

On the modeling of highly localized deformations induced by material failure: The strong discontinuity approach

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Numerical analyses of large engineering structures undergoing highly localized deformations induced by material failure such as cracking in concrete or shear bands in soils still represent a challenge to the scientific community. In this paper, an efficient concept suitable for the analysis of those problems is presented. More precisely, an overview of the Strong Discontinuity Approach (SDA) is given. This specific approach is characterized by the incorporation of strong discontinuities, i.e. discontinuous displacement fields, into standard displacement-based finite elements by means of the Enhanced Assumed Strain (EAS) concept. The fundamentals of the SDA are illustrated and compared to those of other models based on discontinuous deformation mappings. The main part of this contribution deals with the numerical implementation of the SDA. Besides the original finite element formulation of the SDA, two more recently proposed algorithmic frameworks which avoid the use of the static condensation technique are presented. Both models result in a set of equations formally identical to that known from classical plasticity theory and, consequently, it can be solved by applying the return-mapping algorithm. Several recently suggested extensions of the SDA such as rotating surfaces of discontinuous displacements and intersecting discontinuities are discussed and investigated by means of finite element analyses. The applicability of the SDA as well as its numerical performance is illustrated by means of fully three-dimensional ultimate load analyses.