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# FINITE STRAIN FRACTURE WITH INJECTED ANISOTROPIC SOFTENING ELEMENTS

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In the context of both plane and shell fracture problems, we introduce a new algorithm based on our previously proposed (e.g. [1, 2]) rotation of edges and the injection of continuum softening elements directly in the process region. This is a generalization of the classical smeared (or regularized) approach to fracture and can be seen as an intermediate approach between purely cohesive formulations and the smeared modeling. Characteristic lengths in softening are directly included as width of injected elements. For materials with process regions with macroscopic width, the proposed approach is more realistic than the cohesive zone model. This approach is combined with smoothing of complementarity conditions of the constitutive laws and the consistent updated Lagrangian method recently proposed, which simplifies the internal variable transfer. Propagation-wise, edge rotation around crack front nodes in surface discretizations and each rotated edge will be duplicated. Modified edge positions correspond to the predicted crack path (here the Ma-Sutton method). Regularized continuum softening elements are then introduced in the widened gap. The proposed solution has algorithmic and generality benefits with respect to XFEM. As with XFEM, no explicit crack is required, see Figure 1. The propagation algorithm is simpler and the approach is independent of the underlying element used for discretization. To illustrate the advantages of our approach, various yield functions providing particular cohesive behavior are used in testing. Traditional fracture benchmarks and newly proposed verification tests are solved. These were found to be very good in terms of load/deflection behavior.

## REFERENCES

[1] P. Areias and T. Rabczuk. Finite strain fracture of plates and shells with configurational forces and edge rotations. *Int J Numer Meth Eng*, 94:1099–1122, 2013.

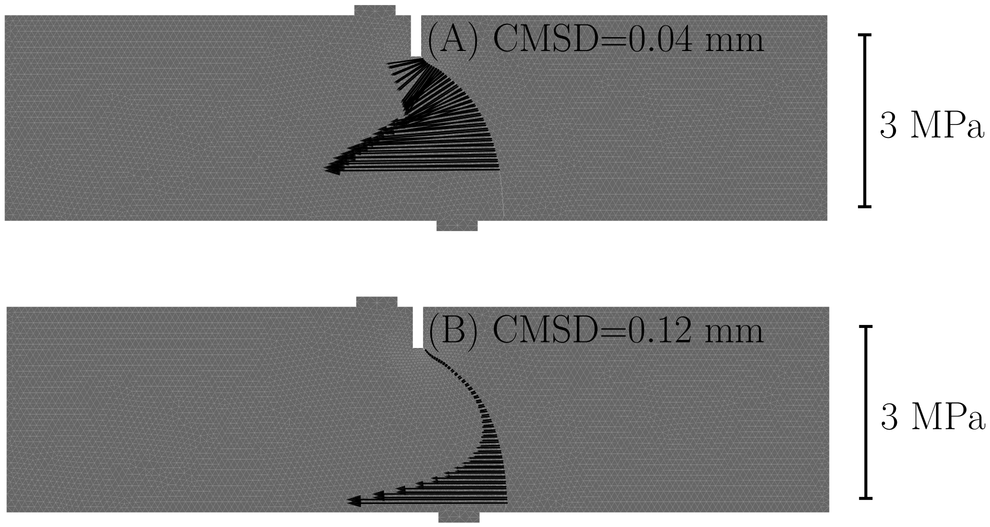


Figure 1: SEN specimen: cohesive vector tails for two distinct values of CMSD (A and B). No explicit crack is required.

[2] P. Areias, T. Rabczuk and D. Dias-da-Costa Element-wise fracture algorithm based on rotation of edges, *Eng Fract Mech*, 110:113–137, 2013.