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Seismic Analysis of RC Framed Building for Different Position of Shear wall

Anil Baral[1], Dr. SK.Yajdani[2]

P.G. Student, Department of Civil Engineering, A.U. College of Engineering (A), Visakhapatnam, Andhra Pradesh, India[1]

Assistant Professor, Department of Civil Engineering, A.U. College of Engineering (A), Visakhapatnam, Andhra Pradesh, India[2]

ABSTRACT: Shear walls are incorporated in building to resist lateral Forces and support the gravity loads. RC shear wall has high in plane stiffness. Positioning of shear wall has influence on the overall behaviour of the building. For effective and efficient performance of building it is essential to position shear wall in an ideal location. This paper presents the response of building with different positioning of shear wall using both Equivalent Static Method (Seismic Coefficient Method) and Response spectrum Analysis. Five different Model of RCC building, one with no shear wall and other four models with different position of shear wall which is subjected to earthquake load in zone V has been studied .This study also incorporates how the bending moment, shear force for beam and axial Force for column vary with change in positioning of RC shear wall. Building are modelled and analysed using standard package ETABS 2013.

KEYWORDS:Shear wall, Equivalent Static Method, Response spectrum Method, Storey Drift

I. INTRODUCTION

Reinforced concrete building can adequately resist both horizontal and vertical load. Whenever there is requirement for a multistorey building to resist higher value of seismic forces, lateral load resisting system such as shear wall should be introduced in a building. Vertical plate like RC wall introduced in building in addition to beam, column and slab are called shear wall. Shear wall can be provided both along the length and width of the building. Properly designed building with shear wall has shown good performance in past earthquake.Mark Finlet, a noted consulting engineer in USA stated that "We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls." Different positioning of shear wall in building produces varying response in the building during application of lateral force.

Anshuman et al (1) performed both linear and nonlinear analysis of 15 storey multistorey buildingwith 11 bays in longitudinal direction and 3 bays in transverse direction using both STAAD pro 2004 and SAP V 10.0.5 software for different positioning of shear wall in building. The building provided with shear wall in 6th&7th frame and 1st and 12th frame in shorter direction showed deflection with in permissible limit. Both bending moment and shear force were reduced in 1st and 12th frame after introduction of shear wall in building.

Effect of change in shear wall location on storey drift of multistorey building subjected to lateral load was performed by Ashish S. Agrawal et al(2). The study of 25 storey building in zone V is presented with some preliminary investigation which is analysed by changing various position of shear wall to determine parameter like Storey drift, axial load and displacement. This analysis is done by using ETAB. It was observed that placing shear wall away from the centre of gravity resulted in increase in most of member forces. The drift is increased as the height of the building is increased and reduced for the top floor. Location of shear wall had effect on dynamic and axial load of the column.
VikasGovalkaret al (3) studied the behaviour of bare frame and infilled Frame with different positioning of shear wall. The effectiveness of shear wall has been studied by eight models. Four bare frame model and four infilled models with different position of shear wall were considered. The analysis was performed using STAAD pro V8i. Infilled model

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was found to be more economical and superior compared to bare Frame model. Axial force was significantly reduced using the shear wall. Few literature review [P.P.Chandukar et al. (2013), VermaS.K. et al. (2014), ShahzadJamilSardar et al. (2013),Varsha R. Harne(2014)] are available which discuss the positioning of shear wall. However more intense research is required for fixing the ideal location of shear wall in multistorey building. Hence this paper presents the analysis of 10 storey building with different position of shear wall using both equivalent static and Response spectrum method.

II. BUILDING MODELLING AND ANALYSIS

For analysis, G+ 9 storeys and plan area is 17*17 m which is located in Zone V is considered. The storey height is 3m in all the floor including the ground Floor. There are 5 bays in building in both X and Y direction. M25 grade concrete and Fe415 structural steel is used. Building is fixed at the base. All the properties of Building are mentioned below:
Size of Beam in all Direction: 300*600 mm
Size of column: 400*600 mm
Thickness of Shear Wall: 300 mm
Thickness of Slab: 150 mm
Thickness of external Wall: 230 mm
Partition Wall: 2KN/M^2 uniformly applied in slab.
Floor Finish: 1KN/m^2
Importance Factor: 1.5
Response Reduction Factor: 3
Type of soil: medium

Five Models are considered for analysis. Label of beam &column and all models are shown below:

Model 1: Building Without Shear Wall.
Model 2: Building with shear wall on each side on Middle
Model 3: Building with Corner Shear wall extending 3m on each side.
Model 4: Building with shear wall in centre
Model 5: Building with shear wall in corner extending 1.5 m on each side

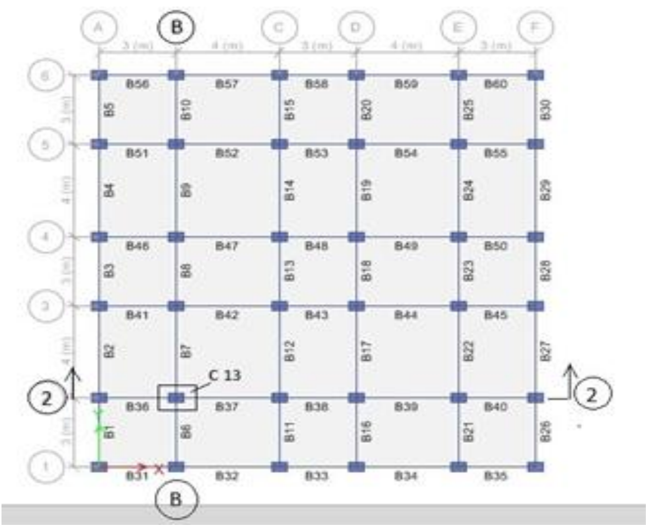

Fig1: Label of Beam for all models

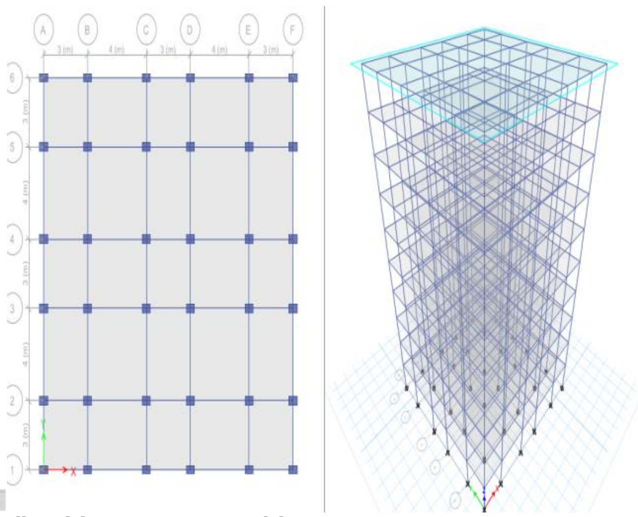

Fig2: Model 1

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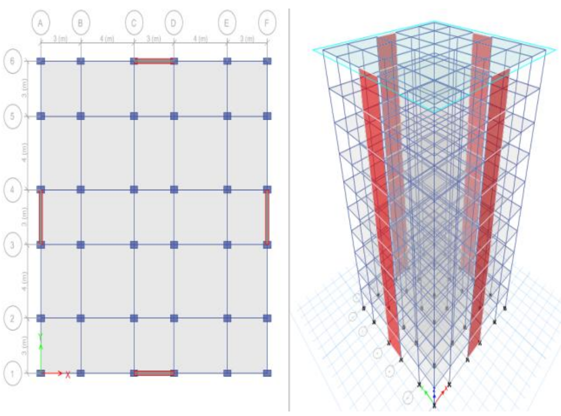
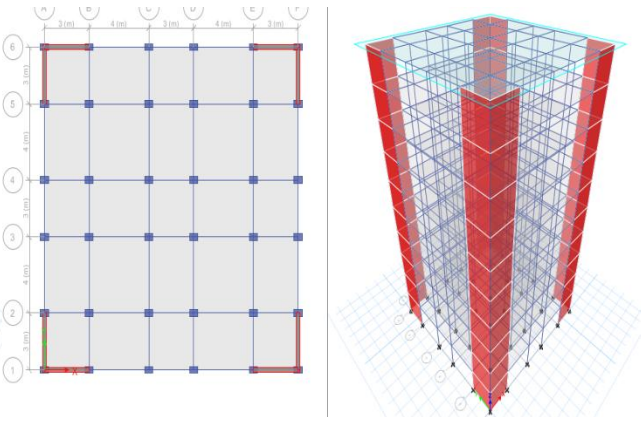

Fig3: Model 2Fig4: Model 3

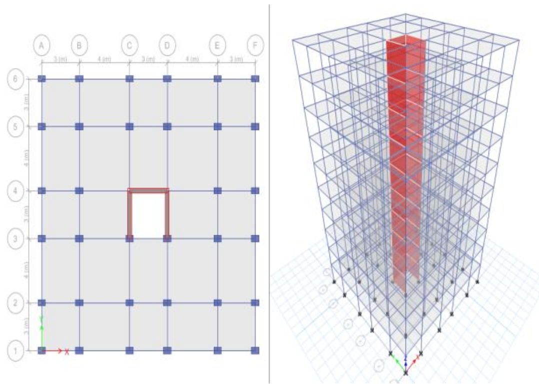
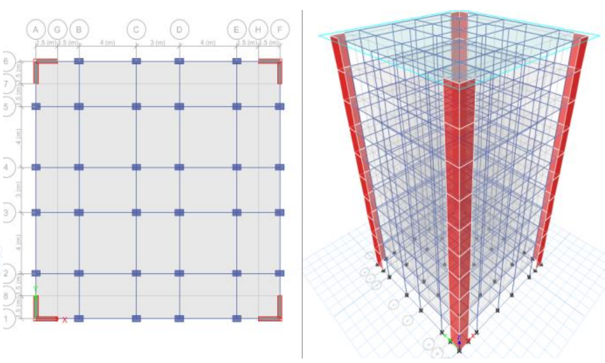

Fig5: Model 4Fig6: Model 5

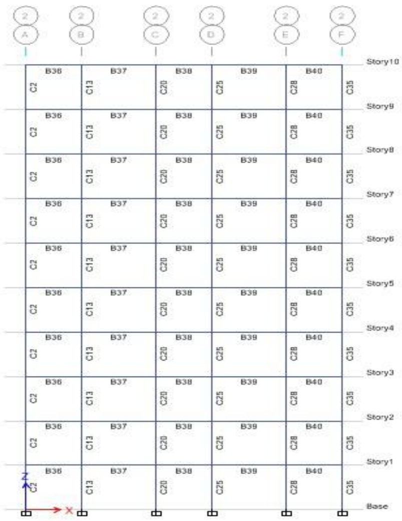

Fig 7: Label of beam and column at section 2-2

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Analysis of building is performed as per IS1893 (part1):2002. Both Equivalent Static analysis and response Spectrum analysis are performed in ETABS 2013.Parameters like Deflection, Storey Drift ,Fundamental period of Vibration, Forces in beam and column were studied.All the Load combination used in the analysis are mention below:

1.5(DL+LL)

$1.2(\mathrm{DL} + \mathrm{LL} \pm EQX)$

$1.2(\mathrm{DL} + \mathrm{LL} \pm EQY)$

$1.5(\mathrm{DL} \pm EQX)$

$1.5(\mathrm{DL} \pm EQY)$

$0.9\mathrm{DL} \pm 1.5EQX$

$0.9\mathrm{DL} \pm 1.5EQY$

$1.2(\mathrm{DL} + \mathrm{LL} \pm RSX)$

$1.2(\mathrm{DL} + \mathrm{LL} \pm RSY)$

$1.5(\mathrm{DL} \pm RSX)$

$1.5(\mathrm{DL} \pm RSY)$

$0.9\mathrm{DL} \pm 1.5RSX$

$0.9\mathrm{DL} \pm 1.5RSY$

Where EQX & EQY and RSX &RSY are lateral force obtained from static analysis and Response spectrum analysis in X and Y direction respectively.

III. RESULT AND DISCISSION

3.1 Fundamental Time period:

Time period forall the model are shown in figure below:

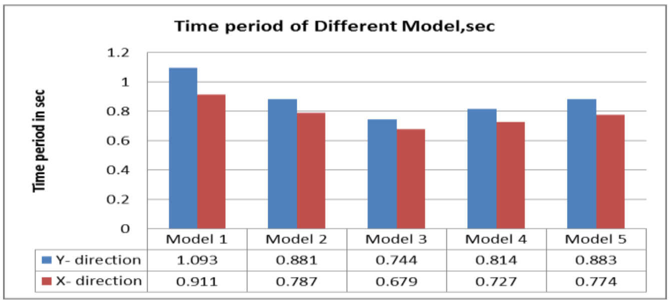

Fig 8: Time period of Models

Model 3 has the least fundamental period of vibration among all the models.

3.2 Modal Mass Participation Factor:

Modal mass participation factor for different model in first 3 modes of vibration in Y- Direction is shown in Fig. below:

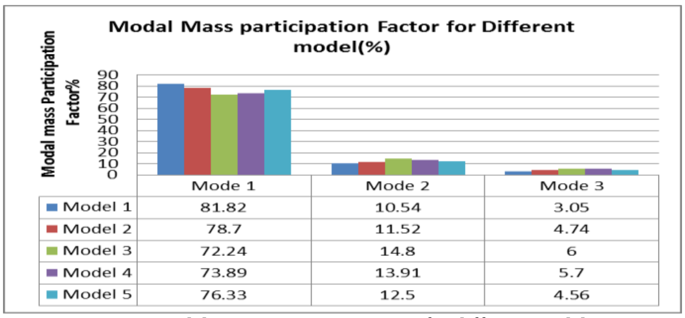

Fig 9: Modal mass Participatin Factor for different model

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Modal Mass participation Factor is found to be higher for model 1 in 1st mode. For 2nd and 3rd mode modal mass participation Factor was higher in case of Model 3.

3.3 Lateral Displacement:

Lateral Displacement of top storey of different model for various Load combinations using Static and Response Spectrum Analysis is shown in table below:

Table 1: Displacement in X-direction

Load Combination	Top Storey Deflection in X- Direction (mm)				
	Model 1	Model 2	Model 3	Model 4	Model 5
1.2DL+1.2 LL+1.2 EQX	59.6	46.6	37.5	44	45.8
1.5 DL +1.5 EQX	74.5	58.2	46.8	55	57.3
0.9 DL + 1.5 EQX	74.5	58.2	46.8	55	57.3
1.2DL+1.2 LL+1.2 RSX	50.1	39.8	37	36.3	39.8
1.5 DL +1.5 RSX	62.6	49.8	46.3	45.4	49.8
0.9 DL + 1.5 RSX	62.6	49.8	46.3	45.4	49.8

Table 2: Displacement in Y-direction

Load Combination	Top Storey Deflection in y- Direction (mm)				
	Model 1	Model 2	Model 3	Model 4	Model 5
1.2DL+1.2 LL+1.2 Eqy	84.4	58.7	45.8	52.6	60.2
1.5 DL +1.5 Eqy	105.5	73.4	57.3	65.9	75.2
0.9 DL + 1.5 Eqy	105.5	73.4	57.3	66.2	75.2
1.2DL+1.2 LL+1.2 Rsy	69.9	49.9	40.5	46.2	51
1.5 DL +1.5 Rsy	87.4	62.4	50.6	57.6	63.7
0.9 DL + 1.5 Rsy	87.4	62.4	50.6	57.3	63.7

Comparison of Lateral displacement of top storey when building is only subjected to Lateral forces as obtained in Static and Response Spectrum Analysis is shown in chart below:

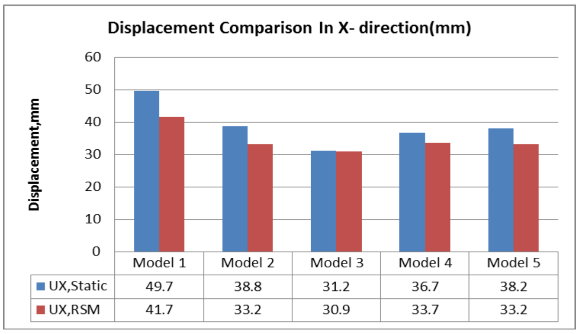

Fig 10: Displacement In X direction

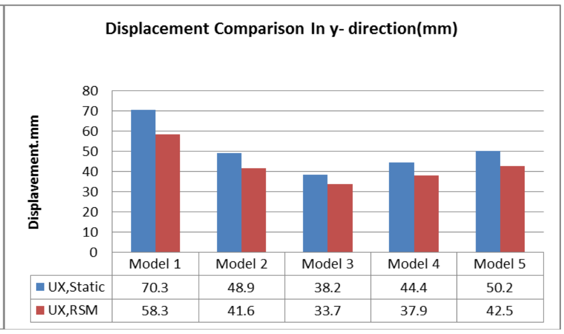

Fig 11: Displacement In Y direction

Lateral displacement is Maximum For Model 1 and Minimum for Model 3 in both static and response spectrum method. Static method of analysis gave higher value of lateral displacement in all the 10 storey model as compared to Response spectrum Method of analysis.

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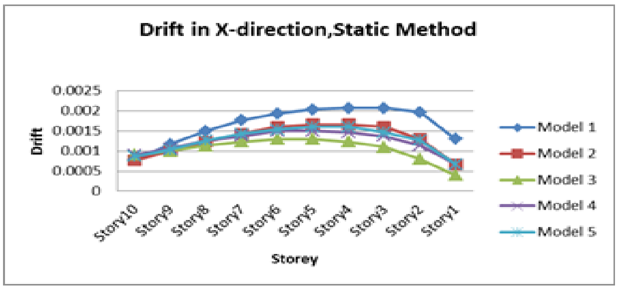
3.4 STOREY DRIFT:

Storey drift is displacement of one level relative to other level above or below. The storey drift of all the five model in X and Y direction using static and RSM is shown in figure below:



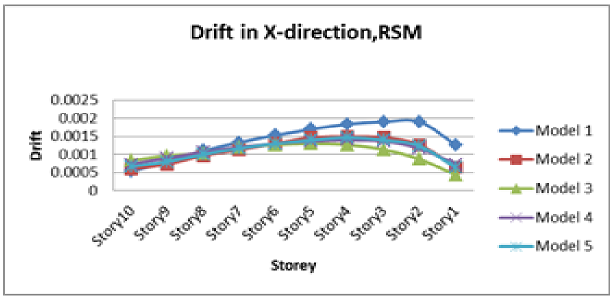
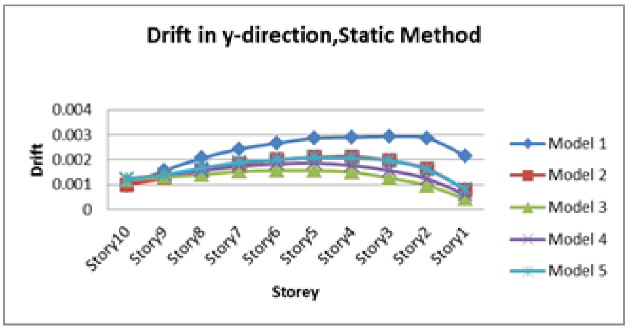


Fig 12 Storey Drift In X direction For static method Fig 13 Storey Drift In X direction For RSM



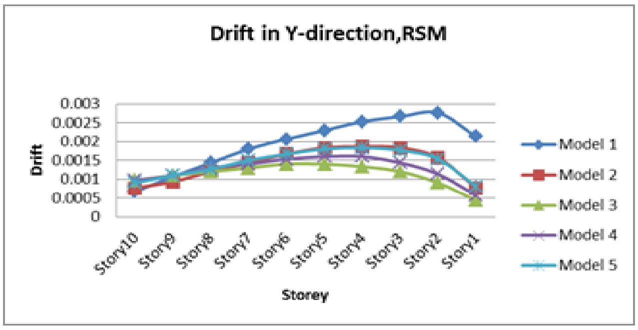


Fig 14 Storey Drift In Y direction For static method Fig 15 Storey Drift In Y direction For RSM

The Storey Drift is minimum in model 3 as compared to other model. Maximum Storey Drift occurred in model 1 which is frame structure with no shear wall. For all the 10 storey Models analysed, storey drift calculated using static method gave higher value of Drift than Response spectrum Analysis.

3.5 BENDING MOMENT AND SHEAR FORCE IN BEAM:

This project also studies the behavior of beam in all the model to find out effect of changing the position of shear wall in bending moment and shear forces. Beam B36, B37, B38, B39, B40 are considered in X- direction and Beam B6, B7, B8, B9. B10 are considered in Y direction for storey 9 as shown in figure1 and figure7. The values of bending moment and shear force shown in the table are for the maximum and minimum values obtained from all the load combination.

Table 3: Bending Moment for beams at Storey 9

Model no.	Bending Moment	Bending Moment for Beam Label in Knm									
		B36	B37	B38	B39	B40	B6	B7	B8	B9	B10
Model 1	(+ve)	40.148	147.72	102.03	147.72	40.14	56.39	160.32	102.13	160.32	56.39
	(-ve)	-72.01	-185.41	-119.62	-185.417	-72.01	-89.39	-198.49	-126.98	-198.49	-89.39
Model2	(+ve)	59.68	145.25	60.53	145.25	59.68	83.74	147.85	44.13	147.85	83.74
	(-ve)	-97.6	-177.33	-79.04	-177.33	-97.6	-120.17	-185.22	-70.89	-185.22	-120.17
Model 3	(+ve)	146.85	171.75	136.36	171.75	146.85	106.12	162.48	143.76	162.48	106.12
	(-ve)	-174.26	-215.03	-148.34	-215.03	-174.26	-147.28	-216.19	-156.76	-216.19	-147.28
Model 4	(+ve)	67.68	160.57	83.28	160.57	67.68	109.41	166.58	77.65	168.09	110.83
	(-ve)	-90.29	-193.36	-102.96	-193.68	-90.29	-137.15	-201.97	-106.01	-206.36	-130.76
Model 5	(+ve)	106.94	166.45	121.8	166.45	106.93	71.86	173.25	128.68	173.25	71.86
	(-ve)	-134.14	-211.544	-135.12	-211.54	-134.14	-115.73	-226.53	-146.36	-226.53	-115.73

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Table 4: Shear Force for beams at Storey 9

Model no.	Shear Force For Beam Label in KN									
	B36	B37	B38	B39	B40	B6	B7	B8	B9	B10
Model 1	69.04	138.2	116.47	138.21	69.04	69.84	136.86	122.37	136.86	69.84
Model2	90.79	133.86	81.07	133.86	90.79	94.88	130.41	67.47	130.41	94.99
Model 3	147.49	152.3	143.5	152.3	147.49	121.55	139.43	141.71	139.43	121.55
Model 4	84.57	143.98	99.67	143.98	84.57	106.7	139.54	93.2	141.9	102.76
Model 5	123.03	150.6	131.95	150.06	123.03	91.84	147.94	130.96	147.94	91.84

3.6 AXIAL FORCE IN COLUMN:

.To understand the behavior of column due to change in position of shear wall axial force for column in different model are studied. The values of axial force shown in the table are for the maximum value obtained from all the Load combination. The values are shown for C13 column.

Table 5: Axial Force in column C13

Storey No.	Column ID	Axial Force in Column(KN)				
		Model	Model 2	Model 3	Model 4	Model 5
10	C 13	255.33	224	172.53	231.09	196.07
9	C 13	508.48	445.65	319.92	458.7	371.73
8	C 13	736.09	656.4	458.09	674.17	531.21
7	C 13	944.59	855.3	615.48	878.39	678.43
6	C 13	1137.5	1044.3	790.76	1072.92	869.76
5	C 13	1320.5	1224.22	973.72	1258.58	1067.94
4	C 13	1561.6	1431.85	1197.79	1483.78	1275.02
3	C 13	1808.4	1667.85	1450.4	1724.13	1544.06
2	C 13	2062.4	1914.32	1711.79	1973.55	1836.34
1	C 13	2328.8	2176.75	1972.16	2237.44	2122.9

IV. CONCLUSION

1. Fundamental Period of vibration was lower For Model 3 having shear wall along the corner edges and higher time period was observed in model 1 having no shear wall in building.
2. From both Equivalent Static analysis and Response Spectrum analysis displacement was higher in case of model 1 and lower in case of Model 3.Static analysis yield higher Value of displacement compared to RSA for all the five Models analysed.
3. Storey drift is highly influenced by the presence of shear wall in the building. Model 3 showed Lower value of storey Drift in comparison to other models. The value of Storey drift obtained for Static analysis was found to be more than the storey Drift obtained From Response spectrum analysis For all the models of 10 storey Building.
4. Shear wall highly influence the forces acting in the Structural member. Higher values of Bending moment and shear force was observed in model 3 for the beams in storey 9 as compared to all other Models. Minimum value of axial force was observed in model3 for C13 column in all the storey of the building compared to other models.

Proper positioning of shear wall results in effective and efficient performance of building during earthquakes. Among the five models studied here model 3 having shear wall along the four corners displayed better result compared to other models.

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NOTATION:

RC	Reinforced Concrete
RSM	Response Spectrum Method
RCC	Reinforced cement concrete

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