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Development of The Multi Forming Type Ultra Precision Die for Sheet Metal (Part Ⅱ)
- Die Design and Die Making -

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Abstract : In this study, we designed and constructed a multi-forming progressive die with a bending, embossing on the multi-stage and performed through the try out. 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 : Auto-feeding, Web size, Die insert, Split die, Strip process layout, Tryout

1. Introduction

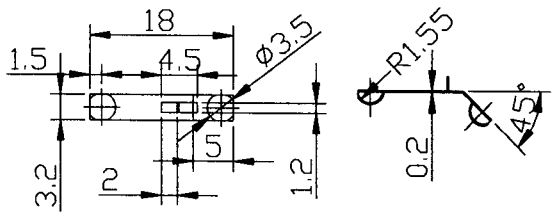
This study(Part Ⅱ) reveals the die design, die making and consideration through the tryout and its analysis. So they need a whole of press tool data, our field experiences, theoretical instructions, and ultra precision machine tool including CNC machining center, wire-cut, EDM, press machine and skillful operation, and its application, die assembling process etc.

According to upper knowledgement, this study could approach to the adaptive and practical die design and making.

Furthermore the goal of the least defect could be obtained.

2. Die Design

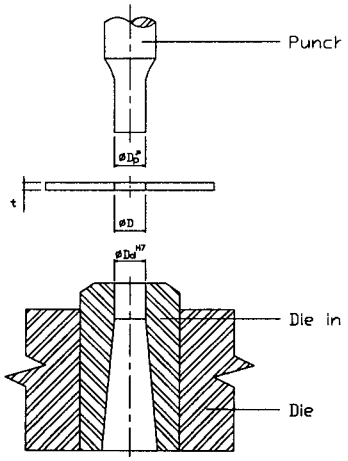
Fig. 1 shows the production part drawing



t : 0.2mm material : SUS304

Fig 1. The production part drawing

Fig. 2 shows the shape of punch and die for piercing blanking, and whole of cutting process.



D_p = D + e (Shrinkage allowance after piecing)

D_d = P + $2C_2$ (C_2 : Clearance(1 side))

D : piecing size of product

Fig. 2 Shape of punch and die

Table. 1 Fitting Tolerance

Division		j 6	H 7
-	3	± 0.003	+ 0.010 - 0
3	6	± 0.004	+ 0.012 - 0
6	10	± 0.0045	+ 0.015 - 0
10	18	± 0.0055	+ 0.018 - 0
18	30	± 0.0065	+ 0.021 - 0

Table. 2 Standard value of e and C_2 by t

t	e	C_2	t	e	C_2
0.1	0.01	0.01	1.2	0.055	0.14
0.2	0.017	0.015	1.4	0.06	0.16
0.3	0.02	0.02	1.6	0.07	0.18
0.4	0.025	0.0276	2.0	0.08	0.22
0.5	0.03	0.035	2.5	0.09	0.25
0.6	0.035	0.04	3.0	0.10	0.28
0.8	0.04	0.05	3.5	0.10	0.31
1.0	0.05	0.06	4.0	0.11	0.35

2.1 Die Development System

Fig. 3 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. 4 Shows the one of a die components drawing by Auto-Lisp under the Auto CAD and Window Environment, as a name of pilot punch. The other die components were designed as this method and experiences, but this paper not included in drawing.

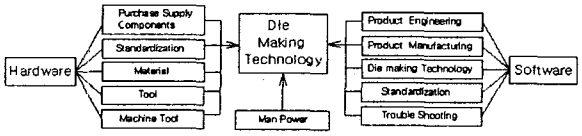


Fig.3 Network of the die developing system

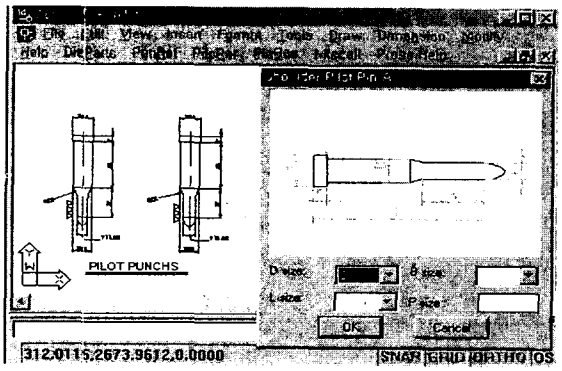


Fig.4 Die component drawing come from Auto-Lisp under the Auto-CAD and Window environment

2.2 Die Design

There are several kinds of die set in the database according to the industrial situation of today.

Sometime in special field, they make special type steel die set for high precision die assembling function.

In this study, we considered the automatic roll feeding of material strip for mass production above one hundred thousands of lot size of production parts necessary for precision production. Therefore we selected special type steel die set for precision production part. Also the guide post must be installed in the die shoe block size allowance through the accurate guide bushing fit. The die set of steels is outer guide post type for a precision working and high pressing force of production part.

Fig. 5 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.

The die components design was accomplished by using the Auto Lisp with database, the others of outer instructions was taken by theoretical calculations and experiences. The standards part was effective method in this work.

The representative drawing of result of this processes is shown in Fig.6.[1-6)]

3. Die Making and Tryout

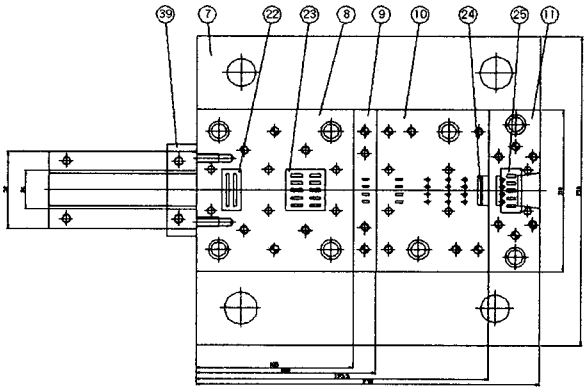
3.1 Die Making

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

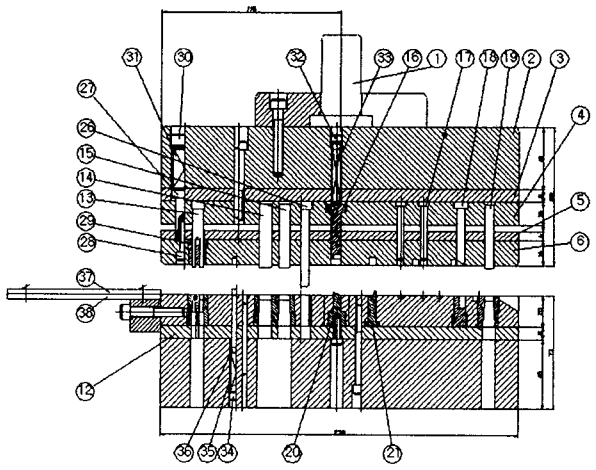
In this study, we used ordinary machine tools, CNC machine tools and EDM etc..[6, 7)]

On the accuracy of the each fitting components with a combination of the tolerance,

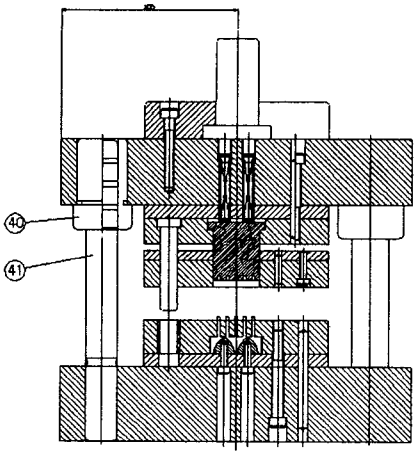
the first thing is guide bush and guide post(outer or inner)



(a) Top view



(b) Front view



(c) Side view

Fig. 5 Die assembling drawing as a result of die design

tolerance H7(hole) h6(shaft) for a slide fitting and the die set and guide post tolerance are H7(hole) p5(shaft) for a tight fitting.

Punch plate and punch a 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.[7~9]

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(under the 0.04% of material thickness) to the left and right side each other.

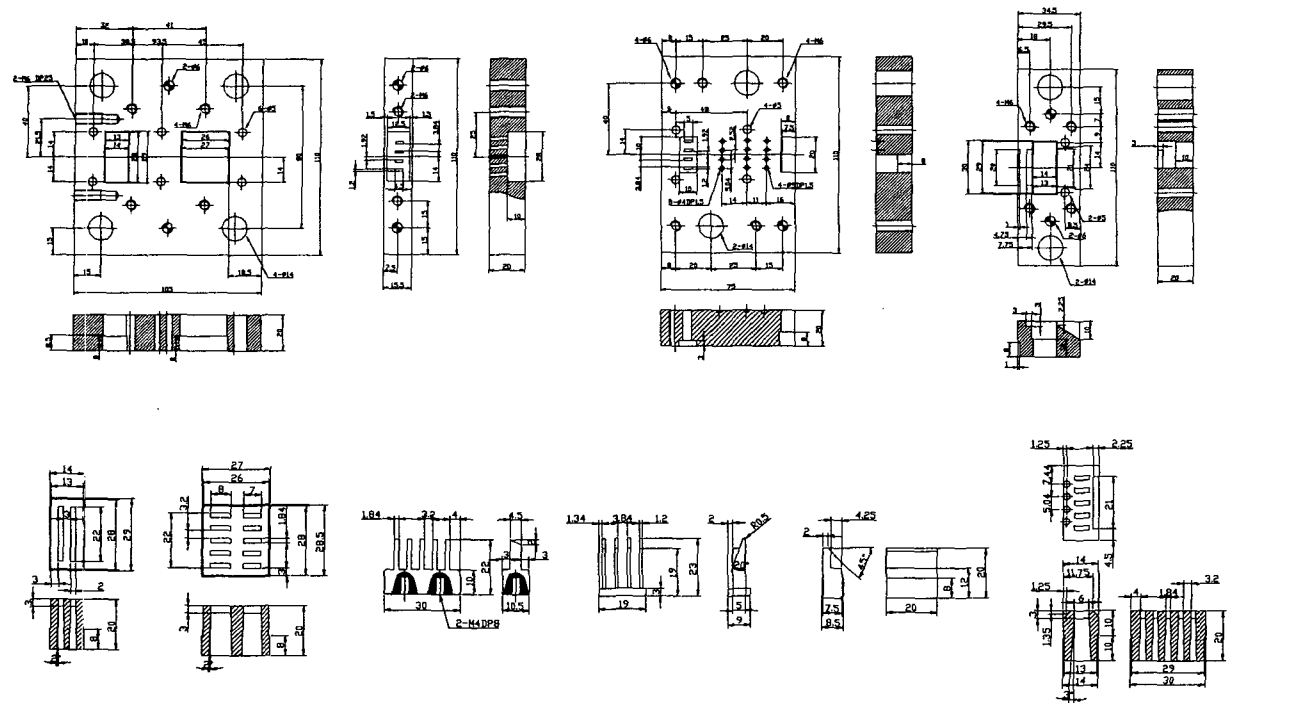
Fig. 7 shows the progress of CNC machining center working

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 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.

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 searching and fine instruments.



NO	DESCRIPTION	SIZE	MAT'L	Q'TY	REMARK
41	GUIDE POST	Ø19×180	STD11	4	
40	GUIDE BUSH	Ø35×55	STD11	4	
39	STOCK GUIDE UNIT	20×62×21	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	SM45C	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 8×5		2	
31	WIRE SPRING	Ø7×40.516×40		10	
30	SET SCREW	M 18.6×8		10	
29	PUNCH GUIDE BUSH	12×25×16	STD11	1	
28	BOLT	M6×26		10	
27	STRIPPER NUT	Ø8×32		10	
26	INNER GUIDE POST	Ø10×55	STD11	1	
25	DIE INSERT	14×30×20	V1	1	
24	DIE INSERT	8.5×20×20	V1	1	
23	DIE INSERT	27×28.5×20	V1	1	
22	DIE INSERT	14×29×20	V1	1	
21	BENDING PUNCH	19×9×23	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	23×8×43	STD11	1	
12	BACKING PLATE	230×110×8	STD11	1	
11	PARTING DIE	43.5×10×20	SM45C	1	
10	EMBOSSING DIE	75.5×110×20	STD11	1	
9	SLIT PUNCH HOLDER	15×110×20	SM45C	1	
8	PIECING 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	230×110×15	STD11	1	
3	BACKING PLATE	230×110×8	STD11	1	
2	UPPER HOLDER	230×210×40	SM45C	1	
1	SHANK	Ø40×60	SM45C	1	

Fig. 6 Die components drawing through the die design

We considered that all of the failures causes are associated with stresses present in the die, which are generated in the manufacturing, its service life or others.

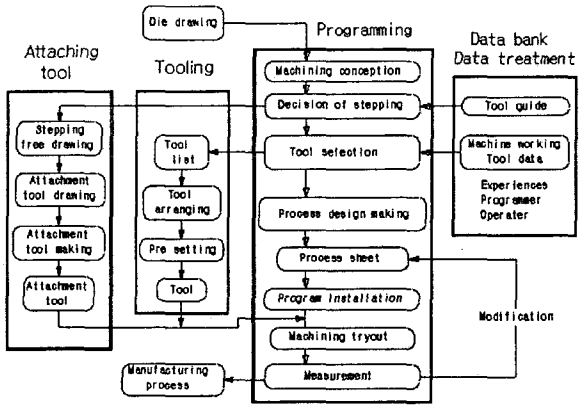
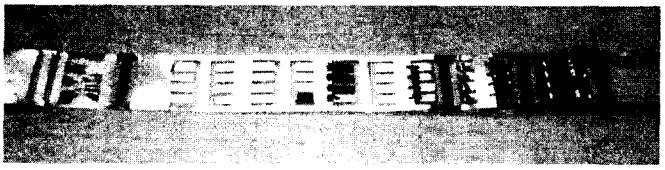
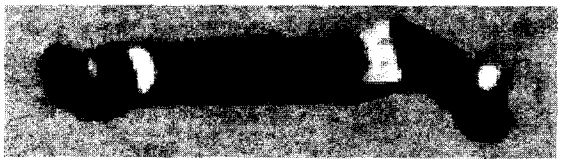


Fig.7 Progress of CNC machining center working



(a) Actual strip process result



(b) Actual product part

Fig. 8 Actual strip process result and it producted part

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 results of least defect quality production part were accomplished by tryout after die components making and its assembling.

(2) The auto-feeding method of its attachment was comparatively effect for this production part material strip progress without pilot stages.

(3) The result of FEM analysis was very exactly for good production of part.

(4) The database and it application technology was important factor for best die design.

Acknowledgement

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