

## Compression Studies of Magneto-Rheological Fluid Filled Foams.

Suraj Deshmukh and G. H. McKinley

Massachusetts Institute of Technology, Department of Mechanical Engineering,  
Cambridge, MA 02139

The mechanical properties, namely stress-strain and energy absorption curves of fluid-filled elastomeric foams in compression have been studied. Flow of micron-sized magnetic particles of a MR fluid, inside the pores of reticulated foam, alters the mechanical properties and significantly improves the energy absorbing capacity through viscous dissipation. The energy absorbing capacity is found to increase by nearly 200% at relatively low strain rates and low magnetic field strengths. Further, it increases with increasing volume fraction of the fluid filling the elastomeric foams. The field-responsive nature of the MR fluids allows smart control of  $\sigma^*$ , the plateau stress, and hence the energy absorption. The extent of viscous dissipation is observed to increase with increasing strain rate. The yield stress of MR fluids has a strong dependence on magnetic field and hence, further enhancements in the dissipation are observed with increasing magnetic fields. A scaling approach is used to explain the observed alterations in the mechanical properties. Further, these properties are investigated for different types of fluids filling the foam, Newtonian and shear-thickening (dilatant). The foam was impregnated with corn-starch in glycerol/water, a shear-thickening fluid and its stress-strain characteristics are compared with glycerol impregnated foam. This shear-thickening fluid shows a sudden hundred to thousand times increase in viscosity at higher shear-rates and this effect is mirrored in the stress-strain characteristics of the filled foam. The dilatant fluid filled foam shows a lower  $\sigma^*$  initially but the stresses increase dramatically at higher strains. A comparison is drawn between the energy absorbing capacities of foam, filled with MR and other fluids and their potential applications in advanced automotive parts are discussed.