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Sesimic Pounding of G+6 Building With Different Building System

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Abstract:

Collisions of buildings that exhibit various dynamic characteristics at the time an earthquake is called as seismic pounding. The prime reason for seismic pounding occurrence is not having enough separation gap in between the buildings. Seismic pounding can be controlled by providing safe gap, but required gap is not possible in Metropolitan cities as the density of the population is very high and it is highly uneconomical. In this study seismic pounding on G+6 buildings with different building system using ETABS Software. In this study we will use different building systems like Frame, Full RCC Shear wall, RCC Shear wall on outer peripheral Corners, RCC Shear wall on middle outer peripheral walls, Full RCC Shear walls on inner peripheral walls, Full X-bracing, X-bracing on outer peripheral Corners, X-bracing on middle outer peripheral walls, X-bracing walls on inner peripheral walls, , Full V-bracing, V-bracing on outer peripheral Corners, V-bracing on middle outer peripheral walls, V-bracing walls on inner peripheral walls. Shear walls locates on Full RCC shear walls on inner peripheral walls has better results compared with other system

Keywords: *Seismic Pounding, Shear Walls, Bracings, Different Building System, E Tabs.*

I. INTRODUCTION

The study of previous and present earthquakes cause that the building structure is at risk of severe damage (or) collapse of the structure during minimum to maximum ground motion. An earthquake with a magnitude of 6 or high can affect or cause a lot of damage to the residential building, Industrial building, marine structure, etc., giving rise to a lot of economic loss.

During these type of earthquakes, the structure tends to sway in either direction due to the dynamic characteristics as a result structure/building which are close to each other (or) not having enough separation gap between the Building will collide each other and leads to a lot of damage to the structure. This entire process is known as Seismic pounding [1].

During an Earthquake, the structure (or) building which is adjacent to each other with collide and lead to damage of the structure. The main problem for seismic pounding is due to lack of enough space between buildings in Metropolitan cites. In Metropolitan cites the cost of land is very high and population density is very high. Seismic pounding is mainly seen in old buildings which are constructed before Earthquake resistant design principles were laid in the earlier decades. The most effective way to avoid seismic pounding is to provide enough separation space between buildings but it is not possible because high cost of land [6].

Another possible way to reduce seismic pounding in the structure design is to reduce the effect of pounding through decreasing lateral displacement by introducing the stiffeners like RC walls, Bracings, Dampers etc. The main objective and scope of the

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study are to evaluate the effects of structural pounding on the of building, to determine the lateral peak displacement during the earthquake ground motion, evaluating the minimum seismic gap between buildings.

The least complex and most fitting route for seismic pounding alleviation is to give a safe division space, however it is occasionally hard to satisfy because of the significant expense of land. An option in contrast to the seismic detachment whole arrangement in the structural configuration is to diminish the impact of Seismic pounding through diminishing sidelong removal by presenting the stiffeners like RC Shear Wall, Bracings, Dampers and so forth. The fundamental target and extent of the investigation are to assess the impacts of basic pounding on the worldwide reaction of working, to decide the parallel pinnacle uprooting during the quake ground movement, assessing the base seismic gap among structures [1].

For the purpose of this Study, E Tabs has been taken, a straight and non-direct static and dynamic investigation and configuration program for three-dimensional structures. The application has many features for solving a wide range of issues from basic 2-D supports to complex 3-D structures. Creation and adjustment of the model, execution of the examination, and checking and advancement of the plan are totally done through this single interface. Graphical presentations of the outcomes, including the constant activity of time-history removals, are effortlessly delivered [2].

II. Literature Survey

Shehata E Abdel Raheem (2016) studied about mathematical modelling of the Adjacent Building has been analyzed and implemented. Seismic pounding is not a linear phenomenon and severe load conditions and load combination leads to a lot of structural damage in high magnitude with a short duration of time studied Numerical with the Equations. They proposed that a sudden stopping of Displacement in the building at the pounding level results in a large and quick acceleration pulse in the opposite direction due to the dynamic properties of the structure. It proposed that the Distribution of Story peak Response depends upon the Building Height. Pounding Effect in Industrial Buildings is mainly caused due to the Equipment in the industries. To reduce the Pounding effect of the adjacent building we must consider the period ratio of the adjacent building. Therefore, if one building is designed as to resist the seismic pounding is not enough to withstand the strike the earthquake events that occur in that condition to eliminate it effective, we should provide to avoid seismic pounding in the buildings [1].

J. D. Chaitanya, M Phani Kumar (2015) focus mainly on the factor affecting seismic pounding were Identified and studied carefully to reduce seismic Pounding effect. Comparing to the Linear dynamic analysis story Displacement values are reduced up to 90 to 95% when compared with the Dynamic analysis. The seismic pounding effect is very small between adjacent Buildings in Linear Dynamic analysis but there is a large variation in terms of non-linear dynamic analysis because the displacement values are more. They proposed that pounding forces can be reduced to 10 to 15 % between adjacent building by increase a separation gap of 10 mm Gradually. So, they proposed that Seismic pounding effect can be reduced with the increase in the separation gap between the Building. They also proposed that seismic pounding can be decreased effectively with the help of Shear walls instead of Full brick Infill walls in the building [2].

Chetan J. Chitte, Anand S. Jadhav, Hemraj R. Kumava (2014) prepared a Mathematical modeling of adjacent Building has been studied in this paper. The displacement for close source ground movement is a lot bigger than those of far source ground movement. Thus, the pounding probability during close source ground movement is a lot bigger than during far-source ground movement with a similar separation gap [3].

Y.L. Xu, Q. He, J.M. Ko (1999) studied and prepared a Multi -degree freedom equations motion of building for the damper connected adjacent Multistorybuilding has been presented under Earthquake Exication for Irregular Damping properties of the system. The outcomes demonstrated that if the damper properties are chosen fittingly, the dynamic qualities of the unlinked structures can be held and the seismic dynamic reactions of the two structures can be essentially decreased. With the introduction of Dampers in the structure maximum reduction in the top story response and base, shear walls are reduced about 72 to 75% respectively [4].

Ineelufar N.K, M.Vahini (2013) their mainly focus on the implantation of the Reinforced Concrete Shear Wall & dampers into the structure. Seismic ponding effect can be Effectively Controlled with the help of damper and Shear wall. The effect of seismic pounding can be controlled in parallel Building by damper up to 25 to 40 % and with the Shear Walls, it can be controlled by 60 to 75 %. In the case of perpendicular Structure, it can be reduced up to 90 % Effectively. Compare all results with Parallel, Perpendicular Structure with Equal and Unequal Height of the Building Shear Walls will have more accurate results with comparison to the Dampers in Seismic pounding [5].

III. Experimental Study

In this study we are mainly focusing on drift and displacement control measures for the G +6 Building with different location of shear walls and Bracing. The specification of each and every component is described below with dimensions. In this study we prepared different models for different location of shear wall and bracing and find out which is most appropriate method for seismic pounding of adjacent building. Seismic Pounding is one of the major problems which cause a lot of problem to the adjacent structure which are close to each other during an Earthquake

1. The model we taken for this study is

G +6 Building with

1. Frame

2. Full RCC Shear wall,

3. RCC Shear wall on outer peripheral Corners,

4. RCC Shear wall on middle outer peripheral walls

5. Full RCC Shear walls on inner peripheral walls

6. Full X-Bracing

7. X-Bracing on outer peripheral Corners

8. X-Bracing on middle outer peripheral walls

9. X-Bracing walls on inner peripheral walls.

10. Full V-Bracing

11. V-Bracing on outer peripheral Corners

12. V-Bracing on middle outer peripheral walls

13. V-Bracing walls on inner peripheral walls

2. The type of the building is a Residential building.

3. Specification of Beam
   a) Concrete Grade M30
   b) Depth 350 mm
   c) Width 250 mm

4. Specification of Column
   a) Concrete Grade M30
   b) Depth 500 mm
   c) Width 500 mm

5. Specification of Slabs
   a) Concrete Grade M30
   b) Slab Thickness 150 mm

6. Specification of RC Wall
   a) Concrete Grade M30
   b) Thickness of wall 100 mm

7. Specification of X-Bracing
   a) Concrete Grade M30
   b) Dimensions 200 x 200 mm

8. Specifications of V-Bracing
   a) Concrete Grade M30
   b) Dimensions 200x200 mm

8. Height of the foundation is 1.5 m.

9. Height of the all stories is 3.0 m.

10. Loads

a) Dead Load

Dead load (DL) of the Building is obtained from the Indian code IS 875(part 1)-1987. The self-weight of the frame sections and area sections are considered by the program automatically.

b) Live Load

Live load (LL) is Obtained from the of IS 875 Part-II

I. Live load on Building = 3 kN/m^2

II. Wall load on roof Level = 2.50 kN/m^2

III. Wall load on other Floor = 7.50 kN/m^2

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11. Earthquake Loads
Earthquake loads are defined as lateral loads on the building structure from the Indian code IS 1893:2002 (part1).

12. The design seismic coefficient to be used in accordance with IS 1893:1984 are shown in Table -1

Table -1: Design Seismic Coefficient

Sl No	Type of Construction	Gap Width/Story, in mm for Design Seismic Coefficient αh = 0.12
1	Box System or frames with shear wall	15.0
2	Moment resistant reinforced concrete frame	20.0
3	Moment resistant Steel frame	30.0

Note: Minimum total gap shall be 25 mm. For any other values of αh, the gap width shall be determined accordingly.

Different Location of Shear Walls and Bracings in G +6 Building.

In this study we are studying the Seismic pounding Effect between two adjacent building dynamic properties and finding out we type of method is best suitable for controlling displacement and drift values. For this Study we are mainly focusing on Shear Wall and Bracings. We prepared 13 models for this project in Different location of inner and outer peripheral walls of building. They are Full RCC Shear wall, RCC Shear wall on outer peripheral Corners, RCC Shear wall on middle outer peripheral walls, Full RCC Shear walls on inner peripheral walls, Full X-Bracing, X-Bracing on outer peripheral Corners, X-Bracing on middle outer peripheral walls, X-Bracing walls on inner peripheral walls., Full V-Bracing, V-Bracing on outer peripheral Corners, V-Bracing on outer peripheral Middle, V-Bracing on middle outer peripheral walls are shown in figure 1 to figures 13

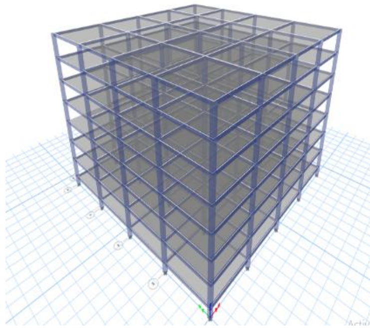

Fig: 1 G+6 Building Frame

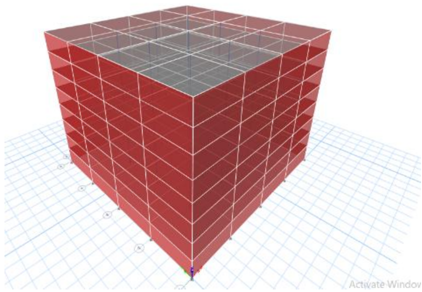

Fig: 2 G +6 Building Frame with Full RCC Shear wall on Outer Peripheral Wall

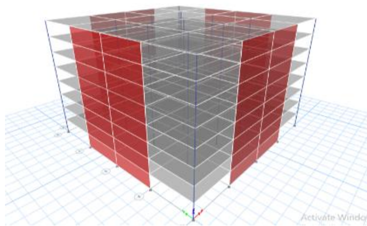

Fig: 3 G+6 Building with RCC Shear wall on Outer peripheral middle

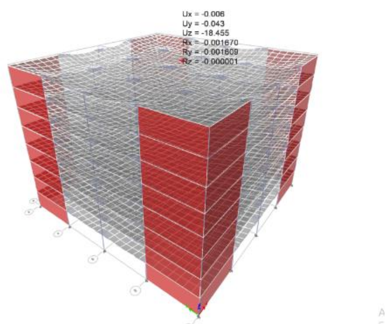

Fig: 4 G+6 Building RCC Shear wall on outer peripheral corners

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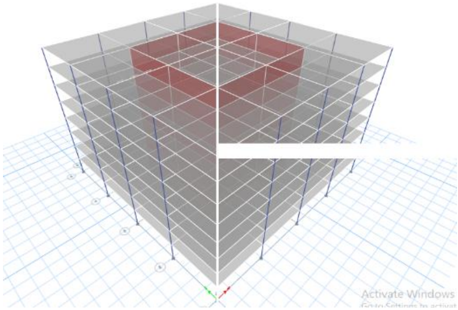

Fig: 5 G+6 Building with RCC Full Shear wall on inner peripheral Walls

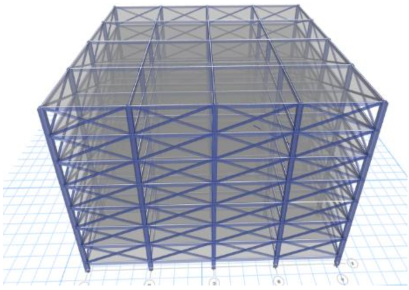

Fig: 6 G+6 Building with Full X-Bracing on outer Peripheral walls

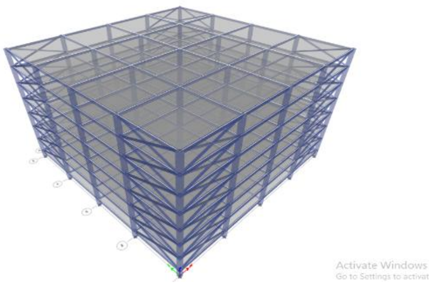

Fig 7: G+6 Building with X-Bracing on outer peripheral Corners

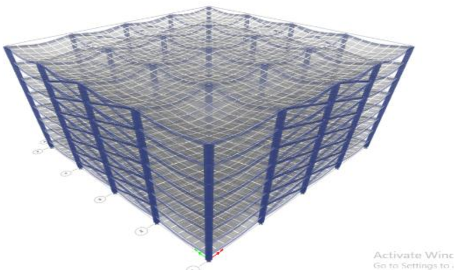

Fig 8: G+6 Building X-Bracing on outer peripheral walls on middle

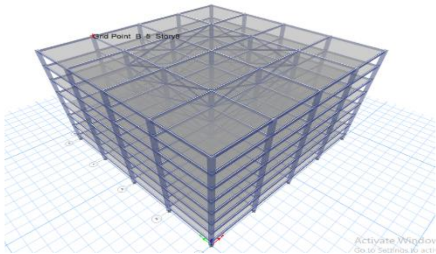

Fig 9: G+6 Building with X-Bracing walls on inner peripheral walls.

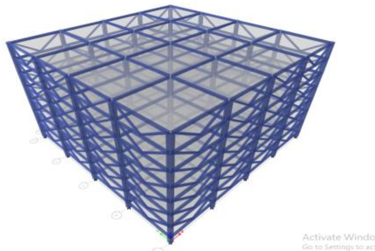

Fig 10:G+6 Building with Full V -Bracing on outer walls

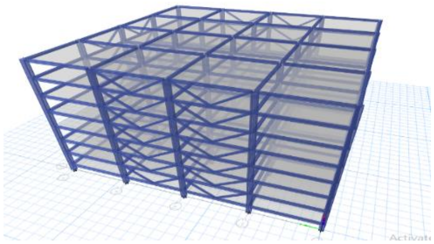

Fig 11: G+6 Building with V-Bracing on outer peripheral walls on middle

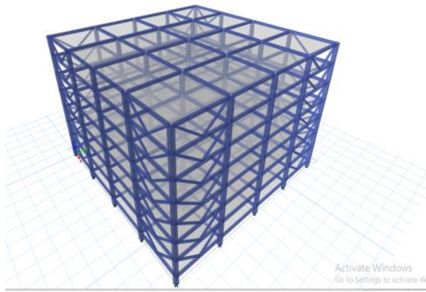

Fig 12: G+6 Building with V-Bracing on Outer peripheral Corners

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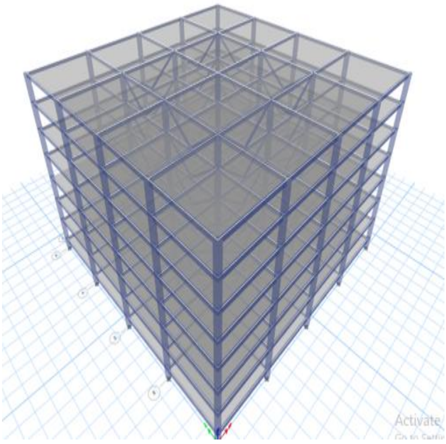

Fig 13:G+6 Building with V-Bracing walls on inner peripheral walls

IV. Analysis and Results

All the results are taken from E Tabs software after analysis. We prepared 13 models with shear walls and bracing at different locations in inner and outer peripheral walls of buildings as mentioned below. All the Displacement values are taken from maximum load combinations which have highest values.

Response spectrum analysis has been carried out as per the response spectra mentioned in IS 1893(part 1) 2002. The displacements for a joint at the top floor for two models have been tabulated in table 2 as below.

From the Table 2 the story displacement values for shear walls at different locations of inner and outer peripheral wall. As from the results displacement and drift values are increasing rapidly as the height of building increases. At the base of the building the displacement values are very negligible but as the Story height increases it leads to a lot of problems to the adjacent buildings during an earthquake. As comparing the results, we can able to know that Full shear wall is very effectively reduce the displacement and drift values compared with different locations in the building. After the Full shear walls, most effective results are obtained for shear wall with Full Inner peripheral walls and it is economically wise it is most suitable.

TABLE: 2 Shear Wall Displacement Values

Story Res -ponse	**Frame**	**Full Outer Periphe ral Shear Wall**	**Outer Corner Peripheral Shear Wall**	**Outer Middle Peripheral Shear Wall**	**Full inner peripheral Shear Walls**
Story	X-Dir	X-Dir	X-Dir	X-Dir	X-Dir
	mm	mm	mm	mm	mm
Story 7	75.729	2.297	8.3	11.88	4.928
Story 6	69.673	2.037	7.204	10.14	4.432
Story 5	61.023	1.758	5.985	8.333	3.819
Story 4	49.947	1.475	4.766	6.527	3.162
Story 3	37.038	1.167	3.56	4.773	2.471
Story 2	23.435	0.879	2.44	3.162	1.792
Story 1	10.73	0.597	1.466	1.778	1.146
Base	1.519	0.326	0.675	0.735	0.565

TABLE: 3X-Bracing Displacement Values

Story Response	**Full Outer Peripheral X-Bracing**	**Outer Corner Peripheral X-Bracing**	**Outer Middle Peripheral X-Bracing**	**Full inner Peripheral X-Bracing**
Story	X-Dir	X-Dir	X-Dir	X-Dir
	mm	mm	mm	mm
Story 7	16.47	33.031	33.031	30.08
Story 6	15.408	30.032	30.032	27.813
Story 5	13.746	26.05	26.05	24.515
Story 4	11.623	21.358	21.358	20.418
Story 3	9.199	16.265	16.265	15.801
Story 2	6.618	11.076	11.076	10.953
Story 1	3.996	6.028	6.028	6.096
Base	1.258	1.409	1.409	1.463

From the Table 3 Story Displacement values for X-Bracing at different locations of inner and outer peripheral wall. As from the results displacement and drift values are increasing rapidly as the height of building increases. At the base of the building the displacement values are very negligible. For the X-Bracing but as the story height increases it leads to a lot of problems to the adjacent buildings during an earthquake and adjacent may sway in same way and lead to lot of problem. As comparing the results, we can able to know that full X-Bracing is very effectively reduce the displacement and drift values compared with different locations in the building. After that full X-Bracing in the Inner peripheral wall has most effective results are obtained for X-Bracing with Full Inner peripheral walls and it is economically wise it is most Suitable.

TABLE: 4 V-BRACING DISPLACEMENT VALUES

Story Response	Full Outer Peripheral V-Bracing	Outer Corner Peripheral V-Bracing	Outer Middle Peripheral V-Bracing	Full inner Peripheral V-Bracing
Story	X-Dir	X-Dir	X-Dir	X-Dir
	mm	mm	mm	mm
Story 7	13.697	28.46	31.919	27.21
Story 6	12.791	26.064	28.814	25.049
Story 5	11.404	22.781	24.847	22.004
Story 4	9.652	18.85	20.286	18.292
Story 3	7.668	14.525	15.418	14.157
Story 2	5.559	10.053	10.501	9.853
Story 1	3.429	5.64	5.759	5.561
Base	1.172	1.423	1.401	1.414

From the Table 4 It is Story Displacement values for V-Bracing at different locations of inner and outer peripheral wall. As from the results displacement and drift values are increasing rapidly as the height of building increases. At the base of the building the displacement values are very negligible. For the V-Bracing but as the Story height increases it leads to a lot of problems to the adjacent buildings during an Earthquake and adjacent may sway in same way and lead to lot of problem. As comparing the results, we can able to know that full V-Bracing is very effectively reduce the displacement and drift values compared with different locations in the building. After that Full V-Bracing in the Inner peripheral wall has a most effective results are obtained for V-Bracing with Full Inner peripheral walls and it is Economical wise it is most suitable. Different Types of bracing System are there among them the most used types are X & V types Bracing System When we compare the detailed comparison in the results between these two type of bracing System, V types Bracing system has less Displacement values Compared with X-Bracing System.

Shear Walls

The Figure 14 Graph maximum displacement results for the frame at the top story is 75.729mm. When Full RC shear wall is assigned, the Displacement at the top story is reduced to 2.297 mm. Further when we assigned RCC Shear wall on outer peripheral Corners the displacement is reduced 8.33 mm and for RCC Shear wall on middle outer peripheral walls Corners displacement values is 11.88 mm Full RCC Shear walls on inner peripheral walls 4.928 mm.

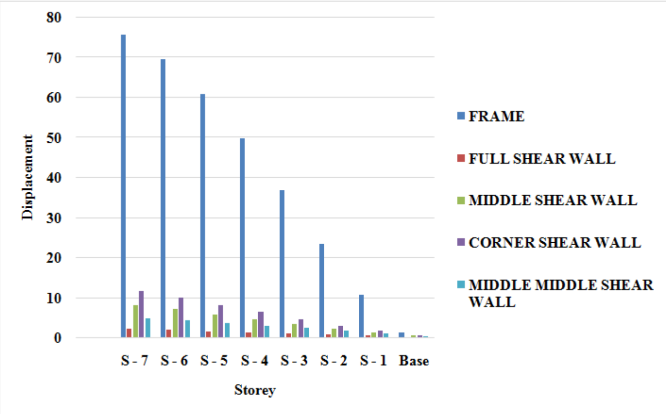

Fig 14: Storey vs Displacement

X-Bracings

The Figure 15 Graph maximum displacement results for the frame at the top story is 75.729mm. When Full X-Bracing is assigned the Displacement at the top story is reduced to 16.47 mm. Further when we assigned X-Bracing on outer peripheral Corners the displacement is reduced 30.231 mm and for X-Bracing on middle outer peripheral walls 33.031

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displacement values is 11.88 mm X-Bracing walls on inner peripheral walls is 4.928 mm.

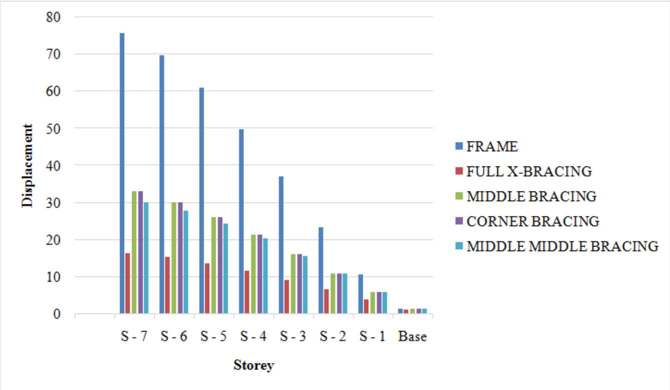

Fig 15: Storey vs Displacement

V-Bracings

The Figure 16 Graph maximum displacement results for the frame at the top story are 75.729 mm. When Full V-Bracing is assigned the Displacement at the top story is reduced to 13.69 mm. Further when we assigned V-Bracing on outer peripheral Corners the displacement is reduced 31.91 mm and for V-Bracing on middle outer peripheral walls 28.46mm V-Bracing walls on inner peripheral walls is 4.928 mm.

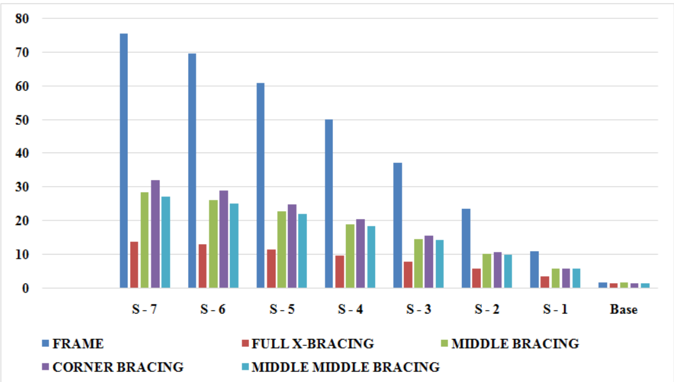

Fig 16: Storey vs Displacement

V. Conclusion and Recommendations

The purpose of the study is to analyze seismic pounding effects between building and known the dynamic character of G +6 Building and find out which method is most suitable method to control displacement and drift. For the analysis of this model we chose E Tabs software. Dynamic analysis is prepared and analysed in the software to known deformation of the structure, displacement and drift which are most important for the seismic pounding analysis, natural frequency, and floor response displacement. For this Study we prepared 13 model consists of 1 frame, 4 shear walls at different location in the building and 4 model on X-bracing and 4-V- bracing in inner and outer peripheral walls in E Tabs software in Response spectrum and made theses conclusion after the analysis

1) Addition of Shear Walls and Bracing into the Structure there is a lot of variation in the Displacement and Drift values in the result.
2) Addition of RCC wall at different location into the structure and X-Bracing at different locations into the structure decrease the Displacement values rapidly.
3) It is found with the help of RCC wall and bracing we can able to reduce the Seismic pounding effects
4) As Result we use Full Shear walls at outer walls, we can able to reduce the Displacement values up to 90 % for G +6 Building.
5) And for the Full X-Bracing at outer walls, we can able to reduce the Displacement values up to 75 % for G +6 Building.
6) But when it comes to Economy point of view it is better use full Shear wall at inner peripheral walls.

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