©Journal of the Technical University – Sofia
Plovdiv branch, Bulgaria
"Fundamental Sciences and Applications" Vol. 19, 2013
International Conference Engineering, Technologies and System
TECHSYS 2013
BULGARIA

THREE-DIMENSIONAL UPPER BOUND AND FINITE ELEMENT SOLUTIONS FOR FORWARD EXTRUSION OF RHOMBOIDAL AND SQUARE SECTIONS FROM ROUND BILLETS THROUGH STREAMLINED DIES

ABDULKAREEM JALIL KADHIM, AHMED WALEED HUSSEIN

Abstract*: The increasing interest in the modeling of metal-forming processes in recent years has brought the development of different analytical and/or numerical technique. In this paper, upper bound and finite element solution are made for a steady-state three-dimensional extrusion of rhomboidal and square sections through a streamlined dies to predict the required power and to show the stresses and strains distribution in the die and billet through the extrusion process . A new method of die surface representation using blending function, and trigonometric relationships, is proposed by which smooth transitions of die contour from the die entrance to the die exit are obtained. The upper bound extrusion pressure is obtained based on derived a general velocity felid. The effects of area reduction, the optimum relative die length, the shape of stream function and frictional conditions are also discussed. The results are in a good agreement with that obtained by other research workers.*

Keywords: Upper bound method; Finite element; Simulation; Streamlined dies; Extrusion process.

1. Introduction:

Extrusion is a metalworking process, in which the raw material is forced through a die to produce long, straight, semi-finished metal products such as bars, solid and hollow sections, tubes, wires, and strips .Non-symmetric extrusion means that both the deformation process and outgoing product is unsymmetrical in shape about the central axis and mostly used to produce shaped sections in industry such as square sections, L-shape, T-shape U-shape. In extrusion, mechanical properties of the material, frictional condition at the tool–workpiece interface, extrusion ratio and die profile, are among the important parameters that significantly affect the desired characteristics of the product [1]. the optimization of these parameters has been one of the most important tasks attention of many researchers. Extrusion die profile can be conical or curved. In the past, due to the difficulty in manufacturing of non-conical dies, most of research works concerned upper bound method. Nowadays, by use of computer numerical control (CNC) machines, and therefore, the case of manufacture of complex die shapes, many pieces of research work have been performed on the optimization of curved die profiles. Chen and Ling [3] gave upper bound solutions to axisymmetric extrusion problems; they used three basic kinds of axisymmetric curved dies, namely, the cosine, elliptical and the hyperbolic types and transformation techniques used in order to achieve a mathematically consistent analysis. D.Y.Yang, C.M.Lee and J.H.Yoon [4] are used finite element method to extrude the shape function through curved dies. Lee et al. [5] designed the optimal die profile for hot rod extrusion that could yield more uniform microstructure. Nagpal and Altan [6] presented new die designs, which had curved surfaces and improved the upper bound on extrusion pressure. In fact, the shape of the die designed by theses authors was so good that it was