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An interface model based on micromechanical analysis

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In many engineering problems, material nonlinear effects are localized in thin zones defined by narrow layers, where high strain gradients occur. The thickness of these layers is often so small that it can be neglected in a mathematical model, whereby the layer is replaced with an interface where displacement discontinuities can take place.

Several interface constitutive models have been developed in the literature to reproduce the mechanical behaviour of different physical problems. In particular, cohesive-zone models, able to simulate the gradual process in which the separation of the incipient crack is constrained by cohesive stresses, have been developed in the framework of the damage mechanics and of the plasticity theory.

A key aspect for many engineering applications of the cohesive-zone models is represented by the combination of the debonding process with friction, especially when interface models are applied for cementitious materials [1,2].

Aim of the present work is the development of a cohesive interface model which takes into account the damage-friction evolution, based on a micromechanical analysis. In particular, a representative volume element (RVE) is defined at the typical point of the interface. The RVE is characterized by the presence of microcracks which can evolve, can be open or closed and can develop frictional stresses.

In order to recover the interface model by means of the homogenization procedure, the RVE is considered subjected to the average relative displacement $\mathbf{s}$, i.e. to the average strain $\mathbf{E}$; it is required the determination of the overall average stress $\mathbf{\Sigma}$. To determine the solution, the problem is split in the superposition of three subproblems. In fact, the overall behavior of the RVE can be obtained as the superposition of the following three problems. The first problem considers the RVE subjected to a relative displacement, assuming that the relative displacement of the crack mouths $\mathbf{d}^e$ is not constrained in any way. In the second problem, the relative displacement $\mathbf{d}^c = -\mathbf{d}^e$ is prescribed between the crack mouths, while the overall relative displacement is enforced to be null. Finally, the third problem accounts for the presence of frictional stresses at the crack mouths.

The overall interface response is determined and numerical applications are developed.

REFERENCES

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