Earing predictions using different associated and non-associated plasticity models

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Sheet metals generally exhibit a considerable anisotropy due to their crystallographic structure and preferred grain orientations resulting from the cold rolling process. The mechanical anisotropic characteristics have a considerable influence on the shape of the specimen after the deformation. Many successful phenomenological models have been proposed for use in Finite Element (FE) codes to simulate the anisotropic behavior of sheet metals.

In this paper, associated and non-associated flow models based on quadratic Hill's and Yld2000-2D are chosen to predict the earing profile in circular cup drawing of deep drawing steel DC06 and a highly textured aluminum alloy. A cup with six ears was observed for DC06 and the studied aluminum alloy.

Assuming the asscociated flow model of S-based Hill's 48, the yield stress function of DC06 resembles an isotropic yield function. On the contrary, tensile test results for this meterial reveal a highly anisotropic material due to variation of lankford coefficients along diferent orientations. A non-associated model can take the dissimilar yield and plastic potential functions into account independently. Therefore better earing prediction can be expected by non-associated flow formulation compared to its associated counterpart even when Hill's 48 is used. Note that quadratic Hill can predict only 4 ears. Finally, associated and non-associated Hill's 48 and YLD-2000D are used to simulate the earing profile and a comparison of the finite element simulations with experimental results is presented.