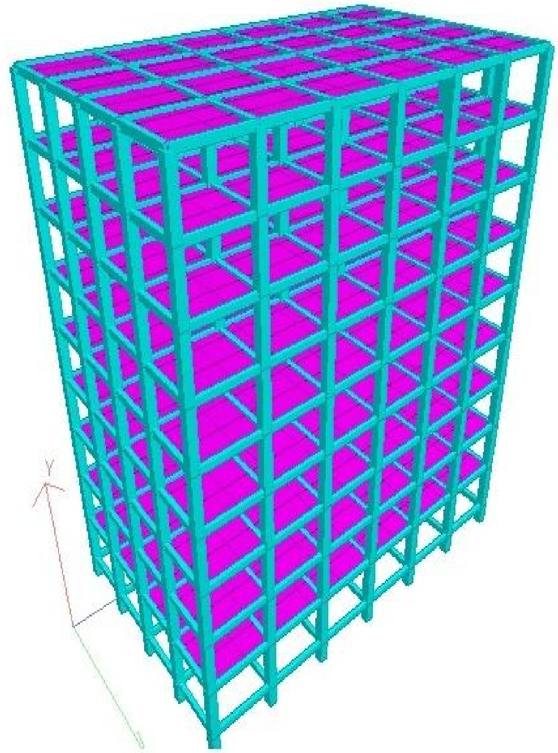

Fig. 5 3D view of model M2

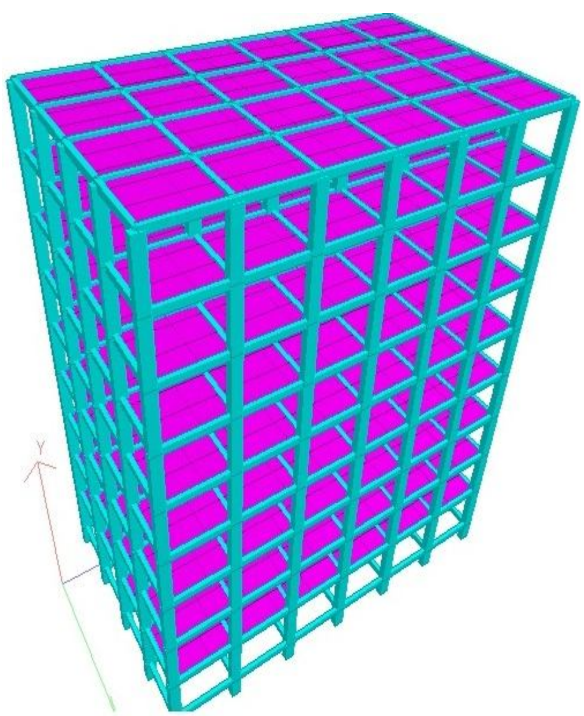

Fig. 6 3D view of model M3

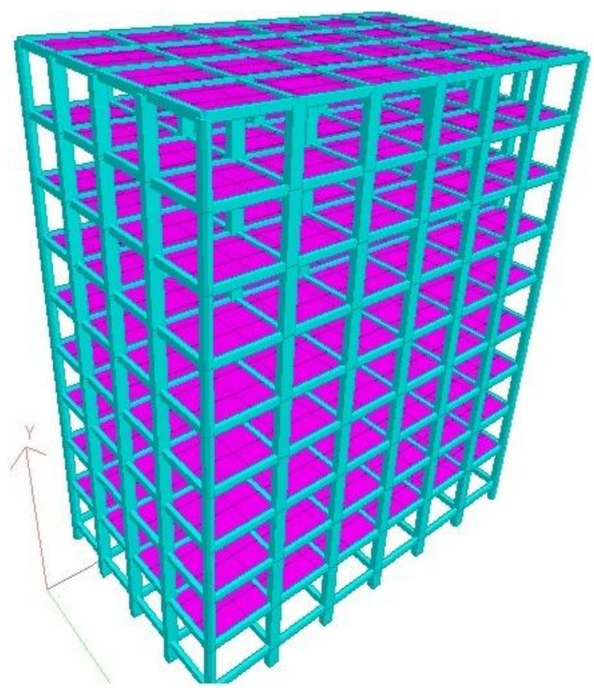

Fig. 7 3D view of model M4

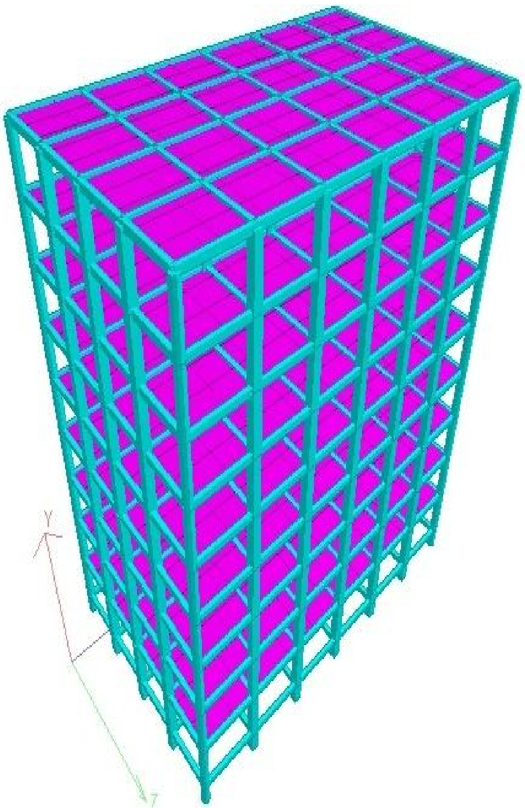

Fig. 8 3D view of model M5

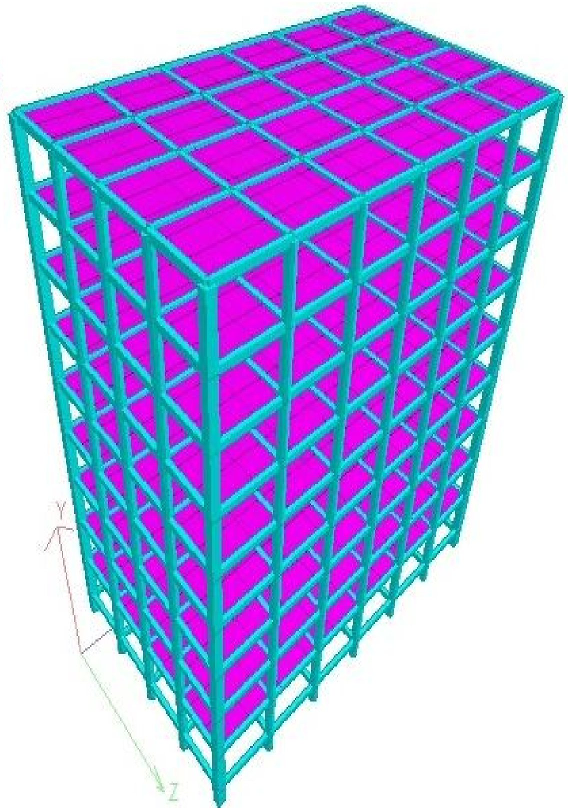

Fig. 9 3D view of model M6

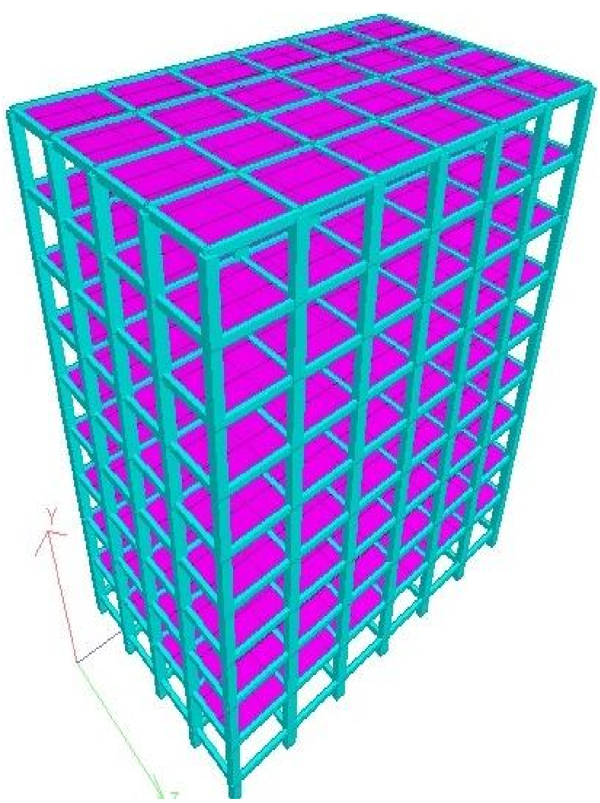

Fig. 10 3D view of model M7

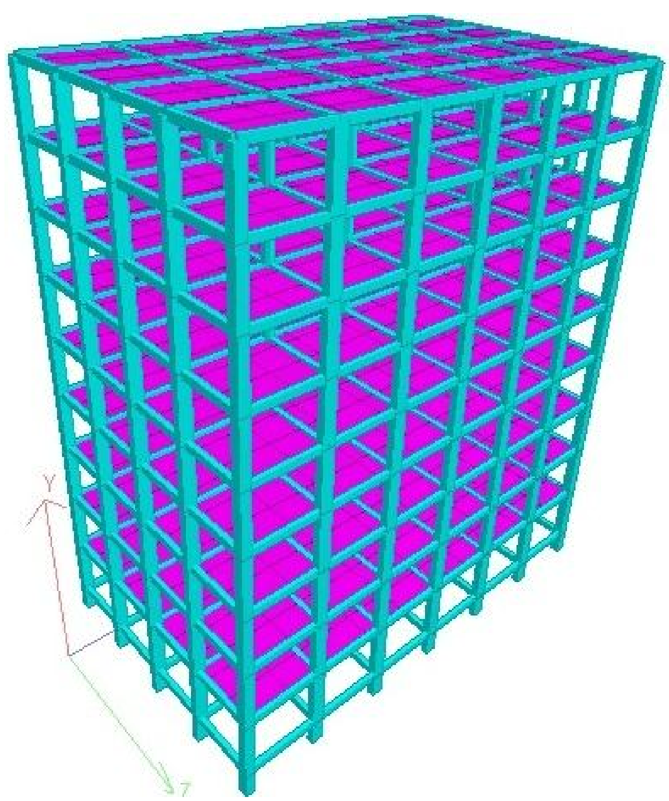

Fig. 11 3D view of model M8

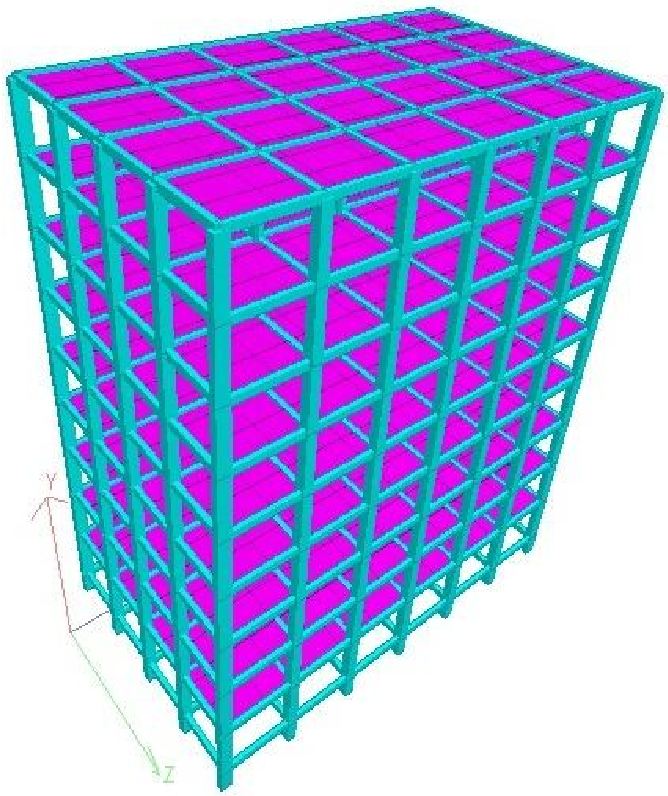

Fig. 12 3D view of model M9

IV. RESULTS AND COMPARISONS

A. Comparison of Results for all Models

1) Comparison for Maximum Axial Forces and Bending Moment

Table 3 Axial force and Bending moment comparison

Sr. No	Model	Max. Axial Force (KN)			Max. Bending Moment (KN.M)		
		FX	FY	FZ	MX	MY	MZ
1	M1	8576.05	261.27	227.50	8.63	478.06	537.49
2	M2	9055.39	369.63	382.23	7.41	1241.09	1249.13
3	M3	8919.43	285.90	306.41	5.85	767.40	823.89
4	M4	8919.99	287.05	303.67	5.92	761.07	847.25
5	M5	9054.99	373.12	386.67	7.46	1254.01	1259.54
6	M6	8576.43	261.14	227.07	8.59	515.37	538.13
7	M7	8919.39	286.74	299.31	5.97	751.10	841.86
8	M8	8578.89	274.63	236.27	7.13	548.35	682.48
9	M9	8559.60	267.09	231.75	7.45	535.29	701.76

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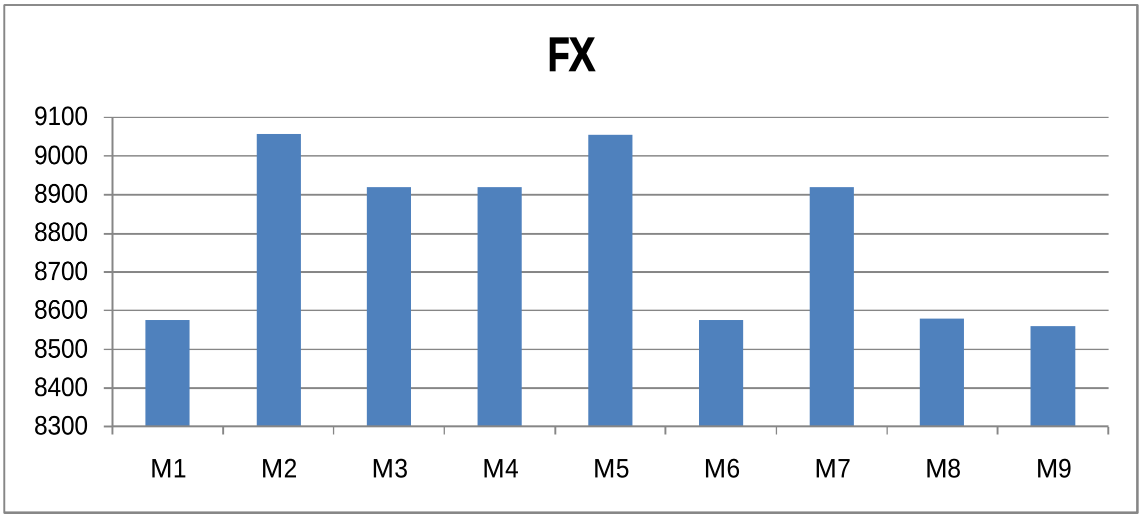

Fig. 13 Comparison of Axial forces in X – Direction

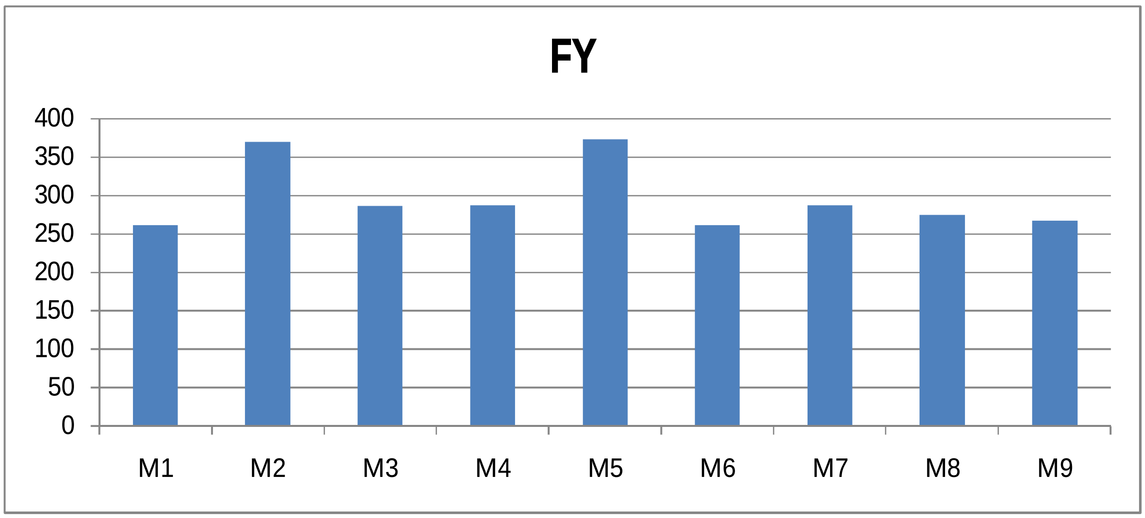

Fig. 14 Comparison of Axial forces in Y – Direction

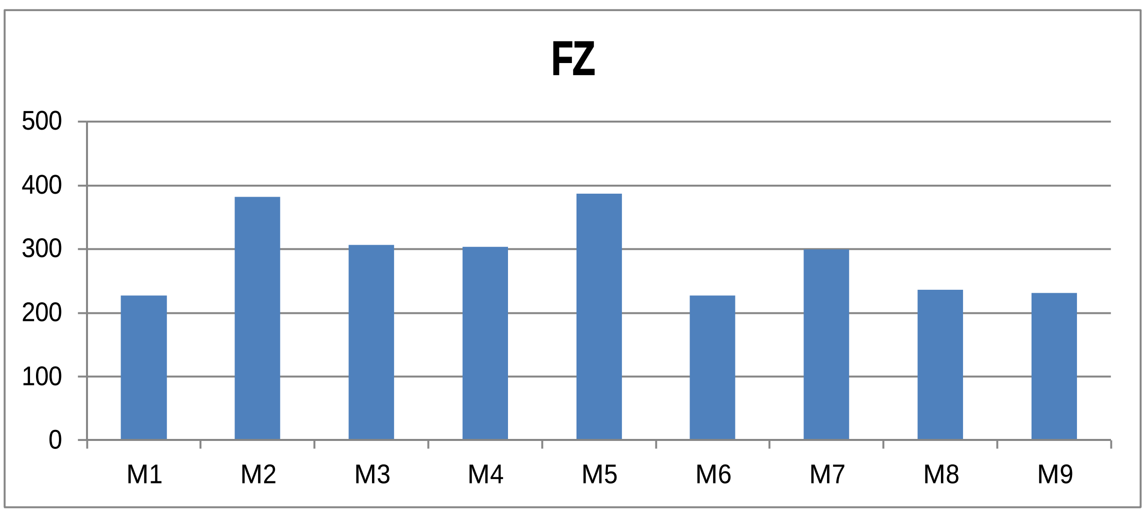

Fig. 15 Comparison of Axial forces in Z – Direction

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2) Comparison for Maximum Displacement

Table. 4 Displacement Comparison

Sr. No	Model	Direction (MM)			Resultant
		X	Y	Z	
1	M1	164.20	4.10	165.32	243.03
2	M2	174.96	4.59	175.54	248.89
3	M3	161.71	4.54	188.05	257.44
4	M4	162.91	4.63	187.71	257.42
5	M5	175.33	4.62	175.99	249.36
6	M6	163.83	4.07	164.88	242.57
7	M7	162.60	4.60	187.19	256.89
8	M8	156.17	4.27	171.17	246.56
9	M9	160.59	4.13	164.00	241.53

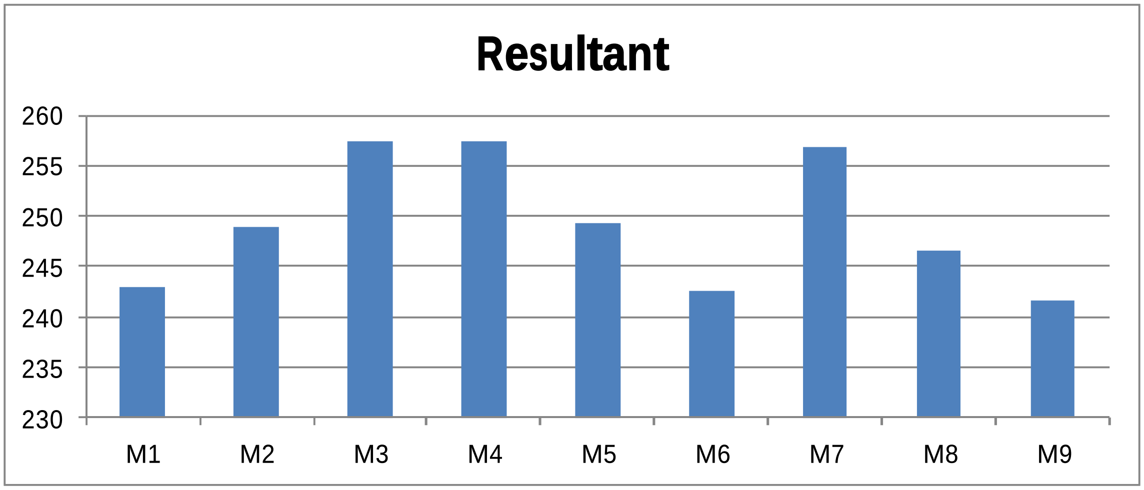

Fig. 16 Comparison of Resultant Displacement

3) Comparison for Base Shear Distribution

Table 5 Base Shear Distribution Comparison

Sr. No	Storey Height (M)	Storey No.	Model								
			M1	M2	M3	M4	M5	M6	M7	M8	M9
1	38.57	9	480.61	489.25	492.18	491.19	488.61	481.25	491.84	481.77	483.32
2	34.84	8	913.60	1046.69	1051.38	1049.78	1045.65	914.64	1050.82	915.48	917.97
3	31.11	7	788.53	891.47	895.11	893.87	890.66	789.34	894.68	789.99	791.94
4	27.38	6	589.87	666.88	669.60	668.66	666.27	590.47	669.27	590.96	592.42
5	23.65	5	419.99	474.82	476.76	476.09	474.38	420.42	476.52	420.76	421.80
6	19.20	4	278.89	315.30	316.59	316.15	315.01	279.18	316.43	279.41	280.09
7	16.19	3	166.57	188.32	189.09	188.83	188.15	166.75	188.99	166.88	167.29
8	12.46	2	83.04	93.88	94.27	94.14	93.80	83.13	94.22	83.20	83.40
9	8.73	1	25.44	29.17	29.29	29.24	29.15	25.42	29.27	25.50	25.56
10	5.00	0	0.37	0.38	0.39	0.39	0.38	0.37	0.39	0.37	0.37

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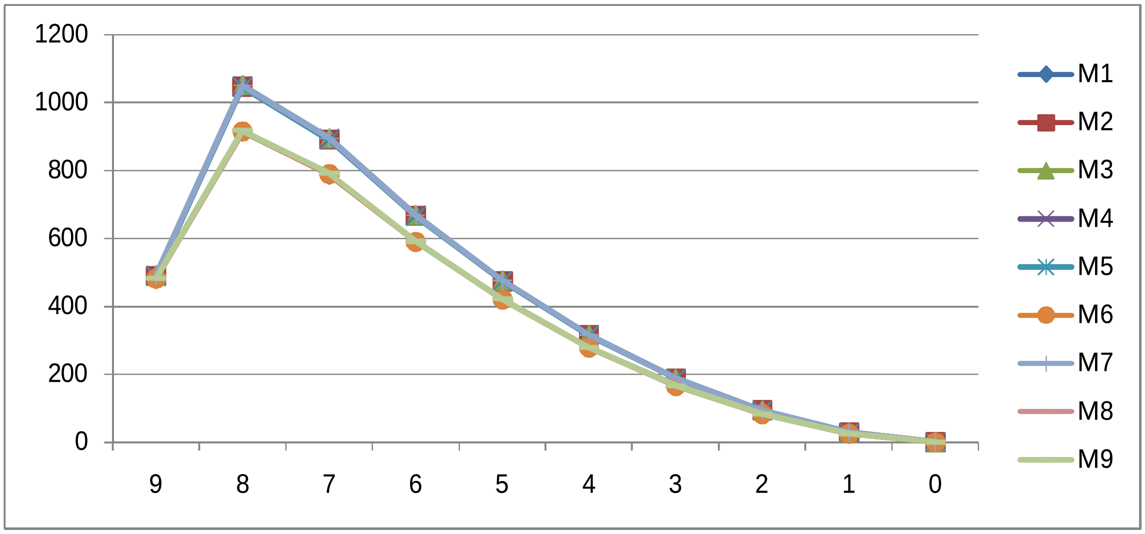

Fig. 17 Comparison of Base Shear Distribution

4) Cost Comparison for all models

Fig. 6 Material Cost Comparion

Sr. No	Shape of Tank	Material	Quantity (MT/CUM)	Rate	Amount (Rs.)	Total Amount (Rs.)
01	M1	Reinforcement	91.10	65117	5932158.70	17546277.10
		Concrete	891.30	13032	11614118.40	
02	M2	Reinforcement	98.43	65117	6409466.31	17038365.51
		Concrete	815.60	13032	10628899.20	
03	M3	Reinforcement	98.38	65117	6406210.46	17265776.06
		Concrete	833.30	13032	10859565.60	
04	M4	Reinforcement	98.55	65117	6417280.35	17364160.35
		Concrete	840.00	13032	10946880	
05	M5	Reinforcement	98.43	65117	6409466.31	17151743.91
		Concrete	824.30	13032	10742277.60	
06	M6	Reinforcement	91.14	65117	8934763.38	17434200.18
		Concrete	882.40	13032	11499436.80	
07	M7	Reinforcement	98.64	65117	6423140.88	17255399.28
		Concrete	831.20	13032	10832198.40	
08	M8	Reinforcement	90.17	65117	5871599.89	16749410.29
		Concrete	834.70	13032	10877810.40	
09	M9	Reinforcement	90.77	65117	5910670.09	16912284.49
		Concrete	844.20	13032	11001614.40	

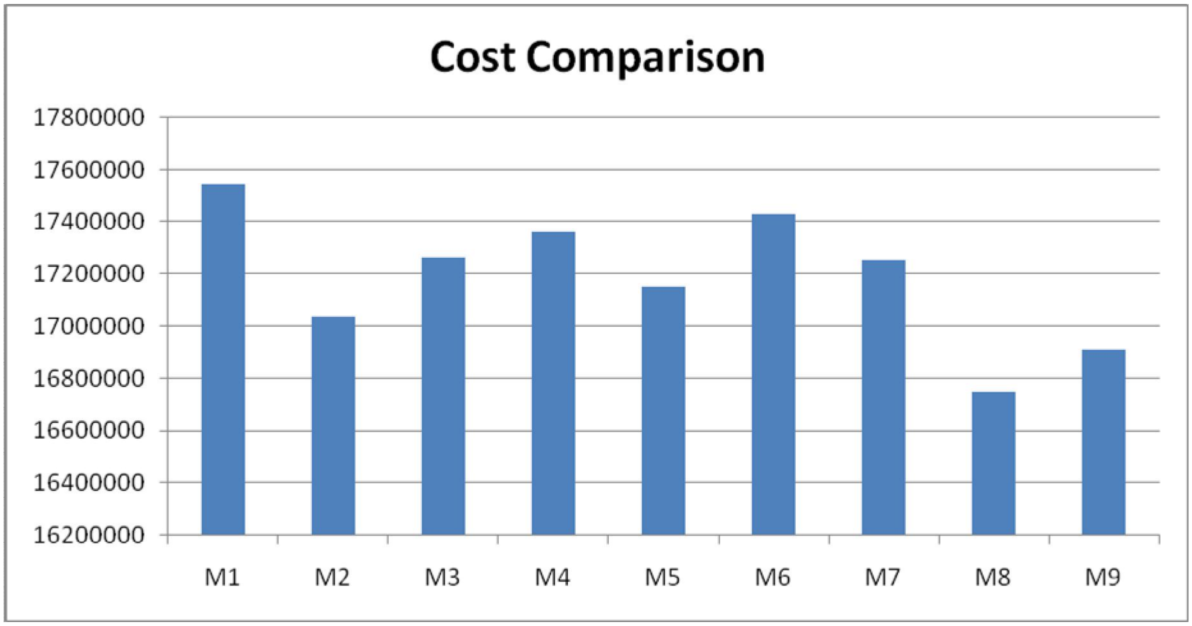

Fig. 18 Comparison of Framing Cost for all models

V. CONCLUSIONS

A. For same loading intensity, model parameters and seismic zone column shapes combination effects seismic behavior of building

B. From Axial Force and bending moment comparison it is found that buildings with Building with Rectangular Column at Corner, Interior column circular and all side column Square have lowest values of axial values than all other column combinations but Building with all Circular columns have lowest vales value of horizontal moments

C. Column base reaction comparison shows that Buildings with Building with Rectangular Column at Corner, Interior column circular and all side column Square gives lower base reaction values but building with Building with all Circular columns has lower horizontal moments

D. Building with Rectangular Column at Corner, Interior column circular and all side column Square shows lower value of displacement than other buildings followed by Building with Square column at corner and all other Circular columns, Building with all Circular columns, Building with Square Column at Corner, Interior column circular and all side column rectangular

E. Change of Colum shape and their combination has effect on storey shear distribution of building, Building with all Circular columns, Building with all Square columns have highest value of base shear compared to other buildings.

F. Cost comparison revels that model Building with Square Column at Corner, Interior column circular and all side column rectangular have lowest framing cost than all other column shape combinations

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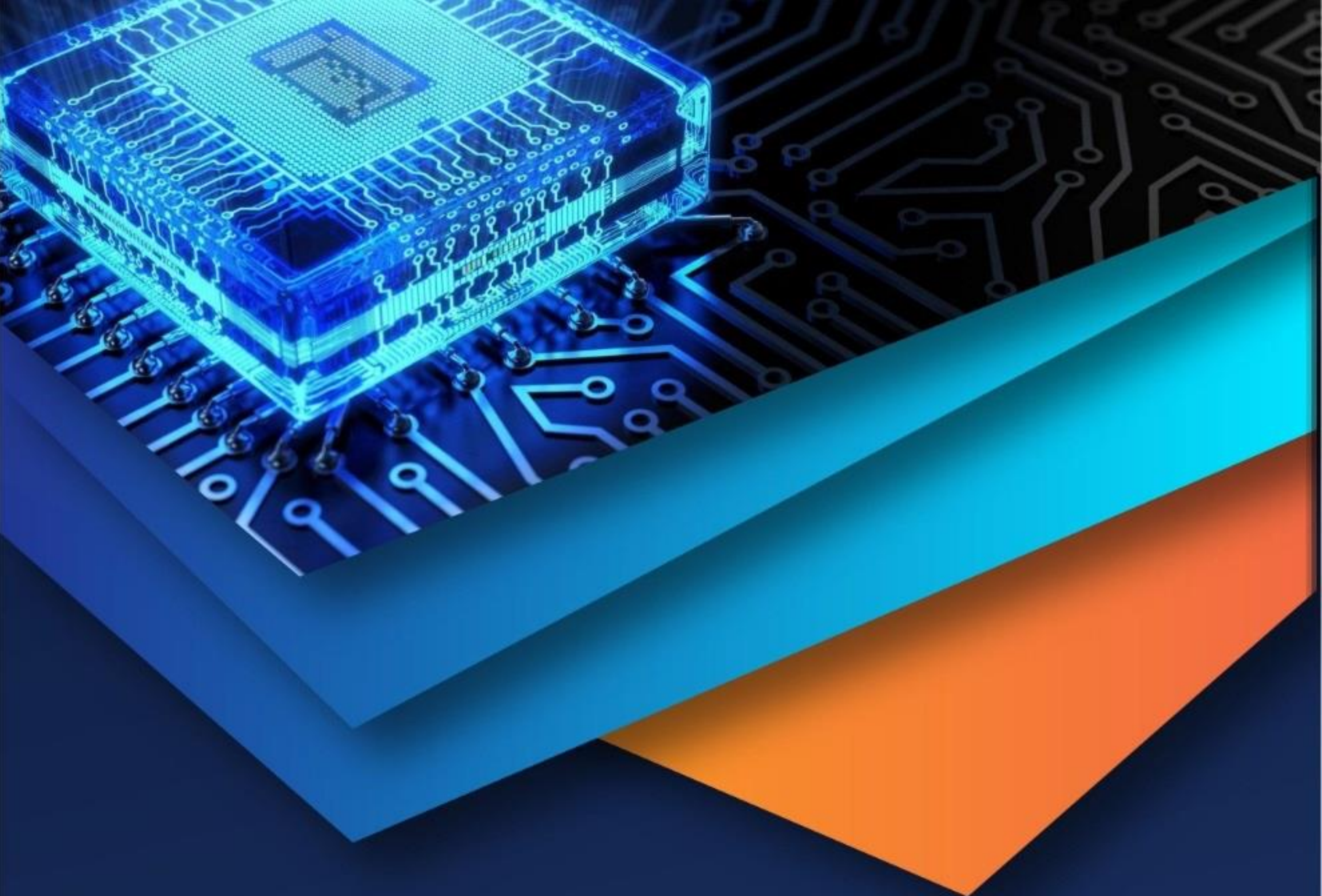

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