DUCTILE DAMAGE MODELING AT MICROLEVEL IN THE FRAME OF A TWO-SCALE APPROACH

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In recent years, modern structures are becoming more complex, and the requirements of their safety and reliability, represent an increasing challenge in the scientific community. The material load-carrying capacity is governed by the microstructural properties. Various microscopic degradation mechanisms such as micro-cracks and damage accumulation can result in loss of structural integrity, which can have catastrophic consequences. Therefore, the development of advanced numerical approaches in the field of material response modelling, especially at microlevel, has been continuously attracting the attention of researchers.

In this contribution, an approach for modelling of ductile damage evolution at microstructural level, represented by a representative sample of material named Representative Volume Element (RVE), is proposed. The nonlocal implicit ductile damage model derived in [1] together with the gradient-enhanced elastoplasticity is employed. The discretization has been performed by the mixed quadrilateral finite elements with the nonlocal equivalent plastic strain as the nodal degrees of freedom in addition to the displacement components. A new scale transition procedure between the micro- and macrolevel is derived, where besides usual homogenization of the stress and constitutive behaviour of a bulk material, particular attention is directed to the consistent upscaling of the damage evolution in the softening regime. To achieve the most realistic material response of the microstructure, the study of appropriate boundary conditions on the RVE is conducted. According to the multiscale computation technique [2], after solving of the RVE boundary value problem, all homogenized variables are mapped to the macrolevel, where they are embedded into the finite element formulation. The standard plane strain quadrilateral finite elements are used. All algorithms derived are implemented into the finite element software ABAQUS via user subroutines. The proposed computational model is verified by using several benchmark examples.

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