

NON-LINEAR FINITE ELEMENT ANALYSIS OF REINFORCED CONCRETE

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ABSTRACT

Strictly based on experimental evidence, a non-linear material model is presented for concrete subjected to membrane stresses. The model assumes a smeared rotating crack approach, tension stiffening, stress degrading effect for concrete parallel to the crack direction, and shear retention of concrete on the crack surface. In addition, the concrete model considers the enhancement in stiffness and strength of concrete under bi-axial compression. A NLFEA computer code was developed by incorporating the model into standard finite element formulations. The code applies to the analysis of rc plates and membranes. Comparison with experimental results indicates the efficiency of the material model in predicting the post-cracking response of reinforced concrete even with lower-order type of elements.

INTRODUCTION

Considerable research work has been reported in recent literature on the formulation of non-linear finite element procedures for the analysis of reinforced concrete shell structures (Huria *et al.* 1993). In most formulations, a layering-shell element scheme was adopted in which the individual element is approximated as being in states of plane stress. While the response of plain and reinforced concrete under plane stress conditions was thoroughly investigated, the material models incorporated in these formulations were incomplete. The concrete models presented by Hu and Schnobrich (1990), and Polak and Vecchio (1993), for instance, overlooked the experimentally verified enhancement in compressive stiffness and strength of concrete under bi-axial compressive states of stress. As such, the application of these models is limited to concrete shell structures having a behaviour characterized by significant cracking of concrete.