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Effect of Steel Bracings on RC Building by Aligning Them at Different Positions

Mohammad Abdul Waseem, A. Vimala

Abstract: ***Earthquake is an unexpected and expensive disaster for both livelihood and economy. In the modern day construction there has been a lot of importance to make the structure resistive against the laterally acting loads. Bracings are an option for lateral load resisting system in tall buildings. The concept of bracings is to add more stiffness and strength to the adequate strength of the structure. Members in a braced frame are generally made of structural steel which can work effectively both in strain and pressure.***

In the present work 13 story irregular building is considered with and without bracings to evaluate the optimum bracing pattern for the structure. By changing the position of the bracings alternately in both horizontal and vertical direction the analysis is carried out. These are the different models analyzed by pushover analysis (a) Building with no bracing, (b) Building with alternate vertical bracing starting from bay-1, (c) Building with alternate vertical bracing starting from bay-2, (d) Building with alternate vertical bracing starting from story-1, (e) Building with alternate vertical bracing starting from story-1. The non linear static results were compared. The various parameters like story drift, shear, time period, stiffness, moment, torsion, performance points are obtained by the analysis for all the models.

Key words: Seismic Action, pushover analysis, drifts, time period, performance points.

I. INTRODUCTION

The Buildings, which appeared to be strong enough, may crumble like houses of cards during earthquake and deficiencies may be exposed. Performance based seismic engineering is the modern approach to earthquake resistance design. The objective of performance-based analysis is to produce structures with predictable seismic performance. In order to utilize performance-based analysis effectively and intelligently, one need to be aware of the uncertainties involved in structural performance. **Capacity:** The overall capacity of a structure depends on the strength and deformation capacity of the individual components of the structure. In order to determine capacities beyond the elastic limits, some form of nonlinear analysis, such as the pushover procedure is required.

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Demand: Ground motion during an earthquake produces complex horizontal displacement patterns in the structures. It is impractical to trace this lateral displacement at each time-step to determine the structural design parameters. **Performance point**: It is the intersection point of the capacity spectrum and demand spectrum. This point represents the global behavior of the structure. Once capacity curve and demand displacement are defined a performance check can be done.

II. OBJECTIVES

The following are the main objectives of the project:

- To study the seismic behavior of building by using IS1893:2002.
- To design the earth quake resistant structure by using steel bracings in zone V.
- To compare the results of story drift, shear force, bending moment, torsion of buildings for earth quake resistant buildings.
- To study the multi story buildings in ETABS by push over analysis.
- To observe the performance point for the behavior of the structure.

III. MODELLING OF THE STRUCTURE

In this paper the behaviour of the 13 story building is studied in ETABS by considering bracings in four different arrangements.

Table 1: Details of structural elements and material data

1	Grade of concrete	M40
2	Grade of steel	HYSD Fe500
3	Beam size	450X600 mm
4	Column size	450X700 mm
5	Slab thickness	150 mm
6	Bracing size	ISA 200X200X15 mm
7	Bottom storey height	4 m
8	Other storey height	3m
9	Live load	$5kN/m^2$
10	Dead load	$2kN/m^2$
11	Density of concrete	$25kN/m^3$
12	Seismic zone	V
13	Importance factor	1.5
14	Response factor	5
15	Damping ratio	5%

The table shows the description of the dimensions of the structural elements, story heights, grade of concrete, grade of steel, thickness of slab, bracing size, loads carrying on the structure.

IV. BUILDING MODELS WITH AND WITHOUT BRACINGS

No Bracings:

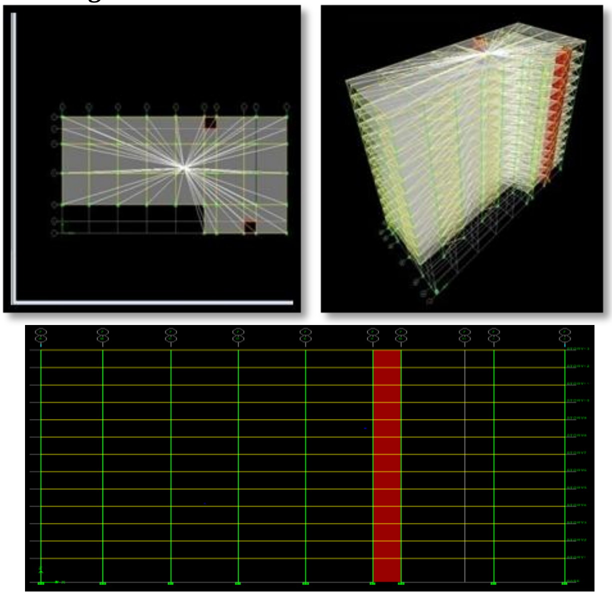

Figure 1: Plan, 3d and elevation view of building without bracings.

Case-I (Vertically):

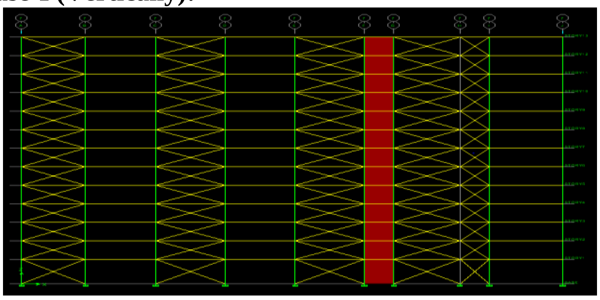

Figure 2: Elevation view of building with alternate bracings. (Vertically from 1bay)

Case-II (Vertically):

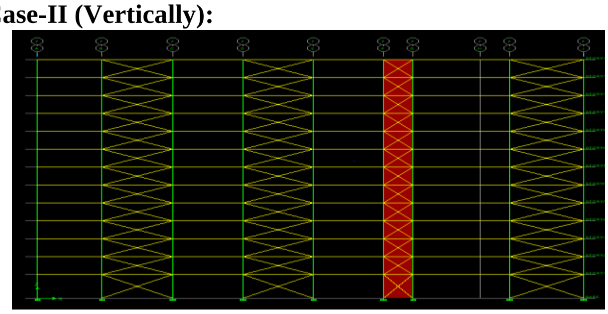

Figure 3: Elevation view of building with alternate bracings. (Vertically from 2bay)

Case-I (Horizontally):

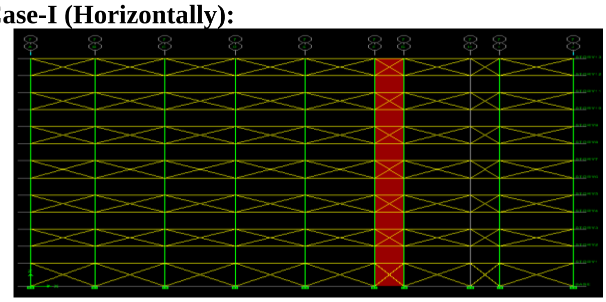

Figure 4: Elevation view of building with alternate bracings. (Horizontally from 1bay).

Case-II (Horizontally):

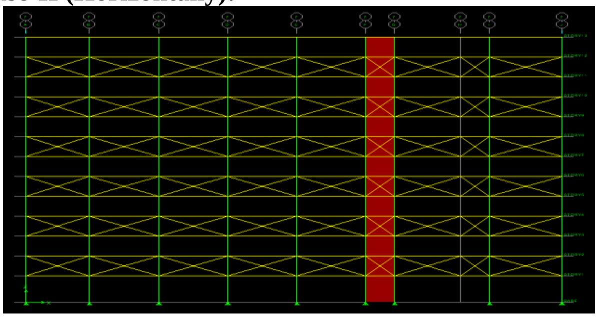

Figure 5: Elevation View of building with alternate bracings. (Horizontally from 2bay).

V. RESULTS AND DISCUSSIONS

Story drift in X direction:

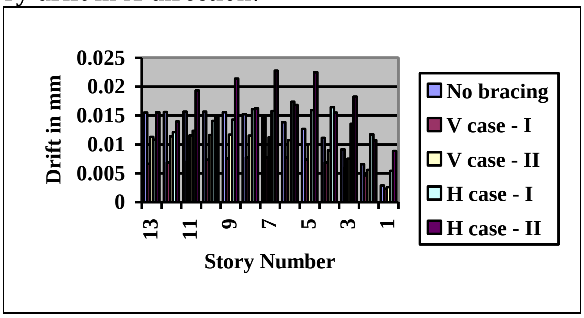

Figure 6: Story shear in X direction

From the above figure it is concluded that the drift (lateral displacement) in X direction is least for the building with vertically alternative bracings case –I than in other remaining cases.

Story drift in Y direction:

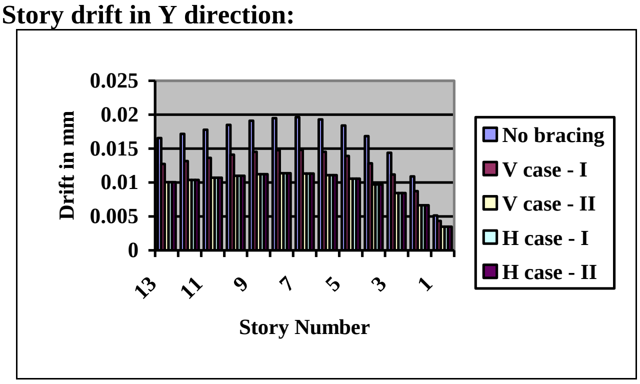

Figure 7: Story shear in Y direction

From the above figure it is concluded that the drift (lateral displacement) in Y direction is least for the building with vertically alternative bracings case –II than in other remaining cases.

Note: The parameters such as story shear, bending moment and time period of the structure increase as the stiffness of building increases due to installation of bracings. The building possesses steel X bracings so here we have increment in the story shear.

Shear force in X direction:

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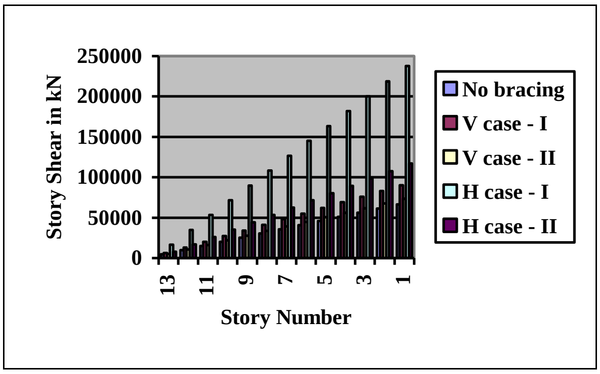

Figure 8: Shear force in X direction

From the above figure it is concluded that the story shear in X direction is least for the building with no bracing than in other remaining cases.

Shear force in Y direction:

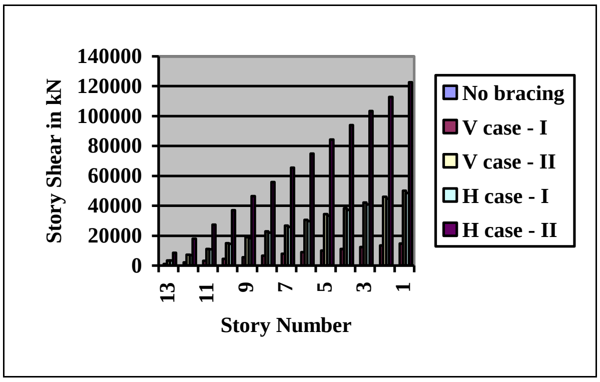

Figure 9: Shear force in Y direction

From the above figure it is concluded that the story shear in Y direction is least for the building with no bracing than in other remaining cases.

Time period:

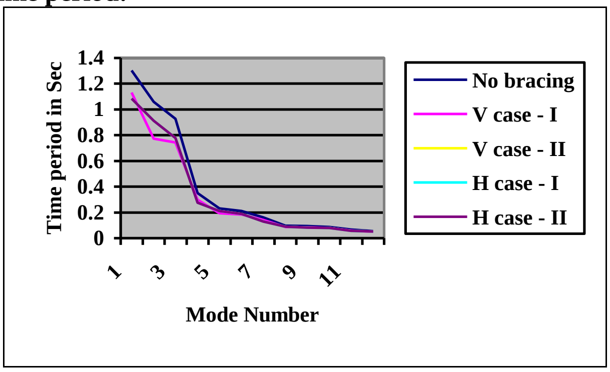

Figure 10: Time period variation

From the above figure it can be concluded that the time period is more for the building with no bracing and less for the building with horizontally alternative bracing case – II.

Stiffness:

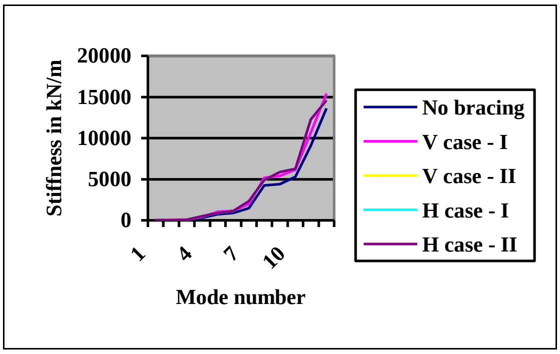

Figure 11: Stiffness variation

From the above figure it is concluded that the value of stiffness is high for the building with vertically alternative bracings case – II than in other remaining cases.

VI. PERFORMANCE POINT BEHAVIOUR

Pushover Curves for the performance point:

Building without bracings:

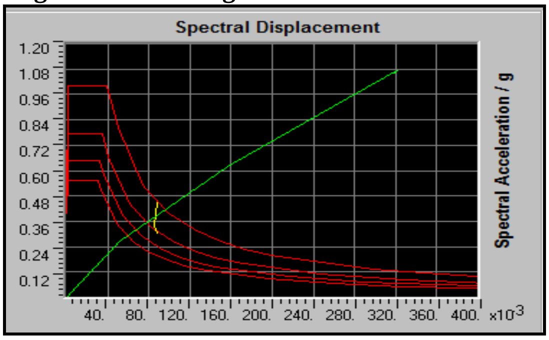

Figure 12: building with no bracings.

From the figure above we can observe the performance point for the building without bracings, the structure remains in the immediate occupancy performance level. Hence the structure is safe at this performance point. The effective time period at the point is 0.929 and the effective damping was 0.064.

Building with alternative bracings Case - I:

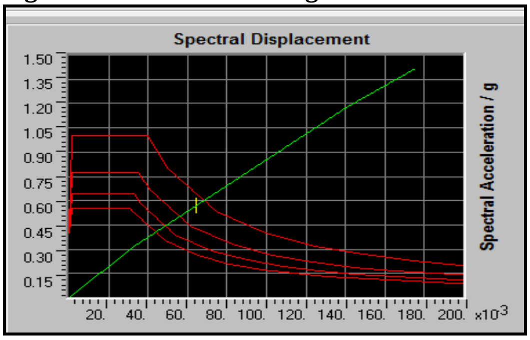

Figure 13: building with bracings (bay wise -I).

From the figure above we observe that the performance point for the building with bracings vertically, the structure remains in the immediate occupancy performance level. Hence the structure is safe at this performance point. The effective time period at the point is 0.662 and the effective damping was 0.054.

Building with alternative bracings Case -II:

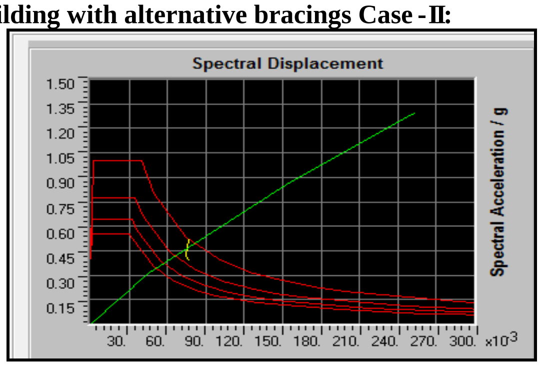

Figure14: building with bracings (bay wise -II).

From the figure above we can observe that the performance point for the building with bracings vertically the structure remains in the immediate occupancy performance level.

Hence the structure is safe at this performance point. The effective time period at the point is 0.790 and the effective damping was 0.058.

Building with bracings in story wise case - I:

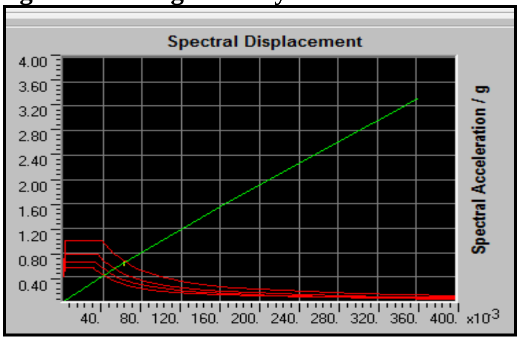

Figure15: building with bracings (story wise -I).

From the figure above we can observe that the performance point for the building with bracings horizontally the structure remains in the immediate occupancy performance level. Hence the structure is safe at this performance point. The effective time period at the point is 0.623 and the effective damping was 0.051.

Building with bracings in story wise case - II:

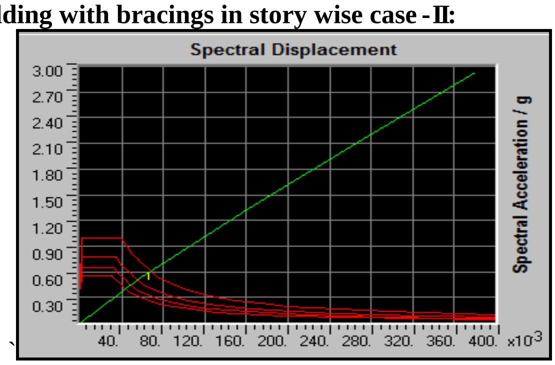

Figure 16: building with bracings (story wise -II).

From the figure above we observe that the performance point for the building with bracings horizontally the structure remains in the immediate occupancy performance level. Hence the structure is safe at this performance point. The effective time period at the point is 0.669 and the effective damping was 0.051.

VII. CONCLUSIONS

From the above research the following conclusions are drawn:

1. The storey drift can be reduced by providing bracing to the buildings
2. The story shear of a braced building is high when compared to unbraced building which indicates that stiffness of building has increased.
3. The time period of the structure decreases with incorporation of the braces as the stiffness of the building will be increased.
4. It is concluded that the arrangements of the bracing system has considerable effect on the performance of the building
5. So from the four braced models considered in this paper model 2 that is building with vertically alternative bracings gives the optimum performance.

VIII. SCOPE FOR FURTHER STUDY

1. In the present paper the pushover analysis is carried out for the G+12 storey buildings with and without bracings. This can be further extended to other tall buildings.
2. In the present paper the conceptual design is kept common, work can be done by optimizing the sizes at various levels.
3. Further investigation can be done on the accuracy of the analysis method adopted.
4. More studies are required to be carried out before any conclusion to be drawn.

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