Design Analysis and Overview of Press Tool With its Defects and Remedies

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ABSTRACT: Tool making is one of the trades, which requires a detailed study, structural analysis and process planning before proceeding with any practical work. The success of any tool largely depends on the process analysis and design analysis of the tool. A systematic approach in tool making is therefore very essential. This project report mainly enlightens the various aspects of “Press Tool”. This report gives brief information about the design analysis and overview of a “PRESS TOOL” which serves the need for mass production of sheet metal component.

Index Terms- Press tool, Stamping, Piercing, Sheet-Metal.

I. INTRODUCTION
Press tool is a device that aids production of large quantity of similar sheet metal component to the required shape, size and dimensional accuracy. The component may be flat blank (Blanking tool) or formed one (Drawing tool, Forming or Bending tool).

A press tool consists mainly of die and punch, which are suitably shaped to get article of desired shape. The sheet metal strip is pierced on the die and the punch is then lowered under a heavy pressure. The metal is thus pressed between punch and die and the article of desired shape is obtained. For preparing article with wide range of shape, pressing is to be carried out in different stage.

Press tools are useful when a large number of similar articles are to be produced.

TYPES OF PRESS TOOLS
- Progressive tool
- Compound tool
- Combination tool
- Fine blanking tool

II. TYPES OF PRESS TOOL OPERATIONS
BLANKING:
Stamping having an irregular contour must be blanked from the strip. Piercing contour must be blanked from the strip. Piercing, Embossing and various other operations may be performed the strip prior to the blanking station.
PIERCING:
Piercing tools pierce holes in previously BLANKED, Formed or Drawn parts. It is often impractical to pierce holes while forming because they would become distorted in the forming operation. In such cases they are pierced in a piercing tool after forming.

CUTT OFF:
Cut off operations are those in which strip of suitable width is cut to length. Preliminary operations before cutting off include Piercing, Notching and Embossing. Although they are relatively simple, cut off tools can produce many parts.

BENDING:
Bending is defined as shaping the material around straight axis which extends completely across material. Metal flow is uniform in this operation.

FORMING:
Forming tools apply more complex forms to work pieces. The line of bend is curved inside of straight and the metal is subjected to plastic flow or deformation. Metal flow is not uniform in this operation as Bending.

DRAWING:
Drawing operation transform the flat sheets of metal into cups, shells or other drawn shapes by subjecting the material to severe plastic deformation.
TRIMMING:
When cups and shells are drawn from flat sheet metal the edge is left away and irregular due to uneven flow of metal. This irregular edge is trimmed in a trimming die.

SHAVING:
Shaving is a secondary operation usually flowing punching in which the surface of the previously flowing punching in which the surface of the previously cut edges is finished smoothly to accurate dimensions. There is little clearance between punch and edge and only a thin section of the edge is removed from the edges of the pieces.

EMBOSSING:
It is shallow forming operation in which the material is stretched over a male die and caused to conform to the male die surface by a female die surface. It results depressed detail on one side and raised detail on opposite side of the work piece.

COINING:
Coining is the process of pressing material in a die so that it flows into the spaces in the detail on the die face.

CURLING:
A curling die rolls the raw edges of the sheet metal into a roll or curl. The purpose is to strength than the raw edges provide protective edges and improve the appearance of the product.

NOTCHING:
It’s one of the cutting operations, in which material cut at the edges of the blank.
III. DESIGN & ITS ANALYSIS

TOOL DESIGN CONSIDERATION
A designer is a person who furnishes the drawings of the tool. He must have a very good knowledge regarding the manufacturing of the tool, selection of materials and other necessary designing aspects. The die design should suit the scale of production, as it will be used for small or large lot or mass production. Press tools should meet the following requirements.

- The accuracy and surface finish of stampings should confirm to the drawing and specification.
- The working part of the die must be adequately strong, durable in operation and easily replaceable when worn-out.
- The tool should ensure the required hourly output, easy maintenance, safe operation and reliable fastening on the press.
- The die should be designed preferably of standard items, using as less parts as possible.
- The scrap should be kept in minimum.

DESIGN OF PRESS TOOL INVOLVES THE FOLLOWING STEPS

- Determination of the force. (Press tonnage) required for the operation.
- Selection of press for requisite force, work piece size and shape.
- Determination of shut height of the tool.
- Calculating the die thickness and margin (minimum cross section)
- Designing of locating elements.
- Selection of hardware items.
- Selection of pillar dies set.
- Deciding punch length and mounting.

IV. TOOL DESIGN PROCEDURE

STUDY OF COMPONENT
The first step in the design procedure is to define the problem in a clear and simple statement of the functional needs. The tool design will receive the part print, information on which tool is needed,
what the capabilities of the tool must be, the type of the press on which tool is used, the number of parts to be produced and pertinent information concerning the part.

**CONCEPT DESIGN**
The research and sketches should be combined to one or two attentive design solution, which may consist of rough working showing the side and top view if needed. The best selected and reworked and the final design decided upon.

**DESIGN CONSIDERATION**
Before start in any design some major considerations are required to be made which can solve majority of the problems while designing the press tool, moulds, jigs and fixtures.

**MANUFACTURING PROCESS**
In any design, manufacturing process should be easy, simplified and majority of the operations should be carried out in house. By considering this point we made our tool as simple as possible for manufacturing.

**MAINTENANCE**
Last but never the least is very much necessary to think about the maintenance, if due to any reason some parts break down, it should be easily manufactured in short time so that ideal times is reduced and that care to be taken during designing.

**THE FOLLOWING DESIGN POINTS SHOULD BE CONSIDERED CAREFULLY**
- Controlling location of the scrap strip.
- Guidance should be extended at least two scrap width in front of first station.
- The type of stripper used.
- Channel clearance should be accurate to allow the strip to move freely.
- Location of figure and stage stoppers.
- Die block should be longer and wide enough so that the location of the holes will be at least one and half times the thickness of the die block away from the edge.
- Dowel should be safe in non cylindrical location such that sections or parts may be mounted in one position only.
- Counter bore in the die block, the tapered hole in the die shoe and the reamed holes in the die shoe must be made from 6-9 mm deeper than needed to allow for grinding of die block.
- Choose the die set, so that when the die block is mounted, it can be ground without removing it from the die shoe.
- Small profile punch should be guided in the stripper plate.

**V. ELEMENTS OF PRESS TOOL**

**TOP PLATE**
It is the top portion of the complete tool, which holds the top assembly or complete tool through the punch holder.
Material: C45 or CI.

**BOTTOM PLATE**
It is also called as die shoe or bolster plate, its main function is to provide a rigid foundation and base to the assembly. It assembles the fixed half of the tool.
Material: C45 or CI.

**STRIPPER PLATE**
This plate is also called as guide plate. This plate helps in stripping operation. It not only strips the strip from the punch but the main function of this plate is to guide the punch accurately which
maintains the alignment between punch and die. Hence the plate is made with same care as die plate. It is made out of mild steel. In some cases this guide plate is also made of tool steel. A channel is milled in the plate which will guide the stock strip.

**GUIDE PILLAR**

These are cylindrical pins known as guide pins or guide pillars. These provide accurate alignment to the die set. One end of the pillar is given press fit in the base plate with H7/p6 tolerance. The other portion, which is sufficiently long, provides guide for top plate for easy sliding.

Material: EN-36 HRc: 54-56

**GUIDE BUSH**

These are mounted to the top plate, which provide smooth sliding contact between pillars and top plate.


**BALL CAUGES**

In progressive press tools the punch and die should align very accurately to provide equal clearance on all sides of the die. In such cases ball cages are used. Ball cages contain ball bearings inserted within them, which provide the sliding movement.

Material: Aluminum or Brass

**PILOTS**

In progressive press tools the function of pilots is to position the stock strip accurately and to bring it into proper position (Registering) for successive blanking, piercing, bending or other press operations. Mechanically fed strip normally under fed and pull forward in the same direction with the feeding motion by the pilots, because any mechanical feeding mechanism utilizes a unidirectional locking device which prevents any back feeding of the strip.

**DIE**

The female member of the tool in which openings are made for the punch to enter in them is termed as die. It includes well supporting and actuating part of the tool. It also includes cutting profiles, bending die insert, pushers, stoppers, strip guides etc.

Material: HCHCR (D3) HRC: 60-62

**PUNCH**

This is most important element of the tool. It is the cutting element of the tool. Punch gives the whole size and the shape on the component. This is made out of high carbon high chromium steel material (D3). [T215 CR12 W90]. Punches are hardened and tempered to 58-60 HRC.

Material: HCHCR, OHNS HRC: 60-62

**PUNCH HOLDER**

This plate is also called as punch plate all the punches are accurately held in this plate. This plate should be thick enough to accommodate punch shoulder and keep the punches perpendicular. It is made out of HCHCR (D2).

Hardness: 56-58HRC.

**DIE PLATE**

In this plate all die inserts held accurately. This plate thickness as same as die inserts thickness .This plate made out of HCHCr (D2).

Hardness: 56-58hrc

**STRIP GUIDE**

In progressive press tool there becomes a requirement of feeding the stock strip along a particular path for each operation to take place. Thus strip guides are used to guide the long stock strip in the required path for each operation can be carried out properly. The strip guide combines of two
material strips or parallel blocks, which are screwed and doweled on the die surface in alignment with the die parameters. It is one of the important elements of the progressive tools with fixed as well as floating stripper.

**Material:** D2   HRC: 56-58

**STOPPERS**

Stoppers are installed on the dies to arrest the feedings movement of the strip, to the requirement.

**Material:** D2   HRC: 52-56

**LIFTERS**

Lifters are assembled in die plate with a close running fit. These are spring actuated to hold and lift the strip.

**Material:** D2   HRC: 52-56

**DOWELS**

Dowels hold the parts in perfect related alignment by absorbing side pressure and lateral thrust. Dowels always should have case hardening.

**SCREWS**

In assembly process the parts of tool are held together rigidly by socket head cap screws. Also screws fastened the assembly. Screws are available in standard size.

**VI. MATERIAL SELECTION FOR DIFFERENT ELEMENTS**

| Bottom plate | - | St-42 |
| Top plate   | - | St-42 |
| Die plate   | - | HCHCR (D2) |
| Punches     | - | HCHCR (D3) |
| Back plate  | - | Case hardened |
| Punch plate | - | HCHCR (D2) |
| Stripper plate | - | HCHCR (D2) |
| Guide plate | - | Case hardened |
| Guide pillar| - | Case hardened |
| Auxiliary guide pillar | - | OHNS |
| Pilot       | - | STD |
| Dowel       | - | STD |
| Lifters     | - | OHNS |

**TYPES OF FITS ASSOCIATED WITH PRESS TOOL**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>TOOL ELEMENTS</th>
<th>TYPE OF FIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blanking punch and Stripper</td>
<td>Running Fit</td>
</tr>
<tr>
<td>2</td>
<td>Piercing punch and Stripper</td>
<td>Running Fit</td>
</tr>
<tr>
<td>3</td>
<td>Guide pillar with Bottom plate</td>
<td>H7/p6(press fit)</td>
</tr>
<tr>
<td>4</td>
<td>Guide pillar with Guide bush</td>
<td>H7/g6(sliding fit)</td>
</tr>
<tr>
<td>5</td>
<td>Punch with Punch holder</td>
<td>H7/k6(Light key fit)</td>
</tr>
<tr>
<td>6</td>
<td>Pilot with Stripper</td>
<td>H7/g6(sliding fit)</td>
</tr>
<tr>
<td>7</td>
<td>Direct pilot with punch</td>
<td>H7/p6(press fit)</td>
</tr>
</tbody>
</table>
8. Pilot with punch holder: H7/k6 (Light key fit)
9. Dowels with Stripper plate: H7/m6 (Medium drive fit)
10. Dowels with Die plate: H7/m6 (Medium drive fit)
11. Dowels with Bottom plate: H7/m6 (Medium drive fit)
12. Dowels with Top plate: H7/m6 (Medium drive fit)
13. Dowels with Punch holder plate: H7/m6 (Medium drive fit)
14. Punch back plate (for Dowels and screws): Running fit
15. Lifter with Die plate: H7/p6 (Light key fit)
17. Adjuster and slot in PHP plate: H7/g6 (Sliding fit)
18. Punch and die: Cutting clearance fit

DEFECTS AND REMEDIES

The various Defects or problems that are reducing are given below:

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>DEFECTS</th>
<th>CAUSES</th>
<th>REMEDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Burr collection at draw die</td>
<td>Thickness of the component</td>
<td>Polish the draw dies and draw punch, Use good lubricants, For every 3 stroke remove the burrs on draw die</td>
</tr>
<tr>
<td>2</td>
<td>Thinning</td>
<td>Clearance is insufficient improper radius on punch &amp; die, Drawing speed is more</td>
<td>Appropriated clearance is given on each draw in punch &amp; die check the radius on draw die &amp; punch and reduce the drawing</td>
</tr>
<tr>
<td>3</td>
<td>Cracking</td>
<td>Insufficient clearance, lubrication problems, Insufficient draw radius on punch &amp; die Drawing speed is more.</td>
<td>Appropriated clearance is to be given on each draw, used good lubricants, Check the radius on punch &amp; die reduce the drawing speed &amp; check the reduction ratio.</td>
</tr>
<tr>
<td>4</td>
<td>Score marks</td>
<td>Insufficient radius is given on punch &amp; die. Lubricants is not effective</td>
<td>Sufficient radius on punch &amp; die. Effective lubricants are use and polish to the draw punch &amp; die.</td>
</tr>
<tr>
<td>5</td>
<td>Ejection problems</td>
<td>Insufficient draft on punch &amp; die, Lubricants problems, Ejection force is low</td>
<td>Sufficient draft to punch &amp; die, Effective lubricants are use and polish to the draw punch &amp; die. Sufficient ejection force or press force.</td>
</tr>
<tr>
<td>6</td>
<td>Spring back</td>
<td>During bending, after bending pressure is released, the elastic stresses remaining in the</td>
<td>Lesser angle is provided than the required angle needed.</td>
</tr>
</tbody>
</table>
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### VII. ASSEMBLY

We have now come to final stage of manufacturing of the tool. Assembly of a tool means seating the parts of the tool in their respective position to get the required work. This is the critical stage of tool manufacturing. Any fault committed during machining of parts will be highlighted and may cause problem during tryout.

**Assembly of tool may be divided into two groups,**

a. BOTTOM HALF  
b. TOP HALF

**BOTTOM HALF**

- Firstly we made chamfer and oil stoned to all elements of bottom half of tool  
- Lifters are placed to back plate and die plate  
- Die plate and back plate is aligned properly to their proper positions according to their reference position to the Bottom plate by dowelling.  
- Finally the Die plate, Back plate and Bottom plate is fastened by means of screws.
TOP HALF

- Firstly we chamfered and oil stoned to all elements of Top half of the tool.
- All punches and pilots are grouped in Punch holder to their proper position and get entered into their relative positions in Bottom half.
- Proper alignment is done to top half of the tool with respect to its Bottom half.
- Springs are provided for proper ejection of the component.
- Finally the top half is get clamped by means of screws only after knowing the perfect alignment between two half of the tool, and then the tool get moved to tryout and then to inspection and finally to dispatch of the components with approval by the quality.

CARE OF TOOL

The sliding are as should be lubricated (pillars and bushes, pushers & lifters). The impact leads to damages of die and punch and the press experiences heavy load of the blank is not lubricated. The ‘Die Maker’ is expected to detect faults of the press tool resulted from poor workmanship and from wrong mounting and adjustments. To do so, he must know the courses of faults and the methods of remedy.

- Wrong installation of the tool will source in many defected finished products. An immediate indication in the wrongly mounted tool is a unilateral friction of the guide pillars.
- Bright surface of the cut at one side of the part witness an inadequate clearances.
- Rapid blunting of the cutting edges of the punch and die at that area the fault is normally due to misaligned bed, this can be detected by releasing the fastening of the lower shoe and measuring the clearance between the tool and the press bed by a feeler gauge.

VIII. CONCLUSION

In course of this project I have gained a great deal of confidence and knowledge in the way of tool manufacturing.

The work has gone in detail in all the analysis methodically. The tool can also be designed and manufactured without any these analyses, but the success and the economics of the tool is not assured.

I have executed my very best to achieve the required results, as far as the tool is concerned. This project has paved a new way for me to tap the knowledge that lies in the waste field of Press tools.

I learned many aspects such as co-operating and adjusting myself with other fellow crew working on this tool. And the strong positive guidance given by our guides during solving of problems is really commendable; hence the success of the design analysis of the tool is assured.

References
1. www.google.com