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ANALYTICAL STUDY ON EARTHQUAKE RESISTANCE OF ULTRA-HIGH STRENGTH CONCRETE MEMBERS CONTAINING STEEL FIBER

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SUMMARY

Reinforced concrete has been used in over 1000 skyscraper constructions in Japan, and ultra-high strength concrete with a compressive strength of over 100N/mm^2 is used for lower stories which are subjected to large axial forces. However, the mechanical properties of concrete under compression become increasingly brittle with increasing concrete strength, and a vast amount of lateral reinforcement is needed to obtain a deformation capacity that satisfies the design criteria.

Ultra-high strength concrete structural members containing steel fiber (SF) are developed to reduce the amount of lateral reinforcement. The effects, such as an increase in strength, toughness and anti-crack performance, have been observed in the presence of SF, but the mechanisms behind the strength increase has not been identified.

The authors performed a 3-D FEM analysis of SF-reinforced ultra-high strength concrete columns and beam-column joints, and reproduced the effectiveness of SF addition in increasing flexural or shear strength and anti-crack performance by setting a positive second stiffness in relation to the concrete tensile stress-strain relationships after the tensile strength has been reached. In the present study, a re-examination of the analytical model and an analysis in relation to reversed cyclical load application are performed, and these analytical results are used to examine the mechanisms behind the strength increase in ultra-high strength concrete members containing SF.

The analytical results showed that the hysteresis loop profiles corresponded largely well with previous test results in a model with a moderate post-ultimate strength stress decrease in concrete tensile stress–strain relationships, and that SF addition is effective in suppressing crack width expansion, increasing crack dispersion, and suppression of column axial strain progression. The analytical results also showed that the shear strength increase of beam-column joints is caused by the effective area increase of concrete compressive strut from SF addition effects.