Analysis of Reinforced Concrete Frame Structure With Different Types of Bracing Systems

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Abstract- *A braced frame is a structural system commonly used to withstand the gravity loads, seismic loads, wind loads etc. Concrete braced reinforced concrete frame and steel braced reinforced concrete frame are used to resist the earthquake loads in high rise buildings. Many existing structures which are unable to resist the seismic loads need to be retrofit to overcome these deficiencies. In present work, analysis of reinforced concrete frame with different types of bracings(X type, V type, Inverted V type, Combined V type and diagonal Type) is studied. A G+13 storey building is analysed for seismic loading. Structure is modelled and analysed using ETABS software.*

Keywords- Bracing system, ETABS, Storey drift, Storey displacement, Storey stiffness.

I. INTRODUCTION

The main aim of the structural systems used in the building is to improve the performance of a building under existing loads or to increase the strength of the structural member under additional loads. Dead load, live load and snow load are the loads resulting from the effect of gravity. Besides these gravity load there are some other loads acting on the structure such as lateral loads caused by wind, blasting or earthquake. Braced frames are the structural system most commonly used in construction, being cost effective, easy to erect and simple to analyse. The main purpose of bracing is to resist lateral load and provide stability to the structure. In braced frame construction we assume that all lateral loads are carried by bracing system and beams and columns are designed to carry vertical load only. The seismic performance of the frame structure is improved by increasing its capacity to carry load and by increasing the stiffness of structure. To provide strength, lateral stiffness, ductility etc steel bracing system can be inserted in a frame.

II. OBJECTIVES

1. The present work is aimed at evaluating the response of braced reinforced concrete frame structure and un-braced reinforce concrete frame structure subjected to earthquake loads.
2. To compare the maximum storey drift for braced frame to that of un-braced frame structure.
3. To compare maximum lateral displacement for braced frame to that of un-braced frame structure.
4. To study the result of base shear and storey stiffness.
5. To study different types of bracing system and identify the suitable one to resist the seismic loads effectively.

III. DESCRIPTION OF BUILDING MODEL

Table no 1

Frame type	Reinforced concrete frame
Building model	13 storey building
Storey height above plinth level	3 m
Beam size	0.23 m x 0.45 m
Column size	0.30 m x 0.45 m
Thickness of slab	0.15 m
Thickness of wall	0.23 m
Steel bracing used	ISA 110X110X10mm
Concrete bracing size	0.23 m x0.23 m
Live load	3 KN/m^2
Floor finish load	0.52 KN/m^2
The unit weight of concrete	25 KN/m^2
Unit weight of AAC blocks	6 KN/m^2
The compressive strength of concrete	25 N/mm2
Yield strength of steel	500 N/mm^2
Seismic Zone	III
Sub-soil type	Type 1 (Hard)
Importance factor	1
Response Reduction Factor	3
Method of Analysis	Linear Static Analysis

- Building model is analysed for seismic loading using software ETABS 2017.
- The load cases considered as per IS 1893-2002.

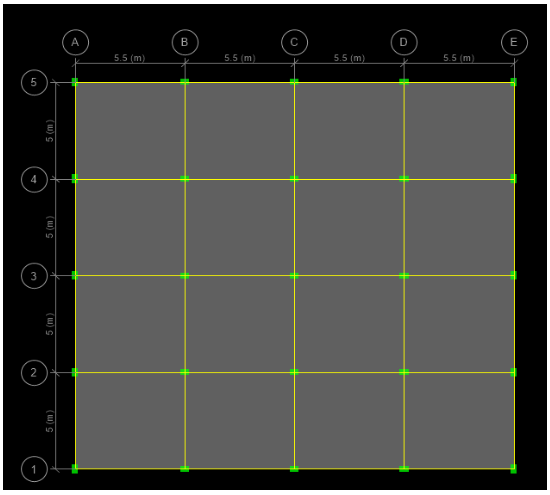


Fig 1: Plan of building model

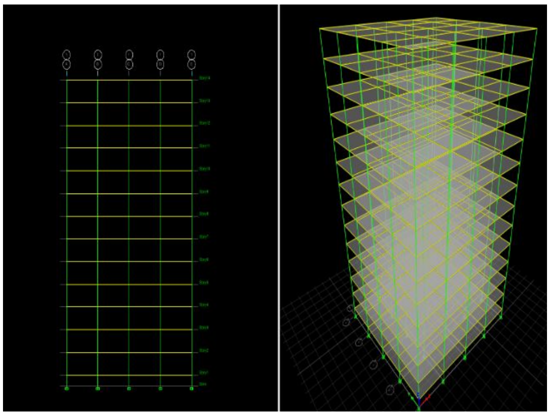


Fig 2: Unbraced building model

a. X type bracings (steel and concrete) (fig 3)
b. V type bracings (steel and concrete) (fig 4)
c.Inverted V type bracings (steel and concrete) (fig 5)
d. Combined V-type bracings (steel and concrete) (fig6)
e. Alternative Diagonal bracings(steel and concrete) (fig 7)

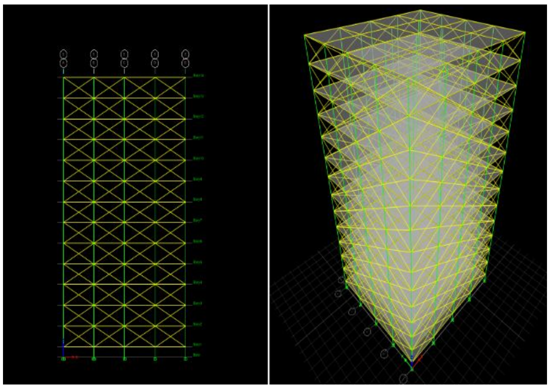
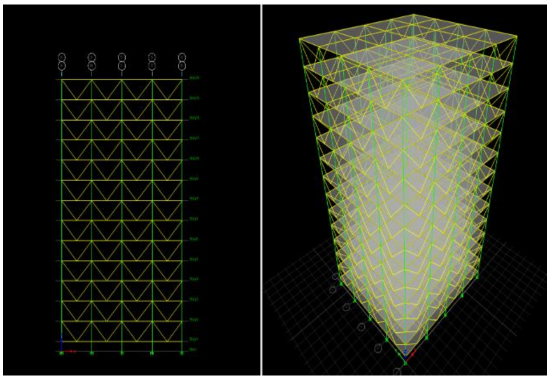


Fig 3



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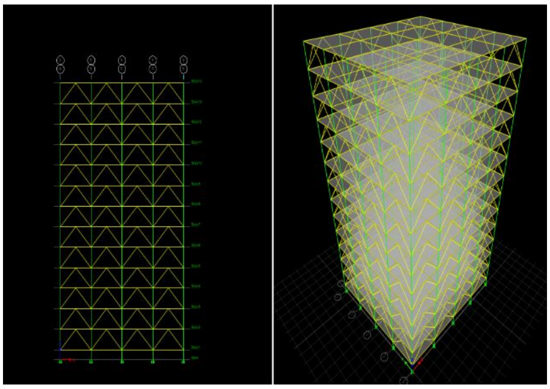

Fig 5

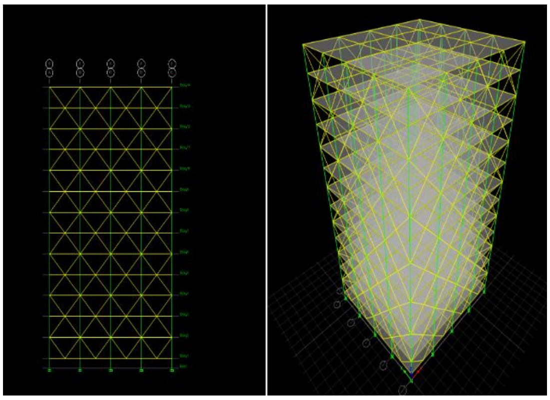

Fig 6

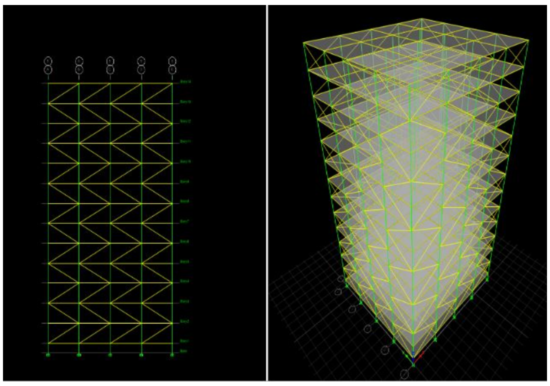

Fig 7

IV. RESULTS & DISCUSSION

1. Lateral Displacement under Seismic loads

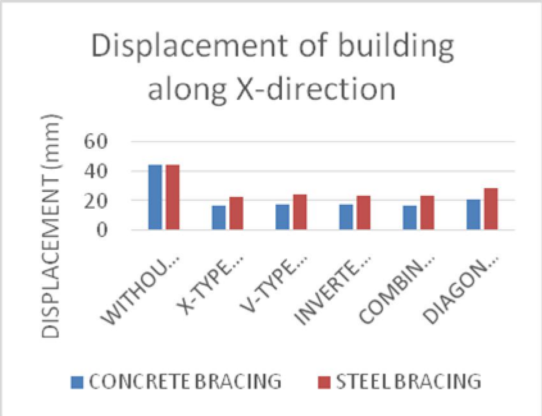

Fig 8: Displacement (mm) of building model in X direction

From fig 8 it is observed that displacement of building is highly reduced for braced frame model. It is observed that displacement is reduced to great extent for combined V-type concrete bracings and X-type steel bracing model along X direction when compared to un-braced building model.

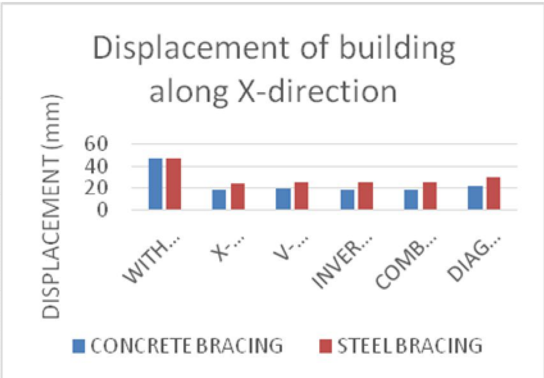

Fig 9: Displacement (mm) of building model in Y direction

From fig 9 it is observed that displacement of building is highly reduced for braced frame model. It is observed that displacement is reduced to great extent for X-type concrete bracing and X-type steel bracing model along Y direction when compared to un-braced building model.

2. Storey Drift

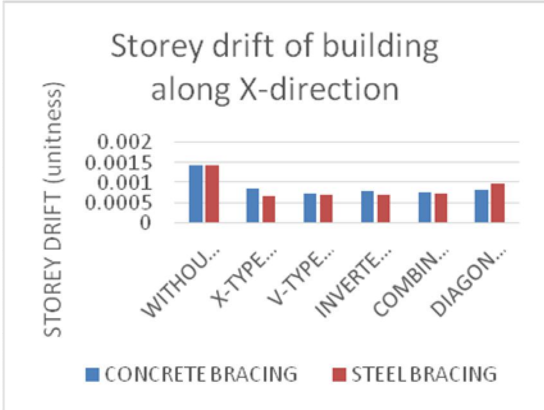

Fig 10: Storey Drift along X direction

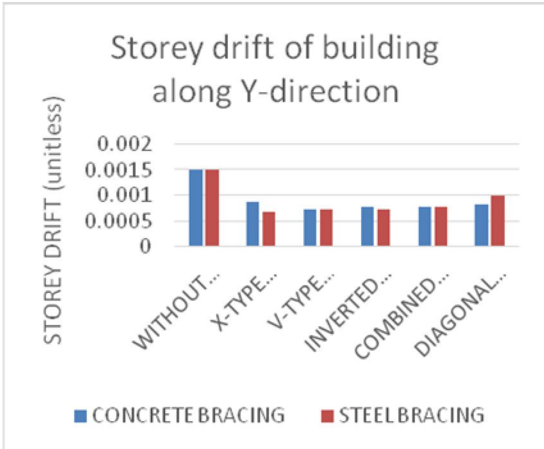

Fig11: Storey Drift along Y direction

From fig 10 and fig 11 it is observed that storey drift of building is highly reduced for braced frame models. It is observed that storey drift of building is reduced to great extent for X-type concrete and X-type steel bracings along both (X and Y) the directions when compared to un-braced building model.

3. Base Shear

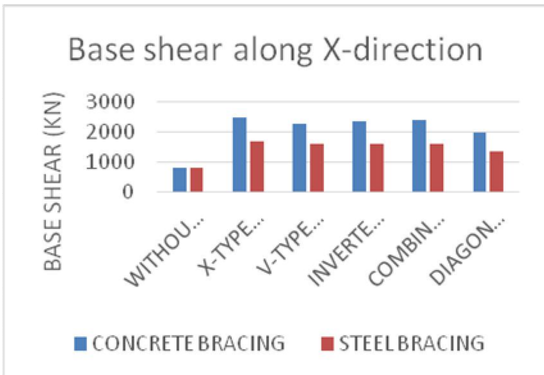

Fig 12: Base Shear along X direction

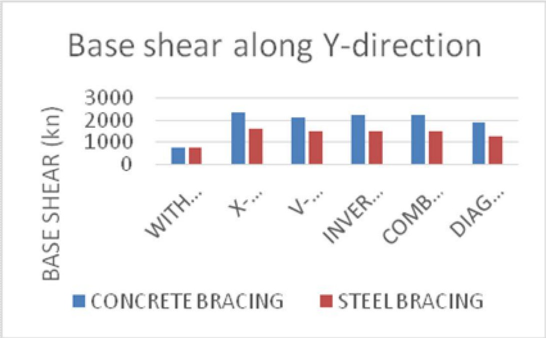

Fig 13: Base shear along Y direction

From fig 12 and fig 13 it is observed that the base shear is maximum for braced frame model and minimum for the un-braced frame model. It is seen that base shear is maximum for X-type of concrete and steel bracing in both (X and Y) directions.

4. Storey Stiffness

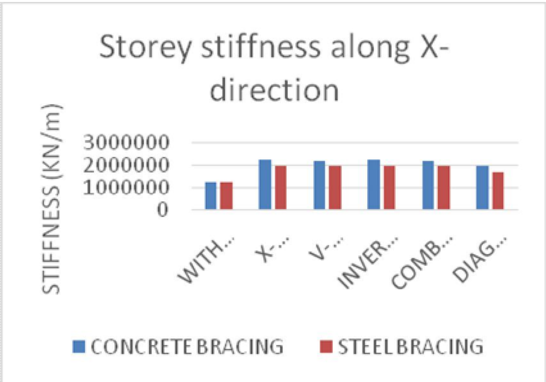

Fig 14: Storey Stiffness along X direction

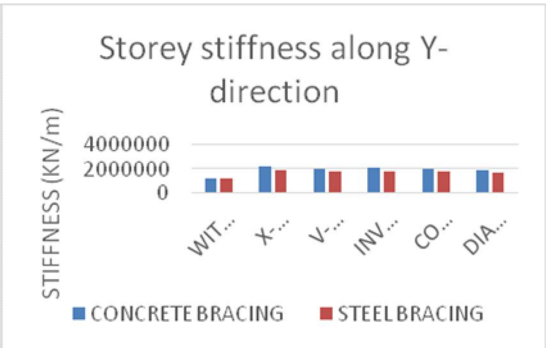

Fig 15: Storey Stiffness along Y direction

From fig 14 and fig 15 it is observed that storey stiffness is maximum for braced frame model and minimum for the un-braced frame model.It is seen that storey stiffness is maximum for X-type of concrete and steel bracing in both (X and Y) direction.

V. CONCLUSION

In the present work building model is analysed for without bracing and with bracing frame structure. After analysis conclusion is made that under the application of different types of bracing system lateral displacement of the structure decreases. It is observed that under the application of cross bracing (X-type bracing) reduction in the displacement and storey drift is maximum compared to other types of bracings. Hence displacement and storey drift is maximum for un-braced frame structure and minimum for braced frame structure.

1. When the bracings are introduced to the building model there is considerable reduction in the storey displacement compared to building model without bracings.
2. For X-type concrete bracing the percentage reduction in the maximum displacement is observed to be 59.6% and for X-type steel bracing the percentage reduction in the maximum displacement is observed to be 46.23% compared to the building model without bracings.
3. For V-type concrete and X-type steel bracings maximum inter storey drift is effectively reduced and percentage reduction is observed to be 50.83% and 54.16% respectively compared to the building model without bracings.
4. Base shear is maximum for X-type concrete and steel bracing system and percentage increase is observed to be 66.98% in X-direction and 67.31% in Y-direction for concrete bracing and 50.82% in X-direction and 52.06% in Y-direction for steel bracing compared to building model without bracings.
5. Storey stiffness is maximum for X-type concrete and steel bracing system and percentage increase is observed to be 43.91% in X-direction and 46.52 % in Y-direction for concrete bracings and 36.8% in X-direction and 37.89% in Y-direction for steel bracings.

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