Impact Strength and Failure Mechanisms of Spot Welds in Automotive Materials

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Abstract

The strength of resistance spot welds (RSW) was evaluated under varying loading directions and loading rates. In an effort to improve vehicle impact modeling, three automotive materials, aluminum alloys AA5754-O and AA6111-T4, and SAE1008 low carbon steel, were evaluated. Materials were welded in conditions similar to a production environment, including welding through the hot-dip galvanized coating on the SAE1008 steel, and mill coating and die-lubricant on the AA5754-O aluminum. Failure strength, in both energy absorbed and peak load, were measured for each material at quasi-static and two impact speeds, for three loading conditions. Cross-tension samples were used for tensile loading, modified lap-shear samples were used for shear loading, and lap-shear samples provided mixed-mode loading. The results showed significant rate dependence for the mild steel, and very little difference for the aluminum alloys. It was also observed that increasing impact speed did not have a linear relationship with the loading rate of the specimen at failure. Both the mechanics of failure and the fixturing used for tests contributed to this. Examination of the lap-shear specimens showed a change in failure mode with increasing impact speed, with shear becoming more dominant at the higher velocity.