A REVIEW OF PRESS TOOL DESIGN PROCESS

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Abstract

For the continual manufacture of parts, press tools are employed. As a result, it becomes necessary to choose a tool material that is both highly durable and capable of withstanding repeated heavy loads. Improper tool material and design decisions can result in significant losses, deformed components, production risks, etc. To overcome these uncertainties, modeling and analysis of the entire press tool in CAD and CAE software applications would be a useful tool. The architecture of presses determines the operations they may perform, including blanking, bending, piercing, shaping, drawing, reducing off, splitting off, embossing, coining, notching, shaving, lancing, dinking, perforating, trimming, and curling. The term "press tool" will also be used to describe blanking, piercing, and bending tools. A strip is defined as being smaller than 6mm in width. Metals that are thicker than 6mm are referred to as plates. A press tool is a tool that lowers production costs while also speeding up production. A review of design processes like calculation, production, and material selection is presented in this study.

Keyword : - *Press Tool, CAD, Die design calculation, Material Selection, Fits, Analysis.*

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1. INTRODUCTION

A press is a tool for dealing with sheet metal that has a stationary bed and a motorised ram that can be moved in either direction to deliver force or the necessary pressure for different metal forming activities. In the Figure, a line diagram of a typical press is explained. hydraulic apparatus The press's frame's design determines the relative positions of the bed and ram. In most cases, the punch is held in the punch holder, which is connected to the ram. The bed of the press has a blaster steel plate attached to it, and the die is mounted on the blaster steel plate. There are numerous capacities, power systems, and frame types for presses. Over the past few years, the use of power presses for the inexpensive production of sheet metal parts (both large and small) has advanced in truly wonderful ways. Through the adoption and use of dies, this contemporary machine tool has proven its effectiveness for producing work beyond what milling machines, shapers, drill presses, and forges can produce.

Aside from the lower production costs, the sheet metal blanks' light weight, interchangeability, and beautiful finished appearance substantially enhance the aesthetics of the machines to which they are attached and, in many cases, enhance the working quality as well. Sheet metal parts have already taken the place of many expensive cast, forged, and machined products in today's practical and cost-conscious world. The relative affordability of press parts and the greater control over their technical and aesthetically pleasing aspects are the apparent causes. The most adaptable product of current technology, metal stampings, are utilised to replace pieces that were previously welded together for several components.

Progressive Die: Progressive die are frequently used in the production of parts for several industries, including the automotive and electrical sectors. This kind of die stamping utilizes a number of separate workstations, each of which executes one or more unique operations on the component. The stock strip is used to transport the work or item from one station to the next before it is finally cut out of the strip.

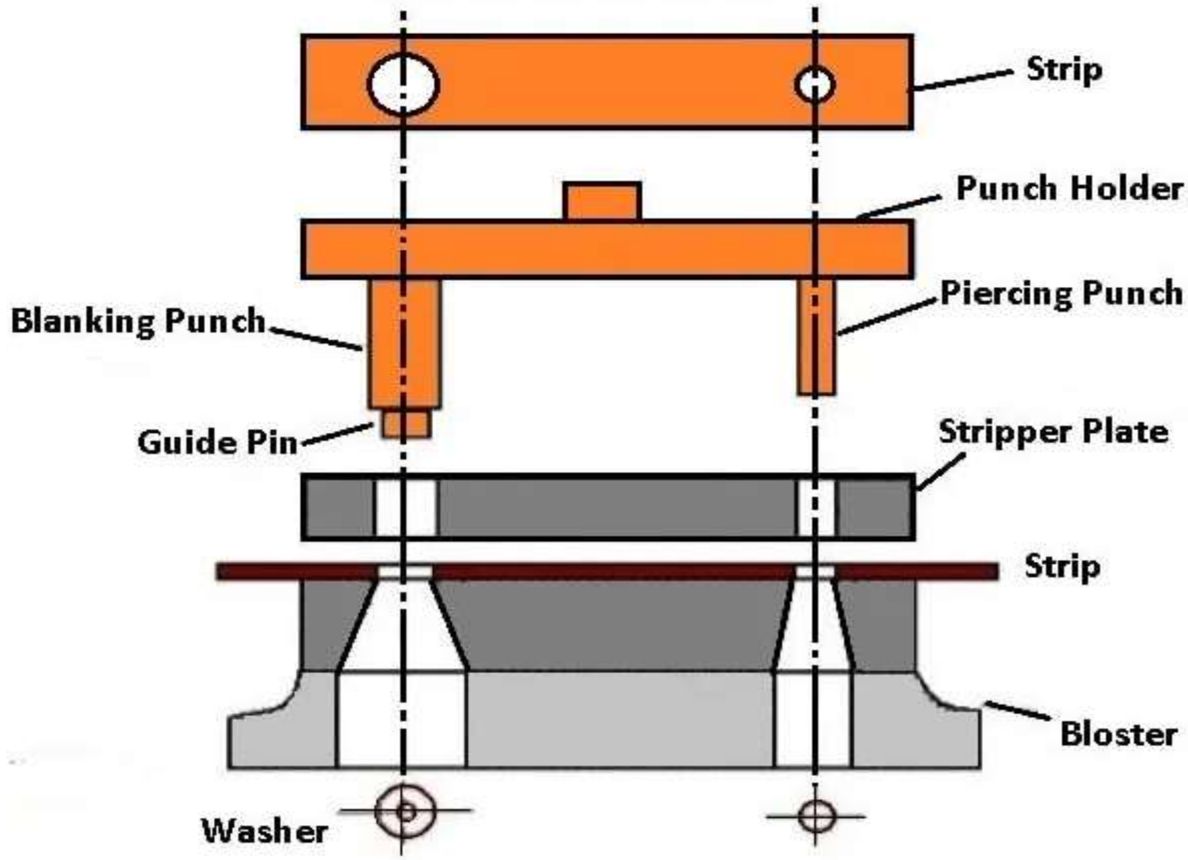

Fig 1 Progressive Die

Source: [10 Types of Dies Used in Manufacturing, Its Components (PDF) (theengineerspost.com)]

Dharshan, B, Ananthapadmanabham, B & Hareesha , N., (2017), The most popular tool for fabricating sheet metal components is the press. While hand fabrication of sheet metal components with complex shapes and dimensional significance in their applications is very challenging, this is especially true for small components like those found in watches and large aircraft parts. Most sheet parts of any shape are now produced utilising specifically created press tools and other combinations of processes. Stampings are items cut and produced from sheet metal. The design of press tools and its manufacturing process are highly specialised and knowledge intensive in nature. Many components that were formerly cast or machined have been replaced with these sheet metal stampings. Press work has become essential for many mass-produced goods due to material economy and the resulting decrease in weight and cost, high productivity, use of unskilled labour, and high degree of possible precision. Examples of such products include automobiles, aircraft, household items, electronic and electrical appliances, and others (16).

Rathod , C, Adlinge, S & Raut, D., (2017), One of the industrial methods that almost eliminates chips is metal shaping. Presses and press tools are mostly used to carry out these activities. These procedures include applying pressure or force to metal workpieces to distort them into the appropriate size and shape. Work on mass production is made easier by presses and press tools. These are regarded as the quickest and most effective methods for shaping sheet metal into finished goods (18).

Kumar, S & Singh, R., (2005), Selecting a die set is an essential step in the press tool design process. Ancient die-set selection techniques involved a variety of calculations and decisions that were supported by knowledge and observational codes. In this study, a choice-making intelligent system for metal stamping press tools is described. To help die designers, an intelligent die-set choice system (IDSS) has been created using a production rule-based professional system approach. (25).

1.1 Methodology:-

The first item selected is a sheet metal washer, which is produced using a press tool. To obtain the component, activities like punching and blanking must be performed. The layout allows for the creation of the blanking punches' shape. The forces necessary to punch and blank the strip are estimated based on the layout. The total press tonnage capacity of the progressive press tool is calculated after adding all the forces. The dimensions of the crucial components of the progressive tool are determined using the combined cutting and bending forces obtained. The remaining parts' dimensions can be found in the press tool data manual. All of the press tool's components are modelled in Autodesk Inventor based on the measurements acquired. The important components of the press tool are analyzed in ANSYS under the consideration of adequate material properties (D3 steel), boundary conditions, and loads.

1.2 Die Design Calculation

Material: Mild Steel
Thickness- 1 mm
Shear strength-345m/mm^2
Supply condition: Strips

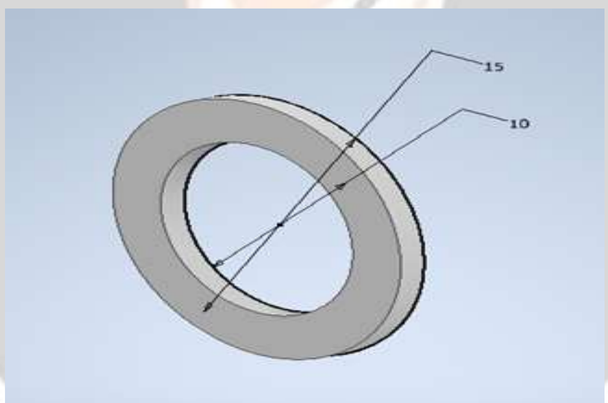

Fig-2 Washer

1.3Strip Layout:-

The succession of the logical, executable actions, or a sequence of concepts, is represented by a strip layout. If there is an error in this series of steps, it will undoubtedly show up in a test press.

Factors to be considered while designing the layout are:

1. Shape of the blank.
2. Production Requirement.
3. Gain Direction.
4. Burr Side.
5. Stock Material.

Fig 3 Strip layout

1.4 Material Utilization:-

It can be defined as the ratio of the area of blanks from strip to the area of the strip before blanking. Material utilization can also be defined as the ratio weight of blank strip to the weight of strip before blanking. Its main objective is to reduce the material wastage and scrap rate

$$\text{Material Utilization} = \frac{\text{Area of blanks from strip}}{\text{Area of the strip before blanking}}$$

$$= \frac{\pi r^2 \text{ x No of component}}{\text{Area of the strip before blanking}}$$

$$= \frac{176.71 \text{ X } 10}{2560}$$

$$= 0.69$$

$$= 69\ \%$$

2. Force Calculation

It is force which has to act on stock material in order to cut the blank or slug. This determines the capacity of press to be used for particular tool.

Calculation for cutting force:

Area = $\pi r^2 t$

r = radius of Punch

t = Sheet thickness

Area of piercing (S_A)= $\pi r^2 t$

$= \pi * 5^2 * 1$

$= 78.53 \text{ mm}^2$

Force for Piercing (V_A)=$S_A * \tau$

$= 78.53 * 345$

$= 27092\text{N}$

Area of Blanking(S_B)= $\pi r^2 t$
$= \pi * 7.5^2 * 1$
$= 176.71 \ mm^2$

Force Blanking(V_B) $= S_B * \tau$
$= 176.71*345$
$=60966 \ N$
Total Force require for cutting(F_{sh}) $=V_A+V_B$
$= 27092 + 60966$
$=88058.53N$
Stripping Force = 20% of total cutting force
$=17611.70 \ N$
Total Press Capacity =Factor of safety {Cutting Force + Stripping Force }
$=1.2*\{ 88058.53 + 17611.70 \}$
$=1.2*1056670.23$
$=126804.28 \ N$
$=12.72 Ton$

2.1 Thickness of Plates

1. Die Thickness $=T_d=\sqrt[3]{F_{sh}}$
$=T_d=\sqrt[3]{88058.53}$
$= 44.48 \cong 46mm$

2.Top Plate $= 1.5 \times T_d= 1.5 \times 46= 69$ mm
3. Bottom Plate $= 2 \times T_d= 2 \times 46 =92$ mm
4. Punch Holder $= 0.5 \times T_d= 0.5 \times 46=23mm$
5. Thrust Plate $= 0.5 \times T_d= 0.5 \times 46 = 23mm$
6. Stripper Plate $= 0.75\times T_d= 0.75 \times 46= 34.5 \cong 36$ mm

2.2 Clearance:

Clearance $= 0.0032\times t \times\sqrt{\tau}$
Where,
t = Sheet Thickness = 0.5mm
τ = Shear Strength = 345 N/mm^2
$= 0.0032 \times 1 \times\sqrt{345}$
$=0.059$ mm

2.3 Fits Between The Mating Parts

- Punch holder and Punches =H7/k6 = Similar fit (Transition Fit)
- Punch and Stripper = H7/k6 =Similar fit (Transition Fit)
- Guide Pillar and Guide bush = H7/g6 = Sliding Fit (Clearance fit)
- Guide bush and Top plate = H7/p6 =Press fit (Interference fit)
- Guide pillar and bottom plate = H7/p6= Press fit (Interference fit)
- Dowel and plate = H7/m6 =Press fit
- Dowel holes = H7/m6= Press fit

3. MATERIAL SELECTION

HCHCR

Cold-work tool steels which include steels are high-carbon, high-chromium steels. steels have 1% Mo and are air hardened. Type D3 steel is oil-quenched; though small sections can be gas quenched after austenitization using vacuum. As a result, tools made with type D3 steel tend to be brittle during hardening.

OHNS

OHNS steel is a general purpose tool steel that is typically used in applications where alloy steels cannot provide sufficient hardness, strength and wear resistance. Chemical composition of OHNS is Carbon 0.94%, Manganese 1.2%, Silicon 0.30%, Chromium 0.50% and Vanadium 0.15%

EN31

EN31 is a quality high carbon alloy steel which offers a high degree of hardness with compressive strength and abrasion resistance. Hardness is 63 HRC

HCHCR material (D3) for Press tool Die and Punch

Table 1 Mechanical Properties HCHCR

Properties	Value	Unit
Elastic Modules	2.1×10^5	MPA
Density	7.7×10^3	Kg/m3

Table 2 Chemical Composition

C	Mn	Al	Mo	P	Cr	Si	V	Fi
1.61	0.34	0.028	0.29	0.02	11.55	0.186	0.135	traces amt.

Table 3 Strengths of materials

Sr.No	Strength Description	Unit in (MPA)
1	Tensile yield Strength	862
2	Tensile Ultimate Strength	862
3	Ultimate yield Strength	1030

3.1 Steel Grades Used For Press Tool Part

Sr.No.	Part Name	Material	Hardness (HRC)
1	Top Plate	M.S	-
2	Bottom Plate	M.S	-
3	Thrust Plate	OHNS	58-60
4	Punch Holder Plate	M.S	-
5	Forming punch / Cutting Punch	HCHCR	60-62
6	Stripper Plate	OHNS	58-60
7	Die Plate	HCHCR	60-62
8	Guide Pillar	EN31	40-45
9	Guide Bush	EN31	40-45
10	Dowel	EN31	40-45
11	Allen Screw	STD.	-

3.2 Cad Model

Autodesk inventor software is used to create the 3D representation of Press Tool.

1. Open Autodesk Inventor file choose the part modeling select the axis of plane.
2. Use tool 2D Sketch to create the 2d geometry.
3. Convert the 2D profile into 3D part, using Extrude tools.
4. Conversion of .ipt path file to STP or .igs file for ANSYS importation.

3.3 Analysis

The most crucial step in analysis is FEM modelling because meshing quality affects simulation realism and plays a key role in this process. 3D solid model in STP file format is imported in ANSYS. All of the geometry's inside and exterior surfaces are meshing. While performing meshing, many shapes or topologies of elements can be used. Depending on the geometry of the CAD Design and Model, several types of elements are used. Tetrahedral element fits complex geometry better than other elements. Tetrahedral elements require less computation time than other elements.

3.3 Boundary Condition and Applied Loads

The geometry of faces, edges, points, vertices, nodes, elements, or the entire model can be subject to boundary requirements. When doing static structural analysis, the loads on the surface that are subject to impact force and self-weight are taken into consideration.

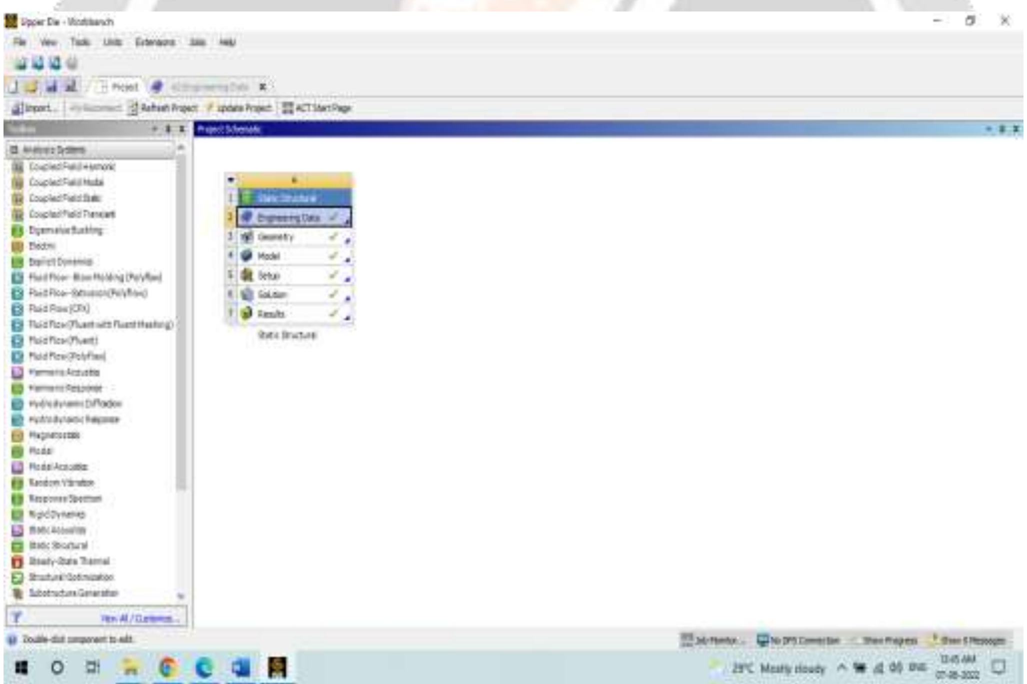

Fig 4 Ansys 22.0

4. CONCLUSIONS

Each file was imported into the ANSYS 22.0 software in STEP format after being modelled in Autodesk Inventor for all of the press tool's components. Prior to analysis, necessary material attributes, boundary conditions, and loads were applied.

The following conclusions were reached after analysis:

• It is noted that the deformation of the components under analysis is well within the recommended deformation and that the stress values for each component are all lower than the corresponding yield stress of the material.

• Any other press tool dimension can be calculated using the method above.

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