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Comparative study of Multistoried Building with X & Inverted V Bracing

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Abstract

The most suitable technique in order to increase the performance and the lateral stability of the RC Frame building situated in earthquake prone areas is the use of steel bracings. In this paper comparison of seismic behavior of G+15 multistoried building situated in zone 4 on medium soil has been carried out on 3 different models by installing different types of bracing i.e X bracing and inverted V bracing. The designed structure should have enough lateral stability in order to resist the lateral force during the seismic shaking, and the parameters such as the storey drift should be within the permissible limits as per the IS 1893-2016. The use of Steel Bracing in Reinforced concrete structure not only helps to reduce the lateral loads during the earthquake but also helps us to reduce the section size of the reinforced concrete structures. In this paper 3 models have been analysed- Model no 1 – G+15 building without steel bracing, Model no 2- G+15 building with X bracing, Model no 3 – G+15 building with inverted V bracing, All the 3 models have been analysed with the help of STAAD PRO V8i software and comparison between these models have been carried out based on 3 seismic parameters such as Storey Drift, Storey Displacement and Base shear.

Keywords

Storey Drift, Storey Displacement, Base Shear, Seismic Analysis, Steel Bracing.

Introduction

In Seismic prone areas multistoried building are most affected by the earthquake forces. Hence structures constructed in earthquake prone zones must be able to resist the lateral load caused by the earthquake shaking along with the gravity loads. The Lateral loads coming on the structure produces sway moments and induces high stresses, thus reduces the stability of the structure, therefore structures should be designed in such a way so that it should sustain the loads coming on them during their service life by possessing adequate strength and it should also be capable of limiting the deformation by possessing the adequate stiffness. Hence in order to reduce the damage, the structure should have enough lateral stability to resist the lateral force during the seismic shaking, hence stiffness is considered more important parameter than strength.

There are different methods which are used to increase the stiffness and stability of the structures. In order to increase the seismic strength of the structure steel bracing or shear walls are used in the structure. This paper deals with the use of steel bracing in order to increase the stability of the structure and decrease the deformation of the structure.

Steel bracings is a highly efficient and economical method of resisting the horizontal forces in a framed structures. Bracing system in structures are used to resist the lateral loads and transmit the loads to the foundation. The bracing can be arranged in various forms, depending upon their arrangement some bracing carry only tension, or alternatively tension and compression. The use of Bracing system reduces the Bending moment and Shear force in the structure and hence prevents the sway of the structure.

The main advantage of the bracing system are :-

1) Compression flange of the main beam tends to buckle horizontally under bending loads. The bracing system resist the buckling of the main beam.
2) Bracing system helps in distributing the vertical loads and lateral loads between the beams.

The main aim of the present Study is to compare the results of 3 models i.e. without bracing, with X bracing

and with inverted V bracing by STAAD PRO V8i software.

Body Of The Paper

Literature Review

Krishnaraj R. Chavan, H.S. Jhadav, (2014) **"**Seismic Response of R C Building With Different Arrangement of Steel Bracing System", Int. Journal of Engineering Research and Applications, Vol. 4, Issue 7 July 2014. This paper dealt with the analysis of G+6 Building situated in zone 3 using STAAD Pro V8i Software by providing different arrangements of steel bracing in RC framed Structure for peripheral Columns, and the results were compared with the structure containing no bracing. It was found that the lateral displacement of the structure can be reduced with the help of X bracing system.

Megha Kalra,(2016) **"**Seismic analysis of Six Storied RC Framed building with bracing system", International Journal of innovative research in science and engineering, Vol. 2, Issue 5 May 2016. This paper generally dealt with the analysis of 6 storey building using Staad Pro V8i software by proving four different types of bracing at three different location. It was found that among the different types of bracing X bracing shows the best performance.

Rishi Mishra, Dr. Abhay Sharma, Dr. Vivek Garg, (2014) "Analysis of RC Building Frames for Seismic Forces Using Different Types of Bracing Systems", International Journal of Engineering Research and Technology (IJERT), Vol. 3, Issue 7 July 2014. This paper generally dealt with the analysis of G+10 building with different bracing system under seismic loading and the result of the different bracing system were compared with the bare framed model in order to evaluate the effectiveness of the different bracing system. It was found out that the bracing system reduces the lateral displacement and the storey drift of the structure.

Nitin Bhojkar, Mahesh Bagade, (2015) "Seismic Evaluation of High-rise Structure by Using Steel Bracing System", International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 3, March 2015. In this paper, the seismic analysis of reinforced concrete (RC) buildings with different types of bracing was studied. A G+9 building was analyzed for seismic zone III as per IS 1893: 2002 using STAAD Pro software. The main parameters consider in this paper to compare the seismic analysis of buildings were lateral displacement, story drift, axial force, base shear. It was found that the X type of steel bracing significantly contributes to the structural stiffness and reduces the maximum inter storey drift of the frames.

Pooja Tiwari, Prof. Sudhir S. Bhadauria,(2017) "Comparative analysis of a tall structure with or without bracing considering seismic load", International Journal Of Engineering Science and Technology, Issue October 2017. In this Paper a comparative study was carried out between a G+20 bare frame model with a G+20 Model containing X Bracing at the corners with the help of Staad Pro v8i software. It was found out that with the help of X bracing system, storey drift , storey displacement of the structure can be reduced and the base shear capacity of the structure can be increased.

Objective

The aim of the study are as follows:-

- To investigate the seismic performance of G+15 multistoried building with and without different types of bracings.
- To compare the seismic performance of the G+15 multistoried building with and without bracing situated in zone 4 on medium soil based on 3 seismic parameters such as storey drift, storey displacement and base shear.

Research Methodology

The analysis of G+15 multistoried building situated in zone 4 on medium soil has been carried out on 3 different models by installing different types of bracing i.e X bracing and inverted V bracing. The structure is regular in plan and regular in elevation with plan dimension of 20m*20m. The height of each storey is 3m and the overall height of the building is 48m.

Design Data

Zone Factor	Zone 4, Z=0.24
Importance Factor	I=1.0
Rock/Soil Type	Medium Soil
Structure Type	RC Frame Building
Damping Ratio	0.05
Beam Size	400mm*400mm
Column Size	350mm*350mm
Slab Depth	150mm

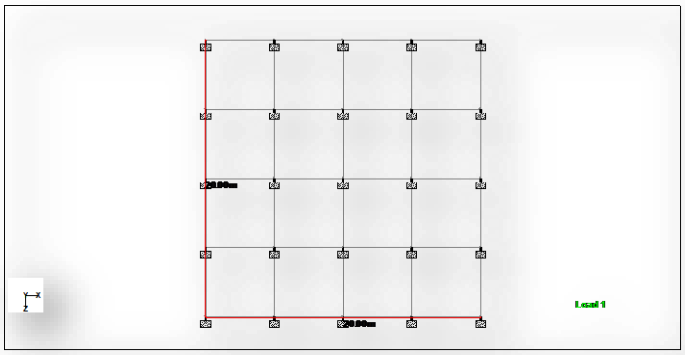

Fig 1: Plan Of the structure

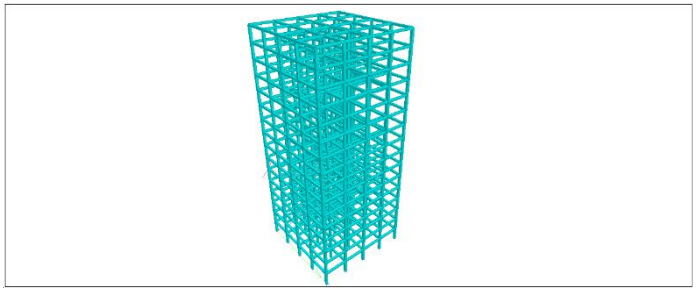

Fig 2: Isometric view of the structure without bracing

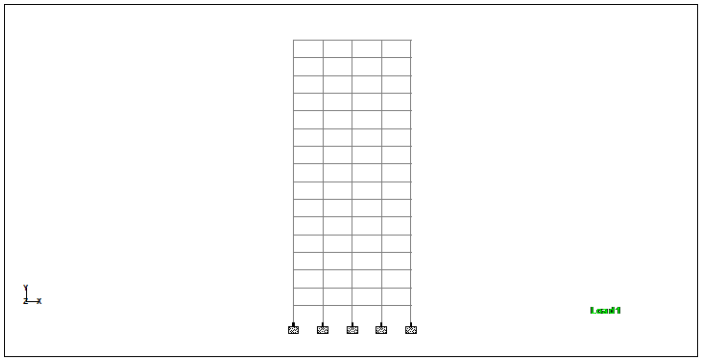

Fig 3: Front View Of The Structure

Loads applied on the structure during analysis:-

1) Dead Load (IS 875 part 1)
   a) Self weight of the Structure = 1Kn/m²
   b) 9'' wall = 13.8 Kn/m
   c) 4.5'' wall = 6.9 Kn/m
   d) Parapet wall = 3.45 Kn/m
   e) Self weight of the slab = 3.75 Kn/m²
2) Live Load (IS 875 part 3)
   Live Load = 3Kn/m²

All the three models are analyzed as per IS 1893- 2016

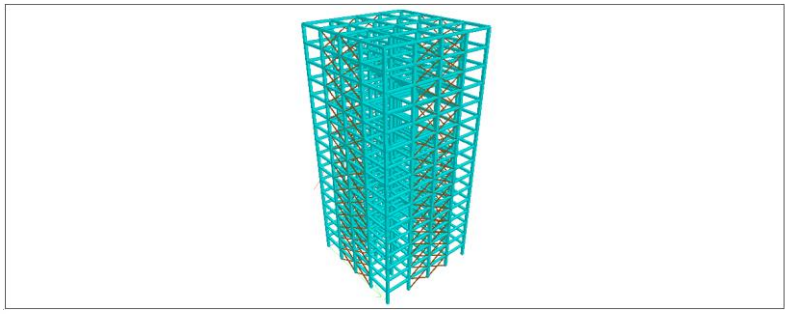

Fig 4: Isometric view of structure with X Bracing

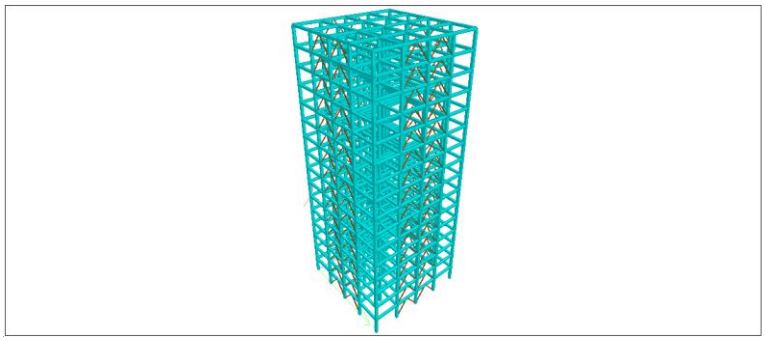

Fig 5: Isometric view of the structure with Inverted V Bracing.

The analysis of all the three model is done on Staad pro V8i software as per IS 1893-2016 after applying the seismic load and the required load combination and the effect of bracing is evaluated on 3 seismic parameters i.e. storey drift, storey displacement and base shear.

Result and Output

Effect of the bracing system on the seismic parameter such as storey drift, storey displacement and base shear are as given below:-

1) Storey Drift

Storey drift for the critical load combination for all the three models are compared with each other. The graph of Storey Drift Vs Storey Height is plotted for all the three models.

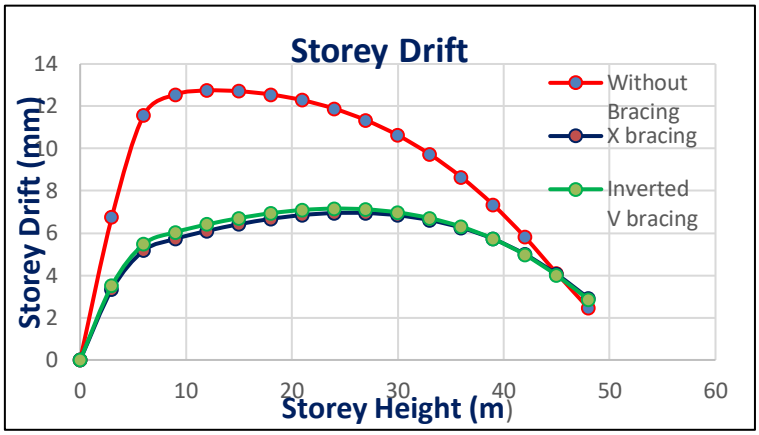

Fig 6: Storey Drift Vs Storey Height

From the above graph it can be concluded that with the help of bracing system in RC Framed structure, storey drift can be reduced by a certain level in the structures situated in earthquake prone areas.

Maximum drift of 6.949mm is observed for X Bracing, max drift of 7.159mm is observed for Inverted V Bracing and a maximum drift of 12.744mm is observed for structure without bracing for the given cross section of beam and column.

From the analysis it can be concluded that Storey Drift is minimum in Model containing X bracing as compared with the other two model i.e model containing inverted v bracing and model without bracing. As per IS 1893 the storey drift in any storey due to minimum specified design force shall not exceed 0.004 times the storey height. It is found that all the results are within permissible limits in the structure containing bracings.

2) Storey Displacement

Storey displacement for the critical load combination for all the three models are compared with each other. The graph of Storey Displacement Vs Storey Height is plotted for all the three models and the comparative study is carried out.

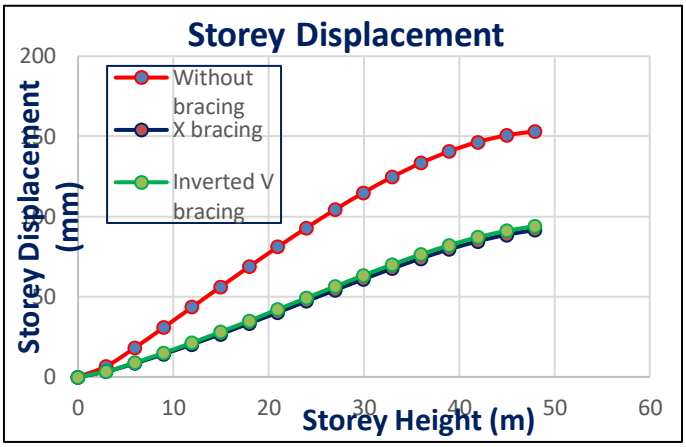

Fig 7: Storey Displacement Vs Storey Height

From the above graph it can be concluded that with the help of bracing system in RC Framed structure, storey displacement can be reduced by a certain level in the structures situated in earthquake prone areas.

Maximum displacement of 91.601mm is observed for X bracing, 94.027mm is observed for Inverted V Bracing and a maximum displacement of 153.136mm is observed in the model without bracing.

From the analysis it can be concluded that Storey Displacement is minimum in Model containing X bracing as compared with the other two model i.e model containing inverted v bracing and model without bracing. Storey Displacement is found out to be maximum in the model containing no bracing system.

3) Base Shear

The maximum base shears at the base for without and with different steel braced building are shown in fig:-

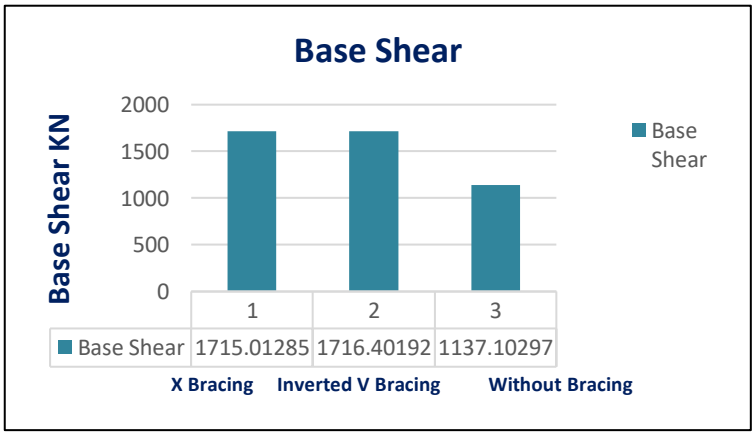

Fig 8: Base Shear

It is evident that the base shear increases with the addition of bracing members

From the above graph it is observed that Base shear is more in Inverted V Bracing system as compared with the other two models. The base shear produced in X and Y direction is same as the stiffness of building is same in both direction. As the stiffness of bracing sections increases, the base shear in building also increases in both directions.

Conclusion

The following conclusion are drawn base on the analysis :-

1) It can be concluded that the performance of the structure can be enhanced by the provision of bracings in the framed structure.

2) Storey drift is found to be minimum in Structure with X Bracing. With the help of X Bracing and inverted V Bracing, storey drift can be reduced by 45.47% and 43.82% respectively.

3) Storey Displacement has been found out to be minimum in structure containing X Bracing. It can be concluded that with the help of X and Inverted V bracing, storey displacement can be reduced by 40.18% and 38.59% respectively.

4) Base shear has been found out to be maximum in Inverted V Bracing. It can be concluded that with the help of X and Inverted V Bracing Base Shear can be increased by 50.82% and 50.94% respectively.

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