IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 6, June 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

Design and Analysis of Progressive Tool for Photo Frame Hook

Mr.Sandeep P V
ME, Manufacturing Engineering
Dept.of mechanical Engineering
S.V.H.E.C - Gobi

Mr. C. Vikhnesh , ME MBA
Assistant Professor
Dept.of mechanical engineering
S.V.H.E.C - Gobi

Abstract

Design and development of progressive tools for the sheet metal component is one important phase in sheet metal manufacturing. Sheet metal press working process by progressive tools is a highly complex process that is vulnerable to various uncertainties such as variation in progressive tools geometry, stripe layout, die shear, material properties, component and press working equipment position error and process parameters related to its manufacturer. These uncertainties in combination can induce heavy manufacturing losses through premature die failure, final part geometric distortion and production risk. Identification of these uncertainties and quantifying them will facilitates a risk free manufacturing environment, which can be obtained by effective tool design.

This project aimed at designing and analyzing a progressive tool for photo frame hook with aid of computer aided design package. The design of the tool is intended both skilled and unskilled labour and mass production of the component, which is cost effective and consumes lesser time for production.

***Keywords**: Progressive tool, Strip layout, Press tonnage, Punching force, Analysis*

1. Introduction

In sheet metal forming when dealing with complicated shapes the process sequence, die geometry, perform shape and process parameters at each stage are designed based on past experiences and trial and error. As a result die and process development may be time consuming and costly. Therefore a computer aided approach is highly desirable for designing robust process sequence to reduce expense. A survey of literature suggest that no theoretical or precise empirical relationship is available that can aid tool users in the rational selection of tool parameters resulting in minimum distortion of tool in operation.

In this investigative thesis work, an attempt has made to go through various design stages of a progressive tool and to conduct an analysis work to determine the safe load, stresses and deflection for the same. Thereby trying to reduce the possible future failures of tool and hence to increase the efficiency of production.

2. Objective of the project work

The purpose of the present investigation is to study the manufacturing of sheet metals by use of a progressive tool. It is necessary to go through the various stages of designing and finding out the possible failures or errors that would happen at the time of manufacturing. In sheet metal forming when dealing with complicated shapes the process sequence, die geometry, perform shape and process parameters at each stage are designed based on past experiences and trial and error. As a result die and process development may be time consuming and costly. Therefore a computer aided approach is highly desirable for designing robust process sequence to reduce expense.

3. Tool Design for Photo Frame Hook

3.1 Component diagram

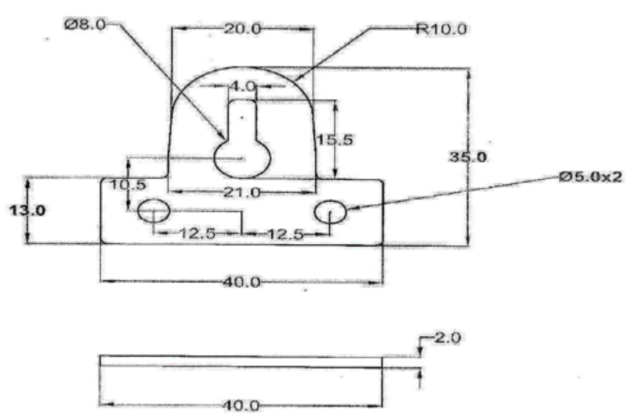

Fig. 3.1 Component Diagram

3.2 Component Analysis

Material	: Mild Steel (S42)
Thickness	: 2 mm
Shear strength	: 35kg/mm^2
Temper grade	: Hard
Supply condition	: Strips
Geometry tolerance	: IS2102

3.3 Strip layout

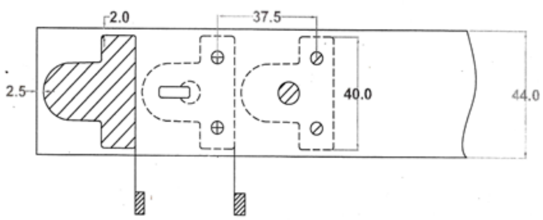

Fig. 3.2 Scrap Strip Layout

3.4 Design Calculations for the Tool

Component Material = MS
Thickness of the strip= 2mm
Component area = 1086.16 mm^2
% of strip used = (Area of component) /(length of strip×width of strip
= (1086.16)/(37.5×44)
= 0.6582
% of strip used = 0.6582×100 = 55.58 %
Shear force =K L t S_{sh} /1000 tons
Where,
K is a constant = 1.1 to 1.5 (based on clearance) L = length of cut in mm
t = thickness of stock in mm
S_{sh}= shear strength of material Kg/mm^2
Shear force = 1.5x211.95x2 x 40/1000
= 25.43 tons
Stripping force = 10% of shear force
= 10x25.43/100
= 2.54 tons
Total force = shear force + stripping force
= 25.43 +2.54
= 27.98 tons
Press tonnage = 1.2 x total force
= 1.2x 27.98
= 33.57 tons.

Thickness of the die plate
(td) = $3\sqrt{F_{sh}}$ F_{sh} =shear load in ton
td = $3\sqrt{16.95}$
= 2.56cm
= 25.6 mm
Die thickness selected = 30mm
Thickness of the punch holder = 0.5x td
= 0.5x30
= 15mm
Thickness of bottom plate (tb) = 1.5xtd
=1.5x30
= 45mm
Thickness of top plate (tp) =1.25xtd
=1.25x30
= 37.5mm
Thickness of stripper plate (ts) = 0.5xtd
= 0.5x30
=15mm
Cutting clearance = 4% of sheet thickness
= 0.04x2
= 0.08 mm/side
Blanking Punch Size = Blank Size – Total Clearance
Piercing Punch Size = Hole size – Total Clearance

3.5 Assembled View of Progressive Tool

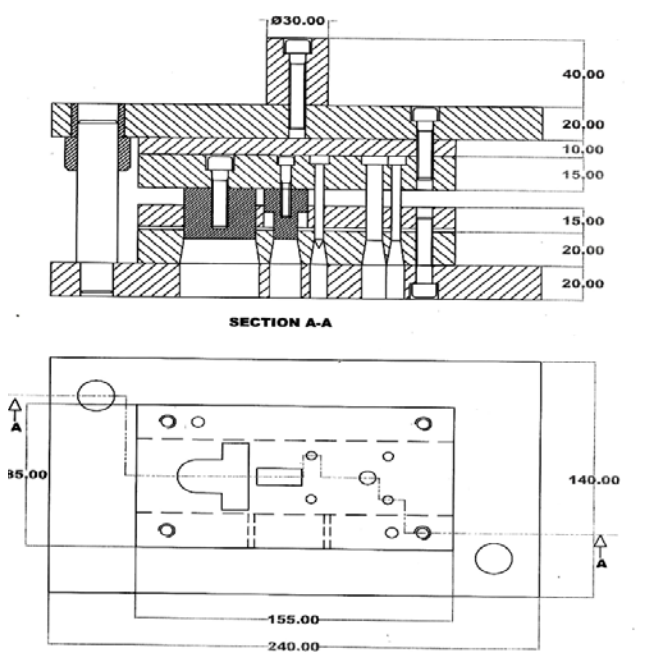

Fig. 3.3. Assembled View Of Progressive Tool

3.6 Die Plate Design

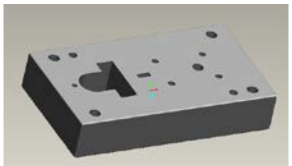

Fig. 3.4 Die Plate

Assuming that the die block (die plate) is considered to be as fixed beam. The shoe deflection is calculated using the strength of material formula for fixed supported beam,

Deflection, $\delta = FL^3/192EI$

Where,

F = 80% of cutting force

$= 0.8 \times 25434$ kgf

$= 203472$ N

$L = 125$ mm, $E = 2.1 \times 10^5$ N/mm^2

$I = bh^3/12 = 3.48 \times 10^5$ mm^4

Where, $b = 155$mm, $h = 30$ mm

$\delta = (203472 \times 125^3)/(192 \times 2.1\times10^5 \times 3.48 \times 10^5.29 \times 10^6)$

$=$ **28.26µm**

Stress, $p = F/A$

$p = 203472 / (0.155 \times 0.085)$

$=$ **5.98×10^7 N/m^2**

3.7 Bottom Plate Design

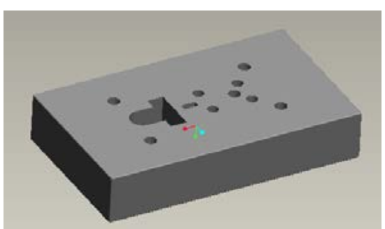

Fig. 3.5 Bottom Plate

Assuming that the bottom plate is considered to be on parallels. The shoe deflection is calculated using the strength of material formula for parallels supported beam,

Deflection, $\delta = FL^3/354EI$

Where,

F = 80% of cutting force

$= 0.8 \times 254340$

$= 209419.3$ N

$E = 2.1 \times 10^5$ N/mm^2

$I = bh^3/12$

$= 1.8 \times 10^6$ mm^4

Where, $b = 286$ mm, $h = 52$ m

$\delta =$ **11.03µm**

Stress, $p = F/A$

$p = 203472 / (0.240 \times 0.140)$

$=$ **6.05×10^6 N/m^2**

3.8 Top Half Design

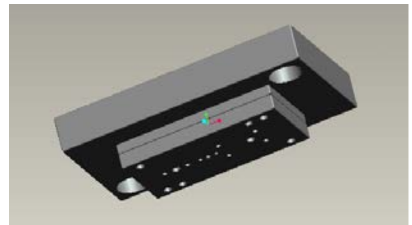

Fig. 3.6 Top Half

Top half includes as for calculation and analysis purpose as top plate, punch back plate and punch plate. Assuming that the Top plate is considered to be on parallels. The shoe deflection is calculated using the strength of material formula,

Deflection, $\delta = FL^3/48EI$

Where,

F = 80% of cutting force

$= 0.8\times254340$

$= 203472$ N

$L = 195$ mm

$E = 2.1 \times 10^5$ N/mm^2

$I = bh^3/12$

$= 2.5 \times 10^6$ mm^4

Where, $b = 240$ mm, $h = 60$ mm

$\delta =$ **3.4 µm**

Stress, $p = F/A$

$= 203472/(0.24\times0.14)$

$=$ **6.05×10^6 N/m^2**

3.9 Stripper Plate Design

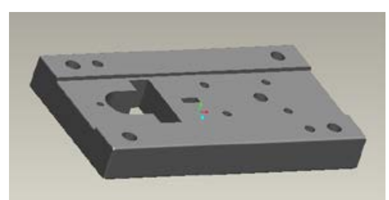

Fig.3. 7 Stripper Plate

Assuming fixed stripper to be considered as a fixed beam support.The fixed stripper plate deflection and stress is calculated using strength of material formulae for parallels supported beam,

Deflection $\delta = FL^3/192EI$

Where, F = 10% to 20% of cutting force

$= 25434$ N

ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

$L = 125$ mm,
$E = 2.1 \times 10^5 N/mm^2$
$I = bh^3/12$
$= 4.35 \times 10^4 mm^4$
Where, b= 155 mm,h= 15 mm
$\delta = 11.92 \mu m$
Stress, $p = F/A$
$p = 52354.8 / (176 \times 20)$
$= 1.93 \times 10^6 N/m^2$

3.10 Piercing Punches

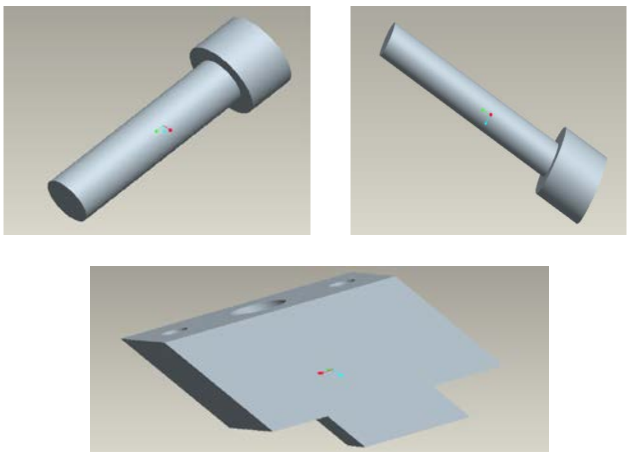

Fig. 3.8 Piercing Punches

Assuming that the piercing punch as consider as one end is fixed and compressive force is acting on other end. Here for cutting operation (piercing operation) 80% of cutting force is acting on punch as compressive nature.

We know that the compressive force on the punch is equal to the shear force on sheet metal.

Piercing Punch-1

Deflection of piercing punch,
$\delta_p = P_p L / A_p E$
Where ,
P_P = Compressive force for piercing operation
$= 37699.1$ N
$L = 42$ mm,
$A_p = 19.63 mm^2$
$,E = 2.1 \times 10^5 N/mm^2$
δ_p = **$3.83 \mu m$**
Stress, $p = F/A$
$p = 2.89 \times 10^6$

Piercing Punch-2

Deflection of piercing punch,
$\delta_p = P_p L / A_p E$
Where ,
P_P = Compressive force for piercing operation
$= 30159.2$ N
$L = 42$ mm,
$A_p = 50.26b mm^2$
$,E = 2.1 \times 10^5 N/mm^2$
δ_p = **$1.19 \mu m$**
Stress, $p = F/A$
$p = 3.50 \times 10^6$

Square Piercing Punch

Deflection of piercing punch,
$\delta_p = P_p L / A_p E$
Where , P_P = Compressive force for piercing operation
$= 27600$ N
$L = 42$ mm,
$A_p = 30 mm^2$
$,E = 2.1 \times 10^5 N/mm^2$
δ_p = **$1.84 \mu m$**
Stress, $p = F/A$
$p = 2.63 \times 10^6$

3.11 Blanking punch

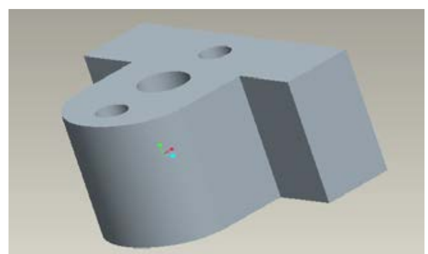

Fig. 3.9 Blanking Punch

Assuming that the blanking punch as consider as one end is fixed and compressive force is acting on other end. Here for cutting operation (blanking operation) 80% of cutting force is acting on punch as compressive nature.
Deflection of blanking punch,
$\delta_p = P_p L / A_p E$
Where , P_b = Compressive force for piercing operation
$= 16849.2$ N
$A_b = 2102.13 mm^2$
$E = 2.1 \times 10^5 N/mm^2$
$L = 42$mm
Deflection of blanking punch, δ_b = **$1.603 \mu m$**
Stress, $p = F/A$
$p = 4.8 \times 10^6$

4. Result of Analysis

Table .1 Result of Analysis

Sl.No	Description	Analysis result		Calculated value	
		Deflection µm	Stress N/m^2	Deflection µm	Stress N/m^2
1	Top half	4.25	6.98×10^6	3.4	6.05×10^6
2	Die plate	25.3	4.65×10^7	28.26	5.98×10^7
3	Stripper plate	11.4	5.82×10^6	11.92	6.05×10^6
4	Square piercing punch	2.54	1.98×10^6	1.19	2.63×10^6
5	Blanking punch	1.45	4.69×10^6	1.603	4.8×10^6
6	piercing Punch-1	4.15	1.37×10^6	3.83	2.89×10^6
7	Piercing Punch-2	1.8	4.87×10^6	1.19	3.50×10^6
8	Bottom plate	10.25	3.13×10^6	11.03	4.37×10^6

5. Conclusion

progressive tool were modelled in Pro-Engineer 4.0. Each individual file was imported to Ansys12.0 software through Initial Graphics Exchange Specification (IGES) format. The following conclusions were made.

1. The results obtained through analysis are approximately nearer to the theoretical values. This demonstrates that the analysis carried out was correct.
2. It is also observed that the design of progressive tool is safe as all the stress values were less than the allowable stress of the material.
3. Manufacturing of progressive tool by analysis result facilitates risk free manufacturing environment, which goes a long way to minimize the overall cost of production.
4. The analysed values reduce the uncertainties in combinations which may induce heavy manufacturing losses by prematic die failure.

References

[1].Taylan Altan, Metal Forming Handbook, Schuler, Berlin Heidelberg, 1998
[2].Ivana Suchy, Hand Book of Die Design, 2nd edition McGraw-Hill, 2006, 1998.
[3]. Vukota Boljanovic, Ph.D. Sheet Metal Forming Process and Die Design, Industrial Press New York, 2004.
[4 David Alkire Smith, Die Materials and Treatments C18.docRev September1, 2005.
[5].Cyril Donaldson, George H LeCain, VC Goold, Tool Design, 3rd edition,Tata McGraw- Hill.
[6].Ch.Mastanamma , K.Prasada Rao, Dr. M.Venkateswara Rao Design and Analysis of Progressive Tool (IJERT) Vol. 1 Issue 6, August, 2012.
[7].Prakash H. Joshi, Press Tools Design and Construction, A.H. Wheeler and Co. Ltd, 411,Surya Kiran, K.G.Marg, New Delhi.
David T. Reid, Fundamentals of Tool Design, 3rd edition, Society of Manufacturing Engineers (SME).