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INVESTIGATING THE EFFECT OF FRP-STRENGTHENING ON THE PERFORMANCE OF REAL-SCALE SHS BRACE

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Under large ground motions, diagonal steel members of lateral bracing systems dissipate the energy by yielding in tension and buckling in compression. However, after several loading cycles, the development of local buckling at the mid-length of the brace exposes the section to the threat of fracture. Square Hollow Section (SHS) which commonly used in concentrically braced frames is highly prone to this premature failure. Recent researches showed that wrapping Fibre Reinforced Polymer (FRP) sheets in transverse direction can improve the behaviour of SHS braces (Shadan and Kabir, 2018a). As Figure 1 shows, FRP wrap with reinforcing the section elements against out-of-plane buckling, inhibits the formation of local buckling. Furthuremore, with applying FRP sheets in the transverse direction, the overall buckling capacity of strengthened braces increased insignificantly, since low global buckling capacity improves the brace ability at dissipation of hysteretic energy (Bruneau et al., 2011).

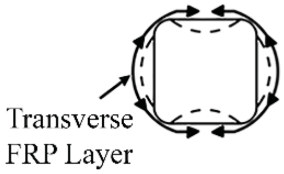

Figure 1. Effect of transverse FRP layer on local buckling (Shaat, 2007).

Through the experimental research done by the authors, the effectiveness of FRP-strengthening was investigated for the SHS braces with maximum length of 2 m (Shadan and Kabir, 2018b). However, the real-scale braces have length ranging from 4 to 9 m. Then, the need for investigating the effect of strengthening on the performance of real-scale braces remains.

In this study, first the validity of numerical model was assessed by comparing the predicted load-deflection curve with the measured results (Figure 2).

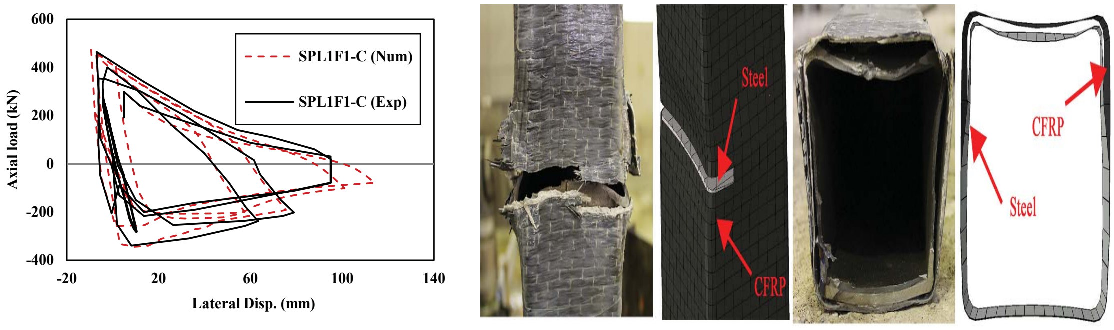

Figure 2. Comparison of numerical and experimental results.

Then, a brace with the length of 7 m was simulated as shown in Figure 3. With the aim of using the strengthening strategy for existing structures, the dimension of the SHS section was selected such that the section is seismically compact in accordance with AISC341-05, while according to a more recent provision, AISC341-16, it cannot be considered as seismically compact section. Hence, the ability of FRP wrap at providing the required compactness was investigated.

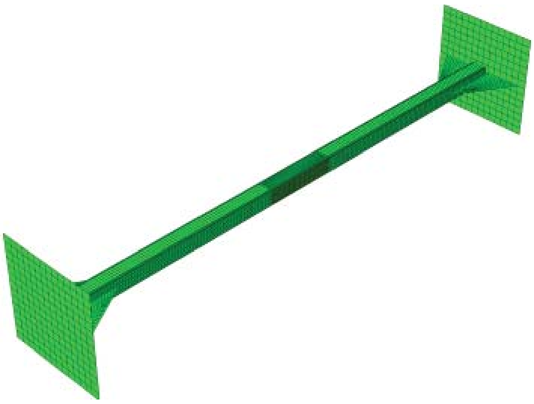

Figure 3. Finite element model of the 7 m long brace.

Results of the study show that strengthening with FRP is also effective at enhancing the performance of real-scale SHS brace. Likewise, the strengthening method could postpone local buckling into next cycles, which expectedly lead to a delay in collapse of brace. The increase in energy dissipation capacity and ductility improvement of real-scale brace are also the results of strengthening with FRP, which prove that enhancing with FRP is a promising way to improve the seismic performance of braces. However, comparing the results of 7 m brace with 2 m brace reveals that with increase in the slenderness ratio of the brace, the efficiency of FRP-strengthening was reduced to some extent.

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