SHEAR STRENGTH OF REINFORCED CONCRETE WALL-BEAM STRUCTURES: UPPER-BOUND ANALYSIS AND EXPERIMENTS

Z.B Mohamed

Abstract

This study presents rigid-plastic methods of analysis of shear failure in reinforced concrete (R.C.) wall-beam type structures when subjected to in-plane loading. The upper-bound approach is emphasised.

Present shear design practice (e.g. BS8110:1985) relies much upon empirical solutions, but it is inadequately substantiated by theoretical analysis when compares with design against bending moments. Review of previous work on shear failure in R.C. beams demonstrates the need for a rational analysis approach which broadly represents the important physical characteristics and mechanics of shear failure and which can reliably predict the shear capacity. The rigorous theory of plasticity in shear which was introduced by researchers in Denmark in the early 1970’s has proved successful for some limited cases. At failure, a simple kinematic rigid-plastic solution was derived for a stringer model with a straight ‘yield line’. Recently, evidence has emerged that the best single yield line between two rigid wall portions may well be curved and not the best yield line between two rigid wall portions may well be curved and not straight. There are different stress states in yield lines and consequently three types of yield line are identified in analysis. These findings enable us to apply for the first time combinations of yield lines to analyse shear failure mechanisms of R.A. wall-beam type structures. The principle of rigid-body plane motion, are used to describe the deformations of failure mechanisms. The search for the best mechanism at failure is made automatically by computer. The model predicts reasonably well the strength and mechanism for the test results reported in literature. The model is extended to a wall-beam with openings loaded in plane.

The tests made on shallow beams without shear reinforcement and deep beams with and without web openings to study the accuracy of the fundamental calculations made by the model. The most critical mechanism predicted by the model is reasonably representative of the observed failure mechanism. The strength prediction is in substantial agreement with the experimental tests. The conclusions drawn from the study are: (1) If a correct mechanism is predicted then a rigid-plastic solution is close to the true behaviour otherwise it is an upper bound, and (2) The plastic solution of R.C. is only an approximate solution.