POLISH ACADEMY OF SCIENCES - COMMITTEE OF MATERIALS SCIENCE
SILESIAN UNIVERSITY OF TECHNOLOGY OF GLIWICE
INSTITUTE OF ENGINEERING MATERIALS AND BIOMATERIALS
ASSOCIATION OF ALUMNI OF SILESIAN UNIVERSITY OF TECHNOLOGY

Conference Proceedings

12th INTERNATIONAL SCIENTIFIC CONFERENCE
ACHIEVEMENTS IN MECHANICAL & MATERIALS ENGINEERING

Lateral extrusion for cross fittings with a lost core of low temperature melting alloy

T. Ohashi[a], H. Watari[b]

[a] Digital Manufacturing Research Center, National Institute of Advanced Industrial Science and Technology, 1-2 Namiki, Tsukuba, Ibaraki, Japan

[b] Oyama National College of Technology

The authors develop lateral extrusion with a lost core to perform cross fittings. Outline of the process is as follows: At first, cavity of pipe, or channel material, is filled up by liquid of low temperature melting material, for instances, low temperature melting alloy, ice (or water) and wax. Then low temperature melting material is solidified to be a soluble core of pipe. Authors call this soluble core the ‘lost core.’ The third, the material is compressed longitudinally as a composite billet, and extruded for lateral direction. After deformation, low temperature melting material is melted and removed. The process starts with longitudinal yielding of the pipe at first, after then, the material is extruded to lateral direction. For the cross fitting having large branch, wrinkles of extruded part because of cycled yielding. The author develops the process to apply fixed small counter punch for the branch.

1. INTRODUCTION

Recently, the bulge processes is taking an important part to make lightweight part structure. The problem of its slow forming speed is being solved, and its good characteristics, that its products are able to have under-cut profile and less the spring-back deformation, helps to extend its applications. However, the forming limit and the expensive dedicated forming machine for it is the barrier to take the process newly.

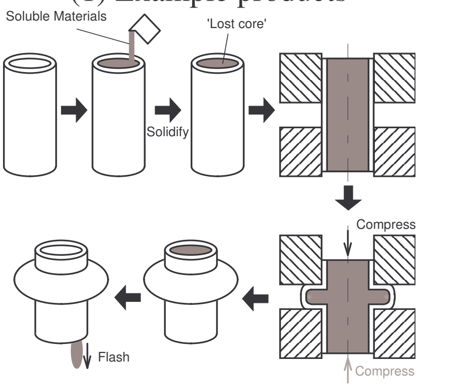
The authors have engaged in the study of forging of hollow parts with a lost core of low temperature melting materials (Fig.1). At first, cavity of pipe, or channel material, is filled up by liquid of low temperature melting material, for instances, low temperature melting alloy, ice (or water) and wax. Then low temperature melting material is solidified to be a soluble core of pipe. Authors call this soluble core the ‘lost core.’ The third, the material is forged to form the shape of a product. Two basic forging patterns are thought for this step, lateral extrusion and upsetting. In this paper, authors choose the former to discuss characteristics of the forging with a lost core because it is simpler and including basics to investigate the latter. After deformation, low temperature melting material is melted and removed. The deformation of the material is not performed by the internal pressure of lost core like –plain hydro-forming, but by extruded material flow mainly [1], so the process can obtain large bulged part easily.

In this paper, authors apply it on the making of cross fitting to find its forming limit, forming defects and its solutions.

2. EXPERIMENTAL CONDITIONS

The A6063S aluminium alloy extruded pipe is used for the experiment. The pipe is annealed at 415°C for 1.5 hours. The thickness is 1.5mm. The author marked at each 2mm for axial direction to track the change of the thickness. **Figure 2** shows dies for the experiment. **Figure 3** shows testing machine. The die set is parted in the two pieces horizontally. In the experiment, the die parts are clamped by the z-slide at 196 KN. Two horizontal slides, we call x-1 and x-2 slide, work in a time. We uses two die sets having different branch diameter; i.e. 10 mm and 16mm.

(1) Example products



(2) Schematic drawing of the process

Fig.1 Lateral extrusion with a lost core

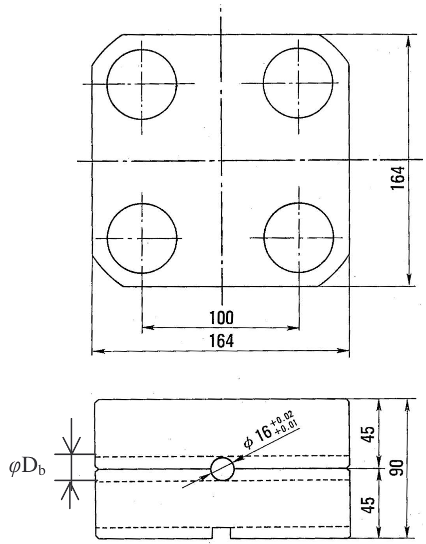


Fig.2 Die set

3. EXPERIMENTAL RESULTS AND DISCUSSIONS

3.1 Thickness distributions

The distribution of thickness of a typical specimen is shown in Fig.4**.** For ordinal hydro-forming, the thickness becomes thinner after forming generally. However, the thickness of the specimen keeps almost initial thickness and more at every measured point. It indicates the process is performed by compression state, and extruded volume does not come from the reduction of the thickness but extruded material form the die chamber. The thickness increases at the rim of the extruded branch, where the tube yields and begins deformation.

3.2 Wrinkles

Fig.5 shows the wrinkle of extruded branch part. If the cause of the wrinkle is the repeat of yielding, it is able to be avoided by reducing the axial height cross section of extruded branch, back support of the extruded part by some counter punch or pressure to prevent wrinkle, or extruding more lost core. Figure 6 shows the result of use of small fixed counter punch to reduce axial height of the extruded branch, support extruded part and help extruding more lost core. The wrinkle is not observed, however the outer diameter of the branch part is as same as the specimen in Fig.5(1). It is as well as for 10 mm diameter branch part.(See Fig.7)

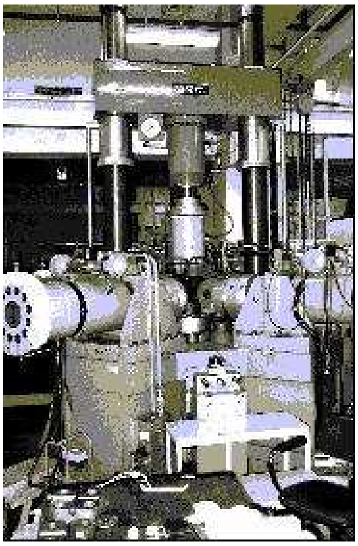


Fig.3 Five axis testing machine

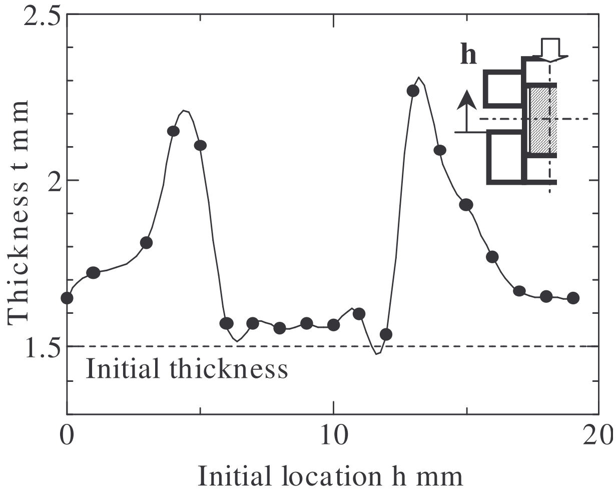


Fig.4 Thickness distribution of formed specimen (16mm diameter branch)

a) b)

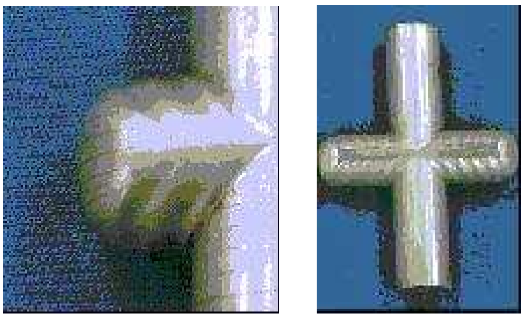


Fig.5 Wrinkle of extruded part, a) example of extruded part b) overview of the wrinkle

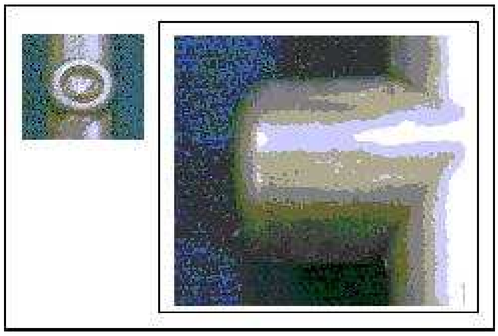


Fig.6 Effect of small fixed counter punch

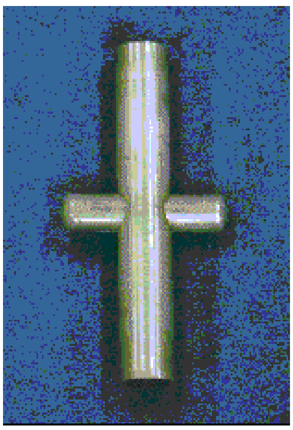


Fig.7 Result of 10 mm diameter branch part

Fig.8 Typical crack of the process

3.3 Crack

Typical crack is shown in Fig.8**.** The crack is caused at the center of cross. It is known that such the crack can be eliminated by jointing in the heat treatment in the case that the crack is very small[3]. However when the pipe repeats yielding, the crack is conveyed to lateral direction and too developed as Fig.8 to be eliminated.

4. CONCLUSIONS

In this paper, authors reports the lateral extrusion process with a lost core for cross fittings. The wrinkle at the extruded branch is observed when the height of extruded part is 16mm. It seems to be caused by repeat of the axial yield of the pipe. The authors confirm that it is not caused when it is 10mm height or the counter small punch is used.

ACKNOWLEDGEMENTS

Mr. Kazuhiro Yuguchi, and Mr are much appreciated to help us to perform the experiment.

REFERENCES

1. T. Ohashi and K. Shinozaki, Forging of Pipes with a Lost Core of Low Temperature Melting Alloy, Advanced.
2. T. Ohashi and K. Hayashi, Lateral Extrusion of A6063 Aluminum Alloys with a Lost Core, J. Mater. Proc. Tech., to be published.
3. K. Shinozaki, MEL report no.148, (1989).
4. JSTP, Tube Forming, (1992),CORONA Publishing Co.LTD.