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Development of the Multi Stage Type Die for Thin Sheet Metal Working

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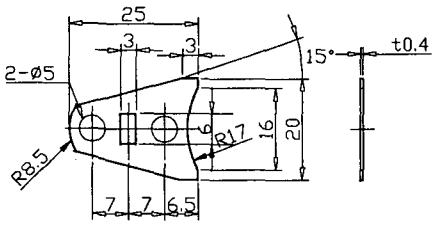
Abstract

The piercing and blanking of thin sheet metal working is specified division in press die design and making.
In order to prevent the defects, 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 it's phenomena, die structure, machine tool working for die making, die materials and it's heat treatment, metal working in field, their know how etc. are included in those factors. 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.

Key Words :Progressive die, Clearance, Strip process layout, Advance FEM(Finite Element Method), Tryout

1. Introduction

The progressive 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 it's making has been the aim chosen by strip process layout, which includes in multi-stages.
The type of this thesis used part of products is shown in Fig. 1 from ordinary product in industrial production line. 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 and making, and their theoretical confidences.[1~2)]



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

Fig. 1 Production part drawing

2. Theoretical Back Ground

Fig. 2 shows the die development system.
In this system, it can be known that the

production engineering, die making 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 it's theoretical background.

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

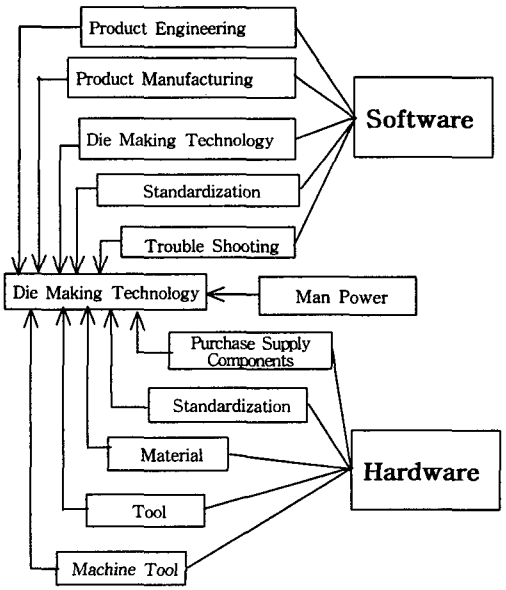


Fig. 2 Flow chart of die developing system

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.

Therefore, on the strip, the part dispose within the turning range from zero degree to one hundred eighty degree is better consideration.

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.

3.Die Design and Making

3.1 Strip Process Layout

Fig. 3 shows the strip process layout making procedure. For the design of strip process layout, the first step is how to decide the

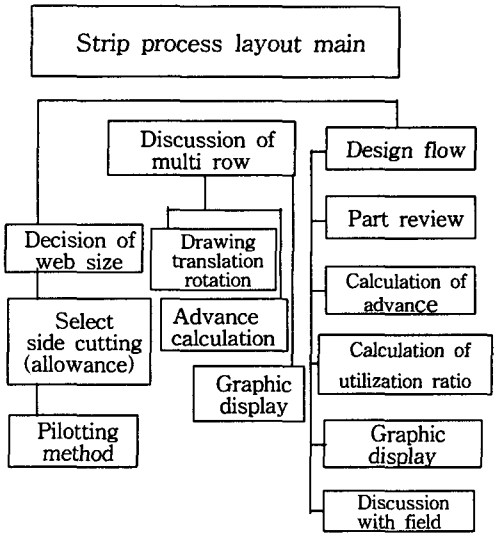


Fig. 3 Flow chart of strip process layout making procedure

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. 3. From upper blank 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. 4 shows the strip process layout. In this layout, the layout followed the collected press tool data base and practical experiences.[1~5)]

3.2 Die Set and Material of Die Components

There are several kinds of die set in data

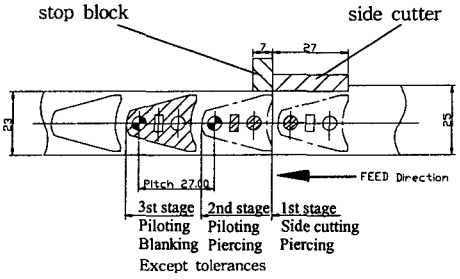


Fig. 4 Strip process layout

base according to the making industry regularly. Some time, in especially field they make special type die set for high precision die assembling function with steels.

In this study, We considered the hand feeding of strip that causes are mass production less than 10,000 lot size of production part and necessary of accurate production part. Hence, the guide post must be installed within die shoe allowance with the fine guide bushing fit.

It was selected that the die set is two guide post type for a precision working and high load of thick wide product in this experimental part.

The die component materials are followed to machine-ability, heat treatment and harden-ability, distortion, die component life upon a press working and cost site etc.

In this study, we considered that the die is used to less than 10000 pieces of lot size. Therefore, die components materials were selected mild steel SM20C mostly except die block and a kind of punches(SKD11).

3.3 FEM Analysis

Due to the stress distribution must be investigated, we used the NASTRAN program for the modelling by finite element method(FEM).

Table 1 Shows the mechanical properties and condition of modelling. At this situation, the clearance was given five percent of material thickness. In this modelling, the distortion of material is come from plane transformation problems except material width direction.

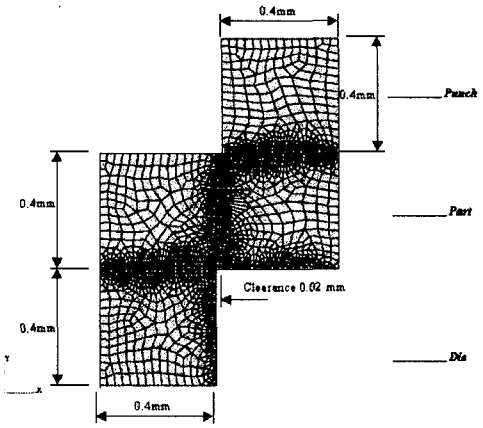
In this process, the stress is created at the point of punch or die's cutting edge with largest one. At this point, in the view of Von Mises stress the satisfied within the stress condition of punch and die.

As the those result, the production part of this study's experimental working could known nothing of problem or trouble.

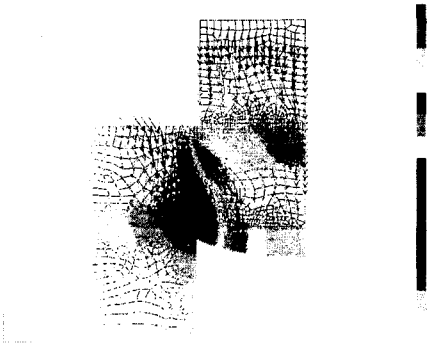
Table 1 Material specifications

Element	STC 4	BsP	SKD 11
E(Kg/mm^2)	21500	10060	62000
Poisson's ratio	0.3	0.33	0.27

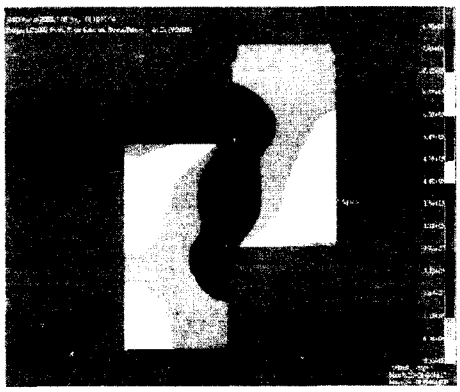
As we can be known in Fig. 5(a)(b)(c)(d) according to the punch stroke progressing, the material receive the shearing deformation and then the fracture behavior of sheet metal is occurring step by step internally between punch and die cutting edges. As we can be known, from Fig. 5(a)(b)(c)(d), in this 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. Especially, Fig.5(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.



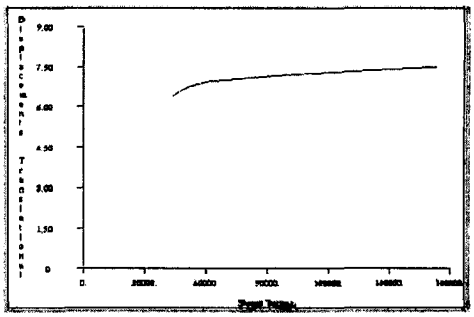
(a) FEM Diagram



(b) Load Spectrum by vector stress



(c) Stress Tensor Distribution



(d) Displacement vs. Stress tensor of distribution

Fig. 5 Result of FEM analysis by NASTRAN

3.4 Die Design

Fig. 6 shows the drawing of die design result. In this figure, we can find the best conditions of the die design database and tooling experiences in working.

Especially, the fixed stripping method is effective press working for low number of lot size less than 10.000 pieces through the side cutting and hand feeding operation. 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 with x direction

According to upper formula, the shank was located 6mm from die assembling center line.

3.5 Die Making

Fig. 7 shows the die making plan and process. In this figure, we can take to a notice that the whole of press die

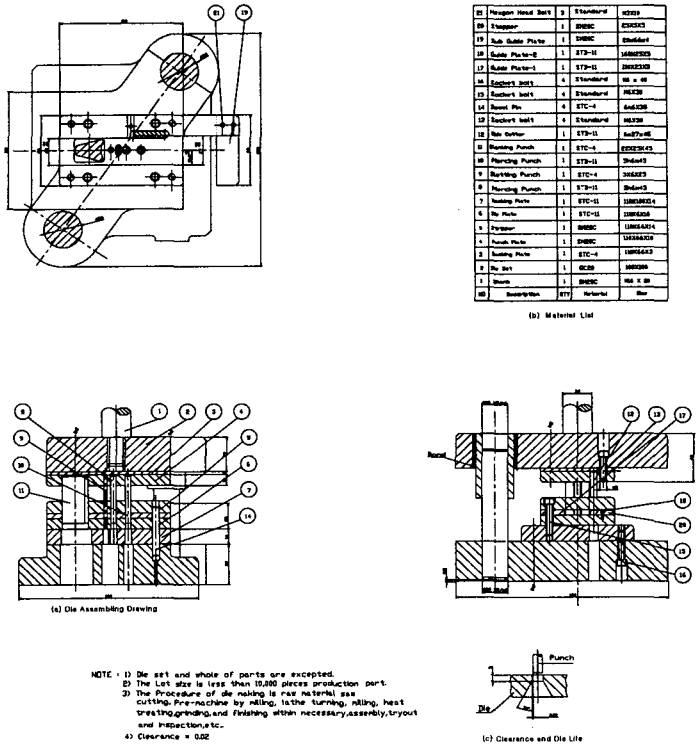


Fig. 6 Die Assembling Drawing

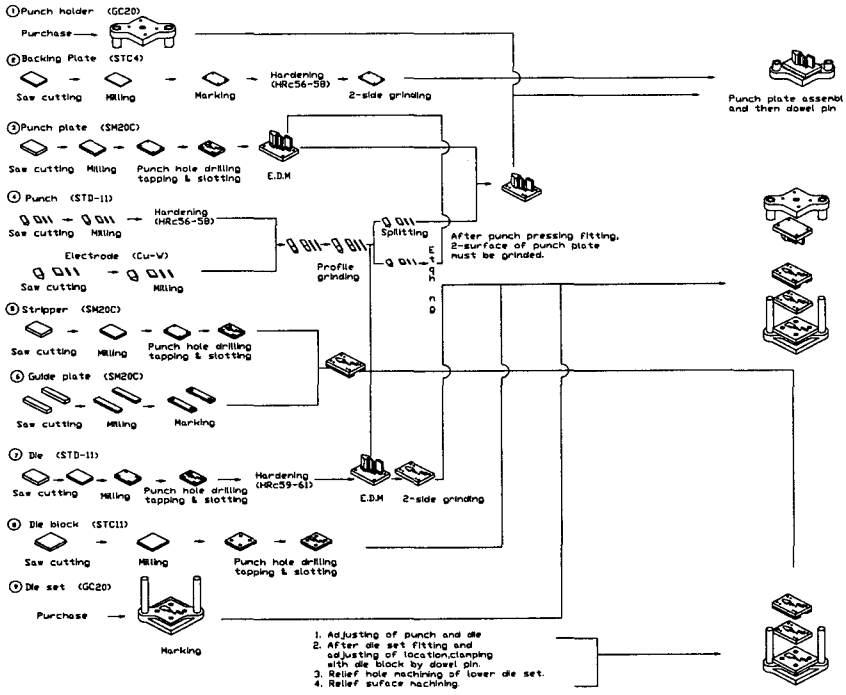


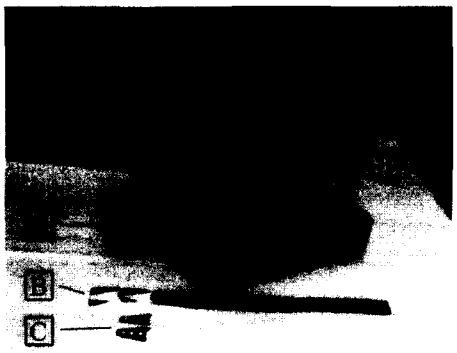
Fig. 7 Experimental die making process

components belong to the precision machine tool working, heat treatment and fitting skills.

4. Experimental Result and Consideration

Fig. 8 shows the result of process layout die components and assembly by photograph. In this figure, we can be known the practical and adaptive result of this experiment.

The production part through the die shoe was adaptive size with accurate tolerances by assembling function. In here, it is proved that the database and tooling experiences is are suitable outputting.



Ⓐ Experimental strip process layout
Ⓑ Die assembly and its components
Ⓒ Part of production by tryout

Fig. 8 Results of real strip process layout, die components and assembling.

5.Conclusion

In order to prevent defects of die development for thin sheet metal working (piercing and blanking). We studied die design and making through the database analysis, tooling experiences, and then we designed the die assembly and its components. The results and consideration of real die making and tryout was obtained the next conclusion.

1. It is effective result that the side cutting and fixed stripper type progressive for the less than 10,000 pieces of lot size.
2. Corresponding to the real press die tryout is no problem in the production part quality, the simulation of punch and die blocks' occurring stress during press working can be proved nevertheless outstanding on the site of strength exactly
3. The development of practical and adaptive die obtained by database and tooling experience, the saving of lead time could be obtained too.

Acknowledgement

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