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Finite element modeling of the seismic behavior and fracture of concentric braces

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In steel construction, hollow structural steel (HSS) sections are frequently used as concentric bracing members in framed structures to resist seismic excitations. The prediction of the fracture life of the HSS tubes is still a concern, despite four decades of cyclic testing and numerical modeling. That work has however, led to stringent limits on the width-to-thickness ratio as in the AISC 2010 seismic provisions. High local strains develop in HSS bracing members because of the geometric nature of the local buckling at the mid-length plastic hinge that leads to severe local rotation with high cyclic strain demand. Thus, brace fracture occurs at smaller inelastic deformation for HSS members than for wide flanges when all other factors are identical. Wide flange (WF) sections could represent an attractive alternative to HSS sections as bracing members. The slight increase in cost per ton of columns and the low compressive resistance of WF braces could be justified by an improved fracture life expectancy and better control in terms of expected strength compared to HSS tubes. In addition, there is the possibility of using the WF braces in opposing pairs in frames. The high over-strength value of HSS bracing members is unfavorable and could lead to fracture in the connection if not taken into account as seen in several earthquakes. Finite element modeling is presented here to predict cracking and fracture life of bracing members under different applied cyclic loadings. It is shown that the fracture life predicted from finite element analysis agrees well with experimental results.

Biography

Madhar Haddad completed his PhD at The University of Calgary and engaged in Post-doctoral studies at the Schools of Engineering at The University of Calgary and the Ecole Poly-technique of Montreal. He is an Assistant Professor of Structural Engineering at the Architectural Engineering Department of the United Arab Emirates University. He has published several papers in refereed journals and conference proceedings.

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