Application of Strong Discontinuities on Reinforced Concrete Structure

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In this lecture, some recent results on the formulation and numerical implementation of the embedded strong discontinuity approach (ESDA) are summarized. The first part of the talk, is related to a three-dimensional methodology to model reinforced concrete members, using finite elements with ESDA. The concept of mixture theory is used to represent the reinforced concrete behavior (composite material), which is constituted by a matrix (plain concrete) and multiple long fibers (steel rebars) in differet directions. The composite material failure is determined by the discontinuous bifurcation analysis, in function of the eigen-values of the composite smoothing-acoustic tensor. In the second part of the lecture a novel approach to the transmission of the most predominant failure mechanisms from micro- to macroscale is presented. While in the bulk part, the fibre and the surrounding matrix are modelled by Elasto-Plastic models, the relevant failure modes such as fibre cracking and debonding are accounted for using traction separation laws. Since the fibres are relatively small, their mechanical fracture properties crucially depend on their geometry. For this reason a size effect study is proposed, in order to calibrate some fracture parameters. Finally the last part of the lecture is concerned with different crystal plasticity theories at finite strains. The proposed model accounts for dislocations through inelastic displacement jumps. Such jumps are embedded into the crystal plasticity model on the basis of the ESDA. The applicability of the ESDA as well as its numerical performance is illustrated by means of fully three-dimensional ultimate load analyses.

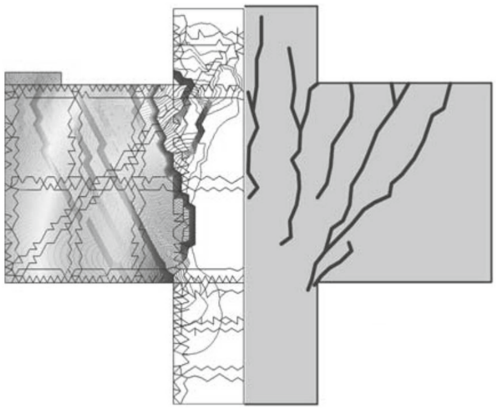

Figure 1: Multiple embedded cracks in reinforced concrete structure

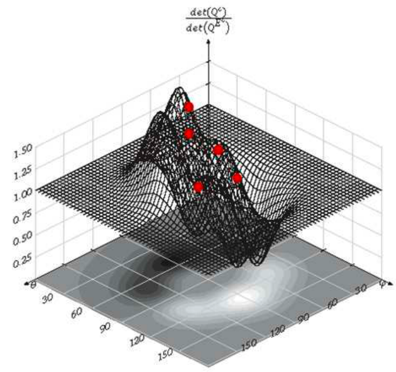

Figure 2: Bifurcation analysis by means of smoothing-acoustic tensor