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Effects of Die Cross Section on Hollow Section Extrusion using Plasticine Experiment

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Abstract

In this study an attempt has been made to study the effect of geometrical processing parameters on tube extrusion using plasticine experiments. Three die cross sections viz Circular, Square and Triangular are accounted for this purpose. Effects of these geometrical parameters on extrusion load are critically examined.

Key-words: Extrusion; Flat die; Deformation; Tube; Plasticine

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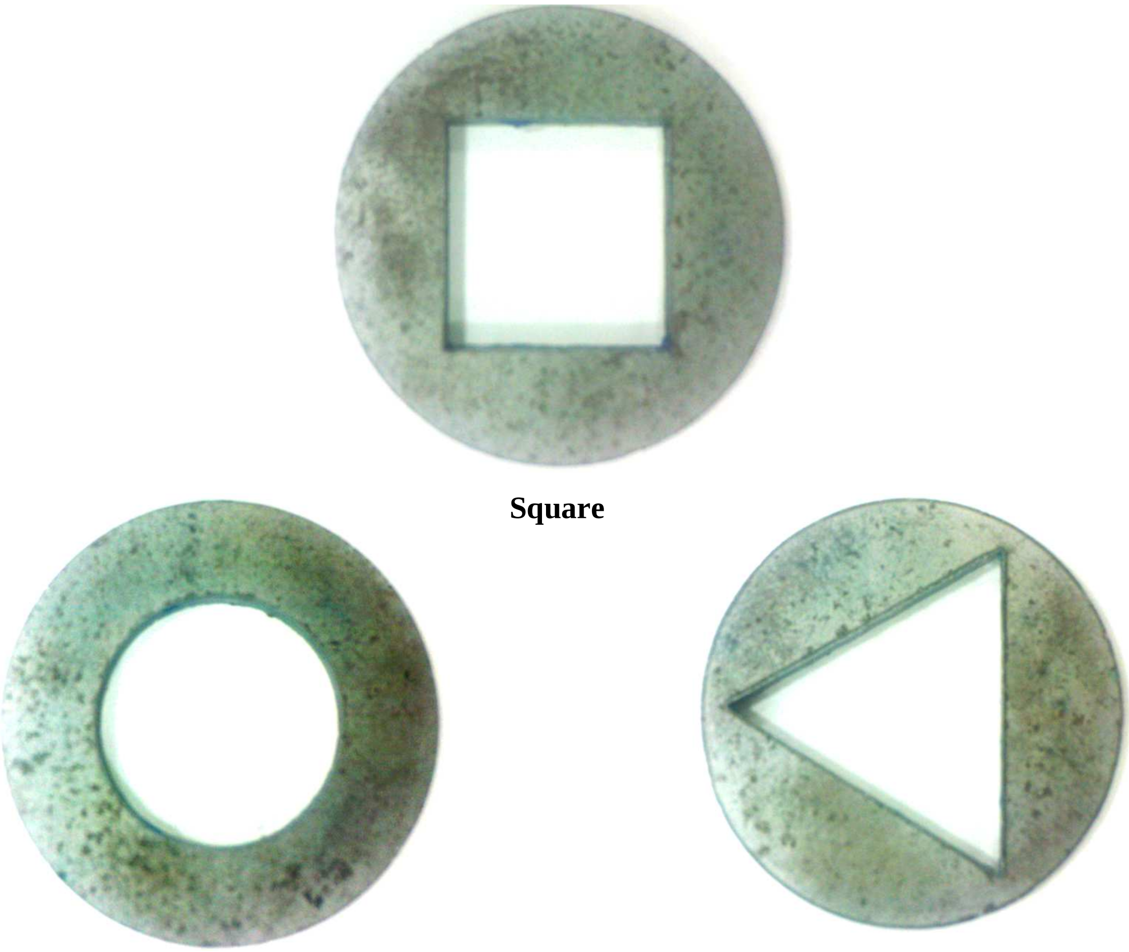
Introduction

Extrusion is the process of confining the metal in a closed cavity and then allowing it to flow from only one opening so that the metal will take the shape of the opening [1]. The operation is identical to the squeezing of toothpaste. Hollow sections are usually extruded by placing a pin or mandrel inside the die and in most cases positive pressure is applied to the internal cavities through the pin. Die geometry plays an important role on the quality of extrudate and the extrusion load. Extrusion process is generally analyzed using three approach i.e analytical, experimental, and computer simulation. Physical modeling materials like plasticine are preferred because their deformation behavior is similar to that of the hot metals. Some of the prominent metals forming studies using plasticine, reported in literature, are summarized below:

Altan et al [2] showed, in the analysis of friction in model experiments, how interface friction could be taken into account in model studies. Backward and forward extrusion loads were predicted from plasticine model experiments and the results were compared with data for various steels. The agreement between predicted and actual loads was generally well within engineering accuracy. Fereshteh-Saniee et al [3] employed a gravity-drop model hammer, designed based on the similarity laws, to carry out several ring tests at medium strain rates. Thirteen lubricants were employed to conduct the ring tests of the plasticine and lead specimens. It was shown that a full range of friction conditions, from nearly zero friction to sticking friction, could be modeled for the physical simulation of the bulk metal forming processes. Fox et al [4] used the plasticine strips which were rolled between cylindrical rollers to model the phenomenon of material transfer in metal rolling. The results confirmed the usefulness of plasticine as a suitable material to investigate the transfer layer formation in metal rolling, and helped in development of experimental procedures to study the evolution of real metal transfer layers. Green et al [5] compared the behavior of plasticine when permanently deformed with that of an ideal metal, and the necessary conditions for similarity between their flow patterns were examined for flow in two and three dimensions. The processes thus examined were: extrusion through square and wedge-shaped dies; indentation of a plane surface by a single wedge and by a row of wedges; and compression of a narrow wedge by a flat die. All these plane strain plasticine experimental results agreed well with theory. Manna et al. [6] reported the results of physical modeling study of the equal channel angular pressing process using two-colour constituent plasticine workpieces in a metallic die. The workpieces were made up of discs as well as spherical balls. The initial shape of the workpieces did not affect the final flow pattern of the microstructure. Material accumulation of the two colour constituents of plasticine was observed in some regions of the billet along the central region at a low and intermediate number of passes. Pertencea et al [7] studied forming process with emphasis on cold processing and its low heating energy input. Cold forming heightens the risk of material cracking, which is associated with the so-called “cold formability” of the metal. The possibility of using model materials in order to simulate the cracking behavior of real materials such as carbon steels was discussed. Hasan Sofuoglu [8] used a new technique to obtain true stress true strain curves for constant strain-rates. All of the experiments were conducted by utilizing non-metallic modeling materials, namely, plasticine. Different colors of plasticine were usually referred to as different types of materials. For the given deformation speed, true stresses and true strains were determined. Sofuoglu Hasan et al [9] simulated three dimensional extrusion process by utilizing physical modeling material and numerical method based on the finite element analysis. Conical dies were used in the extrusion process for both physical and numerical simulations. The study indicated that the extrusion load increases with increase in extrusion ratio and semi-cone die angle as it is theoretically supposed to be.

Fig. 1: Extrusion setup



Square

Circular **Triangular**

Fig. 2: Flat dies by means of different cross sections

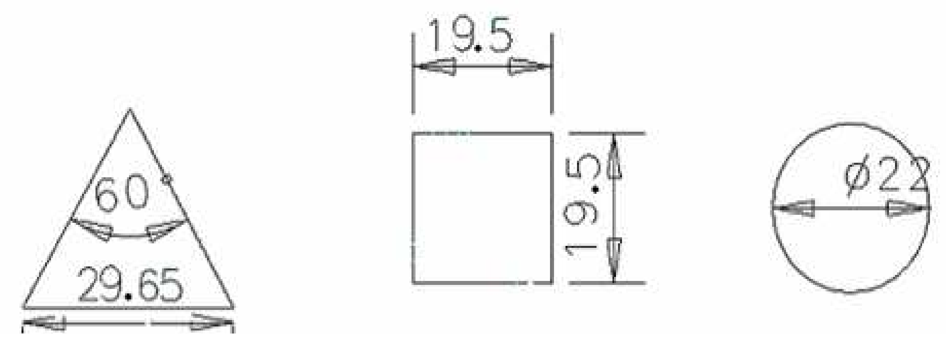
In this study effects of die cross section, on tube extrusion process are studied using plasticine material. Extrusion ratio is kept constant for the three dies (Circular, Square and Triangular). Effects of die sections are critically examined in terms of extrusion load and surface quality.

Extrusion Setup and Experiments

For extrusion experiments a computer controlled testing machine having load cell capacity of 100 kg, shown in Fig.1, has been used.

This is an electric control machine having variable ram speed. Load stroke records can be obtained from the inbuilt computer software and can be graphically plotted. A setup has been made to conduct direct extrusion using the modeling material, i.e. plasticine. The extrusion experiment setup consists of a cylindrical container which is made of steel alloy using the machining process. Three flat dies of different sections (Circular, Square, Triangular) are manufactured using machining. The dies are made of steel alloy. The top view of the three dies is shown in Fig.2.

The cross section area of all the dies is kept constant as 967.12 mm^2. Dimensions of different sections are shown in Fig.3. Mandrel is shown in Fig.4.



Triangular **Square** **Circular**

Fig. 3: Different sectional dimensions (mm)

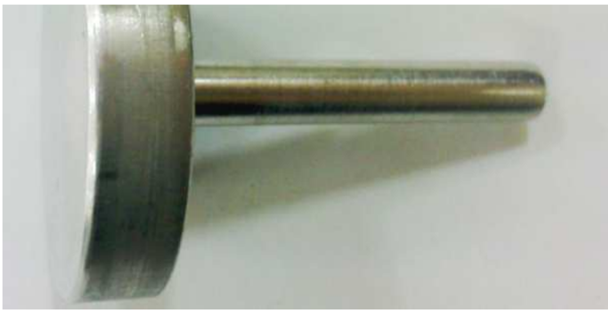


Fig. 4: Mandrel

The dimensions of the die and the container are as follows:

a) Inner diameter of the cylinder = 40 mm
b) Outer diameter of cylinder = 50 mm
c) Height of the container = 74.5 mm
d) Outer diameter of flat dies = 40 mm
e) Die thickness = 3 mm
f) Mandrel diameter = 6 mm for all cases

Container is made in male and female pieces sandwiching die in-between. The plasticine used in the extrusion experiments is prepared by hand kneading. The billet of the plasticine is prepared according to the shape and size of the container by hand moulding. Plasticine of blue colour is used in extrusion experiments. Extrusion speed is kept as 25 mm/min. Extrusion results are recorded in terms of load and extrudate surface quality.

Results and Discussions

Load stroke curve for different die sections are shown in Fig.5.

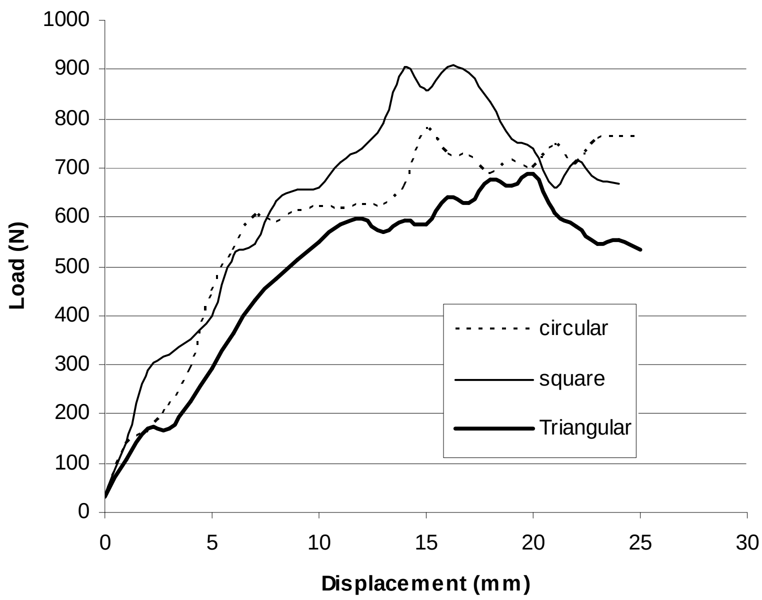


Fig. 5: Load stroke curve for blue (25 mm/min)

It can be observed that maximum and minimum load requirements are for square and triangular sections respectively. Percentage increase of load for circular and square dies with respect to triangular one are 13.05 and 31.78 % respectively. Photographs of extruded hollow sections from different dies are shown in Fig.6.

It can be observed that at the current extrusion speed of 25 mm/min, surface finish obtained is quite good for all extrudates. But corners of non circular sections are prone to crack due to non uniform flow of material. Corner imperfection is maximum in triangular die. Although load requirement is minimum, triangular cross section does not satisfy surface finish criteria. To overcome this deficiency, fillet may be provided at the corners. Base on such experiments using modeling material, efficient die section may be designed.

Fig.6: Extruded hollow sections for different dies

Conclusion

In this study effect of die geometry on hollow section extrusion is studied using plasticine material. Experimental results are critically examined in terms of extrusion load and surface finish. Following are the salient findings of this study:-

1. Maximum load requirement is for square section and minimum load requirement is for triangular sections.
2. Surface finish is best in case of circular and worst in case of triangular section die.
3. Fillet should be provided at the corners of the non circular dies for streamlined flow.

References

[1] G.E. Dieter, Mechanical metallurgy, McGraw Hill Book Company, London, **1988**.
[2] T. Altan, H.J. Henning, A.M. Sabroff, *J. Eng*, **1970**, Ind. 92, 444-452.
[3] F. Fereshteh- Saniee, I. Pillinger, P. Hartley, *Journal of Materials Processing Technology*, **2004**, 153–154, 151–156.
[4] M.N. Fox and M.P.F. Sutcliffe, *Wear*, **2008**, 264, *(1-2)*, 18-25.
[5] A.P. Green, Phil, Mafg, **1951**, 42, 365-373.
[6] R. Manna , Pulkit Agrawal, Sushant Joshi, Mudda K.Basavakumar, N.K. Mukhopadhyay. and G.V.S. Sastr, *Scripta Materialia*, **2005**, 53, *(12)*, 1357-1361.
[7] A.E.M. Pertencea., P.R. Cetlin, *Journal of Material Processing Technology*, **2000**, 103, *(3)*, 434-438.
[8] Hasan Sofuoglu, *Experimental Techniques*, **2003**, March /April.
[9] Hasan Sofuoglu and Hasan Gedikli, *Computational Material Science*, **2004**, 31, 113-124.