Aluminum metal-matrix composites (MMCs) are well positioned to replace steel in numerous manufactured structural components, due to their high strength-to-weight and stiffness ratios. For example, research is currently being conducted in the use of such materials in the construction of tank entry doors, which are currently made of steel and are dangerously heavy for military personnel to lift and close. However, the manufacture of aluminum MMCs is inefficient in many cases due to the loss of material through edge cracking during the hot rolling process which is applied to reduce thick billets of as-cast material to usable sheets.

In the current work, mechanical characterization and numerical modeling of as-cast aluminum A359-SiCp-30% is employed to determine the properties of the composite and identify their dependence on strain rate and temperature conditions. These efforts will allow manufacturers of the material to identify optimum conditions to produce rolled sheets having the desired properties with minimal loss of material through edge cracking. Tensile and torsion tests were performed at a variety of strain rates and temperatures. Data obtained from tensile tests were used to calibrate the parameters of a material model for the composite. The material model was implemented in the ANSYS finite element software suite, and simulations were performed to test the ability of the model to capture the mechanical response of the composite under simulated tension and torsion tests. A temperature- and strain rate-dependent damage model extended the constitutive model to capture the dependence of material failure on testing or service conditions.

Several trends in the mechanical response were identified through analysis of the dependence of experimentally-obtained material properties on temperature and strain rate. The numerical model was found to adequately capture strain rate and temperature dependence of the stress-strain curves in most cases. Ductility modeling allowed prediction of stress and strain conditions which would lead to rupture, as well as identification of areas of a solid model which are most likely to fail under a given set of environmental and load conditions.

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The public is welcome to attend.