IOP Conf. Series: Materials Science and Engineering **383** (2018) 012009 doi:10.1088/1757-899X/383/1/012009

Evaluation of the fine blanking tool for the precise clutch cam of automobile seat lifter pumping device

Jong-Deok Kim[1,*], Kil-Sang Yoon[1], Ok-Rae Kim[1] and Si-Tae Won[2]

[1]Dies & Molds Technology Group, Korea Institute of Industrial Technology, 156, Gaetbul-ro, Yeonsoo-gu, Incheon, 21999, Republic of Korea
[2]Department of Mechanical System Design Engineering, Seoul National University of Science and Technology, 232 Gongneung-ro, Nowon-gu, Seoul, 01811, Republic of Korea

*E-mail: jdk@kitech.re.kr

Abstract. In this paper, the multi-step forming process was studied with the fine blanking (FB) tool and the FB experiments for the precise clutch cam of automobile seat lifer pumping device (PCC). In order to form the PCC, the multi-step compound FB tooling system was taken; the three forces were directly gained from the rams of the FB press and the other force was gained from the auxiliary hydraulic device in the FB press. The FB tool was optimally designed through the FB simulation and fabricated. From the FB experiments with the FB press (Mori Iron Co., Ltd, FB400), the 5 samples of the PCC were taken and measured. All samples fulfilled the tolerance conditions.

1. Introduction

FB is a press working process which makes it possible to produce precise finished components with the clean cutting surface over the whole material thickness in a single stroke. Therefore the FB part has the advantages of the tight dimensional tolerances, no fractures and cracks in the shear surface, no secondary machining.

Generally, the FB process can be used with the conventional press working process in order to form the complex part with good shear surface and in the majority of cases, the progressive tooling system was taken because of good efficiency and productivity. But if the progressive tooling system was applied in case of forming the very precise part, it cannot be obtained because of the tolerance stack in relation to the material feeding. The Daesung Fine Tec. Co., Ltd. being one of the famous Korean companies in the field of fine blanking technology, had developed the forming of the PCC with the three stations progressive FB tooling system: the 1st station - the pilot piercing and semi piercing of diameter 9 mm, the 2nd station - semi piercing of diameter 14 mm, the 3rd station - FB of external form (referring to figure 1). But the total defective proportion was over 30% because of dimension error due to the tolerance stack. Therefore in this paper, the multi-step compound FB tooling system was applied in order to form the PCC as shown in figure 1. The three forces were directly gained from the rams of FB press and the other force was gained from the auxiliary hydraulic device (accumulator) in the FB press.

2. Optimal design of FB tool for PCC

2.1. Analysis of the PCC for FB

The PCC (Material: JIS SNCM220, Thickness: 5mm) was constituted of the web width 2.5 mm. It had the high difficulty rating for FB because the web width is small compared to its thickness [1]. Table 1 shows the mechanical properties of the material.

Table 1. Mechanical Properties of PCC Material (SNCM220).

Yield strength(MPa)	Tensile strength (MPa)	Elongation (%)
349	486.5	32.5

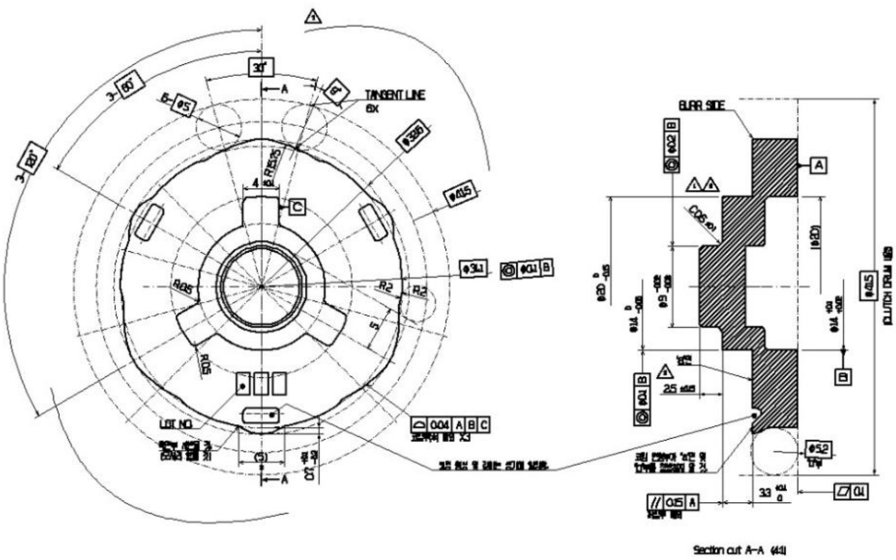

Figure 1. PCC drawing.

2.2. Design of FB tool

At first, the structure of the compound FB tool for the PCC was constructed and the strip layout was designed as shown in figure 2. And then FB forces were calculated according to Franz Birzer's formula [2]. The total forces were 214.92 tons. The FB press with more than 214.92 tons was required, 400 ton hydraulic FB press (Mori Iron Co., Ltd, FB400) was chosen for the FB experiment. The clearance between punch and die of the FB tool was decided to be 0.02mm according to external form [3].

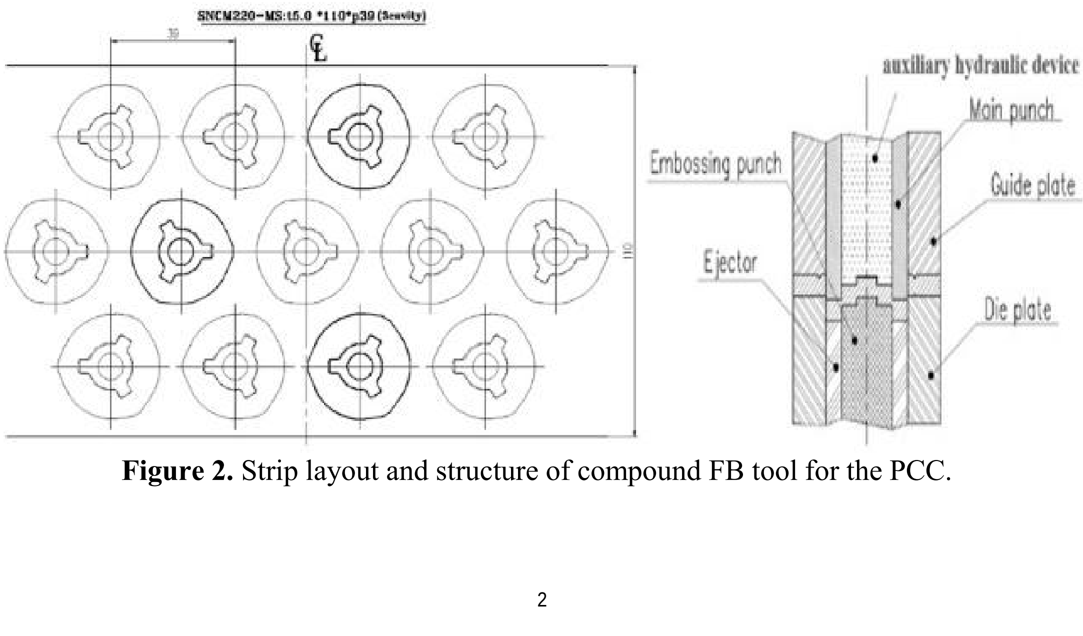

Figure 2. Strip layout and structure of compound FB tool for the PCC.

The V-ring of the FB tool clamps the material strip during the shearing process. It was only designed on the guide plate of the FB tool in order to save the tooling cost. Figure 3 shows the V-ring designed on the guide plate [4].

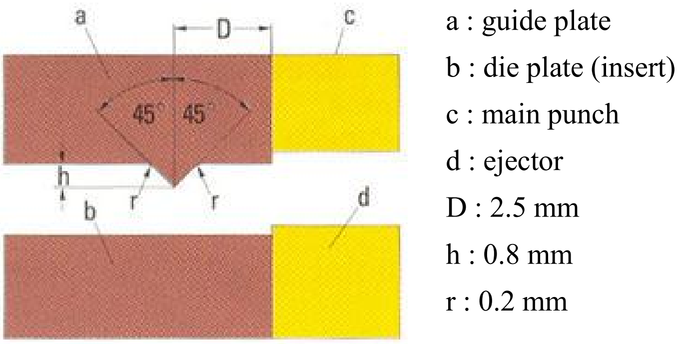

Figure 3. Shape of V-ring on the guide plate.

2.3. FB simulation

The FB simulation was conducted using the commercial FEA software Deform 3D in order to predict the fine blanked shear surface, the stress and strain distribution for the PCC. The simulation model was set to the 1/3 model in consideration of a part's symmetry.

The FB simulation was performed at each step as shown in figure 4. The clamping process by the V-ring indenter (1st step), the semi piercing process of diameter 9mm (2nd step), the semi piercing process of diameter 14mm (3rd step) and then the FB process of external form (4th step) were simulated step by step. Some parts of large deformation were set to locally make less mesh with the mesh window function of the software Deform 3D. The numbers of the mesh element were set to 288,985. The shear speed was set to 20mm/sec and the time increment was 0.001 seconds [5].

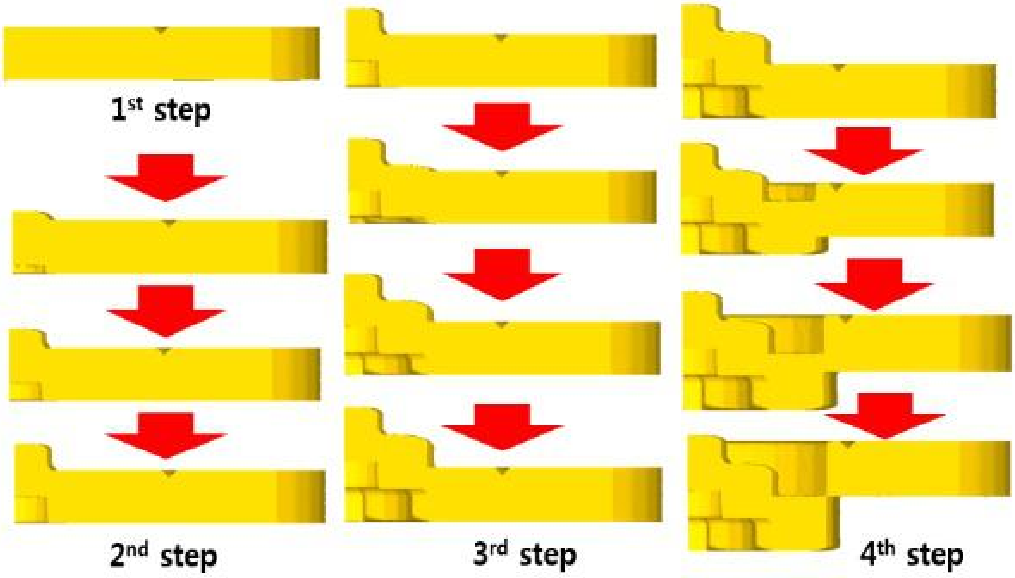

Figure 4. FB simulation procedure.

The shear surface of the PCC was estimated and then the stress distribution and the strain distribution on the PCC were predicted as shown in figure 5. The stress on the PCC was so evenly distributed in the shear surface (1,870MPa) without stress concentration.

3. FB experiments

The compound FB tool for the PCC was fabricated as shown in figure 6 and the FB experiments were performed on a 400 ton hydraulic FB press (Mori Iron Works Co., Ltd. FB 400, Japan). The conditions of the experiments were as follows; The shear force, the V-ring force, and the counter force were each set to 130 tons, 90 tons and 20 tons, respectively, while the shear speed was set to 20mm/sec. The samples from the FB experiments were obtained as shown in figure 7. Their geometric and dimensional accuracy and the surface quality satisfied the target as shown in Table 2.

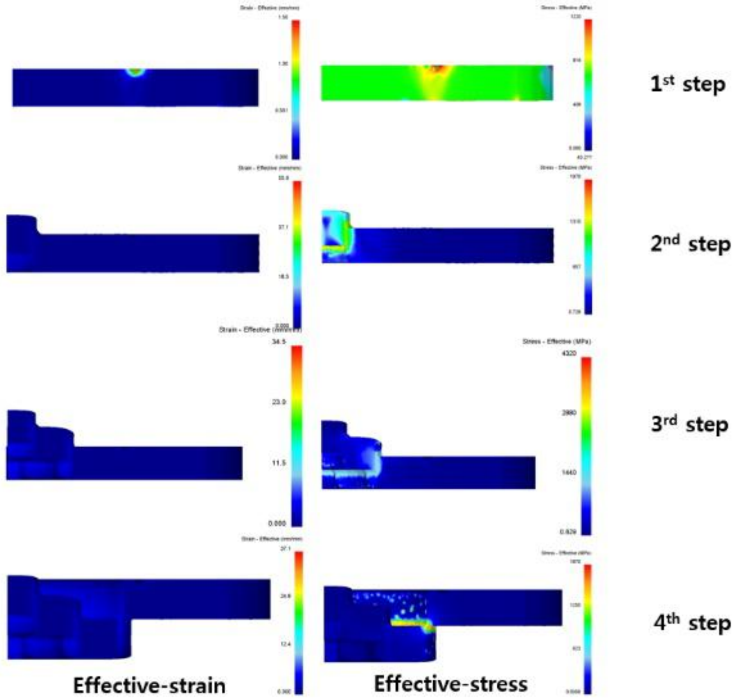

Figure 5. Distributions of the stress and strain on the PCC.

Figure 6. Fabricated compound fine blanking tool.

Figure 7. Samples from the FB experiments.

Table 2. Measured data of 5 samples.

items		target	Measured data
Rate of shear surface		80% ↑	92 %
External semi piercing (ø9)	dimensional tolerance	-0.02/-0.08 mm	8.966 mm
	roundness	0.2	0.013
External semi piercing (ø14)	dimensional tolerance	0/-0.06 mm	13.96 mm
	roundness	0.1	0.068
Height of semi piercing (2.5)	dimensional tolerance	± 0.15 mm	2.634 mm

4. Conclusions

In this study, the FB process for the PCC was evaluated by the simulations and the experiments. The following conclusions were obtained.

(1) The effective stresses on the PCC were uniformly distributed and there was no stress concentration.

(2) The PCC samples from the FB experiments had the shear surface with good quality and satisfied the geometric and dimensional accuracy of target.

References

[1] K. Lange, F. Birzer, P. Hoefel, A. Muhoty, H. Singer, Edelstahlwerke Buderus AG, Feintool AG Lyss, Hoesch Hohenlimburg GmbH, Kaltwaltzwerk Brockhaus GmbH 1997 *Cold forming and Fineblanking – A handbook on cold precessing, material properties, component design* pp 141-65.

[2] Franz Birzer 1997 Forming and fineblanking / cost-effective manufacture of accurate sheetmetal parts Landesberg/Lech, verlag moderne Indusrie

[3] W. Blatter 1991 Introduction into the technology fine blanking tools KAITECH

[4] Taylan Altan 1988 *Metal Forming Handbook* Shuler GmbH, Berlin, Heidelberg, New York, Springer-Verlag, Chapter 4

[5] Jong-Deok Kim, Heung-Kyu Kim, Young-Moo Heo, Sung-Ho Chang 2012 A study on the effect of V-ring position on the die roll height in fine blanking for special automobile seat recliner gear, *Advanced Materials Research* Vols. **383-390**, pp 7122-27