Additive Manufacturing Techniques for Repairable Braced Frames

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Abstract

Special concentrically braced frames (SCBFs) have been used in lateral load-resisting systems over the last decades. SCBFs are designed to provide significant inelastic deformation capacity primarily through tensile yielding and compression buckling. Even though SCBFs satisfy design requirements for life safety, they sustain high levels of damage which results in economic losses due to the need for replacement. This paper proposes a new concept that focuses on concentrating the damage due to tensile yielding and inelastic buckling in a segment of the brace (fuse) while protecting the rest of the brace. This concept enables repairability after high-level seismic excitation by replacing the damaged fuse. The replaceable/recycled fuses are additively manufactured to achieve desired ductility through optimised geometry. The paper includes a description of numerical results from a small-scale specimen tested under cyclic protocol load.

Keywords: concentric braced frames; seismic; repair; deconstruction; additive manufacturing.

1 Introduction

Special concentrically braced frames (SCBFs) represent a distinctive category within the broader class of concentrically braced frames (CBF). These frames are designed as a seismic force-resisting system, specifically engineered to counteract lateral forces induced by seismic events (earthquakes). SCBFs meet both the serviceability and strength limit states. In severe events of earthquakes, SCBFs dissipate seismic energy through yielding in tension, in-elastic buckling in compression, and fracture from low-cycle fatigue, as shown in Figure 1. Moreover, the damage is irreparable, leading to the building's instability and a longer downtime after major seismic events [1].

Researchers over the last few decades have developed devices and structural systems to minimize damage or even fully protect structures during extreme seismic events. Such technologies include seismic isolation [2], passive and semi-active damping devices [3], rocking/self-centring

Figure 1. Inelastic brace buckling failure [1]

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