Numerical Simulation of Failure in Quasi-brittle Materials by a Novel Regularized Damage Model

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Abstract: In this talk, we will present a novel and effective computational approach in terms of continuum damage mechanics using low-order finite elements. The new smeared damage approach is termed as smoothing gradient-enhanced damage model, which is particularly suitable for localized failure problems in quasi-brittle materials (e.g., concrete, limestone). The present formulation is particularly tailored to low-order finite elements (e.g., Q4 or T3), targetting the practice purpose. In this model, the characteristic length is a stress level dependent parameter. The displacements and nonlocal equivalent strain fields are approximated in the framework of low-order finite elements, i.e., the same interpolation functions are used for both primary variables. A novel modified evolving gradient parameter is introduced, which heavily depends on the principal stress and equivalent strain states, serving to reduce the impact of localized deformation and controlling the behavior of damage microprocess during the entire loading history. Some other relevant aspects of the method will also be discussed. The spurious damaged zones and stress oscillation, two major drawbacks induced by the standard gradient damage models, can be overcome by the present method. They are discussed in the representative numerical examples in one- and two-dimensions with shear band analysis for quasi-brittle materials.

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