Seismic Analysis of Reinforced Concrete Frame with Steel Bracings

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Abstract:- Earthquake is the natural calamity known to mankind from many years, from the ancient time researches' researched many ways to protect the buildings. There was a need to control the damage caused by earthquake to the existing buildings. Many existing reinforced concrete buildings need retrofit to overcome deficiencies to resist seismic loads. Bracing was the most effective method which can be incorporated to the existing reinforced concrete buildings. Braced frames can resist large amount of lateral forces and have reduced lateral deflection and thus reduced P-Delta effect. In present study we have used square grid of 20m in each direction of 5m bay in each direction, software used is ETABS 9.7.0, we have compared the results of bare frame and braced frame and found the result that braced frame significantly lower the lateral displacements and drifts compared to bare frame and thus resisting earthquake forces efficiently. The study has been carried out for the Zone V and soft soil as specified in IS 1893-2002.

***Keywords*: Bare Frame, Base Shear, Bracing, Response Spectrum Analysis, Lateral Displacements, Lateral Drifts, Time Period, Concentrically Braced Frames, Lateral Load Resistance.**

1. INTRODUCTION

From the first high rise buildings constructed in the late 19th century until the modern day skyscrapers, the structure has played an important role in the overall design. Increasing height and slenderness brought about a change in the structural engineers focus from static gravity loads to horizontal dynamic loads generated by wind and earthquakes. There was a need to develop the different kind of structural system, one such method came into existence is by incorporating steel braces in the structure. The large ductility and high strength to weight ratio of structural steel make it an ideal material for earthquake resistance. Steel braced frame is one of the structural systems used to resist earthquake loads in multistoried buildings. Bracings resist lateral forces predominantly with members in tension or compression. Braces are subjected to predominantly axial stresses. The buildings which have been damaged can be retrofitted by using braces. Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness.

2. FRAMED STRUCTURES

The frames derive their lateral load resistance from the rigidity of connections between beams and columns. The behaviour of frames is straight forward and their computer modeling is simple. A number of software's are available for the analysis of framed structures. The frames are infilled by masonry panels for the purpose of partition. These partitions are considered non structural and their to lateral load resistance is generally ignored. The behavior of these panels is complex. These act as diagonal bracing members before failing and falling apart from the frame. In many cases, under severe shaking these fail and fall apart before the frame is subjected to ultimate load and that is why their contribution to lateral load resistance is not considered. However, presence of masonry panels alters the dynamic characteristics of frames and the behaviour is particularly complex when the ground storey of the frame buildings does not have masonry infills for the purpose of parking. [3]

3. BRACING SYSTEM

Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing
is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling walls, adding walls to existing columns, encasing columns, and adding steel bracing to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel braced frames are efficient structural systems for buildings subjected to

seismic or wind lateral loadings. Therefore, the use of steel bracing systems for retrofitting reinforced concrete frames with inadequate lateral resistance is attractive. There are varieties of braces possible but for the present study we have taken concentrically braced system. [1]

Concentrically braced frames consist of beams, columns and brace which are connected with pinned connections. Thus, the members can be said to be to form a vertical truss. They resist lateral force by this truss action and develop ductility by inelastic action in braces experiencing tension. They have high elastic stiffness but low ductility as the braces in compression can buckle which is brittle failure. [3]

4. DESIGN PARAMETERS

1. Type of building: Multi Storied Building.
2. Zones: V.
3. Type of soil: Soft soil.
4. Plan of the Building: 20mX20m.
5. Each Bay Size: 5m.
6. Number of Stories: 10.
7. Floor to floor height: 3mts.
8. Live load: 3.5kN/m^2.
9. Beam Size: 0.3mX0.6m.
10. Column Size: 0.5mX0.75m.
11. Slab Thickness: 0.125m.
12. Steel Brace ISMB 500
13. Materials: M50 and Fe415.
14. Seismic analysis: Response Spectrum Method as per IS: 1893 (Part 1):2002.

5. CASES OF STUDY

- Case 1: Bare Frame
- Case 2: Bracings in Middle
- Case 3: Bracings at Corners

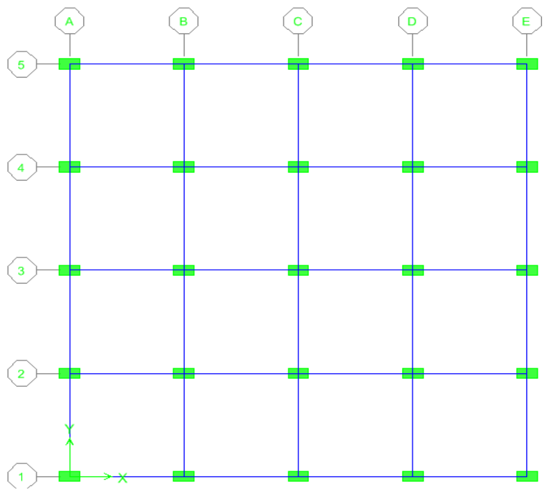

Figure 1: Plan of the Building

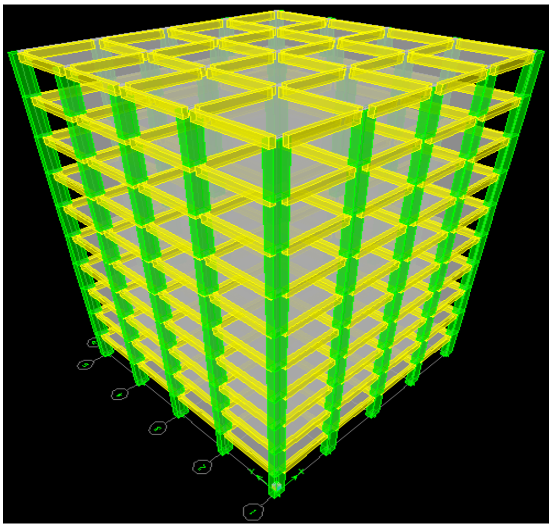

Figure 2: Bare Frame (Case 1)

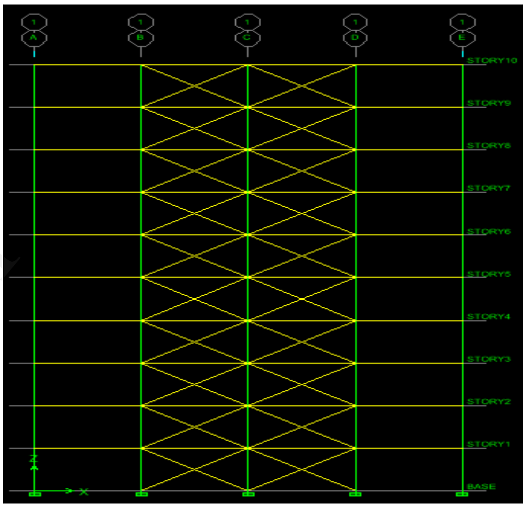

Figure 3: Bracings in middle (Case 2)

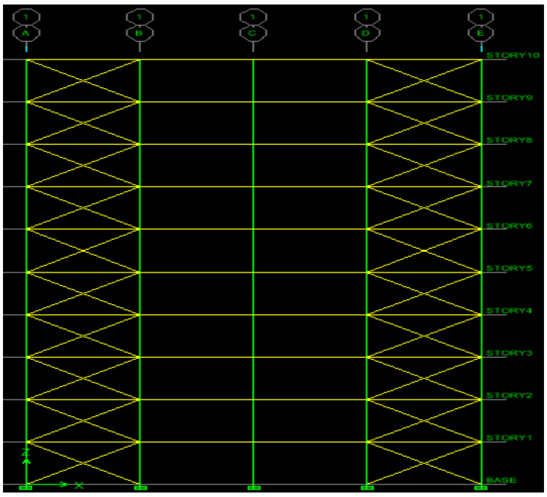

Figure 3: Bracings at Corners (Case 3)

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6. RESULTS

Table 1: Values of Base Shear

Case	Base Shear (kN)
1	3024
2	3577
3	3507

Table 2: Values of Time Period

Case	Time Period (sec)
1	0.8662
2	0.5275
3	0.5812

Table 3: Values of Displacements

Case	Displacements (mm)
1	18.60
2	8.92
3	11.00

Table 4: Values of Drift

Case	Drift (mm)
1	1.351
2	0.543
3	0.654

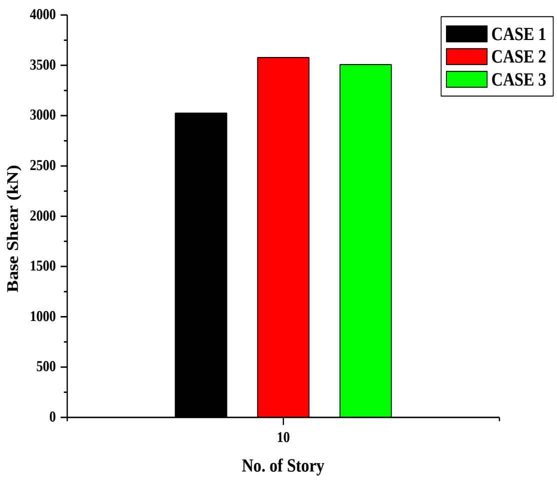

Figure 4: Variation of Base Shear

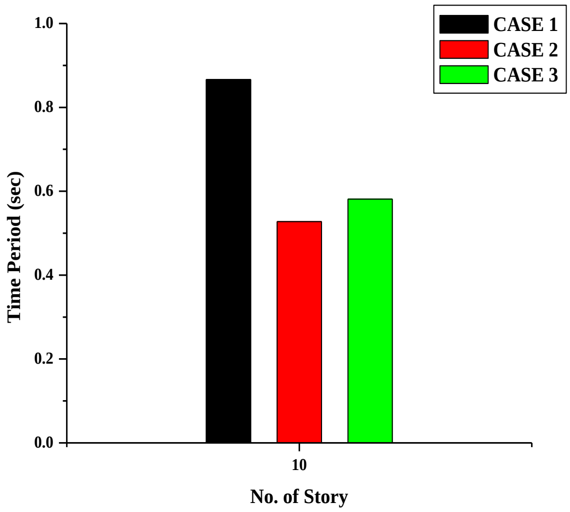

Figure 5: Variation of Time Period

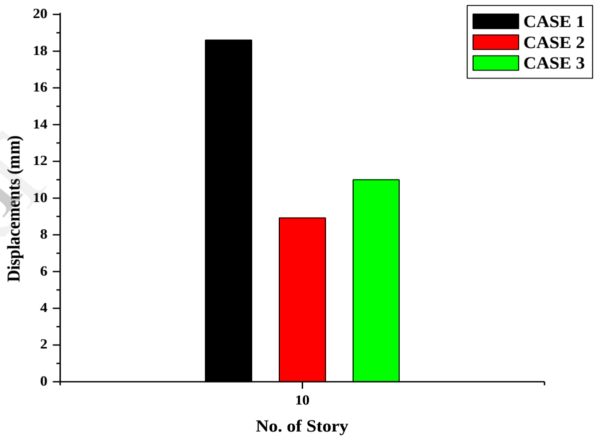

Figure 6: Variation of Displacements

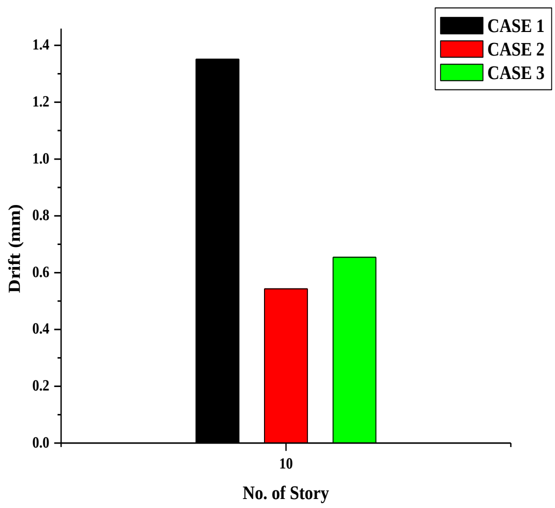

Figure 7: Variation of Drift

7. CONCLUSIONS

- From the above results it is clear that Case 1 (Bare Frame) produces larger displacements and drifts compared to other two cases.
- Case 2(Bracings in middle) has the lowest time period compared to other cases.
- Case 2 gives the lowest displacement values followed by Case 3(Bracings at corners).
- Case 1 has the minimum base shear compared to other cases because the bracings are not included in the Case 1.
- Minimum drift is given by Case 2 , overall Case 2 performs better than Case 3 because of the continuity of braces being maintained by Case 2.

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