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Seismic Analysis of Multi-Storeyed Buildings with Shear Walls, Bracing and Openings

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ABSTRACT: In the present study the effect obtained from the different positions placed in the bracings and shear walls. The parameters for Seismic taken in to consideration are like such as storey displacement, storey drift ratio, storey shear, storey stiffness and time period which are considered to be found over the Response Spectrum Analysis under the consideration of the seismic Zone II as per taking in to the account of IS 1893-Part I (2002) which comes under main code guidelines.

Among all, the models with opening provided with shear walls and bracings are stable against seismic loads with lower storey displacement and storey drift ratio values. Further with high storey stiffness and storey shears. These also have shown lesser time periods. Thus making the structures stable against seismic forces.

KEYWORDS: Shear walls, Bracings, Openings, Response Spectrum Analysis (RSA), Storey displacement, Storey drift ratio, Storey shear, Storey stiffness and Time period.

I. INTRODUCTION

An seismic vibration from the earthquake, huge amount of energy releases from the earth crust. While this energy is formed by a sudden crust and its segment dislocation of the man cause will be volcanic eruption or else it will be a manmade explosion. This dislocation of the crust causes huge destruction. Flow along the surface and at different velocities throughout the surface of the earth.

The opening considered in the Building to provide light and also ventilation along with the climate and its control considered also for rooms.

Here the considered RCC and the component of the structural walls will work in to avoid the lateral forces which will be formed by the wind. If we considered the thickness which will be of the shear walls it's going to be vary from 150 mm to 400 mm. The main consideration Shear walls provides good performance stiffness and also as well as high strength to buildings at a particular direction and also optimum decrease in the lateral displacement which will be of the structures.

Bracings are well performed seismic reduction structural frames, Bracing will strongly reduce the lateral loads in tension and may also in the compression. Taking the several types of bracings are the main X- bracing, V-bracing, Chevron bracing knee bracing and Eccentric bracing.

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II. BUILDING DESCRIPTION

Table 1 shows the parameters and description of the developed models.

TABLE I
DESCRIPTION OF THE MODELS

Sl No.	Parameters	Remarks
1	Structural type	Commercial
2	Total No. of stories	12(G+11)
3	Total height of building from GL to terrace	43m
4	Bays width X-direction	6m
Sl No.	Parameters	Remarks
5	Bays width Y-direction	5m
6	No. of Bays in X-direction	9
7	No. of Bays in Y-direction	7
8	Plan dimensions	54 x 35m
9	Size of column	325 x 675mm
10	Size of beam	325 x 675mm
11	Soil type	Medium
12	Thickness of slab	150mm
13	Thickness of shear wall	250mm
14	Typical storey height	3.25m
15	Base storey height	4m
16	Grade of concrete for columns	M30
17	Grade of concrete for beams	M30
18	Grade of concrete for slab	M30
19	Grade of steel	Fe500
20	Density of concrete block	17.65kN/m ³
21	Density of concrete	25kN/m ³
22	Shape of bracing	X - bracing
23	Dimension of bracing	ISHB 450 @ 92.5kg/m
24	Live load on floor	4kN/m ²
25	Dead load on floor	1.5kN/m ²
26	Wall load	11.18kN/m
27	Soil type	Medium
28	Zone factor	II
29	Importance factor	1.5
30	Response reduction factor	3
31	Poisson's ratio of concrete	0.2

Table 2 shows the details of RC building models with different position of shear walls and bracings considered for seismic analyses. Figure 1 shows the plan, elevation, and 3D view of all the developed RC building models.

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Sl No.	Model	Opening	Shear wall	Bracing
1	M1	-	-	-
2	M2	Centre	-	-
3	M3	Centre	Centre	-
4	M4	Centre	-	Centre
5	M5	Centre	Corner	-
6	M6	Centre	-	Corner
7	M7	Centre	X-4th 5th 6th bays	Y-3rd 4th 5th bays
8	M8	Centre	X-3rd 4th 5th bays	Y-4th 5th 6th bays

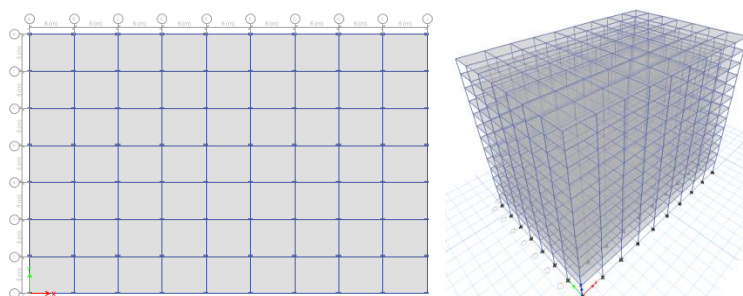


Fig. 1 (a) : Plan of Model M1 Fig. 1 (b) : 3D View of Model M1

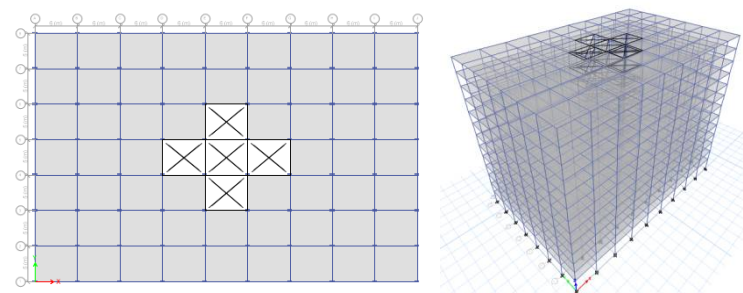


Fig. 1 (c) : Plan of Model M2 Fig. 1 (d) : 3D View of Model M2

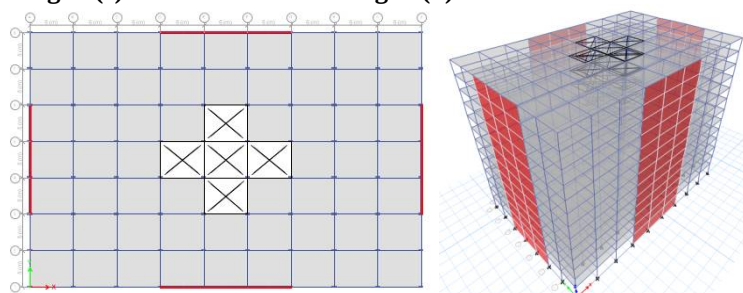


Fig. 1 (e) : Plan of Model M3 Fig. 1 (f) : 3D View of Model M3

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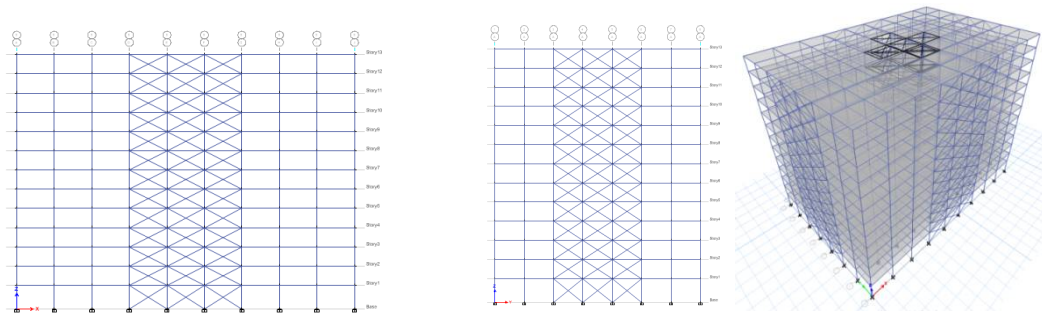


Fig. 1 (g) : Front plan of Model M4 Fig. 1 (h) : Side plan of Model M4 Fig. 1 (i) : 3D View of Model M4

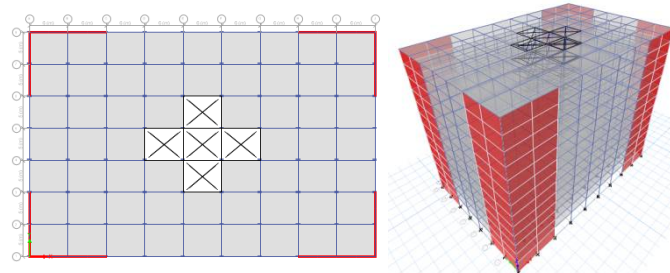


Fig. 1 (j) : Plan of Model M5 Fig. 1 (k) : 3D View of Model M5

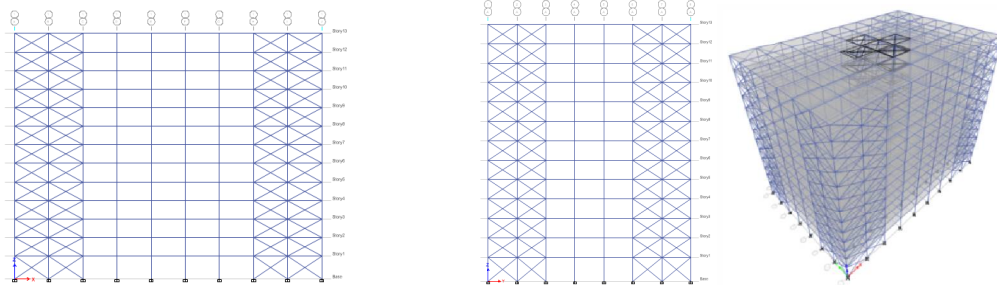


Fig. 1 (l): Front plan of Model M6 Fig. 1 (m): Side plan of Model M6 Fig. 1 (n): 3D View of Model M6

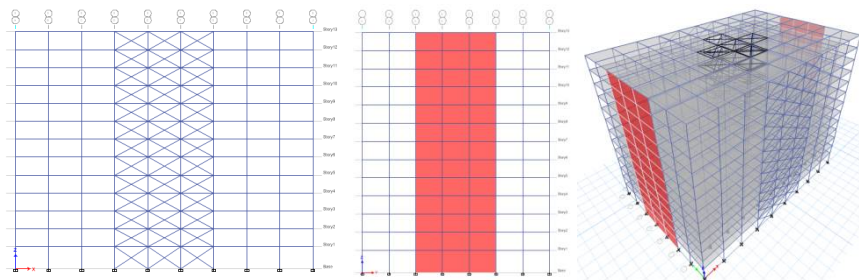


Fig. 1 (o): Front plan of Model M7 Fig. 1 (p): Side plan of Model M7 Fig. 1 (q): 3D View of Model M7

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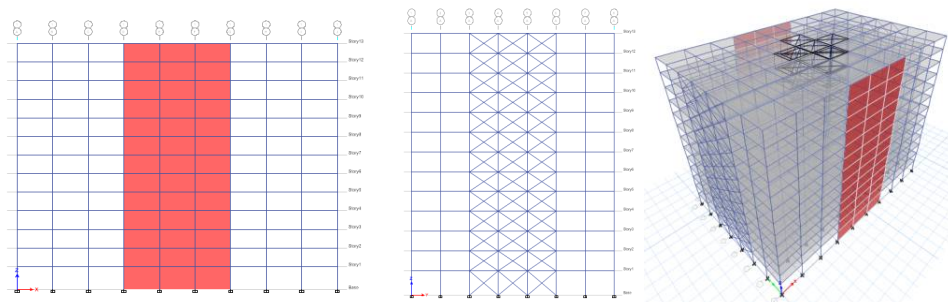


Fig. 1 (r) : Front plan of Model M8 Fig. 1 (s) : Side plan of Model M8 Fig. 1 (t) : 3D View of Model M8

Fig. 1 : Plan ,elevation and 3D view of all the developed RC building models with different position of shear walls and bracings.

III. SEISMIC ANALYSIS

The developed RC building models are subjected to Response Spectrum Analysis (RSA) as per IS 1893–Part 1 (2002) codal provisions. Different seismic parameters like storey displacement, storey drift ratio, storey shear, storey stiffness and time period are obtained from the analyses for all the developed building models.

IV. RESULTS AND DISCUSSION

Figures 2 to 10 show the variation of storey displacement, storey drift ratio, storey shear, storey stiffness and time period over the number of storeys in X and Y directions obtained for all the RC building models by RSA.

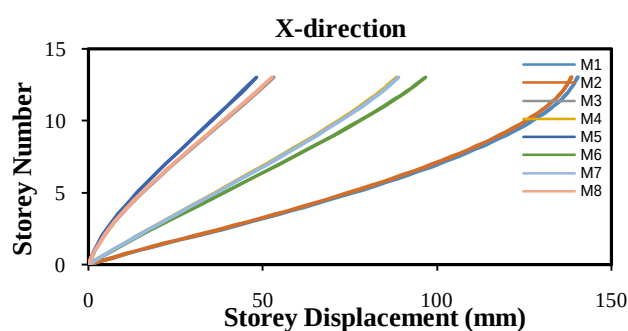


Fig. 2 : Variation of storey displacement in X-direction

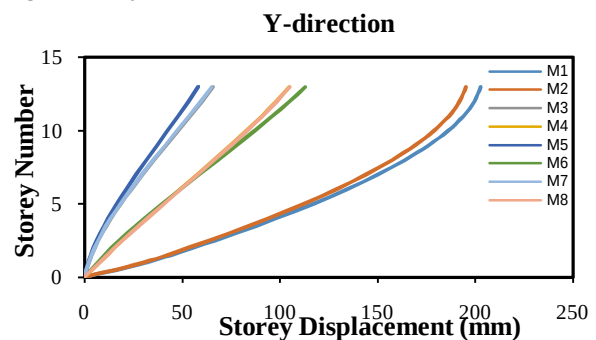


Fig. 3 : Variation of storey displacement in Y-direction

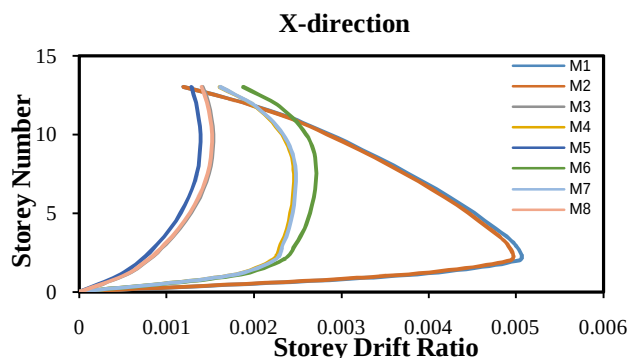


Fig. 4 : Variation of storey drift ratio in X-direction

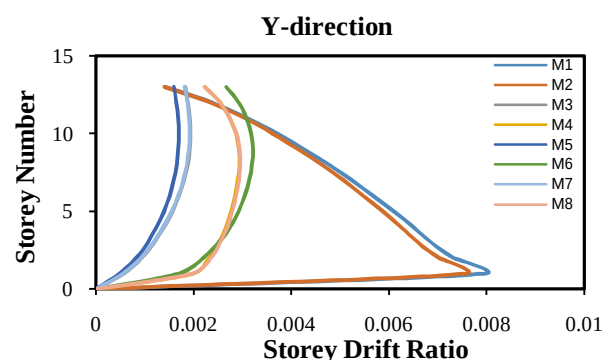


Fig. 5 : Variation of storey drift ratio in Y-direction

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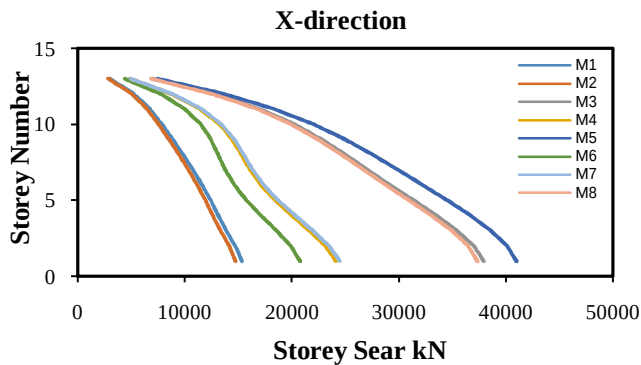


Fig. 6 : Variation of storey shear in X-direction

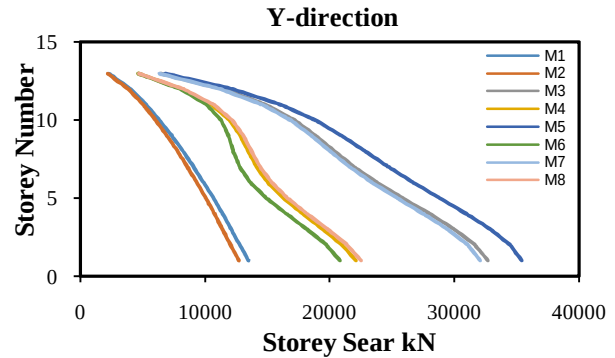


Fig. 7 : Variation of storey shear in Y-direction

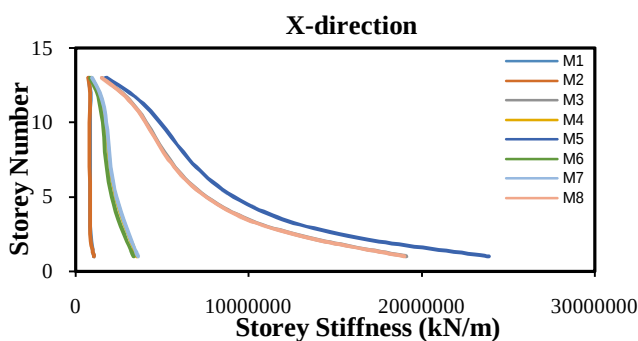


Fig. 8 : Variation of storey stiffness in X-direction

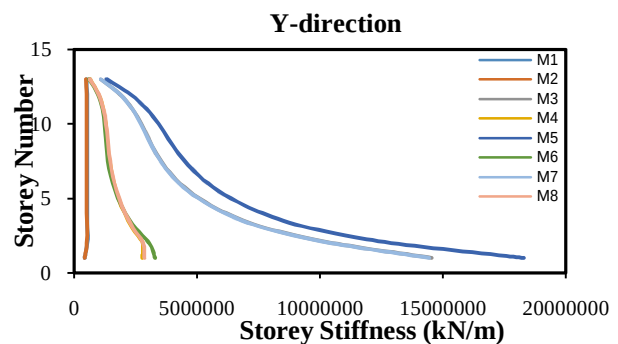


Fig. 9 : Variation of storey stiffness in Y-direction

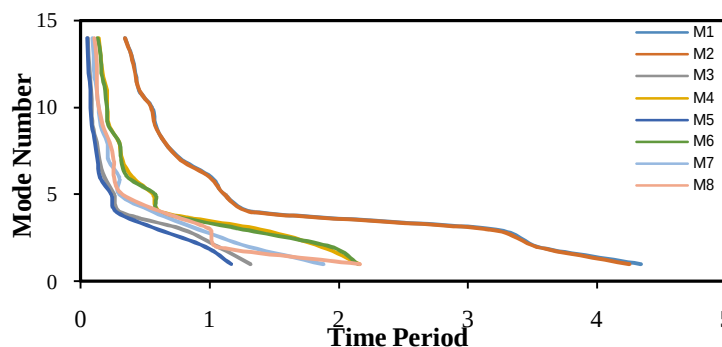


Fig. 10 : Variation of time period of all the models

From Figs. 2 to 10, it can be observed that all the models show different kind of variation w.r.t. storey displacement, storey drift ratio, storey shear and storey stiffness. However, similar kind of variation is exhibited from all the models w.r.t. time period.

Figures 11 to 15 show the variation of maximum storey displacement, storey drift ratio, storey shear, storey stiffness and time period for all the building models by RSA.

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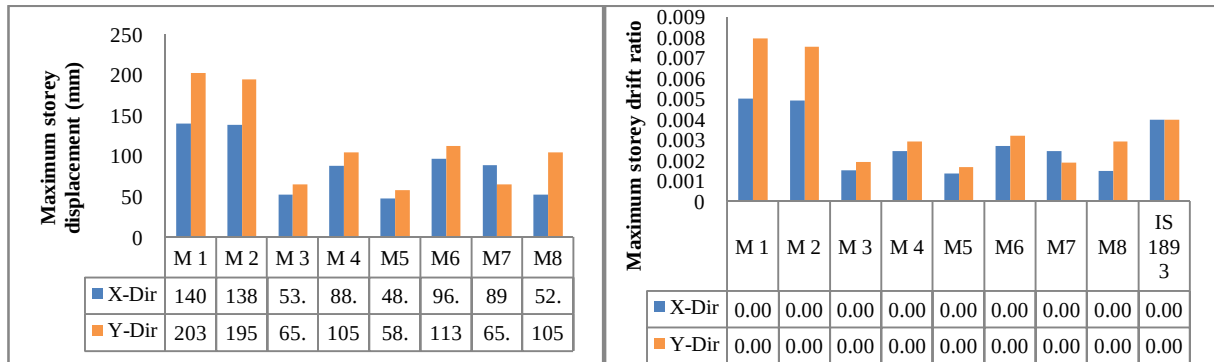


Fig. 11: Maximum storey displacement in X and Y Direction

Fig. 12: Maximum storey drift ratio in X and Y direction

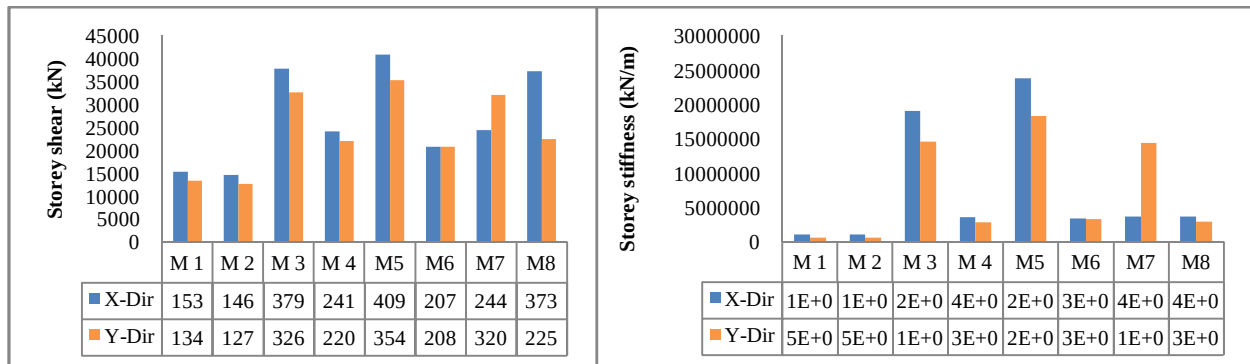


Fig. 13: Maximum storey shear in X and Y directions

Fig. 14: Maximum storey stiffness in X and Y directions

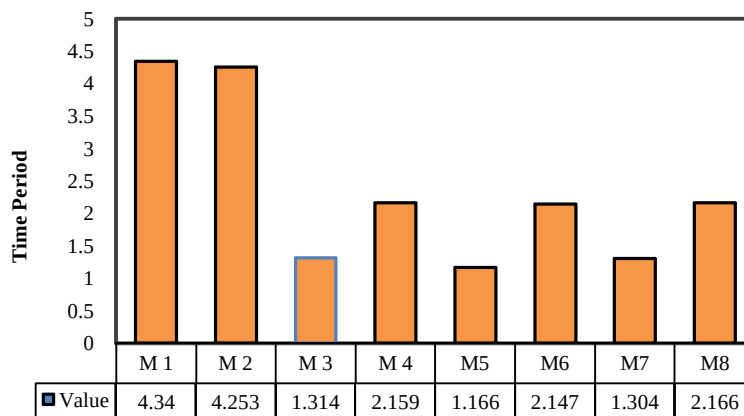


Fig. 15: Maximum Time period of all the models

The Maximum values of storey displacement is observed in Model M1 than the other developed RC building models and least value of maximum displacement is observed in Model M5 in both X and Y direction is shown in Fig. 11.

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The Maximum storey drift ratio obtained from all models except Model M1 and M2 are within the maximum allowable limit as specified by Cl. 7.11.1 of IS 1893–Part 1 (2002). Further, Model M5 in X and Y direction show minimum value of drift ratio value than the other considered models is shown in Fig. 12.

The Maximum values of storey shear is observed in Model M5 than the other developed RC building models and least value of maximum storey shear is observed in Model M2 in both X and Y direction is shown in Fig. 13.

The Maximum value of storey stiffness is observed in Model M5 than the other developed RC building models and least value of maximum storey shear is observed in Model M2 in both X and Y directions is shown in Fig.14.

The Maximum value of time period is observed in model M1 than the other developed RC building models and least value of maximum time period is observed in Model M5 is shown in Fig. 15.

V. CONCLUSION

In the present study, effect of different positions of bracings (X-bracing) and shear walls on performance of 11 storeyed RC building due to seismic is investigated using ETABS software (Version 2016). Seismic parameters such as storey displacement, storey drift ratio, storey shear, storey stiffness and time period are found out using Response Spectrum analysis (RSA) for seismic Zone II considering the stipulation laid down in IS 1893-Part I (2002) codal guidelines.

The important conclusions drawn from the present study are explained below considering the results obtained from RSA.

1. Different variation of displacement obtained from RSA over the number of storeys in X and Y directions for all the developed RC building models. However, displacements in X-direction are observed to be more than that in Y-direction in M1, M2, M3, M4, M5, M6, and M8. Further model M7 displacement in Y-direction is observed to be more than that in X-direction.
2. Different variation of storey drift ratio obtained from RSA over the number of storeys in both X and Y directions for all the developed RC building models. However, storey drift ratios in X-direction are observed to be more than that in Y-direction in M1, M2, M3, M4, M5, M6 and M8 models. Further model M7 storey drift ratio in Y-direction is observed to be more than that in X-direction.
3. Different variation of storey shear obtained from RSA over the number of storey in both X and Y directions for all the developed RC building models. However, storey shear in X-direction are observed to be more than that in Y-direction in M1, M2, M3, M4, M5, M6 and M8 models. Further model M7 storey shear in Y-direction is observed to be more than that in X-direction.
4. Different variation of storey stiffness obtained from RSA over the number of storeys in both X and Y directions for all the developed RC building models. However, storey stiffness in X-direction are observed to be more than that in Y-direction in M1, M2, M3, M4, M5, M6 and M8 models. Further model M7 storey stiffness in Y-direction is observed to be more than that in X-direction.
5. All models show similar kind of variation in case of time period for different modes of vibration Model M3 and M5 minimum value of displacement in X and Y directions respectively than the other considered models.
6. Maximum storey displacement is observed in Model M1 than the other developed RC building models and least value of maximum storey displacement is observed in Model M5 in both X and Y direction.
7. Maximum storey drift ratio obtained from all models except Model M1 and M2 are within the maximum allowable limit as specified by Cl. 7.11.1 of IS 1893–Part 1 (2002). Further, Model M5 in X-direction and M5 in Y-direction show minimum value of drift ratio value than the other considered models.
8. Maximum values of storey shear is observed in Model M5 than the other developed RC building models and least value of maximum storey shear is observed in Model M2 in both X and Y direction.
9. Maximum value of storey stiffness is observed in Model M5 than the other developed RC building models and least value of maximum storey shear is observed in Model M2 in both X and Y directions.
10. Maximum value of time period is observed in model M1 than the other developed RC building models and least value of maximum time period is observed in Model M5.

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Concluding remarks: Among all, the models with opening provided with shear walls and bracings are stable against seismic loads with lower storey displacement and storey drift ratio values. Further with high storey stiffness and storey shears. These also have shown lesser time periods thereby making the structures to be safe against seismic forces.

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