PROCESS OF PRESS TOOL DESIGN AND ITS MANUFACTURING FOR PROGRESSIVE STAMPING OPERATION

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ABSTRACT

Press tools are used to produce a particular component in large quantity. The different types of press tool constructions leads to different operations namely blanking, bending, piercing, forming, drawing, cutting off, parting off, embossing, coining, notching, shaving, lancing, dinking, perforating, trimming, curling etc. Generally metals having thickness less than 6mm is considered as strip Progressive Die is a metalworking method that can encompass punching, coining, bending and several other ways of modifying metal raw material, combined with an automatic feeding system. The feeding system pushes a strip of metal (as it unrolls from a coil) through all of the stations of a progressive stamping die. Each station performs one or more operations until a finished part is made. The final station is a cut off operation, which separates the finished part from the carrying web. The carrying web, along with metal that is punched away in previous operations, is treated as scrap metal. Both are cut away, knocked down (or out of the dies) and then ejected from the die set, and in mass production are often transferred to scrap bins via underground scrap material conveyor belts. The progressive stamping die is placed into a reciprocating stamping press. As the press moves up, the top die moves with it, which allows the material to feed. When the press moves down, the die closes and performs the stamping operation. With each stroke of the press, a completed part is removed from the die.

Since additional work is done in each "station" of the die, it is important that the strip be advanced very precisely so that it aligns within a few thousands of an inch as it moves from station to station. Bullet shaped or conical "pilots" enter previously pierced round holes in the strip to assure this alignment since the feeding mechanism usually cannot provide the necessary precision in feed length.

Progressive stamping can also be produced on transfer presses. These are presses that transfer the components from one station to the next with the use of mechanical "fingers". For mass production of stamped parts which do require complicated in-press operations, it is always advisable to use a progressive press. One of the advantages of this type of press is the production cycle time. Depending upon the part, productions can easily run well over 800 parts/minute. One of the disadvantages of this type of press is that it is not suitable for high precision deep drawing which is when the depth of the stamping exceeds the diameter of the part. When necessary, this process is performed upon a transfer press, which run at slower speeds, and rely on the mechanical fingers to hold the component in place during the entire forming cycle. In the case of the progressive press, only part of the forming cycle can be guided by spring-loaded sleeves or similar, which result in concentricity and ovality issues and non-uniform material thickness. Other disadvantages of progressive presses compared to transfer presses are: increased raw material input required to transfer parts, tools are much more expensive because they are made in blocks with very little independent regulation per station; impossibility to perform processes in the press that require the part leave the strip (example beading, necking, flange curling, thread rolling, rotary stamping etc.).

INTRODUCTION

The press machine may be of electrical type, mechanical type, pneumatic type, manual type and hydraulic type. In today's practical and cost conscious world, sheet metal parts have already replaced many expensive cast, forged and machined products. The common sheet metal forming products are metal desks, file cabinets, appliances, car bodies, aircraft fuselages, mechanical toys and beverage cans and many more. High rate production industries generally use press machines. Thickness can vary significantly, although extremely small thicknesses are considered as sheet and above 6mm are considered as plate. Thickness of the sheet metal fed in between is called its gauge. Sheet metal is simply fed in between the dies of press tool for any press operation to perform. The reciprocating movement of punch is caused due to the ram movement of press machine. Due to its low cost and generally good strength and formability characteristics, low carbon steel is the most commonly used sheet metal because high carbon composition gives high strength to the material. The other sheet metals used are aluminium and titanium in aircraft and aerospace applications. The purpose of this paper is to examine the causes for these seemingly contradictory results. An attempt will be made here to review the previous studies to look into future possibilities of various die designs. Progressive dies are commonly fed from a coil of steel, coil reel for unwinding of coil to a straightener to level the coil and then into a feeder which advances the material into the press and die at a predetermined feed length. Depending on part complexity, the number of stations in the die can be determined. Stamping is usually done on cold metal sheet. See Forging for hot metal forming operations.

General Press Tool Construction

The general press tool construction will have following elements:

1. Shank: It is used as a part for installing the Press tool die in the slide of the press machine with proper alignment.
2. Top Plate: It is used to hold top half of the press tool with press slide. It is also called Bolster Plate.
3. Punch Back Plate: This plate prevents the hardened punches penetrating into top plate. It is also called Pressure Plate or Backup plate.
4. Punch Holder: This plate is used to accommodate the punches of press tool.
5. Punches: To perform cutting and non-cutting operations either plain or profiled punches are used.
6. Die Plate: Die plate will have similar profile of the component where cutting dies usually have holes with land and angular clearance and non-cutting dies will have profiles.
7. Die Back Plate: This plate prevents the hardened Die inserts penetrating into bottom plate.
8. Guide Pillar & Guide Bush: Used for alignment between top and bottom halves of the press tools.
9. Bottom plate: It is used to hold bottom half of the press tool with press slide.
10. Stripper plate: it is used to strip off the component from punches.
11. Strip guides: It is used to guide the strip into the press tool to perform the operation.

Component Details:

Material	SS Grade 50
Thickness	2.5mm
Tensile Strength	450 MPa
Yield Strength	340 MPa
Area of the Component	5176.48 mm^2

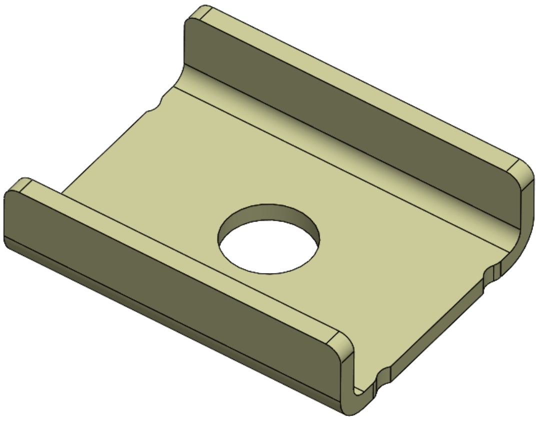


Fig.1 . 3D CAD model of Washer Plate

Strip Layout Development:

Strip layout has to developed in such a way that stock strip utilization is maximum. It will save appreciable amount of stock material and tooling expenses.

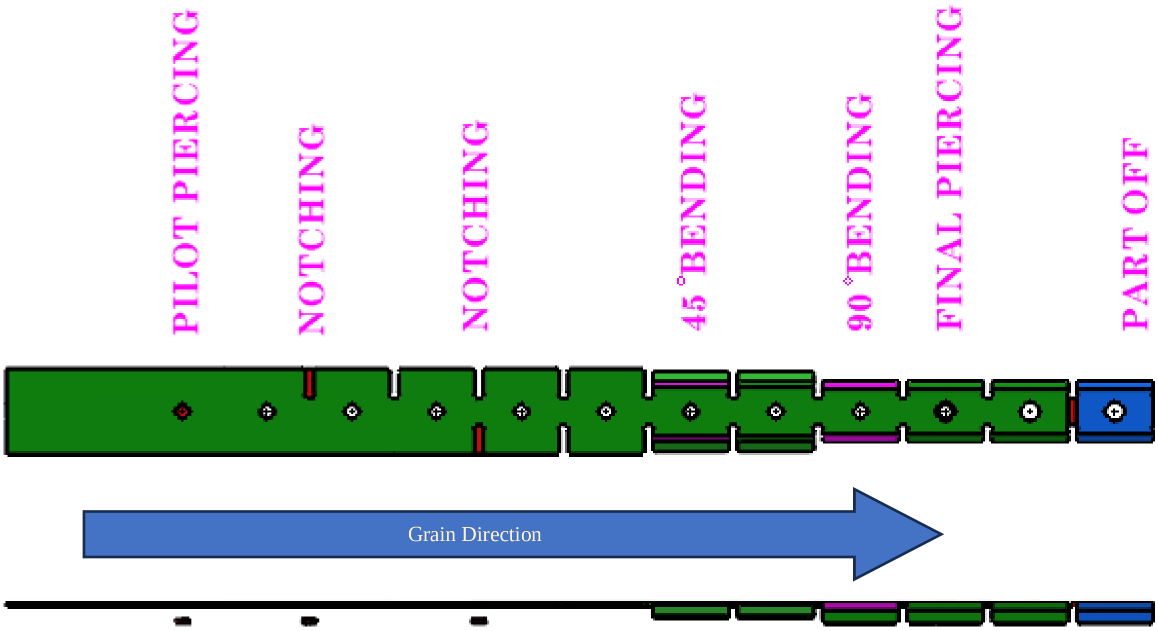


Fig.2 . Strip layout of Washer Plate

Development of strip layout is the primary task for designing of progressive tool. It represents the operations to be carried out at subsequent stations. The above part has to derive this kind of layout . Grain Direction also mentioned. **Grain direction** is a term used to describe the rolling direction of metal after being manufactured into sheet, plate or coil. This manufacturing method is where hot metal is compressed through rollers and forced into shape, elongating the crystals in the process. In this layout so many Idle has shown. Because, we need to drive the punch and die that area that why that place has to be mean by idle. In this layout part has bend direction perpendicular to the feeding direction.

First operation is pilot piercing. Component mid hole has pre pierced to use pilot guiding purpose. Then last final component piercing has to be added. Because bending has disturbed the piercing position of component. Then notching has divided two base. Because strip flow need steady flow. Also bending has divided two stages. One is 45° another one is 90°. Because its cause a spring back on part . we need to neglect this . that's why bending has separated.

Percentage (%) of Strip Utilization:

Strip layout has to develop in such a way that stock strip utilization is maximum. It will save appreciable amount of stock material and tooling expenses. And also reduce the cost of raw material.

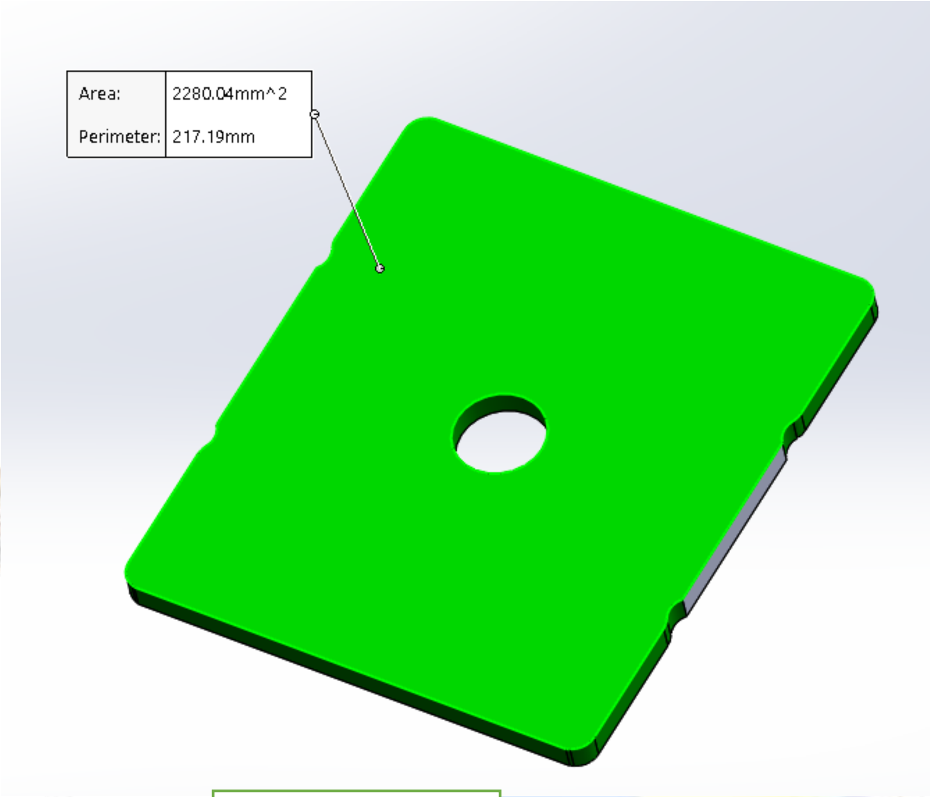


Fig.3.Part Blank condition

Area of Blank = 2280.04 mm²
Strip Pitch = 50 mm
Strip Width = 52 mm
Number of Row = 1 (Single Cavity)

Economy Factor (%)

= [(Area of Blank X No of Row) / (Strip Pitch X Strip Width)] X100

= [(2280.04 X 1) / (50 X 52)] X 100

= 87.69%

Economy Factor = 87.69%

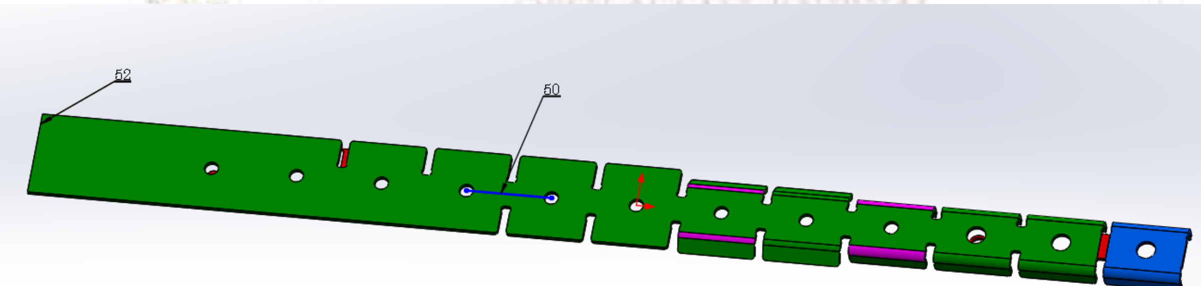


Fig.4. Strip layout pitch and width

Shear Force Calculation:

Shear Force is a force which acts tangentially on the body. It is caused by the tangential component of a force acting on the body. Shear resistance offered by the body is used to resist the effect of shear force on the body. Due to the effect of shear force, the cross-section of the body is deformed, and shear strain will be induced. The shear force also induces shearing stresses in the body. This place we need load Because we need a Press component through tooling operation.

Sheet thickness : 2.5mm
Tensile strength : 450 MPa or 450 Nmm²
Shear Strength : 80% of Tensile Strength (in Tooling)
So, =450 x 80%
=360 MPa or 36 kg/mm²

Total Cutting force = t x S x l
Note,
t – Sheet thickness
S – Shear Strength
l – cutting length

Total Bending force = t x δ x l x 0.33
Note,
t – Sheet thickness
δ – Tensile Strength
l – cutting length
0.33 – Poisson's Ratio
Note,

Strip Width is 52 mm

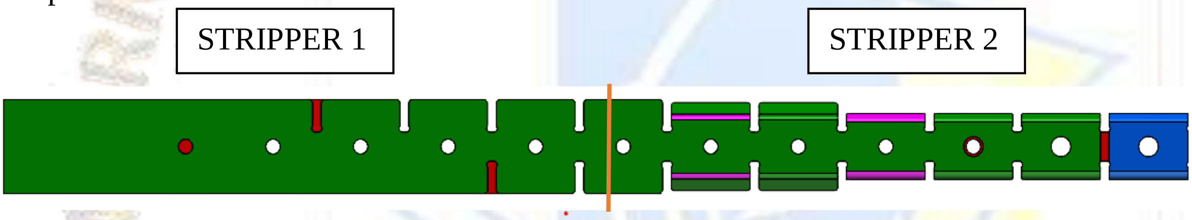


Fig.5 . Stripper condition in strip layout

In Stripper 1 – Required total force:
Piercing cutting length = 2πr mm. in strip [r =4.1 mm].
= 2π x 4.1
=25.75mm
Notching cutting length = 42.05mm (using 3D software)
Notching 1 & 2 is same cutting profile so cutting length is same.
And also no bending has perform in stage 1 stripper. So, bending force is zero.
So to total cutting length,

= 25.75+42.05+42.05
=109.85 ≈ 110 mm
l = 110 mm
Cutting force in stripper 1

=(2.5 x 360 x 110)N
= 99000 N = 9.9 Ton

Total force required in stage 1 = 9.9 Ton

In Stripper 2 – Required total force:
Piercing cutting length = 2πr mm. in strip [r =5.55 mm].
= 2π x 5.55

=34.85mm

Part off Notching cutting length = 17.35+17.35 (using 3D software)
So to total cutting length,

= 34.85+17.35+17.35
=69.55 ≈ 70 mm
l = 70 mm

Cutting force in stripper 2 (only cutting load)

=(2.5 x 360 x 70)N
= 63000 N = 6.3 Ton

Also bending has perform in stage 2, so,
Bending Length in one bending = 45 mm (using 3D software)
Totally 4 bending has performed, So,
= 4 X 45 =180mm
So total bending length is = 180mm
Total bending force,
= (0.33 x 180 x 450 x 2.5) N
= 66825 N ≈ 6.7 Ton

So, total force in stage 2,

= Total Cutting Force In Stage 2 + Total Bending Force In Stage 2
= 6.7 + 6.3 = 13 Ton

Total force required in stage 2 = 13 Ton.

Press Capacity:

Total tonnage of press requirement is sum of total cutting and bending force and its multiply by 1.33 times. Because of safety purpose.

Tonnage of tool = (13+9.9) x 1.33 = 30.45 ≈ **30.5 Tons** required.
Rated press capacity is the tonnage pressure the slide can safely exert at the bottom of the stroke.

Stripping force calculation:

Stripper is one of the part holding and ejection purpose part. Whether without a stripper using notching operation component has shrink and tear by tool. And also forming and drawing operation also required stripper or else part has shown some wrinkle marks and some time tear also wear a punch and die. So, stripper force is one of the part in tooling. In piercing operation we just take only 8 % load is enough. In forming operation 30% of load has been taken. In drawing operation nearly 50% load has to be taken by material property condition. This all take to calculated by the use of total cutting and forming force.

Stage 1 stripping force:
= 9.9 x 8% = **0.792 Ton**
Only notching and pre piercing has perform in this stage

Stage 2 stripping force:

= 6.3 x 8 % = 0.504 Ton (only cutting load)
= 6.7 x 30% = 2.01 Ton (only bending load)

Total striping force in stage 2,
= 0.504 + 2.01
= **2.514 Ton**

Stripping Force In Stage 1 ≈ 0.8 Ton

Stripping Force In Stage 2 ≈ 2.5 Ton

Cutting Clearance Calculation:

Cutting clearance depends on the stock material, Shear strength of material, thickness.

$C/2 = 0.01 \times t \times \sqrt{S}$

Note,

C – cutting clearance, (C/2 -Per side cutting clearance)
t - thickness
S - Shear strength in kg/mm^2

Cutting clearance between punch and dies,

$C/2 = 0.01 \text{ X } 2.5 \text{ X } \sqrt{36}$

C/2 = 0.15 mm

Tool Design Concept:

The below concept has draw and created by 3d model software (solid works).

Top Tool:

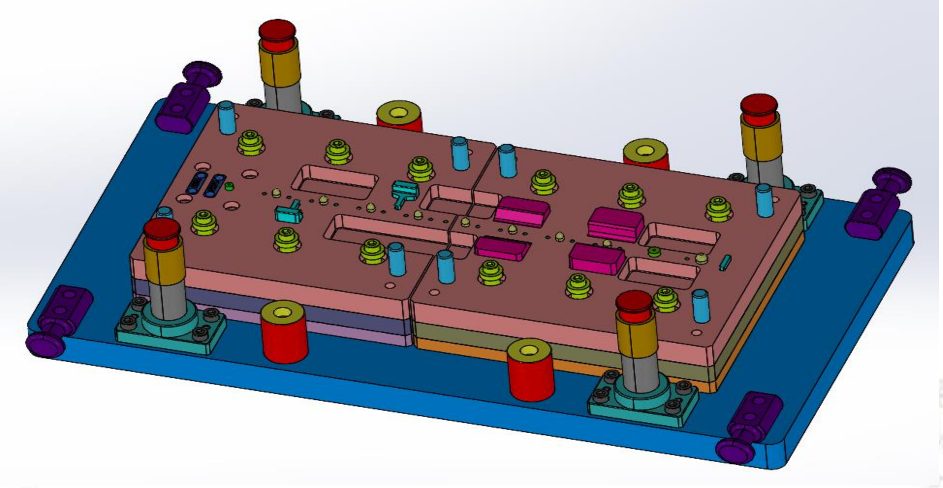


Fig.6 . Top tool of Washer Plate

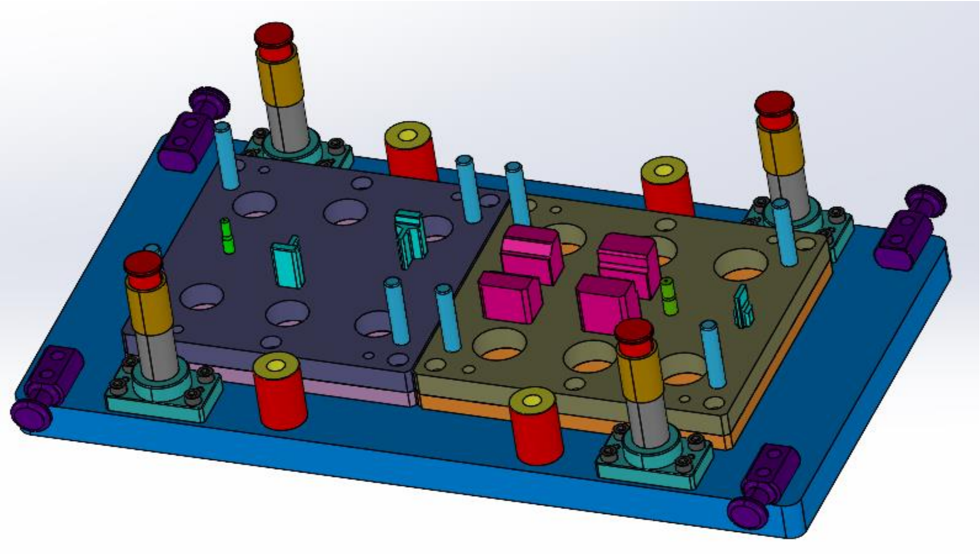


Fig.7. Punch with punch holder in top tool

Bottom Tool:

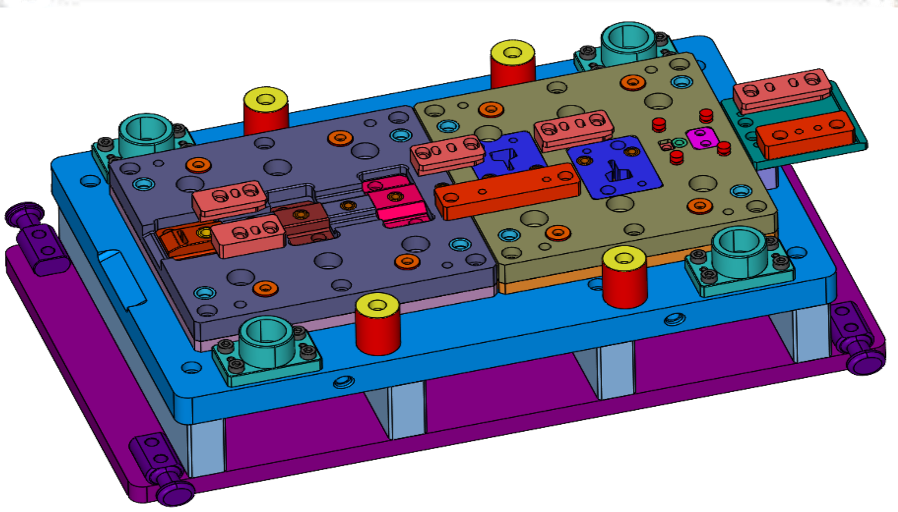


Fig.8 . Bottom tool of Washer Plate

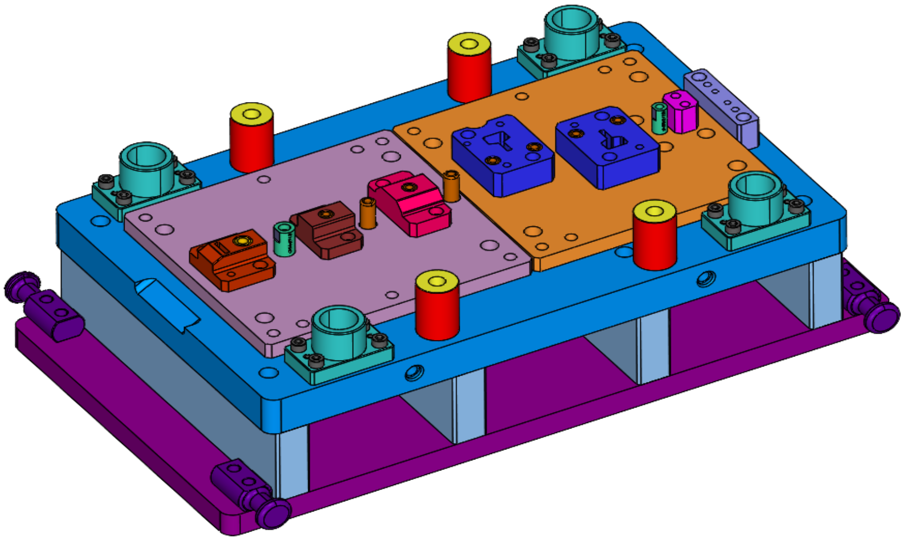


Fig.9. Die assembly in bottom tool

Sectional View:

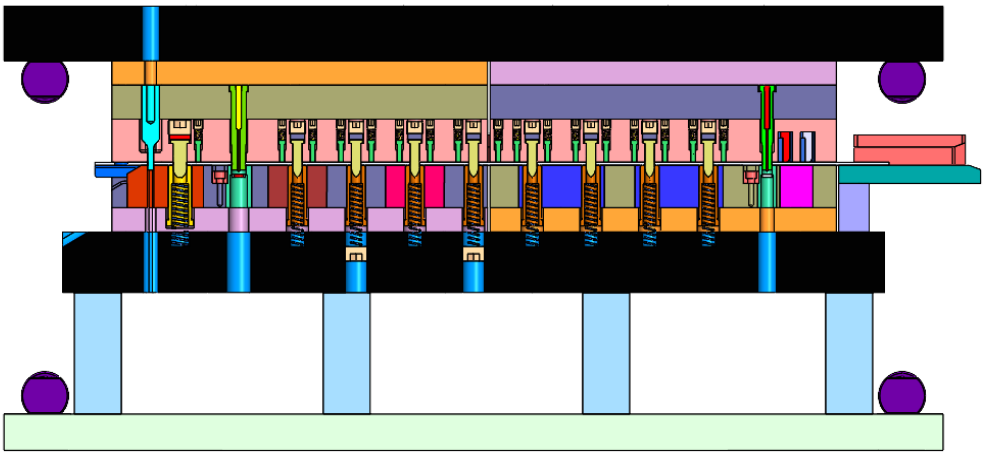
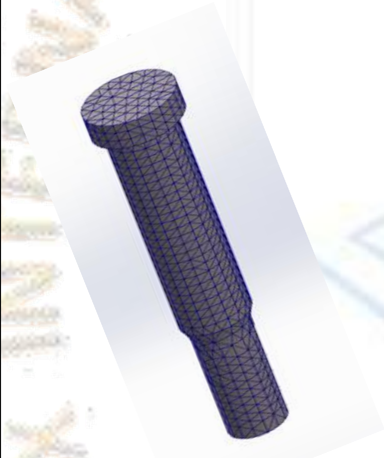


Fig.10. Tool Assembly In Sectional View

Finite Element Analysis of the Punches:

1) Pilot Piercing or Pre Piercing Punch:

Material properties:

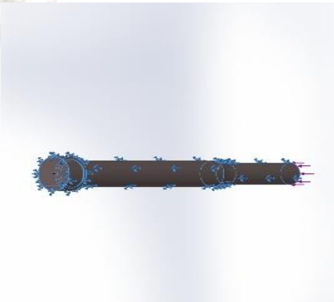
Model Reference	Properties	Volumetric Properties
 Fig.11.Pilot piercing Punch	Name: **D2** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **2.82685e+08 N/m^2** Tensile strength: **5.85e+07 N/m^2**	**Mass:0.0416674 kg** **Volume:5.20843e-06 m^3** **Density:8,000 kg/m^3** **Weight:0.408341 N**

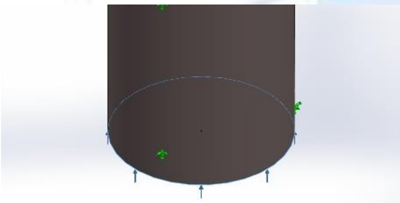
Mesh Information:

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points for High quality mesh	16 Points
Element Size	1.73412 mm
Tolerance	0.0867058 mm
Mesh Quality	High

Total Nodes	11410
Total Elements	7292
Maximum Aspect Ratio	5.6599
% of elements with Aspect Ratio < 3	98.8
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:01

Load & Fixtures:

Fixture name	Fixture Image	Fixture Details
Fixed-1	 Fig.12.Pilot piercing Punch fixed faces	**Entities:** 7 face(s) **Type:** Fixed Geometry

Load name	Load Image	Load Details
Force-1	 Fig.13.Pilot piercing Punch force acting	**Entities:** 1 face(s) **Type:** Apply normal force **Value:** 23,184 N

Study Results:

Factor of safety of the Punch:

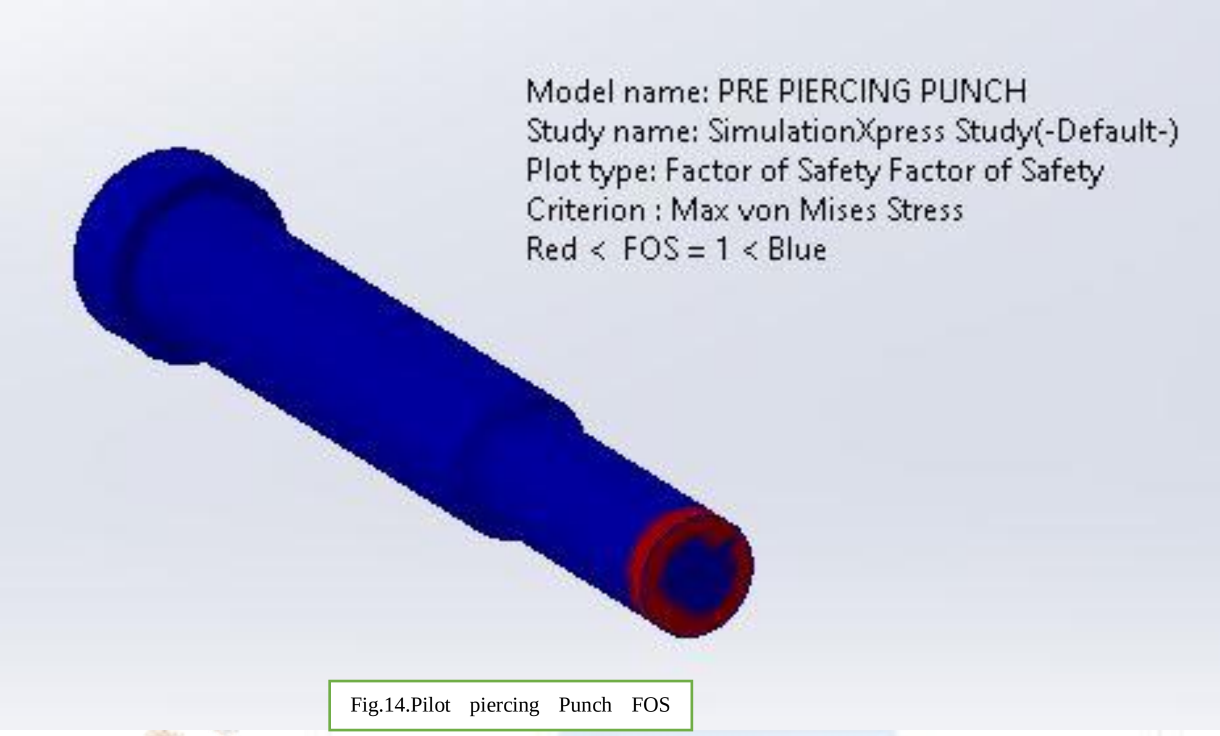


Fig.14.Pilot piercing Punch FOS

Von Mises Stress of the Punch:

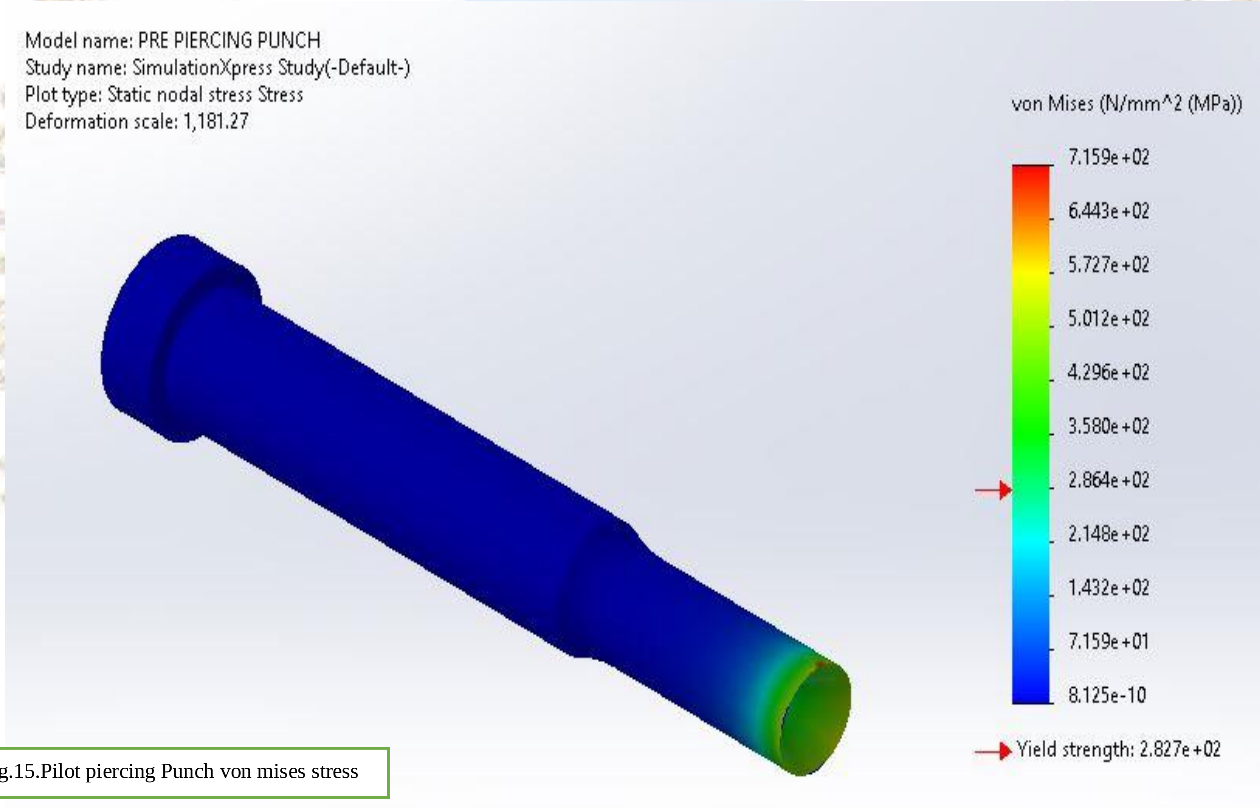


Fig.15.Pilot piercing Punch von mises stress

Displacement of the Punch:

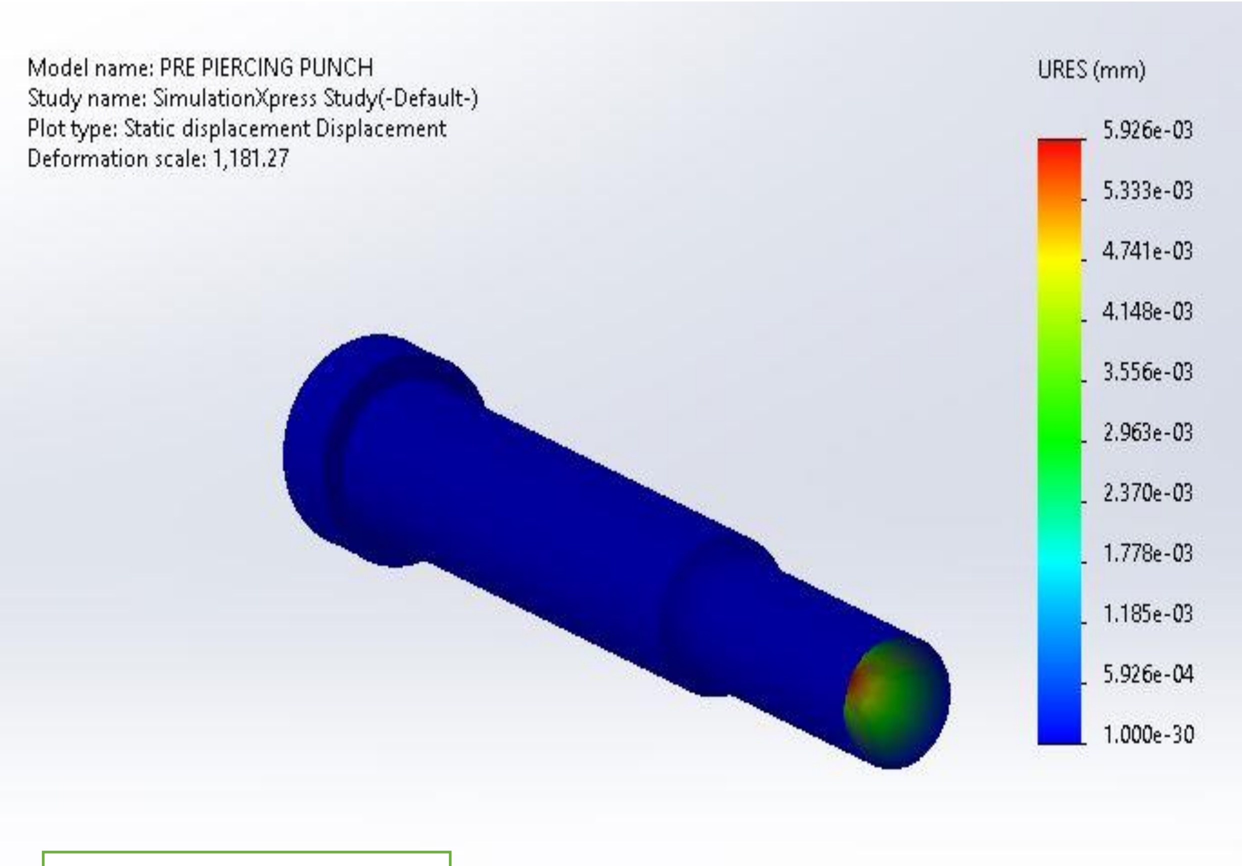
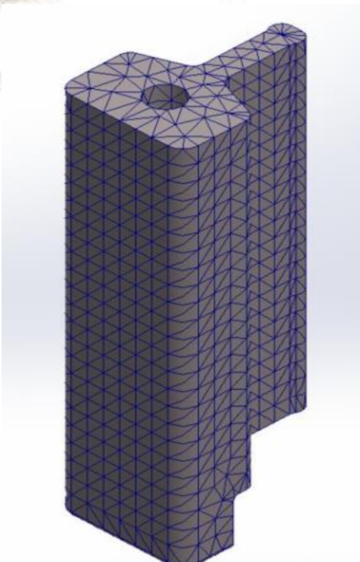


Fig.16.Pilot piercing Punch displacement

2) Notching Punch: (2 Quantity)

Because punches are same profile so same load.

Material properties:

Model Reference	Properties	Volumetric Properties
 Fig.17.Notching punch	Name: **D2** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **2.82685e+08 N/m^2** Tensile strength: **5.85e+07 N/m^2**	**Mass:0.283978 kg** **Volume:3.54972e-05 m^3** **Density:8,000 kg/m^3** **Weight:2.78298 N**

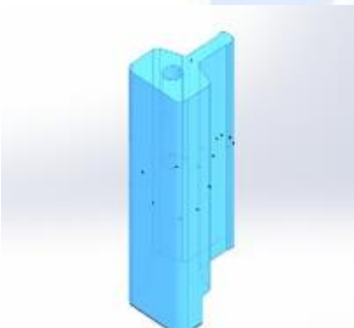
Mesh Information:

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off

Include Mesh Auto Loops:	Off
Jacobian points for High quality mesh	16 Points
Element Size	3.2876 mm
Tolerance	0.16438 mm
Mesh Quality	High

Total Nodes	13214
Total Elements	8259
Maximum Aspect Ratio	4.8649
% of elements with Aspect Ratio < 3	98.6
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:01

Load & Fixtures:

Fixture name	Fixture Image	Fixture Details
Fixed-1	 Fig.18.Notching punch face Fixed	**Entities:** **21 face(s)** **Type:** **Fixed Geometry**

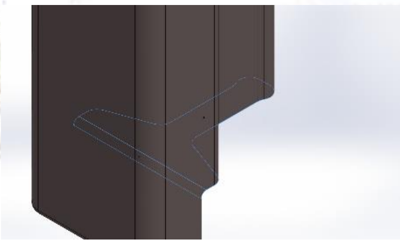
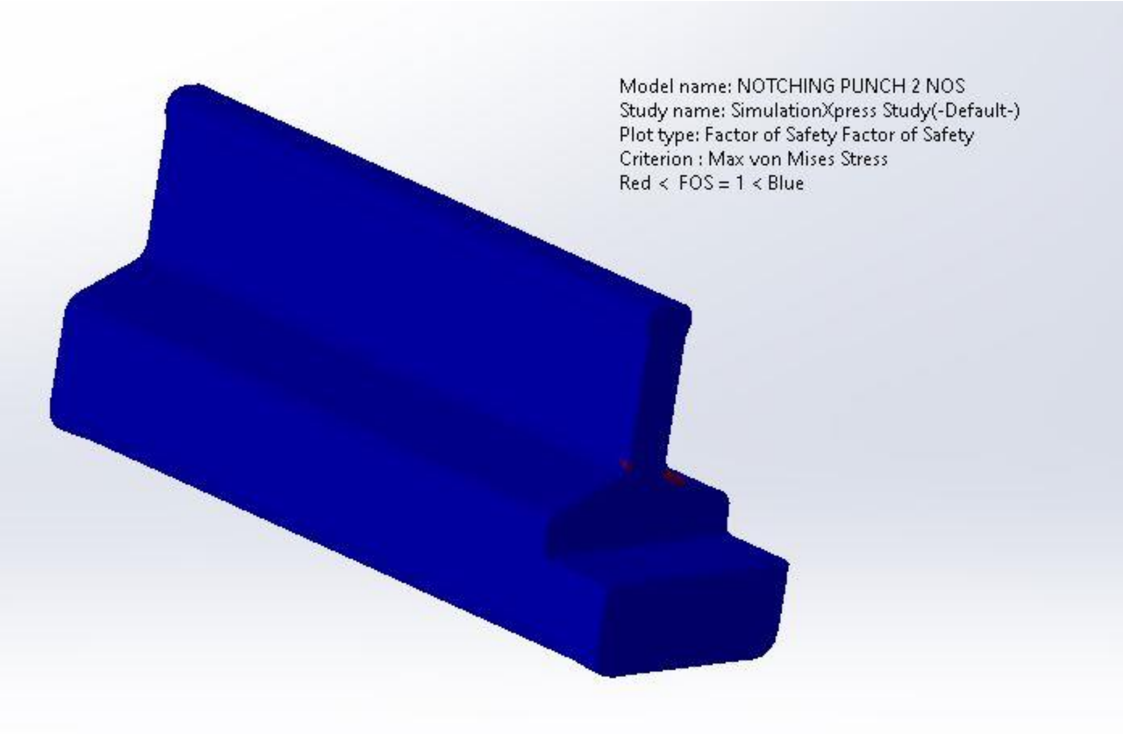
Load name	Load Image	Load Details
Force-1		**Entities:** 2 face(s) **Type:** **Apply normal force** **Value:** **37,845 N**

Fig.19.Notching punch force acting face

Study Results:

Factor of safety of the Punch:



Von Mises Stress of the Punch:

Fig.20.Notching punch FOS

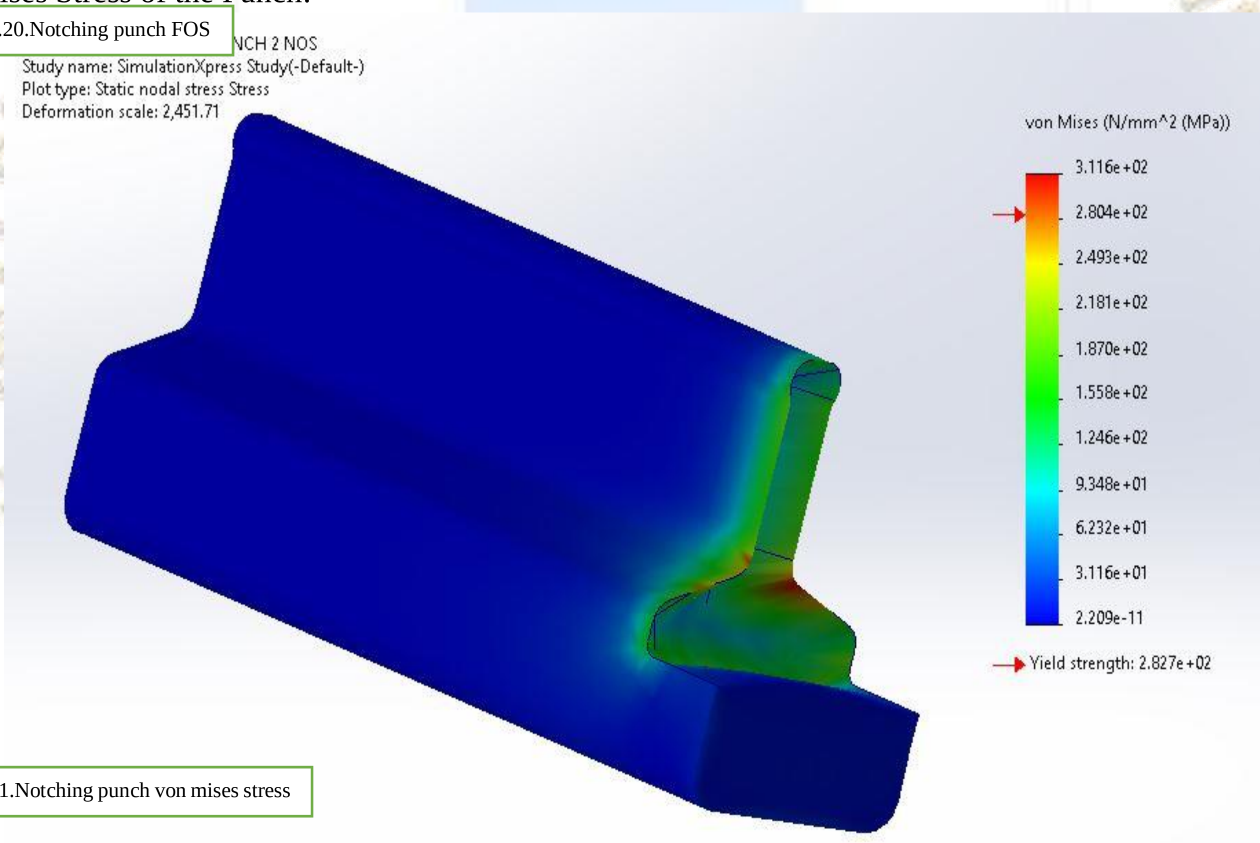


Fig.21.Notching punch von mises stress

Displacement of the Punch:

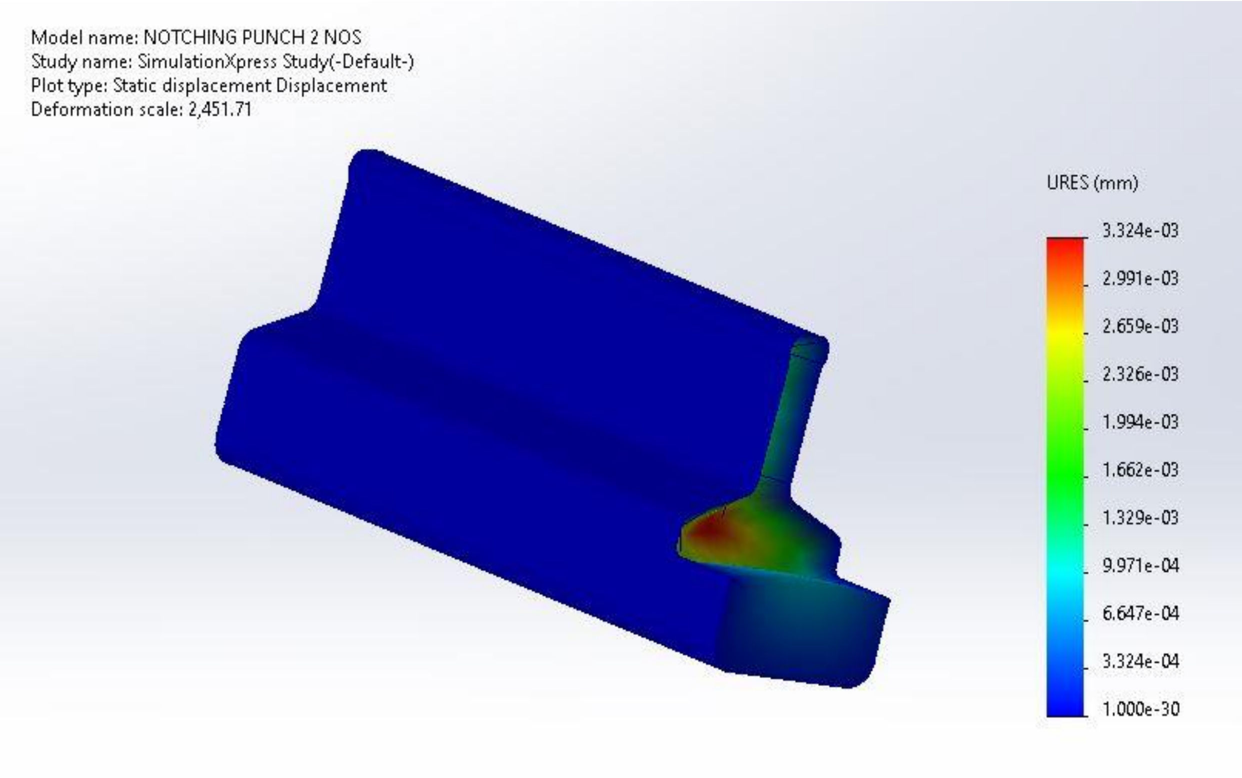
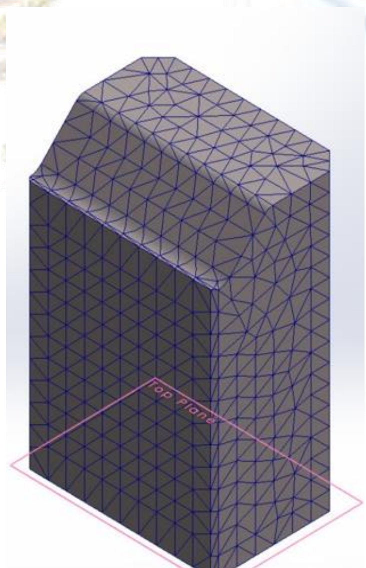


Fig.22.Notching punch Displacement

3) Pre Bend (45deg) Punch: (2 Quantity)

Because punches are same profile & bend line so same load.

Material properties:

Model Reference	Properties	Volumetric Properties
 Fig.23.Pre bend punch mesh view	Name: **D2** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **2.82685e+08 N/m^2** Tensile strength: **5.85e+07 N/m^2**	**Mass:0.980923 kg** **Volume:0.000122615 m^3** **Density:8,000 kg/m^3** **Weight:9.61304 N**

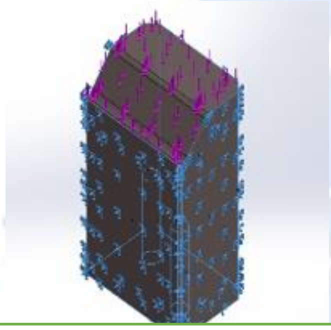
Mesh Information:

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off

Jacobian points for High quality mesh	16 Points
Element Size	4.96949 mm
Tolerance	0.248475 mm
Mesh Quality	High

Total Nodes	13431
Total Elements	8891
Maximum Aspect Ratio	6.6193
% of elements with Aspect Ratio < 3	98.4
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:01

Load & Fixtures:

Fixture name	Fixture Image	Fixture Details
Fixed-1	 Fig.24.Pre bend punch fixed faces	**Entities:** 13 face(s) **Type:** Fixed Geometry

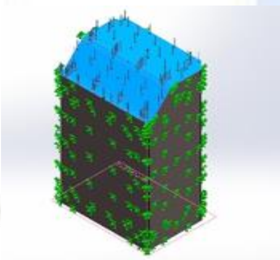
Load name	Load Image	Load Details
Force-1		**Entities:** 4 face(s), 1 plane(s) **Type:** Apply normal force **Value:** 16706.3 N

Fig.25.Pre bend punch force acting faces

Study Results:

Factor of safety of the Punch:

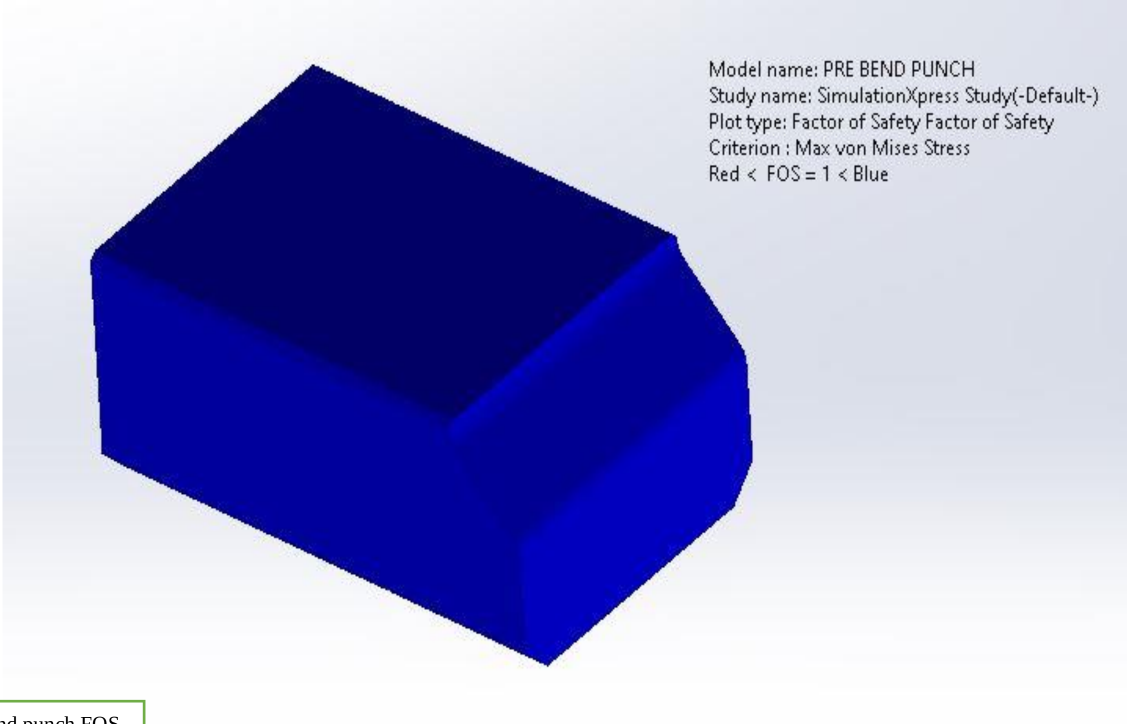


Fig.26.Pre bend punch FOS

Von Mises Stress of the Punch:

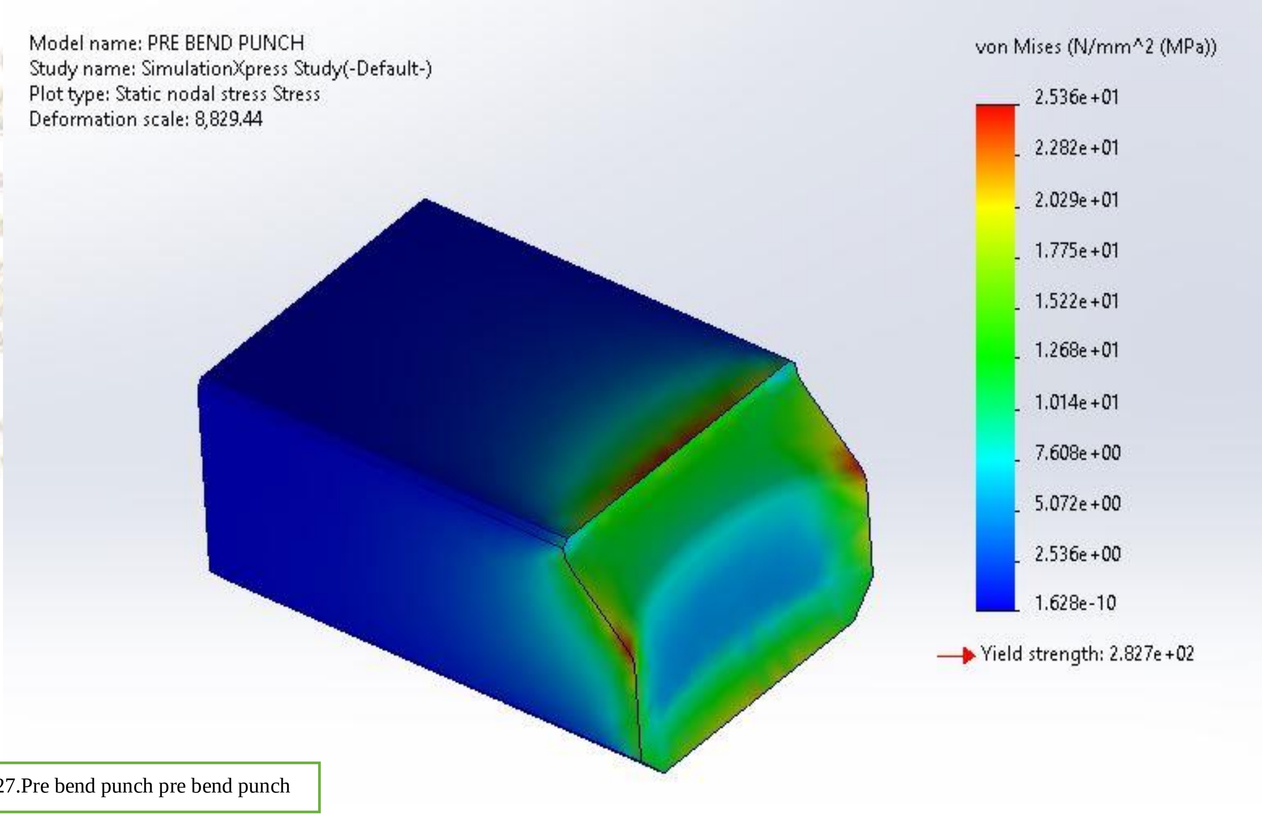


Fig.27.Pre bend punch pre bend punch

Displacement of the Punch:

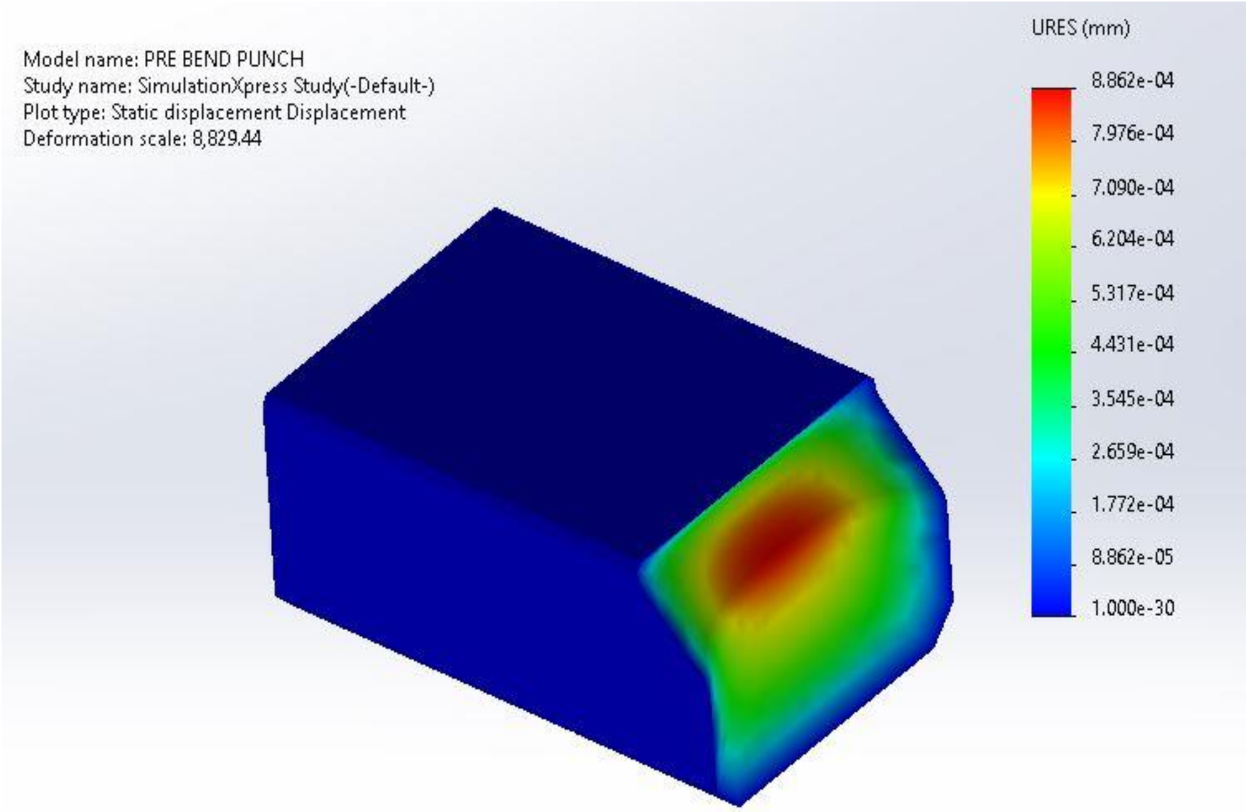
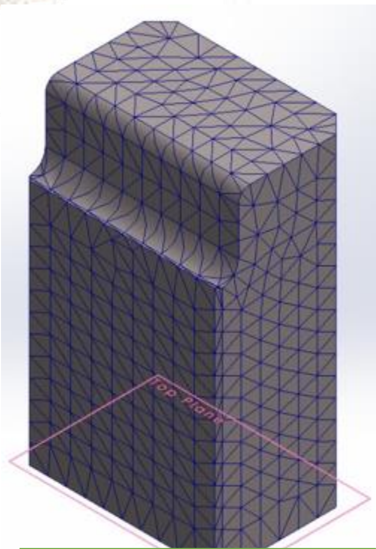


Fig.28.Pre bend punch displacement

4) Pre Bend (45deg) Punch: (2 Quantity)

Because punches are same profile & bend line so same load.

Material properties:

Model Reference	Properties	Volumetric Properties
 Fig.29.Bending punch mesh view	Name: **D2** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **2.82685e+08 N/m^2** Tensile strength: **5.85e+07 N/m^2**	**Mass:1.09121 kg** **Volume:0.000136401 m^3** **Density:8,000 kg/m^3** **Weight:10.6938 N**

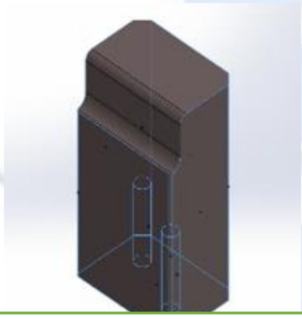
Mesh Information:

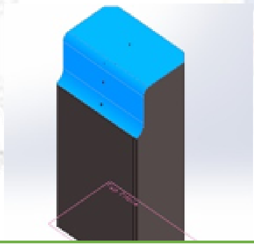
Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off

Include Mesh Auto Loops:	Off
Jacobian points for High quality mesh	16 Points
Element Size	5.14914 mm
Tolerance	0.257457 mm
Mesh Quality	High

Total Nodes	13466
Total Elements	8925
Maximum Aspect Ratio	9.4579
% of elements with Aspect Ratio < 3	98
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:01

Load & Fixtures:

Fixture name	Fixture Image	Fixture Details
Fixed-1	 Fig.30. Bending punch fixed faces	**Entities:** **13 face(s)** **Type:** **Fixed Geometry**

Load name	Load Image	Load Details
Force-1	 Fig.31. Bending punch force acting	**Entities:** **4 face(s), 1 plane(s)** **Type:** **Apply normal force** **Value:** **16706.3 N**

Study Results:

Factor of safety of the Punch:

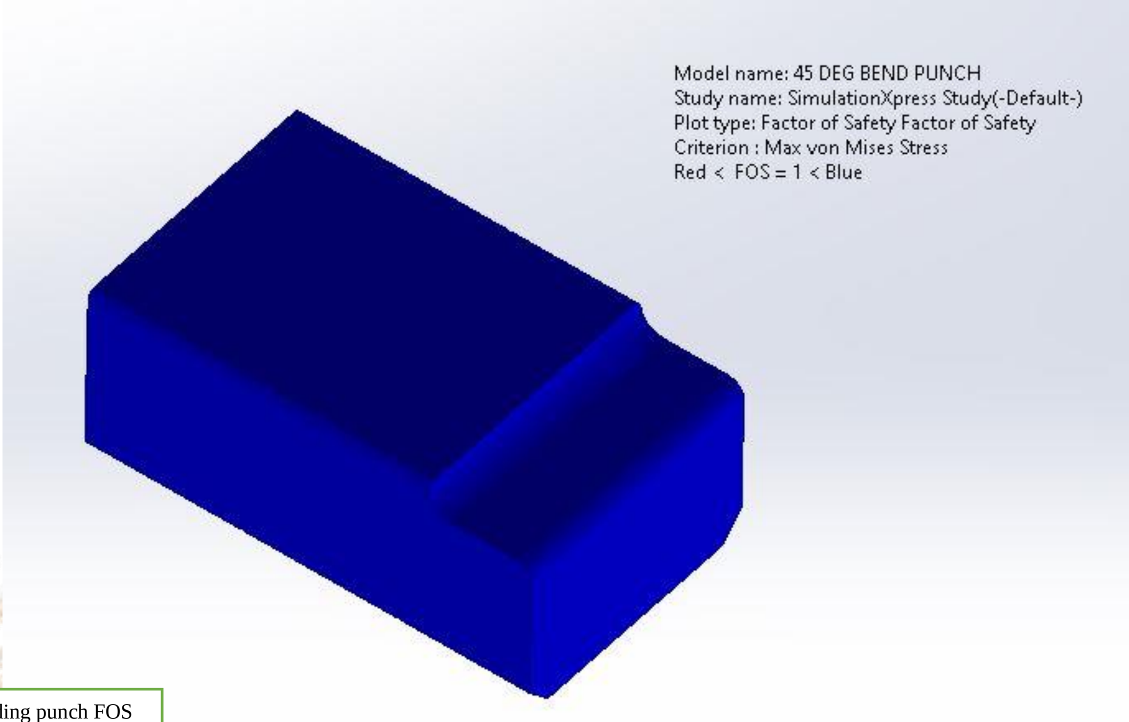


Fig.32. Bending punch FOS

Von Mises Stress of the Punch:

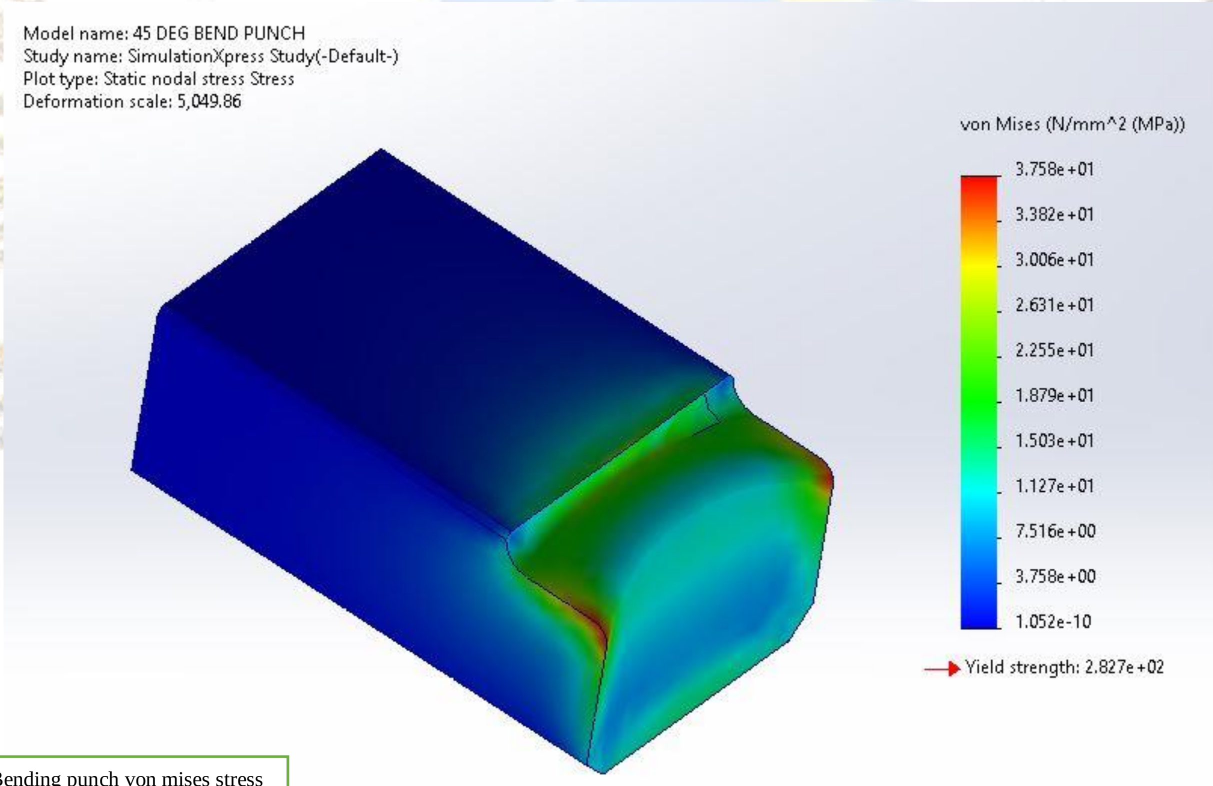


Fig.33. Bending punch von mises stress

Displacement of the Punch:

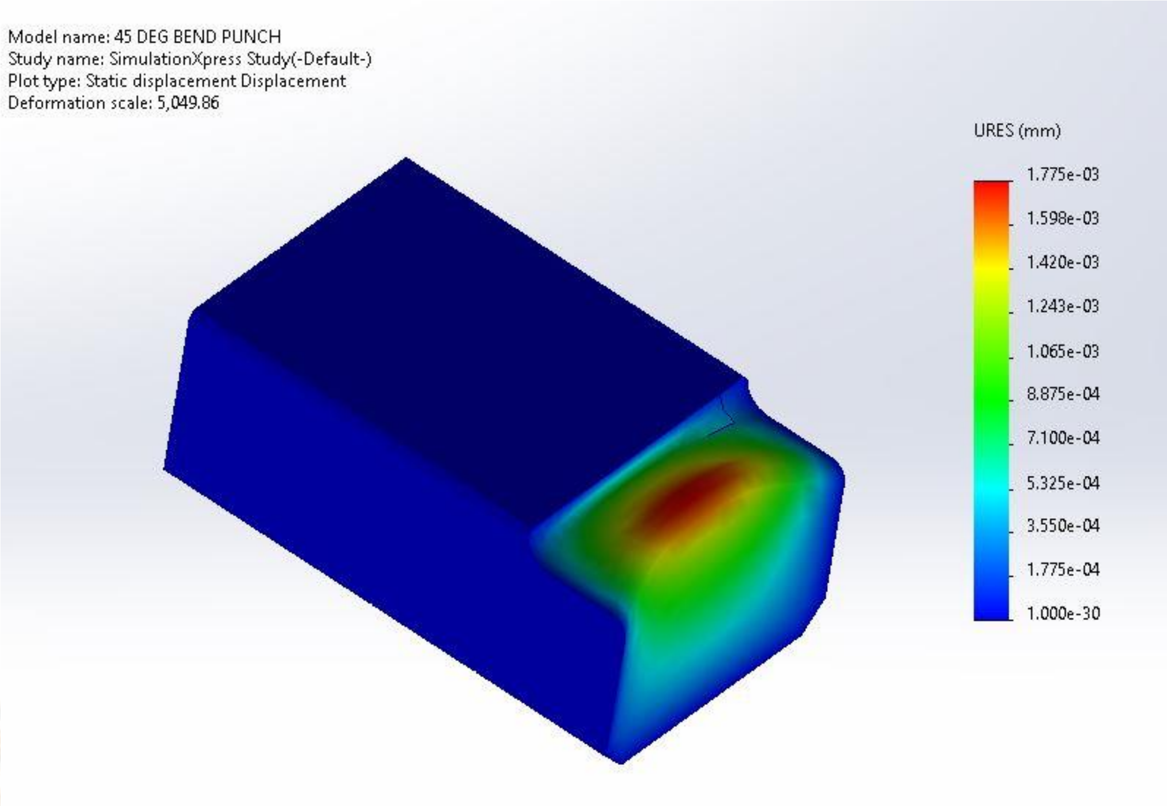
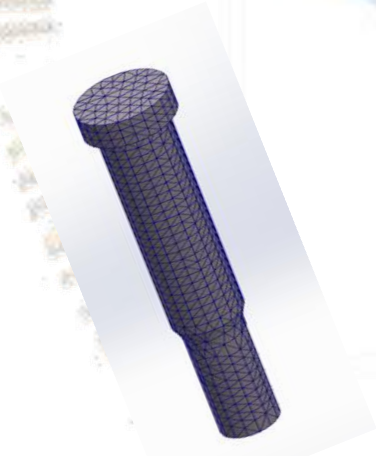


Fig.34. Bending punch displacement

5) Final Piercing Punch:

Material properties:

Model Reference	Properties	Volumetric Properties
 Fig.35. Final piercing punch mesh	Name: **D2** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **2.82685e+08 N/m^2** Tensile strength: **5.85e+07 N/m^2**	**Mass:0.0741003 kg** **Volume:9.26254e-06 m^3** **Density:8,000 kg/m^3** **Weight:0.726183 N**

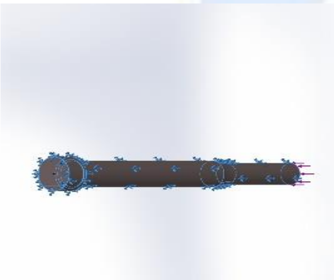
Mesh Information:

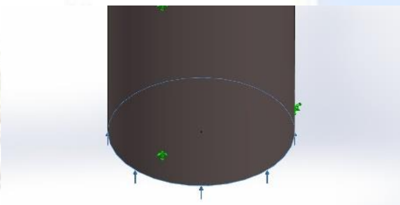
Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off

Jacobian points for High quality mesh	16 Points
Element Size	2.10093 mm
Tolerance	0.105046 mm
Mesh Quality	High

Total Nodes	10532
Total Elements	6766
Maximum Aspect Ratio	6.2929
% of elements with Aspect Ratio < 3	98.7
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:01

Load & Fixtures:

Fixture name	Fixture Image	Fixture Details
Fixed-1	 Fig.36. Final piercing punch fixed faces	**Entities:** 7 face(s) **Type:** Fixed Geometry

Load name	Load Image	Load Details
Force-1	 Fig.37. Final piercing punch force acting	**Entities:** 1 face(s) **Type:** Apply normal force **Value:** 34,365 N

Study Results:

Factor of safety of the Punch:

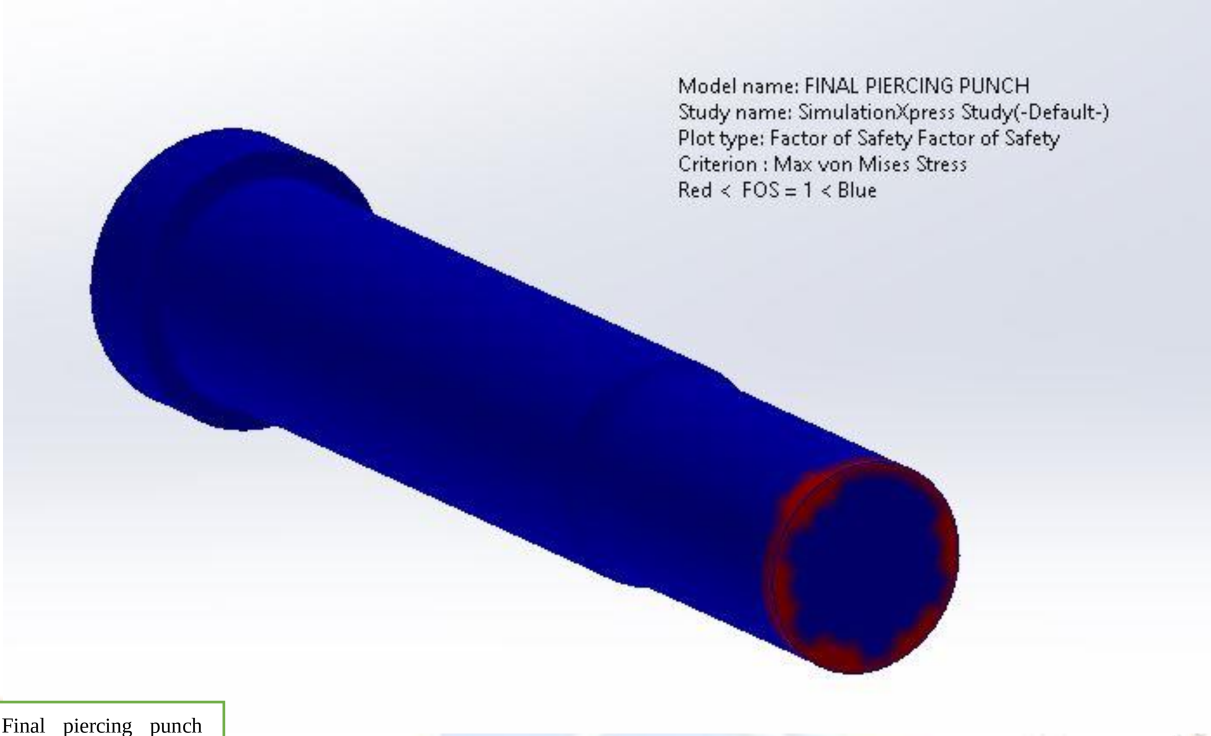


Fig.38. Final piercing punch

Von Mises Stress of the Punch:

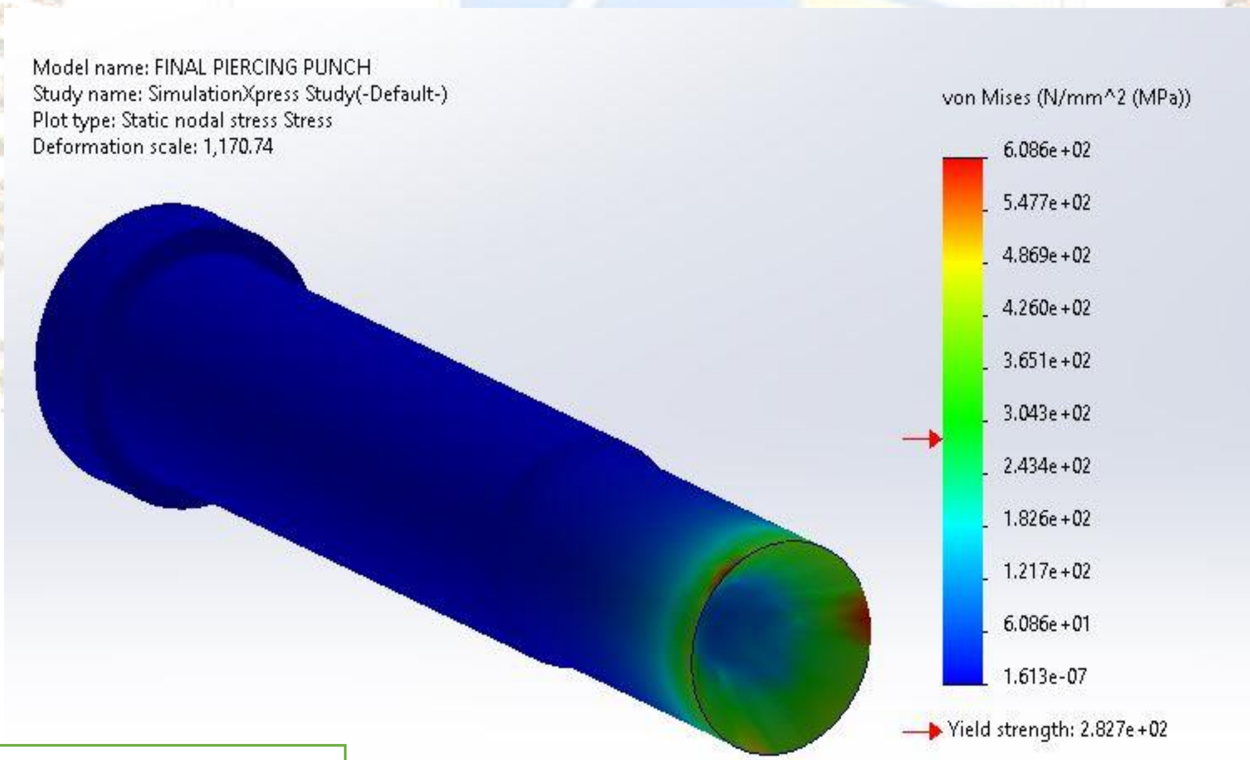


Fig.39. Final piercing punch von mises stress

Displacement of the Punch:

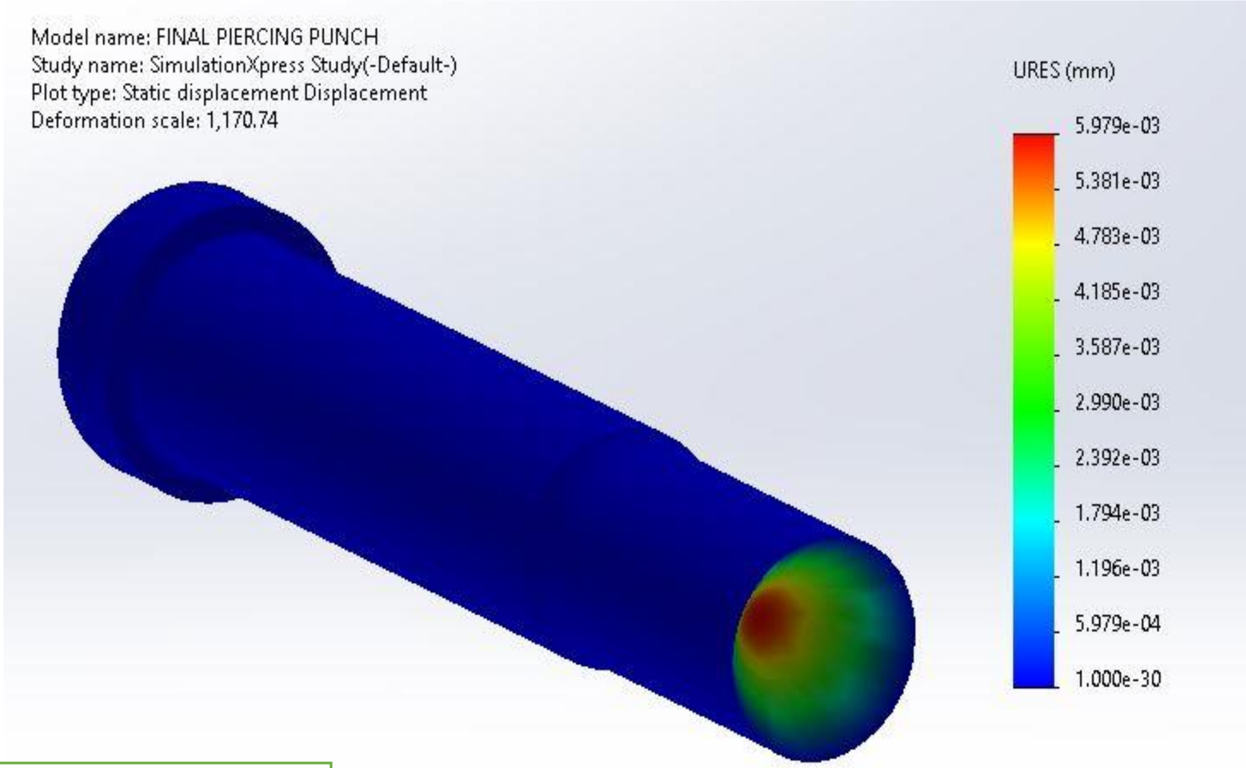
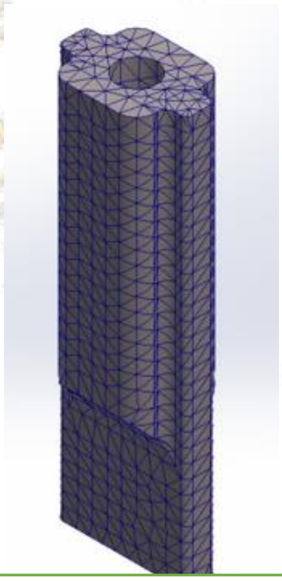


Fig.40. Final piercing punch displacement

6) Part Off Punch:

Material properties:

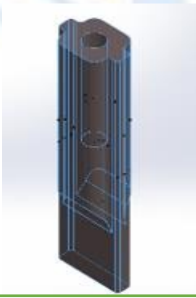
Model Reference	Properties	Volumetric Properties
 Fig.41. Part off punch mesh view	Name: **D2** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **2.82685e+08 N/m^2** Tensile strength: **5.85e+07 N/m^2**	**Mass:0.107352 kg** **Volume:1.3419e-05 m^3** **Density:8,000 kg/m^3** **Weight:1.05205 N**

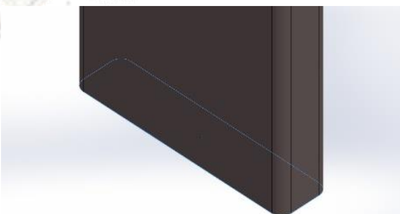
Mesh Information:

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points for High quality mesh	16 Points
Element Size	2.37722 mm
Tolerance	0.118861 mm
Mesh Quality	High

Total Nodes	15236
Total Elements	9679
Maximum Aspect Ratio	12.08
% of elements with Aspect Ratio < 3	95.7
Percentage of elements with Aspect Ratio > 10	0.0827
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:02

Load & Fixtures:

Fixture name	Fixture Image	Fixture Details
Fixed-1	 Fig.42. Part off punch fixed faces	**Entities:** 29 face(s) **Type:** Fixed Geometry

Load name	Load Image	Load Details
Force-1	 Fig.43. Part off punch force acting	**Entities:** 1 face(s) **Type:** Apply normal force **Value:** 31,230N

Study Results:

Factor of safety of the Punch:

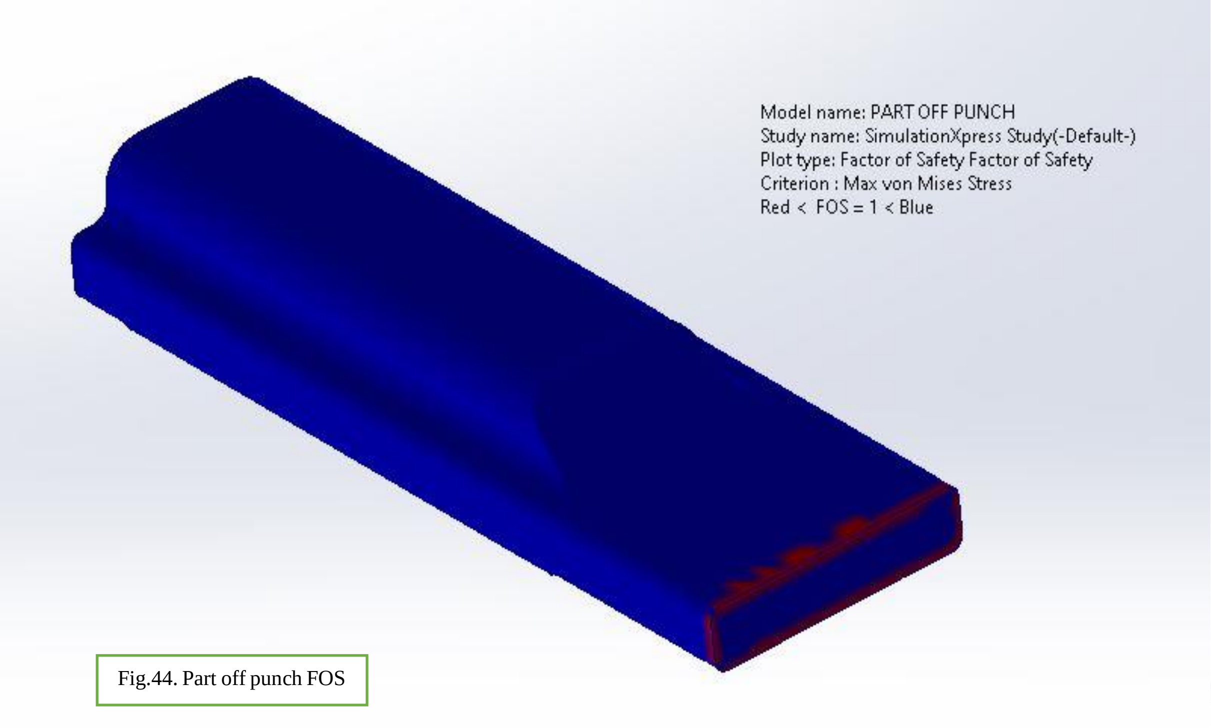


Fig.44. Part off punch FOS

Von Mises Stress of the Punch:

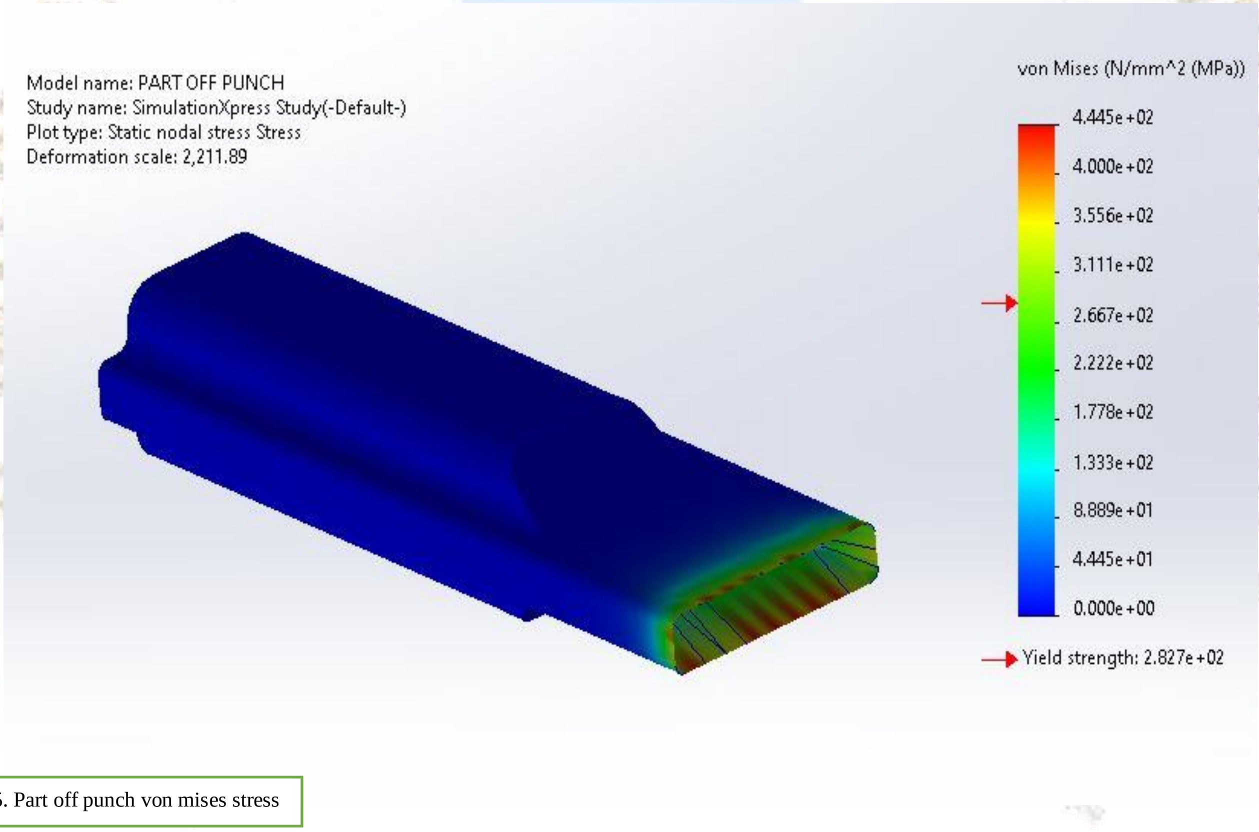


Fig.45. Part off punch von mises stress

Displacement of the Punch:

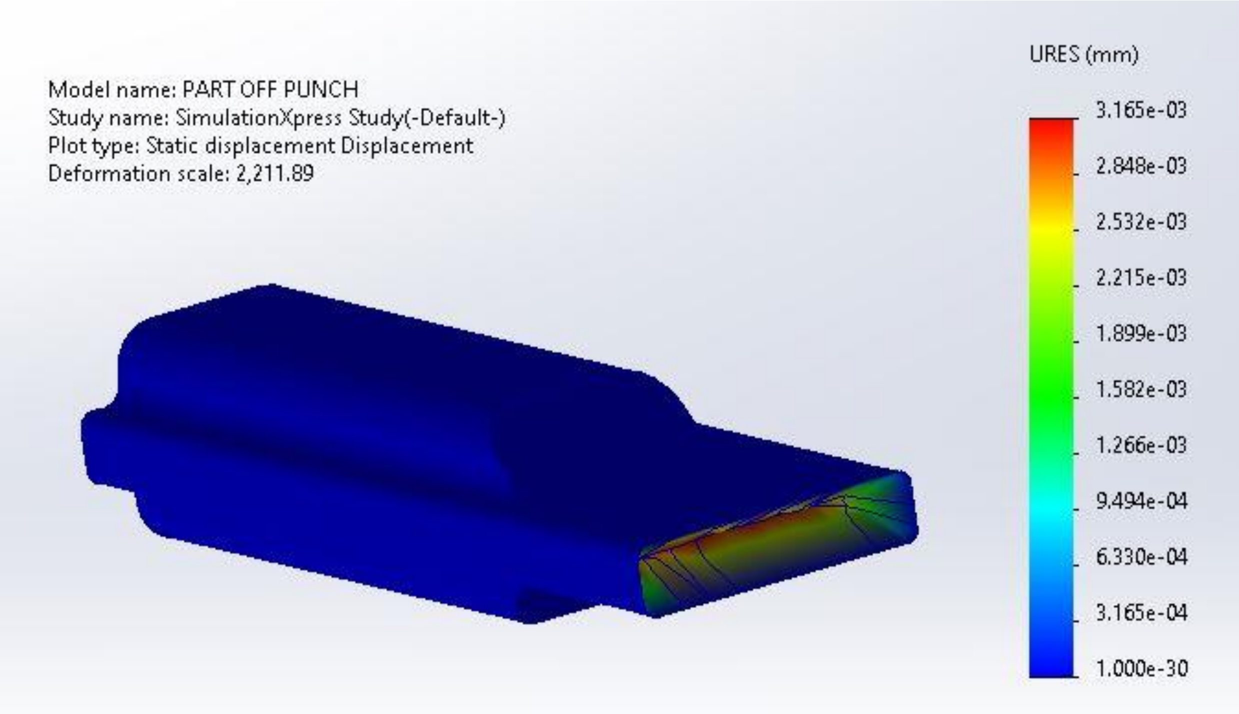


Fig.46. Part off punch displacement

Cost Analysis:

Cost analysis of tool structure is calculated. In standard market price of material is, let's consider given below prices, normally part contact area are covered and conduct by EN31 or OHNS material some rare case using MS, in part working area (Piercing punch and die, forming punch and die), D2 and SKD11 material is used.

So, consider price given below, this tool we use only, MS, OHNS, D2;

Material Name	Per kg Price
MS	₹120
OHNS	₹195
D2	₹400

Tool MS material Weight is 510 kg
OHNS weight is 176 kg
D2 weight is 21 kg

Now calculate material cost = (510 X 120) + (176 X 195) + (400 X 21)
= 61200 + 34320 + 8400
= ₹1,03,920

Material cost is ₹1,03,920
Planning cost square inch price is ₹10
1560 square inch cost is ₹15,600

Grinding cost square inch price is ₹12
1560 square inch cost is ₹18,720

VMC Cost per hour is ₹1000

70 hours running cost is ₹70,000

EDM (wirecut) cost per hour is ₹700
90 hours running cost is ₹63,000
Heat treatment cost per kg is ₹400
197 kg cost is ₹78,800

Assembly work 3 person for 2 months continuously is ₹70,000
Bench work (tapping & Chambering etc.) cost is ₹60,000
Development & Rework cost is ₹1,20,000 (including re machining work)

Design cost of the tool is ₹1,50,000
Polishing & Coating cost ₹1,15,000

Total cost of the tool =(1,03,920 + 15,600 + 18,720 + 70,000 + 63,000 + 78,800 + 70,000 + 60,000 + 1,20,000 + 1,50,000 + 1,15,000)
= ₹8,65,040

So, **Total tool cost is 8,65,040 ₹**

Conclusion:

In this paper, a progressive tool Washer plate is designed, modelled, analysed and drafted. Modelling has done in Solid works 2020. Analysis has done in Solid works 2020 simulation express and Drafted in AutoCAD 2016. Strip layout for maximum stock strip utilization is developed. Stock strip utilization achieved is approximately 87.69 %. Further, finite element analysis for maximum Von-Mises stress and deformation is carried out on the punches using Solid works 2020 simulation express for validating the design. The results obtained are well within the limit. The press capacity obtained is of 30.5 T. The moment generation due to cutting force during cutting stroke will be negligible as location of centre of pressure locate the shank, which will fixed onto the ram of press machine in same axis. By studying the component profile and its method of manufacturing, it is understood that the component is produced by simple single stage tool due which the concentricity in the profile of the component is missing out. To overcome it, progressive tool for its manufacturing is designed so that good profile concentricity can be maintained and finally the cost of component per piece can be reduced as compared from the previous method of manufacturing.

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