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Design Calculation and Analysis of Progressive Press Tool For Square washer

Shiv Shankar Kumar Prasad [1], Asita Kumar Rath [2]*

[1]PG Scholar, Production Engineering Raajdhani Engineering College (BPUT), Bhubaneswar, Odisha, India.

[2]Assistant Professor, Dept. of Mechanical Engineering, Raajdhani Engineering College, Bhubaneswar, Odisha, India.*

shivshankarprasad2006@gmail.com[1], asitr06@gmail.com[2]

Abstract

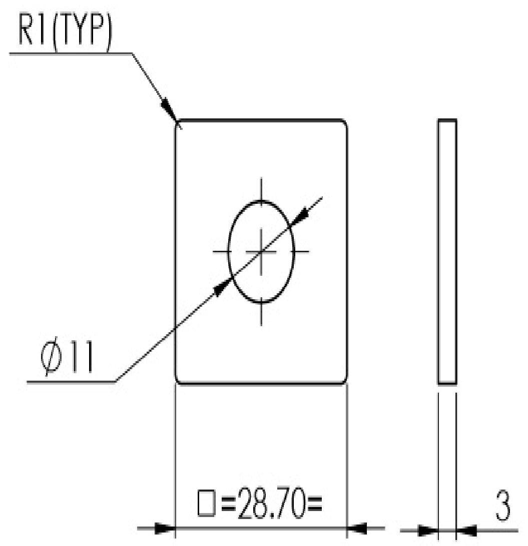
A progressive press tool used for different types of sheet metal operation in a single stroke. All operations may be shared or both shearing and non-shearing operation. This press tool design for a single row one pass layout. Scrap strip layout design categorized into three essential stages, namely – piercing, piloting and blanking. To stop forwarding one stage to another pitch punch method were used. Raw material is used in small segment form and strip is manually fed. This project aimed that each stage stopping position was removed like primary, secondary and final stage with the help of pitch punch method, rear and face strip guide and also used insert based die plate. Die block is EN8 steel and material of insert is tool steel. Square washer was used for automobile, construction and aircraft industry. It also enables distribution of load and gyration persistently opposed. "In this project, utilization of three-dimensional computer aided design software specifically SOLIDWORKS for press tool elements designed". Auto CAD for scrap striped layout and ANSYS for tool element analysis.

Keywords: Scrap strip layout, Design parameters calculation, Die plate layout, Assembly drawing, Element's analysis.

1. Introduction

Progressive tool is a continuous production to produce sheet metal components with the help of punches, dies and other elements like top plate, thrust plate, stripper plate, bottom plat, etc. In press tool we have done two types of operations shearing and non-shearing. If we go to shearing operation the force is applied to shear the sheet metal has above the plastic deformation and non-shearing force has applied to deform the sheet above the elastic limit and below the plastic deformation. In our case only shearing operation is done, so force is applied above the plastic deformation. The process of shearing sheet has four stage- plastic deformation, penetration, fracture and separation. This tool has minimum two operations which are performed at different stages. Last operation is done in last stage blanking or cut off. We provided pilot to registering the sheet in proper position. The design of punch, die and other elements according to our sheet metal component parameters and press machine specification. The accuracy of component depended upon the manufacturing and design parameters of punch and die accuracy, burr and radius formation on component is dependent upon die clearance provided between cutting edge of punch profile and corresponding cutting edge of die profile. To manufacturing the press tool, we can used conventional and non-conventional machines.[1-6].

1.1 Component drawing and data



Material: CRCA1020

Shear strength: 42 Kg/mm2

General tolerance: +0.4 mm

2.Scrap Strip layout Single Row one pass

2.1 Calculation of margin

Unswerving border profile values of face, rear and bridge margin depend on the higher value of profile length or breadth.

If length or breadth is less than 63.5 mm than margin is 1 times of strip thickness.

If length or breadth is 63.5 mm to 203.2 than margin is 1.25 times of strip thickness.

If length or breadth is over 203.2 mm than margin is 1.5 times of strip thickness.

Data required when find economical strip utilization:

Area of blank profile = 822.83 mm2

Number of rows = 01

Strip breadth = 36.7 mm

Pitch length = 31.7 mm

2.2 Percentage of strip utilization [U]

$$\% \text{ U} = \frac{Area\ of\ blank\ profile\ X\ Number\ of\ rows}{Strip\ breadth\ X\ Pitch\ length} X\ 100$$

= (822.83X 1 / 36.7 X 31.7) / 100

= 70.72 %

2.3 Scrap Strip Layout

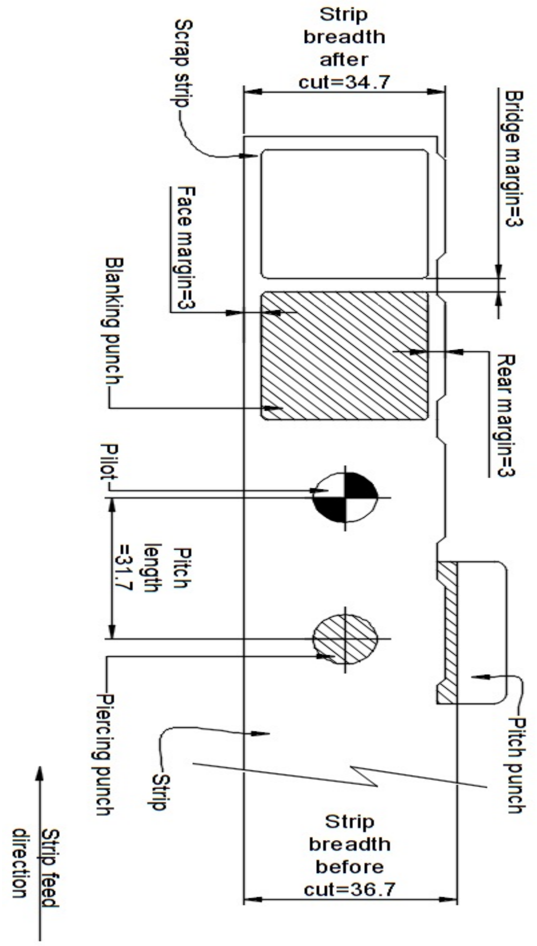


Fig.1. Scrap strip layout

3 Design parameters calculation

3.1 Die clearance [D]

D = K x T x √(S)

= 0.01 X 3 X √42

= 0.20 mm/side

Where,

K = Constant 0.01

T = Strip thickness [mm]

S = Shear strength [kg/mm2]

3.2 Calculation of shearing force [Fsh] and stripping force [Fst]

Fsh = P x T x S

= 184.13 x 3 x 42

= 23200.38 Kg

= 23.2 tons

P = Perimeter of shearing profile [mm]

T = Strip thickness [mm]

S = Shearing strength [kg/mm^2]

Fst = 10 % of shearing force

= 2320.04 Kg

3.3 Press machine capacity [Pc]

Pc = 1.15 x Total shearing force
= 1.15 x 25520.42
= 29348.48 Kg
= 29.35 tons

Total shearing force = Shearing force + Stripping force

3.4 Size of die opening and punch opening

For blank profile

Size of die opening = Size of blank profile

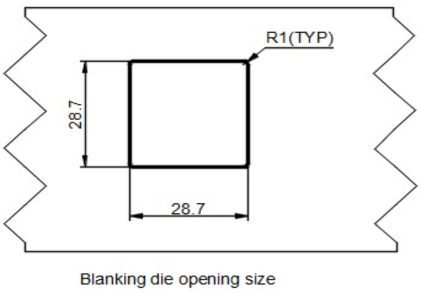


Fig. 2. Blanking die opening size

Size of punch opening = Size of blank profile – die clearance per side

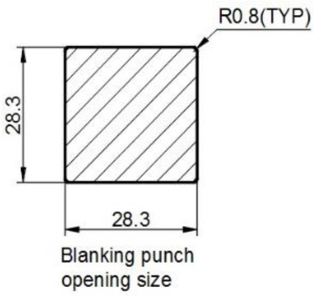


Fig.3. Banking punch operation size

For piercing profile

Size of die opening = Size of piercing profile + die clearance per side

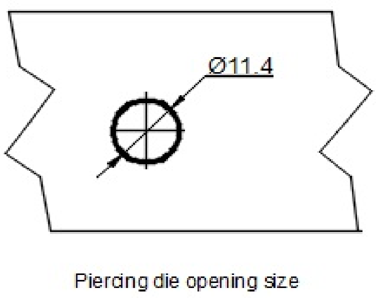


Fig. 4. Piercing die opening size

Size of punch opening = Size of piercing profile

Fig. 5. Piercing punch opening size

3.5 Size of pilot

Diameter of pilot [Pd]

Pd = Piercing punch diameter – 2.5 % of strip thickness.

= n11 – (3 X 0.025)
= 10.92 mm

Length of pilot [Pl]

Pl = Length of highest punch + Strip thickness + 1
= 72 + 3 + 1
= 76 [mm]

3.6 Screw size calculation

Required number of screws = 4
Stripping force = 2320.04kg
Load withstand per screw =
Stripping force / Number of screws
= 2320.04 / 4
= 580.01 Kg.

Root area of the screw =
Load withstand per screw / Permissible stress
Permissible stress = 8 [Kg / mm^2]
= 580.01 / 8
= 72.50 mm^2

Core area = $\pi / 4 \, (D - 1.227P)^2$
D= outer diameter of thread [mm]
P = Pitch of thread [mm]

Die plate design take screw size M12 and dowel size n10

3.7 Die design calculation

Die plate thickness [Td]
Td = Cube roots of shearing force.
Td = $\sqrt[3]{23.2}$
= 2.852 cm
= 28.52 mm
≃29 mm

Die margin = 1.5 X Td
= 1.5 X 29
= 43.50 mm
≃ 44 mm

Die plate length =

Length of cutting profile + (2 X Die margin)

= 92.1 + (2 X 44)

= 180.10 mm

≃ 180 mm

Die plate breadth =

Breadth of cutting profile + (2 X Die margin) + 4d

Where “d” is diameter of screw [mm]

= 33.7 + (2 X 44) + (4 X 12)

= 169.70 mm

≃ 170 mm

Die land = 1.5 X Strip thickness

= 1.5 X 3

= 4.5 mm

≃5 mm

Die relief = 1.5° per side

3.8 Based on the die plate design data the other press tool elements sizes

Top plate thickness =

1.25 to 1.75 times of die plate thickness

= 1.75 X 23

= 40.25 mm

≃ 40 mm

Bottom plate thickness =

1.75 to 2 times of die plate thickness

= 2 X 23

= 46 mm

Thrust plate thickness = 10 mm

Length and breadth of thrust plate same as die plate

Punch holder plate thickness

Same as die plate thickness = 23 mm

Length and breadth of punch holder plate same as die plate

Punch length =

Punch holder plate thickness + 15 mm (Gap between punch holder plate and stripper plate) + Stripper plate thickness + strip guide thickness + strip thickness

= 29 + 15 + 19 + 6 + 3

= 72 mm

Guide pillar diameter calculation for diagonal pillar

W = W1 X A / 4B

= 37.65 X 328.94 / 4 X 180

= 17.20 Kg

Where

W1 = Weight of top half tool assembly [Kg]

A = Span between pillars [mm]

B = Pillar length [mm]

W1 = Weight of (top plate + thrust plate + punch holder plate + cutting punch) X 1.05 [Kg]

= 37.65 Kg

B = 180 mm

A = 328.94 mm

Guide pillar diameter = $\sqrt[4]{WB^3/61.2}$

$= \sqrt[4]{17.20\ X\ (180)^3/61.2}$

= 35.78 mm

≃ 36 mm

4.Die plate layout

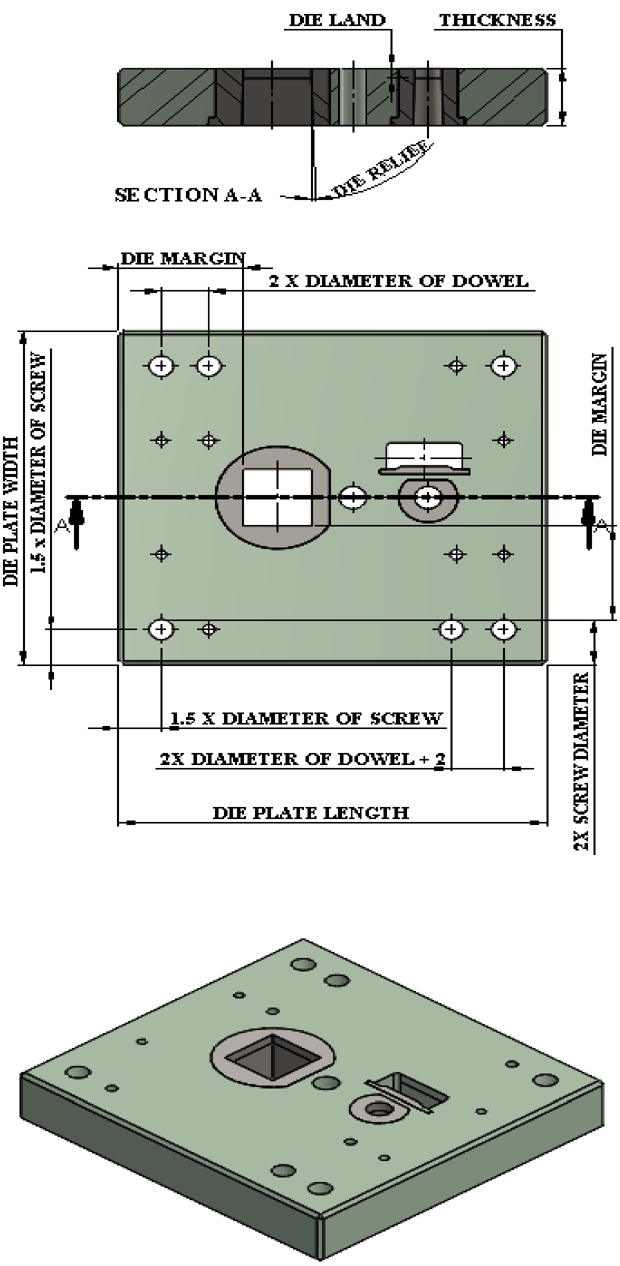


Fig. 6. Die plate layout

5. Assembly drawing

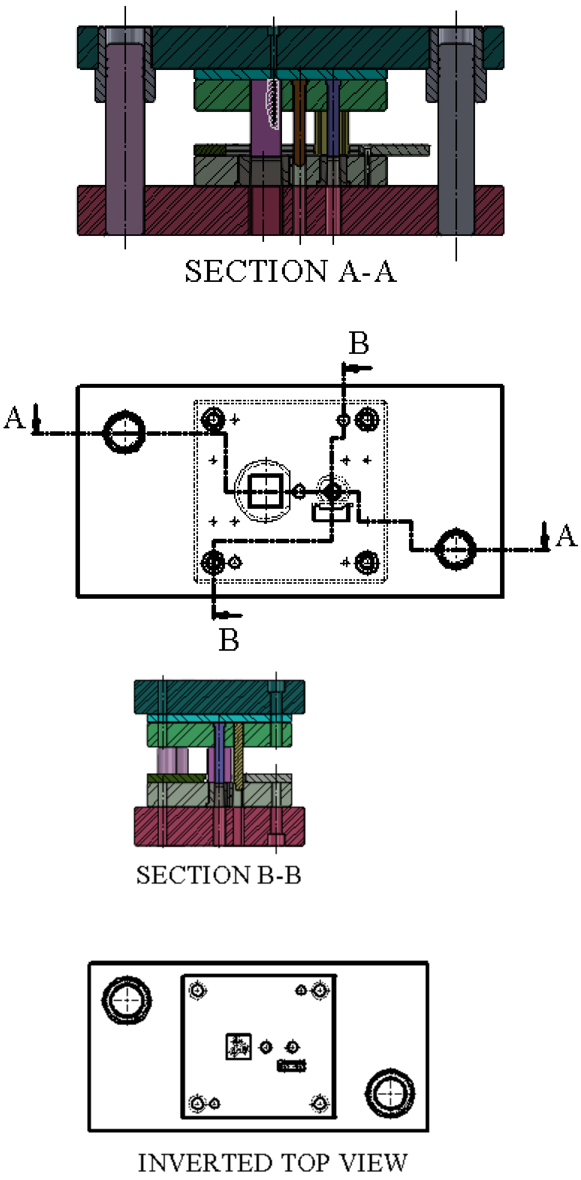


Fig. 7. Progressive tool assembly

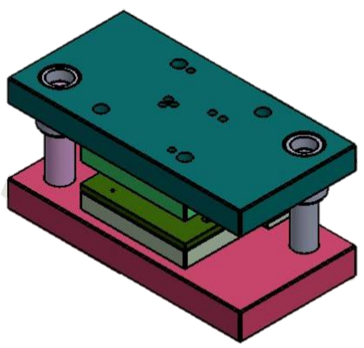


Fig. 8. Progressive assembly in isometric view

6. Element's analysis

Static structural analysis is used to find out the stresses, strains, induces forces and displacement in the elements. When the system structure subjected various loads, developed stresses and strains are calculated using structural analysis. The analysis is done by taking different material properties for different elements which are listed below.[7-10].

Sl. No.	Element name	Material
01	Top plate	Mild steel
02	Thrust plate	OHNS
03	Punch holder plate	EN8
04	Piercing punch	D2
05	Blanking punch	D2
06	Pitch punch	D2
07	Pilot	OHNS
08	Stripper plate	EN8
09	Face strip guide	EN8
10	Rear strip guide	EN8
11	Die block	EN8
12	Die insert	D2
13	Bottom plate	Mild steel
14	Guide bush	EN36
15	Guide pillar	EN36

6.1 Equivalent stress results

Equivalent (von-mises) stress result of top half assembly.

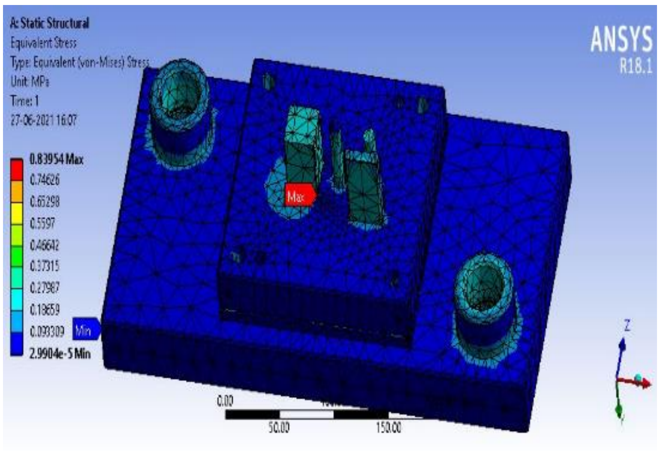


Fig. 9. Top half assembly diagram

Equivalent (von-mises) stress result of bottom half assembly

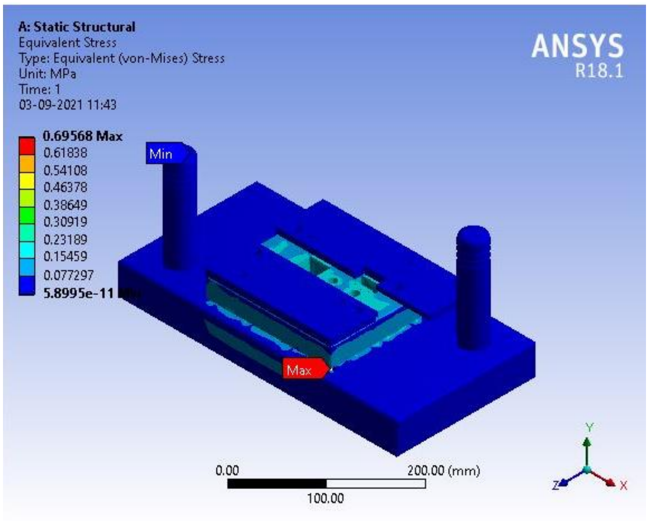


Fig. 10. Bottom half assembly diagram

Equivalent (von-mises) stress result of piercing punch

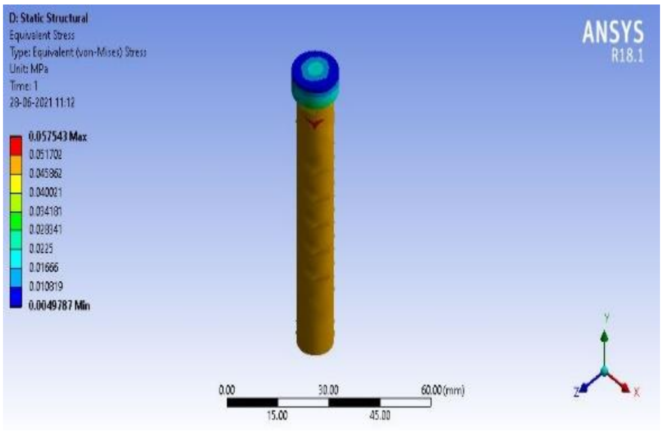


Fig. 11. Piercing punch diagram

Equivalent (von-mises) stress result of blanking punch

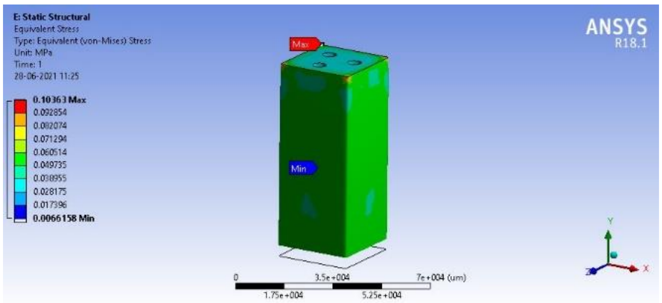


Fig. 12. Blanking punch diagram

Equivalent (von-mises) stress result of pitch punch

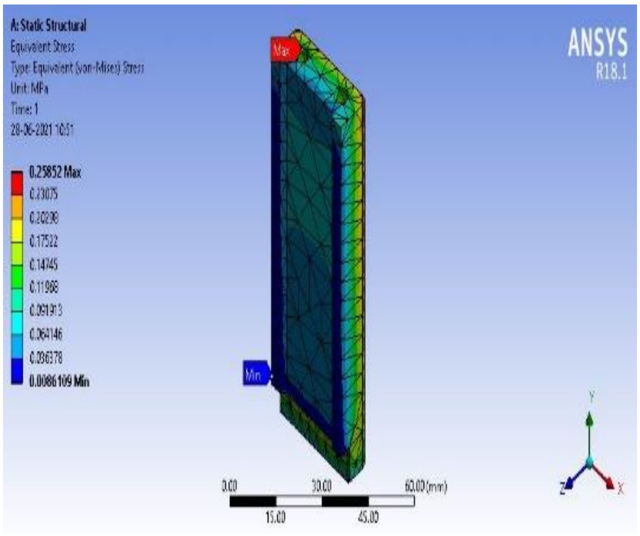


Fig. 13. Pitch punch diagram

Equivalent (von-mises) stress result of pilot

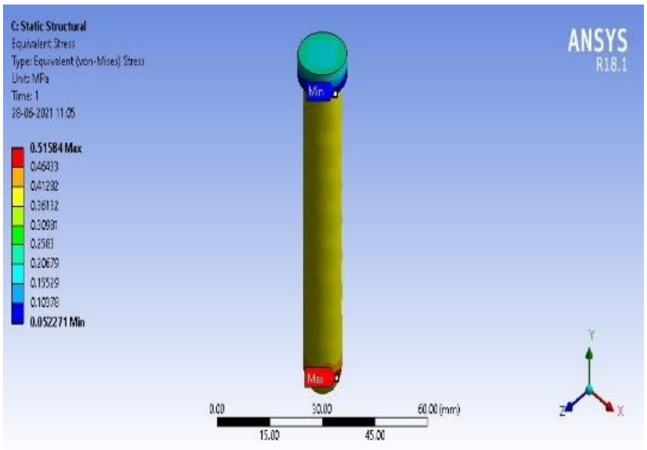


Fig. 14. Pilot diagram

Equivalent (von-mises) stress result of die plate

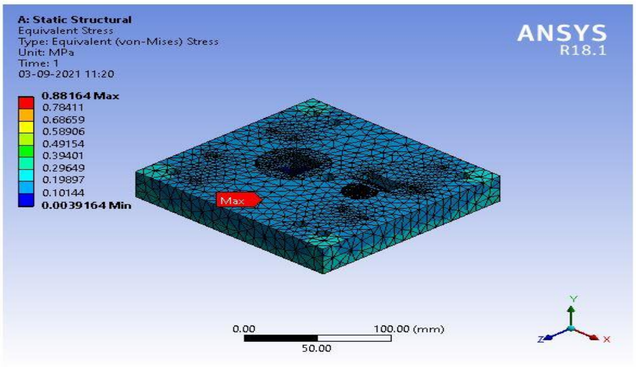


Fig. 15. Die plate diagram

6.2 Deformation results

Deformation result of top half assembly

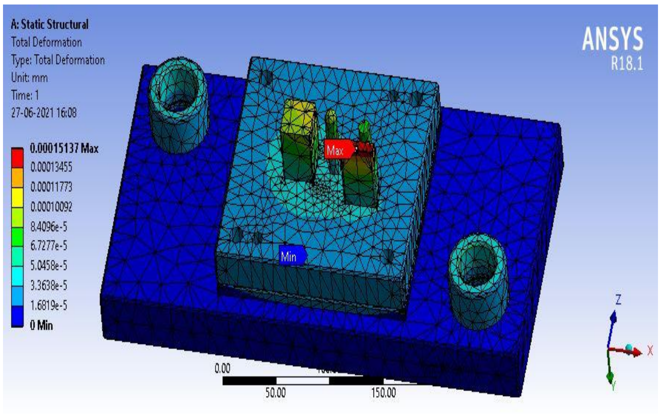


Fig. 16. Top half assembly diagram

Deformation result of bottom half assembly

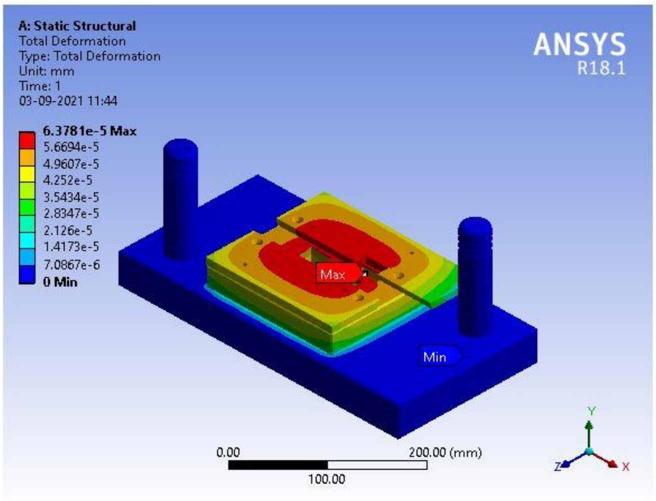


Fig. 17. Bottom assembly diagram

Deformation result of piercing punch

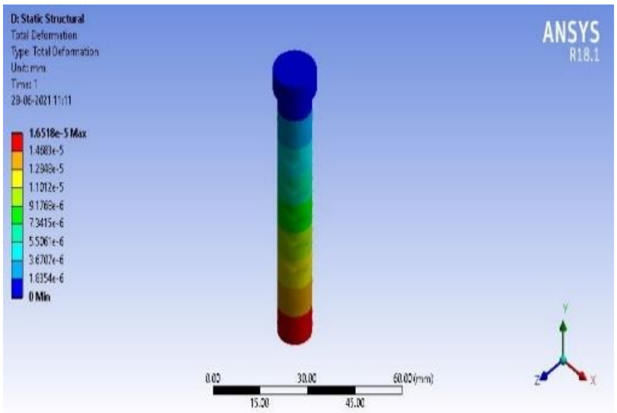


Fig. 18. Piercing punch diagram

Deformation result of blanking punch

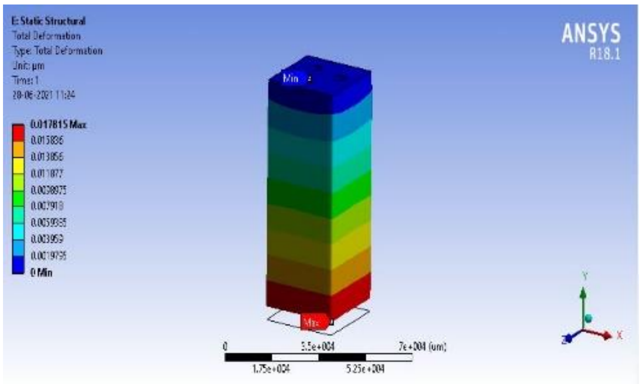


Fig. 19. Blanking punch diagram

Deformation result of pitch punch

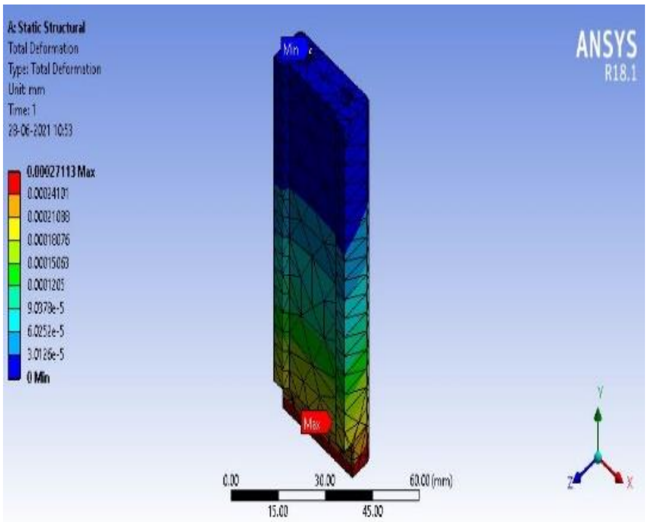


Fig. 20. Pitch punch diagram

Deformation result of pilot

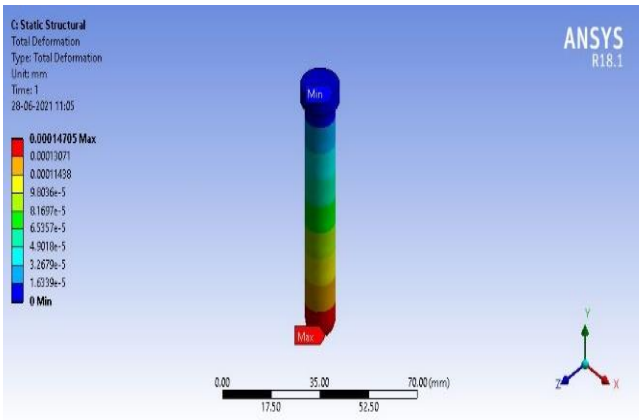


Fig. 21. Pilot diagram

Deformation result of die plate

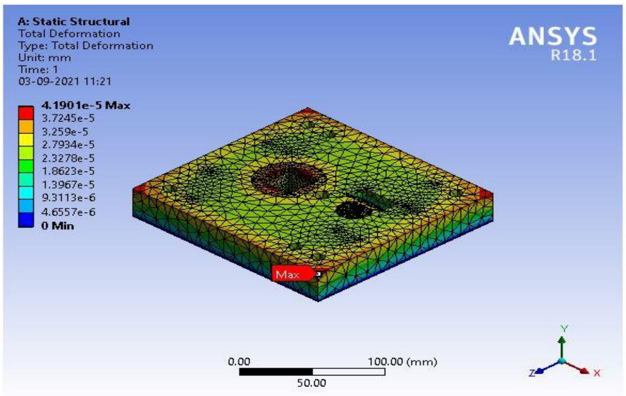


Fig. 22. Die plate diagram

6.3 Result

From the structural analysis carried out above it was found that maximum deformation for punch and die plate were 0.01781 & 4.1901X10^{-5} mm. And the limiting stress [11-15].i.e., equivalent stress was found to be 0.258 & 0.8816 MPa. So, it can be concluded that our design is safe as 100% load was applied after which only very small amount of deformation was found in die plate and punch. The details of all stress and deformation value are listed below.

Table.1. Equivalent Stress (MPa) & Deformation in mm

Sl. No.	Assembly name	Equivalent Stress (MPa)		Deformation (mm)	
		Minimum	Maximum	Minimum	Maximum
01	Top half assembly	2.9904 X10^{-5}	0.8395	0	0.00015
02	Bottom half assembly	5.8995 X 10^{-11}	0.6958	0	6.3781 X 10^{-5}
03	Piercing punch	0.0049	0.0575	0	1.65 X10^{-5}
04	Blanking punch	0.0066	0.1036	0	0.0178
05	Pitch punch	0.0086	0.2585	0	0.0002
06	Pilot	0.0522	0.5158	0	0.0001
07	Die plate	0.0039	0.8816	0	4.1901 X10^{-5}

Conclusions

In this paper design and analysis of progressive press tool for square washer is done. The complete layout and tool were developed using AutoCAD and solid works. Further structural analysis of tool was done to check the strength of die plate and punches. It was found from analysis that strength of die plate and punches are sufficient to resist the force generated on it.

References

Journals

[1]. Gaurav C. Rathod, Dr. D. N. Raut, Samadhan Adlinge, "Study and Analysis of Press Tool Design", International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 07, July – 2017.

Book

[2]. D.Eugene Ostergaard, "Advanced Diemaking", Copyright ©1967 by McGraw-Hill, Inc. Peprinted NTMA 1993.

[3]. Cyril Donaldson, George H LeCain, V C Goold, Joyjeet Ghose, "Tool Design" McGraw Hill Education (India) Private Limited NEW DELHI, Fourth Edition.

[4]. Prakash H. Joshi, "Press Tools Design and Construction, Wheeler Publishing A Division of A. H.Wheeler & Co. Ltd. NEW DELHI . ALLAHABAD.

[5]. J. R PAQUIN, "Die Design Fundamentals", INDUSTRIAL PRESS INC., NEW YORK, N. Y. Machinery Publishing Co., Ltd., Brighton 1, England, Copyright© 1962 by The Industrial Press, New York 13. Printed in the United States of America.

[6]. Ivana Suchy, "Handbook of Die Design", The McGraw Hill companies, Copyright© 2006,1998.

[7]. Dr. P.C. SHARMA, "A Textbook of Production Engineering", S Chand and Company Limited (ISO 9001Certified company), © S Chand and Company Limited, 1982.

[8]. Vukota Boljanovic, "Sheet metal forming Processes and Die Design", Industrial Press Inc. 200 madison Avenue New York 10016.

[9]. David Spitler, Jeff lantrip, Dr. John G. Nee, CMfgE, "Fundamentals of tool Design", Society of manufacturing Engineers, Dearborn, Michigan.

[10].Shri R. Ramachandran, "Tool & Die maker Press tool, Jigs and Fixtures", 2nd Year, National Instructional Media Institute P.B. No. 3142, CTI Campus, Guindy Industrial Estate, Guindy Chennai.
[11].B K Agrawal, "Introduction to Engineering Materials", © 1988, Tata McGraw-Hill Publishing Company Limited.
[12].K. Venkataraman, "Design of Jigs, Fixture and Press Tools", John Wiley & Sons Ltd, The Atrium, Southern Gate Chichester, West Sussex PO19 8SQ United Kingdom.
[13].Daniel B. Dallas., "Progressive Dies. Design and manufactures", McGraw- Hill Inc., New York., 1962.
[14].Jerry Arnold, "Die Makers Handbook", Industrial Press, INC. 32 Haviland Street, Suite 3 South Norwalk, CT 06854.
[15].G. R. Nagpal, "Tool Engineering and Design", Romesh Chander Khanna & Vineet Khanna for Khanna Publishers, 2-B, Nath Market, Nai Sarak Delhi- 110006 (India).