Design and fabrication of multiple press tools for sheet metal operation

Prabhakaran P [1], Dinesh S [2], Akilesh M [3], Vinayagamoorthi M A[4]

[1,2,3] UG Scholar, Department of Mechanical Engineering, Kumaraguru college of technology, Coimbatore.
[4] Assistant Professor, Department of Mechanical Engineering, Kumaraguru college of technology, Coimbatore

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Abstract - *The press tool is the custom based tool that is used to produce component in a large quantity from a sheet metal. A major part of the press tool is die, punch, punch plate, stripper, and ejector. The project work aims to reduce the production time of wire crimp connector. In the traditional method, the part is manufactured through three operations. They are blanking, forming, finishing and the three types of tools and dies are used to produce the component. In this experimental work the replacement of three types of tools and dies with the single custommade press tool and die. In a single operation, the three process is done and got the finished product as the output. The project work concluded that by implementing the custom press tool in the punching machine will increase the production as well as reduction in the cycle time. The production can be increased by three times the existing production method. Keywords: Customized press tool, die plate, sheet metal, cycle time.*

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1. INTRODUCTION:

The punch press works on the principle of converting circular motion into linear motion. The main motor drives the flywheel of the machine, which generates power. The following components are used crankshaft, rocker arm. The connecting rod and the sliding block must have a place linear and circular motion can switch. There are essentially two mechanisms in its design: one is a ball type, and the other is a pin type, both of which transform circular motion of the slider into linear motion and linear motion is used to achieve the necessary shape and precision, the punch deforms the material plastically. The material must fit into a pair of moulds (upper mould and lower mould), between which the machine exerts pressure to deform the material. The reaction force brought on by the force applied to the material during processing is absorbed by the punch machine body. The stamping process has the potential to be more efficient than traditional mechanical processing and create items that are impossible to create through mechanical processing through a variety of Mould applications. It has a wider range of applications now.

1.1 LITERATURE REVIEW:

Khosa et al., 2015. Investigated the design and manufacture of a progressive press tool for a chain link is part of the project work. Conveyor belts use chain links, which are made of mild steel. The link has a thickness of 2 mm. A progressive tool is one that has multiple stations where operations are performed. The device has been designed and manufactured. The manufactured parts are inspected before being assembled. The progressive tool is also put to the test. [1] Parmar et al., 2017 studied the major objective is to develop a die with interchangeable punches and dies and to lighten the material by altering the material of die sets. This should constantly eliminate the loss in production time and reduces the power from loading and unloading the sheets. The components of the die are designed in the solid works and assembled. The Finite element analysis of each part of the die sets are done with the simulation press tool. [2]. Afzal et al., 2019 explained the design and modelling of a progressive cam press tool for the component blade fuse holder, which is utilized in the printed circuit boards of cars, are covered in this article. The component geometry and material specifications are carefully examined at the start of the design and modelling process. The tool development and modelling, which was done with the modelling software Solid Works, are described in detail. The advantages and disadvantages of progressive tools compared to stage tools are also discussed. [3] Shailendra, 2011 study and examines important factors and offers an intelligent system for choosing materials for press tool components used in sheet metal production. The system prompts the user to enter required information before providing intelligent material selection advice via the user interface. Depending on the availability of new materials and technological advancements, the system's knowledge base can be modified. Because the proposed system can be implemented on a PC running AutoCAD software, its low implementation cost makes it accessible to die designers and toolmakers in small and medium-sized sheet metal businesses. A sample run using an example of an industrial component is used to demonstrate the utility of the proposed system. Due to the system's inexpensive implementation cost and its ability to be used with AutoCAD software on a PC, small and medium-sized sheet metal industries may easily afford to use it. [4]. Razlee et al., 2019 investigated and redesign the die and strip layout optimization, the study is conducted using AutoCAD and Solid Work. Following that, ABAQUS/CAE and e-fatigue are used to complete the analysis and life cycle results for punches with various punch edge designs. According to theoretical analysis, punch design plays a significant role in life cycle analysis. By lowering one stage from six to five phases, stage optimization was accomplished. [5]. Andure, 2018 developing a pneumatically operated cutting and punching machine which will use the help of compressed air to drive a shearing blade and punch to carry out the operations on a metallic sheet. As two operations can be performed on the same platform, this machine will prove to be cost-effective and timesaving in the manufacturing process. It has been noted that pneumatic equipment is less expensive than hydraulic equipment. [6]. Venkata & Rayudu, 2021 explained the project work that involves design, analysis, and manufacture of a combination tool to produce tabletop name card holder. The combination of tool done both jobs like blanking and bending. Using the software tool ANSYS, the design and analysis of a combination tool for a developed component have been validated. The component's quality was evaluated and found to be within predetermined limitations when the tool was constructed, tested, and produced for a trial run. [7] Surabhi et al., 2015 describes and forms a basis by accumulating factors for tool life selection. The information is based on an outdated tool that has been carefully examined, with modifications made that are discussed in this paper. In this work, they model a progressive tool for an arc chute plate using the software UNIGRAPHICS. Here, a multi-station die that performs trimming and splitting off operations simultaneously is used. It has been determined by introducing progressive die for arc chute plates that the tool is very practical for medium batch sizes and effective to use. The tool life is 3–12 lac components when utilising a two-step tool die. [8]. Student, 2018 investigated the defects and Remedies. This project report focuses on the various aspects of "Press Tool." This report provides a summary of the design analysis and overview of a "PRESS TOOL" that meets the demand for sheet metal component mass production. The job has been done gradually and in detail for every analysis. Without conducting these studies, the tool could still be built and produced, but its viability and economics are not guaranteed. [9]. Sachin & Yathish, G, 2015 studied the several operations can be performed in series in a progressive tool as the stock registers at different workstations during each stroke leading to the development of the final component. The corresponding processes to create a handle bracket are, respectively, blanking, punching, and bending. The punch and die for the progressive press tool in this job are made of D3 steel, and to ensure the design is safe, static analysis using ANSYS software is then completed. It has been established that the stress values for each component are less than the actual yield stress of the material. [10]

1.2 RESEARCH METHODOLOGY:

The first stage is to choose the component that will be manufactured by the tool. Once the concept of the component design is finished, ensure that the concept of the tool design is functional, manufacturable, maintainable, and that the tool consistently produces the desired target without fail. Designing the tool entails creating precise part drawings of the tool in accordance with the necessary dimensional precision and tolerances. AutoCAD, a design programme, was used to complete the design. All practical applications, including cutting raw materials to the required size and shape in accordance with the design's dimensional correctness and tolerances, are a part of tool production. The produced components will be put together and inspected. Try-out will be completed after the assembly has been confirmed. The manufactured component's dimensional accuracy will be checked. If the dimensions do not meet the required accuracy, the Tool must be reworked or modified, requiring secondary operations, and another test will be conducted. The tool will be set up for mass production and the necessary maintenance work will be carried out periodically if the trial component meets the requisite dimensional accuracy and tolerances.

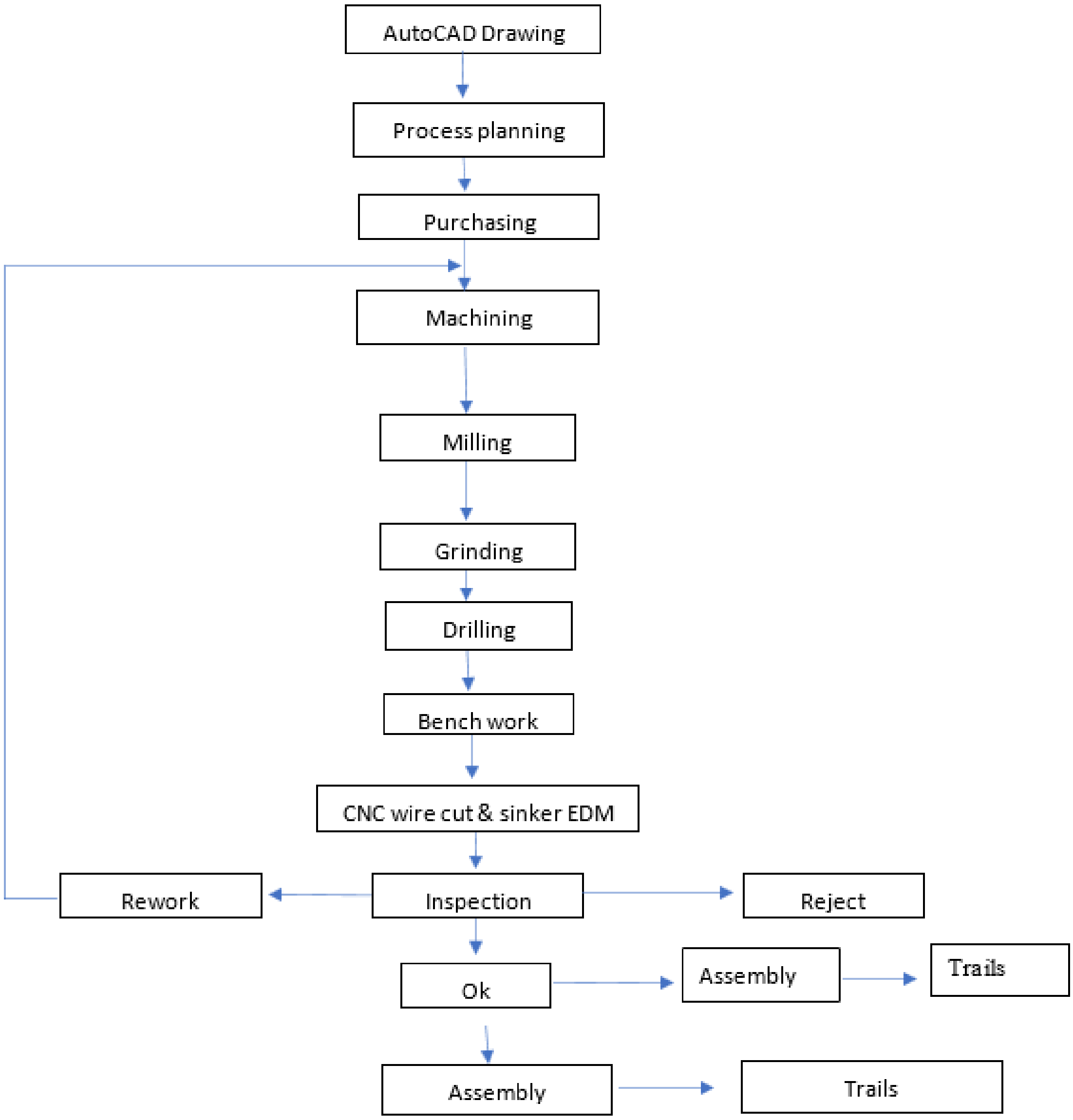

Fig.1 Working Methodology

1.3 DESCRIPTION OF ELEMENTS:

Bottom plate:

Bolster plate and Die shoe are some names for it. It is kept in a soft state and is constructed of either MS or cast iron. The bottom plate temporarily increases lift. offers access to the dies and enough space for the tool to be supported by the press bed. The bottom may have holes. plate that makes it possible for the blank to detach from the tool.

Backup plate or Thrust plate:

It is constructed of OHNS or case-hardened steel that has been hardened and tempered to between 55 and 58 HRC. If case-hardening steel was used, the depth of Carburizing in the casing must range from 0.8 to 1.3 mm. While when cutting, the punch provides upward pressure. thrust, attempting to notch the top plate, leading to in the variation of punches level. Punch should therefore be supported by a to keep it from digging into the top plate, a harder plate was used. For this reason, this plate is also known as a punch retainer plate. that it keeps the punch in place while the procedure is being done.

Die plate:

Die plates, which are female components of tools manufactured of hardened and tempered HCHCR material for cutting operations Tempered to an HRC of 60–62. Regarding non-cutting operations, OHNS To 55–58 HRC, the material is utilised, hardened, and tempered. It gives the component with an exterior shape.

Stripper plate:

It's constructed of MS (St-42) material. It is typically kept in a soft state, however some OHNS-made tools have it hardened and tempered to 55–58 HRC. The plate's primary goal is to remove material from the punches with each stroke. The stripper will also be employed to hold the strip taut and horizontal while it is being worked on, as well as to direct punches. In some cases, it might even steer the stock strip. They are classified into two groups such as fixed strippers and traveling strippers.

Punch holder plate:

It will be in a soft condition and made of MS (St-42). Typically, the punch is inserted using a mild key fit (H7/k6). Sometimes a key or a dowel needs to be placed in the punch holder to stop the profiled punches from rotating.

Top plate:

It is a soft plate composed of MS (St-42), and as opposed to all other plates save the bottom plate, it will be larger overall. To loading on the press, this plate is secured to the press tool's top unit. The tool shank is screwed into this plate, which needs to be thick enough to avoid bending.

Shank:

MS makes up the object. Holding the shank firmly in the ram hole allows the tool to be located and secured to the press ram. The diameter of the press ram bore where a given tool is designed to install determines the tool's shank. Standardized shanks are available for various presses.

2. MACHINE SPECIFICATION:

The sheet metal punching machines use punches that cut through the sheet metal, and the dies, which are placed on the opposite side of the metal piece, serve as a support to ensure that the metal doesn't break while also assisting the punches in producing exact and error-free holes

Fig 2. Punching Machine

Table No. 1 Specification of Punching Machine

S.NO	DESCRIPTION	SPECIFICATION
1	Capacity	3 to 300 Ton
2	Brand	Vivek
3	Categories	C Type Power Press
4	Material	Mild Steel
5	Automation Grade	Automatic
6	Frequency	50 Hz
7	Stroke Adjustment	25-152 mm
8	RAM Adjustment	20-75 mm

MATERIALS AND METHODS:

Electrical crimp Connector:

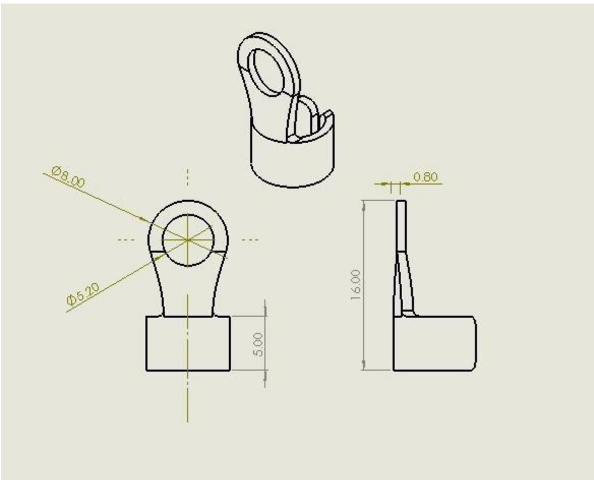

Fig 3. 2D drawing

Fig 4. Electrical crimp Connector

Table No. 2

Name	Punching machine (50 tonnes)
Material	Copper
Thickness	1mm
tensile strength	210 N/mm2
shear strength	172.36 N/mm2
type of tool	Combination tool.

DESIGN CALCULATIONS:

CUTTING CLEARANCE PER SIDE
Cutting clearance is that the intentional gap provided between the sides of a punch and die.
Cutting clearance (cc) = C * S *√ (σ) / 10)
Where,
C = Constant = 0.01
S = Sheet Thickness = 1mm
TMAX = Shear Strength = 130N/mm2
Cc = 0.01 x 1x √ (210/10)
CUTTING Clearance Cc= 0.04mm/side.

Cutting force
Cutting force is which must act on the stock material to chop the blank or slug. This determines the capacity of the press to be used for tool.
Cutting Force (Fc) = L * T * σ where,
L = Total Cut Length = 215mm T = Sheet Thickness =1mm, Shear Strength(σ) = 172.36 N/mm2
Fc = 215x 1 x 172.36, **Cutting force = 37057.4 N**

Bending force
It is the force required to bend the edges of the blank, and therefore the bending associated in the lancing operation.
Bending Force FB = 0.33*S*U*W*t^2/L
Where, W = Width of Stock Material
L = Span = Die Radius + Punch Radius + C
C = Die Clearance
T = Sheet Thickness
Su = Ultimate lastingness (Kg/mm2)
Pad Force FP = 0.5 FB
Total load required FN = FB + FP= 1.5
Load required for one bending FB=0.33×210×100×1^2/1+2
= 2310 N
Load required for 2 bending operations = 2×2310 = 4620 N
Total Load required for 2 bending operations= 1.5x4620 = 6930 N
Force required to at least one side bending in lancing operation
FB= 0.33×210×24×1^2/1+2+1
= 4158N
Total Bending load = 4158N

Stripping force
Stripping force is that the force required to strip the blank from the punches. it's the sum of the cutting force and the stripping force. it's normally expressed in tons.
Stripping force = 10-20% of cutting force
Consider 20% of cutting force
Stripping force = 20 * 37057.4/100
Stripping force= 7411.48 N

Press force
It is the sum of the cutting force, bending force and therefore the stripping force.
Press Force = Adding of all forces
= 37057.4 + 4158 + 7411.48
Press Force = 48626.88 N

Press tonnage
Press tonnage = 1.3 x press force

= 1.3 x 48626.88
= 63214,944 N
Press tonnage 7 tonnes.

Table No. 3

DESCRIPTION	DIMENSION OF DIE PLATES
Thickness of die plate (Td)	Thickness of die plate = 3√Press force = 3√48626.88 Thickness of die plate = 36.49mm But based upon the width of bend required the thickness are often taken as 20mm.
Thickness of bottom plate	Thickness of bottom plate = 2xTd =2x20 Thickness of bottom plate =40mm
Thickness of top plate	Thickness of top plate= 1.5xTd =1.5x20 Thickness of top plate =30mm However, considering the washer's thickness and stroke length. The thickness of Top plate is often taken as 32mm.
Thickness of thrust plate	Thickness of thrust plate = 8 mm
Thickness of punch holder plate	Thickness of punch holder plate= 0.75x28 = 20mm
Thickness of stripper plate	Thickness of stripper plate = 0.75x28 = 20mm

ASSEMBLED PROTOTYPE

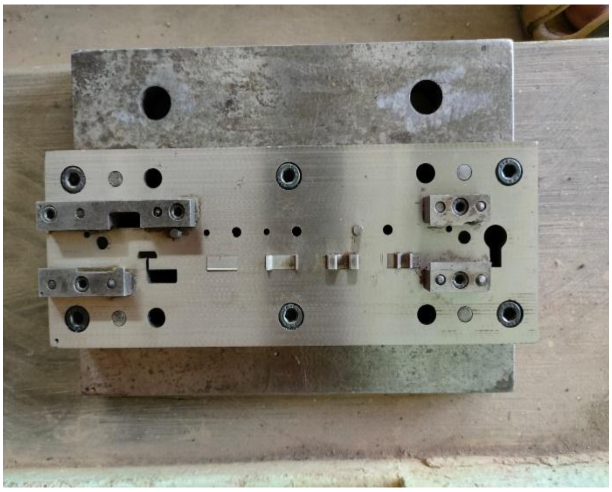

Fig. 5 Assembled die (Top view)

Fig. 6 Assembled die (Side view)

The fig.5 shows the top view of assembled die and Fig.6 shows the side view of assembled die. In this investigation, start with the half of the blanking operation and folding operation is completed up to 90 degrees. Each end of the sheet got merged with one another. At the final stage, another half of blanking process is done and the achieved complete product.

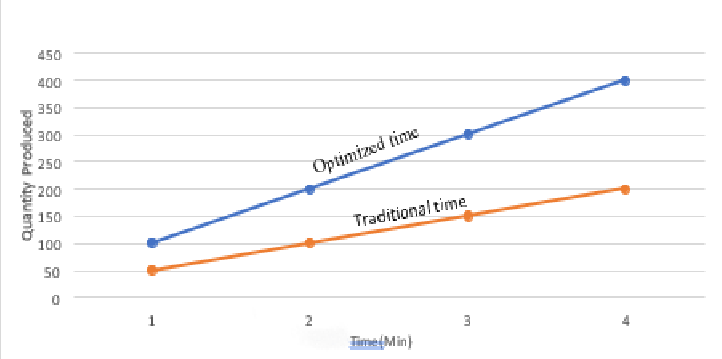

Fig. 7 Time study – Productivity

The graph represents the time and production of both traditional method and innovative method. The blue line clearly represents significant rise in productivity compared to traditional method.

3. CONCLUSIONS

In this experimental investigation, the design of a combination tool was manufactured, and testing. The sequence of operations such as blanking and folding the quality of the component inspected with the instruments, now the Tool is ready for mass production of the given component.

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