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Seismic Response of Buckling Restrained Braced Frames

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Abstract

Buckling restrained bracing systems are effectively being used to reduce seismic response during recent years. But often configurations of these systems are ignored while evaluating their behavior. Aim of this study is to consider the effect of different bracing patterns on the behavior of Buckling Restrained Braced Frames (BRBFs). Multi-storey braced frames with different patterns are modelled. The main variables of this study are the bracing pattern. The effects of bracing patterns on seismic behavior of buckling restrained braces are also considered. The best bracing pattern for a specific bay width and storey height in terms of seismic response are suggested finally.
Keywords- Buckling Restrained Braces, Seismic Analysis, Response Spectrum Analysis, Multi-Storeyed Building, Bracing Patterns

I. INTRODUCTION

Lateral displacements on structural buildings have been of great concerns for engineers. In order to minimize the effect of earthquake and wind forces, special diagonal members, called braces, have been used successfully. However, these members when subjected to compressive forces exhibit buckling deformation and show unsymmetrical hysteretic behaviour in tension and compression. If buckling of steel brace is restrained and the same strength is ensured both in tension and compression, the energy absorption of the brace will be markedly increased and the hysteretic property will be simplified. These requirements motivate researchers and engineers to develop a new type of brace, the buckling-restrained brace (BRB). The concept of the BRB is simple, restraining the buckling of the brace so that the brace exhibits the same behaviour in both tension and compression. The main characteristic of a BRB is its ability to yield both in compression and tension without buckling. A BRB is able to yield in compression because it is detailed and fabricated such that its two main components perform distinct tasks while remaining de-coupled. The load resisting component of a BRB, the steel core, is restrained against overall buckling by the stability component or restraining mechanism, the outer casing filled with concrete. Buckling Restrained Braces (BRBs) can be arranged in different patterns and orientations.

The BRB is a refinement to the conventional steel brace, comprising of an inner steel core encased in a mortar-filled case that restrains the yielding steel from buckling under compression. The interacting surface between the steel core and the confining material is coated with an unbonding agent to effectively decouple the transverse deformations of the two subsystems. When concrete is employed as the encasement material, several types of unbonding materials are available for use, such as epoxy resin, silicon resin, and vinyl tapes (Xie, 2004). Further research into the unbonding material has looked into even more options such as silicon coating, Styrofoam, polyethylene films, and butyl rubber sheets. An idealized model illustrating the decoupled system of the BRB is shown below.

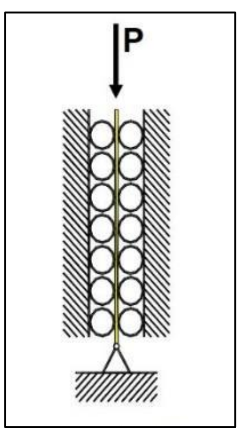

Fig. 1: Axial stress

The rather simple but immensely profound advantage of BRBs over conventional steel braces is that this high-performance brace exhibits the same behaviour in both tension and compression. The figure below shows the balanced hysteretic behaviour of the BRB in both tension and compression, highlighting the limitations of the conventional braces under compressive loadings.

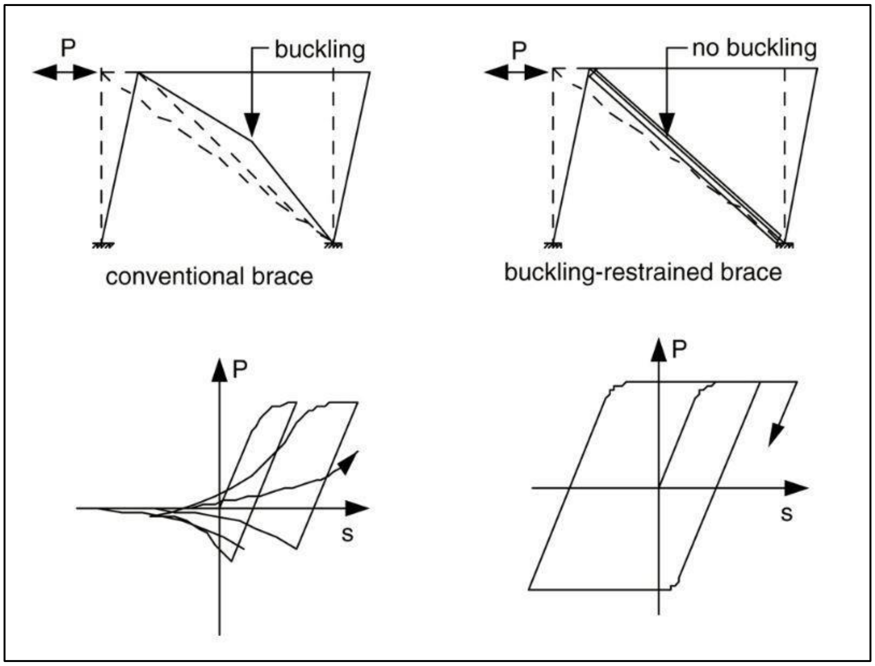

Fig. 2: Hysteric behaviour of Conventional and BR braces

II. MODELLING AND ANALYSIS

A. Modelling

Modelling was carried out in ConSteel. As six storied building of storey height 3m and four bays in x and y direction with a width of 3m is modelled the columns and beams used were steel sections used were HEA 300 for columns and IPE 200 for beams (European standards). ConSteel provides a structural analysis software for the design office mainly involved in constructions of steel and composite structures. It covers all the phases of the design process: modelling; integrated analysis and standard design; detailed examination of cross-sections and structural joints; flexible documentation. The analysis and design approach of ConSteel utilizes entirely the most up-to-date methodologies of the modern structural standards treating the 3D structural model as a whole during the complete process

1) Bracing patterns

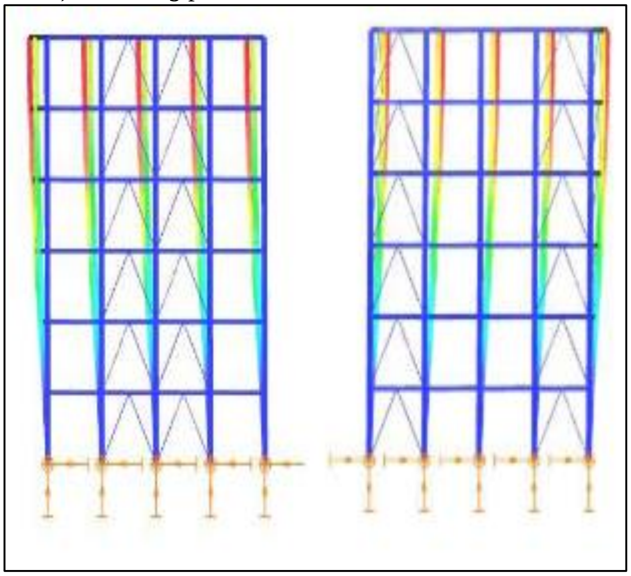

Fig. 3 (a): Inverted V

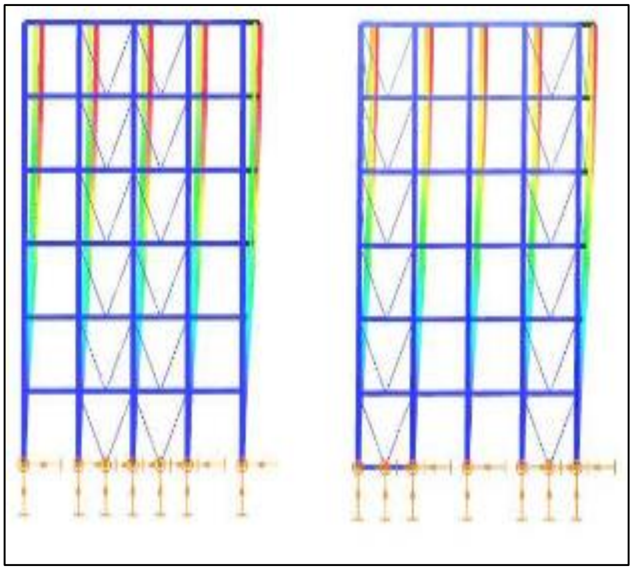

Fig. 3 (b): V

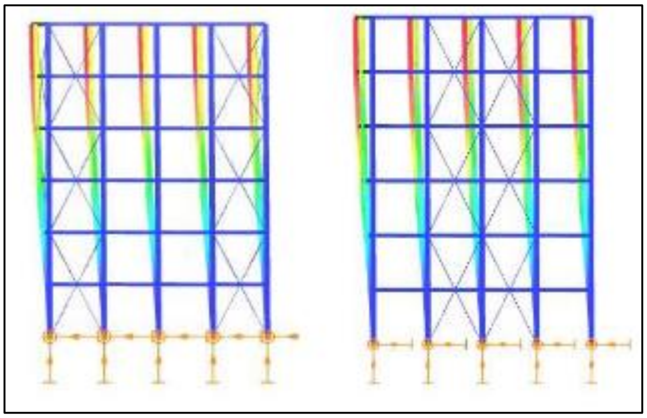

Fig.3 (c): Double story X

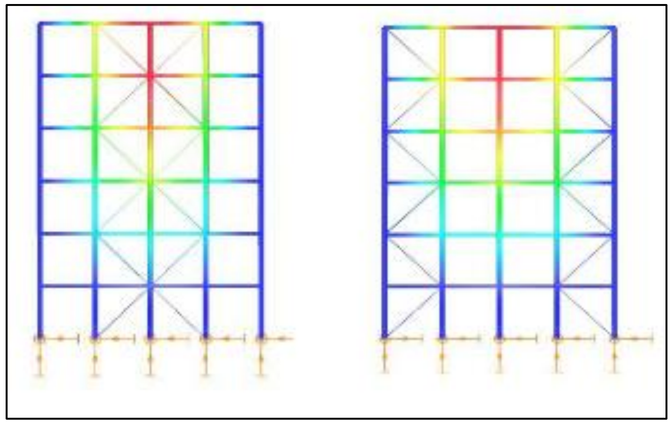

Fig. 3 (d): Diagonal zig-zag

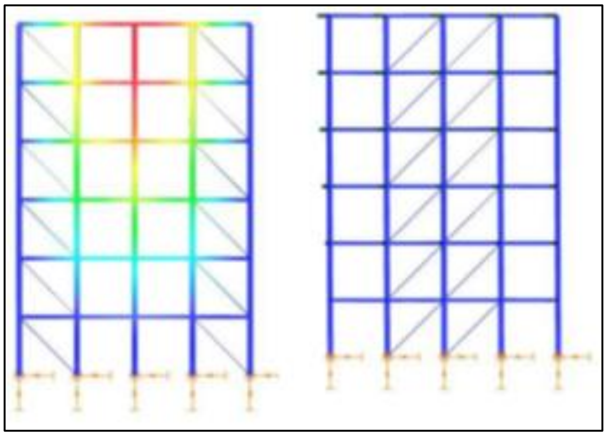

Fig. 3 (e): Diagonal

2) Arrangement of Braces

These bracings can be placed into the building in different arrangements. In one model it can be placed at the middle of four outer face or it can be placed along the four corners of the building.

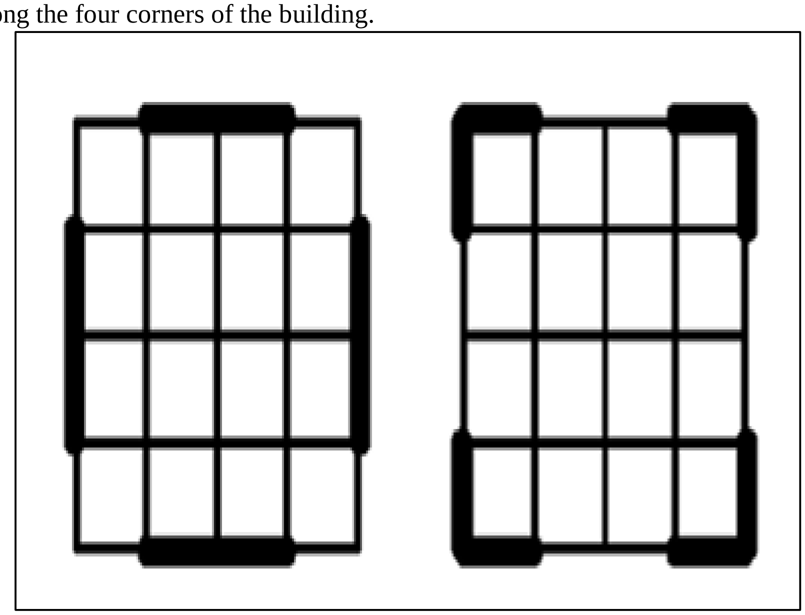

Fig. 4: Arrangement of braces

B. Analysis

Response-spectrum analysis (RSA) is a linear-dynamic statistical analysis method which measures the contribution from each natural mode of vibration to indicate the likely maximum seismic response of an essentially elastic structure. The models were subjected to response spectrum analysis using a standard response spectrum.

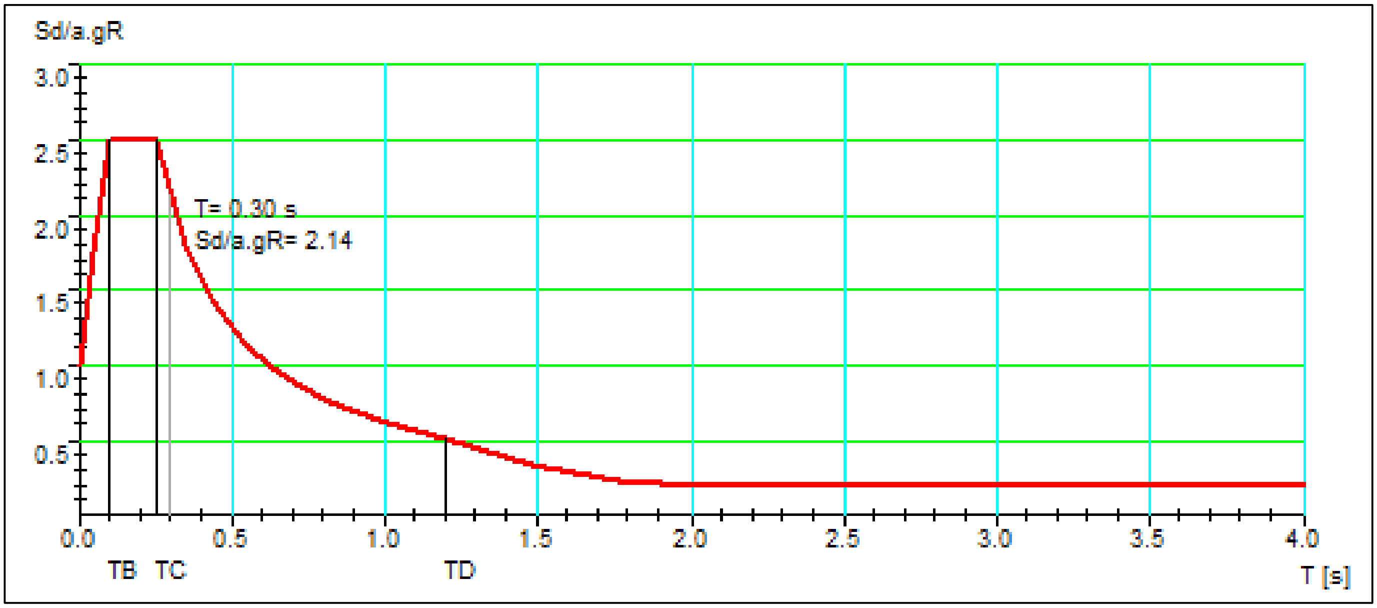

Fig. 5: Standard design spectrum

III. RESULTS

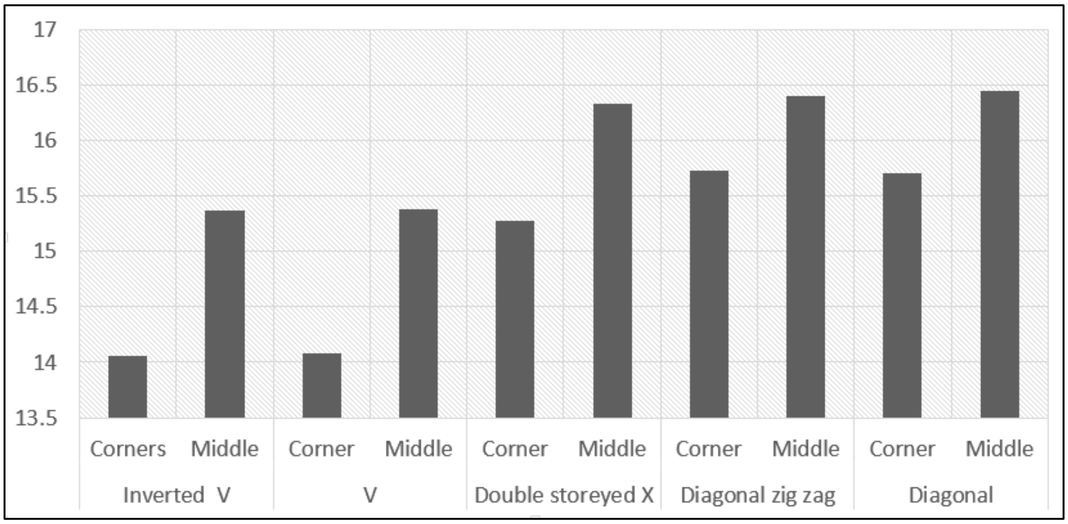

Fig. 6: Comparison of roof displacement

Table 1: Maximum roof displacement

BRACING CONFIGURATION	ARRAINGEMENT	ROOF DISPLACEMENT
Inverted V	Corners	14.06
	Middle	15.37
V	Corner	14.08
	Middle	15.38
Double storeyed X	Corner	15.27
	Middle	16.56
Diagonal zig zag	Corner	15.73
	middle	16.40
diagonal	corner	15.70
	middle	16.45

IV. CONCLUSION

The result of the analysis show that the roof displacement is minimum for inverted v bracing. It is also clear from the analysis that corner arraignment of BRBFs is better as the roof displacement in these models are lesser than that of the other arraignment.

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REFERENCES

[1] Nikhil D. Sontakke, P. S. Lande, (2016) “Comparative Study of Buckling Restrained Braces and Conventional Braces in a Medium Rise Building”.
[2] Larry A. Fahnestock,Richard Sause and and James M. Ricles,(2007)“Seismic Response and Performance of Buckling-Restrained Braced Frames”.
[3] Gary S. Prinz and Paul W. Richards, (2012) “Seismic Performance of Buckling-Restrained Braced Frames with Eccentric Configurations”.
[4] H. Sheikh and A. Massumi, (2008), “Effects of Bracing Configuration on Seismic Behavior of Tall Steel Structures Subjected To Earthquake Ground Motions”.
[5] Saeed Rahjoo, Babak H. Mamaqani, (2014) “X-Bracing Configuration and Seismic Response”.
[6] Qiang Xie, (2004) “State of the art of buckling-restrained braces in Asia”.
[7] Peyman Shademan Heidari, Roohollah, Ahmady Jazany and Hossein Kayhani, (2012) “An Investigation on Bracing Configuration Effects on Behavior of Concentrically Braced Steel Frames”.