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Development of The Multi Forming Type Progressive Die for Thin Sheet Metal

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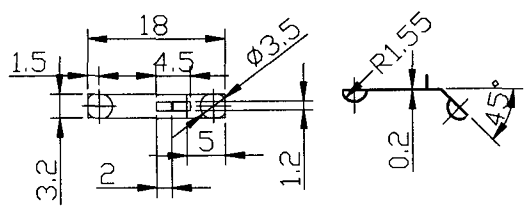
Abstract

This study reveals the thin sheet metal process with multi-forming die that the name is progressive die, as a pilotless type, also high precision production part is made. They require analysis of many kinds of important factors, i.e. theory and practice of metal press working and its phenomena, die structure, machining condition for die making, die material, heat treatment of die components, know-how and so on. In this study, we designed and constructed a multi-forming progressive die as a bending and drawing working of multi-stage and performed through the try out for thin sheet metal. Out of the characteristics of this paper that nothing might be ever seen before such as this type of research method on the all of processes of thin and high precision production part.

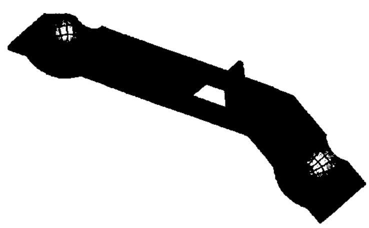
KEY WORDS
Pilotless type, Auto-feeding, Web size, Split die, Strip process layout, Tryout

1. Introduction

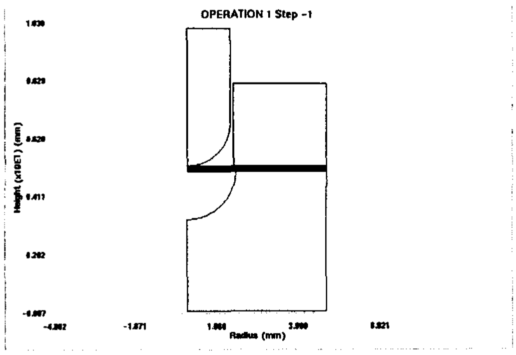
The progressive die with multi-stage performs a series of sheet metal working at two or more stages during each press stroke to produce a piece part as the material strip moves through the die tunnel with a front and back gage. Press working for the optimum die design and its making has been become the purpose of industry by strip process layout with multi-stages.[1,2)]
We used the part of high precision production part(Fig.1) in industrial production line.
So, this study needs a whole of press tool data, our field experiences, theoretical instructions, and ultra precision machine tool and its skillful operating and applications.
The add process of this work was performed FEM analysis by DEFORM. The result of this FEM analysis was very exactly that the output come to the figure ③,④ among ①~⑥ in Fig.1(c).
So we considered that the production working of embossing by one time operation.
According to upper knowledge, this study could approach to the optimum die design. Furthermore the aim of lower defect could be obtained mostly by revision on the tryout[1,2)].



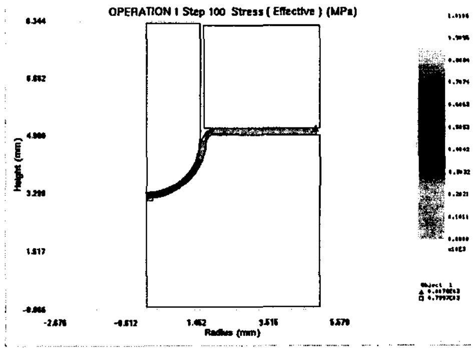
(a) Production part drawing



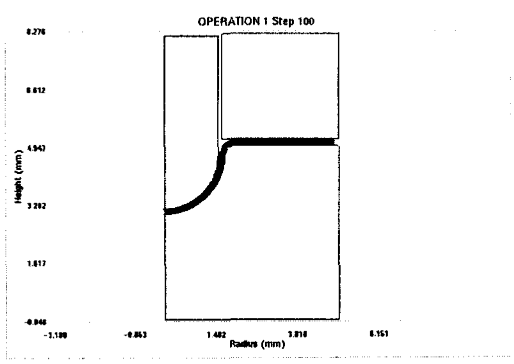
(b) Modelling of production part



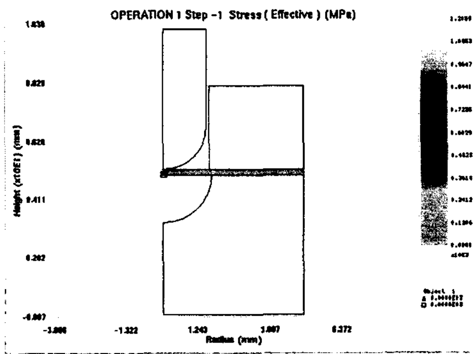
① Mesh system before deformation



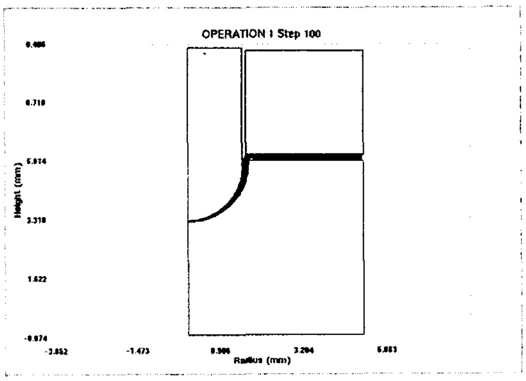
② Distribution of stress in the strip before deformation



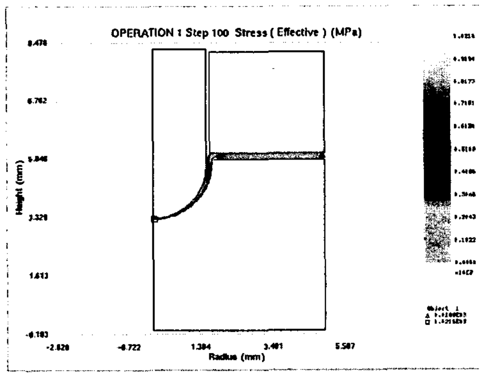
③ Mesh system after deformation



④ Distribution of stress in the strip after deformation



⑤ Mesh system when the problem of deformation



⑥ Distribution of stress in the strip when the problem of deformation

(c) FEM analysis result

Fig 1. Production part drawing and its analysis by I-DEAS and DEFORM

2. Die Design

2.1 Die Development System

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, corresponded instructions of wide and deep technology and it's theoretical background.[1~3)]

Fig.3 Shows the one of die components drawing by Auto CAD and Window Environment, namely pilot punch. The other die components were designed with as this method and experiences, but this paper not included in drawing.

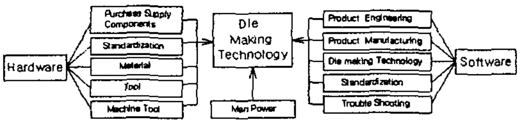


Fig.2 Network of the die developing system

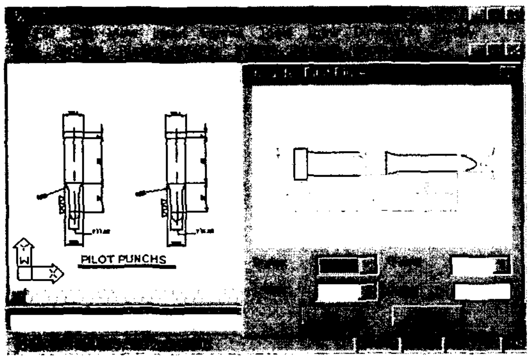


Fig.3 Die component drawing come from Auto-CAD and Window environment

2.2 Strip Process Layout

The disposition of part on strip feed unfolding is the display with constant area repeatedly. Due to upper cause, it must be enough that the decision of part feeding distance (advance, pitch) and disposition of part on the strip lay out must be peformed exactly.

Furthermore, on the strip, the part disposition within the turning range from zero degree to ninety degrees is better consideration. When the tool designer is going to consider his free intention, the zero to ninety degrees of turning range is unnecessary. Tool designer's intention must consider that the best utilization ratio can be found the top of part arrangement.

This is the optimum method of initial die design.[1, 5~6)]

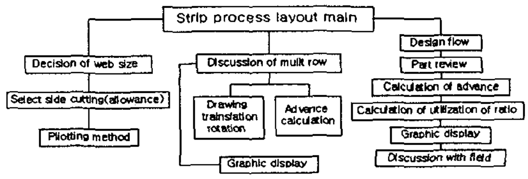
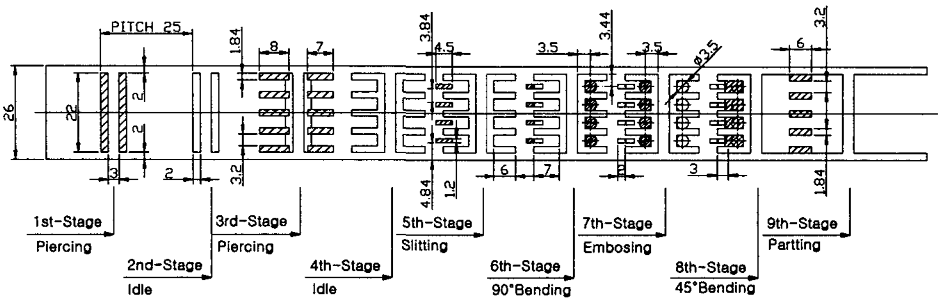


Fig.4 Flow chart of strip process layout design system

At this time we must refer the web size on the strip from database and experience too.

Fig. 4 shows the strip process layout design system. 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. 4.

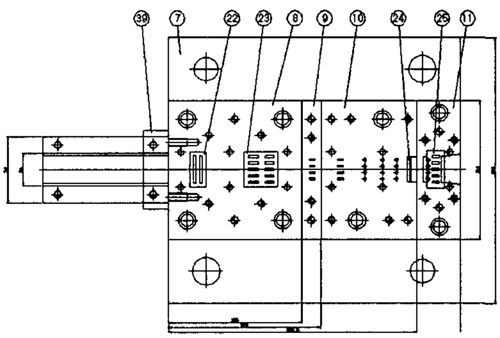
From the strip process layout designing method, the following strip process layout(see Fig.5) was designed the production part drawing. For the strip process layout it was considered that the proper sizes are strip width, web size, advance, side cutting allowance etc.. The first stage performs piecing, the second stage works idle, third stage works piercing, fourth stage works idle, fifth stage performs slitting, sixth stage works 90° bending, seventh stage works embossing, eighth stage works 45° bending, and the last of ninth stage works parting.



(a) Strip process layout

(b) The modelling result of strip process layout by IDEAS

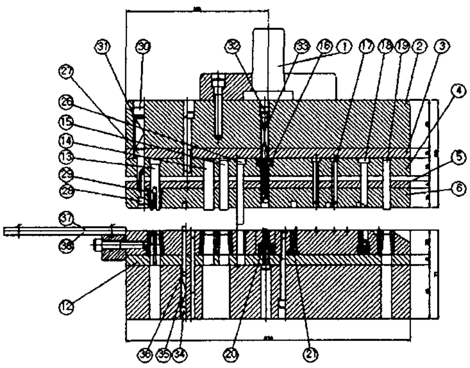
Fig. 5 Strip process layout



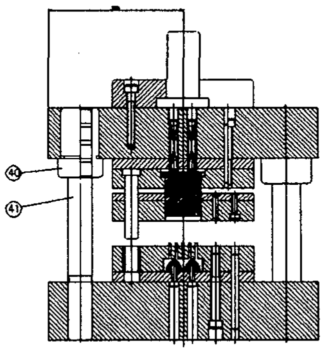
(a) Top view

NO	DESCRIPTION	SIZE	MAT'L	Q'TY	REMARK
41	GUIDE POST	Ø19×150	STC 4	4	
40	GUIDE BUSH	Ø35×55	STC 4	4	
39	STOCK GUIDE UNIT	20×60×21	SM45C	1	
38	STOCK GUIDE UNIT	52×100×3	SM45C	1	
37	STOCK GUIDE UNIT	15×100×3	SM45C	2	
36	LIFTER PIN	Ø7×40.5	STC 4	12	
35	WIRE SPRING	Ø7×40.58×45		12	
34	SET SCREW	M 9×5		12	
33	WIRE SPRING	Ø7×40.55×50		2	
32	SET SCREW	M 9×5		2	
31	WIRE SPRING	Ø7×40.516×40		10	
30	SET SCREW	M 10.6×8		10	
29	PUNCH GUIDE BUSH	12×25×16	STC 4	1	
28	BOLT	M8×25		16	
27	STRIPPER NUT	Ø8×32	STC 4	20	
26	INNER GUIDE POST	Ø10×56	V1	1	
25	DIE INSERT	14×30×20	V1	1	
24	DIE INSERT	85×20×20	V1	1	
23	DIE INSERT	27×20.5×30	V1	1	
22	DIE INSERT	14×30×20	V1	1	
21	BENDING PUNCH	18×9×23	STD11	1	
20	SLIT PUNCH	30×11×22	STD11	1	
19	PARTING PUNCH	8×3×43	STD11	4	
18	BENDING PUNCH	10×24×40	STD11	1	
17	EMBOSSING PUNCH	Ø6×38.5	STD11	8	
16	SLIT PUNCH	13×34×35	STD11	1	
15	PIERCING PUNCH	7×3×43	STD11	4	
14	PIERCING PUNCH	8×3×43	STD11	4	
13	PIERCING PUNCH	25×8×45	STD11	1	
12	BACKING PLATE	230×110×8	STD11	1	
11	PARTING DIE	43.5×30×20	STD11	1	
10	EMBOSSING DIE	75.5×110×20	STD11	1	
9	SLIT PUNCH HOLDER	15×110×20	SM45C	1	
8	PIERCING DIE	105×110×20	SM45C	1	
7	LOWER HOLDER	230×210×45	SM45C	1	
6	STRIPPER PLATE	230×110×16	SM45C	1	
5	BACKING PLATE	230×110×6	STD11	1	
4	PUNCH PLATE	230×110×25	STD11	1	
3	BACKING PLATE	230×110×8	STC 4	1	
2	UPPER HOLDER	230×210×40	SM45C	1	
1	SHANK	Ø40×60	SM45C	1	

(d) Material list



(b) Front view



(c) Side view

Fig 6. Die assembling drawing

In here, the pilot works to take a stability of strip feed and its location, also the idle stage has function of die allowable space and tr̊oble shooting of die.

Fig 6. shows the die assembling drawing.

In this die design result, the most important die mechanism factor is inserted system of die construction due to be long time of die life with tungsten carbide materials.

3. Die Making and Tryout

3.1 Die Making

Punch and die block is main part in die making. In this study, we decided the size of punch and die block depending on data base, theoretical background and our own field experiences. The machining of punch and die block belong to the precision machine tool working, continually raw material cutting, milling, turning, drilling, shaping, profiling, and then heat treating, electronic discharge machining (EDM,, Wire-Cut), jig grinding, especially, CNC machining

In this study, we used ordinary machine tools, CNC machine tools and EDM etc..[6, 7)]

On the accuracy of the each fitting components, namely, with combination of the following tolerance, the first is guide bush and guide post(outer or inner) tolerance H7(hole) h6(shaft) and the die set and guide post tolerance are H7(hole) p5(shaft) for a tight fitting. Punch plate and punch tolerance are H7(hole) m6(shaft) for a tight fitting with minor interference. The second is stripper and the punch tolerance is H7(hole) h6(shaft) too. Die inserting hole and die insert button are H7(hole) m6(shaft) for a minor tight fitting, too. These fitting tolerances are very careful factors for die making because whole die setting method must be within fine central punch and die activities for the symmetrical equalized clearance to the left and right side each other.

Fig. 7 shows the progress of CNC machining center working

3.2 Tryout

Fig.8 shows the actual strip process result and its producted part from tryout working(100 tons power press, 100mm stroke, 40 spm). In this real process strip, we could confirmed the real process for making the production part. Also we checked every dimension of production part with tolerance control.

We could find the jamming problem such as the material strip through the guide tunnel on the die block surface. Also, when the material strip pass through the tunnel, the auto-feeding attachment

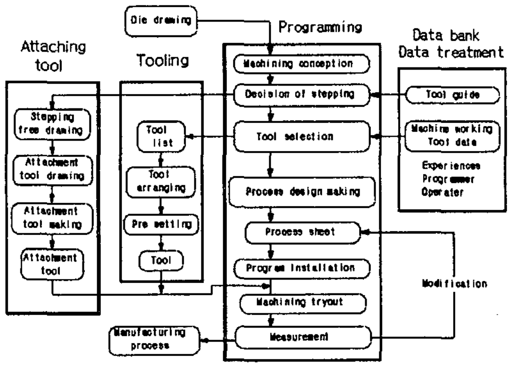
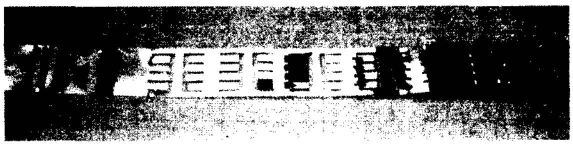


Fig.7 Progress of CNC machining center working

operation must be checked very exactly. The trouble shooting of this problem comes from die setting skill and technology. Furthermore, the production part from try out was very fine by inspection, too.[8,]



(a) Actual producted part

(b) Actual product part

Fig. 8 Actual strip process result and it producted part

At this time, the check of die failures was performed through the production part and strip of every stage with punch and die edge by the survey and fine instruments. We considered that all of the failures cause are associated with stresses present in the die, which are generated during either its manufacturing, its service life or others.

4. Conclusion

Due to prevent the defect occurring of die development, this study performed optimization method by Auto-Lisp with Auto-CAD and WINDOW environment, theoretical calculating and our skilled experiences with the others of database including wide the other of instructions

The result are as follows;

(1) The Auto-Lisp with Auto-CAD and WINDOW environment was very effective method for the design of die.

(2) The result of FEM analysis was very exactly for good production of production part by this paper´s progressive die development.

(3) The results of defectless quality of production part were accomplished by tryout after die components making and its assembling.

(4) The auto-feeding method of its attachment was comparatively effect for this production part material strip progress.

Acknowledgement

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