# Energy dissipation analysis in localized strain softening plasticity and damage models

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## ABSTRACT

The failure mechanisms in various materials are followed by the strain softening behavior. In this work we show how is the total input work introduced into the system by external loads converted to other energy forms. More precisely, we show how to compute amount of kinetic energy, strain energy, plastic free energy and dissipated energy in strain softening materials from softening plasticity and damage constitutive laws. The presented softening constitutive laws are implemented with embedded strong discontinuities so that no mesh dependence is observed in the failure patterns or energy dissipation analysis. Computation of energetic components and dissipation is presented with lattice model that is capable of representing complex failure mechanisms, multiple cracks branching or merging in statics or high speed dynamics [1, 2]. The proposed lattice model is based on Voronoi representation of the domain and cohesive links with enhanced kinematics including the Heaviside function for discontinuity representation.

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## REFERENCES

[1] Nikolic, M; Karavelic, E.; Ibrahimbegovic, A.; Miscevic, P. Lattice element models and their peculiarities. *Archives of Computational Methods in Engineering* (2018), **25 (3)**: 753-784

[2] Nikolic, M.; Do, XN; Ibrahimbegovic, A.; Nikolic, Z. Crack propagation in dynamics by embedded strong discontinuity approach: Enhanced solid versus discrete lattice model. *Computer Methods in Applied Mechanics and Engineering* (2018), **340**: 480-499