ABSTRACT

Strength and Behaviour of Fibre Reinforced Concrete Beams Under Combined Bending, Shear and Torsion

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This investigation studies the strength and behaviour of fibre reinforced concrete beams subjected to various combinations of transverse and twisting loads.

The experimental work involves testing fifty (50) reinforced concrete beams with and without fibres. The beams are divided in two (2) Sections depending upon the nominal cross-section. Twenty (20) beams comprise Section I with nominal cross-section 150 mm X 250 mm. Thirty (30) beams comprise Section II, with nominal cross-section 125 mm X 200 mm. All beams are 2000 mm long.

Twenty nine (29) beams are reinforced with fibres in addition to conventional steel while twenty one (21) contained conventional reinforcement only. The fibre reinforced beams contain fibres equivalent to 1%, 1.5% and 2% fibres by volume. All Section I beams consist of similar conventional reinforcement, in which the longitudinal steel is asymmetrically arranged. Section II

beams consist of twenty (20) beams whose conventional reinforcement is similar to those of Section I beams and ten (10) beams whose longitudinal reinforcement are symmetrically arranged.

Beams are tested under pure bending, pure torsion, combined bending and shear, combined bending and torsion and combined bending, shear and torsion. All combined loaded beams tested under torsion are twisted to failure subsequent to the application of transverse loads.

An analytical model is proposed for the analysis of fibre reinforced concrete beams subjected to combined bending, shear and torsion. The model is based upon the skew-bending approach and treats the fibres included as a separate reinforcing agent. The analysis is simple, direct and sufficiently generalized to extend to the limiting cases of reinforcement types and arrangements and loading conditions. Good correlations are observed between the test results, of this and other relevant investigations, and strengths evaluated using the proposed model. Two hundred and seventy three (273) beams, forty eight (48) of which are tested in this investigation, are correlated.

The finite element method is used to analyse reinforced concrete beams tested under bending and torsion from this and other relevant investigations. Correlation of the analytical results, using Program ADINA for the analysis, with the test results, suggest that the method is useful for analysis of fibre reinforced concrete structural elements. A fibre concrete constitutive material model is proposed for the analysis using the finite element method. This model requires verification which would form part of future research efforts. The analysis using this method will enable focus on the strengthening mechanism of fibres, stress redistribution and optimisation of the reinforcing characteristics of fibres.