Reducing Mesh Dependence in UNTAH
Viscoplasticity and Non–local Plasticity

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Introduction
Simulations of Taylor impact tests on various materials at high temperatures (T > 0.5 Tm) and high strain rates (> 1000/s) show that there is considerable mesh dependence of the solution. We have also found that adding an artificial viscosity to the stress does not lead to any significant improvement in the results.

Viscoplastic stress update algorithms and non–local plasticity models have the potential of providing a solution to the problem of mesh dependence by introducing a physically motivated minimum length scale.

Thermo–viscoplastic model
Rate–dependent plasticity leads to the introduction of an implicit length scale (Needleman, 1988). We have chosen to implement the thermo–viscoplasticity computational model of Srikanth and Zabaras (1999) into UNTAH. This model takes into account most of the phenomena involved in a fire–container–explosive simulation.

Non–local Plasticity Model
An explicit way of introducing a length scale into the plasticity calculations is by using a non–local plasticity model. Various theories exist that use first– and higher–order gradients of the plastic strain and other measures.

The requirement of a boundary condition for the equation containing the gradients is difficult to implement in the material point method. We have decided to explore a nonlocal plasticity model (Acharya and Bassani, 2000) that is based on physical reasoning and does not require an extra boundary conditions for the parameter whose gradient is used as a measure of non–locality. The Acharya and Bassani non–local model fits directly into our current stress update scheme as shown below (Needleman, 2000).

Hardening rule
\[ g = h \left[ \frac{\partial y}{\partial s} \right] \]
\[ h = h \left[ \frac{\partial y}{\partial s} \right] \]

where
\[ s = 1 \]
\[ l = \text{intrinsic length scale} \]

Future Work: The implementation of viscoplastic and nonlocal models into UNTAH and comparisons with results from rate–independent models.

REFERENCES: