BEHAVIOUR OF FIBRE-REINFORCED CONCRETE STRUCTURES UNDER SEISMIC LOADING

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by

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ABSTRACT

The present research is concerned with the modelling of the structural behaviour of steel fibre-reinforced concrete (SFRC) using non-linear finite-element (FE) analysis. Key structural response indicators such as load-deflection curves, strength, stiffness, ductility, energy absorption and cracking were examined. In particular, the potential for fibres to substitute for a reduction in conventional transverse reinforcement was studied. Such reduction is highly desirables in practice as it helps alleviate reinforcement congestion, often experienced in the seismic detailing of critical regions such as beam-column joints. Thus two key parameters were considered, namely reducing transverse reinforcement while increasing the amount of fibres. The reduction in conventional reinforcement was achieved mainly by increasing stirrups spacing (and also by reducing double-hoop arrangement commonly used in seismic detailing of joints).

The behaviour of SFRC structural elements was studied under both monotonic and reversed-cyclic loadings (the latter used to mimic seismic action). Emphasis was initially focused on the study of available experimental data describing the effect of steel fibres on the post-cracking response of concrete. Consequently the SFRC constitutive model proposed by Lok and Xiao (1999) was selected. The numerical model was calibrated against existing experimental data to ensure the reliability of the FE predictions. Subsequently, further analyses were carried out investigating three main case studies namely, simply supported beams, two-span continuous (i.e. statically-indeterminate) columns, and both exterior and interior beam-column joints. Parametric studies were carried out covering the full practical range of steel fibre dosages and appropriate amounts of reduction in conventional transverse reinforcement. The results show that steel fibres increase the load-carrying capacity and stiffness (thus enhancing response at both the serviceability and ultimate limit states, which are important design considerations). Fibres were found also to improve ductility (as well as altering the mode of failure from a brittle to a ductile one).

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