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RESEARCH ARTICLE

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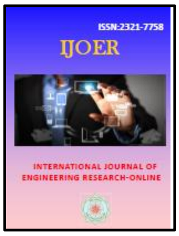
EFFECT OF STEEL BRACINGS ON RC FRAMED STRUCTURES

POLAKA PRASANNA KUMAR REDDY[1], P.RAVI KUMAR[2]
[1]M.Tech student, IV semester, PACE Institute of technology and sciences, Ongole
[2]Assistant Professor , Department of Civil Engineering, PACE Institute of technology and sciences, Ongole



ABSTRACT

Earthquake is the natural calamity known to mankind from many years, from the antiquated time researchers looked into numerous approaches to secure the structures. There was a need to control the damage caused by earthquake to the existing buildings. Many strengthened solid structures need retrofit to overcome inadequacies to oppose seismic loads. Bracing was the best technique which can be used to existing reinforced concrete buildings. Steel bracing is economical, simple to erect, involves less space and has adaptability to plan for meeting the required strength and stiffness. The present work deals with study of effect of steel bracings on RC framed structures. For the purpose of this study, reinforced concrete framed building (G+9) was modeled and analyzed in three parts 1) Model without steel bracings and shear wall 2) Model with different bracing system 3) Model with shear wall. Bracings and shear walls were placed at the middle bays and all these models were analyzed for seismic forces at different seismic zones using E tabs 2015 software. To find out seismic performance of steel bracing and shear wall to RCC building, parameters as Lateral displacement, Story shear and Story drift must be studied. It was found that the chevron type of steel bracing was found to be more efficient in zones II&III and X type of bracing was found to be more efficient in Zones IV&V further steel braced building significantly reduces the lateral drift when compared with shear wall building.

INTRODUCTION

During earthquake motions, deformations take place across the elements of the load-bearing system as a result of the response of buildings to the ground motion. As a consequence of these deformations, internal forces develop across the elements of the load-bearing system and displacement behavior appears across the building. The resultant displacement demand varies depending on the stiffness and mass of the building. In general, buildings with higher stiffness and lower mass have smaller horizontal displacements demands. On the other hand, each building has a specific displacement capacity. In other words, the amount of horizontal displacement that a building can afford without collapsing is limited. The purpose of strengthening methods is to ensure that the displacement demand of a building is to be kept below its displacement capacity. This can mainly be achieved by reducing expected displacement demand of the structure during the strong motion or improving the displacement capacity of the structure.

OBJECTIVE OF THE PROJECT

The main objective of this project is

- To compare response of braced and unbraced building subjected to lateral loads in different seismic zones.
- To identify the suitable bracing systems for resisting the seismic loads efficiently. To

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compare seismic performance of braced system and shear wall system in different seismic zones.

- To find out the better strengthening or retrofitting techniques that can be adopted in a specific zone.

The present work deals with study of effect of steel bracings on RC framed structures. For the purpose of this study, six models of reinforced concrete framed building (G+9) strengthened with different types of concentrically braced frames and shear walls in various seismic zones (i.e., zone- II, III, IV and V) is selected. The frames in each floor were analysed and designed for gravity loads as per IS 456:2000 and for lateral loads (earthquake loads) as per IS 1893:2002 (part 1). To find out effectiveness of steel bracing and shear wall to RCC building there is need to study parameters as Lateral displacement, Story shear, Story drift, design bending moment and shear force. The structure is analysed with liner static and dynamic analysis method using ETABS 2015.As per IS 1893-2002, clause 6.3.1.2 the following load combinations are accounted:-

- 1.5(DL+IL)
- 1.2(DL+IL±EL)
- 1.5(DL±EL)
- 0.9DL±1.5EL

STRUCTURAL CONFIGURATION

Following are the different types of models

- Model without bracings and shear wall(Base model)
- Model with X Bracing
- Model with Diagonal Bracing

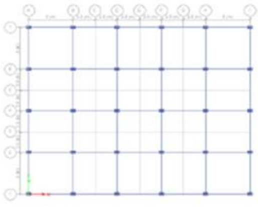
General Description		
Plan dimension	25 x 20 m	
Structure	OMRF	
No. of storey	G + 9	
Floor to floor height	3.00 m	
Foundation type	Isolated footing	
Soil strata	Medium	
Member Properties		
Slab Thickness		150mm
Beams	Plinth Beam	300 x 300 mm
	Floor Beam	300 x 450 mm
Columns		380 x 600mm
Wall Thickness	Exterior wall	230mm
	Interior wall	115mm
Shear wall thickness		230mm
Steel Bracing Size		ISMB300
Material Properties		
Grade of concrete		M25
Grade of steel		Fe 415
Density of concrete		25 kN/m^3
Density of brick		19.20 kN/m^3
Modulus of elasticity of concrete		25000 N/mm^2
Modulus of elasticity of steel		2×10^5 N/mm^2
Load Intensities		
Floor finish		1 KN/m^2
Live load		2 KN/m^2

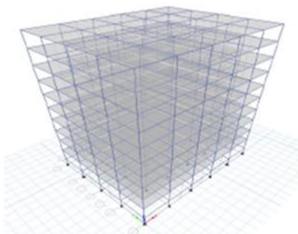
Parameters		values
Seismic Zone Factor	Zone 5	0.36
	Zone 4	0.24
	Zone 3	0.16
	Zone 2	0.10
Importance factor		1.0
Response reduction factor		3.0
Percentage of damping		5%
Soil type		Medium soil

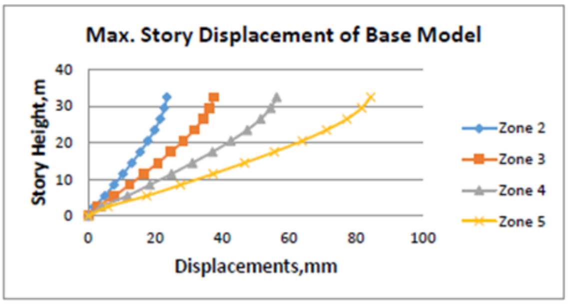
RESULTS AND DISCUSSIONS

Model without Bracing and Shear Wall (Base Model)

In this model, Normal building frame is designed and analyzed considering the parameters like maximum Story displacements, Story Drifts and Story Shear in X and Y directions. Thus, the results obtained are discussed below. The figures shown below are typical plan and elevation view of the structure.







KY Publications

Fig: Comparison of Story Displacement of best fit braced model and shear wall model in Zone 2

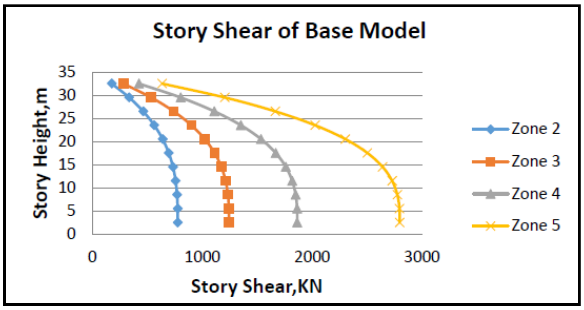


Fig : Story Shear of Base Model from Zone 2 to Zone 5

Model with X Bracing

In this model, Normal building frame is strengthened with X bracing is designed and analysed considering the parameters like maximum Story displacements, Story Drifts and Story Shear in X and Y directions. Thus, the results obtained are discussed below. The bracings are provided at the outer middle bays.

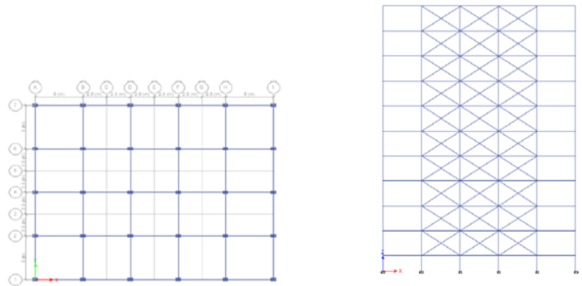
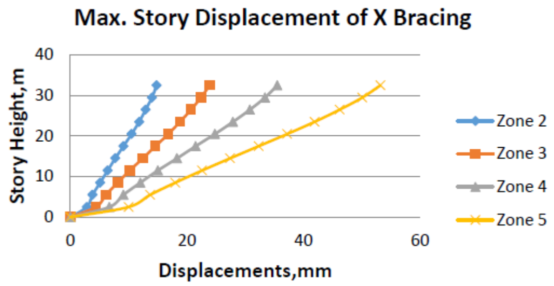


Fig: Plan and Elevation view of X Braced Model



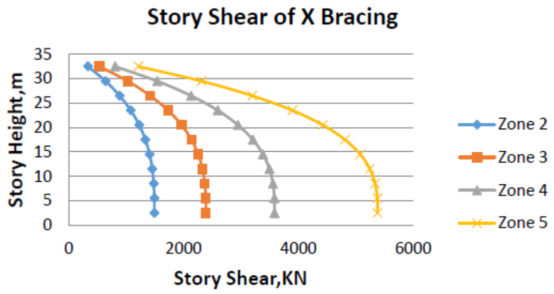


Fig : Story Shear of X Braced Model from Zone 2 to Zone 5

Model with Chevron Bracing(Inverted V Bracing)

In this model, Normal building frame is strengthened with Chevron bracing is designed and analysed considering the parameters like maximum Story displacements, Story Drifts and Story Shear in X and Y directions. Thus, the results obtained are discussed below. The bracings are provided at the outer middle bays.

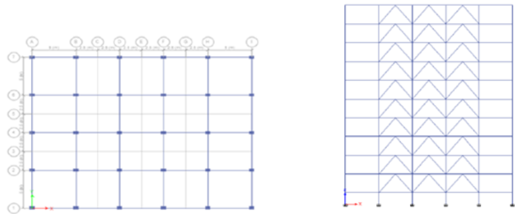


Fig: Plan and Elevation view of Chevron Braced Model

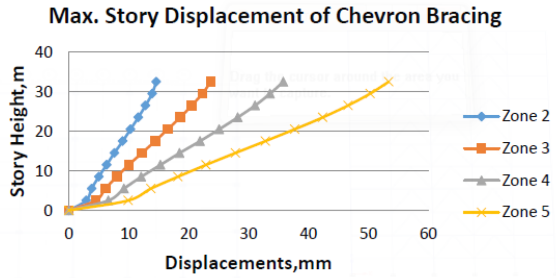


Fig : Max. Story Displacement of Chevron Braced Model from Zone 2 to Zone 5

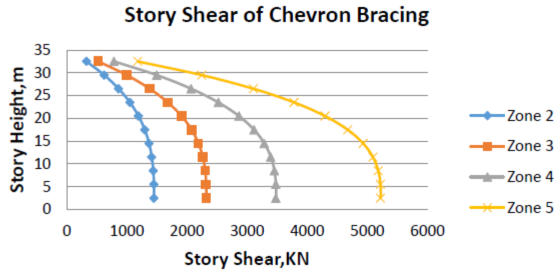


Fig : Story Shear of Chevron Braced Model from Zone 2 to Zone 5

Model with Shear Wall

In this model, Normal building frame is strengthened with Shear Wall is designed and analysed considering the parameters like maximum Story displacements, Story Drifts and Story Shear in X and Y directions. Thus, the results obtained are discussed below. The Shear Wall is provided at the outer middle bays.

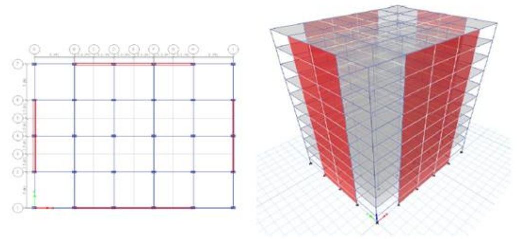


Fig : Plan and Elevation view of Shear Wall Model

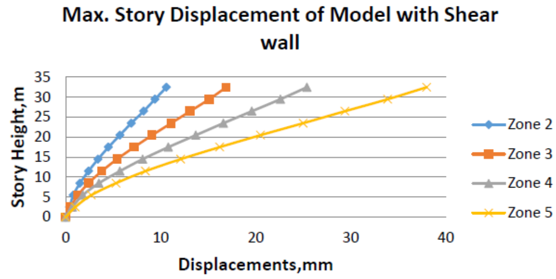


Fig: Max. Story Displacement of Shear Wall Model from Zone 2 to Zone 5

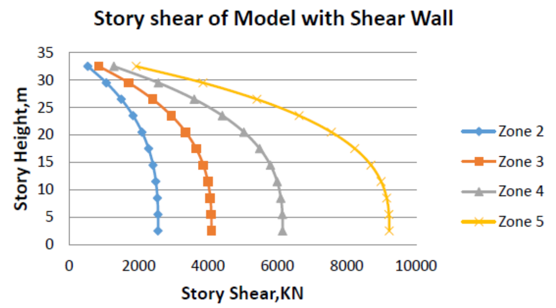


Fig: Story Shear of Shear Wall Model from Zone 2 to Zone 5

Comparison of Seismic Performance of best fit Braced Model and Shear Wall Model in different Zones:

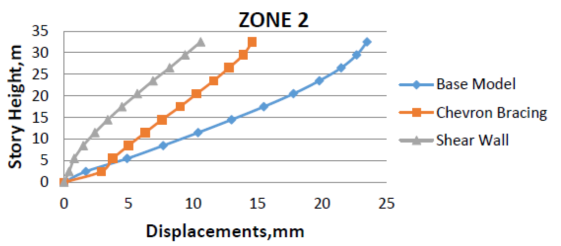


Fig: Comparison of Story Displacement of best fit braced model and shear wall model in Zone 2

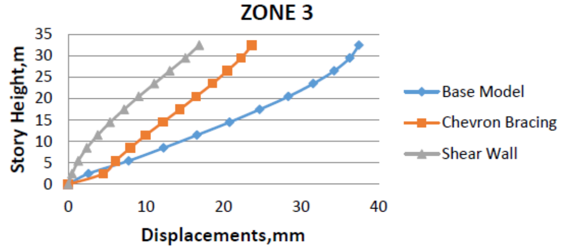


Fig: Comparison of Story Displacement of best fit braced model and shear wall model in Zone 3

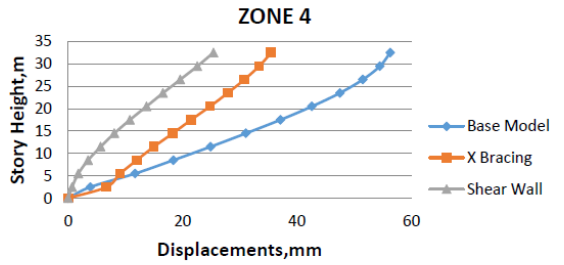


Fig: Comparison of Story Displacement of best fit braced model and shear wall model in Zone 4

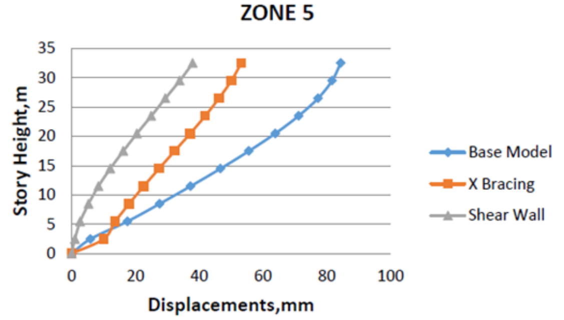


Fig: Comparison of Story Displacement of best fit braced model and shear wall model in Zone 5

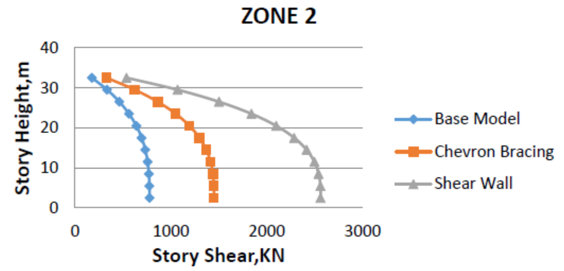


Fig:Comparison of Story Shear of best fit braced model and shear wall model in Zone 2

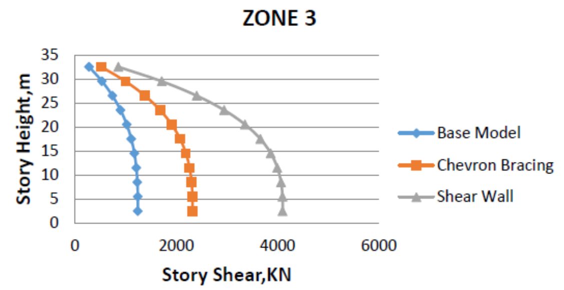


Fig: Comparison of Story Shear of best fit braced model and shear wall model in Zone 3

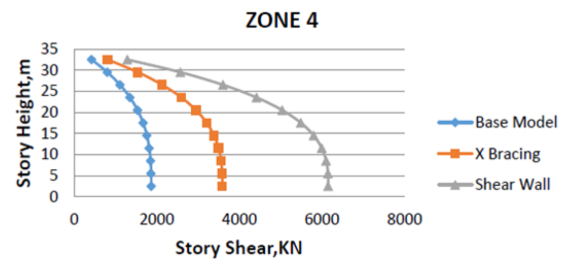


Fig: Comparison of Story Shear of best fit braced model and shear wall model in Zone 4

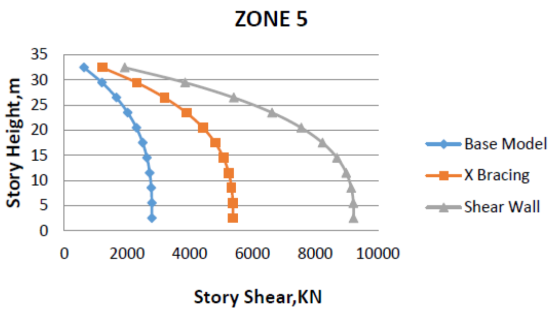


Fig: Comparison of Story Shear of best fit braced model and shear wall model in Zone 5

DISCUSSION

- In Zone 2, maximum story displacement of a normal building is reduced by 37.02%, 18.29%, 37.87%, and 34.04% by using X, diagonal, chevron and V bracings respectively.
- In Zone 3, maximum story displacement of a normal building is reduced by 36.26%, 22.93%, 36.8%, and 34.13% by using X, diagonal, chevron and V bracings respectively.
- In Zone 4, maximum story displacement of a normal building is reduced by 36.94%, 25.75%, 36.41%, and 34.10% by using X, diagonal, chevron and V bracings respectively.
- In Zone 5, maximum story displacement of a normal building is reduced by 36.96%, 27.48%, 36.72%, and 34.12% by using X, diagonal, chevron and V bracings respectively.
- It was found from the figure (Fig. 4.25 to Fig. 4.32) the story displacement and drift was found to be almost similar for X braced and chevron braced building but the story shear is comparatively higher for X braced building
- From feasibility point of view for lesser affected seismic zones chevron bracings can be used because it is possible to accommodate required openings such as windows and doors which are very difficult in other bracing systems like X bracings since X bracing run across the entire wall area.

CONCLUSION

The following conclusions are drawn based on the present study.

- ➢ Steel bracing is one of the advantageous concepts which can be used to strengthen or retrofit the existing structures as strengthening of structures proves to be a better option providing to the economic considerations and immediate shelter problems rather than replacement of buildings.
- ➢ The chevron type of steel bracing was found to be more efficient in zones II&III and X type of bracing was found to be more efficient in Zones IV&V
- ➢ Comparing the seismic performance of different models, it was found that the percentage variation of parameters (Story Displacement and Story Drift) in braced building and shear wall building w.r.t. base model lies in the range 15 to 20%.
- ➢ Steel braced building significantly reduces the lateral drift when compared with shear wall building.
- ➢ Steel bracings can be used as an alternative to other strengthening or retrofitting technique as the aggregate weight of the existing building won't change significantly.
- ➢ The storey drift of steel braced building was less as compared to the unbraced building thus the overall response of the building decreases.
- ➢ The story shear of a braced building was very high when compared to unbraced building which indicates that stiffness of building has increased.

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