Evaluation of a low-cost seismic energy dissipation device for buildings

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Abstract

Safety during earthquakes should be a human right and shall be accessible not only to those who can pay for proprietary high-tech devices but to everyone. Based on that, this paper presents a low-cost, low-tech seismic energy dissipation device. Its experimental behaviour under seismic loading is assessed. The device is classified as buckling-restrained brace (BRB) and, according to its characteristics, it is suitable for new and existing, medium- to low-rise structures. First, the device composing parts are presented. Then, its structural response, in terms of hysteretic behaviour, ductility, and dissipated energy – as obtained from experimental tests – is shown. Experimental results show an excellent behaviour. As a result, it can be said that the device is reliable and its use is recommended for new and existing structures. Design recommendations are also provided.

Keywords: buckling-restrained braces (BRBs); seismic energy dissipation device; passive dissipation; experimental test under seismic loads.

1 Introduction

In one hand, seismic protection devices are an urgent need in poor and developing countries with moderate and high seismicity. Although protection technologies are very common in developed countries such as the United States, New Zealand and Japan, the reality is that many countries still have no development at all on the subject. On the other hand, buckling-restrained braces (BRBs) have shown that they have great performance under seismic actions [1-4]. Both, numerical and experimental studies have shown their great capacity to dissipate seismic energy.

For those reasons, an experimental program has been developed at the National Autonomous University of Mexico (UNAM), in collaboration with some researchers from the University of Manchester in the United Kingdom and the Metropolitan Autonomous University of Mexico City, in order to understand the behaviour of buckling restrained braces (BRBs). During this research program, several interesting results have been obtained. Shaking table of steel models [5, 6] and reinforced concrete models [7], equipped with BRBs, have been conducted. The results show that BRBs are effective to improve the seismic performance of structures under earthquake ground motions. Thanks to this devices, inter-storey drift demands were reduced by half in the studied models. Numerical studies were also conducted [8-10], showing that BRBs help to mitigate residual displacements in structures, reduce the effects of seismic aftershocks and significantly reduce repair costs during the useful life of buildings.

After several experiments have been conducted, very illustrative experiences have been obtained on

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