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A REVIEW OF PERFORMANCE OF RE-ENTRANT CORNERS BUILDING WITH AND WITHOUT IN PLANE CORNER BRACINGS IN DYNAMIC SEISMIC (ANALYTICAL APPROACH).

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Abstract - *Irregularities in building during seismic suffer much higher than the regular shape building in high seismic zones. Indian standard code IS1893(Part-1) provided various guidelines to improve their performance during seismic activity and minimize their post-earth quake damages. One such major irregularities is Re Entrant corners building. To study the behaviour of such building with re-entrant corners and remedial mechanism to be applied so that it can perform better during seismic activity. This study will focus on the performance of such building with and without in plane horizontal bracing provided at re-entrant conners.*

Key Words: Plan irregularity, Re-Entrant Corners, In Plane horizontal bracings, dynamic seismic.

1.INTRODUCTION

Irregularities in building configuration leads to uncertainties in behaviour during transient loading condition such as seismic activities. Irregularities leads to abrupt changes in strength or stiffness of structural element which leads to poor behaviour of overall structure. Past seismic activities have proved that building with irregularities suffer severe damages than the regular configured building. To understand their behaviour and to minimize the effect of re-entrant corners, as per IS 1893 (Part-1) "a building is said to have re-entrant corner in any plan direction, when its structural configuration in plan has a projection of size grater than 15 percent of its overall plan dimension in that direction" hence this study has focused on introducing "in plane horizontal bracing" at corners and studied the different parameters during dynamic seismic. For the study a six storeyed building (A/L= 25%) has been considered, one without any in plane corners bracing and other one with in plane corner bracing at every floor level, Parameters considered during modelling are such as seismic zone-V, Importance factor-1.0, Response Reduction factor-5, Soil type- Medium, Structure type- Special Moment Resisting Frame building.

1.1 LITERATURE REVIEW

Vaishnavi Vishnu Battul[1], Mithun Sawant[2], Tejashri Gulve[3], Rohit Deshmukh[4], studied "Seismic Effect on Re-entrant Corner Columns" and they have observed from above study that for re-entrant corner columns need more attention than the other columns. These columns should be designed properly. After proper modifications the bending moment capacity of re-entrant corner column is increased by 1.5 times.

Nikhil Dixit[1], Abhishek Jhanjhot[2] studied the "Analysis and Design of Irregular Building with Re-entrant Corner using Pushover Analysis". They concluded that the story drifts of a framed structure with the shear wall as a stiff element at the re-entrant corner is less than structures without a shear wall in both zones. The story displacement of four structures with and without a shear wall in both the zone indicate the displacement in direction with load condition i.e., x-direction for PX is less for stiff element (shear wall at the re-entrant corner).

Ganesh Gawande1, Dr. S. B. Borghate 2, studied the "Seismic Performance of Re-Entrant Corner Building Under the Different Earthquake Direction", from the analysis result shows it is concluded that re-entrant plan irregular building is more vulnerable towards seismic impact compared to regular building in terms of top floor displacements. Result shows that re-entrant corner plan irregular building shows an increase up to 42% in considered joint displacement. But in case of nonlinear dynamic analysis the incident angle that produces increase up to 38 % in terms on relative displacements.

A. S. Dhanyashree[1], R. Akash[2], M. Ashok[3], S. R. Premsai[4], B. N. Bhavyashree[5] "Studied the Effect of Re-entrant Corner RC Framed Building under Seismic Load" and strengthening it by Bracing they concluded that Buildings with higher percentage of re-entrant corner are susceptible to more seismic damages particularly in high seismic zones. Building with re-entrant corner shows more displacement at the notches than the regular building. Structure strengthened by bracing at the re-entrant corner showed better performance than the building without bracing.

Shreyasvi CB[1], Shivakumaraswamy[2] studied the "Seismic Response of Buildings with Re – Entrant Corners in Different Seismic Zone" and they concluded that The columns located near the re - entrant corners experience more seismic loads as compared to other interior columns. Hence, they require higher ductile detailing when compared to other columns. Building model with higher percentage of re - entrant corner undergo larger joint displacement. Re - entrant buildings undergo larger displacements and drifts when compared with regular buildings. The modal time periods obtained from response spectrum analysis implicates that the regular buildings have longer time periods than re – entrant buildings. As re - entrant buildings have lesser time periods, they are more susceptible to ground motions and the probability of undergoing damage due to high frequency ground motions is high.

Tarak Banerjee[1], Arya Banerjee[2] studied "A Study on Optimizing the Positioning of Shear Walls for a Plus Shaped Irregular Building" and they concluded that skilfully choosing the positions of shear walls can make a difference in the performance of structures. Storey displacements are found low for model 2, with shear walls at the core and edges, as well as this structure exhibits extremely high values of stiffness and low flexibility. It is performed better in storey drift showing almost equal drifts for all floors. Model 1 exhibits high flexibility in comparison with the other two models, shows higher values of periods. Model 2, where shear walls are placed at the core and along edges, performs better. The model with shear walls at edges and at re-entrant corners showing lower values for torsional moments. Torsional moments reduce considerably by providing shear walls at re-entrant corners.

Bethany Marie Brown, studied "Lateral Loads on Re-entrant Corner Structures "he concluded that he length of the legs of a structure has a direct correlation to the magnitude of the axial forces in the struts in the re-entrant corner. The longer the leg is perpendicular to the strut, the higher the axial force will be in the strut. This is due to the diaphragm being idealized as a simple beam. The axial forces in the interior and exterior chords follow the trend of the bending moment diagram as the length of the variable leg increases. Since it was found that the variable leg acts more similarly to a propped cantilever than a simply supported beam, the axial forces in the interior and exterior chords follow the trend of the bending moment diagram for a propped cantilever instead of a simply supported beam as initially assumed.

1.2 BUILDING MODEL USED IN ANALYSIS

Two 9.0m x9.0m building has been taken for the Staad analysis with 2.250m projection al around the building in symmetrical manner, one without corner bracings and other one with corner bracings with the following seismic parameters, zone-V, Importance factor-1.0, Response Reduction factor-5, Soil type- Medium, Structure type-Special Moment Resisting Frame building.

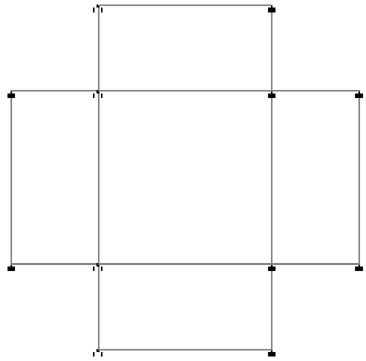

Fig -1: Building without corner bracings (Plan)

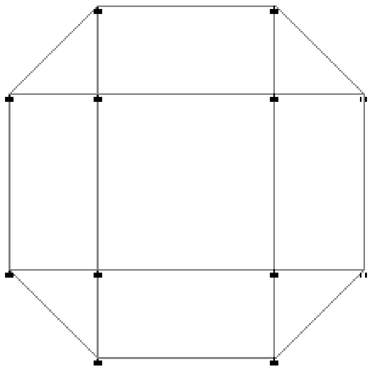

Fig -2: Building with corner bracings (Plan)

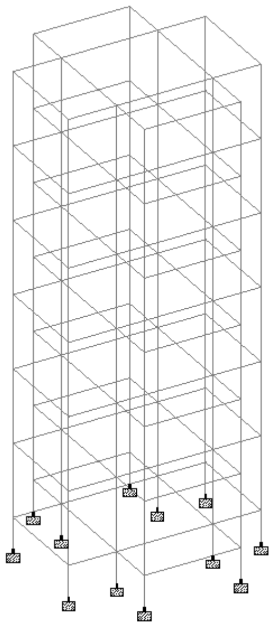

Fig -3: Without Bracings

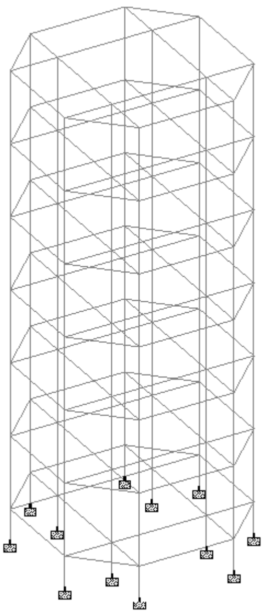

Fig -4: With Bracings

2. ANALYSIS RESULT & DISCUSSION

2.1 MASS PARTICIPATION

From the below data it has found that the structure without the in-plane horizontal 90% mass participate in mode 13 while in structure with in plane horizontal bracing 90% mass participate in mode 9 also mass participation increase with using bracing in the range of 10%. Hence it performs better during seismic activity.

Table -1: Mass Participation without corner bracings

Mode	X	Y	Z	Summ -X	Summ -Y	Summ -Z
1	0	0	75.72	0	0	75.724
2	75.72	0	0	75.724	0	75.724
3	0	0	0	75.724	0	75.724
4	0	0	10.51	75.724	0	86.237
5	10.51	0	0	86.237	0	86.237
6	0	0	0	86.237	0	86.237
7	0	0	0	86.237	0	86.237
8	0	0	3.69	86.237	0	89.928
9	3.69	0	0	89.928	0	89.928
10	0	0	0	89.928	0	89.928
11	0	0	0	89.928	0	89.928
12	0	0	0	89.928	0	89.928
13	0	0	1.81	89.928	0	91.736

Table -2: Mass Participation with corner bracings

Mode	X	Y	Z	Summ -X	Summ -Y	Summ -Z
1	0	0	76.05	0	0	76.053
2	76.05	0	0	76.053	0	76.053
3	0	0	0	76.053	0	76.053
4	0.01	0	10.6	76.059	0	86.654
5	10.6	0	0.01	86.66	0	86.66
6	0	0	0	86.66	0	86.66
7	0	0	0	86.66	0	86.66
8	0.04	0	3.5	86.704	0	90.164
9	3.5	0	0.04	90.208	0	90.208
10	0	0	0	90.208	0	90.208
11	0	0	0	90.208	0	90.208
12	0	0	0	90.208	0	90.208
13	1.47	0	0.23	91.681	0	90.435

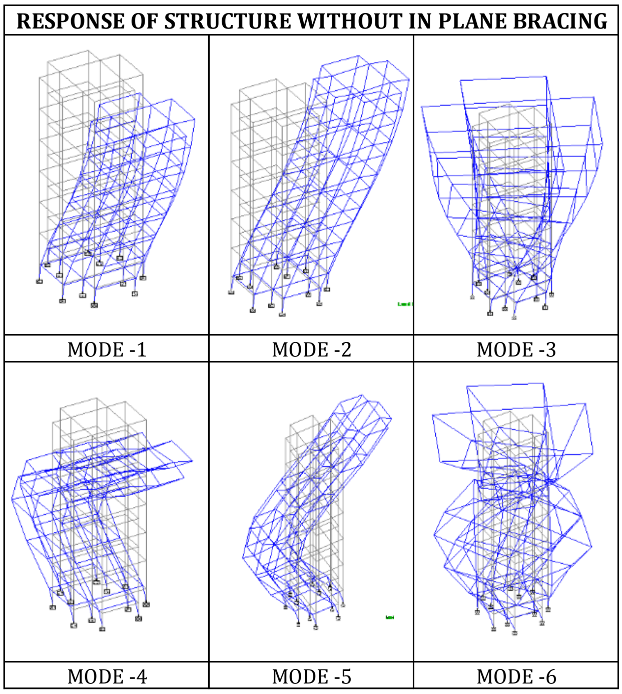

Fig -4: Dynamic Response of six modes

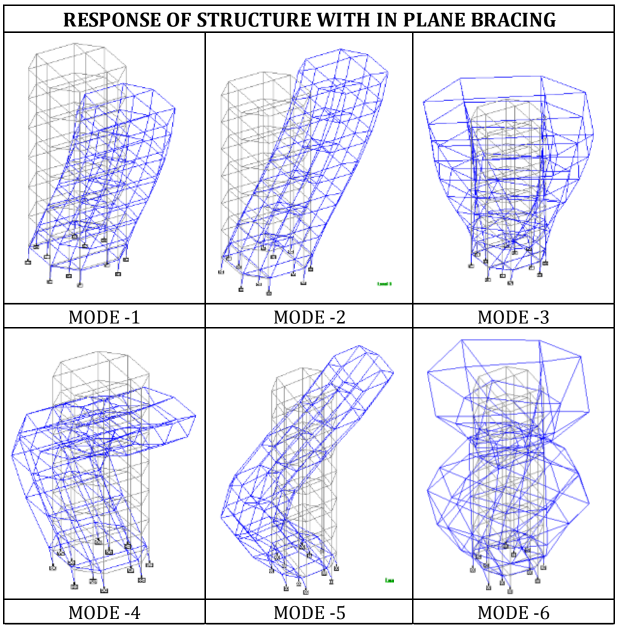

Fig -5: Dynamic Response of six modes

2.2 FREQUENCY

From the below data it has found that the frequency of the structure with the in-plane horizontal bracing increase in the range of 10%. Hence it performs better during seismic activity.

Table -3: Frequency without corner bracings

Mode	Frequency (Cycles/Sec)	Period (Sec)
1	0.75	1.34
2	0.75	1.34
3	0.82	1.21
4	2.42	0.41
5	2.42	0.41
6	2.62	0.38

Table -4: Frequency with corner bracings

Mode	Frequency (Cycles/Sec)	Period (Sec)
1	0.77	1.30
2	0.77	1.30
3	0.91	1.10
4	2.48	0.40
5	2.48	0.40
6	2.85	0.35

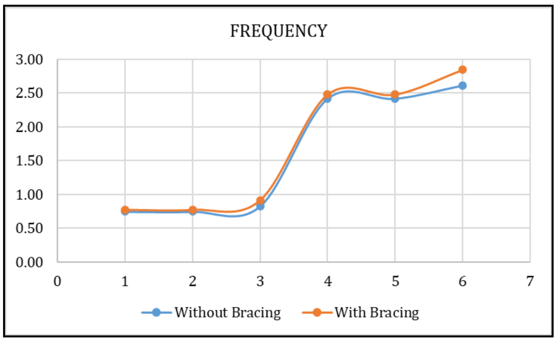

Fig -7: Frequency with & without bracings

2.3 FLOOR DISPLACEMENT

From the below data it has found that the floor displacement of the structure with the in-plane horizontal bracing decrease in the range of 10% because it provided more lateral stiffness in the direction of seismic forces. Hence it performs better during seismic activity.

Table -5: Floor displacement without bracings

Floor	Displacement(cm)	
	X	Z
1	0.1709	0
2	1.4226	0.0002
3	2.9315	0.0001
4	4.3342	0.0002
5	5.5103	0.0001
6	6.3958	0.0003
7	6.9717	0.0007

Table -6: Floor displacement with bracings

Floor	Displacement(cm)	
	X	Z
1	0.1629	0.0003
2	1.3567	0.0006
3	2.7674	0.0004
4	4.0742	0.0004
5	5.1745	0.0004
6	6.0079	0.0003
7	6.5509	0.0009

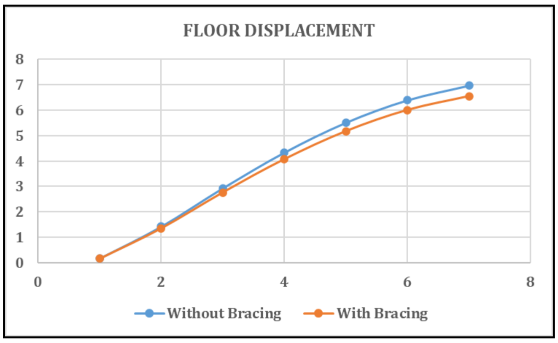

Fig -8: Floor Displacement with & without bracings

2.4 STOREY DRIFT

From the below data it has found that the storey drift of the structure with the in-plane horizontal bracing decrease in the range of 10% as bracing provide lateral stiffness to floors. Hence it performs better during seismic activity.

Table -7: Storey drift without corner bracings

Floor	Storey Drift (cm)	
	X	Z
1	0.1709	0
2	1.2517	0.0001
3	1.5089	0
4	1.4027	0
5	1.1761	0
6	0.8856	0.0002
7	0.5759	0.0004

Table -8: Storey drift with corner bracings

Floor	Storey Drift (cm)	
	X	Z
1	0.1629	0.0003
2	1.1938	0.0003
3	1.4107	0.0002
4	1.3068	0
5	1.1002	0
6	0.8335	0.0001
7	0.543	0.0006

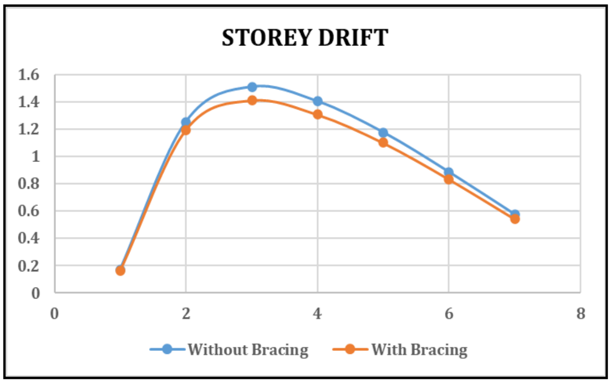

Fig -9: Storey Drift with & without bracings

2.5 NODAL DISPLACEMENT AT TOP

From the below data it has found that the Nodal displacement of the structure with the in-plane horizontal bracing decrease in the range of 10% as bracing provide lateral stiffness to floors. Hence it performs better during seismic activity.

Table -9: Nodal Displacement with without corner bracings

Nodes	Without Bracing	With Bracing
85	69.856	65.575
86	69.828	65.548
87	69.696	65.539
88	69.666	65.5
89	69.666	65.5
90	69.696	65.539
91	69.828	65.548
92	69.856	65.575
93	69.714	65.557
94	69.696	65.529
95	69.696	65.529
96	69.714	65.557

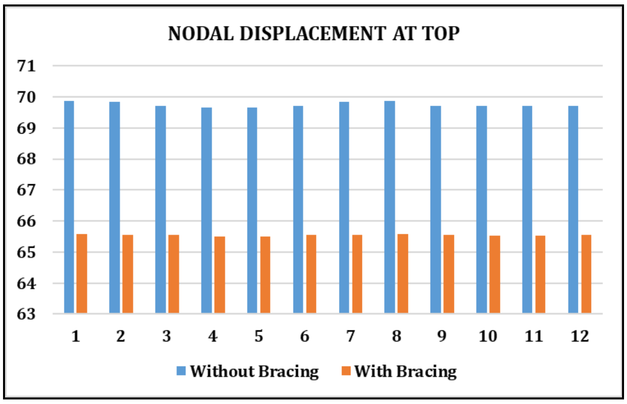

Fig -10: Nodal Displacement at top with & without bracings

3. CONCLUSIONS

- Result shows that re-entrant irregular building is more vulnerable towards seismic compared to re-entrant irregular building with corner bracings in terms of mass participation, without bracing 90% mass participate in mode 13 while with bracing 90% mass participate in mode 9 which is a great improve in its performance in seismic condition.

- Result shows that re-entrant irregular building with corner bracing improves it frequency, floor displacement, storey drift and nodal displacement is decreases almost 10% compare to the re-entrant irregular building without corner bracing.

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