한국해양공학회 2001년도 춘계학술대회 논문집 PP.295~300

Development of The Center Carrier Type Progressive Die for Thick Sheet Metal

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Abstract : The progressive die performs a series of fundamental sheet metal working, particularly this study regards to develop the center carrier feeding type die for thick sheet metal(SS41, 2.5mm) production that is a specific division.

In order to prevent defect on the production, the analysis of production part, optimum design of strip process layout, die design and die making and tryout etc. are necessary.

In this study, we designed and predicted a progressive die of multi stages by wide collected data base and computer aided method.

KEY WORDS : Progressive die, Drawing, Center carrier, Clearance, Strip process layout, Pilot.

1. Introduction

In this study, we used the production part from auto-mobile industrial line. The part tolerances were occupied within ±0.2mm, so, we could select the center carrier method as a direct piloting method through the pre-piercing hole.

Daring with one time drawing, even though the thick metal production part, because of lower drawing depth in this developing project was studied.

According to upper instructions, this study could approach to the optimum die design. Further more the aim of zero defect could be predicted by accumulated data base and experiences.

2. Production part and die developing system

2.1 Analysis of production part

Fig. 1 shows the production part drawing.

The thickness of sheet metal of production part is 2mm which is thick material SS41. So, we selected the part tolerances with in ±0.2mm that is all of them.

In this production part, it has several processes of sheet metal forming work as a piercing blanking drawing etc.

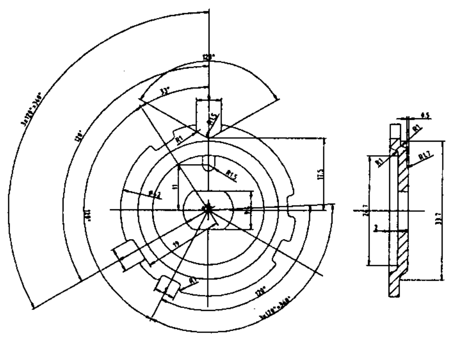


Fig.1 Drawing of the production part

General tolerances : ±0.2mm

Material : SS41

Thickness : 2mm

2.2 Die Developing System

Fig. 2 shows the die development system. In this system, it can be seen that the production engineering, die making technology, standardization, trouble shooting, man power, purchase, tool, material, etc. are connected to software and hardware, corresponded instructions of wide and deep technology and its theoretical background.

Fig. 3 shows the one of die components drawing by Auto Lisp system with Auto-CAD and Window environment, namely, pilot punch drawing. The other die components were followed as this method and experiences.[1,2)]

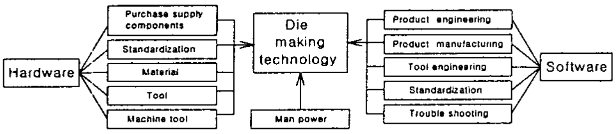


Fig. 2 Network of the die developing system

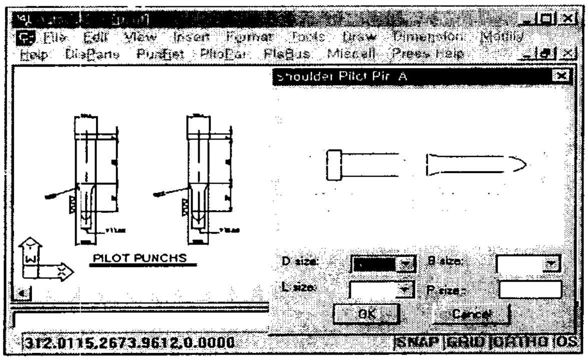


Fig. 3 Die component-pilot pin drawing by Auto-CAD and Window environment

3. Strip Process Lay Out

The first step in developing a die is to design the strip process layout exactly as it appears after all operations have been performed on it.[3,4)]

The disposition of part on strip feed unfolding is the display with constant 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 layout must be peformed exactly. Our intention was the best utilization ratio at the top of part arrangement as a optimum method of initial die design. At this time, it must be refered that the web size on the strip appears on the database and experience too.

Fig. 4 shows 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 quantity of production part, material properties, and material thickness, the second step is same as the flow chart in Fig. 3 [1,2,3)]

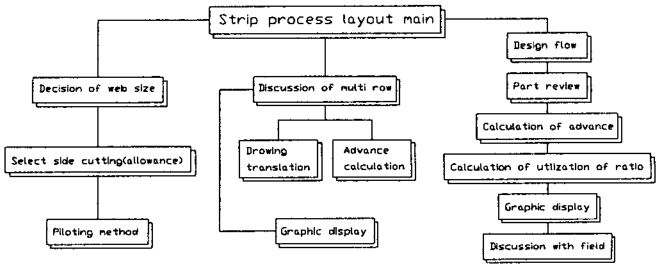


Fig. 4 Flow chart of strip process layout design system

Fig. 5 shows the strip process layout for this production part through the die tunnel. The strip width was decided to 130mm as a triangle type part arrangement due to minimized scrap area of sheet metal.[4,5,6)]

The equation of this decision is as follows.

$$W=(n-1)(D+e)\cos 30^{\circ} + D+2e \qquad (1)$$

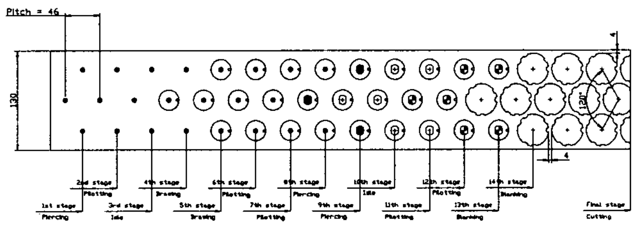
D : Blanking diameter

n : number of punching line

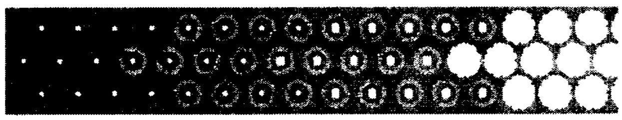
e : web size

In this strip process layout, the main acting stage are in 1st stage(Piercing), 4th and 5th stage (Drawing), 8th stage and 9th stage(Piercing), 13th stage(Blanking) and the final stage(Cutting). Especially, the final stage is working of scrap cutting.

The scrap cutting needs to waste the scrap sheet piece for easy way to storage of metal piece.



(a) 2D method



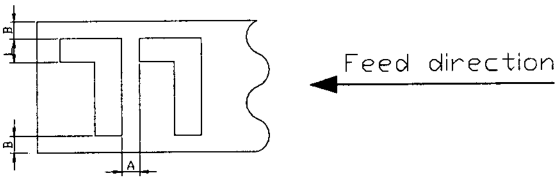
(b) Modelling method by I-DEAS

Fig. 5 Strip process layout

The web size was decided according to the data base as following table. 1[9]

Table 1 standards of web size

Product Material	t \ L	Web Size (A)			Web Size(B)
		~50	20~100	100~	
General	~0.5 0.5~	0.7 0.1+0.6t	1.0 0.65+0.7t	1.2 0.8+0.8t	1.2A
Si steel	~0.5 0.5~	1.1 0.9+t	1.4 1.1+t	1.6 1.3+t	1.2A



4. Die Design

4.1 Disposition of shank

The center line(shank location) of die was calculated by following background.[7,8,9]

$$x_G = \frac{x_1 p_1 + x_2 p_2 + x_3 p_3 + \cdots x_n p_n}{p_1 + p_2 + p_3 + \cdots p_n} \quad (2)$$

$$y_G = \frac{y_1 p_1 + y_2 p_2 + y_3 p_3 + \cdots y_n p_n}{p_1 + p_2 + p_3 + \cdots p_n} \quad (3)$$

where

$x_1 \cdots n$, $y_1 \cdots$: distance each sectors center to die with block edges with X and Y direction,

x_G : distance from shank location point to die block edge to x direction,

y_G : distance from shank location point to die block edge to y direction.

The blank diameter (DB) for drawing of production was calculated by following formula

$$D_B = \sqrt{d_2^{\,2} + 4\, d_1 [h - (0.43R + 0.43r)]} \quad (4)$$

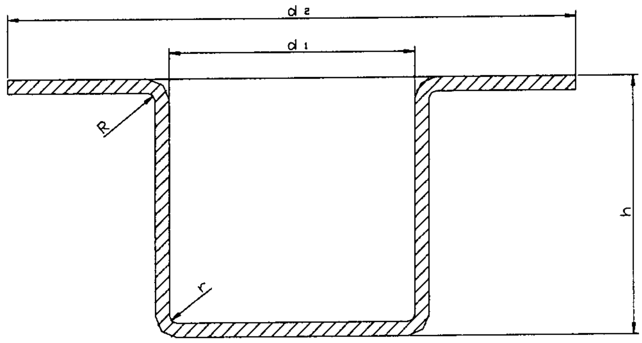
where, d_1 : Drawing diameter

d_2 : Flange diameter

R : Die radius

r : Punch radius

h : Height of drawing product



the thickness of die block was calculated by following formula with safety ratio.

$$T_D = \sqrt[3]{P} \quad (5)$$

where, T_D : Thickness of die block

P : Punching load

4.2 Die set selection

There are several kinds of die set in the data base according to the making industry regularly. Some time in especial field, they make special type steel die set for high precision die assembling function. In this strip for mass production above one hundred thousands of lot size of production part necessary for precision production. Therefore, we selected special type steel die for high precision production part. Also the eight guide posts must be installed in the die block size allowance in the accurate guide bushing fit. The die set is steel type for a precision working and high load of production part. These stage's pilots must have a enough strength to receive the bending force easily as a former pilot similarly.

Fig. 6 shows the result of die design, namely, press die drawing.

4.3 Drawing of die design and its prediction

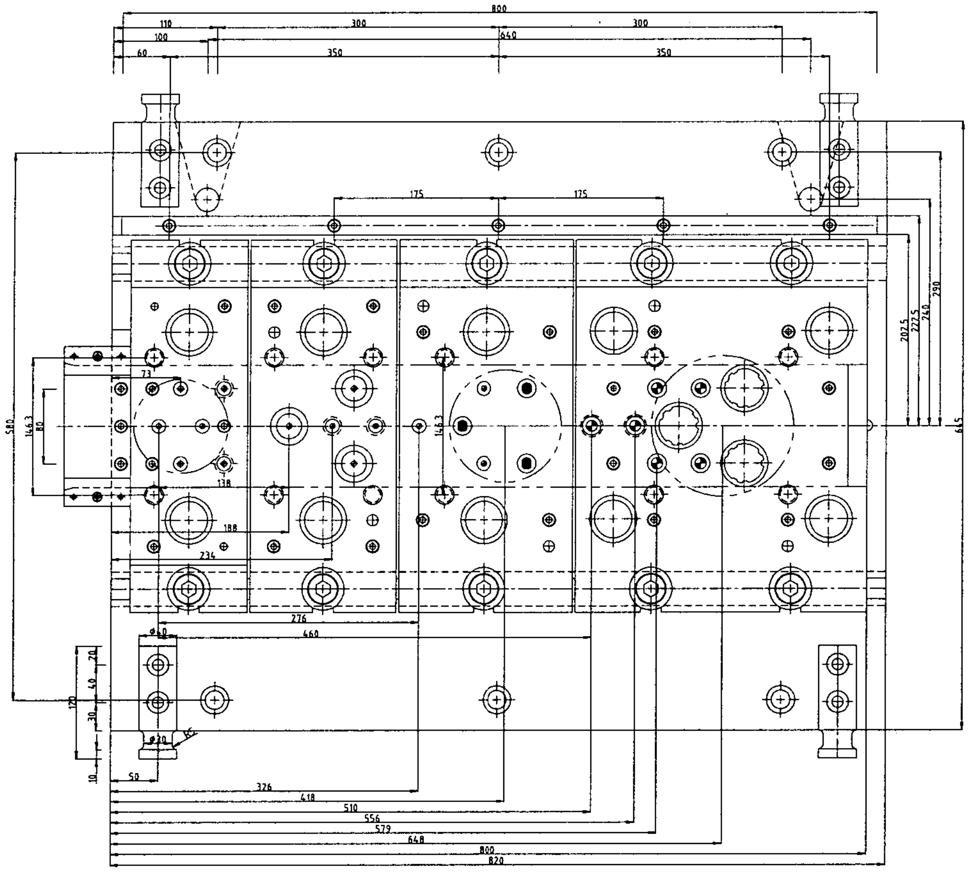
The result of die design of this study appeared by drawing or CAD with Window environment.

Fig. 6 shows the drawing of the die design result.

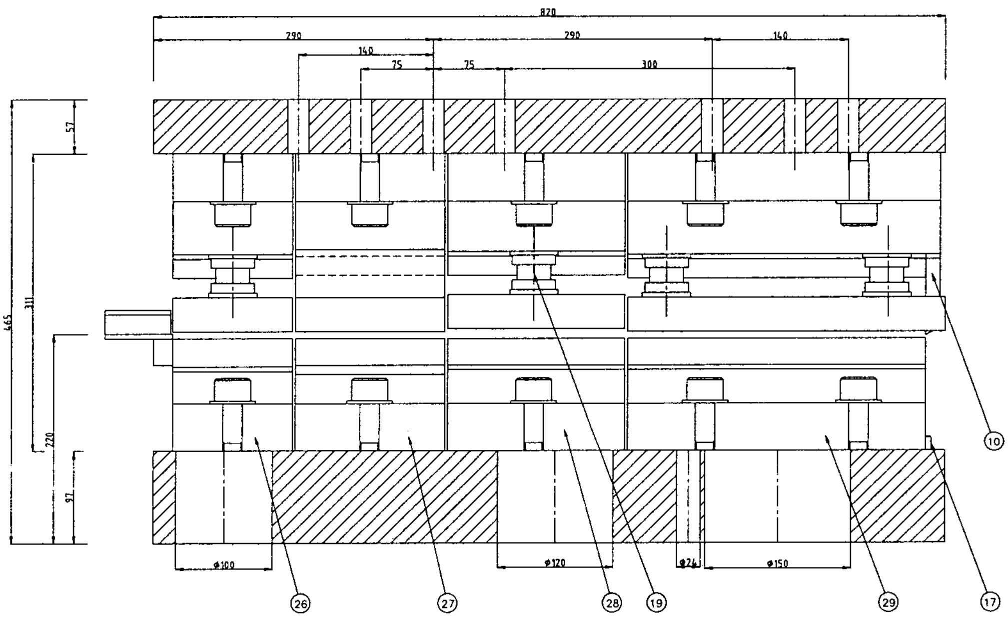
We predicted this result of die design as Fig. 7 modelling of production part by I-DEAS.

Fig. 6 shows the drawing of die.

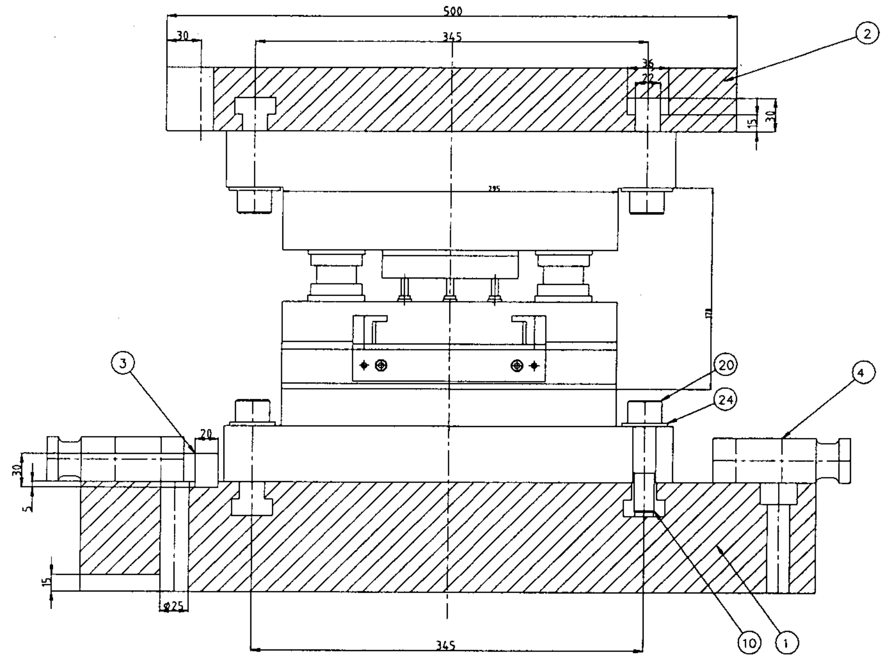
In this figure, we used the split die making method and insert die for easy making and trouble shooting.



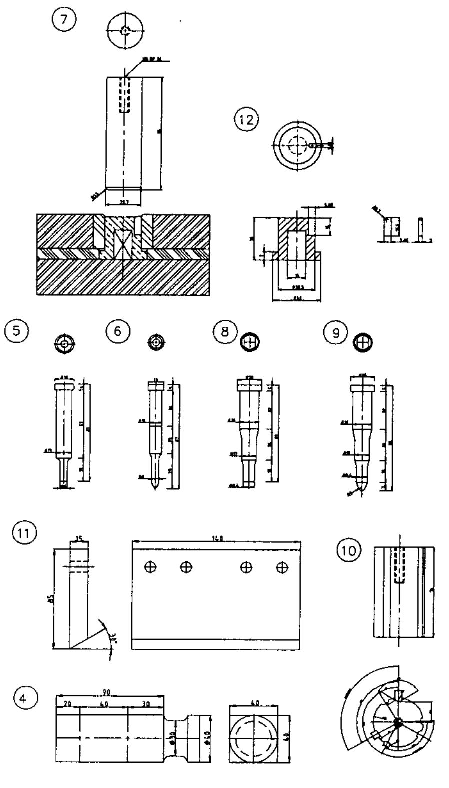
(a) Top view of assembling drawing



(b) Front view of assembling drawing



(c) Side view of assembling drawing

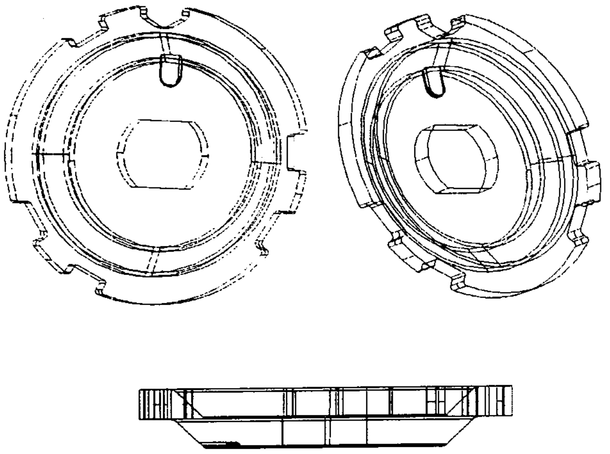


30	BLANKING & CUTTING DIE	310x295	STD1	1	
29	PIERCING DIE SET	185x295	STD1	1	
28	DRAWING DIE SET	155x295	STD1	1	
27	PIERCING DIE SET	124x295	STD1	1	
26	KEY	M20	STD11	2	
25	WASHER	WASHER		20	
24	SET BOLT	M8x60		5	
23	BOLT	M12x50		8	
22	BOLT	M8x40		10	
21	BOLT	M20x80		20	
20	GUIDE POST	ø35	SUJ2	10	
19	STRIPER	37x295	STD1	1	
18	PUNCH PLATE	80x295	STD1	1	
17	DOWEL PIN	ø12x46	STD11	8	
16	GUAGE PIN	ø6x20	STD11	12	
15	PILOT PIN	ø6x48	STD11	3	
14	BLANKING DIE	ø50x36	STD11	3	
13	PIERCING DIE	ø20x36	STD11	6	
12	DROWING DIE	ø30.5x36	STD11	3	
11	CUTTING PUNCH	140x85x15	STD11	1	
10	BLANKING PUNCH	ø42x76	STD11	3	
9	PILOT PIN	ø9.4x88	STD11	6	
8	PIERCING PUNCH	ø9.4x81	STD11	3	
7	DROWING PUNCH	ø29.7x95	STD11	3	
6	PILOT PIN	ø6x87	STD11	11	
5	PIERCING PUNCH	ø6x81	STD11	3	
4	HOOK	40x40x90		1	
3	SETTING KEY	22x35x800	STD11	1	
2	UP HOLDER	825x650x60	STD1	1	
1	DOWN HOLDER	825x650x100	STD1	1	
NO	DESCRIPTION	SIZE	MAT'L	Q'TY	REMARK

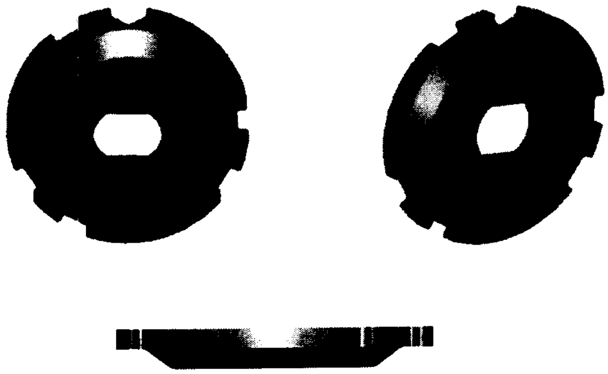
TITLE				WORK NAME	
PROGRSIVE DIE					
DRAWN	CHECKED	REVIEWED	APPROVED	SCALE	DATE	PROJECTION	ITEM NO
[illegible]				N/S	2000.03.16		

(D) die components drawing

Fig. 6 Drawing of die design result



(a)



(b)

Fig. 7 Modelling of the result of die design and its making production part

5. Conclusion

The result of this study for die design and its prediction was as follows.

(1) The center carrier type progressive die could be carefully developed by whole of data-base and our experiences.

(2) The prediction of successful developing was obtained by die design and its modelling.

(3) The split die was terrific effective for die assembling function and trouble shooting on the die design result.

Acknowledgement

This work was supported by the Brain Korea 21 project in 2001.

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