NON-LINEAR BOND MODELLING FOR REINFORCED CONCRETE – A NEWLY MODIFIED BOND MODEL

M. Eltayeb Yousif

Abstract

Bond of reinforcing bars in concrete is known to affect the structural response of reinforced concrete structures in many ways. It plays an important role in concrete cracking behaviour (crack width/spacing) and tension stiffening. It also influences the anchorage of bars and the strength of lap spices and hence, controls the ultimate load-carrying capacity.

Many experimental and analytical attempts since the early seventies of the last century aimed to provide solutions to understand and predict the bond behaviour. On the analytical side many models were built and presented in the literature but, due to the complexities associated with bond behaviour, the majority of these models concentrated on a certain set of parameters, assumed to be the predominant ones, to facilitate the model building and reduce the time and resources required for reasonable solutions.

This thesis presents some modifications to a previously published bond model that is based on user-supplied subroutines and avoids the need for a predefined bond versus slip relation. The modifications introduce the coupling effect of the dilation on bond stress and of the slip on normal stress in the elastic stiffness matrix that controls the model structural response throughout the analysis. The new equations enhance the consistency of the original models by considering the variation of certain *newly-modified* model also removes some limitations related to reversed-cyclic loading like the inability of the previous models to detect the deterioration of the bond surface with increased number of cycles. A new way to update the hardening parameter called a "α *method*" is introduced to remove this limitation. The old setups kept the hardening parameter "κ" constant as long as the total amount of slip stays the

same regardless of the number of loading cycles within the past-slip boundaries, which does not correspond to reality.

The main conclusion, obtained from the results of many finite element models with different configurations and failure modes, was that the suggested modifications were on the whole though not always advantageous, particularly the coupling stiffness components and the α-method. They helped the *newly-modified* model to produce overall improved predictions of the experimental bond structural response that the previous setups.