

## Development of the High Utility Progressive Die for Sheet Metal Forming (Part 2)

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**Key Words** : Die making, Tryout, Tolerance, Assembling function, components drawing, Revision

**Abstract** : Precision progressive die have used for above ten thousand pieces of lot size of production part.

In the field of design and making tool for press working, the progressive die for sheet metal (SPC, thickness :2 mm) is a specific division. In order to prevent the defects, the optimum design of the U-bending production part, strip layout, die design, die making and tryout etc. are necessary. 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 materials, heat treatment of die component, know-how and so on. In this study, we designed and constructed a progressive die of multi-stage and performed try out. Out of these processes the die development could be taken for advance. Especially the result of tryout and its analysis become the characteristics of this paper (part 1 and part 2 ) that nothing might be ever seen before such as this type of research method on all the processes. In the part 2 of this study we treated die making and tryout mostly.

### 1. Introduction

The multi-forming 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 strip stock moves through the die. Press working for the optimum die design and its making has been become the purpose of industry by strip process layout with multi-stages. We used the part of ordinary product in industrial production line or society of our general living field as this paper subject.

So, this study needs a whole of press tool data, related software our field experiences, and theoretical references. According to upper instruction this study could approach to the optimum die design and making. Furthermore the aim of zero defects could be obtained mostly by revision on the try out.<sup>1,2)</sup>

### 2. Die Making

#### 2.1 Die Assembling Drawing and Its Components Drawing

Fig.1 shows the die assembling drawing by front view from part 1 of this study. At the same time, we worked die components drawing in Fig.2, but too many components were in this progressive die, so we selected punches and others as a limitation of components.

The other components will be studied next part 3 and part 4 of this study.

About die inserts treating, Ferrotic steel was used by its maker's suppling by orders, and then die inserts machining was performed by mirror machine tool and hand finishing finally. Especially, die insert's radius shoulders were finished as a mirror surface by too many times hand polishing.

## 2.2 Die Making System

Fig.3 shows the progress of CNC machining center working. Fig.4 shows the press die making system. 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 to the left and right side each other. In this study, we used ordinary machine tools, CNC machine tools and EDM, etc. On the accuracy of each fitting component, tolerances, the first is guide bush and guide post(outer or inner) tolerances are H7(hole) h6(shaft) and the die set and guide post tolerances are H7(hole) p5(shaft) for a tight fitting. Punch plate and punch tolerances 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).<sup>6,7)</sup>

Fig.5 shows the wear amount of die materials.

In this figure we can select the adaptive die block material STD11 and die inserts material Ferrotic according to the punch and die characteristics in the case of use. 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 can 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 and mirror machine tool.<sup>3-5)</sup>

See Fig.6 as a die making machine tools.

## 3. Tryout Result

Fig.7 shows the actual strip process result from tryout working. In this actual process strip, we could confirm the real process for making the production part. Also we checked every size 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 passes through the tunnel, the roll feeding device operation must be checked very exactly. The trouble shooting of this problem comes from die setting skill and technology. Furthermore, the production part from

tryout was very fine by inspection, too.

At this time, the check of die failures was performed through the production part and actual 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 those stresses present in the die, those are generated during either its manufacturing, its service life or both.

Fig.8 (a) shows the result of production part modeling by I-DEAS software. Fig.8(b) shows the produced actual part by tryout with screwpress.

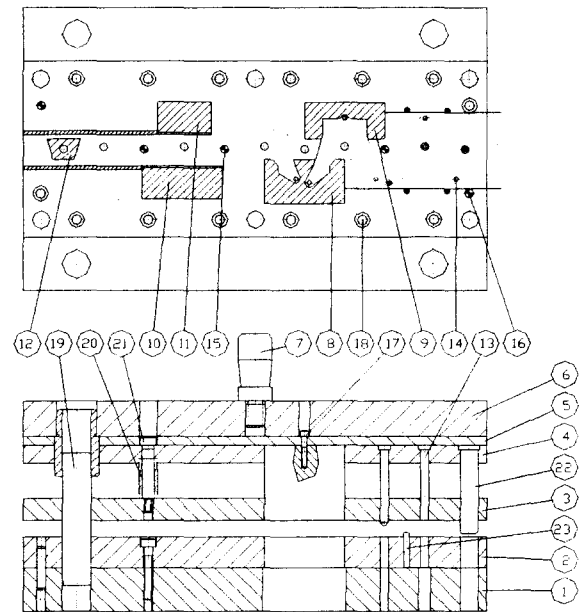


Fig.1 Die assembling drawing

23	LOCATE PIN	1	STC3	
22	INNER GUIDE POST	1	STC3	
21	STRIPPER BOLT	1	STANARD	M10*60
20	SPRING	1	STANARD	Ø21*45
19	GUIDE POST & BUSH	1	STC3	
18	BOLT	14	STANARD	M12*60
17	BOLT	5	STANARD	M6*25
16	DOWEL PIN	2	STC3	Hrc 58
15	PILOT PUNCH	3	STC3	Hrc 60
14	PIERCING PUNCH-2	1	STD11	Hrc 60
13	PIERCING PUNCH-1	1	STD11	Hrc 60
12	PATING PUNCH	1	STD11	Hrc 60
11	BENDING PUNCH-2	1	STD11	Hrc 60
10	BENDING PUNCH-1	1	STD11	Hrc 60
9	NOTCHING PUNCH-2	1	STD11	Hrc 60
8	NOTCHING PUNCH-1	1	STD11	Hrc 60
7	SHANK	1	SM45C	
6	UPPER PLATE	1	SM45C	
5	BACKING PLATE	1	STC3	Hrc 55
4	PUNCH PLATE	1	STC3	
3	STRIPPER	1	STC3	
2	DIE PLATE	1	STD11	Hrc 60
1	LOWER PLATE	1	SM45C	
NO	Description	QTY	Material	Remark

Table.1 Material List

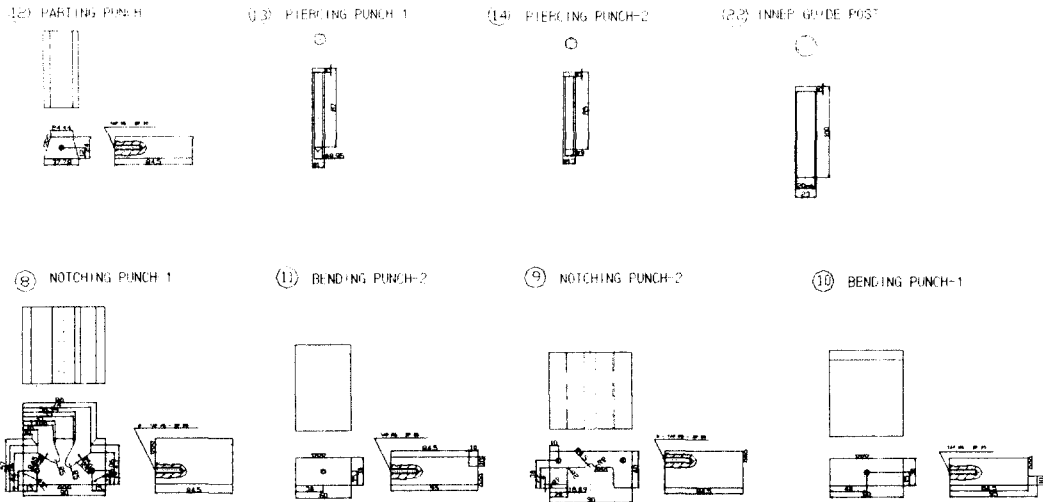


Fig.2 Die component drawing

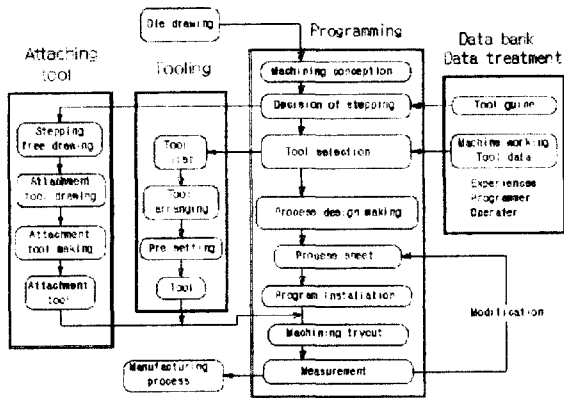
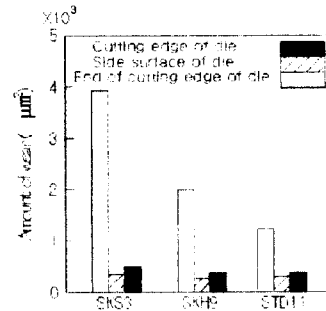


Fig.3 Progress of CNC machining center working



(b) Effect of tool steels by die wear

φ 10 blanking, H<sub>R</sub>C61 (punch, die)  
bainite steel, 10% clearance lubrication  
lot size : 10,000

Fig.5 Comparative materials of punch and die

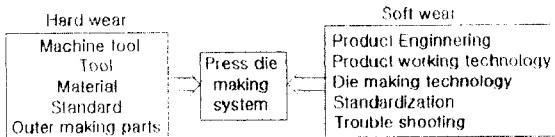
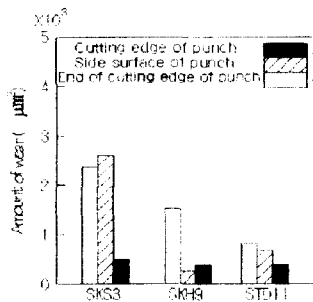


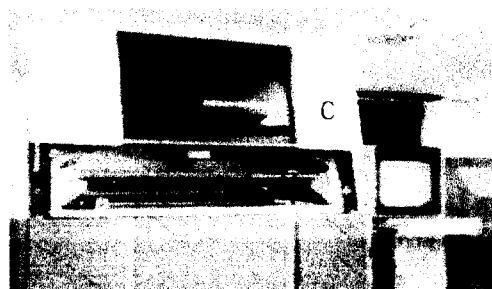
Fig.4 Press die making system



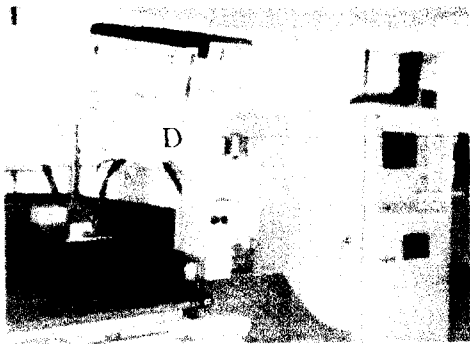
(a) Effect of tool steels by punch wear



(a) Machining center(A) and cylindrical grinding machine(B)



(b) Rapid profile laser machine (C)



(c) Wire electric discharge machine (D)



(d) Wire cut(E), turning m/c(F) and power drilling m/c(G)

Fig.6 Die making machine tools

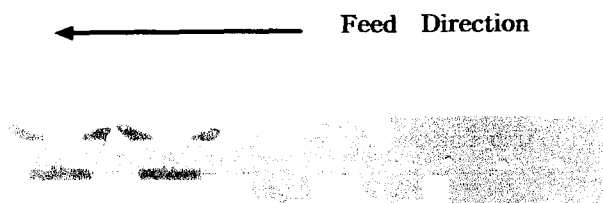


Fig.7(a) Result of strip process layout modeling by I-DEAS

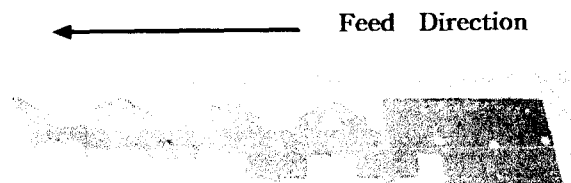


Fig.7(b) Result of real strip process layout by tryout

Fig.8 shows the result of tryout namely real production part. In this result, we considered that the shape and size with tolerance were satisfied.



Fig.8(a) Result of production part modeling by I-DEAS

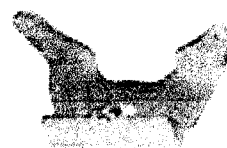


Fig.8(b) Produced actual part by tryout

## 4. Conclusion

In order to prevent the defect of die design and making, this study developed the practical and adaptive die assembling and its components of the multi forming with U- bending process.

This study could be carried out actual die making by the theoretical back ground, data base and our field experiences.

The result are as follows;

- (1) Precision multi-forming progressive die could be made exactly.
- (2) The result of die making and its tryout could be performed with screw press by all need equipments of very skilled technology.
- (3) The split die making system was available performances for die assembling function and trouble shooting.
- (4) For the continuous die assembling function increased, the revision of die components were necessary with die components accuracy on tryout process.

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