



An Experimental Study on One of the All Steel Buckling Restrained Brace (S-BRB)

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ABSTRACT

Bracing is one of the primary devices that induced for resisting earthquake and wind lateral loads. Initially, the system was simple but as the time passed, due to shortcomings and economical problems, the type of braces changed and the changes were followed by its own complexion and complications. With better understanding of behavior and performance of the simple braces, the uses of these increased, but buckling was most problems in the braces. In 1973, buckling resisting braces (BRB) were introduced. In this version of braces, a steel tube prevents the buckling of axial members, which in turn leads to an increased in BRB forces. The aim of the present study was to investigate an all steel BRB with specific detailing in order to produce a uniform plastic region. Its advantages of use of this BRB are being lighter, ease of construction, core opening re-evaluation possibility after loading and use of single material.... To do so, some experimental processes on six specimens with 1:4 scales were made. The results indicated that if the required details are observed the brace would have proper behavior and high-energy absorption.

KEYWORDS

Buckling Restrained Brace, Concentric Braces, All steel BRB, Passive Damper, Ductile Diagonal Members.

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1- INTRODUCTION

Buckling-restrained braces (BRBs) have been developed in Japan from 1970's, and have been used for the seismic devices of low-rise buildings and hysteresis dampers of high rise buildings [1]. As a damage-controlling member, BRBs offer not only stiffness but also excellent energy dissipation through uniformly distributed yielding on the cross section along the whole core plate. Typical BRB consist of an inner steel core surrounded by an outer encasing member. The former carries the axial loads, while the later provides lateral supports to the core and prevents it from buckling in compression at the target lateral displacement.

Several researchers have conducted extensive research on the behavior of BRBs experimentally and analytically. Watanabe et al. [2] introduced a BRB comprised of a steel plate encased in a steel tube that filled with mortar. In their study, the outer tube was mainly responsible for buckling inhibition. Afterwards, Kamura *et al.* [3], Liu *et al.* [4] and Nagao and Takahashi [5] presented several configurations for steel tube encased in surrounding mortar. Other researchers such as Ohi *et al.* [6], Ning MA. *et al.* [7], Tremblay *et al.* [8], Narihara [9] and Murase *et al.* [10] have done valuable research on the performance of BRBs and proposed different forms and configuration for the steel core. In 2005, the design of buckling-restrained braced frame (BRBF) is adopted in the seismic provisions [AISC 2005].

2- METHODOLOGY

Conventional steel frames undertake large levels of lateral deformations when subjected to strong ground motion or wind forces. If this deformation is excessive, structural and nonstructural damage is evident, compromising the structural integrity. Damage becomes stronger as p-delta actions take place, product of large deformations.

To override such deformations, various types of elements and devices have been used in steel frames. Diagonal elements, called braces, have been implemented as additional structural members that increase the stiffness and energy dissipation, and control relative interstory deformations in an effective way, thus protecting the structure against damage and improving the overall behavior.

Flexural buckling, a failure mode in which the member deforms laterally and losses its stiffness and load carrying capacity, is the most common problem associated to compression elements. When this failure occurs, lateral stiffness drops; frame stability decreases significantly, causing severe damage to the structural and non structural elements and in some events taking the structure to collapse.

To overcome the above mentioned problems, a new type of brace was developed in Japan about thirty ago. These braces are designed such that buckling is inhibited to occur, exhibiting adequate behavior and symmetrical hysteresis curves under the action of both tensile and compressive cycles, produced by the action of the seismic forces.

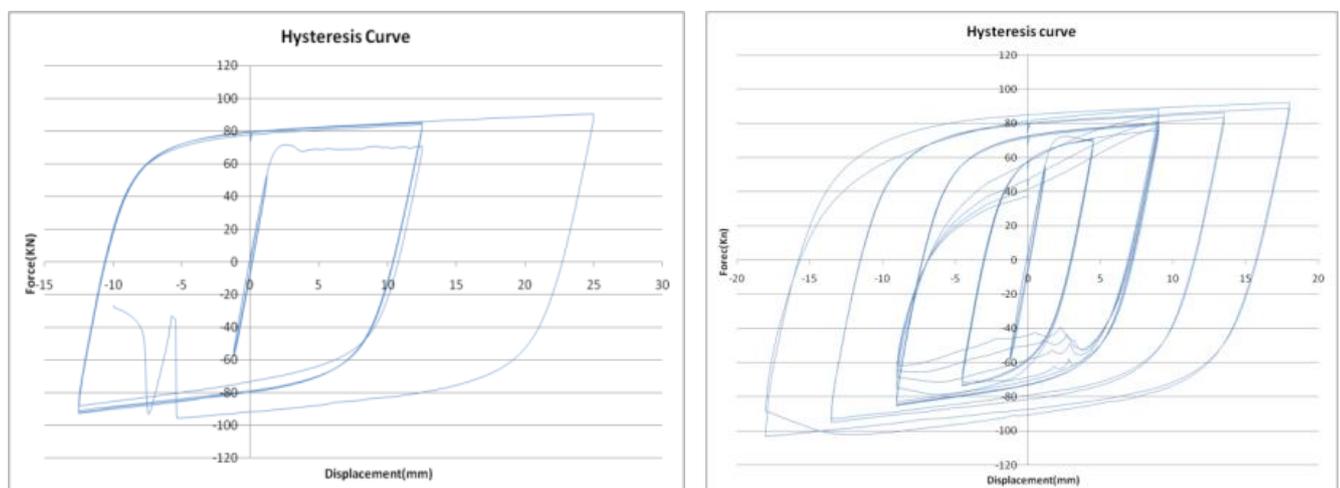


Figure (1): Hysteresis curve of 2 specimens

This paper describes a uniaxial tests program performed on six All-steel buckling-restrained braces (S-BRBs). In their tests, were examined one brace cores and one buckling-restraining mechanism but the applied loading histories on specimens included incremental displacement protocol corresponding AISC 2005. These specimens sustained core strain of close to 3% and S-

BRB maximum ductility demands of over 20 with minimal damage and no stiffness or strength degradation.

All specimens except one showed satisfactory performance with stable hysteretic response. The testing program demonstrated that a properly detailed S-BRB can withstand sever seismic input and maintain its full load-carrying capacity.

3- CONCLUSIONS

The traditional BRBs, with mortar filling in a steel tube to prevent the core plate from buckling, have been extensively employed in Japan and U.S. However, manufacturing procedures are complex due to the many interfaces needed for different materials and the time consuming process of fabricating and strengthening the mortar. Also, quality control is difficult and cannot be assured beforehand, without testing during the manufacturing process and after earthquake. With the objective of overcoming the disadvantages of traditional BRBs, the novel type of buckling restrained brace is proposed in this study.

The present results show that all steel BRB with specific detailing are in order to produce a uniform plastic region. Its advantages to use this BRB are being lighter, ease of constructions, core opening re-evaluation possibility after loading and the use of single material... To do so, some experimental processes on six specimens with 1:4 scales were made. The results indicated that if the required details are observed, the brace would have proper behavior and high-energy absorption.

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