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Static and dynamic experimental response of anisotropic sheet metals

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Sheet metals are used in many industrial applications because of their formability and lightness, whereas advanced structural applications would also benefit from the maximization of two opposite features such as high resistance and high ductility (energy absorption). Due to the technological processes involved in the manufacturing of these materials, they often exhibit an anisotropic behavior, posing further issues for their mechanical characterization with respect to isotropic metals. The derivation of the effective true stress-true strain curve requires the experimental derivation of the evolving cross section which, during a tension test, is subjected to a mix of three shrinking modes superimposed to each other, respectively consisting of homothetical shrinking ("isotropic"change of size at constant shape), anisotropy-induced unsymmetrical shrinking (change of size at different rates along different directions), and localization-induced distortion (change of shape due to localizing strain). While the two former contributions are common to both round and flat specimens, the latter one is mostly enhanced in flat specimens with low values of the thickness-width ratio. This work presents a simple experimental methodology for determining the three contributions above, by using a single-camera video acquisition and a single frame of the failed cross section surfaces. The appropriate derivation of the evolving cross section delivers a steady accurate quantification of the anisotropy Lankford coefficient and a reliable effective true curve, both correctly applying also beyond necking onset and up to failure on a section-averaged basis.

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