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Development of the Practical and Adaptive Die of Fixed Stripper Type for Marine Part Sheet Metal Working(part 1)

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Key Words : *Progressive die, Piercing, Clearance, Advance, Production part, Strip Process layout, FEM(Finite Element Method)*

Abstract : *The piercing and blanking of thin sheet metal working is specified division in press die design and making. In order to prevent the detects, the optimum design of the production part, strip process layout, die design, die making and try out etc. are necessary the analysis of effective factors. For example, theory and practice of metal shearing process and its phenomena, die structure, machine tool working for die making, die materials and its heat treatment, metal working in industrial and its know how etc. In this study, we analyzed whole of data base, theoretical back ground of metal working process, and then performed the progressive die tryout with the screw press. This study regards to the aim of small quantity of production part's press working.*

Part 1 of this study reveals with production part and strip process layout design.

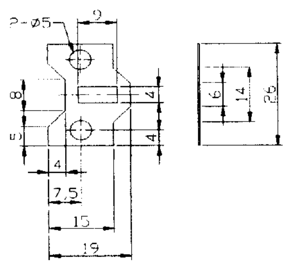
1. Introduction

The step die performs a series of fundamental sheet metal working in two or more stations(stages) during each press working for the adaptive die design and its making have been the aim chosen by strip process layout which includes in multi-stages.

The type of this paper used a part of products is shown in Fig. 1 from ordinary production in industrial.

Therefore, this study needs whole of press tool data, field experiences, and theoretical background.

According to upper instructions, this study could be obtained approaching the practical and adaptive die design.[1~3]



Unit : mm
Tolerance of dimension : ±0.1
Part thickness : 0.4mm
Material : BsP
Lot size : 10000

Fig.1 Production part drawing

2. Die Development System and Theoretical Back Ground

2.1 Die Developing System

Fig. 2 shows the die development system.

In this system, it can be known that the production engineering, die design technology, standardization, trouble shooting, man power, purchase, tool, material, etc. are connected with software and hardware. Hence, the die development must review the corresponded instructions of wide and deep technology and its theoretical background.

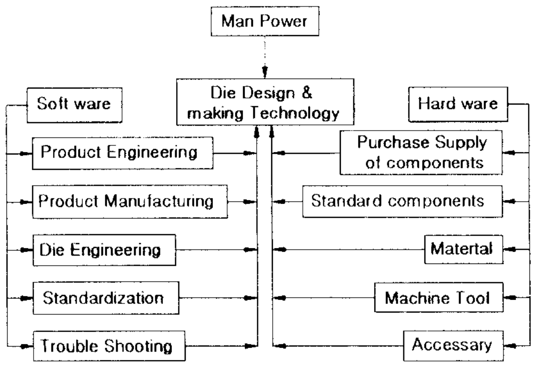


Fig.2 Flow chart of die developing system

2.2 Piercing and Blanking Force

The shearing force uses on the metal cutting process such as the force of the piercing, blanking, notching, side cutting, trimming etc. Following formula is foundation of its calculation.[4,5]

$$F_s = l \cdot t \cdot \tau \qquad (1)$$

where, F_s : shearing force

l : shearing length

t : material thickness

τ : shearing strength

2.3 Clearance, Relief Angle and Die Life

The clearance is affected from the production part accuracy, material, and thickness, etc. In the fine blanking, the clearance is selected less than 1 micron ordinarily. Fig. 3 shows the clearance, relief angle die life in piercing or blanking die. Relief angle is very important necessary for blank or slags getting out and die block making. It considered optimum condition that the blanks or slags are not received interference between material (strip) and die hole surface. The wasteless layout, and adaptive die design should be obtained from database.[3,4,5]

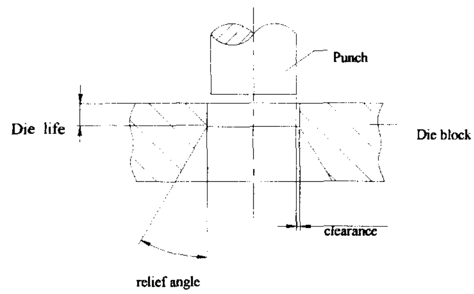


Fig. 3 Clearance, relief angle and die life

2.4 Strip Process Layout

Due to raising up the utilization ratio of material that is calculated by following formula.

$$\zeta_m = \frac{A}{P \times w} \times 100(\%) \qquad (2)$$

where, ζ_m : utilization ratio of material

A : part area

P : advance (pitch)

w : width of strip

When the adaptive ratio of utilization ratio is required, the minimum webs, side cutting allowance is considered, and then it can be calculated by formula, data base, field experiences. The step of strip layout is a part producing display on the strip. In this step, web, pilot, punch, roll direction of material, strip width etc.. should be considered and utilization ratio should be increased too. The web size is shown in Fig. 4. The decision of web size should be according to the data base. Table. 1 shows the web size in the case of less than 0.8mm material thickness.

Table 1 Ordinary web size

	Web size(A,B) (mm)	
strip width (W)	standard	minimum
0~25	1 t	0.8
25~75	1¼ t	1.2
75~150	1½ t	2.5

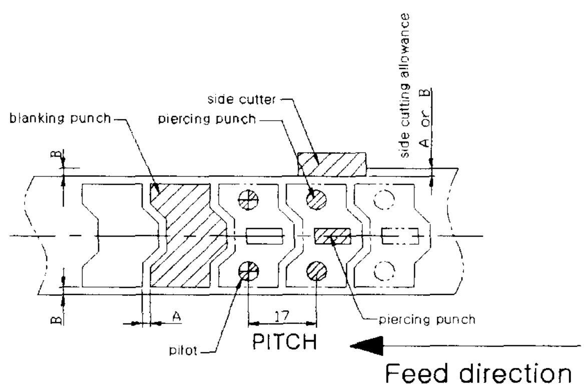


Fig.4 Web size on the strip process layout

2.5 Acting force on the component Material, Punch and Die

In this study, we used the ordinary machine tools, and we took the heat treatment. The die part tolerance is less than ±0.01 mm mostly. Force in the effect of tool edge activities, Fig. 5 shows the perpendicular force P_p, P_d on die surface, perpendicular and comparative bigger force than F_P, F_d. At this time, above half of every force is taken out to the zone of plastic deformation of material with a created hit activities.[6,7,8,9]

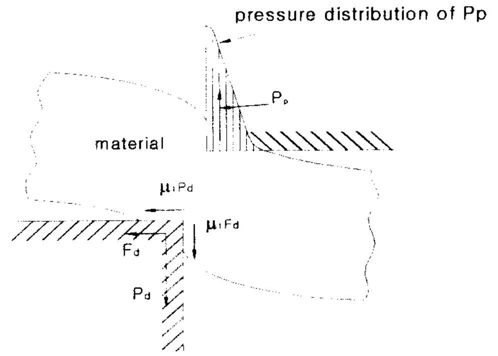
3. Die design

3.1 FEM Modeling

Due to the stress distribution must be investigated, we used the ANSYS program for the modeling by finite element method(FEM).[10]

Table 2 Shows the mechanical properties and condition of modeling. At this situation, the clearance was given five percent of material thickness.

In this modeling, the distortion of material is come from plane transformation problems except material width direction. In this process, the stress is created at the point of punch or die's cutting edge with largest one. At this point, in the view of Von Mises stress the satisfied within the stress condition of punch and die. As the those result, the production part of this study's experimental working could known nothing of problem or trouble.[10,11]



Vertical force : $P_d + \mu_2 F_d = P_d + \mu_2 F_p$

Horizontal force : $F_d(\pm)\mu 1 P_d = F_p(\pm)\mu_1 P_p$

Fig. 5 Acting force on the material, punch and die

Table 2 Material specifications

Element	STC 4	BsP	SKD 11
E(Kg/mm²)	21500	10060	62000
Poisson's ratio	0.3	0.33	0.27

As we can be known in Fig. 6(a)(b) according to the punch stroke progressing, the material receive the shearing deformation and then the fracture behavior of sheet metal is been occurring step by step internally between punch and die cutting edges. As we can be known, from Fig. 6(a)(b), in this procedure the stress created from inner site of punch and die materials, then it is connected to fracture situation. But in this study, we can find no problem of press tool working control.[12,13]

Fig. 6(b) shows the maximum stress area by vectors. In this vectors also that we can be known vectors of stress are progress between punch and die. The result of this simulation means the no problem of this experiment.

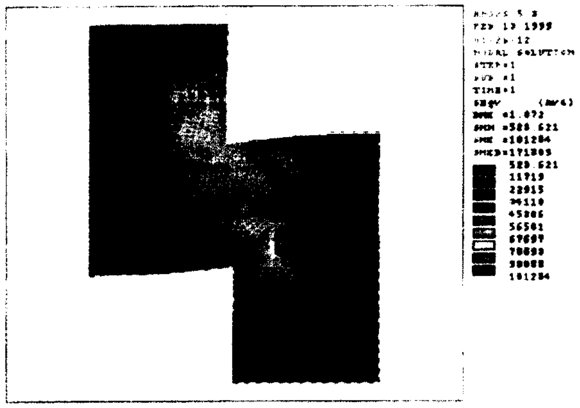


Fig. 6(a) Stress distribution in the punch and die[12]

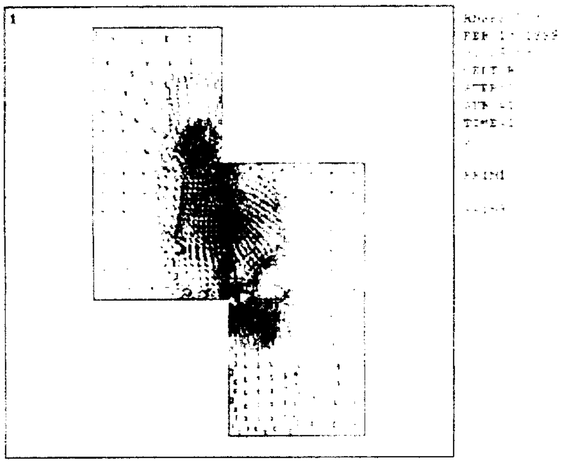


Fig.6(b) Vector location for results elements centroid in punch and die[12]

Fig.6 Simulation of punch and die block stress during press working by FEM

3.2 Shank Disposition

Shank disposition is decided by following equation.[11]

$$x_G = \frac{x_1P_1 + x_2P_2 + x_3P_3 + \ldots\ldots + x_nP_n}{P_1 + P_2 + P_3 + \ldots\ldots + P_n} \quad (3)$$

$$y_G = \frac{y_1P_1 + y_2P_2 + y_3P_3 + \ldots\ldots + y_nP_n}{P_1 + P_2 + P_3 + \ldots\ldots + P_n} \quad (4)$$

Where, $x_{1\ldots n}$, $y_{1\ldots n}$: distance from the each sectors center to die block edges with x and y direction

$P_{1\ldots n}$: punch loads each sectors

x_G : distance from shank center to die block edge as x direction

y_G : distance from shank center to die block edge as y direction

According to upper formula, the shank was located x_G, y_G mm from die assembling edge line.(sometime namely it's called as datum)

3.3 Strip Process Layout

The disposition of part is the display of the part with constant space repeatedly.

Due to upper cause, it must be enough to the decision of part feeding distance (advance, pitch) and position on angle of part on the strip be peformed exactly.

Tool designer's intention must consider that the best utilization ratio can be found the top of part arrangement. This is the adaptive method of initial die design.

Fig. 8 show the strip process layout design procedure. For the design of strip process layout, the first step is how to decide the feeding method which is according to the lot size of production part material properties, and material thickness, the second step is same with a such as flow chart of Fig. 8.

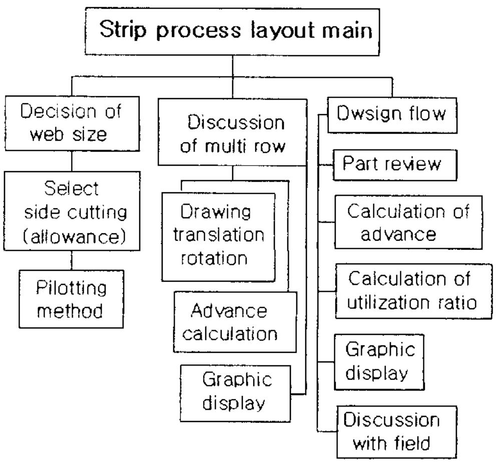


Fig. 8 Flow chart of strip process layout making procedure

From upper strip process layout designing procedure and experiences, we could decide the following strip process layout. The strip process layout was considered properly size which is strip width, web, advance(pitch), side cutting allowance etc. belonged.

Fig. 9 shows the strip process layout. In this layout, the layout followed the collected press tool data base and practical experiences.[12,13)]

Especially, as a strip process lay out of Fig.9. The pilot was shown second stage on the strip process layout. This pilot's function is satisfying after prepiercing in first stage. Therefore tolerance control of production part is expected efficiently.

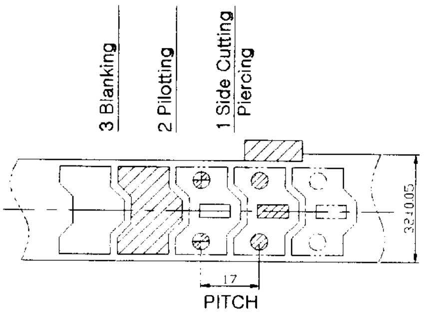


Fig.9 Strip process layout

4. Conclusion

Due to developing of progressive die used to press worked mass production part.

We studied die design and making through the fundamental background, database, tooling experiences and those relational system. T
he result of this study of real die design was obtained follows.

1. The development system of die design has effective function given to real die development result.
2. The adaptive and ordinary web size decision was available for the die design.
3. Whole weight of die center is become to shank disposition through the calculation also it is available to make the equalizing of die balanced weight.
4. It was effective method that FEM simulation performed to predesign for zero-defect of die design.

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