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DISPLACEMENT ANALYSIS OF BRACING SYSTEM FOR R.C.C. BUILDING UNDER VARIOUS EARTHQUAKE ZONES

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Abstract: Bracing system provides an excellent approach for strengthening and stiffening existing building for lateral forces. Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. Bracings are usually provided to increase stiffness and stability of the structure under lateral loading and also to reduce lateral displacement significantly. Braced frames can resist large amount of lateral forces and have reduced lateral deflection. The models are analyzed by equivalent static analysis as per IS 1893:2002 using STAAD Pro software. In proposed problem G+ 10 story building frame is analysed for different bracing system under seismic loading. The suitability of the bracing systems is to resist the seismic loads efficiently and also to compare the response of different bracing in different earthquake zones. The comparison is made between the X–Braced, K–Braced and V–Braced for particular seismic zone. Steel braced frame is one of the structural systems used to resist lateral loads in multi-storied buildings. Three different types of bracing systems studied in this research program are X–bracing, K–bracing, and V–bracing for different earthquake zones.

Keywords: Seismic; Bracing system; moment; Reinforced Cement Concrete, Shear force; Storey displacement; storey drift; V Bracing, etc.

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INTRODUCTION

A large number of existing buildings in India are severely deficient against earthquake forces and the number of such buildings is growing very rapidly. This has been highlighted in the past earthquake. India at present is fast developing country which requires demands in increase of infrastructure facilities along with the growth of population. Due to increased population, the demand of land for housing is increasing day by day. To fulfill the need of the land for housing and other commercial offices, vertical development that is multistoried buildings are the only option. So we provide bracing systems, shear walls, dampers etc to resist or transfer these lateral forces to the structure uniformly without affecting the stability and strength of the structure. Steel braced frame is one of the structural systems used to resist earthquake loads in multistoried buildings. Bracings resist lateral forces predominantly with members in tension or compression. Braces are subjected to predominantly axial stresses.

1.1 BRACING SYSTEM

Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling walls, adding walls to existing columns, encasing columns, and adding steel bracing to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength.

1.2. OBJECTIVE OF THIS PAPER

1. To evaluate the more suitable Steel bracing system for resisting the seismic load efficiently in different earthquake zones .
2. To analyze the response of symmetrical building with braces subjected to seismic loading using STAAD V8i.
3. To carry out displacement analysis of different types of bracing system.

2. WORK CARRIED OUT

A G+10 floors reinforced concrete building analysis is carried out using STAAD Pro V8i software. The lateral loads to be applied on the buildings are based on the Indian Standard. Building is analysed according to IS456-2008 and earthquake loading is applied as per the recommendation of IS1893-2002. Different configurations of frames are selected such as X bracing, V bracing and K bracing and analyzed. The study is performed for seismic zone II,III,IV,V as per IS1893-2002

Table 1 Details of model data of the building

Sr No.	Description	Parameter
1	Depth of foundation	2.0 m
2	No. of stories	G + 10
3	Type of building use	Residential
4	Floor to Floor height	3.0m
5	Seismic zone	II,III,IV,V
6	Unit wt. of masonry wall	20 kN/m3
7	Beam size	0.3 m x 0.5 m
8	Column size	0.3 m x 0.6 m
9	Thickness of slab	150 mm
10	Thickness of wall	230mm
11	Type of steel	Fe-415
12	Grade of concrete	M-20
13	Bracing	ISMC 300

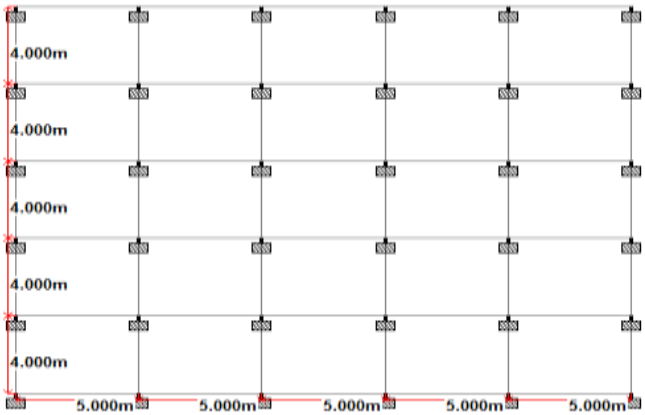

Fig 1: Plan of proposed structural frame

2.1 MODELLING

Building frame with the following geometrical types are considered for analysis in 4 different seismic zones (Zone II, Zone III, Zone IV and Zone V) for seismic and gravity loading in each configurations of frames.

Fig 2: Structure frame without Bracing system

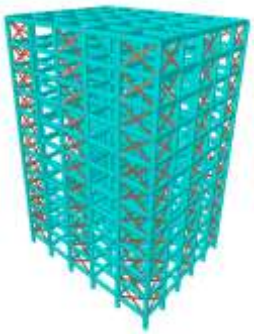

Fig 3: Structure with X Bracing system

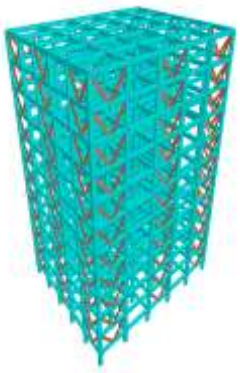

Fig 4: Structure with V-bracing system

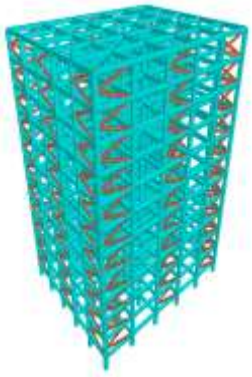

Fig 5:Structure with K Bracing system

RESULT

3.1. Maximum Lateral Displacements

The lateral displacements of unbraced building for the cases of dead and live load for seismic analysis in all the three directions are presented in Table 2&3. The results are compared with that of buildings with various types of bracings. It is observed that the maximum lateral displacements are reduced due to the presence of bracings. It is observed that the lateral displacements are reduced to the largest extent for X type of bracing systems bracing for all seismic zones.

Table 2 Maximum Lateral Displacement in mm. in X direction

Displacements (mm) Structure In X Direction				
Structure Types	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Bare frame	95.238	151.257	226.218	338.821
X-Bracing	50.673	86.322	117.759	175.828
V-Bracing	54.169	84.857	126.218	188.532
K-Bracing	61.279	96.389	143.605	214.676

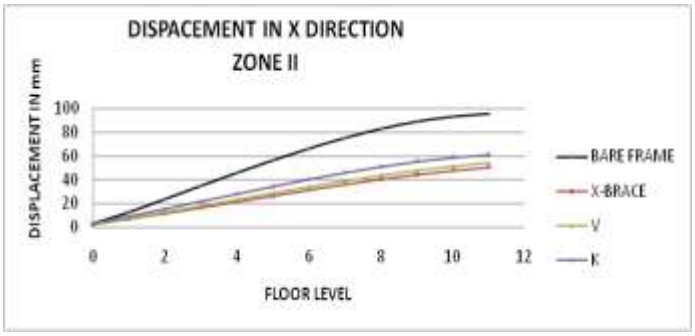

Fig 6: Lateral Displacements (mm) in X direction

Fig 7: Lateral Displacements (mm) in X direction

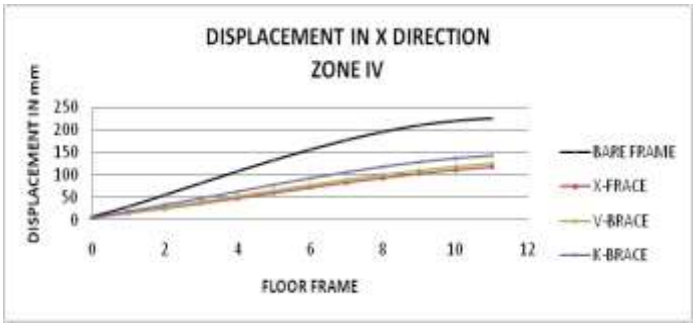

Fig 8: Lateral Displacements (mm) in X direction

Fig 9: Lateral Displacements (mm) in X direction

Table 3 Maximum Lateral Displacement in mm. in Z direction

Displacements (mm) Structure In Z Direction				
Structure Types	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Bare frame	133.259	212.336	317.98	476.57
X-Bracing	62.999	107.773	147.787	220.974
V-Bracing	68.787	108.494	161.826	242.062
K-Bracing	74.081	117.047	174.702	261.406

Fig 10: Lateral Displacements (mm) in Z direction

Fig 11: Lateral Displacements (mm) in Z direction

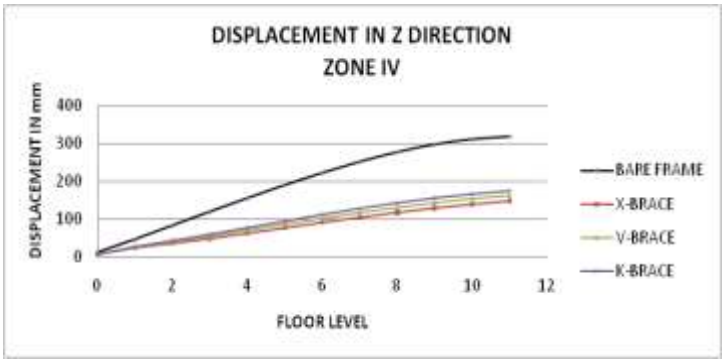

Fig 12: Lateral Displacements (mm) in Z direction

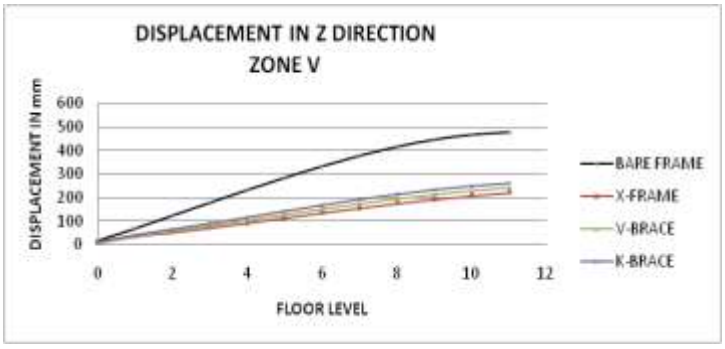

Fig 13: Lateral Displacements (mm) in Z direction

4. OBSERVATIONS & CONCLUSIONS

- It is observed that the maximum lateral displacements are reduced due to the presence of bracings.

- It is observed that the lateral displacements are reduced to the largest extent for X type of bracing systems bracing for all seismic zones.
- It has been concluded that the displacement of the structure decreases after the application of bracing system.
- The concept of using steel bracing is advantageous to resist the seismic forces.
- The maximum reduction in the lateral displacement occurs after the application of X-bracing system.

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