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Regularized sequentially linear saw-tooth softening model. (English) Zbl 1112.74476

Summary: After a brief discussion on crack models, it is demonstrated that cracking is often accompanied by snaps and jumps in the load-displacement response which complicate the analysis. This paper provides a solution by simplifying non-linear crack models into sequentially linear saw-tooth models, either saw-tooth tension-softening for unreinforced material or saw-tooth tension-stiffening for reinforced material. A linear analysis is performed, the most critical element is traced, the stiffness and strength of that element are reduced according to the saw-tooth curve, and the process is repeated. This approach circumvents the use of incremental-iterative procedures and negative stiffness moduli and is inherently stable. The main part of the paper is devoted to a regularization procedure that provides mesh-size objectivity of the saw-tooth model. The procedure is similar to the one commonly used in the smeared crack framework but, in addition, both the initial tensile strength and the ultimate strain are rescaled. In this way, the dissipated fracture energy is invariant with respect not only to the mesh size, but also to the number of saw-teeth adopted to discretize the softening branch.

Finally, the potential of the model for large-scale fracture analysis is demonstrated. A masonry façade subjected to tunnelling induced settlements is analysed. The very sharp snap-backs associated with brittle fracture of the façade automatically emerge with sequentially linear analysis, whereas non-linear analysis of the façade using smeared or discrete crack models shows substantial difficulties despite the use of arc-length schemes.

MSC:

74R05   Brittle damage

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sequentially linear analysis; mesh objectivity; regularization; saw-tooth softening; snap-back; fracture; quasi-brittle; masonry; concrete

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