The time-step choice in regularized damage model simulations

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The choice of the time-step in regularized damage models as phase-field or Lip-field is seldom discussed. There is however a great interest in looking at this issue because it reveals difficulties in the simulation of regularized damage models.

In the presentation, we will consider three kind of models : a two-spring system, a 1D bar and, finally, several 2D geometries. For each model, we will consider both the quasi-static model (massless) and the dynamic model version. Regarding dynamics, explicit as well as implicit schemes will be considered.

The following topics will be discussed : time-continuity of the solution, snap-back, convexity with respect to the time-step choice, accuracy of the numerical solution with respect to analytical one (when available).

Having understood the impact of the time-step choice, we will then propose an automatic adaptive scheme for the time-step in order to reduce the computational time while keeping a given accuracy. The adaptive scheme allows to shift from explicit to implicit time integration and vice versa.

References

[2] N. Moës and N. Chevaugeon, Lipschitz regularization for softening material models: the Lip-field approach, Comptes Rendus Mécanique 349 (2021) 415–434

[3] N. Chevaugeon and N. Moës, Lipschitz regularization for fracture: the Lip-field approach, Computer Methods in Applied Mechanics and Engineering 402 (2022) 115644.

[1] C. Miehe, F. Welschinger and H. Martina, Thermodynamically consistent phase-field models of fracture: Variational principles and multi-field FE implementations, International Journal for Numerical Methods in Engineering 83 (2010) 1273–1311.

[4] J.-Y. Wu, A unified phase-field theory for the mechanics of damage and quasi-brittle failure, Journal of the Mechanics and Physics of Solids 103 (2017) 72–99.

[5] L. Noels, L. Stainier, J.-P. Ponthot and J. Bonini, Determination automatique de la taille du pas de temps pour les schemas implicites en dynamique non lineaire, Mecanique et Industries, 3(2002) 63–77.