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On the investigation of experimental and numerical behaviour of spot-welded assemblies submitted to quasi-static and dynamic loadings

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When subjecting a metallic structure to an impact or a crash, two kinds of fracture can be seen to appear jointly: rupture initiated in the sheet and rupture located on the joint areas.

Depending on the type of transportation mean and materials used for the design of the vehicles, structures can be assembled either by rivets, spot-welds or weld beads.

To prevent the failure of these joints, which can lead to a complete and particularly brutal structural disarticulation, their behaviour must be studied.

The aims of this work are to measure the response of a spot-welded joint under quasi-static and dynamic loadings, to determine the load velocity influence on its behaviour, to understand how and where the failure starts and propagates in the assembly. Results will increase the representativeness of spot-weld models and failure criteria used to model assemblies in a macroscopic way.

Original tests, which make it possible to mix loading directions and to control the boundary conditions around the spot-weld and the deformation of the metal sheet, were developed and performed under quasi-static and dynamic loadings on an hydraulic jack in a range of velocities from 5mm/mn to 1m/s. A new device was also developed to test spot-welds in pure tensile direction on a Split Hopkinson Bar. This device uses SHB in a no-direct tensile testing configuration and a velocity of 13 m/s is reached. Load-displacement responses, failure mechanisms and topographies were obtained.

To complete experiments, a fine numerical model of the spot-weld was performed. The elastic-plastic properties of the HAZ were experimentally identified using some materials having undergone heat treatments. This model allows us to understand where the deformations are located, how the failure is initiated and how the cracks are propagated in the weld.