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Energy Dissipation in Buildings using Buckling Restrained Bracings. (BRB) – A Review

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Abstract - *Earthquakes are the natural calamities which occur due to the sudden shaking of the surface of the earth resulting into the releasing of energy which causes seismic waves. A building dissipates energy either by undergoing large-scale movement or by sustaining increased strains in key building elements such as columns and beams. Both of these processes eventually result in some degree of damage. Structural engineers around the world are trying to innovate new technologies to increase the seismic performance of the structures to make it more resistant to the earthquake forces. Energy Dissipation devices are not used for supporting the structure but are used for enhancing the strength and stability of the structure. During the earthquakes, when the seismic energy passes through them these devices absorb them and thus damp the motion of building. Buckling Restrained Bracings (BRB) are one of the latest new technologies which are used nowadays to effectively dissipate the energy from the earthquakes and increases the seismic performance of the structure.*

Key Words: **Earthquake, seismic performance, energy dissipation, Buckling Restrained Bracings (BRB)**

1. INTRODUCTION

Energy Dissipation technology is a technology to improve the earthquake resistance of structures. During an earthquake, a certain amount of energy is transferred to the building. While buildings can dissipate, or damp, this energy, the capacity to do so before becoming deformed or damaged is quite limited. Buildings are equipped with additional devices which have high damping capacity by which we can greatly decrease the seismic energy entering in the structure.

A Buckling Restrained Brace (BRB) is a structural brace in a building, designed to allow the building to withstand lateral loadings, typically earthquake-induced loading. It consists of a slender steel core, a concrete casing designed to continuously support the core and prevent buckling under axial compression, and an interface region that prevents undesired interactions between the two. Braced frames that use BRBs also known as Buckling Restrained Braced Frames or BRBFs have significant advantages over typical braced frames. Buckling Restrained Bracings (BRB) consists of four main components parts

[1] Steel Core
[2] Bond Preventing Layer
[3] Infill Material
[4] Casing or Wrapping

2. LITERATURE REVIEW

A review of some of the literatures done by some researchers around the world on the energy dissipation using Buckling Restrained Bracing is presented below.

In the research thesis done by John Andrew Tinker (2011), he suggested to make the Buckling Restrained Bracing lighter in weight by replacing the steel core by using high ductile aluminium core. When we replace concentrically braced systems with the buckling restrained bracing the self-weight of the structure increases as these are heavier than the conventional braced systems. This research paper suggested to use lighter yet stronger material as a replacement for the material used in buckling restrained bracing to make it lighter in weight to reduce the self-weight of the structure. [6]

In the research done by M. Bosco, E.M. Marino & P.P. Rossi (2012) the design of steel frames using Buckling Restrained Bracings. This paper highlighted the fact that no design codes (for eg:- IS 800 – 2007, Eurocode 8, etc.) are equipped with the provisions for designing earthquake resistant structures using BRBs. This paper gave the design procedure for the Buckling Restrained Bracings using a case study. [8]

In another research done by K.K. Sangle, K.M. Bajoria, V. Mhalungkar (2012) the Indian standard code provisions was used for designing the different types of bracings such as Diagonal A – Brace, Diagonal – B Brace, X – Brace and K – Brace for a G + 40 level storey building and studied the effects of earthquake on the high rise structure with and without bracings. [7]

The research done by Bin Wu, Yang Mei (2014) on the Finite Element Analysis showed the buckling mechanism of the Buckling Restrained Bracings. The development of buckling mode was obtained under increasing axial load. The formulae for the contact force and the maximum bending moment was obtained in this research paper. [1]

In the research done by Huanjun Jiang, Shurong Li, Yulong Zhuc (2016), a brief introduction is given about the Energy Dissipation and also Buckling Restrained Braces were introduced with their properties. A comparative study was

done between two high rise buildings was done using conventional diagonal bracings and Buckling Restrained Bracings. Both the structures were analyzed for earthquake loads and the seismic performance was studied. After the analysis the structure with BRB was having significant improvement in the seismic capacity than the ordinary structure. [4]

In the research article by Hamdy Abou Elfath, Mostafa Ramadan, Fozeya Omar Alkanai (2016) the seismic requirements of the existing structures were studied to know their capacities and vulnerabilities to seismic loads with respect to existing design codes. The existing structure can be retrofitted using the Buckling Restrained Bracings to increase the lateral strength requirements of the structures. A 3 bay 5 storey existing structure was studied and analyzed using retrofitting technique. Using Buckling Restrained Bracing for retrofitting techniques can increase the lateral stability of the existing structures. [3]

In the research work done by Bin Wua, Junkai Lua, Yang Mei, Jian Zhang (2016) the design of BRB with the effect of friction between the Steel core and the infill concrete material was studied. Stiffening part was proposed between the concrete infill and steel core to improve the stability and strength of the bracings. Finite Element Analysis was done between the existing buckling restrained bracings and the proposed stiffened core were compared which showed the stiffened was proved better than the unstiffened core. [2]

In the research done by Jing – Zhong Tong, Yan – Lin Guo (2017) the benefits of the buckling restrained bracings was discussed along with the proposal of adding collar at the end of the bracing on the unrestrained portion of the bracing. This collar is added to prevent local buckling of the unrestrained portion and it was analyzed using ANSYS software and was validated using Finite Element Method. [5]

In a review paper done by Nayana Surendran, Asha Varma (2017) for the Buckling Restrained Bracings, the benefits of BRB over the concentrically braced structures were shown with a background study over the development of the Buckling Restrained Bracings and its properties. [9]

3. CONCLUSIONS

Following points can be summarized from the literature survey:-

[1] Buckling Restrained Bracings (BRB) are proven to be more effective in increasing the seismic performance of the structure than the conventional braced system using many case studies in various research papers.

[2] Many research papers have also suggested various design procedures for designing the BRB system, but no standard codal provision (IS, Eurocode, etc.) have detailed procedure of designing and analyzing the BRB system.

[3] Certain formulae given in the research papers can be used for designing the buckling restrained bracings.

[4] Many research papers have suggested adding components such as collars, stiffeners, etc. to the BRB to make it stronger and effective in resisting earthquake forces.

[5] Some of the research papers also suggested alternative materials as a replacement of the material used in BRB to make it lighter in weight.

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