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Finite Element Analysis for Earing Prediction Incorporating the BBC2003 Material Model with Fully Implicit Integration Method: Derivation and Numerical Algorithm

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Abstract : In this research work, a sophisticated yield criterion known as BBC2003, capable of describing planar anisotropic behaviors of aluminum alloy sheets, was integrated into the commercial finite element code ABAQUS/Standard via a user subroutine. The complete formulation of the implementation process using a fully implicit integration scheme, i.e., the classic backward Euler method, is presented, and relevant aspects of the yield criterion are introduced. In order to solve nonlinear differential and algebraic equations, the line-search algorithm was adopted in the user-defined material subroutine (UMAT) to expand the convergence domain of the iterative Newton-Raphson method. The developed subroutine was used to simulate a challenging computational problem with complex stress states, i.e., deep drawing of an anisotropic aluminum alloy AA3105. The accuracy and stability of the developed subroutine were confirmed by comparing the numerically predicted earing and thickness variation profiles with the experimental results, which showed an excellent agreement between numerical and experimental earing and thickness profiles. The integration of the BBC2003 yield criterion into ABAQUS/Standard represents a significant contribution to the field of computational mechanics and provides a useful tool for analyzing the mechanical behavior of anisotropic materials subjected to complex loading conditions.

Keywords : BBC2003 yield function, plastic anisotropy, fully implicit integration scheme, line search algorithm, explicit and implicit integration schemes

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