STRENGTH AND SERVICEABILITY OF REINFORCED CONCRETE DEEP BEAMS

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Abstract

Results from tests on 19 top-loaded, simply supported, lightweight concrete deep beams without web reinforcement, designed to fail in shear, are presented in Part I. The results confirm previous findings, that the shear span-depth ratio has an important influence on failure loads while the span-depth ratio, in general, does not. However, it appears that beams loaded at a single point at mid-span may be weaker than beams loaded at a single point at mid-span may be weaker than beams loaded over the same shear span at two points. Existing equations for predicting the ultimate shear strength of deep beams are adequate for the test data.

Part II, the results of tests on eight large-scale simply supported, deep beams with rectangular web openings under two-point top load are presented. These tests show that when a web opening interrupts the flow of stress in the shear span the beam deforms mainly by rigid-body rotation of three large blocks of the beam in the shear span. It appears that the serviceability limit state of crack widths will be more important in design than the ultimate limit state. Using the observed deformation, a method of analysis for deep beams with web openings at the ultimate limit state is presented; the analysis indicates that the web opening only affects the behaviour of the beam if it intersects the line joining the loading and support reaction points. An extension of the analysis to include the serviceability limit states of crack widths is suggested. Design guidance is given.

Finally, in Part II, application of the bound theorems of limit analysis to reinforced concrete deep beams is considered. It is shown that rigorous application of the theorems is difficult, even if the necessary material idealisations and assumptions are regarded as acceptable. Application of a reduced concrete yield strength to account for strain softening behaviour of the concrete is investigated, using a multiplying factor; a unique value does not

appear to exist for this factor. Consequently the bound theorems of limit analysis cannot be used to safely predict the strength of reinforced concrete deep beams.