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A new method for predicting advanced yield criteria input parameters from mechanical properties

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Abstract

Many advanced yield criteria have been developed in the last twenty years, but their use in forming simulations is still limited. In most simulations, the traditional Hill'48 model is still applied and this is understandable given that it is easy to use and does not require extensive test data. However, the Hill'48 criterion is too rigid to describe all stress states accurately, for this a more advanced model is needed. The drawback of such models is that they usually require data from an extensive range of laboratory tests.

In the sheet metal forming industry, the tensile test is the standard procedure with which the mechanical properties of sheet metals are measured. It is therefore desirable that the multiple parameters required for advanced yield criteria are also able to be derived from the mechanical properties from the tensile test, as for Hill'48.

In the work presented here, a correlation has been established between measured stress factor input parameters and the mechanical properties derived from the tensile test. Leading from this correlation, a new method is proposed to generate stress factors directly from simple mechanical properties. With this method it is possible to predict the biaxial, plane strain and shear points accurately using only tensile test data, notably tensile strength, uniform elongation and the plastic anisotropy *r*-value measured at 0°, 45° and 90° to the rolling direction.

Initially aimed at low carbon steels, the proposed method is shown to be applicable to stainless steel and aluminium alloys as well. The accuracy of the predicted stress factors has been verified by comparing simulation results with measurements of strain distribution, punch force, displacement and temperature. The comparisons of three strain paths on Nakazima specimens taken from a forming steel and a dual phase steel show a very good agreement between the measured and simulation results. Additionally, a series of cross die tests on eleven