An Automated Design System of Press Die Components Using 3-D CAD Library

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Abstract. Standard components usage in a press die is recognized as a way for a cost reduction and a short lead time. It also provides a way for a quick maintenance of a die under repair. It is expected to contribute to integration of CAD/CAM system for manufacturing dies in the future. This paper presents a 3D CAD library which is constructed using the standard components and is used for designing a press die. This 3D CAD library is generated by a database system made of Microsoft Access for standard components and by CATIA V5 R10 API for geometric features. The library is implemented using Visual Basic 6.0 utility of CATIA API function in the Windows NT environment. It creates a 3D model of the standard components of press die easily when a die designer inputs numerical values of geometric features and the BOM of the completely assembled parts. It also generates automatically the assembly drawing of die set by using variables for standard values of die parts. Therefore users can save the cost of time to design the press die components, and even a beginner can use this program with ease. The test results of the 3D CAD library for designing shearing and bending dies verify its usefulness and feasibility.

Keywords: 3D CAD Library, Press Die Components, Microsoft Access, CATIA, API, Visual Basic , Design, Database, BOM.

1 Introduction

Today, one of the most important demands of industries is to reduce the development time and cost for products. Among several different manufacturing processes for production, a press die has been recognized as an efficient method for mass production [1,2].

With the introduction of Computer Aided Design (CAD) system in 1980's, the way of die design procedure was dramatically improved for drawing and management. However, 2 D CAD system had still limitations in design analysis, manufacturing, assembly, and inspection process, so that human should monitor all processes. In other words, it was essential to keep highly skilled person in die design process. Since 1990s, these limitations were overcome with the introduction of 3D CAD system, in

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which the difficulties on the interference check between parts and 3D model recognition were resolved.

A die system for a product can be classified into injection dies and press dies. The injection die automatic design system has already been established due to convenient steps in production process. Commercial software such as MOLDACE [3] and CADMAX [4] are popular in industries based on 2 D CAD modeling. Recently, 3 D CAD library establishment for mold base for injection die and mold die parts has been studied [1,2]. Based on 3D solid model, IMOLD, MOLDWARE, RAMDES, Pro/Mold, K-Mold provide a standard library to designers [5,6,7].

However, contrast to injection mold, 3D solid model do not provide enough libraries for press mold because the application of press mold is so broad, even though the standardized part is strongly required in press mold design. Some major big companies developed in-house API to support standardization, but other small companies have very limited to use this type of standardized system.

In this paper, 3 D CAD libraries data bases are built and applied to press die design in order to support and expedite design and manufacturing process of small company press die application system. The Microsoft Access is used to build database of die standardized part, so that any beginner level designer can easily search die part and modify it if any design change is necessary. Therefore, 3 D CAD model can be easily generated by just inputting numerical values in data base system. Also, the developed automatic system can easily generate the global assembly by putting together some parts. This automated design system is based on CATIA solid modeler [8], and Visual Basic is used for API. This automated press die design system is applied to shear and bending press die design, and provide efficient design system.

2 Press Die Components

Press die manufacturing, which uses the plastic deformation of materials, consist of shear manufacturing, bending manufacturing, draw manufacturing, compress manufacturing,

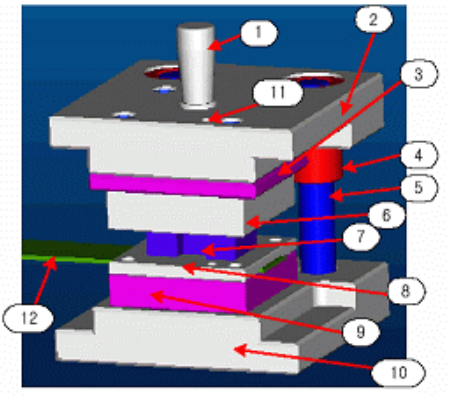


Fig. 1. The Structure of a Shearing Die

Table 1. BOM of Fig.1

Item	Name	Material	Hardness
1	shank		HRC52~54
2	punch holder		
3	backing plate	STD11	HRC57~60
4	guid bush		
5	guid post		HRC58~
6	punch plate		HRC58~60
7	punch	STD11	HRC60~
8	stripper plate		
9	die	STD11	HRC60~
10	die holder		
11	dowel pin		HRC52~54

and so on. Fig. 1 illustrates general layout of shear press. The main components of press die are punch, punch plate, backing plate, stripper plate, die, punch holder, die holder, shank, dowel pin, guide post, guide bush. Table 1 represents the list of part shown in Fig. 1.

3 Die System Configuration and Design

3.1 System Configuration

The die system consists of 3 modules as shown in Fig.2.

- Standard part data base
- Standard part generation API
- Standard and non-standard part library search module

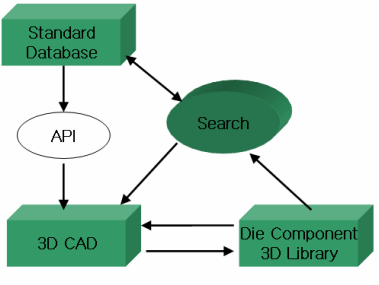


Fig. 2. The configuration of the 3D CAD Library

Fig. 2 shows the flow to create and build part three dimensional library of the standard and non-standard die part based on the data base of part dimensions and specifications. The solid line presents the search process in the die parts three dimensional libraries instead of creating parts again, when certain parts have already created.

3.2 Database

The standardization of die parts is made based on the standard of Korea Die Manufacturing Association. The basic layout of press die database can be divided into 5 items in order to figure out easily the necessary components in the die design process. Table 2 shows the five standard components of press die.

Table 2. Standard components of press die

Die set
Punch and retainer
Pilot and related part
Plate and bush
Other Standard part

3.3 Search Module

Search module is developed to provide the appropriate specifications for the provided dimensions. Fig. 3 shows the flow of generating die part three dimension libraries based on the developed search module.

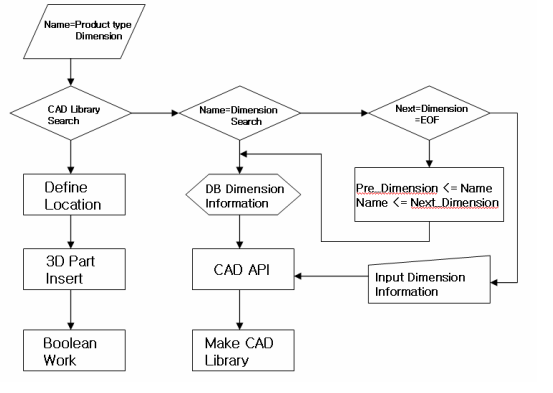
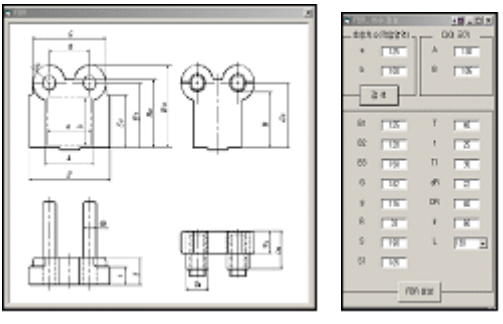


Fig. 3. The Flow Chart for Generating Press Die Components

3.4 System Configuration

Standard part generation is made by 3-D CAD commercial software CATIA, in which the provided API features is used along with Visual Basic 6.0. Fig. 4 (a) illustrates the

(a)



(b)

Fig. 4. Dialog Boxes of Die Set Components

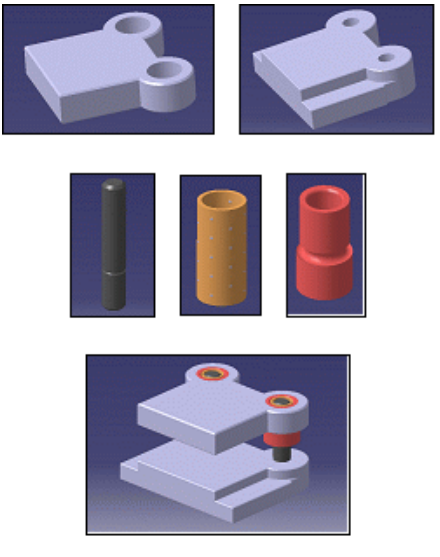


Fig. 5. FBR 125X100 Die Set

dialog box for the die set and the related components, and Fig. 4 (b) shows the dialog box to search the appropriate standard and non-standard parts close to the user specified dimensions. Fig. 5 presents the search results of 125 x 100 FBR die set components and assembly, which are generated from the three dimension library.

4 Design Automation System Application

4.1 Shear Press Design

Fig.6 shows the shear die design. First, the suitable die set is selected, and then three dimension die set components are generated. Fig. 7 illustrates shank B type, and Fig shows the punch plate, backing plate, stripper plate, die plate, which are necessary for assembling die set. The fastener and positioning components are generated in Fig.9. Fig. 10 presents the positioning spot generated in die holder, punch holder, and each plate. Once all processes are finished, each part is put into positioning spot and assembled as shown in Fig. 11, in which the basic shear die is assembled. Fig. 11 shows punch holder, backing plate, punch plate for each bolt and pin. Then rounding work is proceeded for the final configuration of each part. Fig. 12 and Fig. 13 shows the modified components of the final configuration and the assembly of shear die. Table 3 shows the BOM for component name, number, and materials of shear die, shown in Fig. 13.

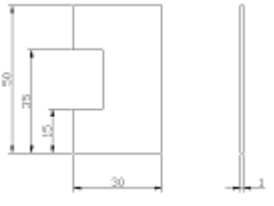


Fig. 6. Product 1

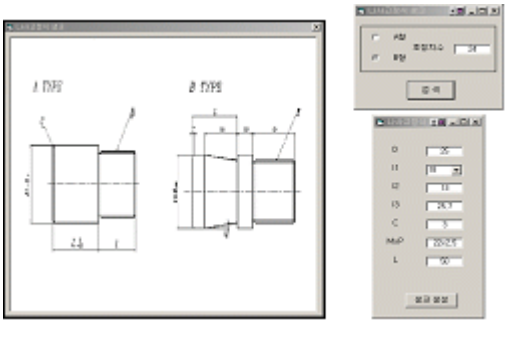


Fig. 7. Dialog Box of Shank

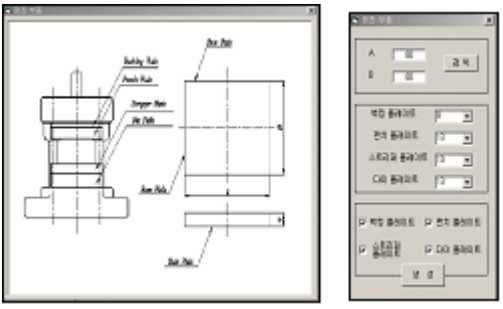


Fig. 8. Dialog Box of Each Plate

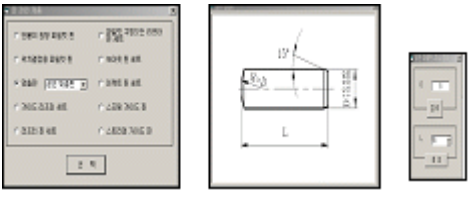


Fig. 9. Dialog Box of Dowel Pin

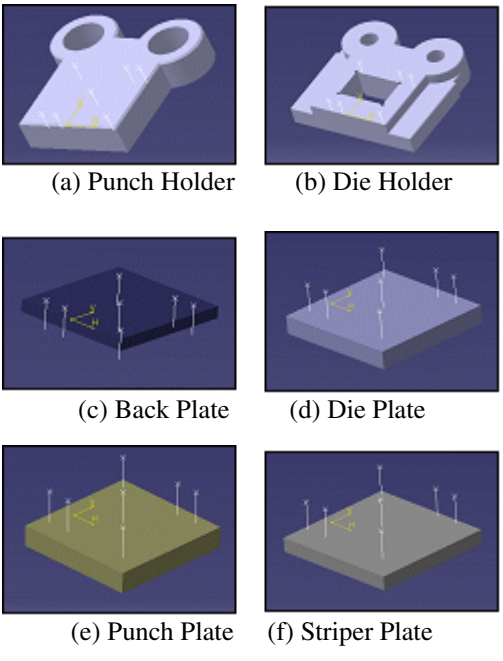


Fig. 10. The Position of each Component

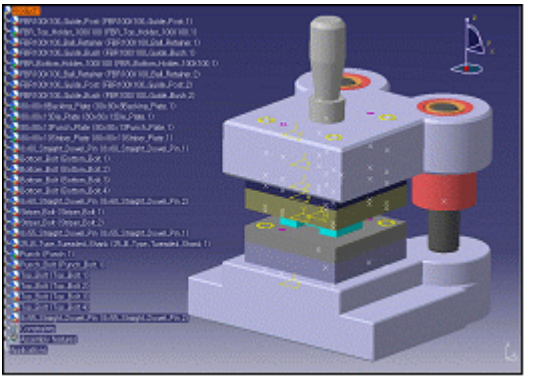
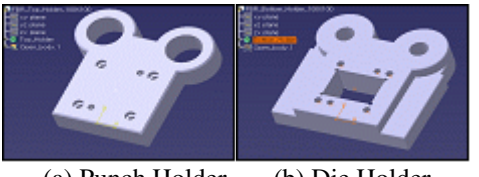
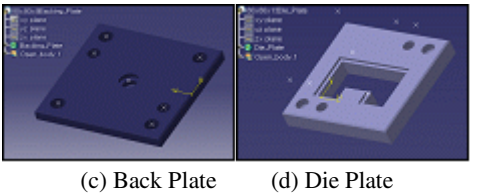


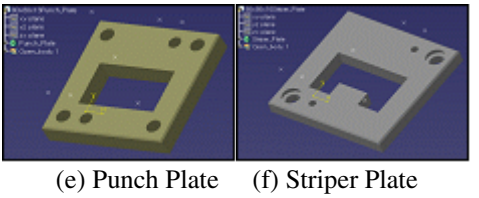
Fig. 11. Assembly of Shearing Die



(a) Punch Holder (b) Die Holder

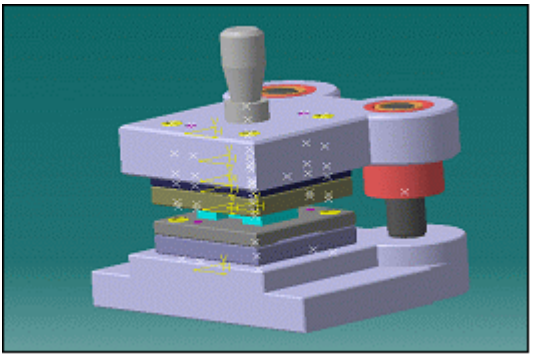


(c) Back Plate (d) Die Plate

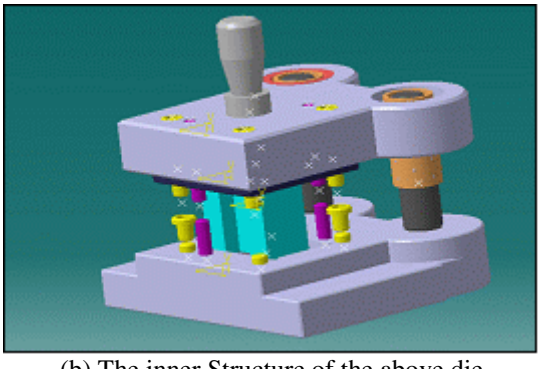


(e) Punch Plate (f) Striper Plate

Fig. 12. Components at the Final Stage



(a) The Assembly of Shearing Die for Product 1



(b) The inner Structure of the above die

Fig. 13. The Final Assembly of Shearing Die

Table 3. BOM of the Product 1

	A	B	C	D	E	F	G
1	Part name	Quantity	Material	Volume	CdgX	CdgY	CdgZ
2	Top_Bolt	4	SCM4	3,94168E-06	0	0	0,02968371
3	8X55_Straight_Dowel_Pin	2	STS3	2,71968E-06	0	0	0,0275765
4	Punch_Bolt	1	SCM4	1,24146E-06	0	0	0,00910916
5	Punch	1	SKD11	6,37062E-05	0	0,016414315	0,0248358
6	25_B_Type_Tureaded_Shank	1	SM45C	3,34078E-05	0	0	0,04229848
7	Striper_Bolt	2	SCM4	1,24146E-06	0	0	0,00910916
8	8X60_Straight_Dowel_Pin	2	STS3	2,97101E-06	0	0	0,03007647
9	Bottom_Bolt	4	SCM4	3,43274E-06	0	0	0,02546107
10	80X80X10Striper_Plate	1	SS41,SM50C,STC3,STS93,STD11	4,56601E-05	1,65058E-05	0,041354537	0,00516995
11	80X80X13Punch_Plate	1	SS41,SM50C,STC3,STS93,STD11	5,99327E-05	0	0,041634274	0,00641897
12	80X80X13Die_Plate	1	SS41,SM50C,STC3,STS93,STD11	6,21772E-05	0	0,041019119	0,00647145
13	80X80X8Backing_Plate	1	SS41,SM50C,STC3,STS93,STD11	4,71855E-05	0	0,040000071	0,00398632
14	FBR100X100_Guide_Bush	2	STB2	4,318E-05	0	0	0,02689662
15	FBR100X100_Guide_Post	2	STB2	4,86216E-05	0	0	0,06511833
16	FBR100X100_Ball_Retainer	2	alloy Al, alloy Cu (Steel Ball = GC20)	1,1801E-05	0	0	0,03
17	FBR_Bottom_Holder_100X100	1	GC20	7,16558E-04	0	0,07779275	0,01847516
18	FBR_Top_Holder_100X100	1	GC20	5,196E-04	0	0,074313767	0,01742132

4.2 Bending Press Design

In order to design bending die, shown in Fig. 14, the reasonable size of FCR die set is selected to generate three dimensional die set components, in which the shank A type shown in Fig. 7 and all components of die set such as punch plate, packing plate, stripper plate, and die plate. Then knock-out pin set is generated in Fig. 15. Fig. 16 describes the determination of position for punches and the generation of points and axis for the parts. Once all processes are completed, each part is assembled according to the position point, then the basic bending die is manufactured. The position of punch holder and punch plate and assembled parts are shown in Fig. 17. Fig. 18 and Fig. 19 presents the final part and assembly for the bending die. Table 4 explains the BOM of the product shown in Fig. 19 and describes the name, number, and materials of bending die.

Fig. 14. Product 2

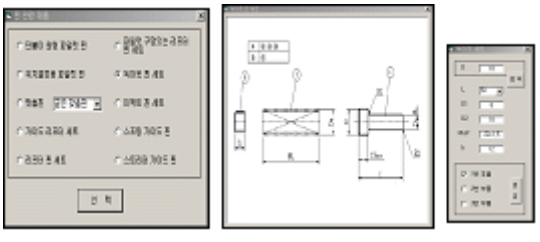
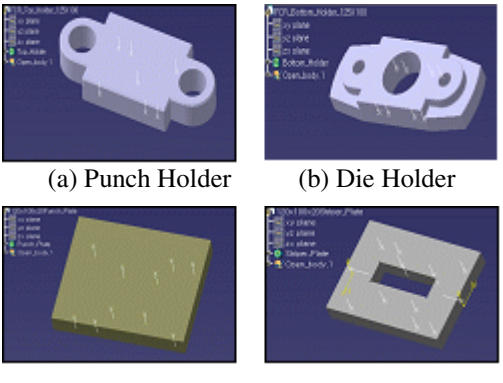


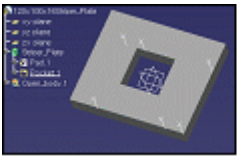
Fig. 15. Result of the automatic design



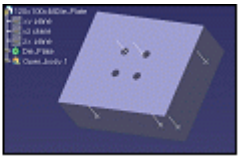
(a) Punch Holder (b) Die Holder

(c) Punch Plate (d) Striper Plate 1

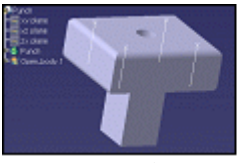
Fig. 16. Result of the automatic design



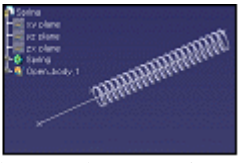
(e) Striper Plate 2



(f) Die Plate

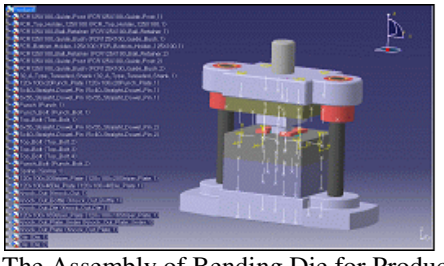


(g) Punch

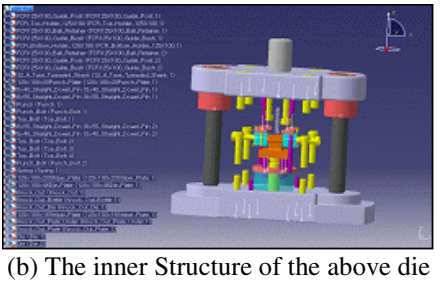


(h) Knock Out Spring

Fig. 16. (*continued*)

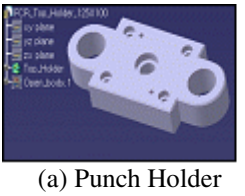


(a) The Assembly of Bending Die for Product 1

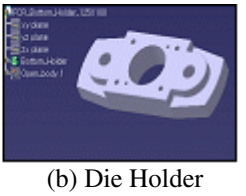


(b) The inner Structure of the above die

Fig. 17. Result of the automatic design

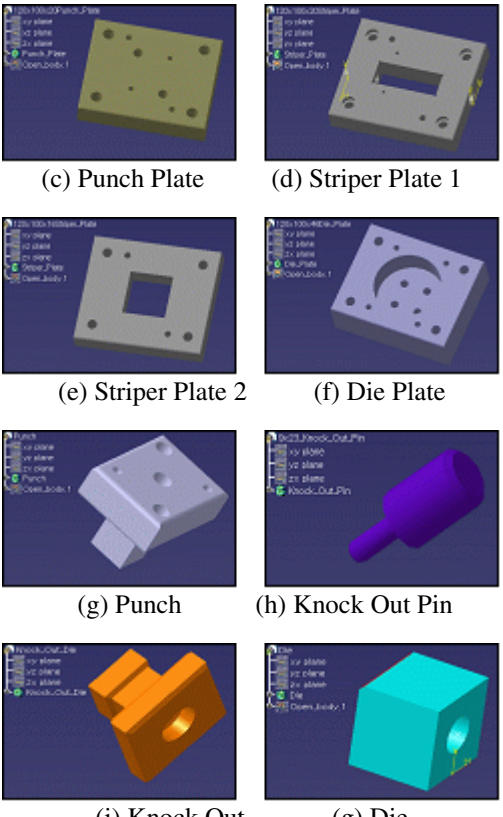


(a) Punch Holder



(b) Die Holder

Fig. 18. Result of the automatic design



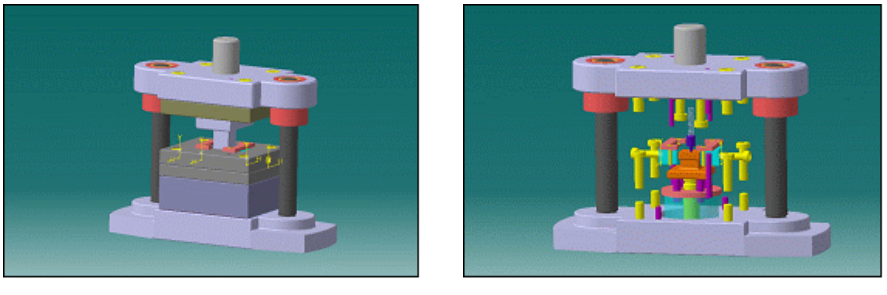
(c) Punch Plate (d) Striper Plate 1

(e) Striper Plate 2 (f) Die Plate

(g) Punch (h) Knock Out Pin

(i) Knock Out (g) Die

Fig. 18. (*continued*)



(a) The Assembly of Bending Die for Product 2 (b) The inner Structure of the above die

Fig. 19. Result of the automatic design

Table 4. BOM of the Product 2

	A	B	C	D	E	F	G
1	Part name	Quantity	Material	Volume	CdgX	CdgY	CdgZ
2	9X23_Knock_Out_Pin	1	STC4	9,10748E-07	0	0	0,01521375
3	Striper_Bolt_Part	4	SCM4	2,30034E-07	0	0	0,01462701
4	8X30_Straight_Dowel_Pin	4	STS3	1,46305E-06	0	0	0,0150767
5	6X55_Straight_Dowel_Pin	6	STS3	1,53081E-06	0	0	0,02746357
6	Striper_Bolt	4	SCM4	3,33062E-06	0	0	0,0255136
7	Part20	2	STS3	2,86415E-06	2,48560E-02	6,47231E-03	0,00253995
8	Striper_Side_Bolt	2	SCM4	2,94891E-06	0	0	0,0224011
9	Bottom_Bolt	4	SCM4	4,47732E-06	0	0	0,03368204
10	Die	2	SKC11	6,53511E-06	0	-3,72365E-04	0,00998521
11	Knock_Out_Plate	1	SM20C	1,49440E-05	0	0	0,00293946
12	Knock_Out_Plate_Under	1	SM20C	1,55472E-05	0	0	0,003
13	20X100X16Striper_Plate	1	SS41,SM50C,STC3,STS93,STD11	1,60986E-04	0	0	0,008
14	Knock_Out_Die	1	SM45C	2,22406E-05	0	0	0,01086974
15	Knock_Out_Bottle	1	SCM4	2,09675E-05	0	0	0,04009356
16	Knock_Out	1		8,32229E-05	0	0	0,0205
17	20X100X46Die_Plate	1	SS41,SM50C,STC3,STS93,STD11	4,24885E-04	0	-1,27499E-05	0,02478388
18	20X100X20Striper_Plate	1	SS41,SM50C,STC3,STS93,STD11	1,99209E-04	2,55129E-05	0	0,00992777
19	Spring	1	SPC2	6,74078E-08	0	0	0,01699711
20	Punch_Bolt	2	SCM4	3,12955E-06	0	0	0,02301189
21	Op_Bolt	4	SCM4	6,40974E-06	0	0	0,03177053
22	5X40_Straight_Dowel_Pin	2	STS3	7,68517E-07	0	0	0,01989783
23	Punch	1	SKH3	5,85505E-05	0	0	-0,0143921
24	20X100X20Punch_Plate	1	SS41,SM50C,STC3,STS93,STD11	2,27586E-04	0	0	0,00999629
25	32_A_Type_Tureaded_Shank	1	SM45C	5,29118E-05	0	0	0,04562546
26	FCR125X100_Guide_Bush	2	STB2	4,31800E-05	0	0	0,02689662
27	FCR125X100_Guide_Post	2	STB2	8,47342E-05	0	0	0,11269691
28	FCR125X100_Ball_Retainer	2	alloy Al, alloy Cu (Steel Ball = GC20)	1,18010E-05	0	0	0,03
29	FCR_Bottom_Holder_125X100	1	GC20	7,69175E-04	0	0	0,01837779
30	FCR_Top_Holder_125X100	1	GC20	5,63250E-04	0	0	0,01727743

5 Conclusion

This paper presents an automated design system of press die components using 3-D CAD library. The press die 3 D component generation program build databases for die part components, then those database are used for the design of shear and bend die design.

1) 3D CAD library is established for the press die with dialog box type.
2) For non-standard dimensions, the closet dimension standard information is provided, so that the designer can be encouraged to use the standard part.
3) The position and axis are used for component assembly instead of presenting complete configuration for all components, so the interference of components can be identified in advance.
4) In shear die and bending die design, the press die part 3 D CAD library is used to create BOM, so that beginner designer can accomplish the pre die design efficiently.

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