CERIS Civil Engineering Research and Innovation for Sustainability

Strength and ductility of short rubberized concrete filled steel tubes for seismic areas

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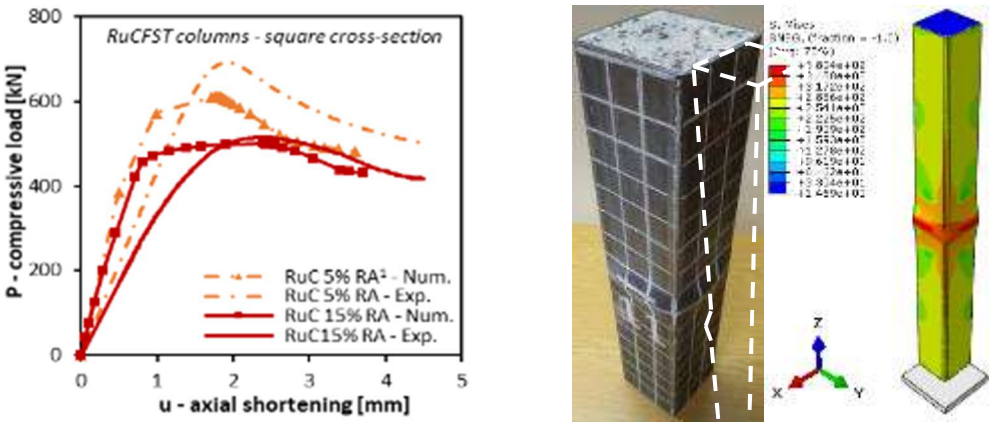
Summary

With the advent of high-strength materials, high-strength Concrete Filled Steel Tubes (CFST) columns often exhibit low ductility. Hence, the objective of the work was to study the mechanical behaviour of short CFST columns with enhanced ductility, via the concrete core, using for this rubberized concrete (RuC). The columns are therefore designated rubberized concrete filled steel tubes (RuCFST). In RuC, natural aggregates are partially replaced with rubber aggregates from end-of-life tyres: one the one side, the disposal of tyres in landfills is reduced; on the other, the extraction of natural aggregates is also decreased. Regarding mechanical properties, RuC has lower stiffness and strength but, inversely, higher ductility than natural aggregate concrete (NAC). Firstly, an experimental campaign was conducted to study the mechanical properties of the steel grades and concrete mixes (RuC and NAC) used in the columns. Additionally, an image processing (using MATLAB)-extended finite element method (using ABAQUS) coupled procedure was developed, with the objective of performing an in-depth numerical characterization of the mechanical behaviour of RuC. Then, the mechanical behaviour of short CFST and RuCFST columns (with square – Figure, rectangular and circular cross-sections) was studied when these were subjected (i) to monotonic concentric compression and (ii) to cyclic bending combined with compression.

The investigation of the columns subjected to both load cases comprised experimental, numerical and design parts. It was concluded that in both load cases, RuCFST columns exhibit lower stiffness and strength than their NAC counterparts but the reductions are not as high as in the case of RuC compared with NAC, due to the contribution of the steel tube to strength and confinement of concrete. Regarding ductility, in monotonic compression, both experimentally and numerically, it was shown that this property is much higher in RuCFST columns than in CFST columns. However, when subjected to cyclic loading, the ductility of RuCFST columns is similar to that of CFST columns. Regarding comparisons between predicted (using EN 1994-1-1) and experimental maximum loads of the columns, some investigation is still required if the predictions are to be improved, especially concerning topics such as the strength of confined concrete (especially RuC) and consideration of local buckling of the steel tube.

Keywords

Rubberized Concrete Filled Steel Tubular (RuCFST) columns, strength and ductility, experimental testing, numerical modelling, design study.



(a) (b)

Experimental and numerical (a) load-shortening curves; and (b) collapse configurations of RuCFST columns (1RA denotes Rubber Aggregas).