Investigation of hybrid multi-core buckling-restrained brace components

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Abstract

Contemporary seismic-resistant design of steel braced frames is based on dissipating seismic energy through significant inelastic axial deformation in brace components. Buckling-restrained braced (BRB) frames are a type of concentrically braced frame (CBF) characterised by braces that yield both in tension and in compression. These braces therefore exhibit superior cyclic performance compared with traditional CBFs. However, buckling-restrained braces commonly display a low post-yield stiffness, causing substantial interstory drifts and large residual drifts after seismic events. Moreover, yielding of the core is often only tied to a single performance objective, thus making its performance at other levels of seismicity largely unknown. One promising solution is the use of a hybrid BRB, where multiple cores made from different metals are connected in parallel to work together and complement each other. This research is geared towards first evaluating the potential of different combinations of core materials, followed by the design of a hybrid BRB system that can accommodate multiple core plates. Results show that the post-yield behaviour of hybrid BRBs is improved by employing a combination of 350WT carbon steel and another metal with low-yield and high strain-hardening behaviour, such as stainless steels, aluminium alloys, or other grades of carbon steels. Finally, a detailed overview of one hybrid BRB solution is proposed.

Keywords: seismic design; concentrically braced frames; buckling-restrained braces; hybrid; energy dissipation; cyclic response; steel; aluminium

1 Introduction

Because of their great lateral stiffness and strength, concentrically braced frames (CBFs) are among the most popular lateral load resisting systems for the seismic design of steel structures [1]. Buckling-restrained braced frames (BRBFs) are a special type of CBFs that exhibit superior seismic performance. The main components of this system are the buckling-restrained braces (BRBs), which were first experimentally tested during the 1970s [2]. BRBs display a very stable and almost symmetrical hysteresis response because of their ability to yield equally both in tension and in compression [3]. BRBs comprise of three main elements: (i) a ductile metallic core which acts as energy dissipating element; (ii) a restraining mechanism that encases the core in order to prevent global instability of the brace; and (iii) an unbonding layer located at the interface between the core and the restraining member to reduce the transfer of axial forces to the casing [4].

Although stable and repeatable responses have been observed from current BRB designs, their structural applications and several experimental studies on BRBs have highlighted a few recurrent

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