Seismic Analysis of RC Building with Steel Bracing

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Abstract

A multi-storey building that are made of RC frame, the greater importance is given to make structure safe against lateral load. Lateral load are produced due to wind, earthquakes etc. By providing steel bracing in RC frame building, these load can be reduced or transfer. The use of steel bracing system in RC frame is a workable solution for resisting lateral load. In this study a two different G+8 and G+10 storey building is analysed for different bracing system under seismic load in ETABs software. Building is located in seismic Zone-V.Four configuration of bracing (X, V, diagonal and Inverted-V bracing) is used. The parameters obtained in terms of Storey displacement and Storey drift. Compared these parameters for these two different Zone .It is seen that Inverted-V bracing system gives better result as compare to other two.

Key words: RC frame, Bracing system, Storey displacement, Storey Drift

Introduction

A multi-storey building is generally made up of RCC frame. A reinforcement building is designed for multipurpose like residence, business, school, hospital etc. A reinforcement building should be designed to have a capacity of carry gravity loads(Azad and Abd Gani 2016). The most common gravity load acting on building are dead load, live load and snow load. Apart from these loads a buildings are also subjected to lateral load. The lateral load generated due to earthquake. Lateral load is reversal in nature which cause develop high stresses on building and generated sway moment which cause a building may damage(Badoux and Jirsa 1990). Therefore, it is very important to designed a RCC building to have sufficient strength to resist or transmit these lateralload(Srivastava et al. n.d.).

There are several ways to resist or transfer this load. Steel bracing system in RCC frame building is most way to counteract these seismic load and provide safety. By providing steel bracing in RCC frame building the strength of building is improved, bracing is used to stabilize laterally for the majority of the tall building structures. After providing steel bracing in RCC frame building load will be transferred to the frame and passes on to the braces, by passing weak column while increasing strength. The main advantages of using steel bracing are their high strength, stiffness and economical in cost(Kumar et al. 2021).

Objective:

1. Different configuration of steel braces (X, V and Inverted-V) are used to resist the lateral loads and choose most effective bracing configuration.
2. To determine Storey displacement and Storey drift for all four bracing system.

Methodology:

Modelling and analysis in ETABS software.(Roy et al. 2021) Worked on G+10(ZONE II) building with two type of bracing system (X and V braced) on ETABS software The result find sout in terms of base shear and storey displacement It is observed that X-braced compared to unbraced frame. (Maheri and Sahebi 1997)Worked on irregular building with bracing system(V, Inverted V, X and K braced) in ETABS. Building analysed according to seismic zone III. The main parameter considered are storey displacement and storey shear storey. Bracing system are provided on alternate grid. It is find out that storey displacement is reduced by X-braced.(Khan and Rawat 2016)Worked on G+10 story building frame The building plan is analysed in different zone ZONEII, ZONEIII and ZONEIV in STADD-Pro software. The results of various bracing systems (X Bracing, V Bracing, K Bracing, Inverted V Bracing, and Inverted K Bracing) are compared with unbraced frame. Result is obtained in terms of storey drift and story displacement. It is find out that Inverted V-braced reduce the drift up to 57% and the displacement is reduced up to51% as compare to unbraced frame. Inverted V braced give better result as compare to other bracing system. (Fan et al. 2009)Worked on eighteen storey building (ZONE V) and use three different types of bracings and each bracing has been provided at three different locations. The types of bracing studied are X-brace, V-brace and K-brace. In all different cases of braced RC frames are analysed and compared with unbraced RC frame, using ETABs with Response Spectrum method. Result obtained in terms of lateral displacement and storey drift. It is find out X-braced frame gives better result.(Azad and Abd Gani 2016)G+12 building (ZONE V) with and without braced system is analysed on ETABS by Time History Analysis. X, V and Inverted V braced taken for this analysis. Due to different behaviour of structure Inverted V bracing system proves as effective member to control Storey drift, and gives maximum Storey shear unbraced system.

Building Modelling:

A G+8 andG+10 storey RC frame building is modelled in ETABS software. Model is created with four different types of bracing (X, V, diagonal and Inverted-V bracing). Following properties are considered for modeling the building.

Table4.1; Building Plan and dimensions

Plan area	25m*15m
Floor height	3m
Column size	0.5m*0.5m
Beam size	0.45m*0.3m
Thickness of slab	150mm
Column cover	0.04m
Beam cover	0.025m

Material properties:

Table4.2; Material properties of Concrete

Column	M30
Beam	M30
Slab	M30
Density of RCC	2500kg/m3
Density of PCC	2400kg/m3

Table4.3; Material properties of Steel

Main bars	Fe415
Confinement bars	Fe415
Density of Steel	7850kg/m3

Table4.4; Material properties of Load

External wall load	13.8 KN/m2
Internal wall load	7.2 KN/m2
Live load	3.5 KN/m2
Floor finish load	2KN/m2

Table4.5; Material properties of Seismic Data

Seismic Zone	Zone
Zone factor	0.36
Importance factor	1
Response reduction factor	5

Load combinations:

1.5 (DL + LL)
1.2 (DL + LL ± EQX)
3. 1.2 (DL + LL ± EQY)
4. 1.5 (DL ± EQX)
1.5 (DL± EQY)
0.9 (DL ± EQ)

Steel braces:

ISMB500 (I-Section)

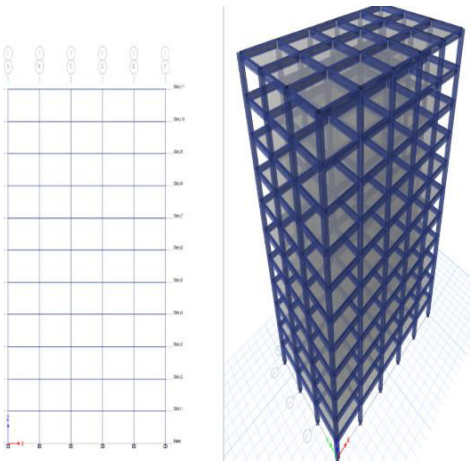


Fig (4.1): Unbraced frame

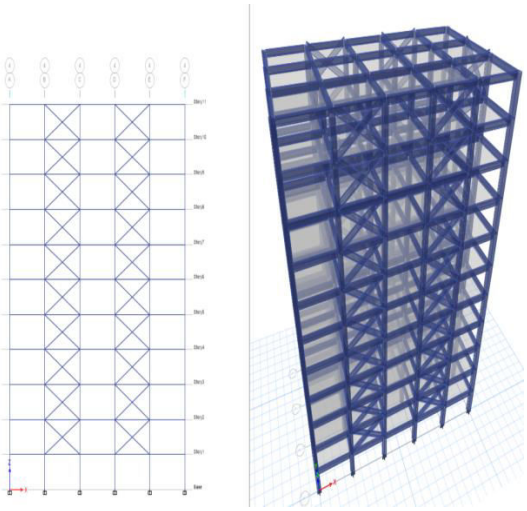


Fig (4.2): X bracing frame

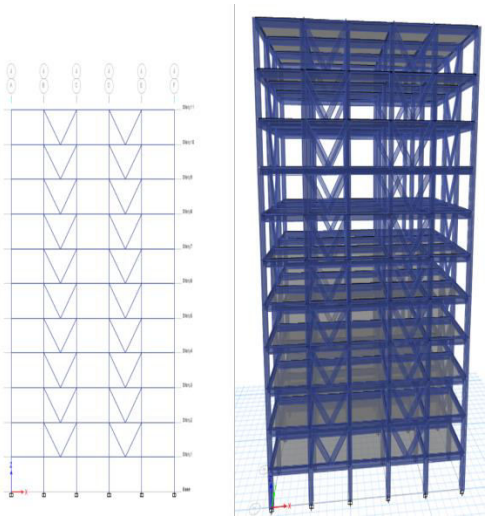
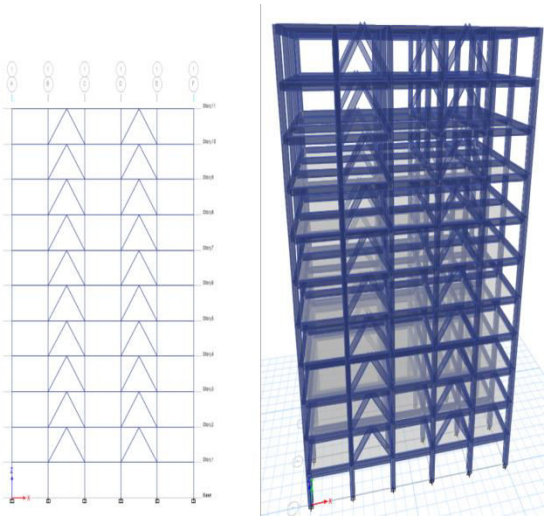


Fig (4.3): V bracing frame



(4.4): Inverted V bracing frame

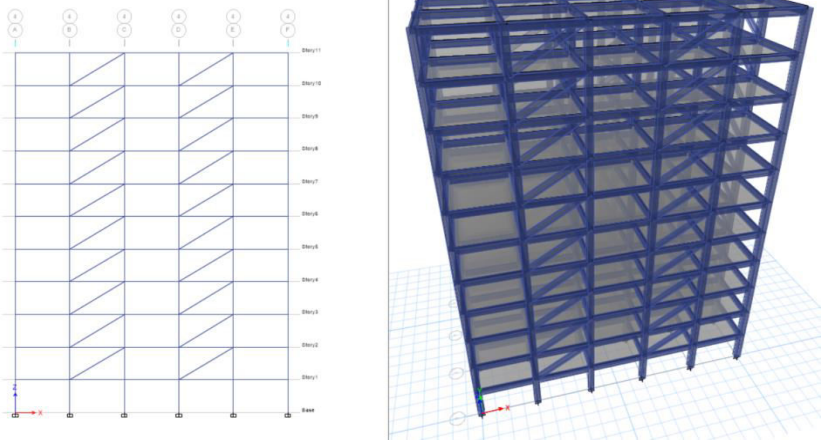


Fig (4.5): Diagonal bracing frame

Result and Discussion

After analysis of G+10 and G+8 storey building in ETABS software. Results are obtained in terms of storey drift and storey displacement. Storey displacement and storey drift obtained individually for all case for both building. Obtained parameter (lateral displacement and storey building drift) for unbraced system are compare with X, V, Inverted V and diagonal bracing system(Azad and Abd Gani 2016). After Comparing all these systems, it is observed that, building drift minimum when modelled with steel bracing system. Storey displacement also reduced after providing steel bracing. By comparing all results find effective one for resisting lateral load produce due to seismic load. Graphs and tables for all different cases are given below;

Storey displacement

Case1: G+8 storey building

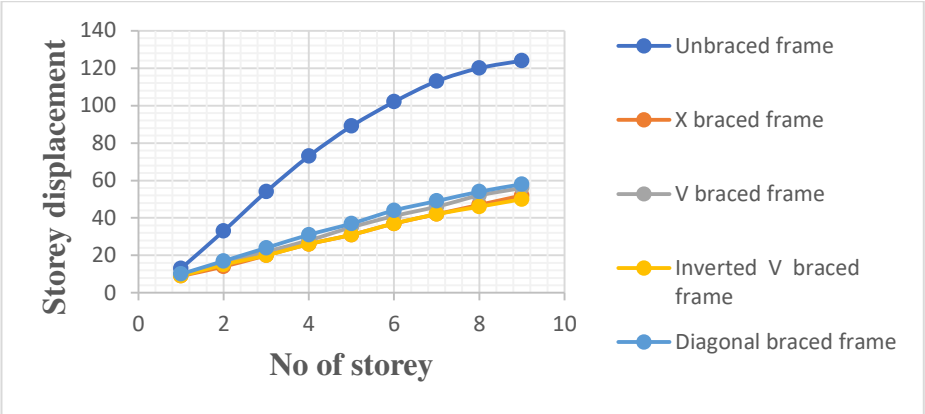


Fig (5.1): Storey displacement in X direction forG+8building

Maximum storey displacement is found in top storey displacement and the value is 124mm.In this case maximum storey displacement is reduced by 58%, 58%, 60% and 53% by using X, V, Inverted V and diagonal bracing respectively(Kumar et al. 2021).

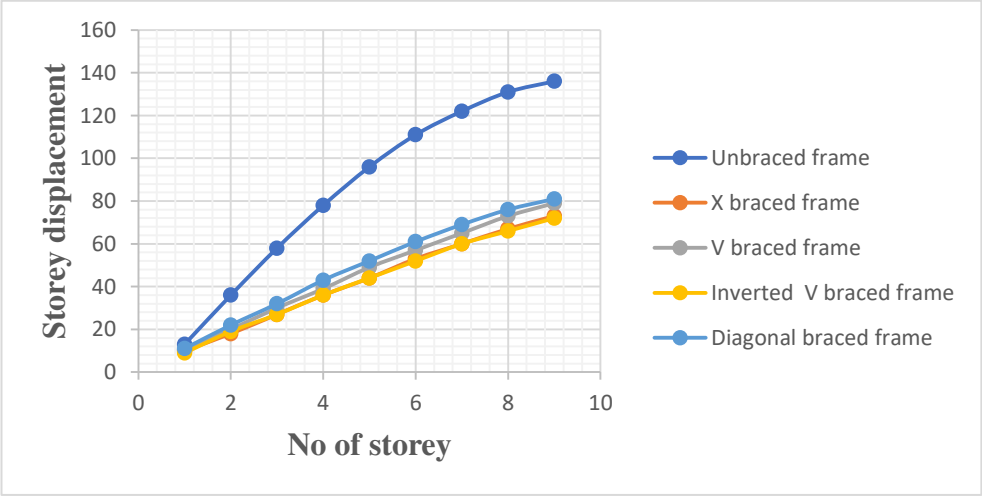


Fig (5.2): Storey displacement in Y direction for G+8 building

Maximum storey displacement is found in top storey displacement and the value is 136mm. In this case maximum storey displacement is reduced by %, 46%, 42% and 47% and 40% by using X, V, Inverted V and diagonal bracing respectively(Bhojkar and Bagade 2015).

Case2: G+10 storey building

- Maximum storey displacement in X-direction for this building are given below in table

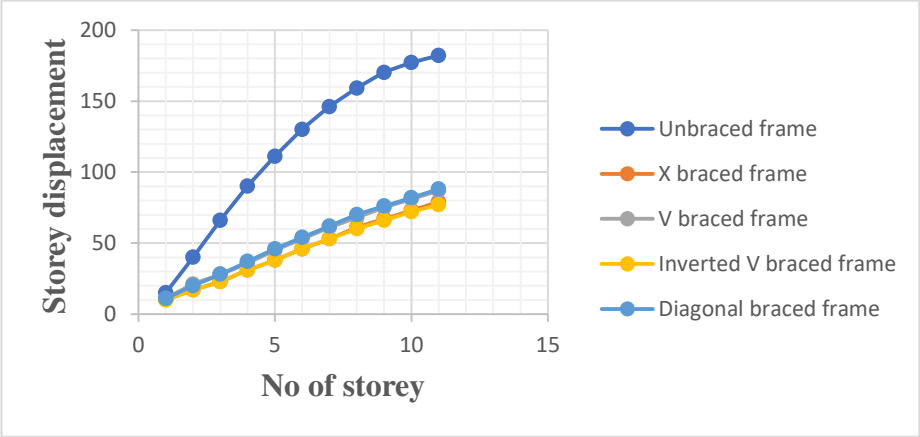


Fig (5.3): Storey displacement in X direction for G+10 building

Maximum storey displacement is found in top storey displacement and the value is 182mm. In this case maximum storey displacement is reduced by 56%, 56.5%, 58% and 51% by using X, V, Inverted V and diagonal bracing respectively.

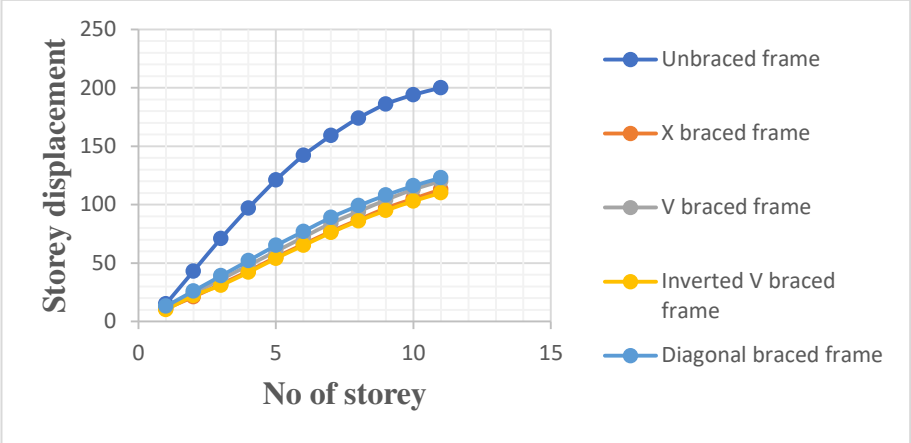


Fig (5.4): Storey displacement in Y direction for G+10 building

Maximum storey displacement is found in top storey displacement and the value is200mm. In this case maximum storey displacement is reduced by 43.5%, 40%, 45% and 38.5% by using X, V, Inverted V and diagonal bracing respectively

Storey drift

Case1: G+8 storey building

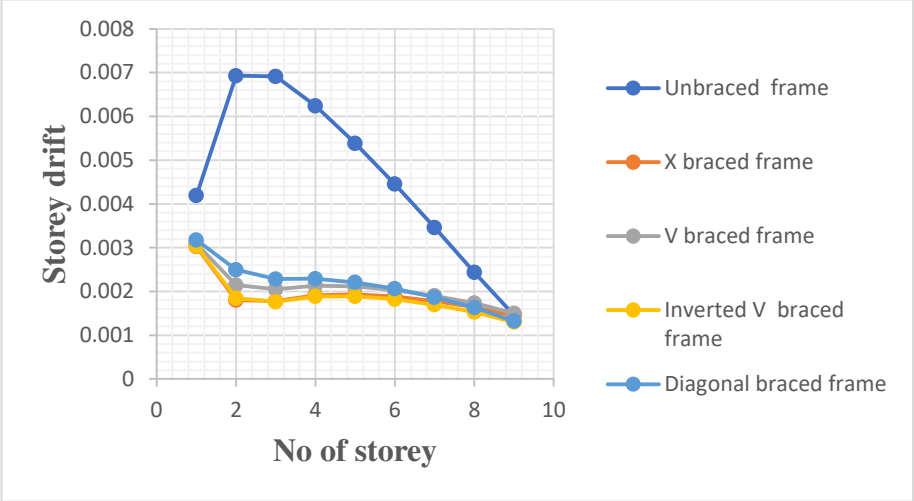


Fig (5.5): Storey drift in X direction for G+8 building

After providing steel brace in building, it increases the lateral stiffness of the building. Due to the increase in stiffness, the lateral deformation of the building is reduced as compared to that of the bare frame (unbraced frame). From above figure it is clear that storey 2 drift maximum for this model(Azad and Abd Gani 2016).

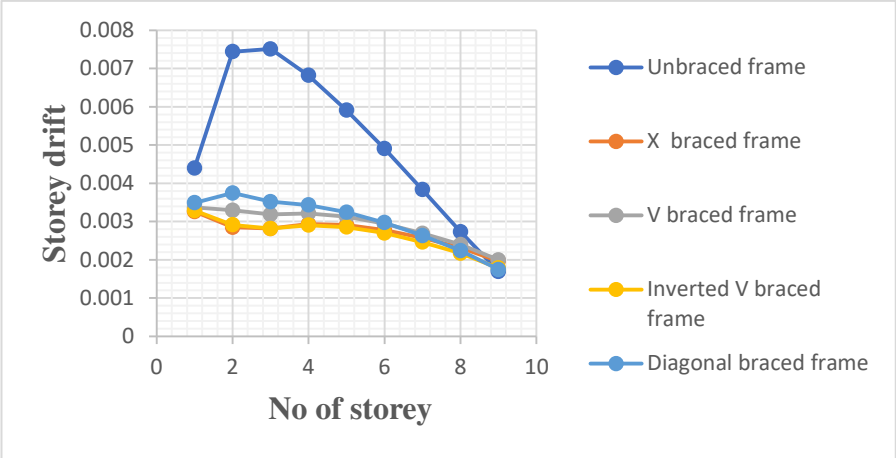


Fig (5.6): Storey drift in Y direction for G+8 building

After providing steel brace in building, it increases the lateral stiffness of the building. Due to the increase in stiffness, the lateral deformation of the building is reduced as compared to that of the bare frame (unbraced frame). From above figure it is clear that storey 3 drift maximum for this model(Baikerikar and Kanagali 2014).

Case2: G+10 storey building

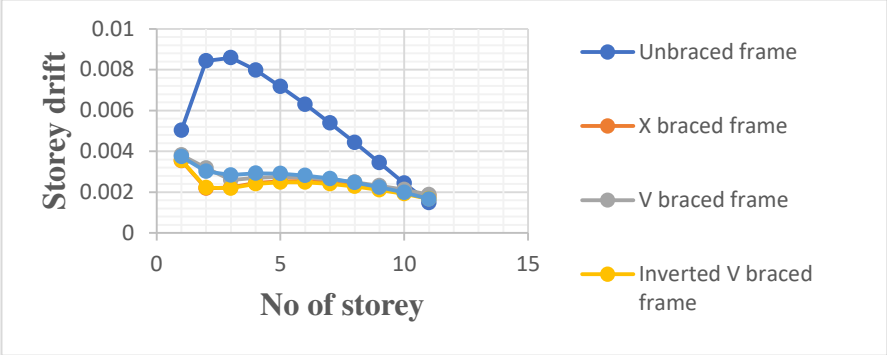


Fig (5.7): Storey drift in X direction for G+10 building

After providing steel brace in building, it increases the lateral stiffness of the building. Due to the increase in stiffness, the lateral deformation of the building is reduced as compared to that of the bare frame (unbraced frame). From above figure it is clear that storey 3 drift maximum for this model(Badoux and Jirsa 1990).

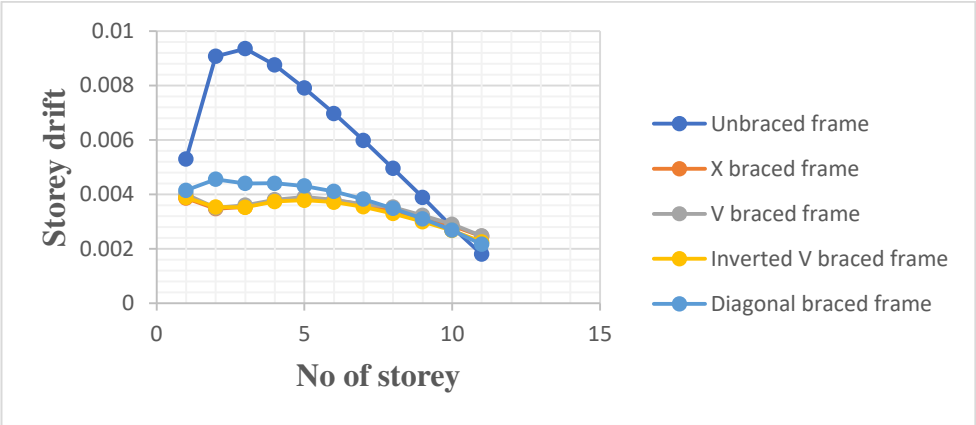


Fig (5.8): Storey drift in Y direction for G+10 building

After providing steel brace in building, it increases the lateral stiffness of the building. Due to the increase in stiffness, the lateral deformation of the building is reduced as compared to that of the bare frame (unbraced frame). From above figure it is clear that storey 3 drift maximum for this model.

Conclusion

After analyzing both building G+8 and G+10 storey building in seismic ZONEV in ETABS software with different shape of bracing. Following are the conclusion comes out:

- Steel bracings can be used to strengthening of structure.
- Steel bracing is also used as retrofitting purpose.
- Steel bracing is an advantageous concept for strengthening or retrofitting existing structures.
- The concept of using steel bracing in reinforced building to resist seismic forces is helpful.
- After providing Steel bracing in RCC building, building drift less as compare to unbraced frame. Building drift less in case of inverted V bracing.

- The bracing system effectively reduces the lateral displacement of the structure as compared to Unbraced frame. And Inverted V bracing is more effective as compare to other two.
- Invert-V bracing system gives more lateral support to the structure as compared to structure without bracing.
- The total weight on the building will not change significantly (much) if steel bracing is used.

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