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A New Device for High Strain Rate Fracture Testing under Tensile Loading

by

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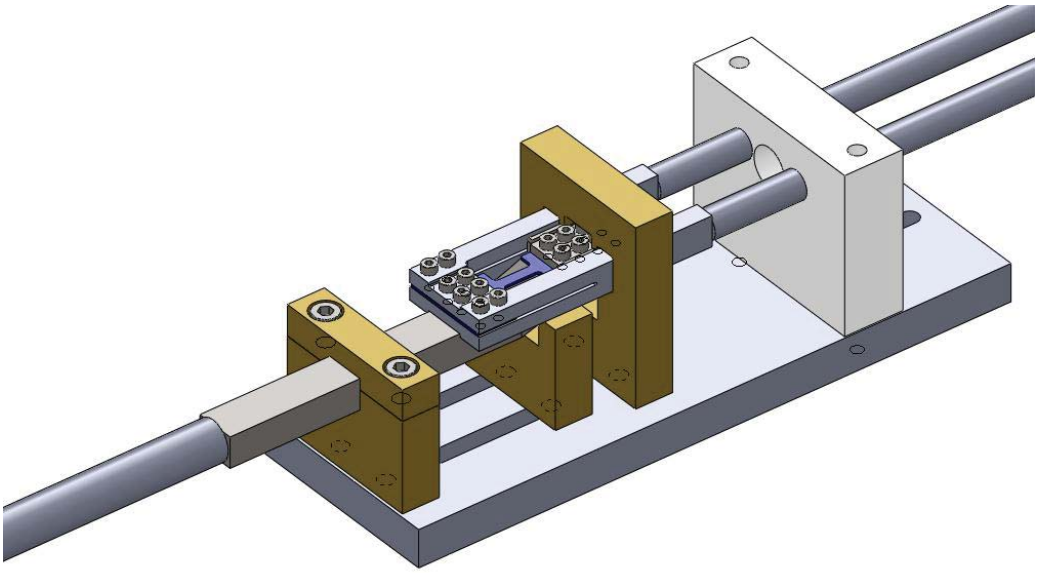

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Abstract

A new experimental technique has been developed for high strain rate fracture testing of sheet materials under tensile loading. A specifically designed device is inserted between the input and output bars of a modified Slip Hopkinson Pressure Bar system (SHPB), which reverses the compressive loading pulse generated in the SHPB and loads the specimen under tension. The modified SHPB features two output bars that are used to measure the force applied to the specimen gage section, while a high speed video camera takes pictures of the specimen gage section at about 100kHz to measure displacements and strains by Digital Image Correlation. The experimental procedure is validated numerically by means of Finite Element Simulations.

In addition to uniaxial experiments at different strain rates (from $10^{-3}s^{-1}$ to $10^{-3}s^{-1}$), tensile tests are performed on notched specimens on a TRIP780 steel sheet. Using a hybrid experimental-numerical approach, the stress and strain histories inside the specimens are determined up to the point of fracture. Experimental results show that the material initial yield is rate independent at low strain rates ($\dot{\varepsilon} < 10s^{-1}$) while the strain hardening behavior exhibits rate dependence over all the range of strain rates considered. Regardless of the stress state, it is found that the equivalent plastic strain at fracture is significantly increased at higher strain rates.

Keywords: strain rate, SHPB, tensile dynamic loading, AHSS, fracture.