Ductile Fracture Prediction with Forming Effects Mapping of Press Hardened Steels

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The escalating usage of Advanced High Strength and Press Hardened Steels to enhance crashworthiness while improving fuel efficiency through light-weighting of vehicles, has become a surmountable challenge to the auto industry. Furthermore, the expanded safety assessment like the IHS-Small Overlap crash test greatly intensify the need for an accurate and reliable fracture prediction model that will take into account the forming effects of the structural components, critical to the inherent load cases. In this study, a press hardened steel component of 1500 MPa ultimate tensile strength and 1.5mm gage thickness, is investigated under experimental and virtual three point bending load conditions. The simulations were conducted with no forming effects, and with thickness variation mapped from optically measured parts. The constitutive numerical model includes a phenomenological plasticity-damage model, formulated within the shell mechanics framework to encompass both the dilatational and plastic deviatoric energy terms. The model calibration was done with only two coupon level tests; uniaxial and plane strain. Excellent correlation of fracture mode and force-stroke curves were seen between experimental and numerical results that considered the thickness mapping of the press hardened component. On the contrary, the model that maintained uniform thickness failed to predict the correct fracture mode and overall response.