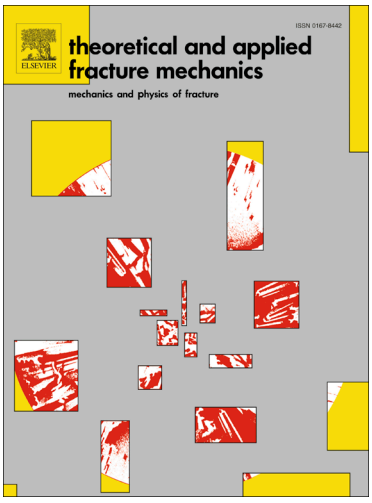

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Numerical estimation of the bearing capacity of resistance spot welds in martensitic boron steels using a J-integral fracture criterion

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Abstract

Predicting the bearing capacity of resistance spot welds (RSW) during vehicle crash tests has become a crucial task for the automotive industry, since the recent introduction of advanced high strength steels (AHSS) such as martensitic boron steels (e.g. 22MnB5). The spot weld joints of these steels exhibit relatively low bearing strengths, compared to those of more ductile high strength steels. Currently, the bearing capacity of spot weld joints is characterized through extensive experimental campaigns. In this article, a model for quantification of the bearing capacity of RSW using a finite-element J-integral fracture criterion is presented. The model takes into account geometric and mechanical features of the spot weld, namely the weld diameter and the mechanical properties distribution resulting from the welding process. An experimental loading test campaign is carried out for calibration and validation purposes, considering multiple sheet thickness combinations, loading angles and weld sizes. Experimental observations of the failed spot welds and preliminary simulations show that failure is caused mostly by stress concentration around the sharp weld notch. Consequently, the J-integral obtained from detailed finite element simulations is used to asses the stress/strain concentration along the first crack advance direction predicted by the acoustic tensor. The computed J-integral values are compared to the material toughness to obtain the joint's maximum force. The resulting simulated and experimental bearing capacities show a good agreement for all tested configurations.