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# Study of Diaphragm Irregular Steel Building using Eccentric Bracing

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**Abstract —** *In the earthquake resistant design, the building has to go on its base at regular motion, causing the inertia force in the building, resulting in constant stress. India has experienced the number of earthquakes that cause major damage to the residential and industrial structure. For earthquake-resistant design the general building should be able to break minor, medium, shaking. Under the circumstances of the building, simple shape configurations transfer the earthquake force in the straight path to the construction base, whereas the load of transferring the load in a complex shape is indirect, causing tension in the corner. In this study, structure with diaphragm irregularity is taken and that structure is analyzed with dynamic analysis method Response Spectrum using ETABs software. The analysis was done to obtain that which location of bracing is appropriate for diaphragm irregular structure using different types of bracing system provided eccentrically.*

***Keywords***- *Diaphragm Irregularity, Response Spectrum Analysis, Steel Structure, Asymmetrical Plan, Bracing System, ETABs.*

## I. INTRODUCTION

In a multi-storey frame building, earthquake damage typically starts at the places of structural vulnerabilities present in the lateral weight resistant frames. This behavior of multi-storey framed buildings during strong earthquake speed depends on the distribution of mass, hardness, strength in horizontal and vertical planes of buildings. In some cases, these weaknesses can arise due to the hardness, power, or imbalance in the mass with diaphragm. Such discontent between the diaphragms is often associated with the sudden variation in frame geometry with the length of the building.
According to IS-1893:2002: Diaphragms with abrupt discontinuities or variations in stiffness, which includes those having cut-out or open areas greater than 50 percent of the gross enclosed diaphragm area, or changes in effective diaphragm stiffness of more than 50 percent from one storey to the next. In the present study, a typical multi storey steel building is analyzed using commercial software ETABs for nonlinear dynamic (Response Spectrum) analysis. All the analysis has been carried out considering diaphragm discontinuity and the results so obtained have been compared. This study is done for steel framed multistory building with fixed support conditions.

## II. OBJECTIVE OF THIS PAPER

The main objective of this paper is to understand the behaviour of different types of bracings which is provided eccentrically in irregular structure with diaphragm irregularity under seismic load, performing Response spectrum analysis with software approach and to find which bracing system is most appropriate system if it is provided eccentrically in the centre of the elevation of all the four direction.

## III. MODELLING AND ANALYSIS OF BUILDING

The analysis of 15 Story, T-shape building is carried out using ETABs professional software for special moment resisting frame (SMRF) situated in zone III. The G+14 steel structure is analyzed under seismic loading. Story displacement, story drifts, story shear and axial forces are compared using different types of bracing systems in structure which is taken eccentrically. In this study, the floor area is same up to $8^{th}$ floor and the diaphragm irregularity has been taken above $8^{th}$ floor. The geometry of the building is taken as below table.

 

Table 1 Detail of the Building

| Building | Details |
|---|---|
| Plan size | 40.00m × 40.00m |
| Usage | Industrial/Residential Building |
| Building height | 45.00m (G+14) |
| Grade of Steel | Fe 415 |
| Grade of Concrete | M-25 |
| Seismic Zone* | III |
| Column size | UPTO 8TH FLOOR= BUILTUP |
| | 9TH TO 15 FLOOR= BUILTUP ISHB250* |
| Beam sixe | UPTO 8TH FLOOR= ISWB450 |
| | 9TH TO 15 FLOOR= ISMB500 |
| Slab thickness | 125mm |
| Live load | 2kN/$m^2$ on slabs |

The bracings are located at the center of all the four sides of building elevation. Three types of eccentric bracings are assigned in the structure and the data were compared. Story displacement, story drift, story shear and the axial forces on the columns are recorded and compared. The data were compared to see which type of bracing system is appropriate for structure if it is provided at the center bay of the structure. Models providing different types of bracing are shown in figure 1, figure 2, figure 3 and figure 4.

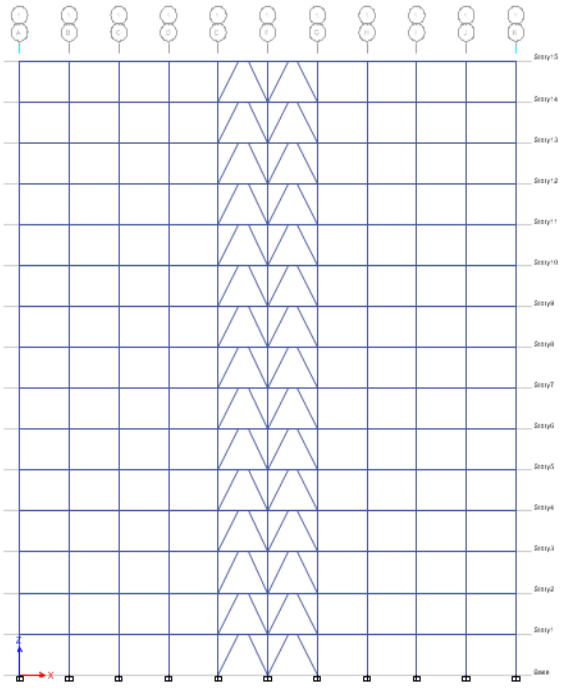

Fig. 1.Structure With Inverted V-Bracing

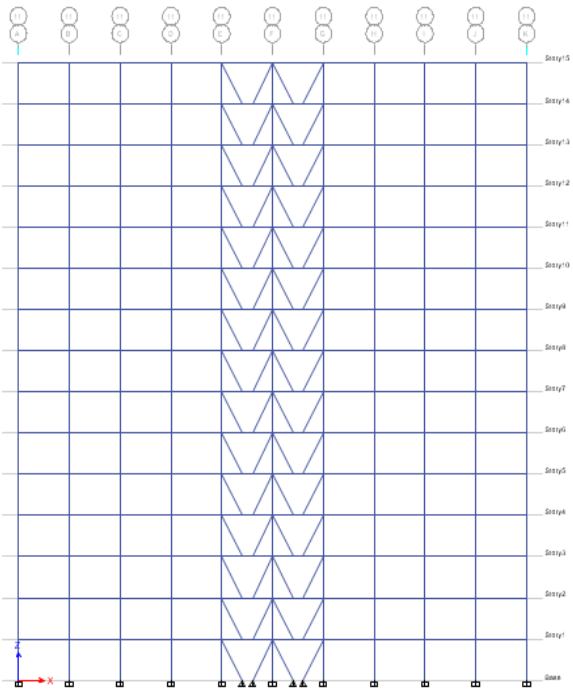

Fig.2.Structure With V-Bracing

 

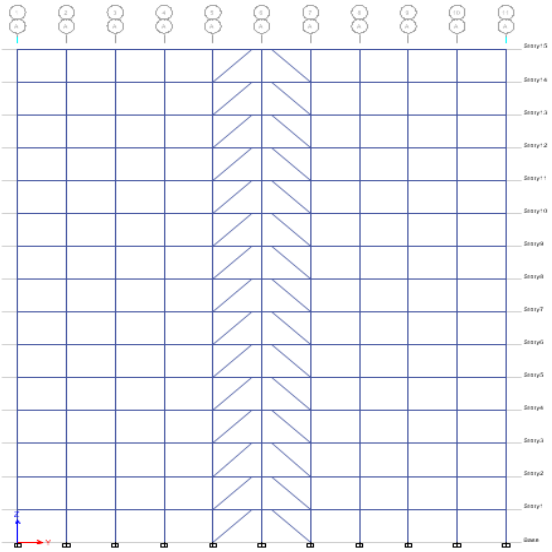

Fig. 3.Structure With Diagonal-Bracing

## IV. RESULTS OF ANALYSIS

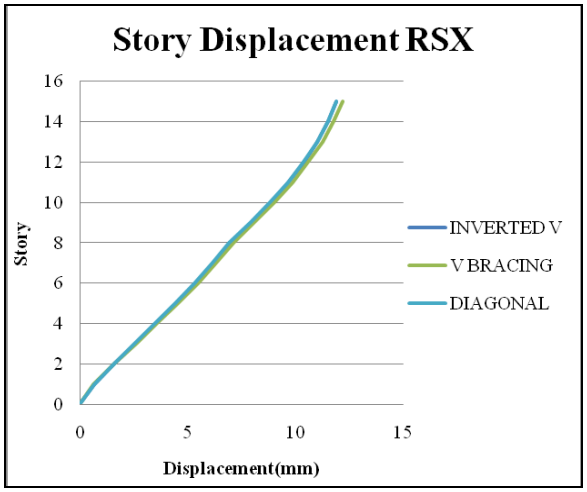


Fig 4 Story Displacement (Mm) In X-Direction

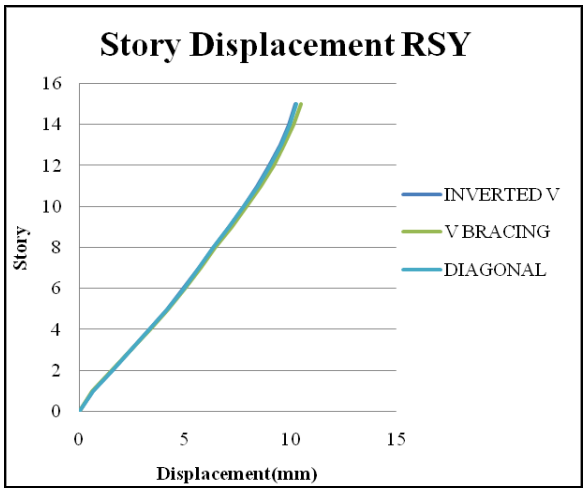


Fig 5 Story Displacement (Mm) In Y-Direction

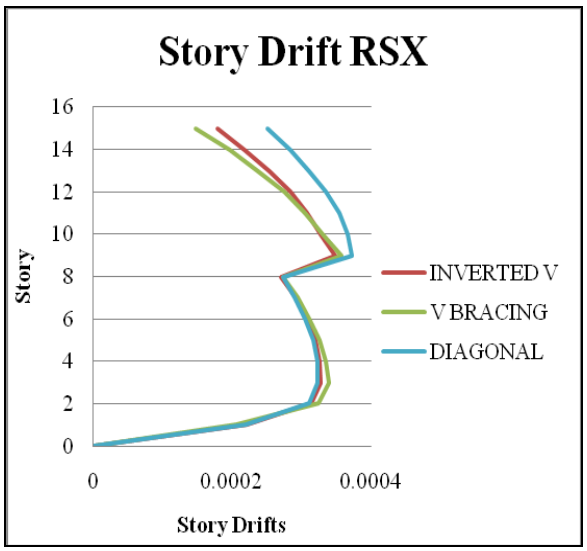


Fig 6 Story Drift (Mm) In X-Direction

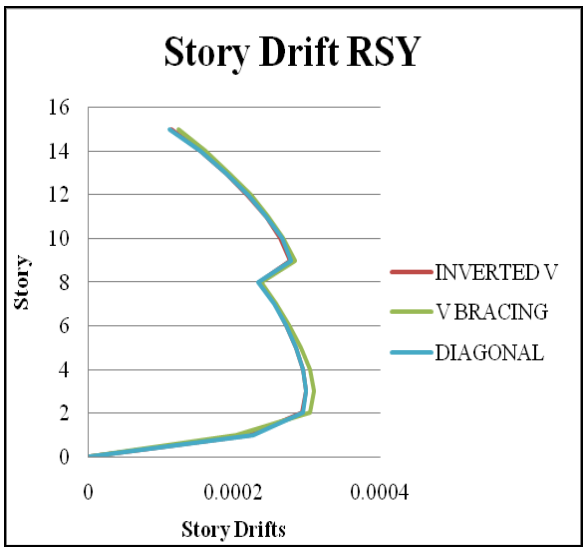


Fig 7 Story Driftv(Mm) In Y-Direction

 

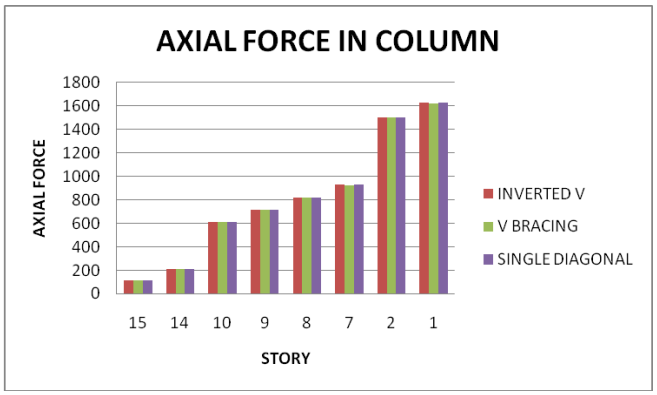


Fig 8. Axial Forces In Column (Kn)

## V. DISCUSSION ON RESULTS

- Fig 4 & Fig 5 show the lateral displacement for seismic load in RSX & RSY direction respectively at each story level. The lateral displacements of the structure in X & Y direction with different bracing systems are compared. The above graph shows that the minimum displacement obtained bracing system in X direction & Y direction is Inverted V shape bracing
- Fig 6 & fig 7 show the story drifts for seismic load in RSX & RSY direction. The Story Drifts of the structure with different bracing systems are compared. The above graph shows that the minimum story drifts obtained bracing system in X direction & Y direction is V-bracing.
- Fig 8 shows the axial force in column under seismic load in both RSX & RSY direction. The axial forces obtain by comparing all the axial forces for all the types of bracing system which are taken. The above graph shows that minimum axial force on column is in V shape bracing.

## VI. CONCLUSION

- The comparative study of diaphragm irregular steel structure has been studied using software ETAB. The analysis has been done by dynamic method Response Spectrum. Different parameters like story displacement, story drift and axial forces in column are compared with all the types of bracing system and the results are obtained. The analysis has been performed for obtained the most appropriate bracing system with diaphragm irregularity. After the analysis of the structure, it has been concluded that V shape bracing system is most appropriate bracing system in structure with diaphragm irregularity.

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