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Structural Behaviour of Small-Scale Fibre-Filled Steel Tubular Planar Frames

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Abstract : There is a growing interest in the construction industry towards hybrid systems. The hybrid systems use construction materials such as timber, steel, and concrete smartly, can be prefabricated, and are cost-effective and sustainable solutions to an industry targeting reduced carbon footprint. Moreover, in case of periodical shortage in timber resources, reusable and waste wood such as fibres can be used in the hybrid modules, which facilitates the circular economy. In this research, a hybrid frame is proposed and experimentally validated by introducing dried wood fibre products inside cold-formed steel square hollow sections without using any adhesives. As such, fibre-filled steel tubular (FFST) columns, beams, and 2D frames are manufactured and tested. The results show that the FFST columns have stiffness and strength 44% and 55% higher than cold-formed steel columns, respectively. The bearing strength of the FFST beams shows an increase of 39.5% compared to steel only. The flexural stiffness and strength of the FFST beams are 8.5% and 28% higher than the bare steel beams, respectively. The FFST frame depicted an 18.4% higher ultimate load capacity than the steel-only frame under a mid-point concentrated load. Moreover, the FFST beam-to-column bolted connection showed high ductile performance. The initial results and the proposed simple manufacturing process suggest that the proposed FFST concept can be upscaled and used in real structures.

Keywords : wood fibre, reusing wood, fibre-filled steel, hybrid construction
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