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A Mathematical Based Prediction of the Forming Limit of Thin-Walled Sheet Metals

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Abstract : Studying the sheet metals is one of the most important research areas in the field of metal forming due to their extensive applications in the aerospace industries. A useful method for determining the forming limit of these materials and consequently preventing the rupture of sheet metals during the forming process is the use of the forming limit curve (FLC). In addition to specifying the forming limit, this curve also delineates a boundary for the allowed values of strain in sheet metal forming; these characteristics of the FLC along with its accuracy of computation and wide range of applications have made this curve the basis of research in the present paper. This study presents a new model that not only agrees with the results obtained from the above mentioned theory, but also eliminates its shortcomings. In this theory, like in the M-K theory, a thin sheet with an inhomogeneity as a gradient thickness reduction with a sinusoidal function has been chosen and subjected to two-dimensional stress. Through analytical evaluation, ultimately, a governing differential equation has been obtained. The numerical solution of this equation for the range of positive strains (stretched region) yields the results that agree with the results obtained from M-K theory. Also the solution of this equation for the range of negative strains (tension region) completes the FLC curve. The findings obtained by applying this equation on two alloys with the hardening exponents of 0.4 and 0.24 indicate the validity of the presented equation.

Keywords : sheet metal, metal forming, forming limit curve (FLC), M-K theory
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