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The optimum location of the shear wall in irregular plan multi-storey RC frame structure under lateral loads

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ABSTRACT

Shear wall is the structural element which is commonly used to resist lateral load in multi-storey RC frame structure. Shear walls have terribly high in-plane strength and stiffness, which resist horizontal loads due to earthquake and wind and support vertical loads simultaneously, creating them quite advantageous in several structural engineering applications. The scope of present work is to determine the optimum position of the shear wall in plan irregular multi-Storey RC frame structure. Effectiveness and efficient of RC walls are investigated by the used of four different models, whereas model A is without shear wall structural system and other are different arrangements of the shear wall. A G+19 storey RC frame structure situated in zone V, soil type is medium and applied seismic load and wind load as per IS Code. Response spectrum method is used to analysis in ETABS 16.1.0 software and determines some parameter like base shear, storey drift and Storey displacement of a structure.

Keywords: *Base share, Story displacement, Plan irregular building, Shear wall, Storey drift.*

1. INTRODUCTION

Generally, shear walls are a structural vertical member which is allowed to resist the combination of axial load, shear and moment which is elicited by horizontal forces and vertical forces transfer to the reinforced concrete wall from alternative support [1][2]. Shear walls are a structural element which is used to increase the rigidity to resist both the vertical and horizontal load. If RC framed multi-storey structure is designed as bare frame, the column and beam sizes become larger and quite heavier and so many problems arises at their joint, where placing and vibrating of concrete are congested and displacement is large which is induces by heavy loads in structural member, therefore, shear walls are an essential for safety, durable, and economy [3][4]. When the shear wall is situated in an optimum location in the RC frame structure then they are acting as an efficient horizontal load resisting system [7]. The scope of present work is to determine the advantageous location of the shear wall in plan irregular multi-storey RC frame structure. Effectiveness and efficient of RC wall are investigated by the used of four different models, whereas model A is without shear wall and other are different arrangements of the shear wall. All these models are compared with the help of different parameters like base shear, storey drift and storey displacement of a structure. A G+19 storey RC frame structure situated in severe zone V, soil type is medium and applied earthquake load according to IS: 1893 (PART-I):2002, and wind load as per IS: 875 (PART-III):1987. Response spectrum method is used for analysis by using ETABS 16.1.0 software and structure was assumed to be OMRF.

2. OBJECTIVE

The main objective of the study are:

- To analyze the multi-storey RC framed structure (G+19) for seismic zone V by Response spectrum method.
- To determine the optimum position of shear walls in respect of lateral displacement by taking an irregular plan of the RC frame structure.
- To determine some parameters like base shear, Storey displacement and storey drifts.

3. METHODOLOGY

3.1 Modal Data

Number of storey	G+19
Height of storey	3 m
Grade of steel	HYSD 500
Grade of concrete	M25
Size of column	(400x600) mm
Beam size	(300x500) mm
Thickness of slab	125 mm
Shear wall thickness	300 mm
Speed of wind	50 m/s
Terrain category	2
Earthquake zone	Severe(V)
Response reduction factor	3
Type of soil	Medium(II)
Importance factor	1
Assumed load as per IS code	
Dead	1 kN/m^2
Live	2 kN/m^2
230 mm thick wall	10.53 kN/m
Floor finishing	1.5 kN/m^2

3.2 Different arrangement of model

In this study different location of shear wall is taken for different Model A follows:

- Model A- Bare frame.
- Model B- Shear wall at the center core.
- Model C- Corner Shear wall.
- Model D- Center core and corner shear wall.

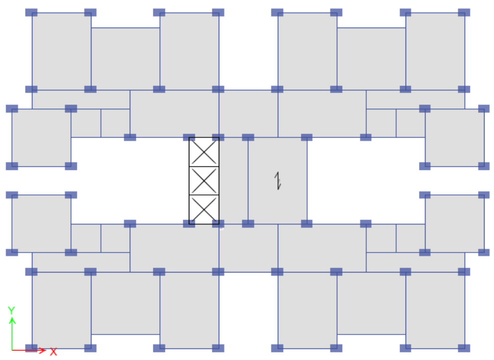

Chart-1: Model A

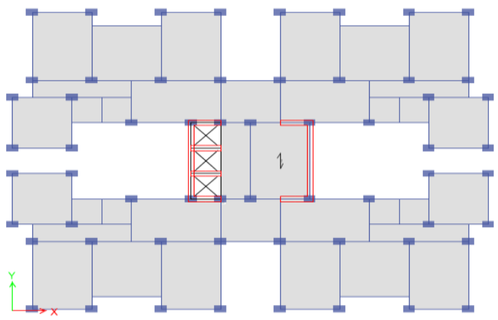

Chart-2: Model B

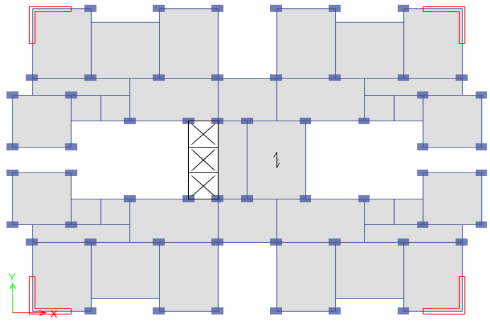

Chart-3: Model C

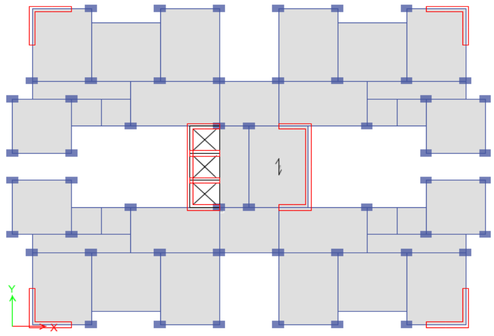

Chart-4: Model D

4. RESULT AND DISCUSSION

4.1 Base Shear

The base shear of an RC frame structure with and without a shear wall is calculated by response spectrum method in ETABS.

Table 1: Base shear for a different model

Model	Base shear (kN)	
	X- direction	Y- direction
A	3262.67	2436.97
B	3895.44	3646.04
C	3605.26	2934.63
D	4129.29	3942.24

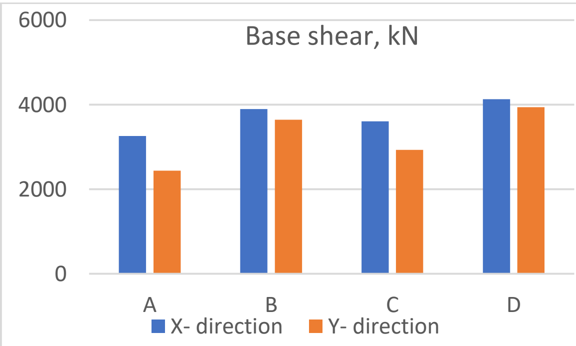

Chart-5: Base shear for a different model

From the analysis, it observed that due to the provision of shear wall base shear of building increases. Among all the different locations of the shear wall, the building having a shear wall at center core and corner (Model D) shows higher base shear.

4.2 Storey Displacement

Table-2: Storey displacement along the x-direction.

Story No.	Story displacement, mm			
	Model			
	A	B	C	D
20	89.617	82.545	84.361	80.016
19	86.841	79.649	81.38	76.962
18	83.807	76.519	78.059	73.638
17	80.369	73.099	74.44	70.066
16	76.545	69.373	70.546	66.317
15	72.368	65.35	66.409	62.311
14	67.884	61.061	62.033	58.064
13	63.137	56.544	57.411	53.608
12	58.171	51.842	52.583	48.978
11	53.033	47	47.591	44.216
10	47.771	42.061	42.482	39.365
9	42.432	37.069	37.304	34.469
8	37.061	32.068	32.111	29.578
7	31.705	27.103	26.956	24.743
6	26.407	22.223	21.896	20.022
5	21.211	17.475	16.996	15.48
4	16.163	12.915	12.361	11.199
3	11.31	8.658	8.122	7.286
2	6.714	4.846	4.62	3.977
1	4.352	1.704	1.674	1.351
Base	0.000	0.000	0.000	0.000

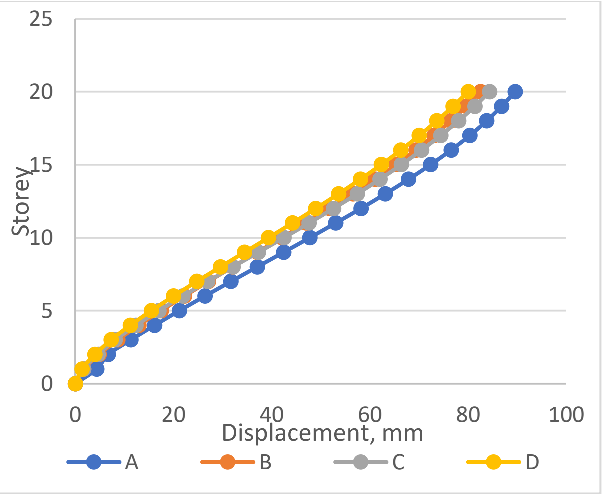

Chart-6: Storey displacement along x-direction

Table-3: Storey displacement along the y-direction

Story No.	Story displacement, mm			
	Model			
	A	B	C	D
20	123.108	102.864	106.886	91.452
19	118.909	98.301	102.274	87.119
18	114.293	93.399	97.568	82.613
17	109.19	88.216	92.66	77.943
16	103.616	82.785	87.475	73.238
15	97.615	77.128	82.073	68.321
14	91.249	71.273	76.448	63.192
13	84.583	65.253	70.554	57.889
12	77.68	59.112	64.449	52.457
11	70.603	52.898	58.192	46.945
10	63.417	46.664	51.84	41.406
9	56.183	40.472	45.45	35.893
8	48.962	34.386	39.079	30.467
7	42.181	28.478	32.787	20.123
6	35.969	22.832	26.635	15.348
5	29.648	17.534	20.653	10.951
4	23.258	12.667	14.837	7.037
3	16.845	8.395	9.641	3.746
2	10.502	4.789	5.538	1.267
1	4.414	1.826	2.11	1.267
Base	0.000	0.000	0.000	0.000

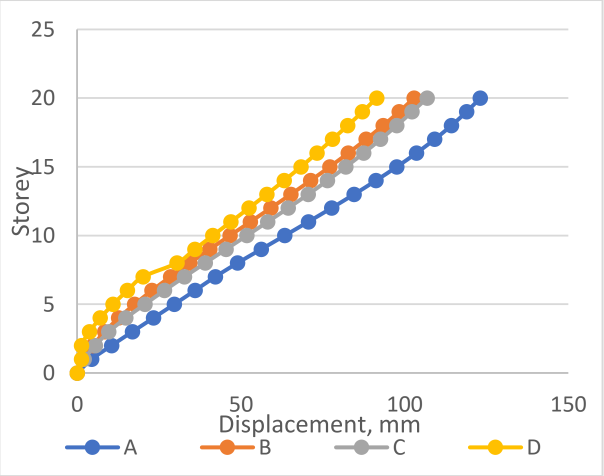

Chart-7: Storey displacement along the y-direction

Table-4: Max. Storey displacement

Model	Max. Storey displacement, mm	
	X- direction	Y- direction
A	89.617	123.108
B	82.545	102.864
C	84.361	106.886
D	80.016	91.452

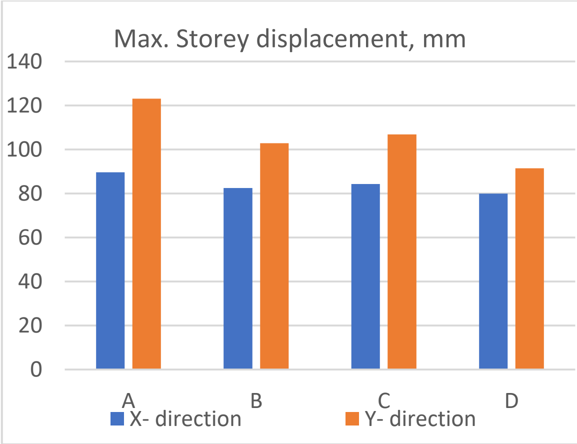

Chart 8: Max. Storey displacement

It observed that provision of shear wall reduces the displacement of a building. Among all the different location of the shear wall, the shear wall at center core and corner (Model D) shows less displacement.

4.3 Storey Drift

Storey drift is the drift or displacement of one level of multi-storey RC frame structure relative to the other level below [8]. According to IS 1893(Part 1): 2002, *clause* ***7.11.1.*** Storey drift should be less than 0.004 times of storey height.

So, storey drift limitation is (0.004 × 3000) mm = 12mm. The numerical value which is got from the analysis is shown in the table are within the limitation.

Table-5: Max. Storey drift

Model	Max. Storey drift, mm	
	X- direction	Y- direction
A	5.379	7.241
B	5.012	6.262
C	5.207	6.449
D	4.916	5.593

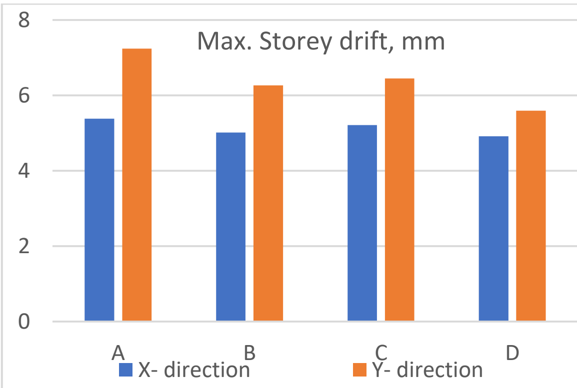

Chart-9: Max. Storey drift

It observed that provision of shear wall also reduces the storey drift of a building. Among all the different location of the shear wall, center core and corner shear wall (Model D) shows less storey drift.

5. CONCLUSION

In this study, Response spectrum analysis was preformed by taking G+19 storey building of irregular plan on medium soil and zone V and comparired by providing different arrangements of the shear wall to determine the advantageous location with the help of different parameters.

The following specific conclusion from present work are:

- Seismic behavior of RC frame structure can be affected by providing a shear wall which increases the strength and stiffness of structure, and also reduce storey displacement and storey drift.
- The irregular plan with shear wall gives less drift and less displacement as compared to irregular plan without a shear wall, and irregular plan with the shear wall is having a higher value of base shear than the bare frame.
- The storey drift and storey displacement of the center core and corner shear wall are less as compare to without shear wall, center core shear wall, and corner shear wall.
- Hence we conclude that shear wall at center core and corner is the optimum location of the shear wall.

6. REFERENCES

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