FINITE ELEMENT ANALYSIS OF CONCRETE MEMBERS CONSIDERING THE EFFECTS OF CRACKING AND THE INCLUSION OF REINFORCEMENT

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Abstract

The finite element method appears to be the best currently available method for analysing the stresses and deformations of reinforced concrete after cracks have been developed. Many adaptations are needed, however, to enable the finite element method to be used to model the complex behaviour of reinforced concrete members to a satisfactory degree.

Constant strain triangular elements were chosen for this study because it was considered that, the reinforced concrete, a larger number of simple elements of this type would be preferable to a smaller number of complex elements. It was found that, by reconsidering the basic stress-strain relationships for constant strain elements, a significant improvement in the stress contours can be obtained and the oscillation of stress usually associated with constant strain elements can be eliminated.

Particular attention was directed toward the solution of problems associated with cracking. Efforts were made to model the initiation and propagation of cracks in a manner which would avoid, to as large a degree as possible, the effect of arbitrarily chosen element subdivision patterns. To accomplish this, cracks were considered to progress through elements rather than being restricted to following element boundaries. An “experimental design” approach was used to reduce the number of trials required to ascertain the significant variables which affect the modelling of crack propagation.

It was considered that the reinforcing bars should be placeable at any arbitrary location with respect to the predetermined pattern of concrete elements. This enables a “cut and try” approach to be used for the design of a concrete member because the reinforcing bars can then be relocated or increased in size without altering the concrete elements. It was

found that simple relationships could be developed to relate the nodal forces and displacements of the concrete to the forces and displacements at the nodes along the reinforcing.

Program modification are suggested to reduce execution time and storage requirements, to facilitate data input and to enable results to be presented in a clearer and more meaningful manner.