A UNIFIED MODEL FOR METAL FAILURE CAPTURING SHEAR BANDING AND FRACTURE

Haim Waisman

Department of Civil Engineering and Engineering Mechanics, Columbia University, New York, NY 10027,
waisman@civil.columbia.edu

Focus Material: Metals

Focus of the Presentation: *(i) Physics-based multi-scale model development;*

Abstract

Dynamic fracture of metals may be brittle or ductile depending on factors such as material properties, loading rate and specimen geometry. At high strain rates, a thermo plastic instability known as shear banding may occur, which typically precedes fracture. A thermodynamically consistent model which accounts for both shear banding and dynamic fracture and can thus capture both failure bodes at intermediate strain rates, is proposed. The model consists of an elastic-viscoplastic material with strain hardening, strain rate hardening, and thermal softening. Fracture is modeled with the phase field method, for which a novel modification is presented here to account for the creation of fracture surfaces by inelastic work.

In this presentation I will focus on model derivation, implementation and stability analysis to determine the onset of shear or fracture localization, based on a linear perturbation analysis. Numerical results will be presented to illustrate the predictive capabilities of the unified model and the stability criterion obtained.

References

[1] McAuliffe C. and Waisman H., 2015, "A unified model for metal failure capturing shear banding and fracture," International Journal of Plasticity, 65:131-151.

[2] McAuliffe C. and Waisman H., 2016, "A coupled phase field shear band model for Ductile-Brittle transition in notched plate impacts," Computer Methods in Applied Mechanics and Engineering, 305:173–195.

[2] Arriaga M., McAuliffe C. and Waisman H., 2015, "Onset of shear band localization by a local generalized eigenvalue analysis," Computer Methods in Applied Mechanics and Engineering, 289:179-208.