한국해양공학회 2001년도 춘계학술대회 논문집 PP.289~294

# Development of The Pilotless Type Progressive Die for Thin Sheet Metal

Sung-Bo Sim*, Chan-Ho Jang**, Yul-Min Sung***

* *School of Mech. Eng. Pukyong National Univ.*

** *Graduate School, Pukyong National Univ.*

*** *Industrial Graduate School, Pukyong National Univ.*

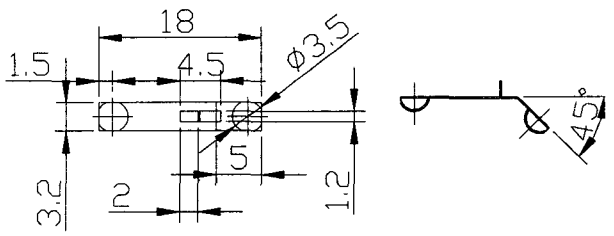
**Abstract** : This study reveals the thin sheet metal process with multi-forming die that the name is progressive die, also high precision production part is made. They require analysis of many kinds of important factors, i.e. theory and practice of metal press working and its phenomena, die structure, 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 working of 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** : Pilotless type, Auto-feeding, Web size, Split die, Strip process layout, Tryout

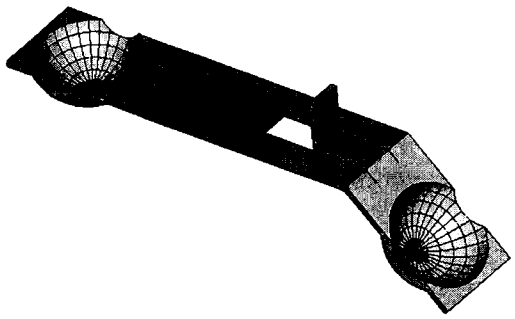
## 1. Introduction

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. 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.




**(a) Production part drawing**



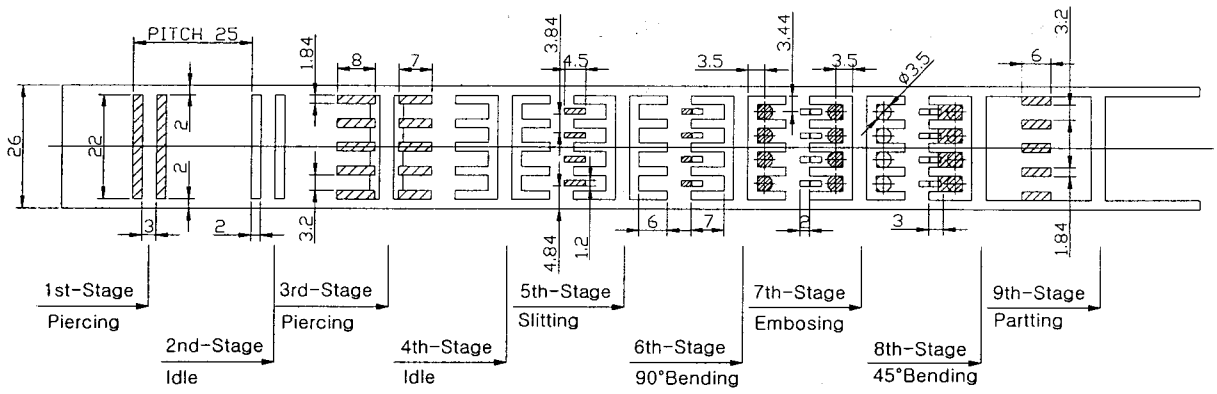
**(b) Modelling result of production part**

**Fig. 1 Production part drawing and its modelling by IDEAS**

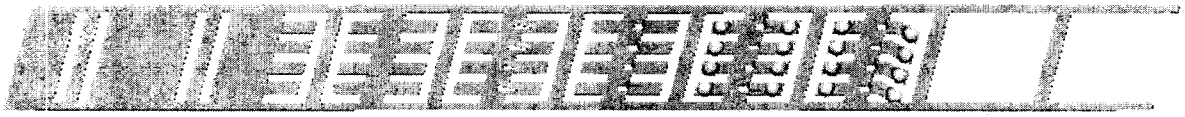
According to upper knowledge using, this study could approach to the optimum die design. Furthermore the aim of zero defect could be obtained mostly by revision on the try out[1,2].

## 2. Die assembling design

In this study, we used Auto Lisp with Auto-CAD system and WINDOW environment to design the die, the others of without Auto Lisp database altered to our instructions and experiences. The first step of this

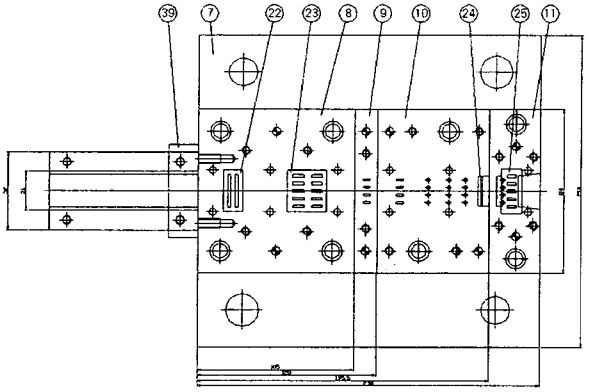



(a) Strip process layout

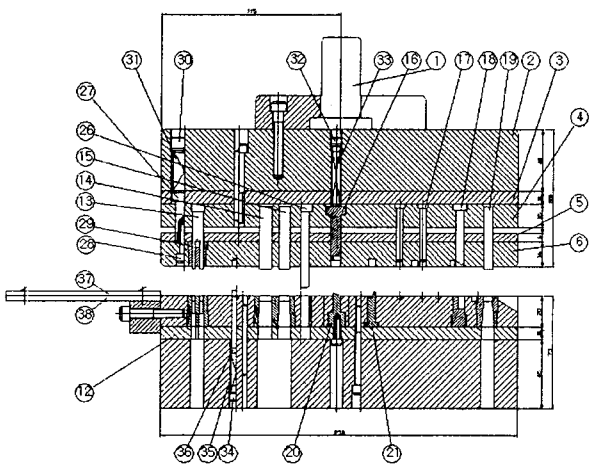


(b) The modelling result of strip process layout by IDEAS

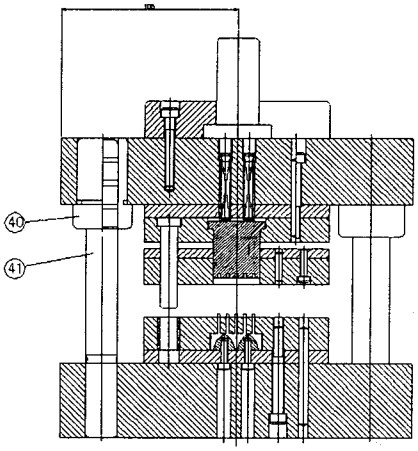
Fig. 2 Strip process layout



(a) Top view

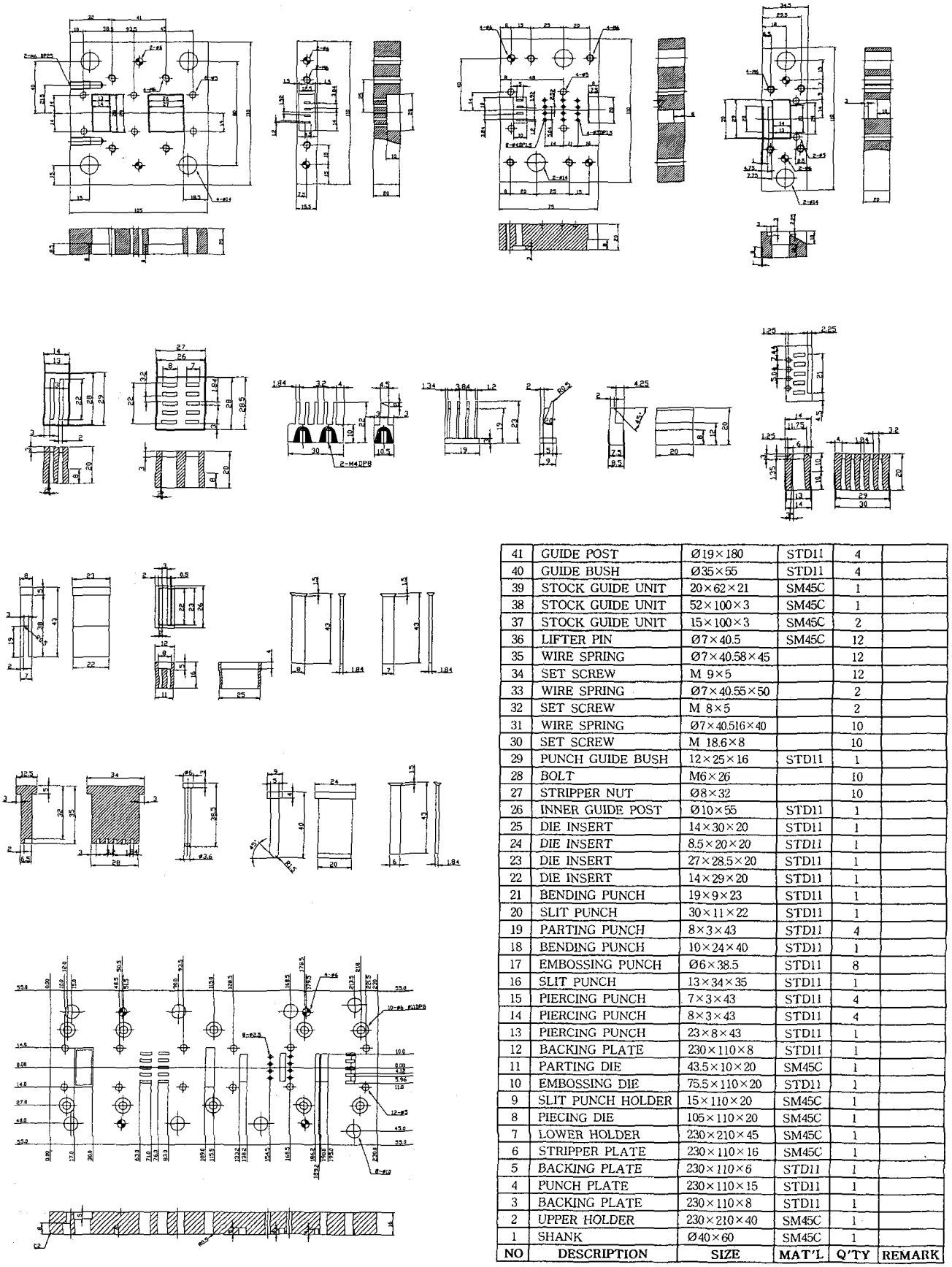


(b) Front view



(c) Side view

Fig. 3 Die assembling drawing



| 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 | STD11 | 1 | |
| 24 | DIE INSERT | 8.5×20×20 | STD11 | 1 | |
| 23 | DIE INSERT | 27×28.5×20 | STD11 | 1 | |
| 22 | DIE INSERT | 14×29×20 | STD11 | 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. 4 Die components drawing (Punch and die and part-list)

study was review of production part drawing in Fig.1. The second that appeared work was strip layout design in Fig.2 according to those developing system and our instructions and experiences.

The third step was die assembling 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 high 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(additional guide posts were 8 inner guide posts in die block region). Fig.3 shows the result of die design in this study, namely, summary assembling die drawing.[1,2,3,4]

## 3. Die Components Design

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.

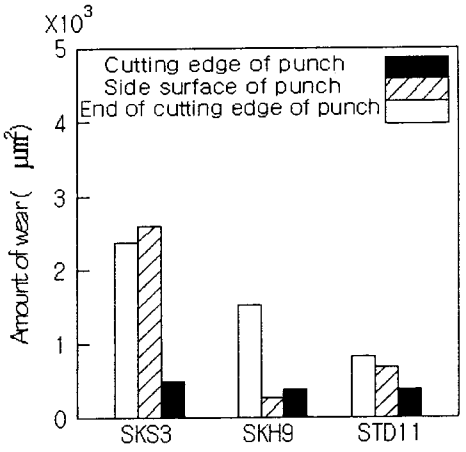
The representative drawing of result of this processes is shown in Fig.4.

## 4. Die Making and Tryout

### 4.1 Die Making

Fig.5 shows the wear amount of die materials.[5]

In this figure we can select the adaptive die material STD27 according to the punch and die features. 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 and mirror machining..




(a) Effect of tool steels by punch wear


(b) Effect of tool steels by die wear
$\phi$ 10 blanking, $H_RC61$(punch, die)
baintesteel, 10% clearance-lubrication
lot size : 10,000

**Fig.5** Comparison of punch and die material

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. 6 shows the progress of CNC machining center working

### 4.2 Tryout

Fig.7 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.[8, 9]

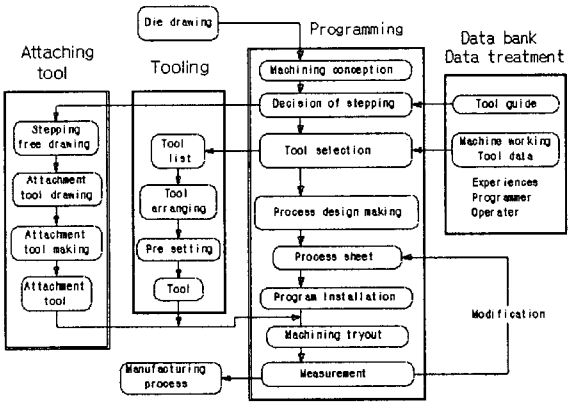
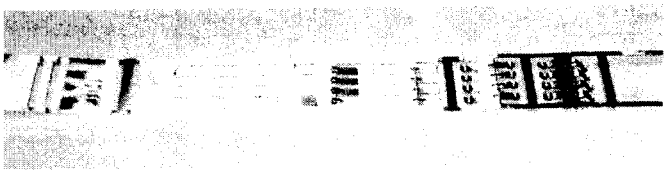



**Fig.6** Progress of CNC machining center working

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.



**(a) Actual producted part**

**(b) Actual product part**

**Fig. 7 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 Auto-Lisp with Auto-CAD and WINDOW environment was very effective method for the design of die.

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

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

## Acknowledgement

This work was supported by Brain Korea21 project in 2001

## References

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

(2) Sim, Sung-Bo, Song, Young-Seok, May,(1999)

Development of the Practical and Adaptive Die for Sheet Metals(2), Proceeding of KCORE Conference, pp. 149~155.
(3) Karl, a.Keys,(1982) Innovation in Die Design, SME, pp. 71~99.
(4) Hutota, M., (1975) Preworking and Die Making, Higan Tech. Paper Co., pp. 121~180.
(5) Hutota. T,(1969) Databook of Pressworking Process Design, Press Tech, Vol. 7 No. 13, Higan Tech. Paper Co., pp. 1~201.
(6) Donald, F. Eary, Edward, A. Reed, (1982), Techniques of Pressworking sheet Metal, Prentice Hall, Inc, Tool and Die Failures, ASM, pp. 18~31.
(7) Sung-Bo Sim, Young-Seok Song,(1999), Development for Practical and Adaptive Progressive Die for Design and Making of Marine Part Sheet Metals(1), Inter. Jour. of Ocean Eng. and Tech., KCORE, Vol. 2 No. 2, pp. 19~25.
(8) M. I. Moto,(1969), Press-Progressive Die Higan Industrical Paper Co.
(9) M. H. Moto,(1970), Press working and Die Making, Higa, Industrial Paper Co.