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A Study on the Development of Progressive Die for Cutoff Type U-Bending Process

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Abstract

The Cut off-type progressive die for U-bending production part is a very specific division. This study reveals the sheet metal forming process with multi-forming die by Center Carrier type feeding system. Through the FEM simulation by DEFORM, it was accepted to u-bending process as the first performance to design of strip process layout.

The next process of die development was studied according to sequence of die development, i.e. die structure, machining condition for die making, die materials, heat treatment of die components, know-how and so on. The feature of this study is the die development of scrapless progressive die of multi-stage through the Modeling on the I-DEAS program, components drawing on the Auto-Lisp, CAD/CAM application, ordinary machine tool operating and revision by tryout.

1. INTRODUCTION

Progressive die performs a series of fundamental sheet metal working at two or more stages during the press running to produce a piece part as the strip stock moving through the die. Press working from the optimum die design and its making has been the purpose of mass production in industrial field.

So, this study needs a whole of press tool data, our field experiences, and theoretical instructions. According to upper factors, this study could be achieved to the optimum die design through the FEM simulation, I-DEAS modeling, and practical method of die making.

Furthermore the aim of least defects could be obtained mostly by revision through the tryout.

2. DIE DESIGN

2.1 Die Developing System

Fig. 1 shows the network of 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 its theoretical background.[1~3)]

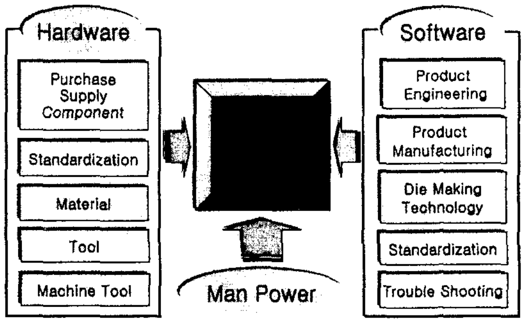


Fig.1 Network of die developing system

Fig. 2 shows one of die components drawing by existing Auto-Lisp program under the AutoCAD and Window environment. The other die components have followed to this method and experiences.

2.2 Strip Process Layout

The disposition of part on strip feed unfolding was displayed with constant area repetedly. Due to upper cause, it must be enough that the decision of strip feeding distance (advance, pitch) and disposition of each stage on the strip lay out are performed exactly. Our intention considered that the best utilization ratio of sheet metal can be obtained as taking the accurate strip process layout design through the theoretical calculation and field experiences.[4)]

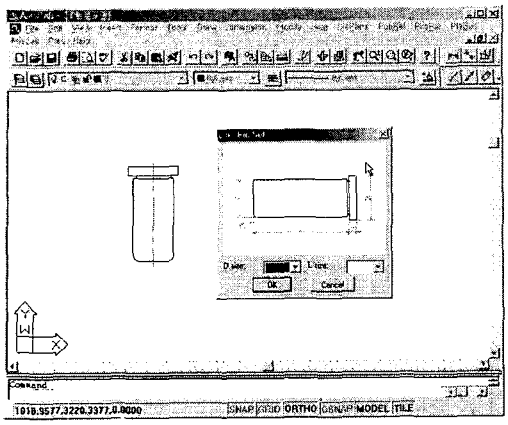


Fig.2 Die component drawing by Auto-Lisp

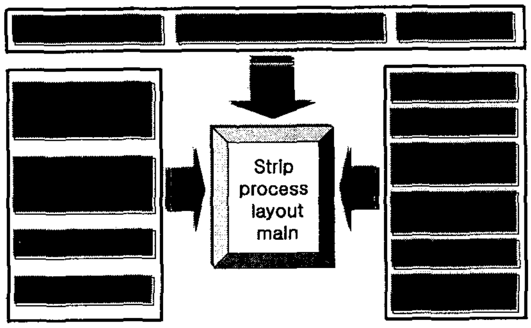


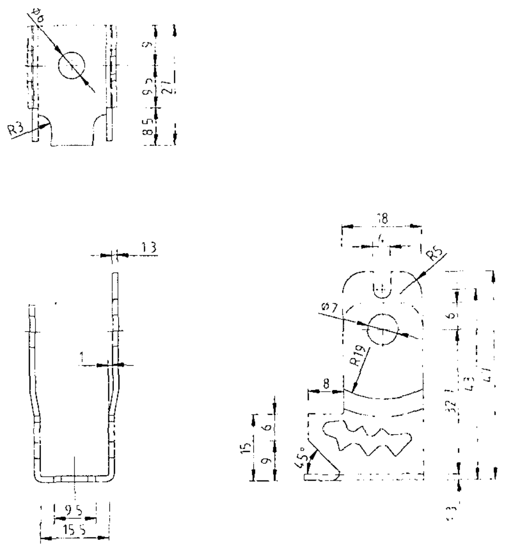
Fig.3 Flow chart of strip process layout design system

This is the optimum method of initial die design. At this time we referred the web size on the strip from database and its related instructions.

Fig. 3 shows the flow chart 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 quantity of production part, accuracy of production part, material properties, and material thickness, the second step is followed to this flow chart of Fig. 3

Fig.4 shows the production part and its developing length(99mm) used to the thick sheet metal(material : SPCC, thickness : 1.3mm) production part. From the strip process layout designing method, we could design the following strip process layout as the Fig.5 by the Fig.4 production part drawing. The strip process layout was considered that the proper sizes are strip width, web size, pitch, notching allowance etc..[5)]

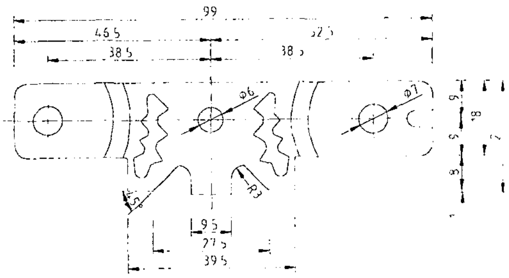
The first stage operates piercing, the second stage works piloting, the third stage works notching, fourth



Tolerances : ± 0.2mm

Material : SPCC, Thickness : 1.3mm

(a) Part drawing



(b) Part developing length

Fig. 4 Drawing of production part and its developing length

stage works piercing, fifth stage performs piloting with a idleness.

The sixth stage is bending stage, also seventh stage works piercing.

The eighth stage works u-bending, in this stage, we must take care of pilot damage or fracture of the causes of dislocation. The ninth stage is idle stage.

The tenth stage is sizing stage. The eleventh stage works part cutting as a complete stage. After that, the strip process layout was obtained as the result in the Fig. 5.

2.3 Clearance and Gap

This experimental press working material is proper

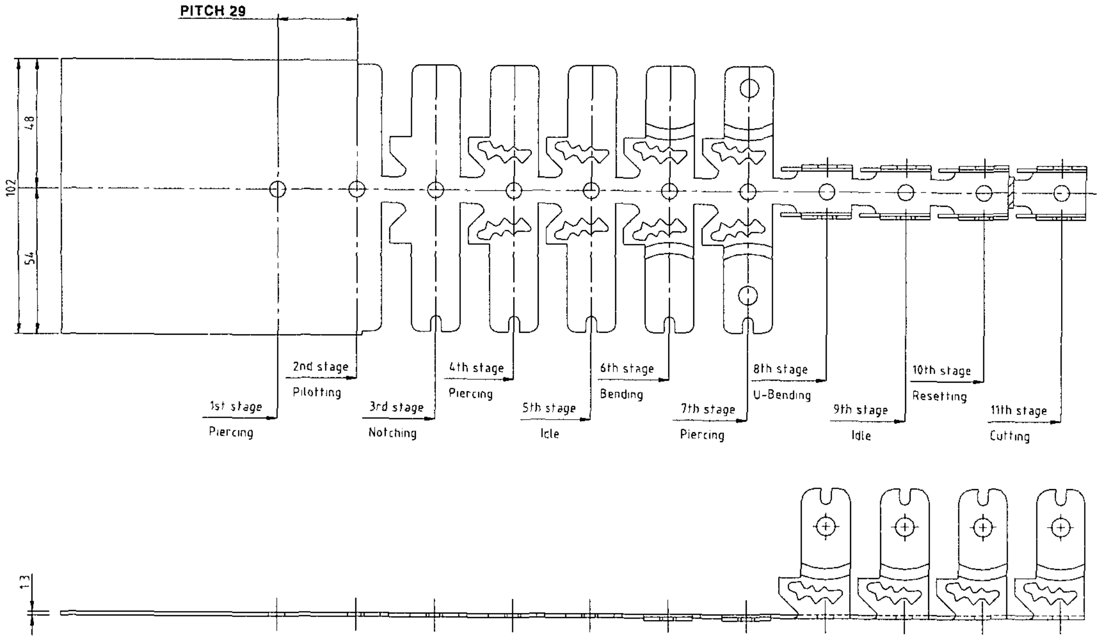


Fig. 5 Drawing of Strip Process Layout

thick as a justly 1.3mm(SPCC).

Therefore, the clearance is large amount of 0.05mm between punch edge and die edge for the piercing and notching etc. At this time the burr at the cutted edge of sheet metal could be created minimized amount in actual production part as a tryout result.

The gap between punch and die wall for the u-bending was taken 1.1times of material thickness by database and experiences.

2.4 FEM simulation

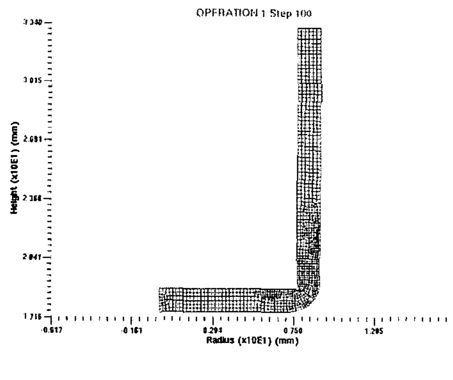
Fig. 6 shows the result of FEM simulation of u-bending corner by DEFORM programming.

At this time the parameter of supporting to FEM simulation by DEFORM programming is shown in table. 1. Through the Fig. 6 (a) (b) (c) (d), it was predicted that the u-bending crack is not created by the parameter of sheet metal of SPCC as shown in table.1 and the other database.

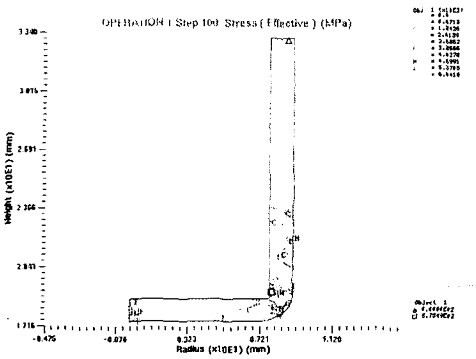
Also, we considered that the result of FEM simulation for u-bending in this production part never occurred the crack phenomena. Therefore, it could be well done to the strip process lay out design as shown in Fig. 5.

Table. 1 The parameter for FEM simulation

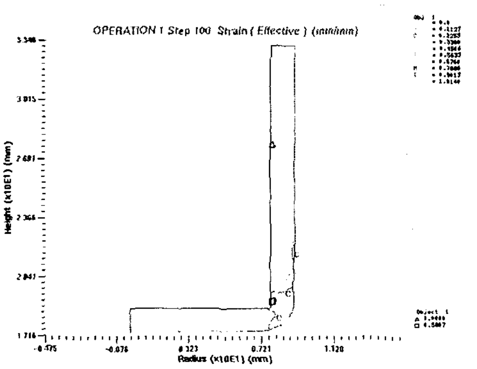
	Unit	Value
Young modulus	GPa	200
Poison ratio		0.3
Tensile Strength	MPa	760
Yield Strength	MPa	380



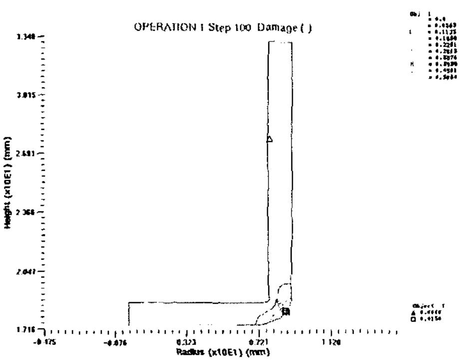
(a) Operation 1 step 100 meshing



(b) Operation 1 step 100 stress line contour



(c) Operation 1 step 100 strain line contour

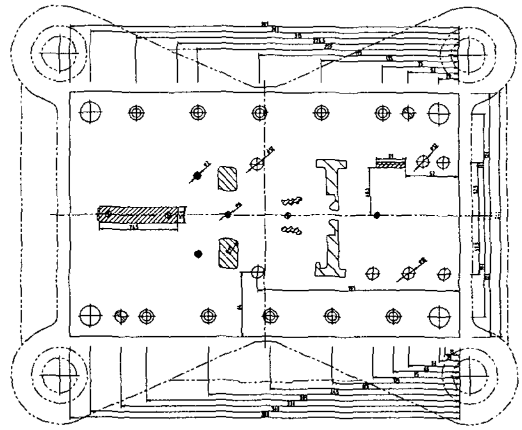


(d) Operation 1 step 100 damaged line contour

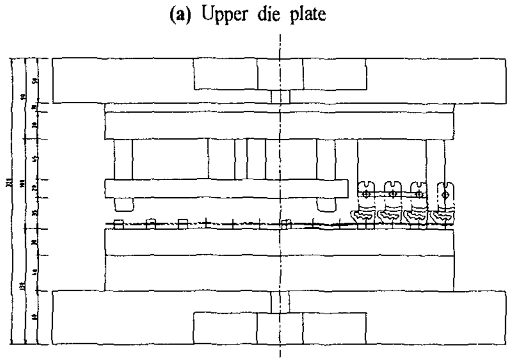
Fig. 6 Result of FEM Simulation by DEFORM

2.5 Die Set Selection

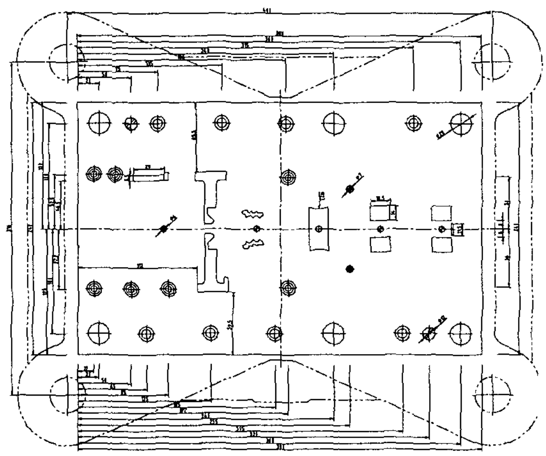
There are several kinds of die set model in the toolmaker regularly. Some time in the particular field, they make special type steel die set for high precision die assembling function. In this study, we considered the automatic roll feeding of strip for the mass production above one hundred thousand of production part and precision production needed, so we selected special type steel die for high precision production part.



(a) Upper die plate



(b) Front view drawing



(c) Lower die

Fig. 7 Die assembling drawing

Also the guide post must be installed within the die block and die shoe size allowance with the accurate guide bushing fit. It was selected that the die set is 6 inner guide posts and 4 outer guide posts type for a precision working and high load of pressing. Fig.7 shows the result of die design called press die assembling drawing.

3. DIE MAKING and TRYOUT

3.1 Die Making

It was selected SKD11 high alloy steel for punch and die block as a cause of containing of minimized wear among whole of die materials.

Especially the die insert material was selected V_1 hard metal for the split die components. In this study, we decided the sizes of punch and die block depending on data base, theoretical background and our own field experiences.[6] The machining of punch and die block can belong to the precision machine tool working through the raw material cutting, milling, turning, drilling, profiling, heat treating, electronic discharge machining (EDM, Wire-Cut), jig grinding, especially, CNC machining and mirror machining etc.. Fig. 8 shows the progression of CNC machining center working.

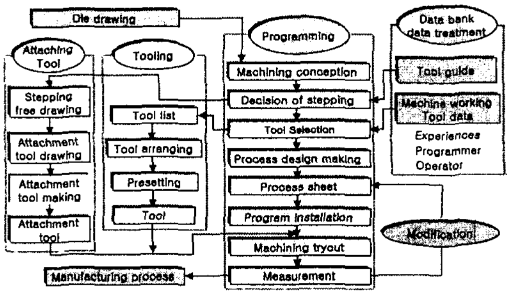


Fig. 8 Progress of CNC machining center working

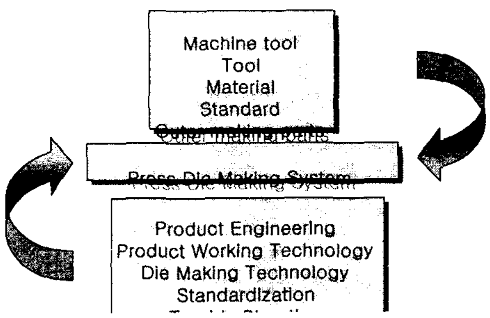


Fig. 9 Press die making system

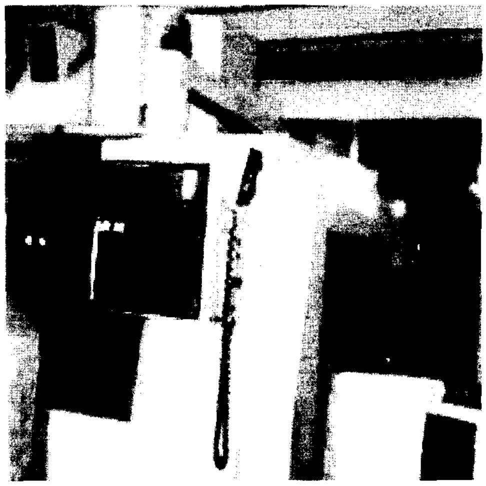


Fig. 10 CNC machinining center for die making

Fig. 9 shows the press die making system.

Fig. 10 shows the CNC machining center for a representative of die making machine tools.

In this study, we used ordinary machine tools, CNC machine tools and EDM etc..On the accuracy of each fitting component with combination of the following tolerances, the first case is guide bush and guide post tolerance as the H7(hole) h6(shaft) for a slide fitting.

The die set and guide post tolerances are H7(hole) p5(shaft) for a tight fitting. The Punch plate and punch tolerance are H7(hole) m6(shaft) for a tight fitting with a minor interference. The second is stripper and punch tolerances are H7(hole) h6(shaft) for a slide fitting. The die inserting hole and die inserting button are H7(hole) m6(shaft) for a minor tight fitting. These fitting tolerances are very careful factors for die making because whole of die setting method must be within fine punch and die activities for the symmetrical equalized clearance to the left and right side each other.

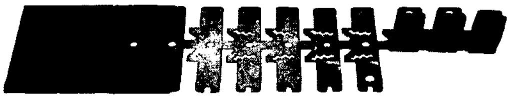
3.2 Try out

Fig. 11 shows the actual strip process result from tryout working(200ton power press, 100mm stroke, 40 SPM). In this actual process strip, we could confirm the real process for making the production part.

Also we checked the every size of production part with a tolerance control.

We could find the jamming problem such as the material strip through the guide tunnel on the die block surface.

(a) Actual production part



(b) Actual strip by tryout

Fig. 11 Actual production part and strip by tryout

Also, when the material strip passing through the die tunnel, the roll feeding device operation was checked very exactly. The trouble shooting of this problem was come from die setting skill and technology. 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 surveying and measuring with fine instruments.

We considered that all of the failure causes are associated with stress occurring and impact of components in the die components running or its service life etc..[7]

4. CONCLUSION

In order to prevent the defect of die design and making, this study developed the practical and adaptive die assembling and components. This method could be taken from the theoretical back ground, data base and our field experiences and FEM simulation etc..

The results are as follows :

1) FEM simulation of strip process layout by DEFORM programming was obtained successful result.

2) The die design was performed as optimum result with the least defects in the die developing.

3) The trouble shooting was performed as a success method of tryout after die making.

4) For the increasing the utility ratio of material of production part, the scrapless type progressive die became to the optimum design result.

ACKNOWLEDGEMENT

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REFERENCES

(1) Sim Sung-Bo, Park Sun-Kyu, "Development of the Practical and Adaptive Die for Sheet Metals(1)", Proceedings of KCORE conference, May, PP.141~148, 1999.

(2) Sim Sung-Bo, Song Young-Seok, "Development of the Practical and Adaptive Die for Sheet Metals(2)", Proceedings of KCORE conference, May, PP.149~155, 1999.

(3) A.Keys Karl, "Innovations in Die Design", SME, PP. 71~99, 1982.

(4) Hashi Moto M., "Preworking and Die Making" Higan Tech. Paper Co., PP.121~180, 1975.

(5) Hutota.T "Databook of Pressworking Process Design" Press Tech.,Vol.7 No.13 Higan Tech. Paper Co, PP.1~201, 1969.

(6) F. Eary Donald, A. Reed Edward "Techniques of Pressworking Sheet Metal" Prentice Hall, Inc, PP37~93, 1974.

(7) Kalpakjian Serope, "Tool and Die Failures", ASM, PP.18~31, 1982.