CHAPTER 4

PROGRESSIVE DIE DESIGN

This chapter is the principle of progressive die design for a wheel frame of caster wheel. Progressive die is a complicated die because it has to consider all sequences of operation , working force and many factors. Once the progressive die do a replacement , there will be some changes such as process flow , line layout, the management. Therefore before decision is made, the top manager has to understand the design procedure and die design.

4.1 Steps of die design

The step of design has to carried out in proper step in order to prevent confusion and in correct way because progressive die is a complicated die with synchronized sequences. Therefore it has to be aware of design step. The step of design is listed as following

4.1.1 Product pattern or shape

Study the shape of product whether progressive die is able to perform or not by considering the shape product. According to drawing for wheel frame, it is a round shape, there is no undercut and no down- taper shape. Round sharp is a normal shape that not complicated to do progressive die.

4.1.2 Material thickness

The thickness of material is neither so thin nor thick .if so thin, it can not be pilot, if it is so thick it is a straightening problem. In this case, the thickness of material of wheel frame is acceptable. The thickness is between1.5-2 mm. Material must be a rolled steel so that it can be feed continuously into die.

4.1.3 Layout of die working step

By considering that a material strip will not be snapped till the last step (cut off) and the movement of strip in the die will not be obstructed for example forming has to come after pierce to prevent hole distortion by forming because part is stretch after forming. The gap between each step on die has to be aware, because it will affect to the durability and force withstanding of die and the center of gravity. More over it has to consider the scrap of each operation.

4.1.4 Working force

The working force is necessary to be calculated for the die design in term of force withstanding. Working force is shown in the next item.

4.1.5 Design in a rough draft and draw in CAD and fill out data and Specifications.

4.1.6 Review the finished design in CAD

Drawing of product to be designed

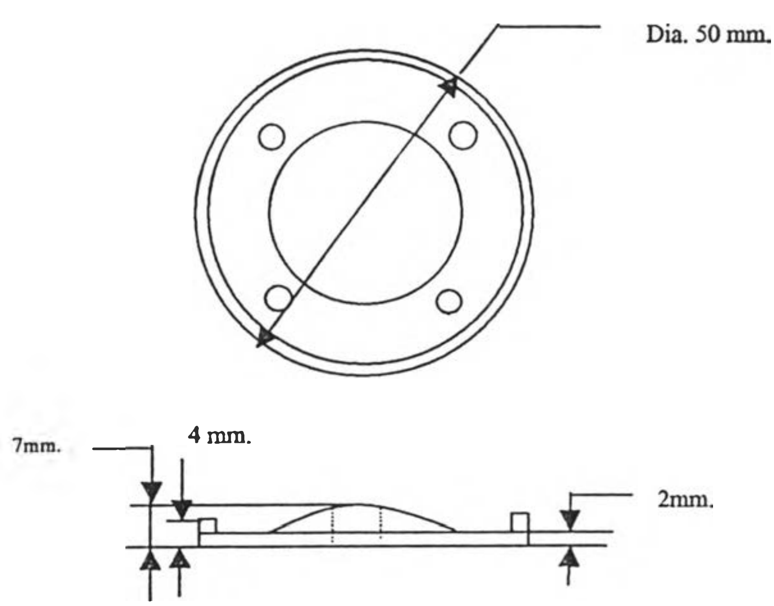


Figure 4.1 Drawing of wheel frame

4.2 The process of working step design in progressive die

After consider a pattern of product, the next step is to design process step in progressive die of making wheel frame. It can be determined in 5 steps as following,

1. Piercing pilot

Pilot is first step. It is to make a step of pierced 2 holes on sheet metal for pilot metal coil in the right manner and gap between each operation progression. The propose is to guarantee the progression. Without pierce pilot ,stripper plate or metal coil will not move forwards in precise step of progression.

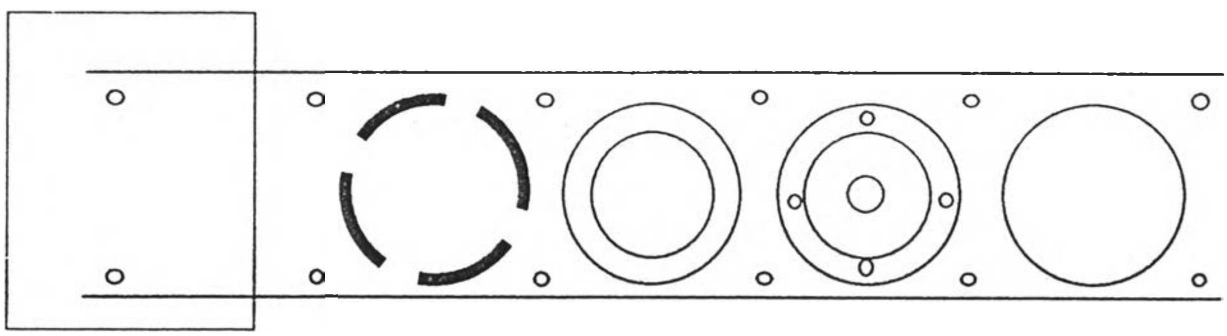


Figure 4.2 Piercing pilot process

2. Blanking

Blanking is the second step. It is to cut in profile wheel shape and leave out at a four connection gab. Blanking is needed in making wheel frame because it allows metal to be formed easily since it prevents metal from distortion and spring back case in a forming operation. The gab allows part to be connected with stripper through the end of operation.

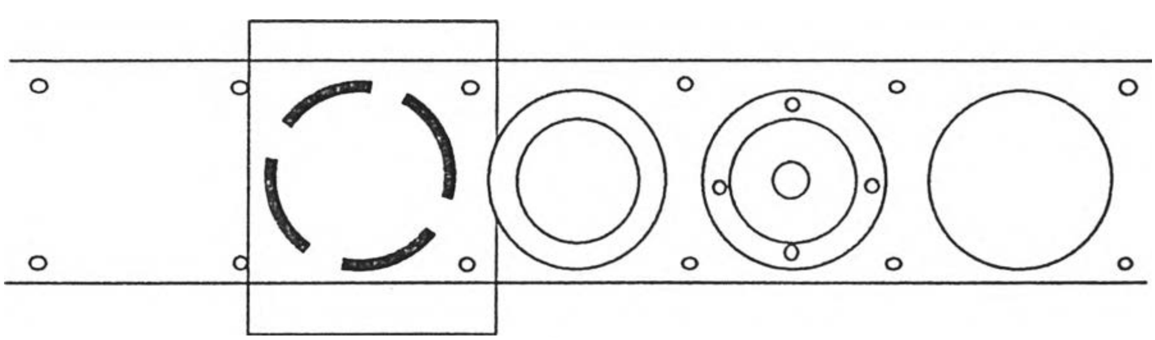


Figure 4.3 Blanking Process

3. Forming

Forming is the third step. It is to perform one -completed forming wheel shape. Spring back and distortion of forming is eliminated because there is a gap allowance compensation on the previous process. Forming operation is the most maximum force of all operations for making wheel frame. In making wheel frame, there is only 1 completed forming operation because shape is not so complicated ,not to deep and no undercut of part to be formed.

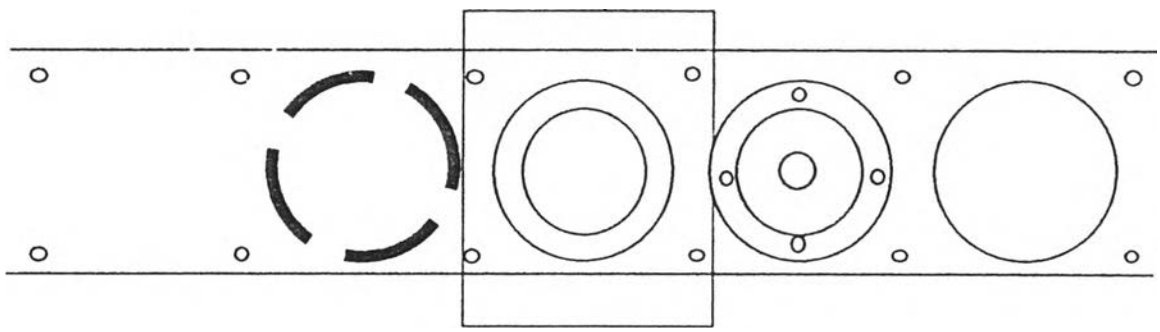


Figure 4.4 Forming process

4. Pierce hole

Pierce hole is forth step. It is to pierce 4 holes at the same time. These 4 holes are for fitting rivets on. Pierce tool needs to be replaced occasionally because burr will occur due to worn out tool.

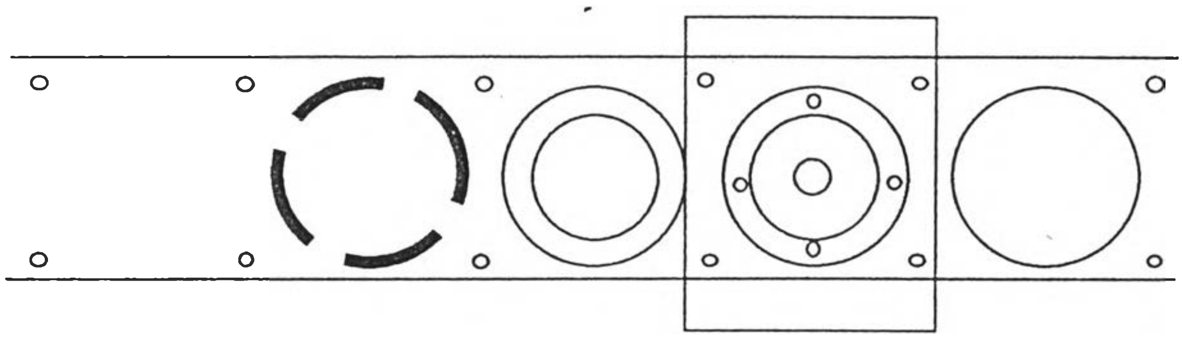


Figure 4.5 Pierce holes

5. Cut off

Cut off is the fifth step. This is the last process of making wheel frame. It is to snap finished part off from stripper plate. Part is ejected out by ejector pin. Without ejector, part will be stuck up inside die due to force from cut -off applied. Container underneath is needed to allow finished part slide down into container.

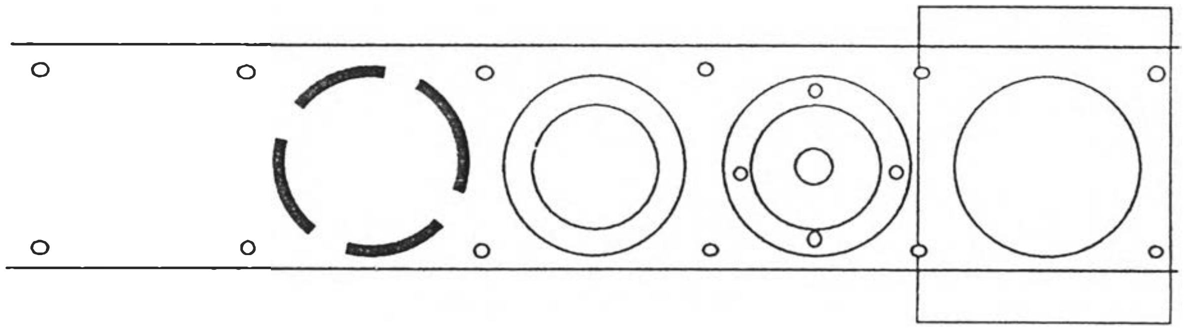


Figure 4.6 Cut off

4.3 Production Process

The process starts from rolled cold metal installed in uncoilor machine then metal is pulled from uncoilor machine by auto feeder into a progressive die. Every operation is operated at the same time but progress simultaneously until complete all operations. Finished part will be cut off from strip plate metal. What operator need to do is to install roll coil to uncoilor with air feeder and die set up.

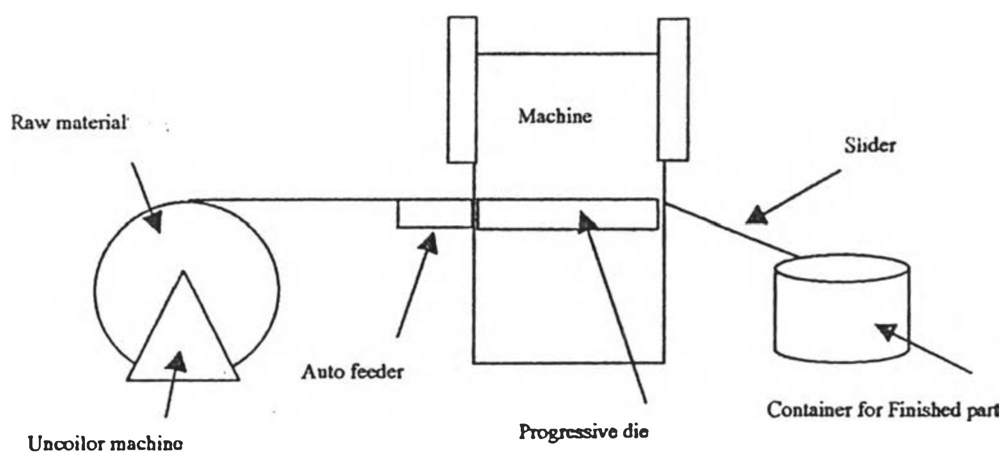


Figure 4.7 Production process from input →process →output

4.4 Resources

- Material

Material for the progressive die is normally a cold rolled sheet. Because progressive die is a continuous process therefore material has to be a continuous material which is a cold rolled sheet metal. However cost of cold rolled is a little expensive than single sheet's that used in single die.

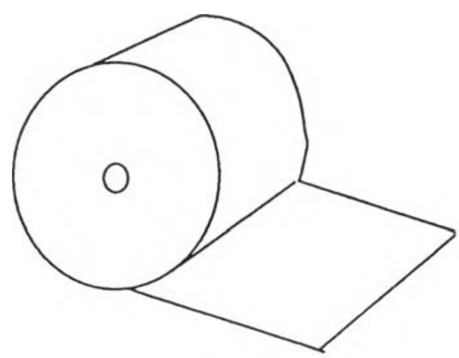


Figure 4.8 Roll sheet metal

- Machine

Machine for running progressive die is the same types with the single die's but may require a little more capacity. This is actually depending upon a progressive die to be located. In this case, force for overall operations is not exceed 80 ton machine(see calculation on working force next issue). Therefore existing machine is capable to run progressive die.

- Man

Man power or operator for progressive die is negligible. Operator does not need stand-by all the time while process is running. Operator is responsible to install rolled coil or change new rolled coil once material is running out and make sure all parameters is under control. One operator will be able to handle for all cases but need to be trained "on the job training" and basic knowledge of progressive die before running.

4.5 Calculate working force

Working force acting on die has to be calculated to study the capability of machine whether it is capable to withstand total force of progressive die or not. To calculation force needs to be concerned on some material property. It needs to be collected in order to calculate the force.

Steel metal sheet	S41
Thickness of material	2 mm.
Strain force	1,000 kg/cm or 100 kg/mm
Shear force	75 kg/mm

In die design, working force is the factor to consider for considering appropriate machine capacity. In the case of making wheel, there are working force to be concerned such as piercing force, nourishing force, forming force) stamping.

The formular of the working force is obtained from Prof. Chuowalit " the principle of die technology " King Rama4 institute of technology, 1985

1. Pierce force is a force to make hole for pilot.

   D= 5.10 mm, 2 holes

   Pierce force = 2 (P ∅ 5.10)

   = 2(2 πr) x shear force

   = 2 ((3.14) (5.10)(2)(75)/1,000))

   = 4.8 tons

2. Stamping is a force apply on part to form in required shape the area.

   Stamping force = strain forcex2πrx

   = 100 x 2x3.14x25/1,000

   = 15.7 tons

3. Piercing center is a force applied to punch enter hole.

   = (3.14x 12x2x75)/1,000

   = 5.65 tons

4. Piercing fitting is a force applied to punch fitting 4holes round wheel frame.

   = 4(3.14x5x75x2/1,000)

   = 9.42 tons

5. Cut off is a force applied to cut a contour of wheel frame out of strip metal.

   = 2 x3.14x25x75/1,000

   = 11.78 tons

   = 77 tons

6. Stripping force

Normally when material is cut or pierced, material is stacked with puncher therefore it needs some force to pull material out of punch or cut. It is called stripping force. This force is also making a perfect progression. Normally 15% of working force.

Stripping force =0.15x total force

=(0.15)(77)

= 11.55 tons

7. Power press

Power press is force for total maximum force for achieves progressive die. This is to find the machine, which appropriate to support the progressive die. Working force plus stripping force does it.

Power press = working force +stripping force

= 11.55+77

= 88.55 tons

8. Side force is force that produces acting perpendicular with working force. This is to calculate for determining six of fasteners of die.

$$\text{Side force} = \frac{\text{cutting force x clearance}}{\text{T - \% penetration}}$$

Where, cutting force = working force + stripping force

$$= \frac{(88.55)\times(0.125)}{(2-0.6)}$$

$$= 7.9 \text{ kg.}$$

Therefore side force = 7.9 kg.

9. Thickness of die is the minimum of thickness of progressive die to cope with total force applied.

$$\text{Thickness of die} = \sqrt[3]{\text{working force (kg)}}$$

$$= \sqrt[3]{77{,}000}$$

$$= 42 \text{ mm}$$

The minimum thickness is 42 mm.

4.5 The die design in CAD

The die design is design in CAD release 13 in next page

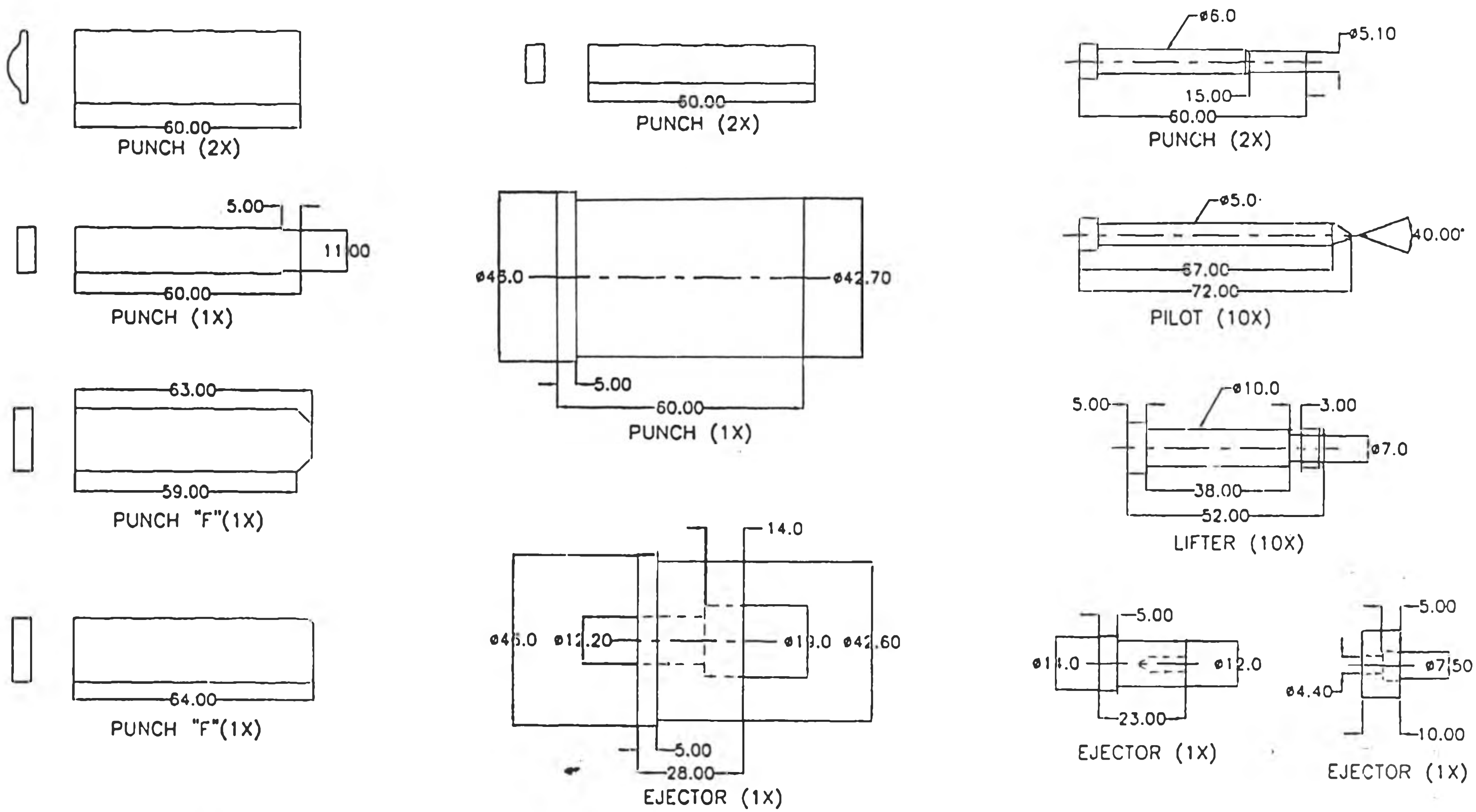


Figure 4.9 Drawing of punch tool

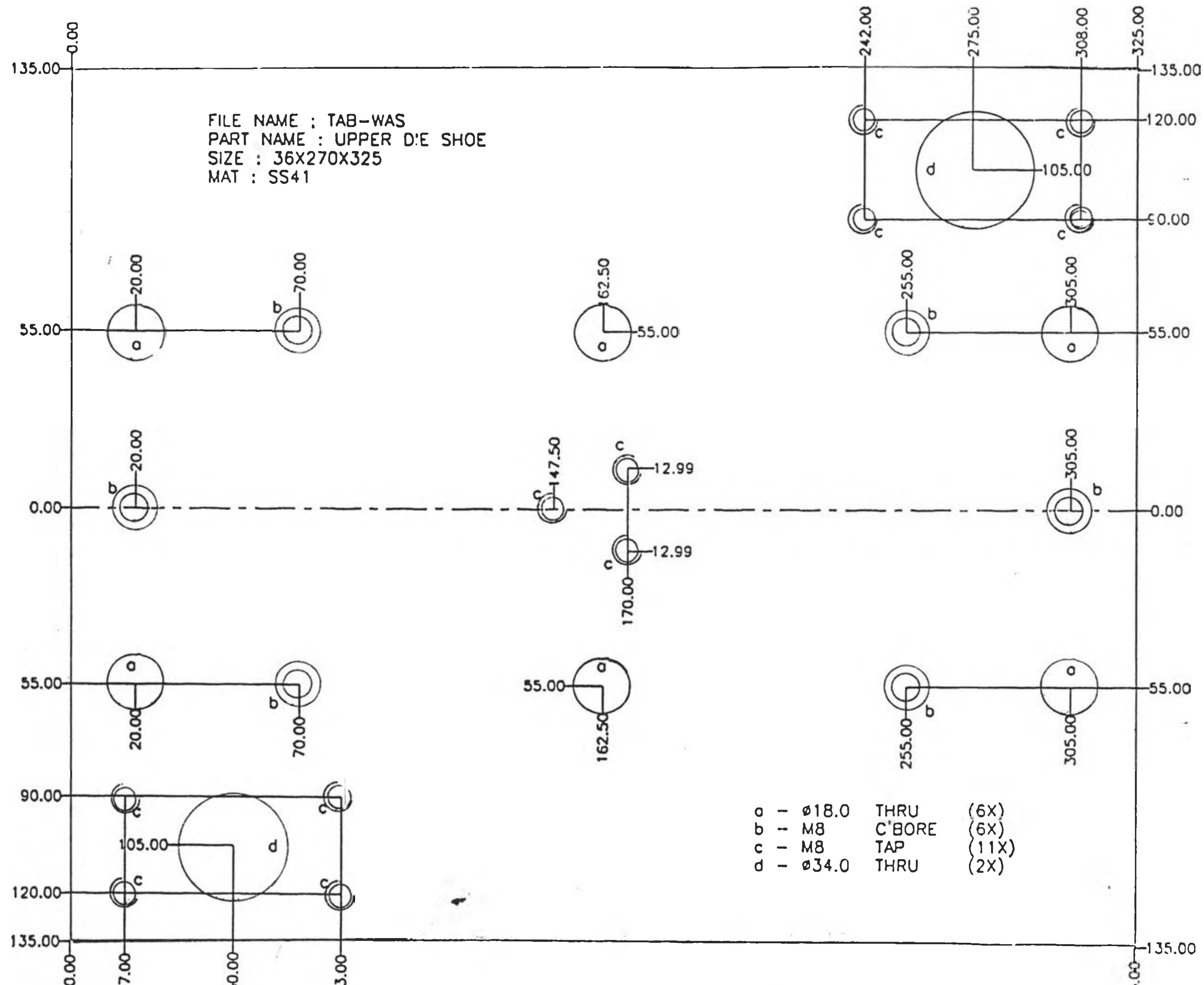
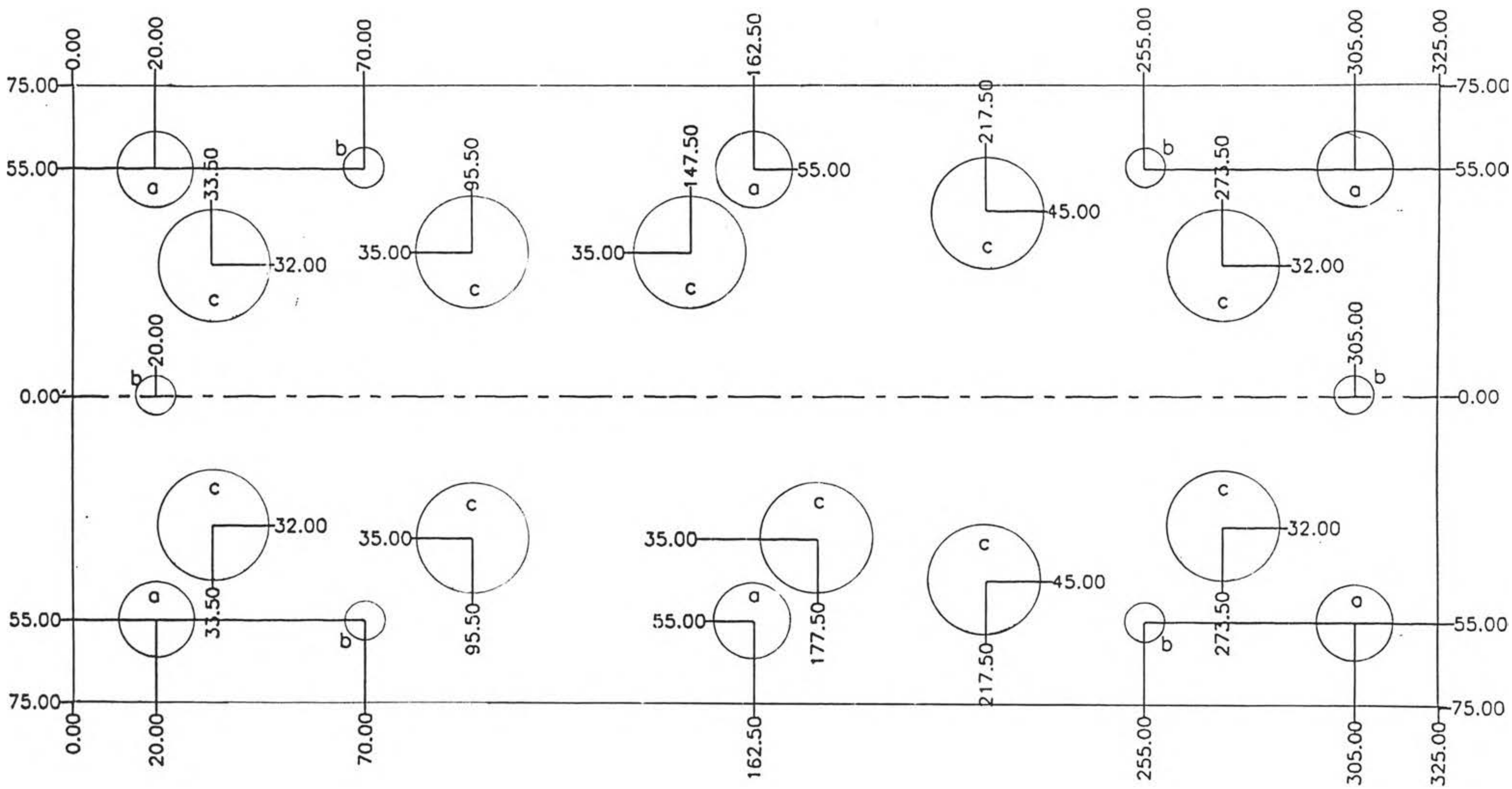


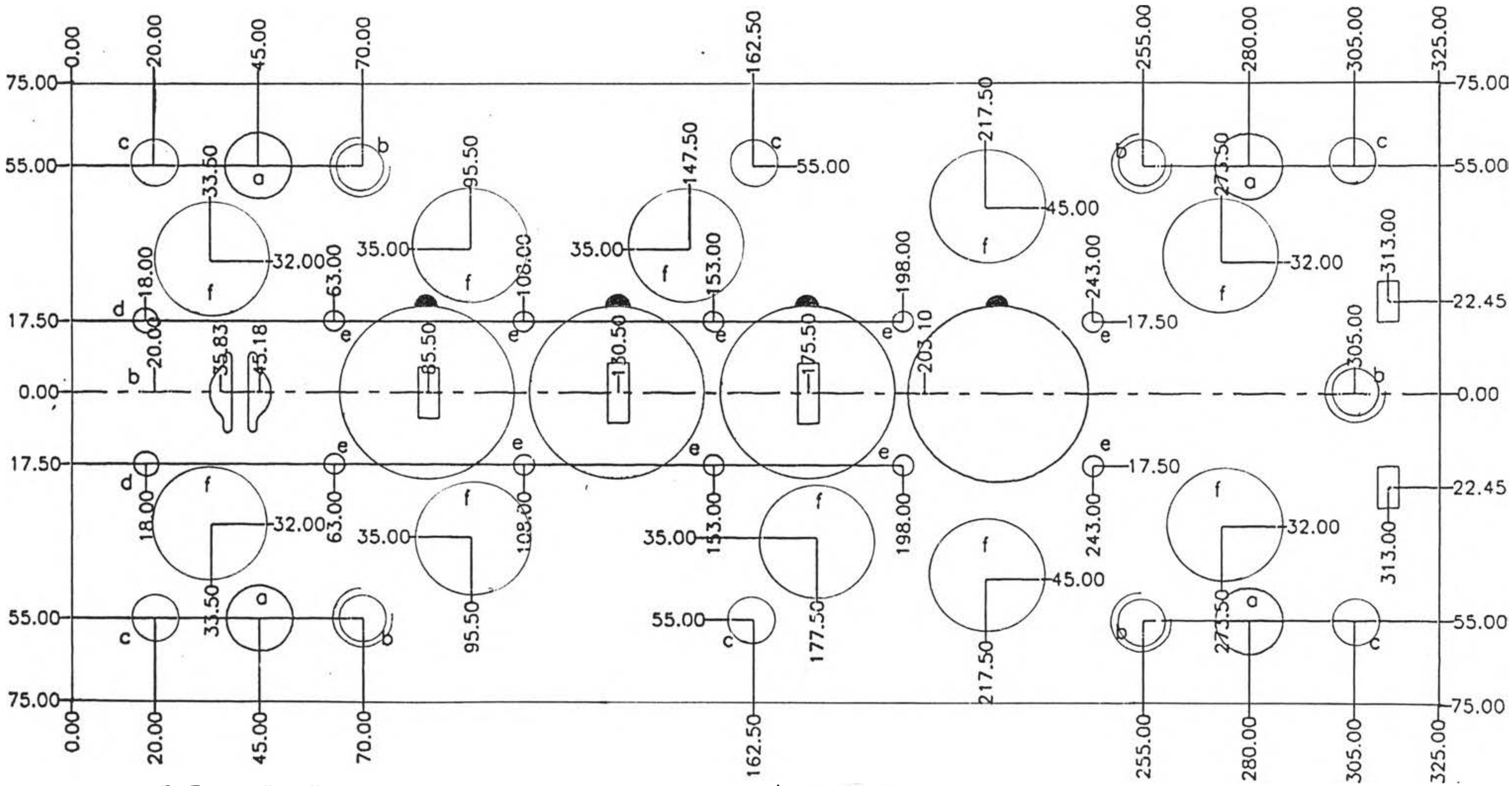
Figure 4.10 Drawing of upper die shoe



FILE NAME : TAP-WAS
PART NAME : PUNCH PACKING
SIZE : 15X150X325
MAT : S50C

c – ø18.0 THRU (6X)
b – ø9.0 THRU (6X)
c – ø26.0 THRU (10X)

Figure 4.11 Drawing of punch packing

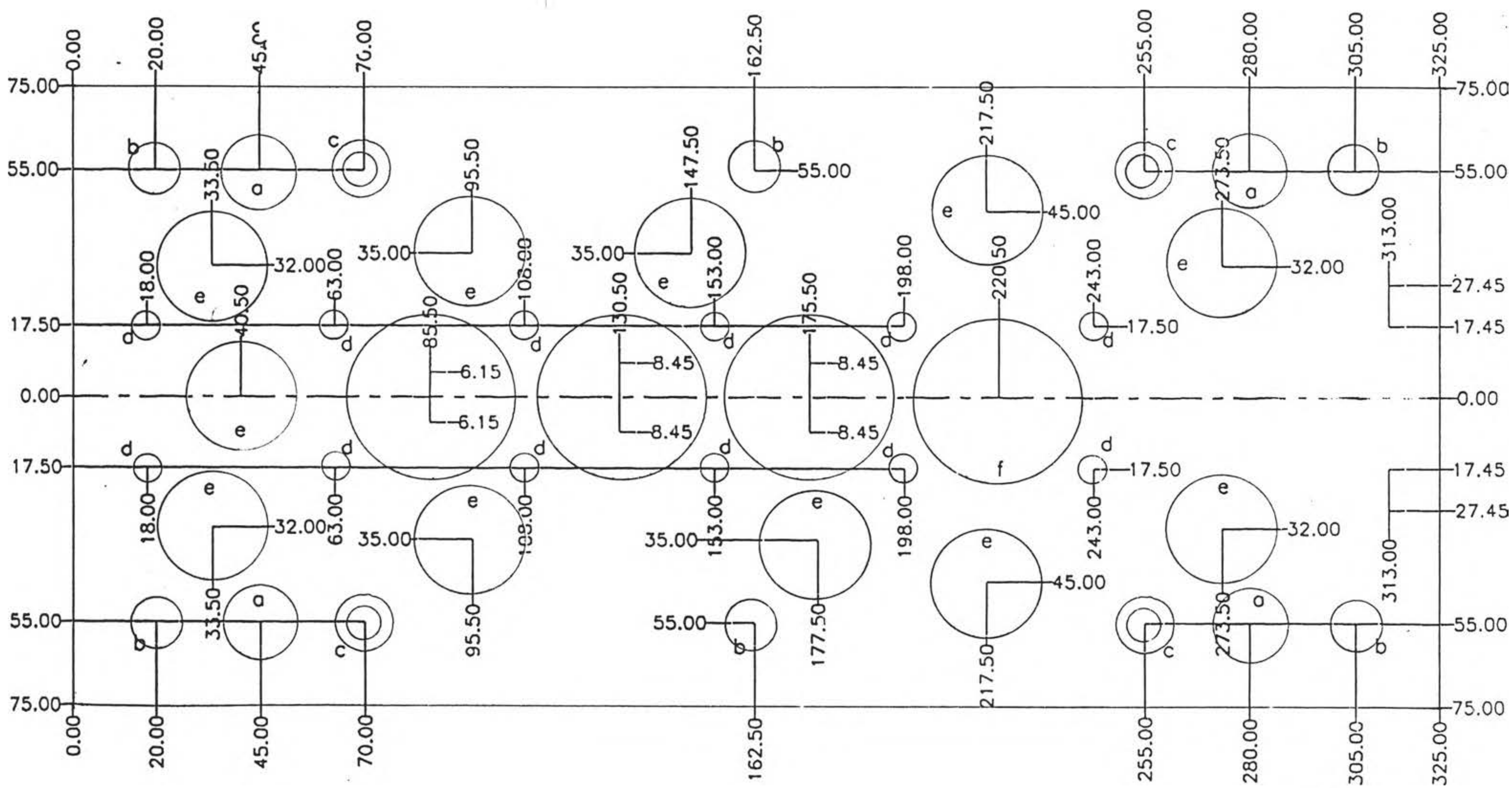


FILE NAME : TAB-WAS
PART NAME : PUNCH HOLDER
SIZE : 23X150X325
MAT : S50C

a –	ø16.0	W/C	(4X)
b –	M8	TAP	(6X)
c –	ø11.0	THRU	(6X)
d –	ø6.0	W/C	(2X)
e –	ø5.0	W/C	(10X)
f –	ø26.0	THRU	(10X)

NOTE :
LINE IN CYAN W/C +0.07/S.
LINE IN RED W/C –0.04/S.

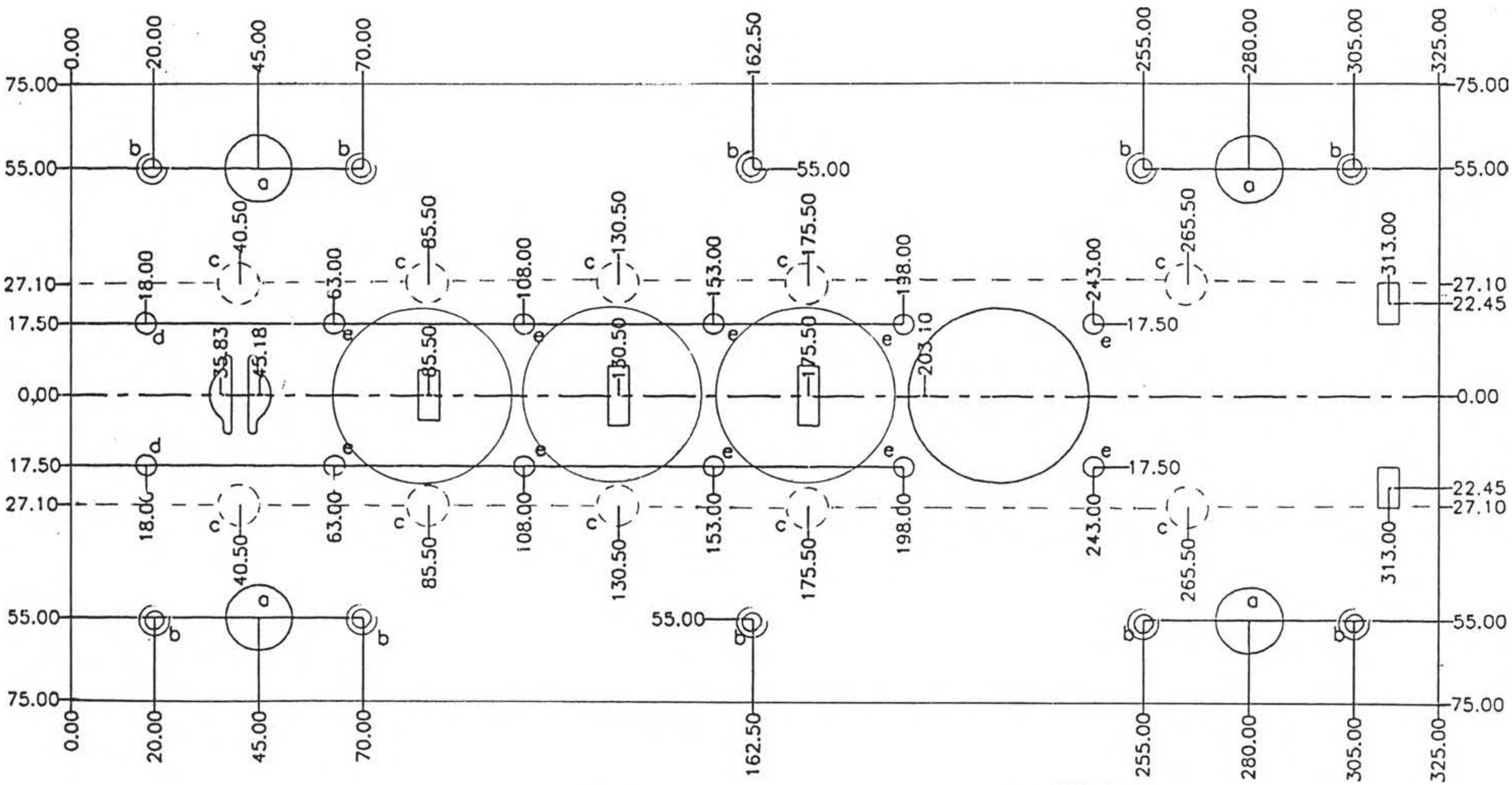
Figure 4.12 Drawing of punch holder



FILE NAME : TAB–WAS
PART NAME : BOTTOMING PLATE
SIZE : 14X150X325
MAT : SS41

a –	ø18.0	THRU	(4X)
b –	ø11.0	THRU	(6X)
c –	M8	C'BORE	(4X)
d –	ø7.0	THRU	(12X)
e –	ø26.0	THRU	(11X)
f –	ø45.0	THRU	(1X)

Figure 4.13 Drawing of bottom plate

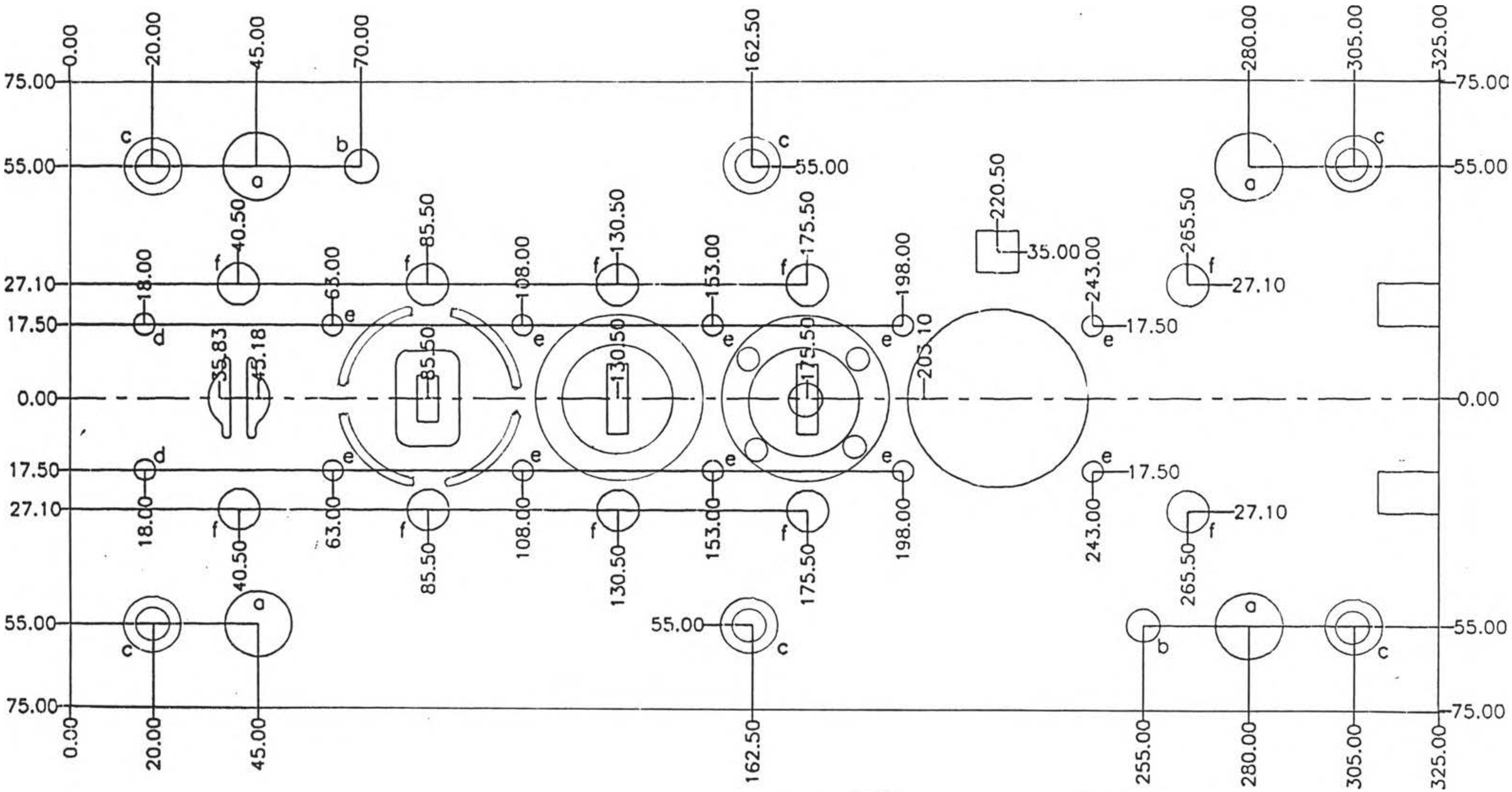


FILE NAME : TAB-WAS
PART NAME : STR-PLATE
SIZE : 22X150X325
MAT : SKD11
HRC : 54-56

a –	ø16.0	W/C	(4X)
b –	M8	TAP	(6X)
c –	ø12.0	D=10.0	(10X)
d –	ø5.10	W/C	(2X)
e –	ø5.0	W/C	(10X)

NOTE :
LINE IN CYAN W/C +0.02/S.
LINE IN RED W/C -0.03/S.

Figure 4.14 Drawing of STR plate

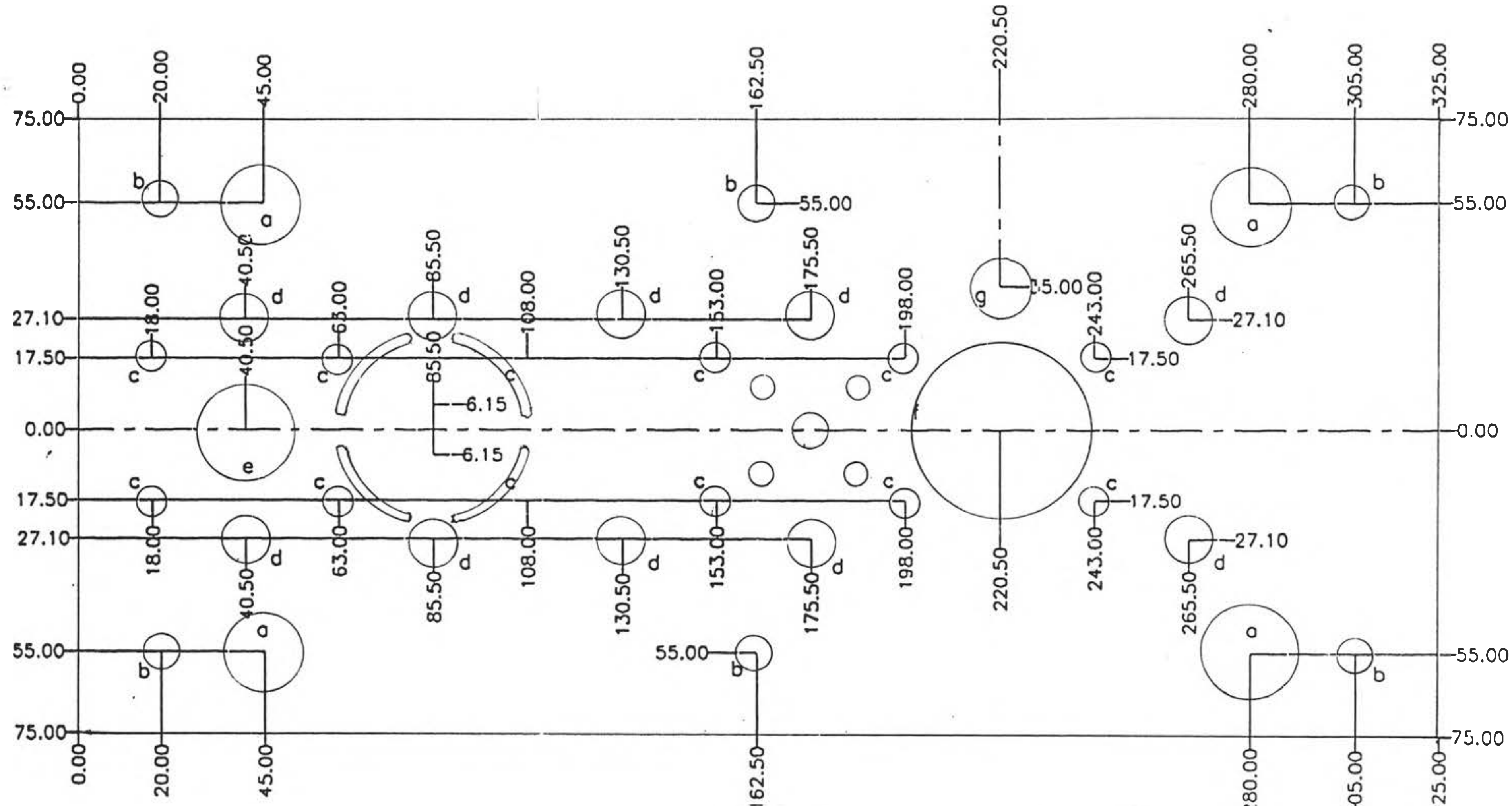


FILE NAME : TAB-WAS
PART NAME : DIE PLATE
SIZE : 23X150X325
MAT : SKD11
HRC : 58-60

a – ø16.0	W/C	(4X)
b – ø8.0	W/C	(2X)
c – M8	C'BORE	(6X)
d – ø5.10	W/C	(2X)
e – ø5.0	W/C	(10X)
f – ø10.0	W/C	(10X)

NOTE :
LINE IN CYAN W/C +0.015/S.
LINE IN RED W/C +0.05/S TAPER.
LINE IN MAGENTA W/C FULL SIZE.

Figure 4.15 Drawing of die plate



FILE NAME : TAP-WAS
PART NAME : DIE PACKING
SIZE : 23X150X325
MAT : SS41

a – ø18.0	THRU	(4X)
b – ø9.0	THRU	(6X)
c – ø7.0	THRU	(12X)
d – ø14.0	THRU	(10X)
e – ø26.0	THRU	(1X)
f – ø48.0	THRU	(1X)
g – ø18.0	THRU	(1X)

Figure 4.16 Drawing of die packing

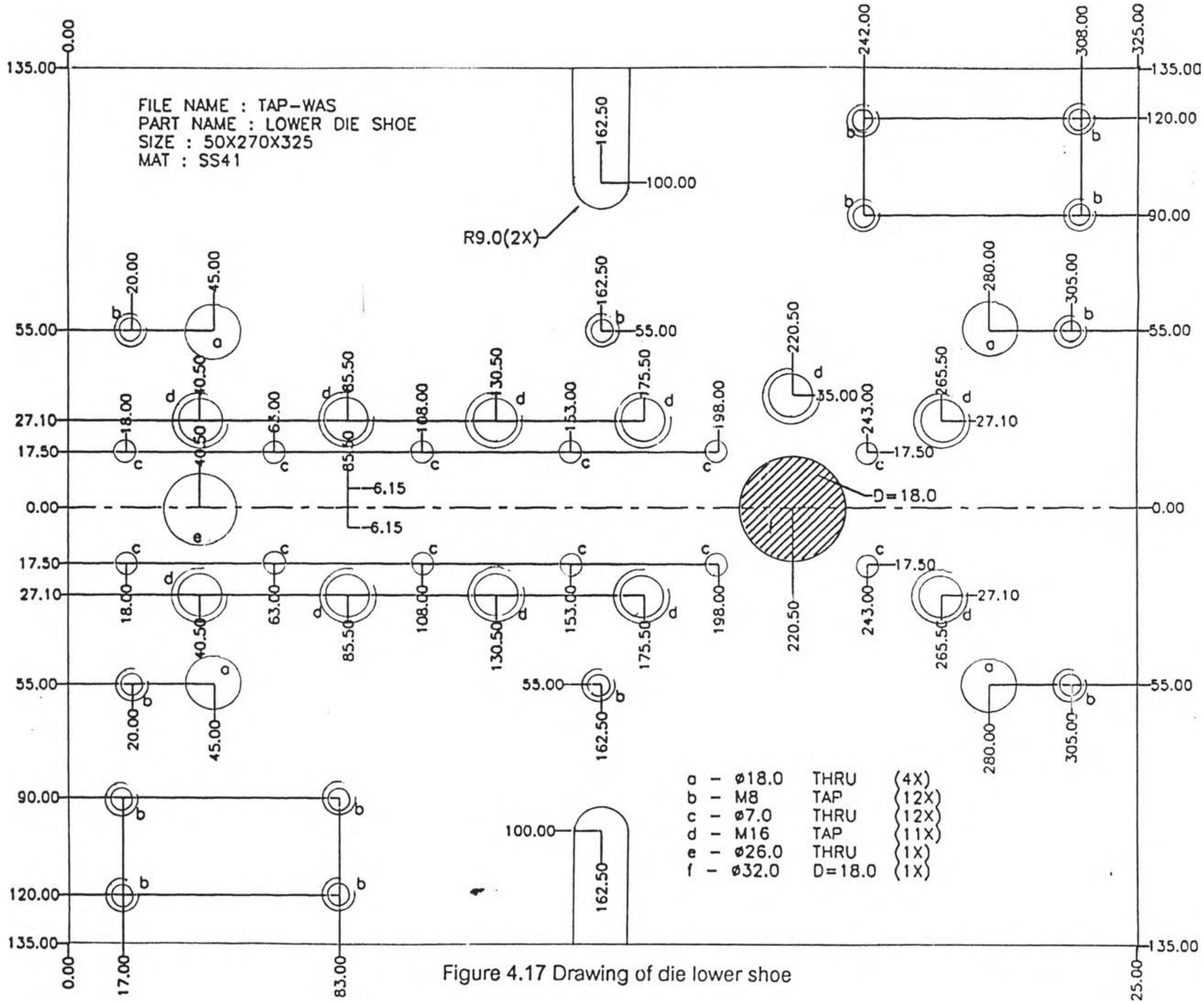
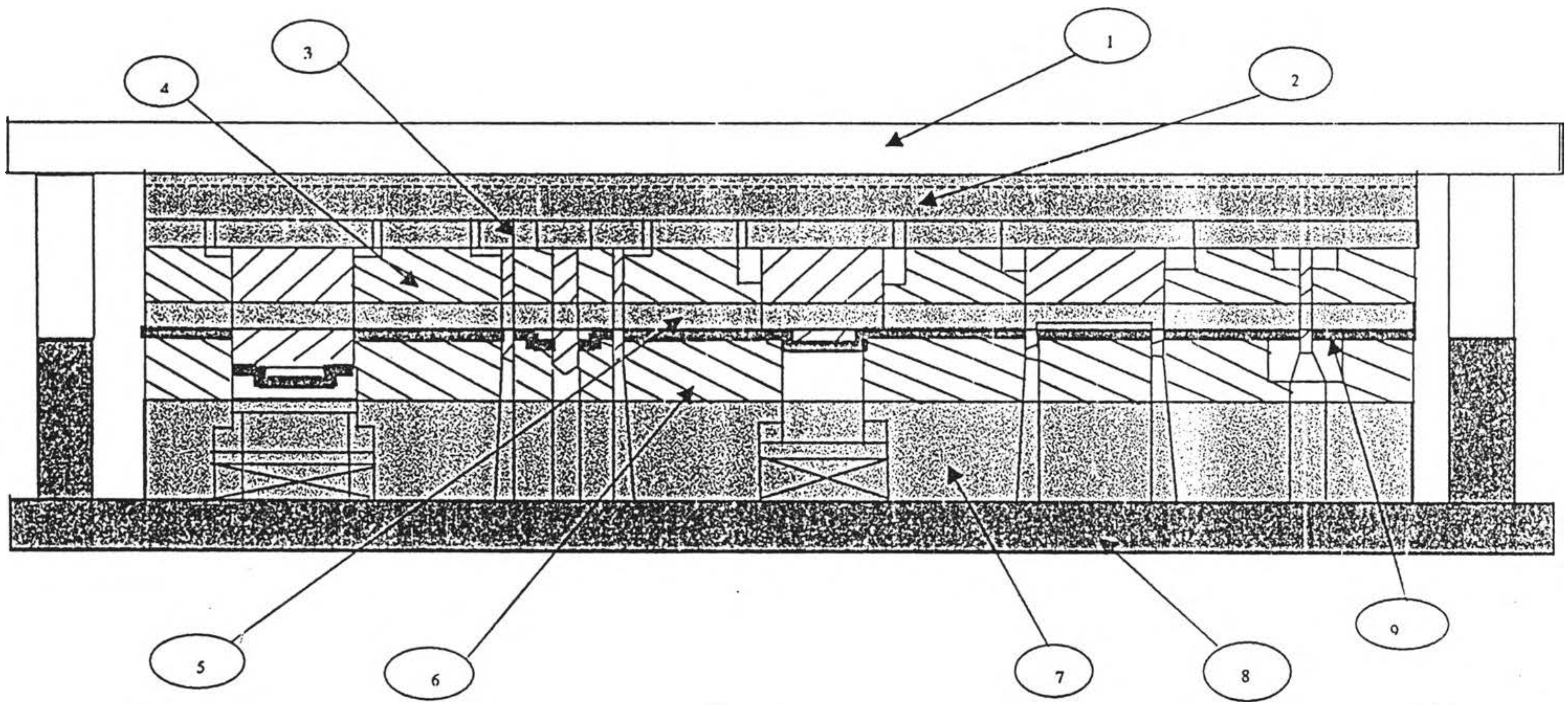


Figure 4.17 Drawing of die lower shoe

ต้นฉบับ หน้าขาดหาย



1 Upper die shoe

2 Punch packing

3 Punch holder

4 Bottom plate

5 STR plate

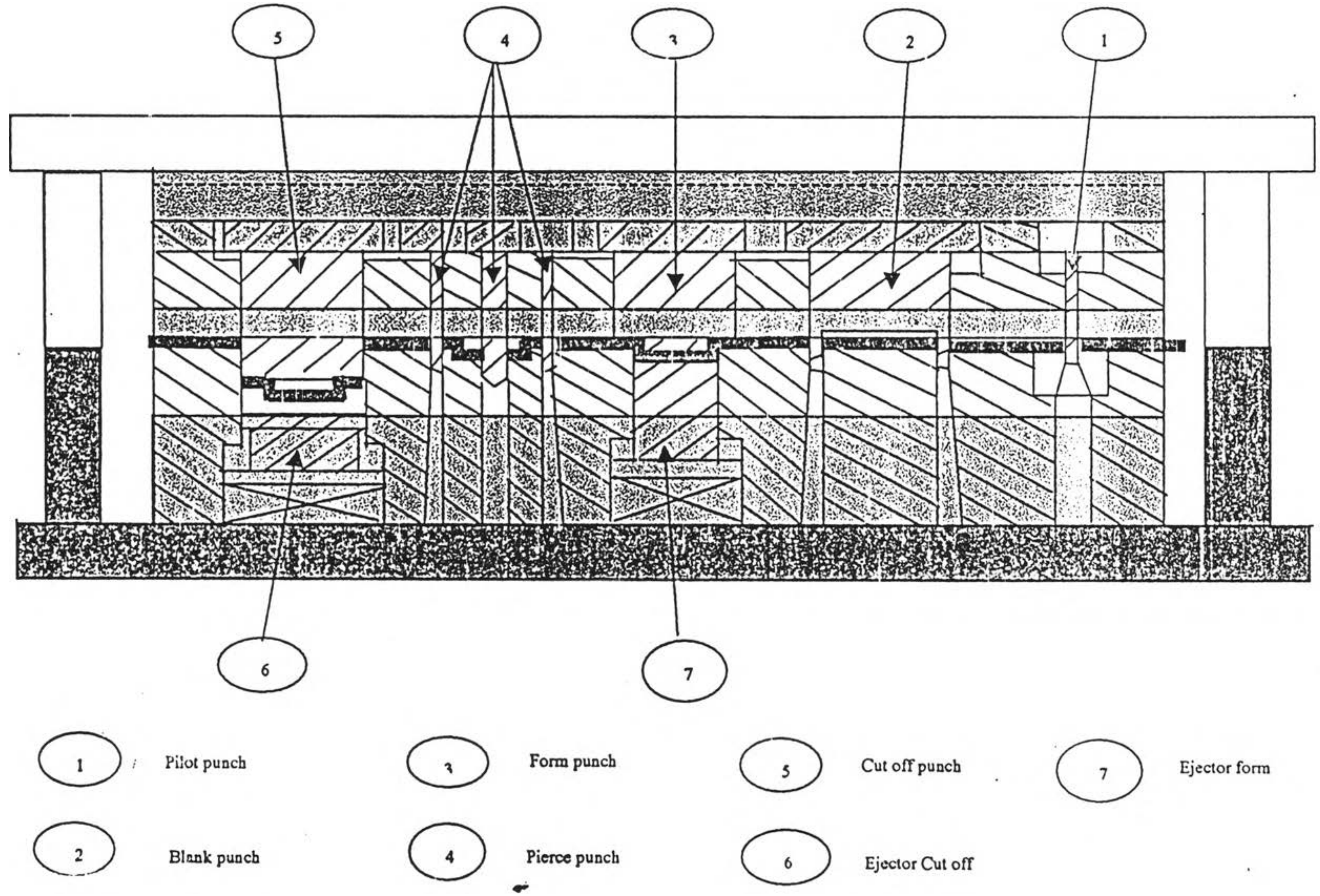
6 Die plate

7 Die packing

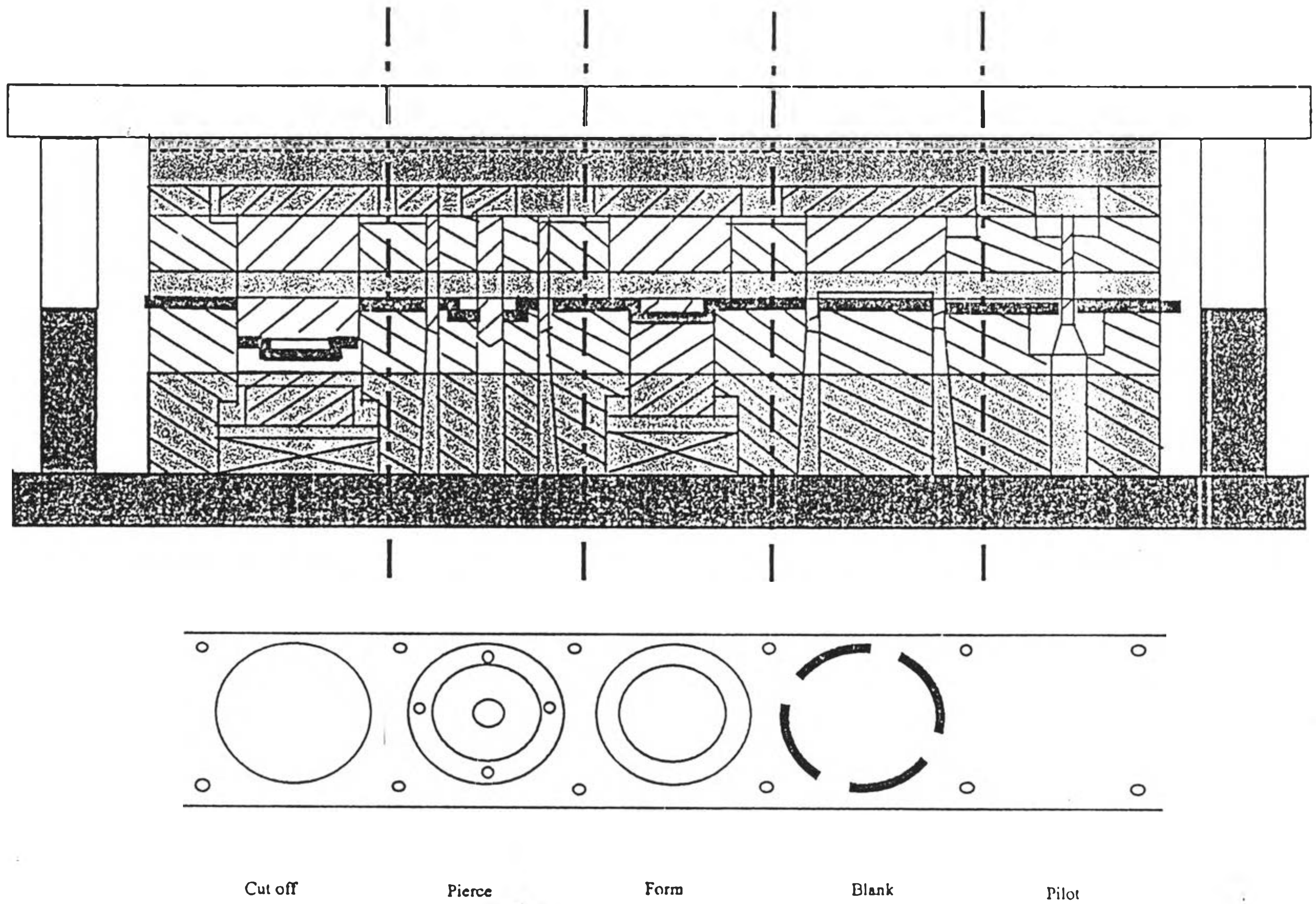
8 Lower die shoe

9 Strip material

Picture 4.19 Completed assembly progressive die



Picture 4.20 Position identification of Punches



Picture 4.21 Operation Process of progressive die

Details of die components

- Punch component sets (Drawing 4.1)

Punch component sets are tools to perform each operation in progressive die. They are located in different positions depending on operation on die design. The positions of all punches located are shown in picture.

- Upper die shoe (Drawing 4.2)

Upper die shoe is one of die components which located on upper of die set. The propose is to hold a die set with guide post of the machine so that die is able to move up-down along guide post.

- Punch packing (Drawing 4.3)

Punch packing is to hold upper die and punch holder together by slot block. It is where a series of absorb spring for punches located. Punch packing is also to prevent impact force from punch tool when perform processes.

- Punch holder (Drawing 4.4)

Punch holder is to hold set of punchers in its places. Punch holder is useful in term of technical once any punch is worn out , that particular punch can be easily changed a new one without change a whole lot.

- Bottom plate (Drawing 4.5)

Bottom plate is to support and guide set of punches from punch holder to its position when set of punches move down to perform press working and eject part once process is done.

- Stripper plate(Drawing 4.6)

Stripper plate is to hold strip metal to stay still in the right position or desire position. Its function is also to prevent metal sheet from distortion.

- Die plate(Drawing 4.7)

Die plate act as a female die which design on shape of product in each step to perform shape when punch moving down.

- Die packing (Drawing 4.8)

Die packing is to hold a lower die and punch holder together by slot block. It is where a series of absorb spring for die located. Die packing is also to prevent impact force from punch perform processes.

- Lower die shoe (Drawing 4.9)

Lower die shoe is one of die components which located on bottom of die set. The propose is to hold a die set with guide post of the machine on bottom so that die is able to move up-down along guide post.

4.6 Detail of calculation of cost in making progressive die

4.6.1 Progressive die cost

Cost of progressive die obtained from 3 items

4.6.1.1 Material cost

4.6.1.2 Labor cost

4.6.1.3 Indirect cost

4.6.1.1 Material cost

Material cost is divided into 2 types

- Standard part

It is part that can be used directly for fabricate die such as spring, pin, guide

Table 4.1 standard material list and cost

NO.	PART NAME	UNIT	PRICE/UNIT (BAHT)	PRICE
1	GUIDE POST (BALL BEARING)	2	1,780	3,560
2	STR-GUIDE	4	1,126	4,504
3	STR-BOLT	6	312	1,872
4	SPRING	12	266	3,192
5	PUNCH	10	520	5,200
6	EJECTOR	3	188	564
7	LEFTER	10	330	3,300
8	PILOT	10	453	4,530
			TOTAL	26,722

Total cost for standard part = 26722 Baht

- Raw Material

It is part need to be purchased in selling size and operated in required actual size. The rate charge for milling is 3.50 baht per cm. (this is done by outsource).

Table 4.2 raw material cost.

NAME	MAT'L	Qty	ACTUAL SIZE	WEIGHT	COST/KG	MAT'LCOST	MILLING	TOTAL
UPPER DIE SHOE	SS41	1	36X270X325	24.79	20	495.8	6824.4	7320.2
PUNCH PACKING	S50C	1	15X150X325	5.74	42	241.08	3563.7	3804.78
PUNCH HOLDER	S50C	1	23X150X325	8.8	42	369.6	3796.5	4166.1
BOTTOMING PLATE	SS41	1	14X150X325	5.36	20	107.2	3534.6	3641.8
STR- PLATE	SKD11	1	22X150X325	8.42	42	353.64	3767.4	4121.04
DIE PLATE	SHD11	1	23X150X325	8.8	42	369.6	3796.5	4166.1
DIE PACKING	SS41	1	23X150X325	8.8	20	176	3796.5	3972.5
LOWER DIE SHOE	SS41	1	50X270X325	34.44	20	688.8	7332.6	8021.4
							TOTAL	39213.92

Sample of calculation for table 4.2

Steel grade S 65 C 32 baht /kg

Specific density of steel 7,850 kg/m

Size of material orders 505x805x42 mm.

Volume .505x.805x.042 = 0.017 m

Weight of steel 0.017x7,850 =133.45 kg

Cost of steel 133.45x32 = 4,270.4 baht

4.6.1.2 The labor cost

Labor cost can be calculated from total time of each operation job then multiplied by cost per minute. To fabricate die. There are 3 processes to be done

1. Drilling
2. Wire cut
3. Milling (outsource)

- Cost of drilling

Labor cost	275 baht /day
Lunch	30 baht/day
Total	330 bath/day or 0.69 baht /min

Therefore cost per minute is 0.69 baht.

Calculate total cost of drilling

Total cost of drilling can be obtained by total time drilling which can be identified by number of job done or number of hole to drill. After that, convert total time of drilling into total cost by multiple cost of drilling per minutes which is 0.69 baht. Therefore cost of drilling can be achieved.

$$\text{Time to drill}^* = \frac{\text{piercing position x number of hole x diameter of drill}}{\text{Cutting speed x feed rate}}$$

* The above formula are obtained from "principle of die design and technology". King Rama 4 institute of technology

Table 4.1 List of break down time in drilling process(Unit: min)

ITEM NO.	HOLE (mm.)	STEP OF DRILL HOLE (mm.)	DEPTH (mm.)	CUTTING SPEED (m/sec)	FEED RATE (mm/r)	No.OF HOLE	TIME (sec)
1	18	10	36	20	0.20	6	1.70
		18	36	20	0.10	6	6.10
	8	8	36	20	0.20	6	1.36
	8	8	36	20	0.20	11	2.49
	34	10	36	20	0.20	2	0.57
		20	36	20	0.10	2	2.26
		34	36	20	0.05	2	7.69
TOTAL							22.16
2	18	10	15	20	0.20	6	0.71
		18	15	20	0.10	6	2.54
	9	9	15	20	0.20	6	0.64
	26	10	15	20	0.20	10	1.18
		20	15	20	0.10	10	4.71
		26	15	20	0.10	10	6.12
TOTAL							15.90
3	16	10	23	20	0.20	4	0.72
		16	23	20	0.10	4	2.31
	8	8	23	20	0.20	6	0.87
	11	11	23	20	0.20	6	1.19
	6	6	23	20	0.20	2	0.22
	5	5	23	20	0.20	10	0.90
	26	10	23	20	0.20	10	1.81
		20	23	20	0.10	10	7.22

		26	23	20	0.05	10	18.78
TOTAL							34.02
4	18	10	14	20	0.20	4	0.44
		18	14	20	0.10	4	1.58
	11	11	14	20	0.20	6	0.73
	8	8	14	20	0.20	4	0.35
	7	7	14	20	0.20	12	0.92
	26	10	14	20	0.20	11	1.21
		20	14	20	0.10	11	4.84
		26	14	20	0.05	11	12.57
	45	10	14	20	0.20	1	0.11
		20	14	20	0.10	1	0.44
		30	14	20	0.05	1	1.32
		45	14	20	0.05	1	1.98
TOTAL							26.49
5	16	10	22	20	0.20	4	0.69
		16	22	20	0.10	4	2.21
	8	8	22	20	0.20	6	0.83
	12	12	10	20	0.20	10	0.94
	5.1	5.1	22	20	0.20	2	0.18
	5	5	22	20	0.20	10	0.86
TOTAL							5.71
6	16	16	23	20	0.20	4	1.16
	8	8	23	20	0.20	2	0.29
	8	8	23	20	0.20	6	0.87
	5.1	5.1	23	20	0.20	2	0.18
	5	5	23	20	0.20	10	0.90
	10	10	23	20	0.20	10	1.81
TOTAL							5.20

7	18	10	23	20	0.20	4	0.72
		18	23	20	0.10	4	2.60
	9	9	23	20	0.20	6	0.98
	7	7	23	20	0.20	12	1.52
	14	14	23	20	0.20	10	2.53
	26	10	23	20	0.20	1	0.18
		20	23	20	0.10	1	0.72
		26	23	20	0.05	1	1.88
	48	10	23	20	0.20	1	0.18
		20	23	20	0.10	1	0.72
		30	23	20	0.05	1	2.17
		48	23	20	0.05	1	3.47
	18	10	23	20	0.20	1	0.18
		18	23	20	0.10	1	0.65
TOTAL							18.49
8	18	10	50	20	0.20	4	1.57
		18	50	20	0.10	4	5.65
	8	8	50	20	0.20	12	3.77
	7	7	50	20	0.20	12	3.30
	16	16	50	20	0.10	11	13.82
	26	10	50	20	0.20	1	0.39
		20	50	20	0.10	1	1.57
		26	50	20	0.05	1	4.08
	32	10	18	20	0.20	1	0.14
		20	18	20	0.10	1	0.57
		32	18	20	0.05	1	1.81
TOTAL							36.66
TOTAL TIME							164.62 mins
TOTAL COST							138.28 baht

From "principle of die design and technology". King Rama 4 institute of technology, drilling technique to achieve a big diameter hole, drilling has to start from guide drill then follow by bigger diameter drill. This is the steps to achieve a big hole and prevent drill breakage. For above example, diameter of 32 mm. Guide drill dia. 10mm. is done first, then followed by dia. 20mm and finally finished by dia. 32 mm. Items No. and diameter of holes to be drilled are referred from figure 4.2-4.10.

Cost of drilling is 0.83 baht/min.

Therefore, total cost of drilling is 164.62minsx 0.84 baht/min) =138.28 baht

- Cost of wire cut

Table 4.4 Wire cut process for progressive die making

ITEM NO.	PART NAME	LENGTH OF CUT (MM.)	AREA OF CUT (MM.)	VOL	COST OF WIRE CUT
3	Punch holder	255.00	5,865.00	1	4,398.75
5	STR plate	255.00	5,610.00	1	4,207.50
6	Die plate	355.00	8,165.00	1	6,123.75
8	Lower die shoe	158.00	7,900.00	1	5,925.00
4	Bottoming plate	284.00	3,976.00	1	2,982.00
7	die packing	42.00	966.00	1	724.50
TOTAL					30,774.00

Cost of wire cut is 0.75 baht /mm.

Total cost for wire cut is 30,774 baht.

Therefore total cost of labor for making progressive die is wire cut +drilling = 30,774+138.28+allowance 10%= **34,003.5 baht**

- Other support machine and equipment
  - Automatic Air Feeder (price quoted from index) 60,000 baht
  - Uncoiler machine (price quoted from index) 120,000 baht

4.6.2 The operating cost in progressive die

4.6.2.1 Direct Labor cost

Progressive dies use only 1 operator to operate whereby single die use 4 operators , therefore labor cost will be

Salary 200 bath /day

Lunch 30 baht /day

There are 11 operators (reduce 3 operators from single die)for progressive die

Total labor cost per year =230x250x11 = 632,500 baht

4.6.2.2 Direct material

The usage for steel per wheel (plus excess material) is 355 g or 0.35kg

Steel price is 20 baht /kg

Therefore material cost = 0.35x20= 7 baht /wheel

Order to be produced approximately 3,000 pieces per day

Total working day 250 day/year

Total material cost is 7x3,000x250 = 5,250,000 bath

4.6.2.3 Indirect cost and overhead

- Indirect labor

There are 5 man powers for maintenance, die set up, warehouse, stock,

Labor cost 150 baht/day

Lunch 30 baht/day

Working day 250 days / year

Total indirect labor = 180x250x5= 225,000 baht

- Overhead

Overhead is unable to calculate accurately because progressive die is not existing yet. Therefore This thesis use a 12 month backward data from other progressive die industry after that, use a statistic method "linear regression" to calculate in order to get overhead cost of this company.

1.1 Get an operating cost on progressive die industry (benchmarking) within 12 months backwards

1.2 Divided the relation into 2 relationships

1.3 The relationship of direct material VS indirect cost

1.4 The relationship of labor VS indirect cost

1.5 Plot graph of those 2 relationships

1.6 Each relationships , find the relationship of linear regression (r)

1.7 Each relationship , draw the line and find the relationship of linear equation Y= MX+C

- Get an operating cost on progressive die in other industry (benchmarking) within 12 month, year 2002

Month	Indirect cost (milion baht)	Material (million baht)	Labor (milion baht)
1	1.22	4.11	0.52
2	2.14	5.32	0.82
3	1.75	4.68	0.63
4	2.35	5.24	0.76
5	2.05	5.12	0.66
6	1.59	4.56	0.58
7	1.98	5.04	0.78
8	2.35	5.68	0.88
9	2.46	5.88	0.89
10	2.67	5.87	0.9
11	2.78	6.22	0.92
12	2.73	6.16	0.91
Total	26.07	63.88	9.25

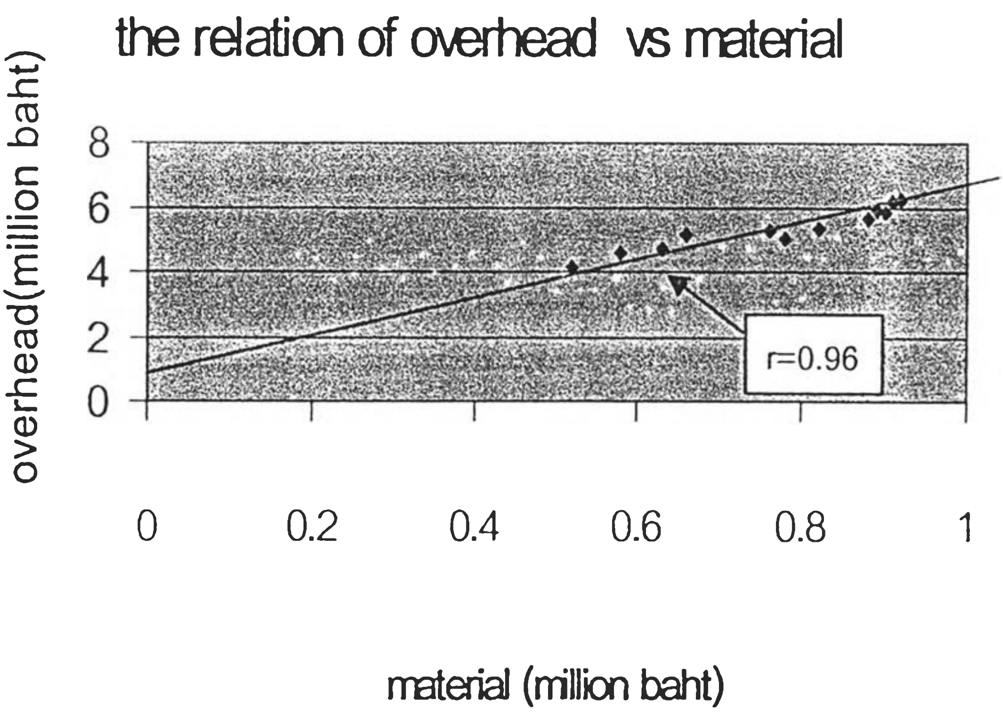
Table 4.5 12- month operating cost

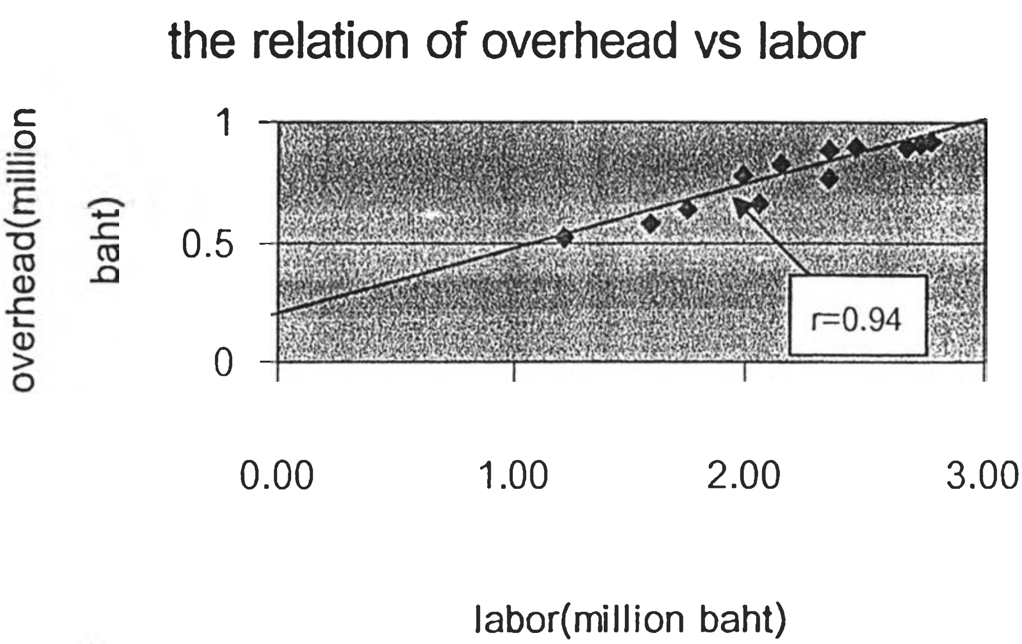
- Divided the relation into 2 relationships

  First , take relationship of overhead VS direct material

  Second , take relationship of overhead VS labor

- Plot graph of those 2 relationships





- Find the relationship of correlation and linear regression

Use Microsoft excel program to calculate

1. The coefficient of correlation of direct material and indirect is 0.96 and linear regression is Y= 0.25x - 1.32
2. The coefficient of correlation of labor and indirect cost =0.94 and linear regression is Y= 0.36x- 0.17

Since coefficient of correlation of labor has maximum value (0.96) that means overhead cost is most likely varies on material cost and it can be explained that overhead cost will be 0.25 bath per material 1 bath. Therefore, the overhead of operating cost on progressive die = total cost of material in progressive die calculated x0.25

= 632,500 x0.25

= 1,312,500 baht

The overhead of the progressive die in this company is approximately 1,312,500 baht. This overhead cost is included such as energy cost, indirect material, indirect labor taxation, insurance, maintenance

4.6.2 Summary of cost on progressive die

1. Investment

1.1 Die	Unit: Baht
▪ Material	659,35.92
▪ Labor	34,003.5
▪ Indirect cost	119,927.3
1.2 Air feeder	62,000
1.3 Uncoilor machine	115,000
Total cost for investment	396,866.72 baht

2. Operating cost (1 year)

2.1 Direct material	5,250,000
2.2 Direct labor	575,000
2.3 Overhead	1,312,500
Total cost for operating	7,137,500 baht