Comparison of different constitutive models for concrete in simple numerical tests

Michał Szczecina*, Andrzej Winnicki†

* Kielce University of Technology
Department of Civil Engineering and Architecture
al. Tysiąclecia Państwa Polskiego 7, 25-314
e-mail: michalsz@tu.kielce.pl

† Cracow University of Technology
Faculty of Civil Engineering
ul. Warszawska 24, 31-155 Kraków
Email: andrzej@hypatia.l5.pk.edu.pl

ABSTRACT

Constitutive models for concrete accounting for quasi-brittle behaviour in tension can be based on different theoretical formulations, e.g. plasticity, damage, smeared crack approach, discrete cracks [1-3]. Their FE implementations for continuous approaches can be equipped with different localisation limiters: gradient, integral, viscous or simply use crack band model. Material parameters for different models can be tailored in such a way that they will give very similar results for simple loading tests, e.g. uniaxial tension or simple shear. However, these models can produce surprisingly different results for the mixed-mode fracture [4-6].

The aim of the presented research is to compare two existing concrete models in the Abaqus software for the mixed-mode fracture: Concrete Damaged Plasticity and Concrete Smeared Cracking. Concrete Damaged Plasticity (CPD) model is a combination of plasticity theory and damage mechanics [3]. The model introduces damage parameters in tension in compression which are used to modify elastic stiffness. The plastic flow is assumed as nonassociated. Concrete Smeared Cracking (CSC) model is based on the classical theory of plasticity using strain rate decomposition, compression yield criterion, associated flow and isotropic hardening. A crack detection surface is used to determine the occurrence and orientation of cracks. The models are examined in the following tests:

- Willam's test – a tension-shear test performed at the point level on a single four-node element in two steps: uniaxial tension and then two-axial tension with additional shear strain [3],
- Nooru-Mohamed's test – a double-edge notched specimen under a combination of tension and shear [4,5],
- Schlangen's test – a single-edge notched concrete beam under four-point shear loading [6].

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