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MODELLING SOFTENING MATERIALS IN ENGINEERING PRACTICE USING FEM AND CRACK BAND METHOD

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Abstract. When finite element nonlinear analysis is applied to address the typical engineering problems such as ultimate load carrying capacity or serviceability limits such as deflections or crack width, a special care should be taken for the proper definition of the crack band namely in the presence of reinforcement. The pioneering work of Bažant and Oh (Materials and Structures, RILEM 16 (3): 155–177, (1983)) introduced the crack band approach to address the issue of proper energy dissipation in nonlinear finite element analysis of brittle materials such as for instance concrete. The method has become a standard approach in most commercial as well as scientific programs for advanced finite element modeling of concrete and reinforced concrete structures. Engineers often apply nonlinear analysis with crack band approach to solve practical engineering problems. This rapid development is also embraced by the development of new national and international design standards. For instance model fib Model Code 2010 introduced for the first time a comprehensive system for the treatment of safety and model uncertainty for structural assessment and design based on nonlinear analysis. The paper attempts to provide a comprehensive treatment of the problem, when very large or very small finite elements are used in nonlinear simulations of reinforced concrete structure based on smeared crack models and crack band method as described in more detail in Červenka and Papanikolaou (Int Journal of Plasticity, 24(2): 192-220 (2008)). The paper proposes three localization limiters for practical applications of nonlinear finite element model using the smeared crack approach and crack band method both for tension and compression. The application of these localization limiters is demonstrated and verified on several problems ranging from shear failure, bending behavior and compressive failure. It is demonstrated that the simple application of these limiters can increase the accuracy of finite element analysis even if very small or very large finite element sizes are used, which is often necessity in practice or research and development.

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