Micromechanics-based Determination of Effective Elastic Properties of Polymer Bonded Explosives
Biswajit Banerjee and Daniel O. Adams
Dept. of Mechanical Engineering, University of Utah, Salt Lake City, UT 84112

Abstract
Polymer bonded explosives are particulate composites containingclay-like particle and a low-density binder. The particles exhibit an extremely high fraction of the volume of the composite, often greater than 90% of the volume. In addition, the elastic module of the composite can be four orders of magnitude higher than that of the binder at room temperature and higher and low stress rates. Under these circumstances, rigorous micromechanics models and more conventional homogenization methods are inadequate. A different micromechanics technique can be used to identify volume fractions and modulus contrasts at which stress-bridging effects in polymer bonded explosives become significant.

Introduction
Mechanical properties of polymer bonded explosive (PBE) have traditionally been determined experimentally. The limitations of mechanical testing of these materials render experiments highly expensive. However, recent improvements in computational power, numerical determination of mechanical properties of PBEs become feasible. Micromechanics bridges the gap between mechanical properties of the constituent phases and the response of the composite at a macroscopic level. Mechanical behavior of a composite material. Elastic properties of a composite can be obtained using micromechanics-based models. The mechanical properties of the composite are obtained. RCM calculations were performed with blocks of 2 x 2 subcells and each subcell was divided into 256 x 256 four-noded elements.

Polymer Bonded Explosives
Polymer bonded explosives are particulate composites. The primary components of these composites are explosive particles, polymer binder, and a low-density binder. The volume fraction of the composite is typically around 90% of the total volume as shown in Table 1. The mechanical behavior of the binder is strain rate and temperature dependent. As a result, the response of the composite is strongly dependent on strain rate and temperature.

Micromechanics:

Table 1: Typical polymer bonded explosives [1, 2]

Table 2: Elastic moduli of HMX, RDX, and PBX 9501 [3, 4, 5, 6, 7, 8, 9].

Table 3: Experimental data for PBX 9501 [8].

Figure 3: DEM vs. FEM calculations for model PBX 9501 microstructures.

Figure 4: DEM vs. FEM calculations for model PBX 9501 microstructures.

Conclusions
1) RCM predictions are improved by increasing the number of finite element approximations.
2) Improved RCM predictions are obtained by increasing the number of finite element approximations.
3) FEM predictions are consistently higher than DEM predictions.
4) RCM predictions of Young’s modulus for the model microstructures were performed with 256 x 256 four-noded elements. Elastic properties of HMX and RDX have been determined using a recursive cells method (RCM). The RCM results converge to the experimental data with increasing subcell per block.

References