International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 08 | Aug 2020 www.irjet.net p-ISSN: 2395-0072

A COMPARATIVE STUDY ON SEISMIC PERFORMANCE OF CONVENTIONAL AND MONOLITHIC RC STRUCTURES

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Abstract : *In the present study, the performance of G+10 storeyed conventional and monolithic RC models in different zones are investigated for earthquake forces using ETABS software. Seismic parameters such as storey displacement, storey drift ratio, storey shear and overturning moment are obtained using response spectrum analysis for seismic zones II, III, IV and V as per IS 1893-Part 1 (2016). For the considered plan, number of stories, and dimensions of the RC structural components, both conventional and monolithic RC models safely resist the earthquake w.r.t. storey drift ratio as the maximum value is within the permissible limits as specified by IS 1893-Part 1 (2016). Monolithic RC models show higher value of storey shear and lesser value of overturning moment as compared to conventional RC models. Monolithic RC models are preferred in high seismic zones as they show high structural performance in resisting displacement, drift and over turning moment.*

Keywords: *Conventional models, Monolithic models, ETABS, Response spectrum analysis*

I. INTRODUCTION

Construction of multi-storeyed structures require high level technology and advanced construction equipment like Aluform and Mivan shuttering technologies which are widely used in the construction of conventional and monolithic structures. Earthquake is a sudden movement of tectonic plates within the earth's crust. This sudden movement is caused due to volcanic eruption, mining activity, nuclear tests, landslides, rupture along fault plane of rocks etc. This results in sudden release of energy which forms the seismic waves in the crust of earth and these waves travels to surface causing earthquake. Earthquake magnitude is measured by using Richter's scale. As per IS 1893-Part 1 (2016), depending upon the seismic severity there are four zones in India.

II. BUILDING DESCRIPTION

Table 1 shows the parameters considered in modelling conventional and monolithic RC models.

Table 1: Parameters of the developed conventional and monolithic RC models

Sl. No.	Parameter	Remarks
1	Structure type	B+G+10
2	Total No. of stories	12
3	Total height of building from GL to terrace	38.5 m
4	Total height of building from base to terrace	42.00 m
5	Size of column	300 x 900 mm
6	Size of beam	230 x 600 mm
7	Thickness of slab upto 3x3 m size	125 mm
8	Thickness of slab above 3x3 m size	150 mm
9	Shear wall thickness	300 mm
10	Typical storey height	3.5 m
11	Base storey height	3.5 m
12	Height of parapet wall	1.2 m
13	Grade of concrete for structural components	M 30

Sl. No.	Parameter	Remarks
14	Grade of steel	Fe 500
15	Density of concrete	25 kN/m^3
16	Live load on floor	2 kN/m^2
17	Floor finish on all floors	1.65 kN/m^2
18	Floor finish on toilet floors	5.15 kN/m^2
19	Soil type	Medium
20	Zones	II, III, IV and V
21	Importance factor (EQ)	1
22	Response reduction factor for conventional structure	5
23	Response reduction factor for monolithic structure	3

Tables 2 and 3 show the model identity for conventional and monolithic models in different seismic zones of IS 1893-Part 1 (2016).

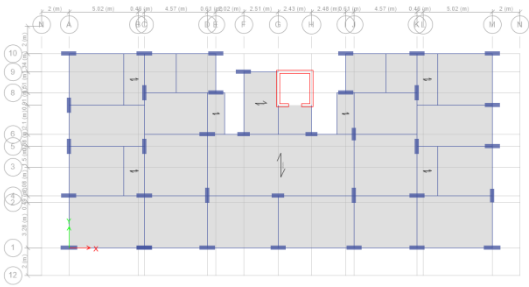
Table 2: Model identity for conventional RC models

Sl. No.	Model	Seismic zone
1	CS II	II
2	CS III	III
3	CS IV	IV
4	CS V	V

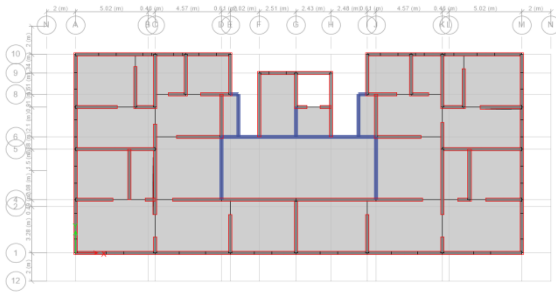
Table 3: Model identity for monolithic RC models

Sl. No.	Model	Seismic zone
1	MS II	II
2	MS III	III
3	MS IV	IV
4	MS V	V

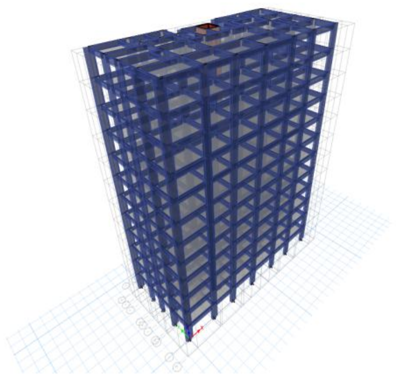
Figure 1 shows the plan and 3D views of the developed conventional and monolithic RC models in all the seismic zones.



Plan

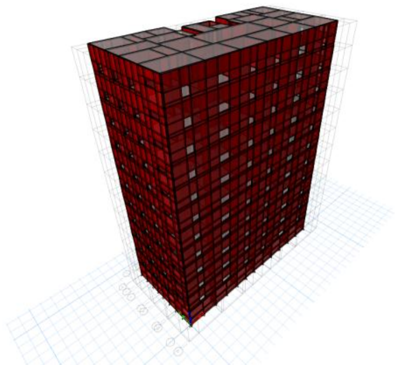


Plan



3D view

(a) : Conventional Model



3D view

(b) : Monolithic Model

Fig. 1 Plan and 3D views of all the developed models

III. SESMIC ANALYSIS OF MODELS

Using ETABS 2017 software, the developed conventional and monolithic RC models are subjected to Response Spectrum Analysis(RSA) as per IS 1893-Part 1 (2016). At each storey level, seismic parameters such as displacement, drift ratio, shear and overturning moments are obtained from the analysis for all the models in seismic zones II, III, IV and V.

IV. RESULTS AND DISCUSSION

Figures 2 to 9 show the variation of storey displacement, storey drift ratio, storey shear and overturning moment over the number of storeys in both X and Y directions obtained for all the conventional and monolithic RC models by RSA.

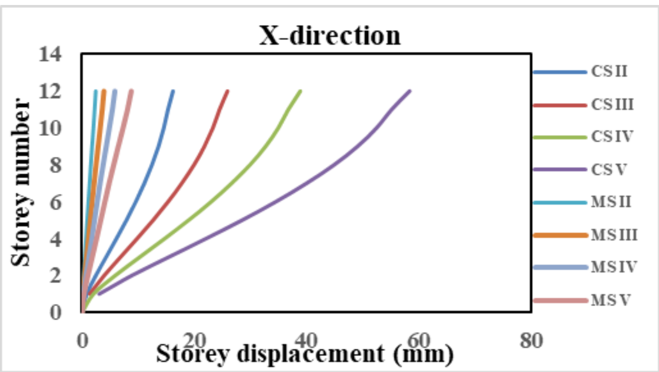


Fig. 2 : Storey displacement in X-direction of all the models

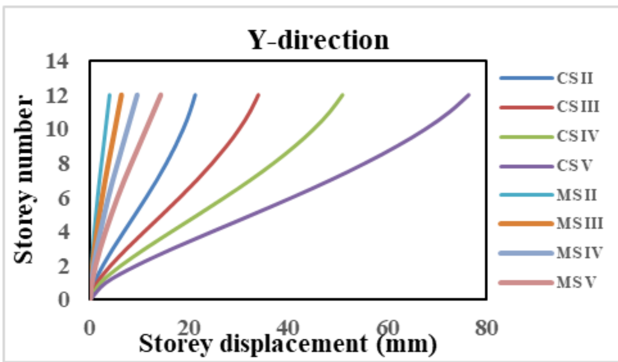


Fig. 3 : Storey displacement in Y-direction of all the models

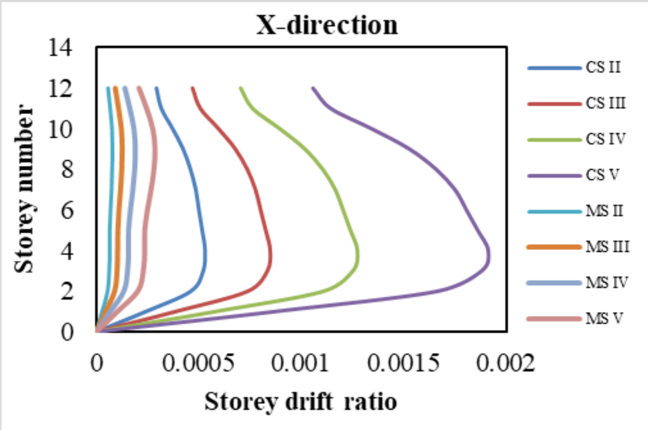


Fig. 4 : Storey drift ratio in X-direction of all the models

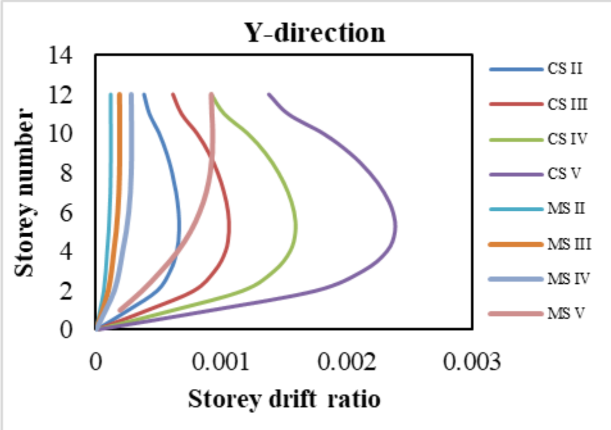


Fig. 5 : Storey drift ratio in Y-direction of all the models

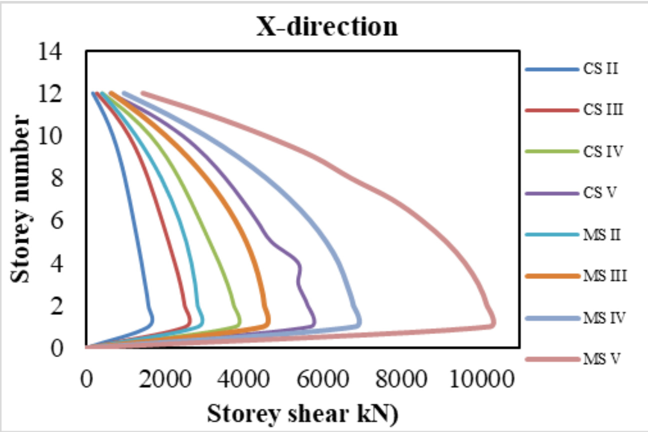


Fig. 6 : Storey shear in X-direction of all the models

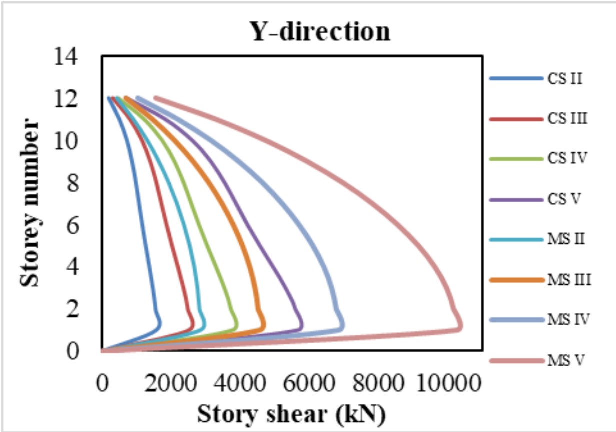


Fig. 7 : Storey shear in Y-direction of all the models

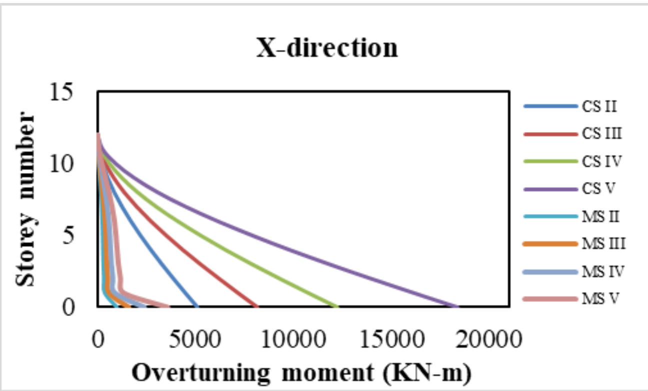


Fig. 8 : Overturning moment in X-direction of all the models

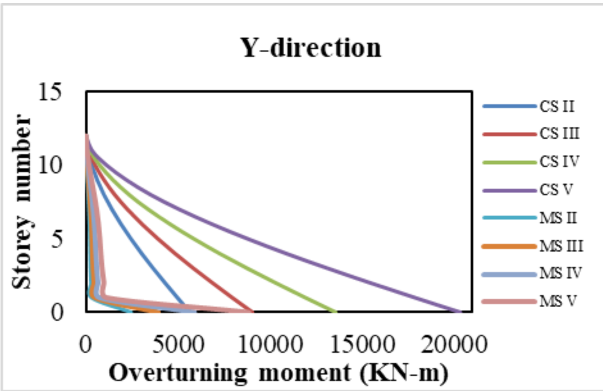


Fig. 9 : Overturning moment in Y-direction of all the models

From Figs. 2 to 9, Monolithic RC models show higher value of storey shear and lesser value of overturning moment as compared to conventional RC models. Storey displacement and storey drift are less for monolithic RC models as compared to conventional RC models.

Figures 10 to 17 show the variation of maximum storey displacement, storey drift ratio, storey shear and overturning moment for all the conventional and monolithic RC models by RSA.

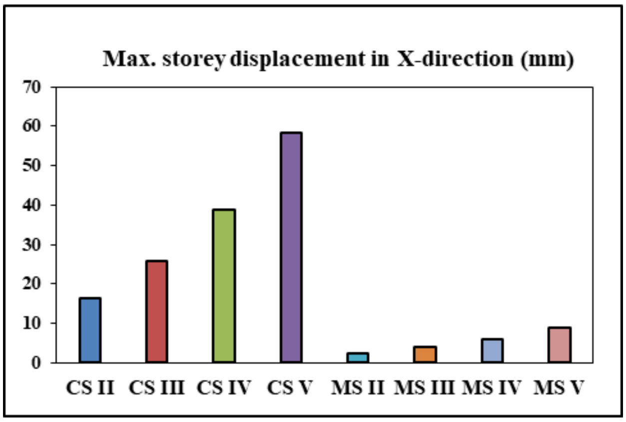


Fig. 10 : Maximum storey displacement in X-direction for all the models

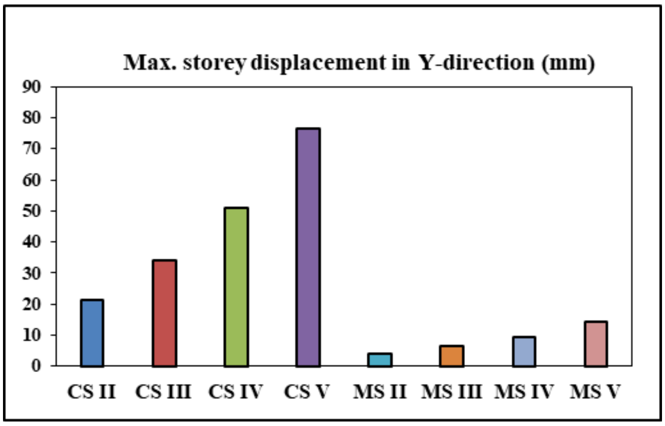


Fig. 11 : Maximum storey displacement in Y-direction for all the models

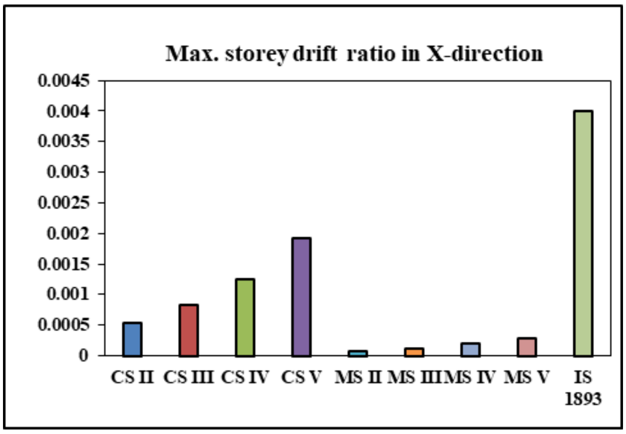


Fig. 12 : Maximum storey drift ratio in X-direction for all the models

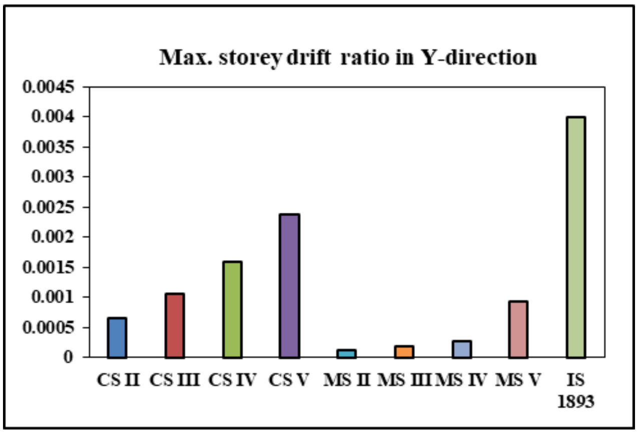


Fig. 13 : Maximum storey drift ratio in Y-direction for all the models

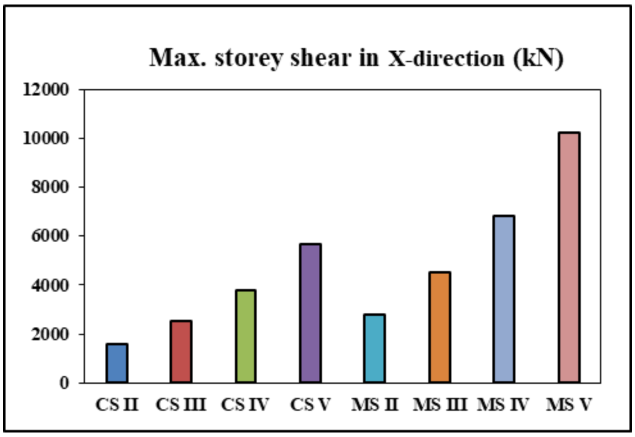


Fig. 14 : Maximum storey shear in X-direction for all the models

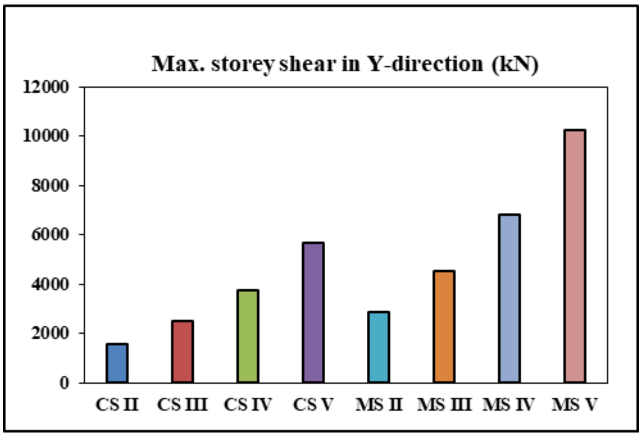


Fig. 15 : Maximum storey shear in Y-direction for all the models

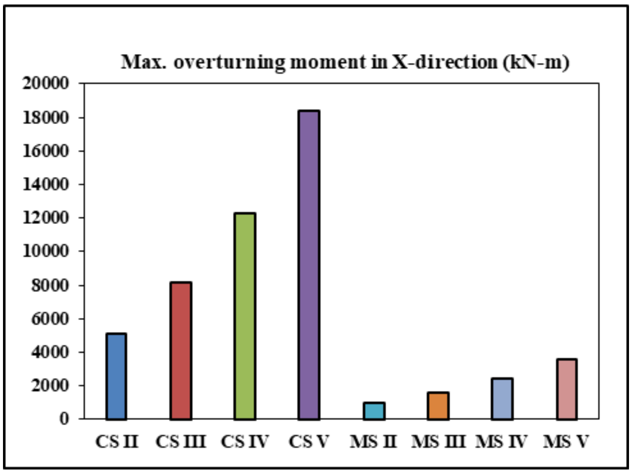


Fig. 16 : Maximum overturning moment in X-direction for all the models

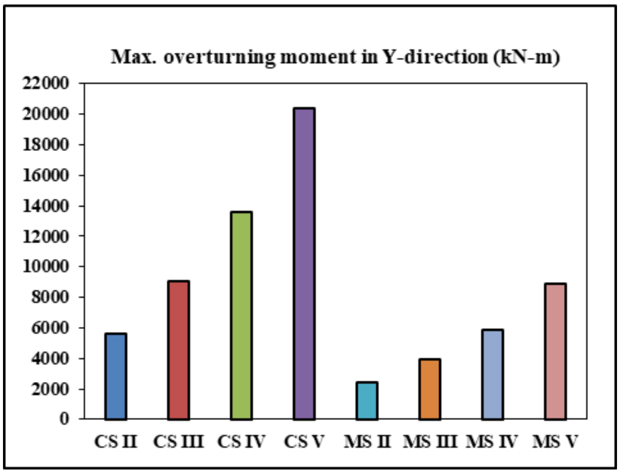


Fig. 17 : Maximum overturning moment in Y-direction for all the models

From Figs. 10 and 11, it is observed that in both conventional and monolithic RC models, the maximum storey displacement increases with increase in seismic zones in both X and Y directions. Maximum displacement values in Y direction are observed to be more than the displacement values in X direction for all the models. However, less value of maximum storey displacement is observed in monolithic RC models than the conventional RC models for all the seismic zones in both X and Y directions.

From Figs. 12 and 13, it is observed that in both conventional and monolithic RC models, the maximum storey drift ratio increases with increase in seismic zones in both X and Y directions. Maximum storey drift ratio values in Y-direction are observed to be more than the drift ratio values in X-direction for all the models. However, less value of maximum storey drift ratio is observed in monolithic RC models than the conventional RC models for all the seismic zones in both X and Y directions. However the maximum storey drift ratio value observed in all the models is within the allowable limit as specified in Cl.7.11.1 of per IS 1893-Part 1 (2016).

From Figs. 14 and 15, it is observed that in both conventional and monolithic RC models, maximum storey shear increases with increase in seismic zones in both X and Y directions. Maximum value of storey shear in both X and Y directions are observed to be almost equal. However, less value of maximum storey shear is observed in conventional RC models than the monolithic RC models for all the seismic zones in both X and Y directions.

From Figs. 16 and 17, it is observed that in both conventional and monolithic RC models, the maximum overturning moment increases with increase in seismic zones in both X and Y directions. Maximum overturning moment values in Y-direction are observed to be more than the overturning moment values in X-direction for all the models. However, more value of maximum overturning moment is observed in conventional RC models than the monolithic RC models for all the seismic zones in both X and Y directions.

V. CONCLUSIONS

In the present study, the performance of G+10 storeyed conventional and monolithic RC models in different zones are investigated for earthquake forces using ETABS software. Seismic parameters such as storey displacement, storey drift ratio, storey shear and overturning moment are obtained using response spectrum analysis for seismic zones II, III, IV and V as per IS 1893-Part 1 (2016).

The important conclusions drawn from present study are as follows.

1. All the conventional and monolithic RC models exhibit similar kind of variation in storey displacement. However, storey displacement in Y-direction is found to be more than that of X-direction.
2. For both conventional and monolithic RC models, the maximum storey displacement increases with increase in seismic zones in both X and Y directions. Maximum displacement values in Y direction are observed to be more than the displacement values in X direction for all the models. However, less value of maximum storey displacement is observed in monolithic RC models than the conventional RC models for all the seismic zones in both X and Y directions.

3. All the conventional and monolithic RC models exhibits similar kind of variation in storey drift ratio. However, storey drift ratio in Y-direction is found to be more than that of X-direction.
4. For both conventional and monolithic RC models, the maximum storey drift ratio increases with increase in seismic zones in both X and Y directions. Maximum storey drift ratio values in Y-direction are observed to be more than the drift ratio values in X-direction for all the models. Less value of maximum storey drift ratio is observed in monolithic RC models than the conventional RC models for all the seismic zones in both X and Y directions. However the maximum storey drift ratio value observed in all the models is within the allowable limit as specified in Cl.7.11.1 of per IS 1893-Part 1 (2016).
5. All the conventional and monolithic RC models exhibit similar kind of variation in storey shear. However, storey shear in X and Ydirections are found to be relatively equal.
6. For both conventional and monolithic RC models, maximum storey shear increases with increase in seismic zones in both X and Y directions. Maximum value of storey shear in both X and Y directions are observed to be almost equal. However, less value of maximum storey shear is observed in conventional RC models than the monolithic RC models for all the seismic zones in both X and Y directions.
7. All the conventional and monolithic RC models exhibit similar kind of variation w.r.t. overturning moment. However overturning moment in X-direction is found to be less than that of Y-direction.
8. For both conventional and monolithic RC models, the maximum overturning moment increases with increase in seismic zones in both X and Y directions. Maximum overturning moment values in Y-direction are observed to be more than the overturning moment values in X-direction for all the models. However, more value of maximum overturning moment is observed in conventional RC models than the monolithic RC models for all the seismic zones in both X and Y directions.

Concluding Remarks : For the considered plan, number of stories, and dimensions of the RC structural components, both conventional and monolithic RC models safely resist the earthquake w.r.t. storey drift ratio as the maximum value is within the permissible limits as specified by IS 1893-Part 1 (2016). Monolithic RC models show higher value of storey shear and lesser value of overturning moment as compared to conventional RC models. Monolithic RC models are preferred in high seismic zones as they show high structural performance in resisting displacement, drift and over turning moment.

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