Design and Fabrication of Progressive Tool for Sheet Metal Component

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Abstract

The aim is to reduce the cost of the progressive dies without compromising on the quality of output. Using the optimum resources possible in designing the progressive dies frame can effect this reduction in the cost of the progressive dies.A progressive die performs a series of fundamental sheet metal operations at two or more stations during each press stroke in order to develop a work piece as the strip stock moves through the die. Each working station performs one or more distinct die operations but strip must move from the first station through each succeeding station to produce a complete part.The linear travel of the strip stock at each press stroke is called the "progression", "advance" or "pitch" and is equal to the infestation distance. The main advantage of computer-aided progressive die design and machining is ability to build precision tooling in less time and at a lower cost.[Kumar et al… 2000]

Introduction

The component which we are making is a "mulch-purpose opener", in which we have a bottle opener, four to five type of wrench and bottom of that contains a screw driver. This component is made with the help of progressive die of a single station. A progressive die performs a series of fundamental sheet metal operations at one or more stations during each press stroke in order to develop a work piece as the strip stock moves through the die. Each working station performs one or more distinct die operations but strip must move from the first station through each succeeding station to produce a complete part.

The linear travel of the strip stock at each press stroke is called the "progression", "advance" or "pitch" and is equal to the infestation distance. In progressive tool the final component is obtained by progressing the sheet metal or strip in many stages. In each and every stage the component will get its shape stage by stage. The full shape will be obtained at the final stage. Progressive die provide a effective way to convert raw coil stock into a finished product with minimal handling.[Jyoti et Al…2012]As material feeds from station to station in a die, it progressively works into a completed part. Progressive dies usually run from right to left. The part material feeds one progression for each press cycle. Early stations typically perforate holes that serve as pilots to locate the stock strip, in later stations each station perform an operation on a work piece during a stroke of the press. Between strokes the piece in the metal strip is transferred to the next station.A finished work piece is made at each stroke of the press.

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While the piercing punch cuts a hole in the stroke. Design of sheet metal dies is a large division of tool engineering, used in varying degree in manufacturing industries like automobile, electronic, house hold wares and in furniture.

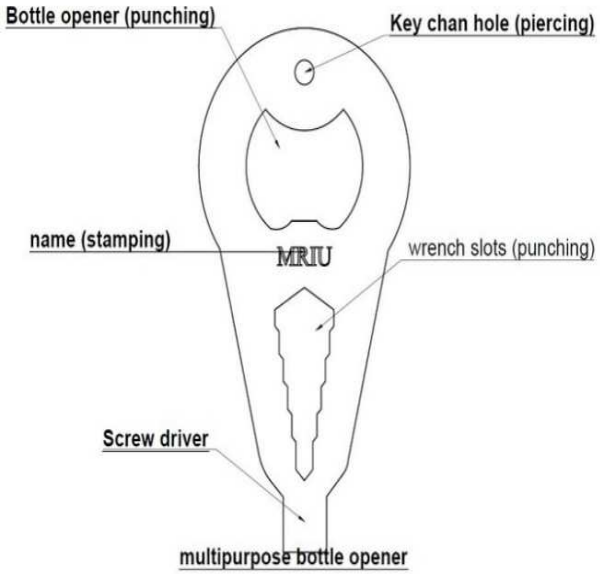

Fig 1.

There is no doubt that accuracy achieved by the new ideas in design and construction applied by the press tool designer, coupled latest development made in related fields made more productive, durable and economical. These are: -

- The variety in press specification gives the liberty to the designer to think innovative.
- The latest machining process made the complex designs made easy, like wire cut, EDM, Profile Grinding.
- Good operation planning
- The Safety Provisions has reduced the accidents and the productivity has been increased.
- "Simulation Software's give the designer freedom from taking risky decisions.
- The use and availability of Standard Elements has reduced the design and development period
- The concept of "Flexible Blank Holder" has given the scope to control the flow of the material in a better way.
- Hardened and toughened new martial & heat treatment process made the design easy. Four factors are essential contributions to first class presswork are:
- Excellent tool design
- Accurate tool design
- Knowledge press setting

Types of Press Tools

Progressive Tool

A progressive tool differs from a stage tool in the following respect: in a progressive tool the final component is obtained by progressing the sheetmetal or strip in more than one stage. At each stage the tool will progressively shape the component towards its final shape, with the final stage normally being cutting-off.

Compound Tool

The compound tool differs from progressive and stage tools by the arrangement of the punch and die. It is an inverted tool where blanking and piercing takes place in a single stage and also the blanking punch will act as the piercing die.

Combination Tool

In a combination tool two or more operations such as bending and trimming will be performed simultaneously. Two or more

operations such as forming, drawing, extruding, embossing may be combined on the component with various cutting operations like blanking, piercing, broaching and cut off takes place- it can perform a cutting and non cutting operations in a single tool.

Significance of Progressive Die

Since progressive dies initial implementation cost is very high, so by analyzing it thermally & structurally decision making of implementation of this die becomes easy. By the analysis of progressive die we can suggests the changes that can be done in tooling material and the die itself to improve the productivity. This can be done by knowing the stress acting on each part of die as well as on tools which are used in die. Another main objective of this project is we can also calculate increase in productivity in progressive die than normal compound die. This can be done by comparing the time taken in operation of a sheet metal between progressive die and normal die.

Advantages of Progressive Die

- Progressive die can operate more than one operation at a time in sequ.ence which eliminates the idle time in a sheet metal working.
- Progressive die can produce parts in batch as well as in mass which increases the productivity by large value compared to normal die.
- Progressive dies reduces the man power by operating in continuous sequence.
- In progressive dies quality parts are produced continuously.

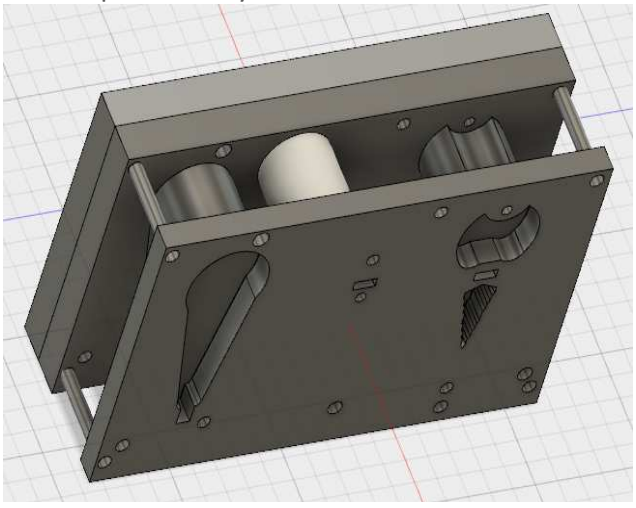

Fig 5.Upper die assembly

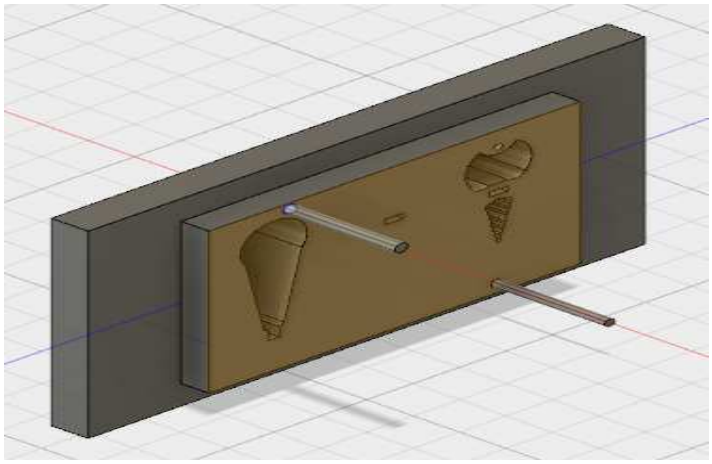

Fig 6.Lower die assembly

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Design of Progressive Die

Top plate, bottom plate and are the most basic part of the die and these two plates are guided by the nuts and bolts. This alignment is done here for improving accuracy, part quality, die life and reduce the setup time. The lower plate support the die, die housing, raisers etc. And the top plate supports the punch, punch backup plate, bush etc.

Design Analysis

Die Clearance: It is depend on the part material property. If the material is ductile in nature then the clearance is small and for brittle material it is large clearance. If the clearance is given in reverse then there for ductile material it pass through die means here it draw from die instead of cutting. And in ductile material it damages the cutting edges of punch and die. The die clearance for mild steel is 2.5% or 5% of thickness per side.

C = 2.5% of thickness

2.5/100*2 = 0.05 mm

Force analysis:Shear Force = Fs = L.S*t*

For Piercing: Fs = L.S*t*

= 49.298*2*392.4

= 38.68 KN

For Blanking: Fs = L.S*t*

= 567.3*2*392.4

= 445.21 KN

Total Shear Force = 38.68+445.21

= 483.9 KN or 49.34 ton

Stripping Force

It is require to remove the strip from the punch after the cutting operation. It is given as 10% of total shear force.

Stripping force = 10% of total shear force

= 0.1*483.89

= 48.389 KN

Total Force = T.S.F + Stripping Force

= 483.89+48.389

= 532.279 KN

The factor of safety is consider to be 20% more

∴ Requirement of press capacity = 120% of total force

= 1.2*532.279

= 638.734 KN

Die Block: The bottom assembly is the female part of the punch tool. The most important part of the bottom assembly is die block. The cutting edge is given to the die block. The land is also provided on the die block. This land is provided for the proper cutting. The land for the die is given by the 1.5t.

∴The stress in the die block is given as:-

$T_d = 483.89*10^3/200*130$

$= 18.611\ N/mm^2$

The allowable strength is D2 material is $200N/mm^{2.}$ The calculated value is 18.611 N/mm^2. So the design of the die block is safe.

Bottom Plate: The bottom plate is the base of lower assembly. There is a die block, raiser, guide pillars are mounted on the bottom plate. This bottom plate is used to clamp the lower assembly of the press tool over the bolster plate by using the clamping device. The bottom plate is made from the mild steel material.Thickness of bottom plate is given as;

$T = 1.5*T*T_d$

= 1.5*2*18.611

= 55.83 mm

= 532.279*10^3/200*130

= 20.47 N/mm^2

Punch: Punch is made part of the press tool. The cutting operation is carried out here. So the material required for manufacturing the punch is harder than the part material. So D-2 material is used for punch manufacturing.

The travel of the punch is given by:-

Travel = Entry in stripper + Entry in die + Part thickness

= 15+3+2 = 20 mm

Thickness of punch is depend on the punch alignment with stripper plate , compressed length of spring, and with the punch travel. So here we take 20mm as punch thickness. The clearance is given on punch in blanking operation.

Critical force acting on punch is given by Euler's formula such as

$F_{cri} = 2\pi^2 EI/l^2$

Where, E – Modulus of elasticity

I – Minimum moment of inertia for punch

$I_{min} = \pi D^4/64 = 2980.90\ mm^4$

The critical maximum length of punch is

$I_{max} = 111103.56/271.974 = 408.50$ mm

P – Load acting on punch (73.97 KN)

Area of punch is;

$A = \pi * D^2/4 = 193.49\ mm^2$

$r_g = (I_{min}/A)^{0.5} = (15.40)^{0.5} = 3.92$ mm

Slenderness ratio = L_e/r_g =

Top plate

$T = T_d$

= 2*15.7

= 31.4 mm

= 638.73*10^3/200*130 = 24.56 N/mm^2

Allowable limit is 410N/mm^2, so the design is safe here.

Result and Discussion

The die which we are making in this project will reduce the noise pollution in nature, as we discussed in past times multi station progressive dies are used which increases the noise in atmosphere and these machines can only be used in industrial area, but now we are making the die that is single station which reduces the noise pollution to environment. Since the die is single station, fewer machines are used for manufacturing the component which reduces power consumption of electricity which can be consume by other people in society and due to saving in all the things, the overall cost of the product also reduces, which can be easily purchased by the medium class society. The multi-purpose opener which is a bottle opener, a screw driver, diff types of wrench openers is single component which can be easily be used by anyone at any time whenever required. The material which we will use in the project is stainless steel which does not get rust easily, due to this the component will last long and change of product will not require for long time, that will reduces expenses of a common people.

Future Scope

The die which we are making enhances the production by producing maximum no of units in minimum amount of time. As a result the wastage of raw material decreases which also reduces the cost of raw material. As it is a single station die it reduces manufacturing cost, which reduces the overall cost of product.

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