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A MIXED-MODE COHESIVE MODEL ACCOUNTING FOR SMALL TO LARGE OPENINGS TRANSITION

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A new mixed-mode cohesive model, able to handle the transition from small to large openings is presented. The proposed model is an extension of the isotropic damage model formulated in [1] for the simulation of mixed-mode delamination with variable mode-ratio, under the assumption of small relative displacements. While in the case of small openings the interface behaviour is governed by the interaction between normal and shear tractions, when large openings are involved, other phenomena, such as fiber bridging or interfacial fibrillation, affect the mechanical response, usually causing an increment in the fracture energy. Moreover, in the presence of large openings, the rotational equilibrium of the cohesive element may be not satisfied, as discussed in [2]. In this work, the small opening case is handled by means of a classical interface element, whose cohesive behaviour is however characterized by two forms of the traction-separation law, different in Mode I and II, to account for the fact that fiber bridging is promoted mainly by Mode I loading conditions: a classical bilinear law in Mode II and a trilinear law in Mode I. A fibril element, similar to the directional cohesive element considered in [3], is adopted to account for large openings, ensuring rotational equilibrium since the interface tractions and openings are co-linear. It is assumed that the transition from the small openings continuum model to the fibril one takes place in pure Mode I at the damage level corresponding to the change of slope in the softening branch. In mixed-mode, the transition is assumed to be triggered at a damage level increasing with the mode-ratio, whereas no transition can occur in Mode II. The insertion of the fibril element is smooth, with no discontinuities in the dissipated energy, nor in the transmitted cohesive tractions.

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