Analysis of RC Frame Structure Using Shear Wall Under Seismic Action for Existing Building

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Abstract: **In recent decades the goal of building rehabilitation and strengthening has gained research attention and numerous techniques have been developed to achieve this.In India where we have a huge population and during renovation work for strengthen purpose of a building we have to vacate the building which ultimately disturbs the living life of humans. This study shows that without disturbing planning of building it is possible to provide strength and increase ductility of building. For that shear walls are placed at parallel sides of existing building frame to improve the seismic capacity of the structure.**

Keywords—Frame Structure;RC Shear wall; ETABS.

1. INTRODUCTION

Many reinforced concrete (RC) buildings have either collapsed or experienced different levels of damage during past earthquakes. Many investigations have been carried out on buildings that were damaged or ruined by different earthquake. They usually cannot provide the required ductility, lateral stiffness and strength, which are definitely lower than the limits imposed by the modern building codes. Due to low lateral stiffness and strength, vulnerable structures are subjected to large displacement demands, which cannot be met adequately as they have low ductility. This study investigates the performance of exterior RC shear walls that are placed parallel to the building's sides [1]. Installing a shear wall to existing building structural system will surely improve the seismic capacity of the structure [2].

2. ANALYTICAL STUDY

For this study generate two models in E-tabs software one is without shear wall and second one with shear walls at exterior corners of the building model.

2.1 Model Properties and analytical results

A model of (G+8) story reinforced concrete framed building is located in the seismic zone-IV and on medium soil [3]. The building measures 25 m, each way in plan at all floor levels. Story heights are about 3m at all elevations and bottom story is 3.5 m in height. The roof and floors are of concrete slabs consisting of a 125 mm slab thickness. The beams in the building are of (0.3 m x 0.5 m) and columns in the building are (0.3m x 0.75m). The material properties are fck = 20 Mpa, fck = 25 Mpa and Fy = 415 Mpa [4].

2.1.1 ANALYTICAL RESULTS OF MODEL-1

After analysis with different load combination, results for displacement and shear in different stories and natural time period of vibration in case of earthquake show in tabular form below.

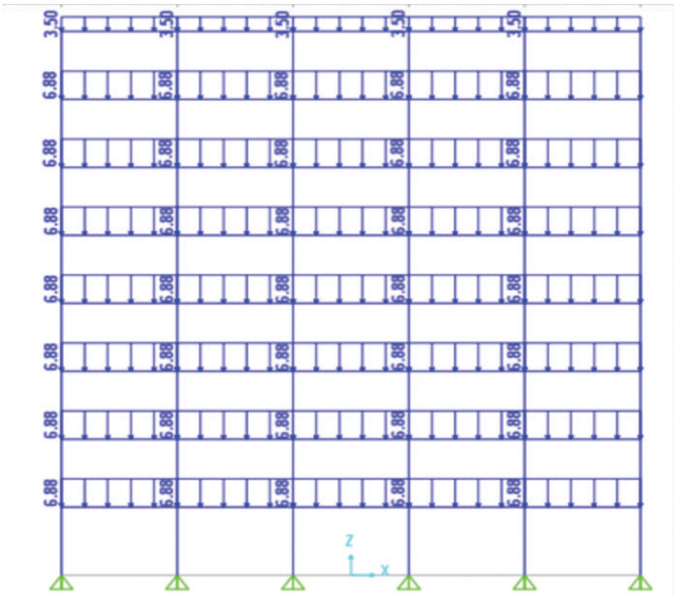

Fig.1 Load Diagram

Table1: Displacement in X and Y direction

Displacement in X and Y direction (mm)			
Sr. No.	**Story**	**Displacement in X**	**Displacement in Y**
1	Story 1	2.42	5.15
2	Story 2	5.93	10.08
3	Story 3	9.7	14.83
4	Story 4	13.33	19.29
5	Story 5	16.63	23.28
6	Story 6	19.38	26.6
7	Story 7	21.44	29
8	Story 8	22.79	30.3

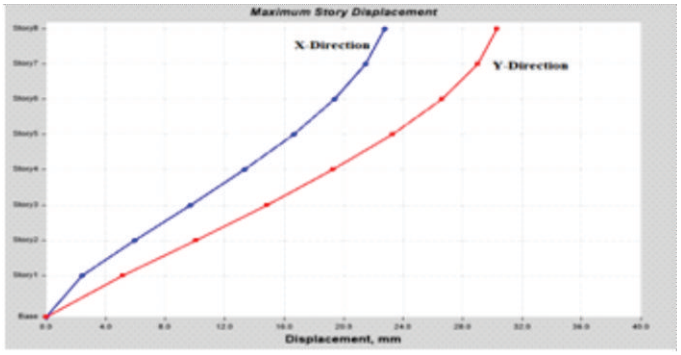

Fig.2 Displacement In X and Y Direction

Table 2: Story Shear in X and Y Direction

Story	Shear X	Shear Y
	KN	**KN**
Story8	538.2917	379.7228
Story7	1070.6927	755.2902
Story6	1464.8825	1033.3604
Story5	1741.5928	1228.5579
Story4	1921.5553	1355.5074
Story3	2025.5016	1428.8335
Story2	2074.1635	1463.1606
Story1	2088.3975	1473.2016

Table 3: Natural Time Period of vibration for Case-1 due to EQX and EQY

Mode	Period (sec)
1	2.169
2	1.572
3	1.53
4	0.707
5	0.497
6	0.475
7	0.413
8	0.287
9	0.277
10	0.256

Table 4: Column forces results for critical section

Building framed structure without external shear wall				
Load Case	P(Load) (KN)	V(Shear) (KN)	T(Torsion) (KN-m)	M(Moment) (KN-m)
EQ X	517.58	48.4271	0.0376	167.802
EQ X	517.58	48.4271	0.0376	93.3849
EQ X	517.58	48.4271	0.0376	16.8043
EQ Y	489.23	0.1034	-0.0109	-0.8151
EQ Y	489.23	0.1034	-0.0109	-0.9603
EQ Y	489.23	0.1034	-0.0109	-1.0832

Table 5: Beam forces result for critical section

Load Case	Station	P(Load)	Shear force	Moment
EQX	0.8125	4.5328	11.5177	21.962
EQX	1.25	4.5328	11.5177	16.922
EQX	1.6667	2.3666	10.1967	11.692

2.1.2 ANALYTICAL RESULTS OF MODEL- 2

R.C. framed structure of (G+8) story, located in seismic zone IV on medium soil strata. Material properties, geometrical properties, and assign loads are same as of case-1. But in this problem addition of external shear wall has been placed at the corner of structure and at center of exterior sides. In this case load of shear wall at exterior sides considered in analysis. Thickness 200mm and M 30 grade of concrete used for shear wall.

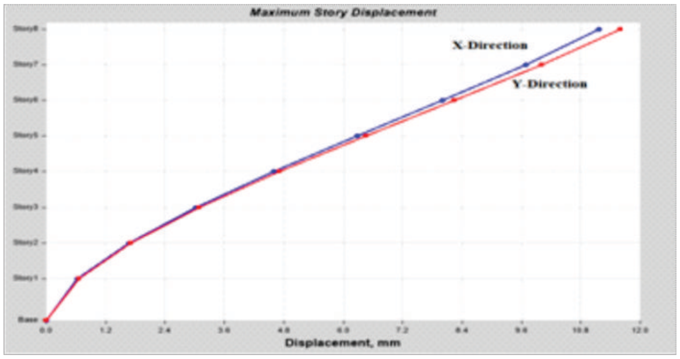

Fig.3 Displacement In X and Y Direction

Table 4: Displacement in X direction

Displacement in X and Y direction (mm)			
Sr. No.	**Story**	**Displacement in X**	**Displacement in Y**
1	Story 1	0.63	0.65
2	Story 2	1.66	1.69
3	Story 3	3.02	3.09
4	Story 4	4.59	4.71
5	Story 5	6.27	6.455
6	Story 6	8.0	8.244
7	Story 7	9.69	10.01
8	Story 8	11.16	11.66

Fig.4 Position of Shear wall in Building Frame

Table 5: Story Shear in X and Y direction

Story	Shear X	Shear Y
	KN	**KN**
Story8	1190.6054	1153.5285
Story7	2513.9244	2435.6628
Story6	3494.2976	3385.5459
Story5	4182.9095	4052.7597
Story4	4630.8779	4486.7946
Story3	4889.2552	4737.0918
Story2	5009.0858	4853.0564
Story1	5041.4648	4884.3219

Table 6: Natural period of vibration of Model – 2 in case of EQX and EQY

Mode	Period (sec)
1	0.635
2	0.615
3	0.379
4	0.165
5	0.16
6	0.096
7	0.094
8	0.091
9	0.075
10	0.07

Table 7: Column forces results for critical section

Building framed structure without external shear wall				
Load Case	P(Load) (KN)	V(Shear) (KN)	T(Torsion) (KN-m)	M(Moment) (KN-m)
EQ X	245.23	13.2779	0.3513	43.2538
EQ X	245.23	13.2779	0.3513	22.626
EQ X	245.23	13.2779	0.3513	1.1818
EQ Y	217.28	-1.7205	-0.3653	-1.441
EQ Y	217.28	-1.7205	-0.3653	1.1557
EQ Y	217.28	-1.7205	-0.3653	3.7108

Table 8: Beam forces result for critical section

Load Case	Station	P(Load)	Shear force	Moment
EQX	0.8125	7.9522	8.298	11.69
EQX	1.25	7.9522	7.956	9.023
EQX	1.6667	3.3564	7.956	4.235

3. RESULT COMPARISIONS OF BOTH MODELS

Comparison is done between above two models and compare lateral load in X and Y direction, shear force at every story and time period of vibration.

Lateral Displacement: By the comparison of results study shows that providing external shear wall to the existing building effectively and efficiently reduce the lateral displacement of a building up to a reasonable extent, which is in the permissible range which our Indian codes recommends Second model shows that by providing external shear wall lateral displacement has been reduced to more the 50% which ultimately makes building strong from excessive vibrations.

Table 7: Lateral Displacement in X and Y- Direction

Story	Lateral Displacement in X (mm)		Lateral Displacement in Y (mm)	
	Model 1	Model 2	Model 1	Model 2
Story 1	2.42	0.63	5.15	0.65
Story 2	5.93	1.66	10.08	1.69
Story 3	9.7	3.02	14.83	3.09
Story 4	13.33	4.59	19.29	4.71
Story 5	16.63	6.27	23.28	6.455
Story 6	19.38	8	26.6	8.244
Story 7	21.44	9.69	29	10.01
Story 8	22.79	11.16	30.3	11.66

Base Shear: In that study increased the mass or weight of the building by introducing shear wall at its exterior portion by this whole structure act as a monolithic structure during earthquake vibration and the results shows in table for case 1 and case 2 prove that by providing external shear wall to the existing building framed structure in both direction symmetrically base shear value at each floor level has been increased to a minor extent but this little increase in mass has reduced our displacement value to much lesser extent.

Table 8: Base shear for model in X and Y direction

Story	Story Shear in X Direction(KN)		Story Shear in Y Direction(KN)	
	Model 1	Model 2	Model 1	Model 2
Story 1	538.292	1133.294	379.723	1153.5285
Story 2	1070.69	2384.944	755.29	2435.6628
Story 3	1464.88	3312.1143	1033.36	3385.5459
Story 4	1741.59	3963.2646	1228.56	4052.7597
Story 5	1921.56	4386.7586	1355.51	4486.7946
Story 6	2025.5	4630.8506	1428.83	4737.0918
Story 7	2074.16	4742.7809	1463.16	4853.0564
Story 8	2088.4	4776.2654	1473.2	4884.3219

Natural period of Vibration: From tables 9 it is confirm that less stiffness structures or rather flexibility have more time period for different modes, as this can be seen from table of model-1[5].

When the stiffness is provided to the structure with the help of external shear wall, now time period of different modes comes out to be lesser than that of model – 1, table 9 show that 1st mode time period of model- 1 is 2.169 seconds and for model – 2 for the same mode time period is 0.635seconds.

Table 9: Natural time period of vibration for Case 1 and 2 due EQX and EQY

Mode	Period (sec)	Period (sec)
1	2.169	0.635
2	1.572	0.615
3	1.53	0.379
4	0.707	0.165
5	0.497	0.16
6	0.475	0.096
7	0.413	0.094
8	0.287	0.091
9	0.277	0.075
10	0.256	0.07

Beam Forces: Comparison of beam forces results for both cases shows that by providing external shear wall acting load on beam is reduced because shear wall taking most of loads so forces value decreased in a reasonable amount. And even weak beams do not fails due the above load and remains at stronger side.

Column Forces: Form the results of table 4 and 7 for both models in combined form, we clearly see that in model-1 all the values for forces comes out to be more than that of when compared with model-2. In case of model-1 most of the load due to EQX and EQY is taken by framed structure as there is no special lateral load resisting element in the building (like shear wall) but in model-2 most of the lateral load due to EQX and EQY is taken by the external shear wall. So forces acting on the column members come out to be less in value, and its show that decrease in forces for the strengthened models with shear wall (Model-2). This clearly shows that the shear walls are playing its part in taking the lateral forces due to earthquake force

4. CONCLUSION

From this study and its outcomes clearly indicates that building can be strengthened by inspecting the degree of their vulnerability, by the use of external shear walls along the parallel sides of the building and connection can be made effectively between the exterior shear wall and existing building using dowel bars of sufficient diameter (steel bars) to act as a monolithic structure during lateral forces acting on it. Thus various parameters like displacement, story shear, time period, forces in column and beams have been reduced moment reduced up to 75% shear force 72 % and displacement reduced up to 50% which makes the building on stronger then earlier condition.

In India this method of strengthening has greater need, where retrofitting of old construction requires a huge cost, so by introducing this method we can make the old constructions susceptible to lateral load to stronger one with less amount of money as well as time period.

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