Enhancing the performance of knee beam–column joint using hybrid fibers reinforced concrete

ABSTRACT

The knee beam–column joint is a critical location in a Reinforced Concrete (RC) structure particularly when subjected to earthquake vibrations. The current structural design codes dictate the use of high amounts of steel reinforcements in the frame joint to manage large strain demands in seismic-prone regions. However, these codes could result in the congestion of steel reinforcements in the limited joint area which can consequently produce numerous construction complications. This study aims to improve the structural performance of Knee Joint (KJ) by reducing the load induced to the embedded steel reinforcements during seismic vibrations. Hence, this study attempted to develop a Hybrid Fiber Reinforced Concrete (HyFRC) by combining multiple synthetic fibers to be introduced onto KJ. Six KJ specimens were cast using fve developed HyFRC materials and one Control specimen to be experimentally tested under lateral cyclic loading. The results indicated signifcant improvements for the HyFRC KJ specimens particularly in energy dissipation capacity, stifness degradation rate, displacement ductility toughness, steel reinforcement strain and hysteretic behavior. A total of six Finite Element (FE) KJ models were developed using the HyFRC materials to verify the results from the experimental testing. The accuracy of the proposed FE models resulted in average percentage diferences of 25.89% for peak load, 3.45% for peak load displacement and 0.18% for maximum displacements from the experimental data. In conclusion, this study developed HyFRC materials that are benefcial in providing cost-efcient alternatives to Reinforced Concrete (RC) KJ structures in areas with low to moderate level of seismic risks.

Keyword: FORTA fibers; Synthetic fibers; Hybrid fiber reinforced concrete; Fiber reinforced concrete; Knee joint; Beam–column; Toughness; Cyclic loading