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Seismic Response of R C Building With Different Arrangement of Steel Bracing System

Krishnaraj R. Chavan[1], H.S.Jadhav[2]
[1]Student, M.Tech Civil Structures, Rajarambapu Institute of Technology, Rajaramnagar
[2]Professor, Civil Engineering, Rajarambapu Institute of Technology, Rajaramnagar

ABSTRACT
In general the most suitable choices in improvement of reinforcement concrete frame against lateral loading is used steel bracing system. The use of steel bracing has potential advantage over other scheme like higher strength and stiffness, economical, occupies less space, adds much less weight to existing structure. In this study, the seismic analysis of reinforced concrete (RC) buildings with different types of bracing (Diagonal, V type, inverted V type, X type) is studied. The bracing is provided for peripheral columns. A seven-storey (G+6) building is situated at seismic zone III. The building models are analyze by equivalent static analysis as per IS 1893:2002 using Staad Pro V8i software. The main parameters consider in this paper to compare the seismic analysis of buildings are lateral displacement, storey drift, axial force, base shear. It is found that the X type of steel bracing significantly contributes to the structural stiffness and reduces the maximum interstorey drift of R.C.C building than other bracing system.

Keywords: Base Shear, Lateral Displacement, Retrofit, Seismic Analysis, Steel Bracing, Storey Drift, etc.

I. INTRODUCTION

1.1 General

Most of the multistory buildings are made of RCC frame building so it's great importance given to make the structure safe against lateral load produce due to wind, earthquake. There are various lateral resisting system and steel bracing is one of them. Due to their high strength, stiffness and lateral load capacity, steel bracing are an ideal choice for lateral load resisting system in a reinforced concrete structures.

Strengthening and retrofit of RC Structures with Steel Bracing Systems

Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure [7]. 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 [2]. 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. There are various techniques such as infilling walls, adding walls to existing columns, shear wall, 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 would be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. Therefore, the use of steel bracing systems for retrofitting reinforced concrete frames with inadequate lateral resistance is attractive.

Types of Bracings

There are two types of bracing systems
1) Concentric Bracing System and 2) Eccentric Bracing System

The steel braces are usually placed in vertically aligned spans. This system allows to obtaining a great increase of stiffness with a minimal added weight.

1) Concentric bracings increase the lateral stiffness of the frame thus increases the natural frequency and also usually decreases the lateral storey drift. However, increase in the stiffness may attract a larger inertia force due to earthquake. Further, while the bracings decrease the bending moments and shear forces in columns and they increase the axial compression in the columns to which they are connected.

2) Eccentric Bracings reduce the lateral stiffness of the system and improve the energy dissipation capacity. The lateral stiffness of the system depends upon the flexural stiffness property of the beams and columns, thus reducing the lateral stiffness of the frame. The vertical component of the bracing forces due to earthquake causes lateral concentrated load on the beams at the point of connection of the eccentric bracings.

II. MODELING

The RC building used in this study are seven storied (G+6). buildings have same floor plan with 4-4m bays along longitudinal direction and 3-4m bays along transverse direction as shown in figure. 2.1

The storey height is 3m for all the stories. The live load taken has 3 KN/m ^{2} for all floors while the floor while the floor finish load is taken as 1 kN/m^2 on all other floors. Thickness of brick wall over all floor beams is taken as 0.230 m. Thickness of slab is taken as 0.125 m. The unit weight of reinforced concrete is 25kN/m^3 and brick masonry is taken as 20 kN/m^3. The compressive strength of concrete is 25 N/mm^2 and yield strength of steel reinforcements is 415 N/mm^2.The modulus of elasticity of concrete and steel are 25000 N/mm^2 and 2×10^5 N/mm^2 respectively.The steel bracing used is ISA 110X110X10.

All the above mentioned building frames are analysed as per requirment of IS 456 and IS 1893. All the structures have been considered to be located in seismic region III with an importance factor 1 and sub-soil type 2 (medium). Seismic analysis is carried out on building models using the software Staad pro V8i. The load cases considered in the seismic analysis are as per IS 1893 – 2002.

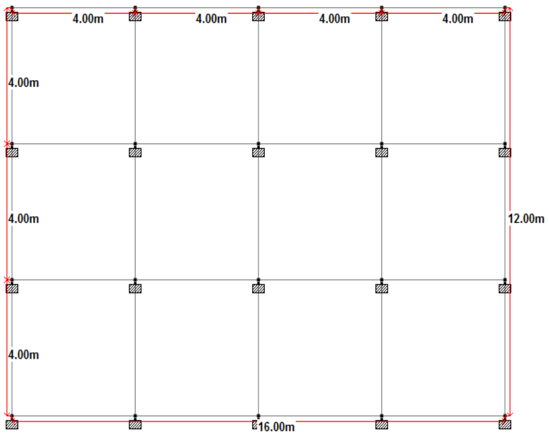

Fig. 2.1 Building Plan

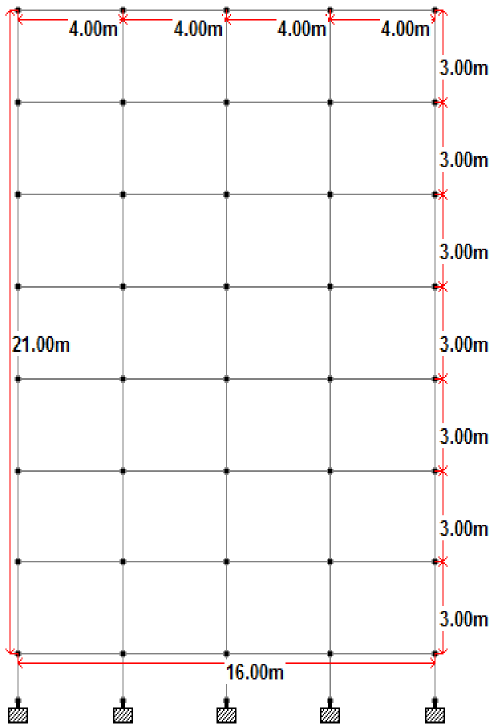

Fig.2.2 Elevation of building

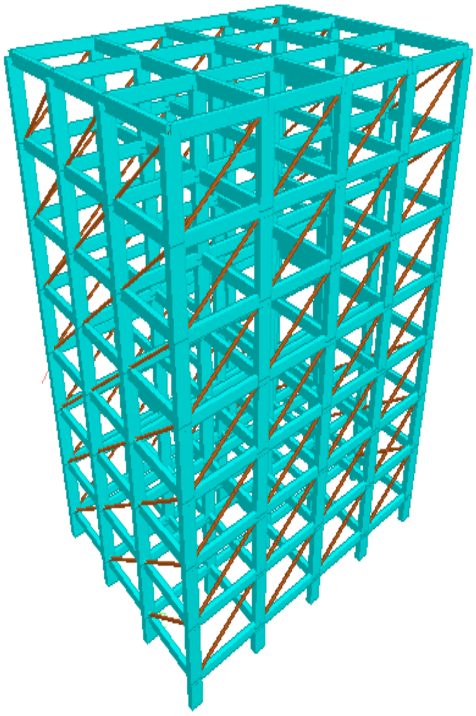

Fig. 2.3 Diagonal Bracing

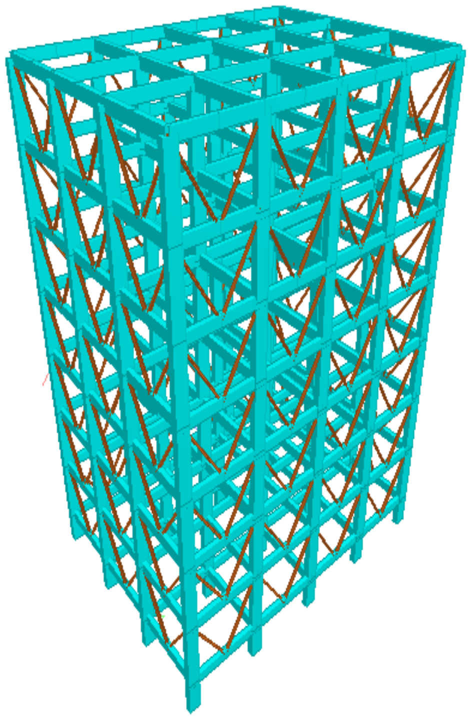

Fig.2.4 V Type Bracing

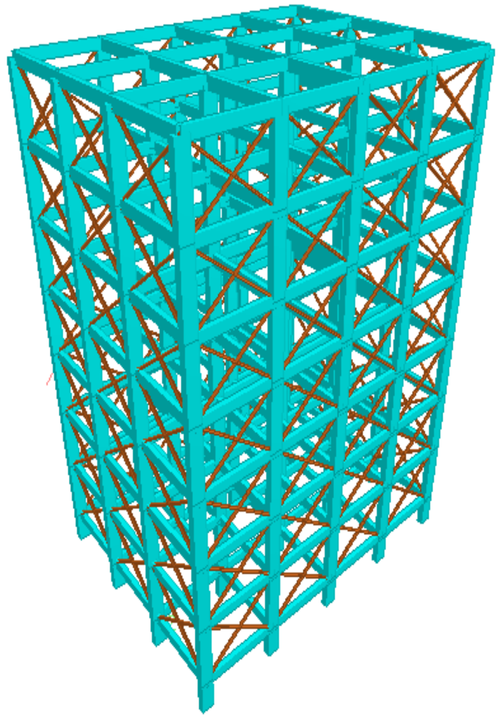

Fig. 2.6 X Type Bracing

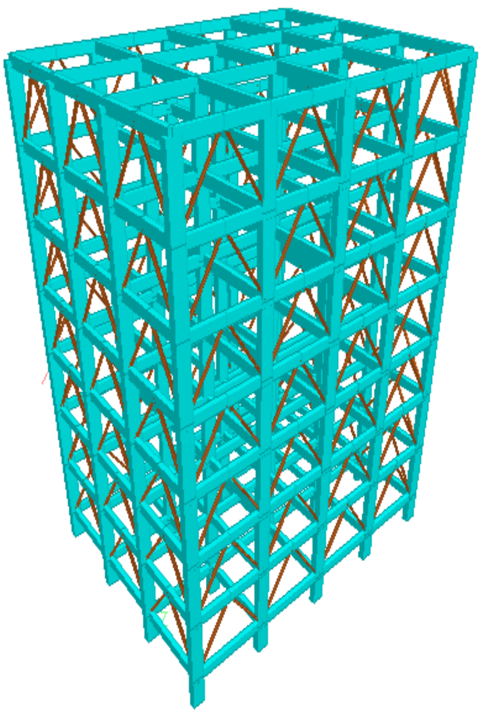

Fig. 2.5 Inverted V Type Bracing

III. RESULTS AND DISCUSSION

3.1 Lateral displacements

The graphs of lateral displacement versus no of storey are plotted in X direction and Z direction for without and with different bracing systems.

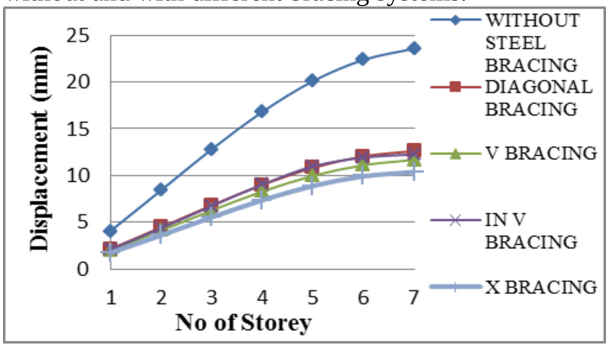

Fig. 3.1 Maximum Lateral Displacements (mm) in X Direction

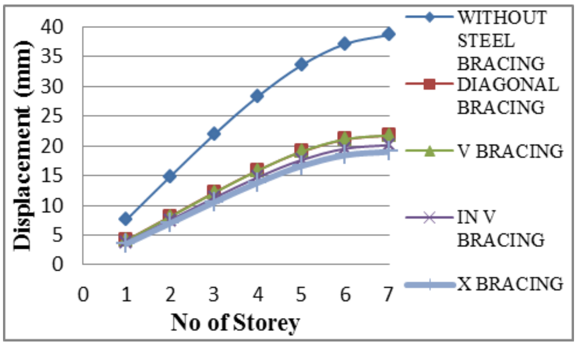

Fig. 3.2 Maximum Lateral Displacements (mm) in Z Direction

From fig.3.1 and fig.3.2, it is observed that the lateral displacement are reduced to largest extent for X type of bacing systems, while the displacement is maximum for the system without bracing. The displacement are reduced sequentially for bracing diagonal, V and Inverted V. These patterns are observed due to increased stiffness provided by the respective bracings. Top roof displacement for the system with X bracing is reduced by 55.97% in X direction and 50.81 % in Z direction as compared to that of without bracing system

3.2 Storey Drifts

The graphs of storey drift versus storey level are plotted in X direction and Z direction for without and with different bracing systems.

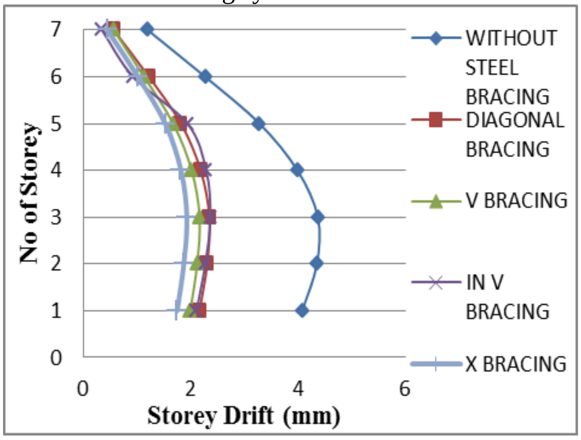

Fig. 3.3 Storey Drift Displacements (mm) in X Direction

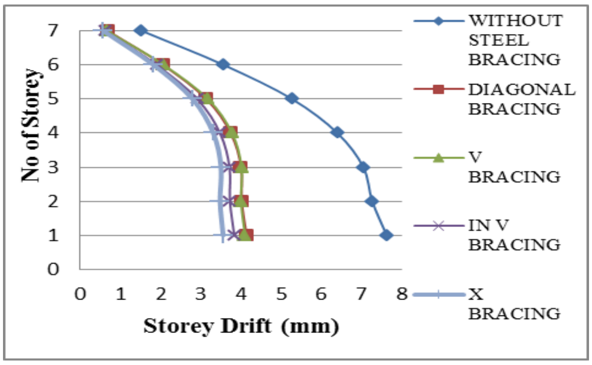

Fig.3.4 Storey Drift Displacements (mm) in Z Direction

From fig.3.3 and fig.3.4, it can be seen that storey drift in X braced building in both X and Y direction are reduced in comparison with the without steel bracing building. The maximum drift at the third storey in X direction reduces by 55.83% and at first storey in Y direction by 53.41% for X bracing system.

3.3Axial Force

The graph shows maximum axial forces in column for without and with different steel braced building are shown in fig.

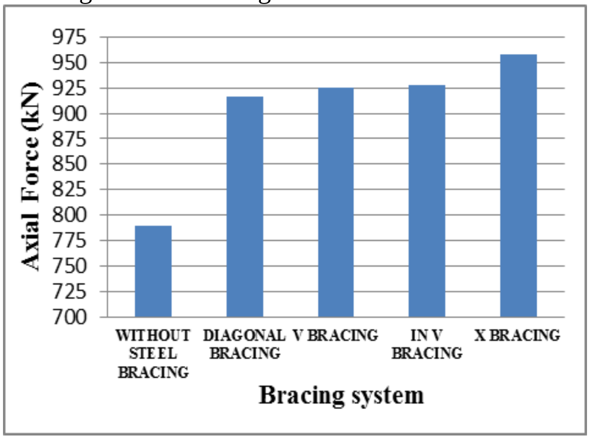

Fig.3.5 Axial Force (kN) in Column

From fig.3.5, it can be observed that the axial forces are maximum for X type of bacing systems, while these are minimum for the system without bracing. . Axial force at the ground floor level column for the system with x bracing is increased by 21.25% as compared to that of without bracing system.

3.4 Base shear

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

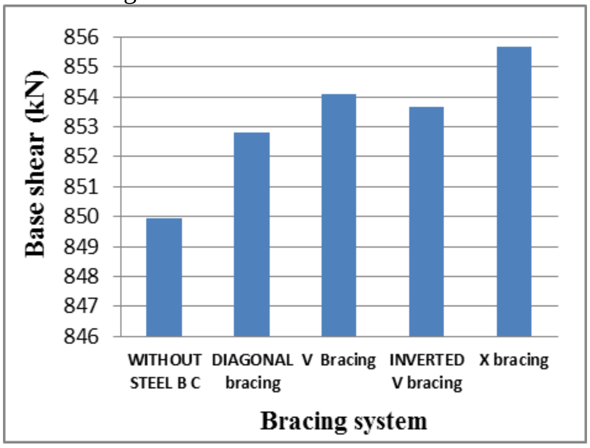

Fig. 3.6 Base shear in kN

From fig.3.6, it can be observed that the base shear in X bracing system is more as compared to other diagonal, V bracing system and inverted V bracing system. The base shear produce in X and Y direction is same because 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.

IV. CONCLUSIONS

The following conclusions are drawn based on analysis.

1. Steel bracings used as an alternative to the other strengthen or retrofitting techniques.
2. Using steel bracings the total weight on the existing building will not change significantly.
3. The lateral displacement of the building is reduced by 50% to 56 % by the use of X Type steel bracing system, and X bracing type reduced maximum displacement.
4. The steel braced building of base shear increase compared to without steel bracing which indicates that stiffness of building is increases.

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