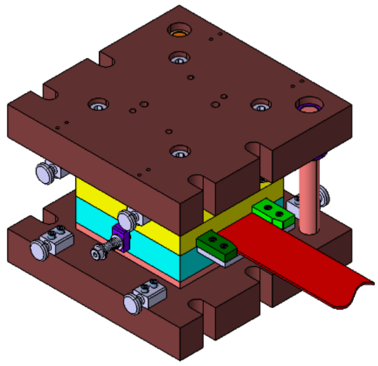
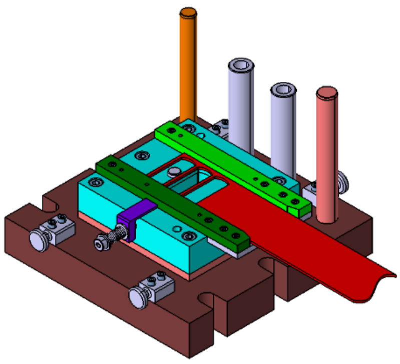
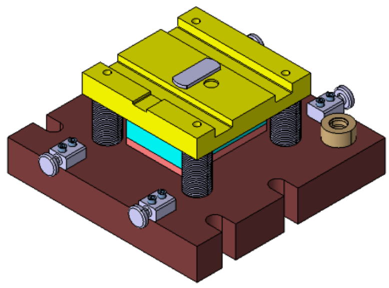
Internship Report

Press Tool Design with Catia V5

Design Calculations + 3D Design + 2D Drafting







Internship Report Submitted By

Prasannakumar S

Internship carried out at

ROYAL MECHANICAL

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Maxpertise Technology Labs Pvt. Ltd., Bengaluru.

About the Company

https://elearn.royal-mechanical.com/

https://elearn.royal-mechanical.com/ is an online school for mechanical engineers owned by Maxpertise Technology Labs Pvt. Ltd.

The objective of https://elearn.royal-mechanical.com/ is to offer job-oriented courses for mechanical engineers and bridge the gap between academia and the industry.

https://elearn.royal-mechanical.com/ **offers job-oriented online courses in the below areas**

CAD Skills	Technical Skills	Soft Skills
▪ Catia v5 ▪ Fusion 360	▪ Tooling Design – Jigs, Fixtures, and Press Tools ▪ Product Design – Automotive, Aerospace, and Industrial Automation. ▪ Geometric Dimensioning and Tolerancing (GD&T)	▪ How to Get Mechanical Engineering Jobs? ▪ Spoken English for Mechanical Engineers

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Internship Certificate

(After Printing the Report,

Replace this page with the

Internship Certificate provided by Maxpertise Technology Labs Pvt. Ltd.)

1. The objective of this Internship

Below are the top three objectives of the Internship at Maxpertise Technology Labs Pvt. Ltd., Bengaluru.

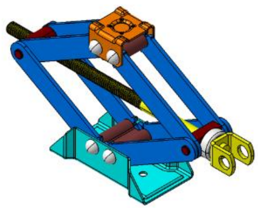
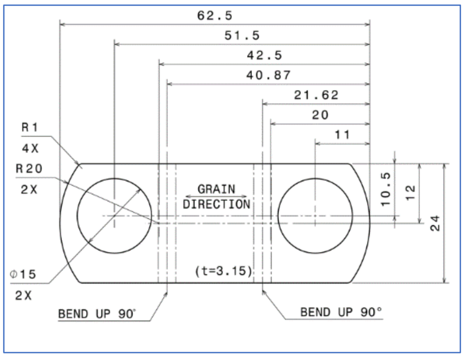
(1)	**(2)**	**(3)**
Learn Catia V5	**Learn the Design of Blanking Die (Press Tool)**	**Design of Blanking Die (Press Tool)**
Learn the below-mentioned modules of Catia V5 ✓ Sketcher workbench ✓ Part design workbench ✓ Assembly workbench ✓ Drafting workbench	Learn the Design of Blanking Die for the "Power Screw Support Bracket" of a "Car Scissor Jack" 	**Mini Project:** Design of Blanking die using Catia V5 for the below part. 

Table 1: Objectives of Internship

2. About Catia V5

Catia is a Software developed by the French company DASSAULT SYSTEMES, which is used for

- ✓ CAD (Computer-Aided Design)
- ✓ CAM (Computer-Aided Manufacturing)
- ✓ CAE (Computer-Aided Engineering)

Full-Form of CATIA is a Computer-Aided Three-dimensional Interactive Application.

Catia V5 is the most preferred design software by the world's leading companies in Automotive, Aerospace, Defence, Transportation, Medical Devices, Industrial Machinery, Ship Building, Architecture, Construction, Power, Petroleum, Engineering Services, and many more.

3. About the Press & Press Tool

Press: A Press is a Machine that provides the Force necessary to cut/form the sheet metal workpiece

Press Tool: A "Press Tool" is a "Tool" which cuts or forms the sheet metal workpiece. "Press Tool" is also called "Stamping Die." Press Tool is used predominantly in the automotive industry.

4. About Blanking

Blanking is a shearing operation performed on the sheet metal.

The Blank (Useful Product) is sheared from the Raw Material (Sheet Metal Strip)

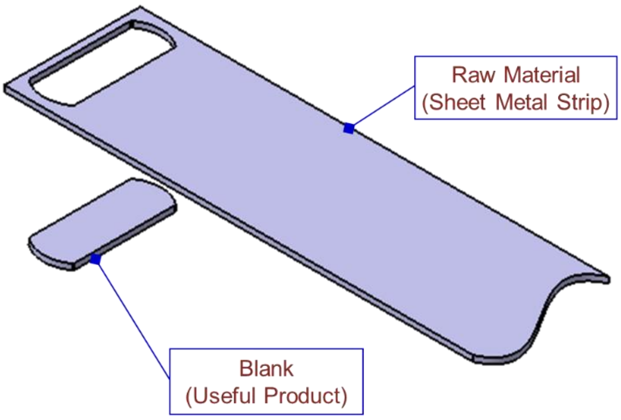


Figure 1: Blanking Operation

4.1. Cutting Clearance

Cutting Clearance: The space/gap between Punch's cutting edge and the cutting edge of the die.

Proper clearance is very much essential for the shearing to happen.

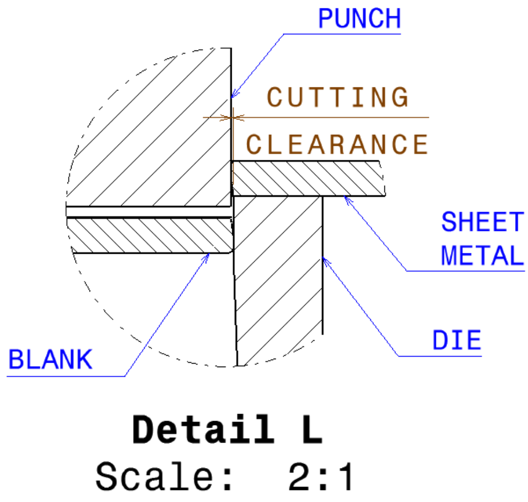


Figure 2: Illustration of Cutting Clearance

Cutting Clearance for Blanking (6% to 8% of sheet metal thickness)
Precision Blanking = 6% of sheet metal thickness
Ordinary Blanking = 8% of sheet metal thickness

Table 2: Values of Cutting Clearance

5. The Design Process

Below mentioned flow chart depicts the design process to design the Blanking Die (Press Tool)

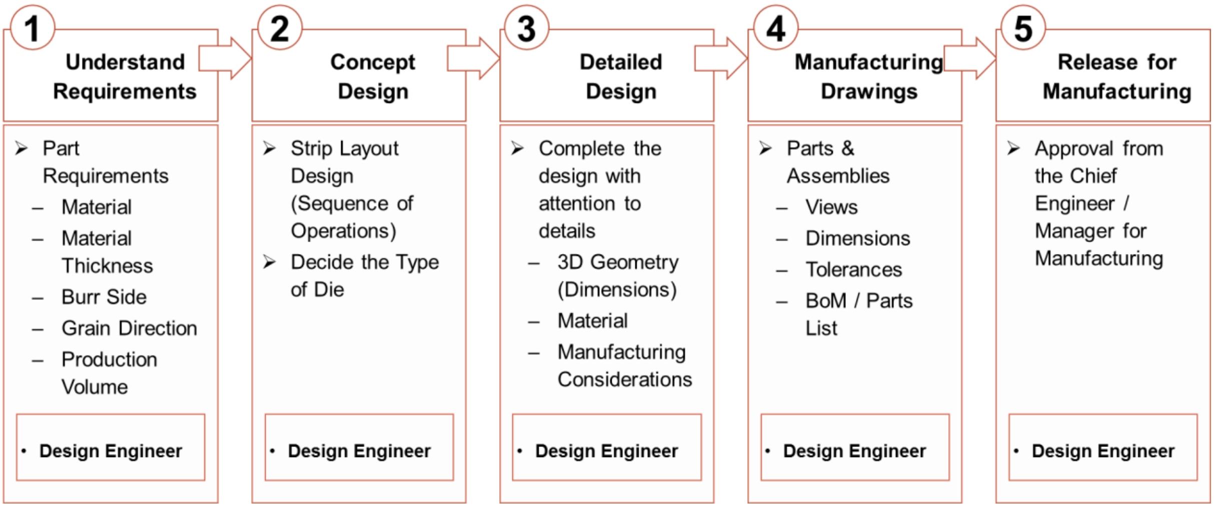


Figure 3: The Design Process

6. Design of Blanking Die (Press Tool)

6.1. Understand Requirements

Below mentioned drawing depicts the part drawing for which the Blanking die (press tool) is designed.

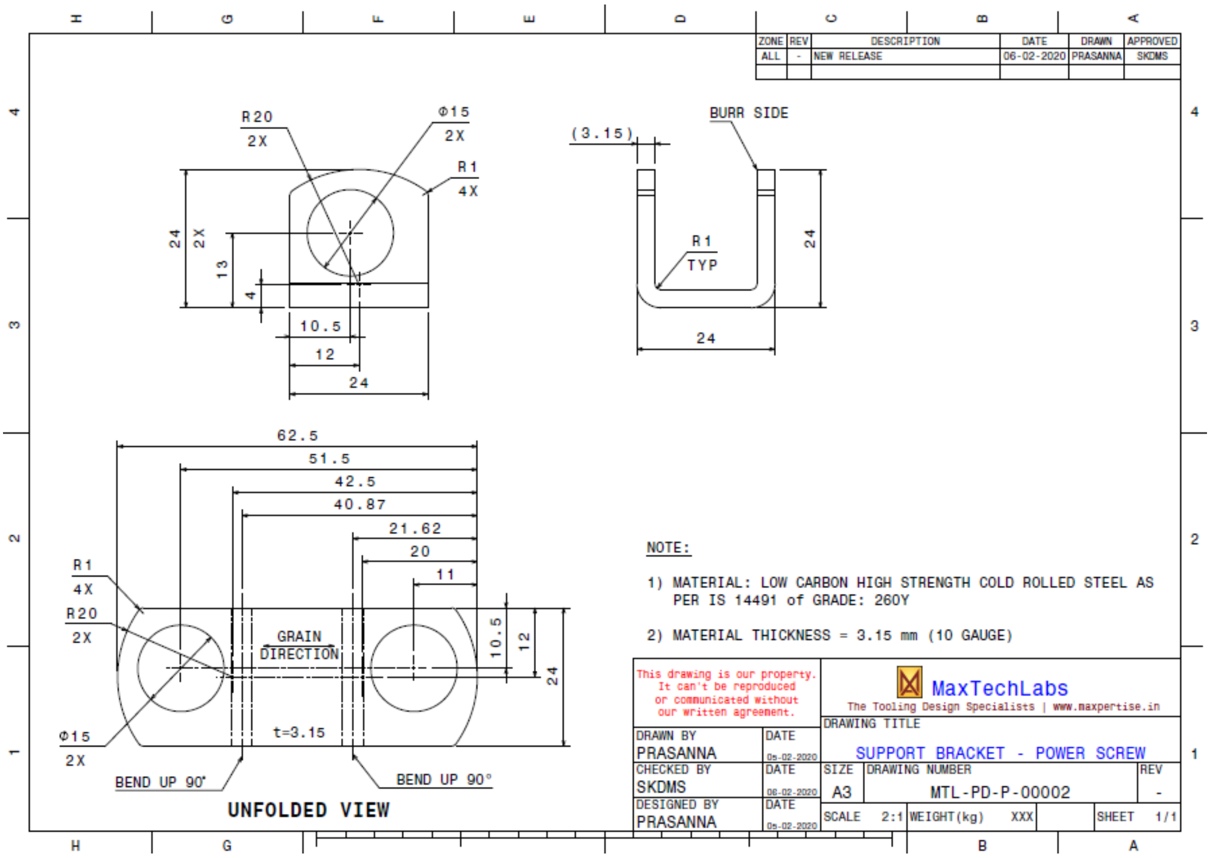


Figure 4: The Part Drawing

6.1.1. The Part Material

As per the part drawing, the part material is LOW CARBON HIGH STRENGTH COLD ROLLED STEEL AS PER IS 14491 of GRADE: 260Y

As per IS 14491, for LOW CARBON HIGH STRENGTH COLD ROLLED STEEL AS PER IS 14491 of GRADE: 260Y

σ_y = 260 N/mm2

σ_t = 350 N/mm2

6.1.2. The Part Material Thickness

As per the part drawing, the part material thickness is 3.15mm.

6.2. Concept Design (Strip Layout Design)

Below mentioned flow chart depicts the design process to design the Strip Layout.

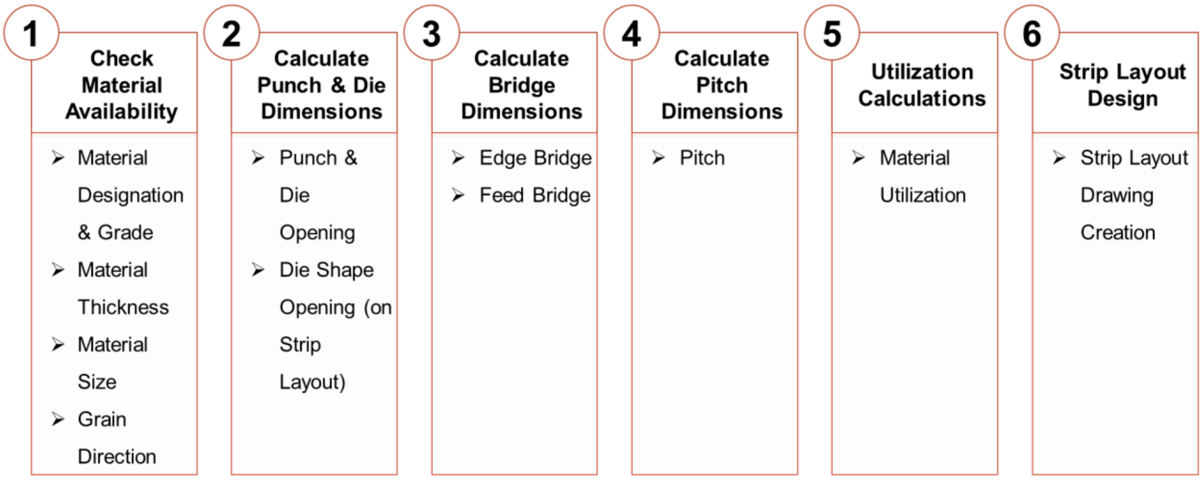


Figure 5: The Strip Layout Design Procedure

6.2.1. Check Material Availability

Of all the sizes available with the material supplier, below mentioned raw material size is selected.

Length = 2500mm

Width = 1000mm

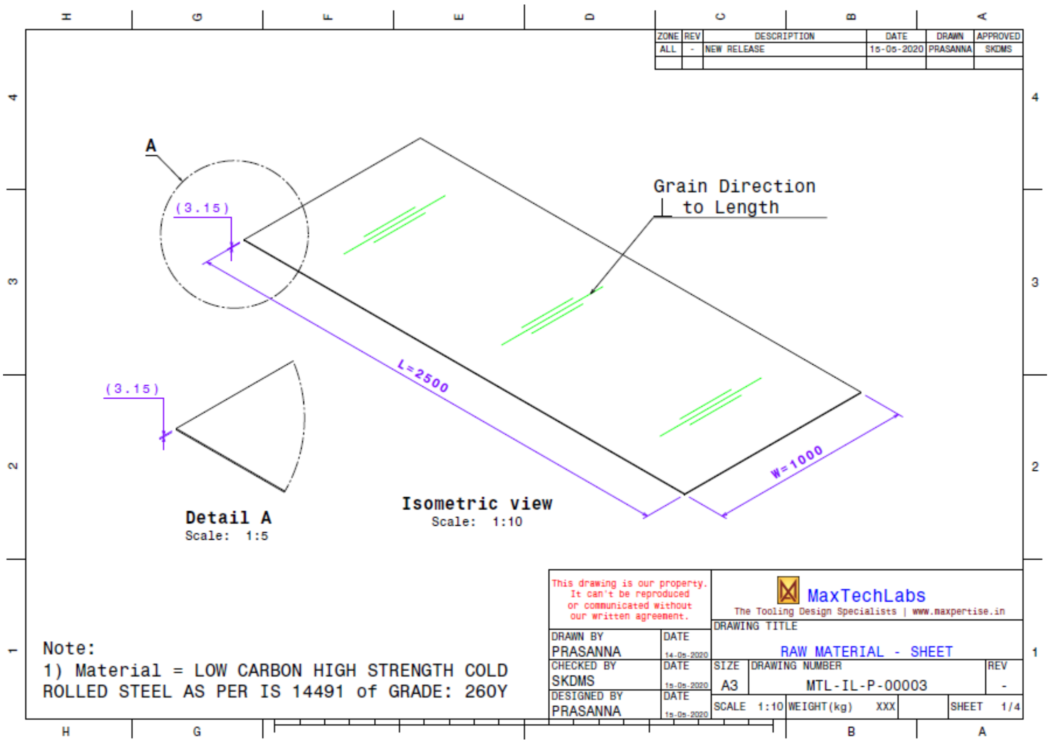


Figure 6: Raw Material Size

The Raw material can be slit along its length or its width.

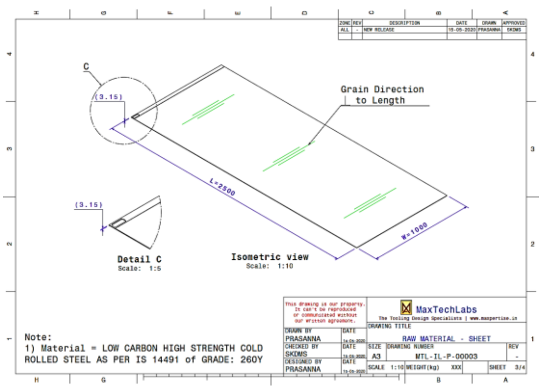
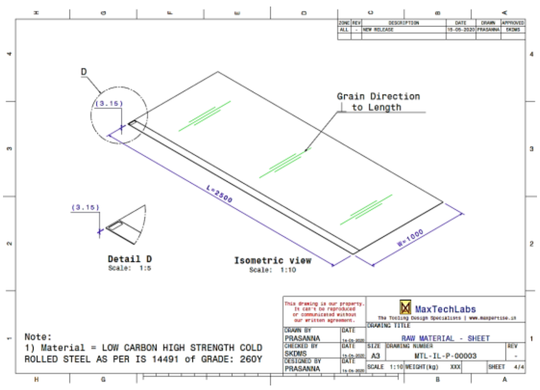
Slit along Length	Slit Along Width
	

Figure 7: Raw Material Slitting

6.2.2. Calculate Punch & Die Dimensions

Calculations – Cutting Clearance, Punch Shape & Die Shape	
Cutting Clearance (Considering Ordinary Blanking)	= 8% of sheet metal thickness
	= 8% x 3.15 mm
	= 0.252 mm
Die Opening Dimension	= Component Dimension
	= 62.5mm x 24mm
Punch Shape Dimension	= Component Dimension - (2 * Cutting Clearance)
	= (62.5 – (2 x 0.252)) mm x (24 – (2 x 0.252)) mm
	= 61.996 mm x 23.496 mm

Table 3: Calculations – Cutting Clearance, Punch Shape & Die Shape

6.2.3. Calculate the Bridge Dimensions

Feed Bridge is a function of the length of the component.

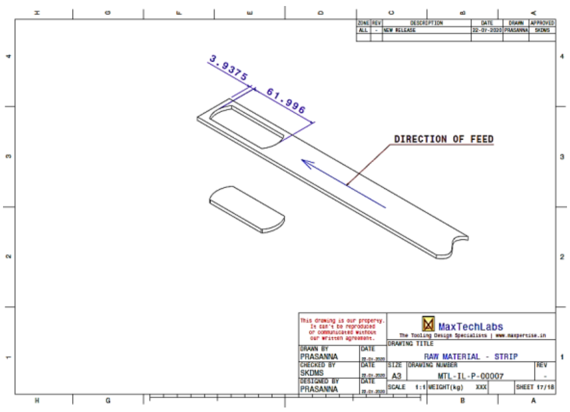
Length of the Component, mm	Feed Bridge, mm	Minimum Feed Bridge, mm
L ≤ 50	t	1.6
51 ≤ L ≤ 150	1.25 t	2.4
151 ≤ L ≤ 250	1.5 t	3.2
251 ≤ L ≤ 400	1.75 t	4.8

Table 4: Feed Bridge Dimensions

Calculations – Feed Bridge & Edge Bridge	
Feed Bridge	= 1.25 * t
	= 1.25 * 3.15
	= 3.9375 mm
Edge Bridge	= 1.2 * 3.9375
	= 4.725 mm

Table 5: Calculations – Feed Bridge & Edge Bridge

Slit along Length	Slit Along Width



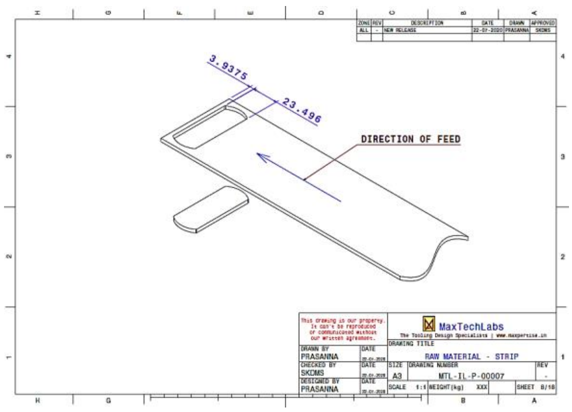
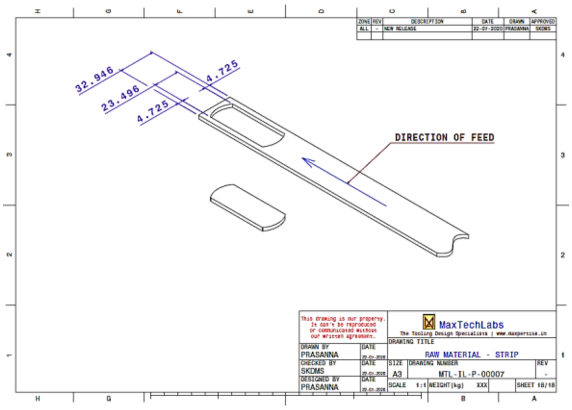


Figure 8: Feed Bridge Dimensions

Slit along Length



Slit Along Width

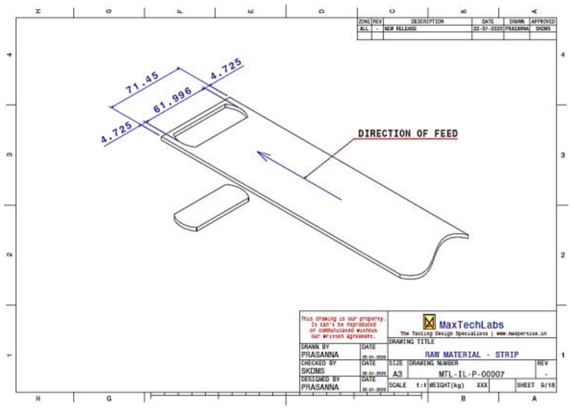
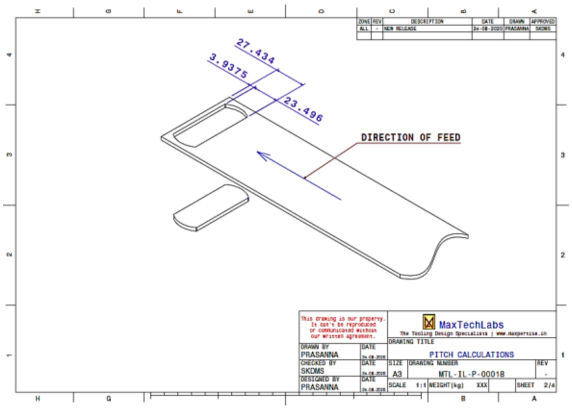


Figure 9: Edge Bridge Dimensions

6.2.4. Calculate the Pitch

Slit along Length	Slit Along Width
Pitch = Edge Bridge + Shape Opening Width	Pitch = Edge Bridge + Shape Opening Length
= 3.9375 + 23.496	= 3.9375 + 61.996
= 27.434	= 65.934



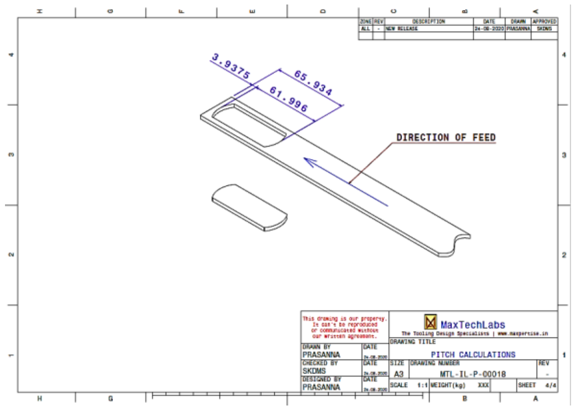


Figure 10: Pitch Dimensions

6.2.5. Calculate the Material Utilization

Calculations – Total Number of Components			
		1. Slit along the Length	**2. Slit along the width**
Strip Width	=	71.446mm	32.946mm
Strip Width with Tolerance	=	71.446 ± 0.3 mm	32.946 ± 0.3
MMC of Strip Width	=	**71.746 mm**	**33.246 mm**
No. of Strips per Sheet Metal	=	$\frac{\text{Sheet Metal Width}}{\text{MMC of Strip Width}}$	$\frac{\text{Sheet Metal Length}}{\text{MMC of Strip Width}}$
	=	$\frac{1000}{71.746}$ = 13.9 = **13**	$\frac{2500}{33.243}$ = 75.2 = **75**
No. of Components per Strip	=	$\frac{\text{Sheet Metal Length}}{\text{Pitch}}$	$\frac{\text{Sheet Metal Wi}dth}{\text{Pitch}}$
	=	$\frac{2500}{27.434}$ = 91.1 = **91**	$\frac{1000}{65.934}$ = 15.2 = **15**
Total No. of Components per Sheet Metal	=	No. of Strips per Sheet Metal x No. of Components per Strip	No. of Strips per Sheet Metal x No. of Components per Strip
	=	13 x 91 = **1183**	75 x 15 = **1125**

Table 6: Calculations – Total Number of Components

By slitting the sheet metal along its length, we produce more components.

Utilization Calculations for Slit along the Length		
Total No. of Components per Sheet Metal	=	1183
Area of Component	=	1438.65 mm^2
Material Utilization	=	$\frac{\text{Total Utilized Area}}{\text{Area of Sheet Meal}}$
	=	$(\frac{1183 \text{ x } 1438.65}{2500 \text{ x } 1000})$ x 100
	=	**68%**

Table 7: Utilization Calculations

6.2.6. Final Design of the Strip Layout Drawing

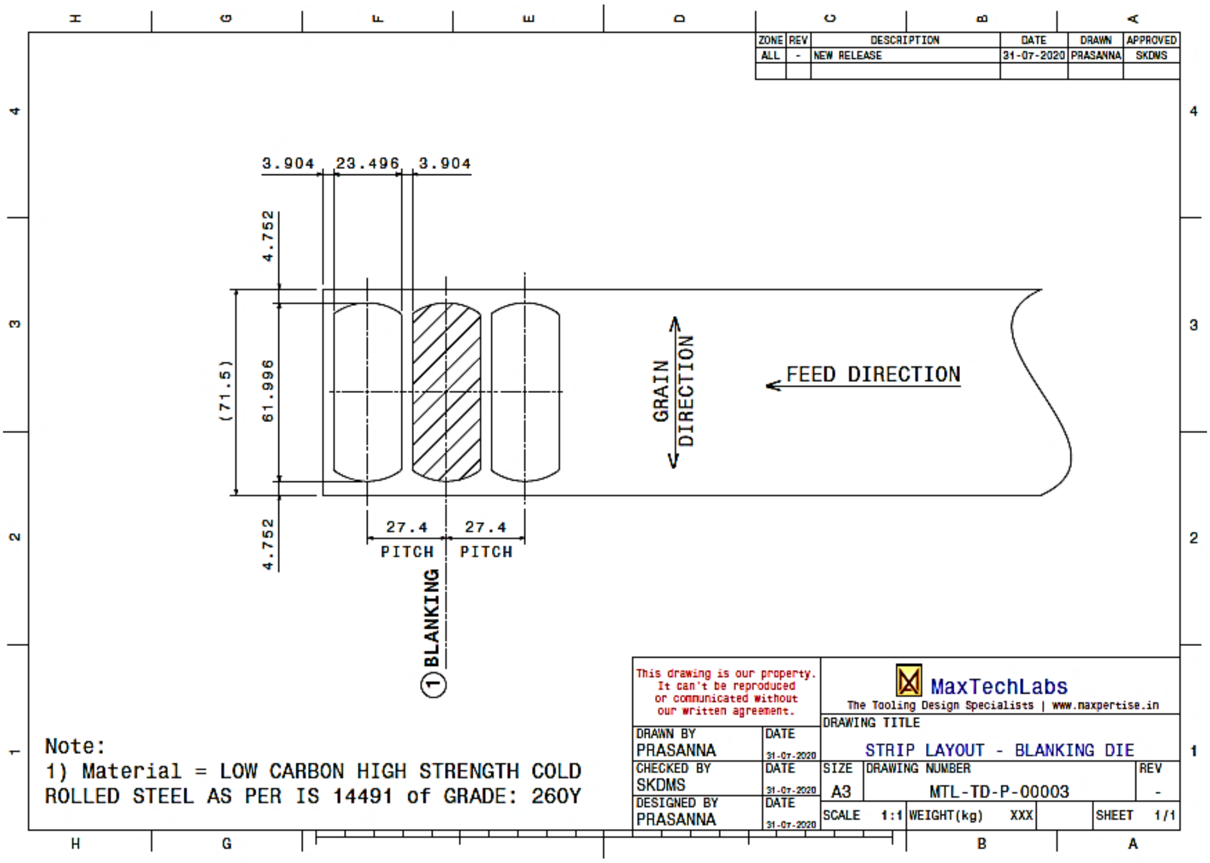


Figure 11: Strip Layout Drawing

6.3. Force and Tonnage Calculations

6.3.1. Perimeter Calculations

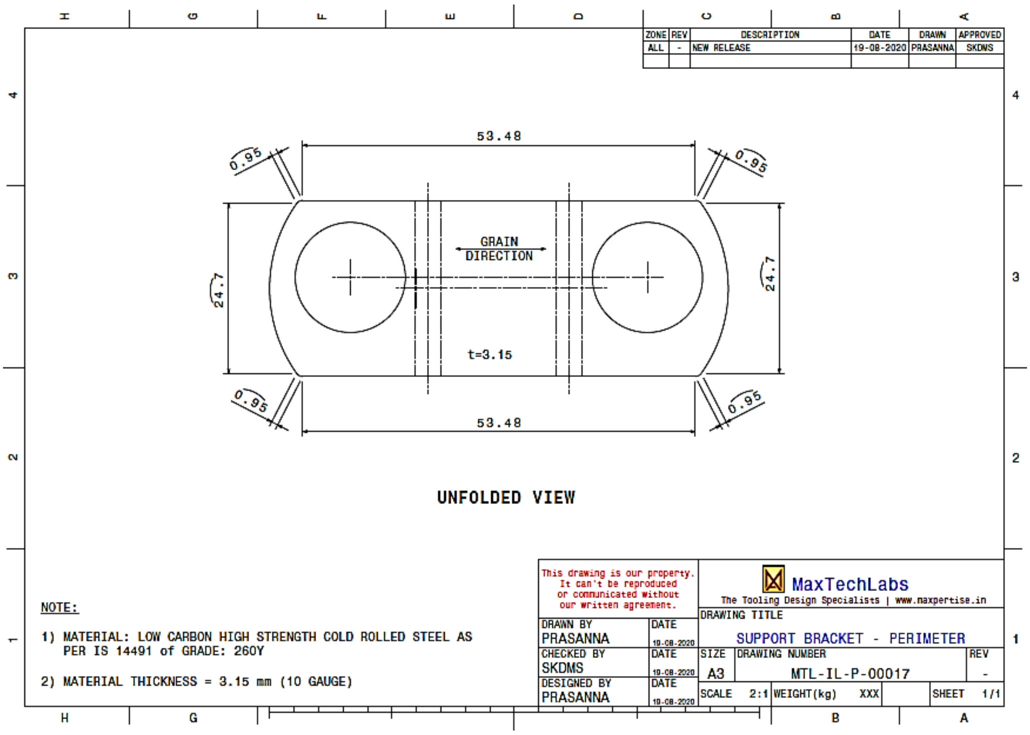


Figure 12: Component Perimeter

Perimeter Calculations		
Perimeter	=	(53.48 * 2) + (24.7 * 2) + (0.95 * 4)
	=	107.0 + 49.4 + 1.9
	=	**160.16 mm**

Table 8: Perimeter Calculations

6.3.2. Shear Force Calculations

The formula to calculate the Shear Force is

$$F_{sh} = \frac{0.8 * p * t * TS}{1000}$$

Calculations – Shear Force				
F_{sh}	**=**	**Shear Force**	**tonnes**	**= 14.41**
p	=	Perimeter of Shear	mm	= 160.16
t	=	Thickness of Sheet	mm	= 3.15
TS	=	Tensile Strength of Material	kg/mm^2	= 35.7

Table 9: Shear Force Calculations

6.3.3. Tonnage Calculations

The formula to calculate the press tonnage is

$$PT = 1.5 * F_{sh}$$

Press Tonnage Calculations:				
PT	**=**	**Press Tonnage**	**tonnes**	**= 21.62**
F_{sh}	=	Shear Force	tonnes	= 14.41

Table 10: Press Tonnage Calculations

6.3.4. Press Selection & Specifications

Press Capacity / Tonnage ≥ Calculated Press Tonnage

We will design the press tool for the 40tonnes Press available in the production facility.

Below mentioned Press shall be used for component production.

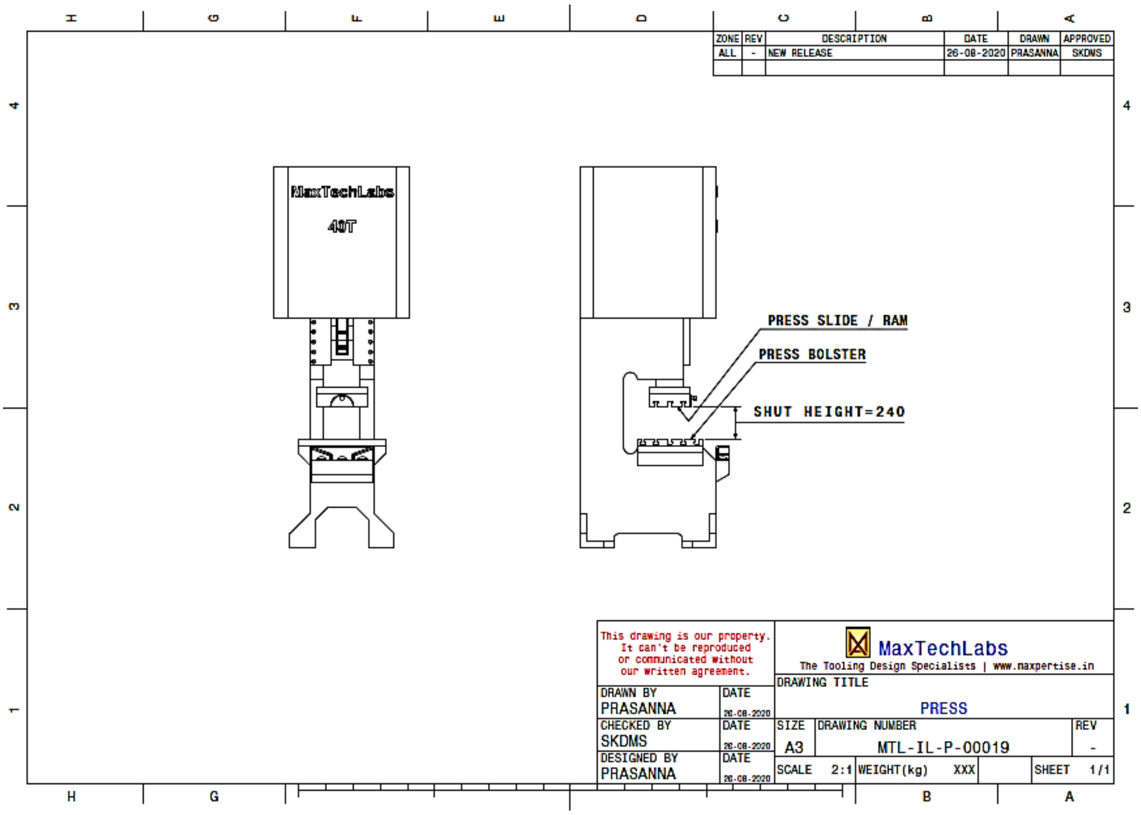


Figure 13: Press

Press Bolster Drawing is shown below.

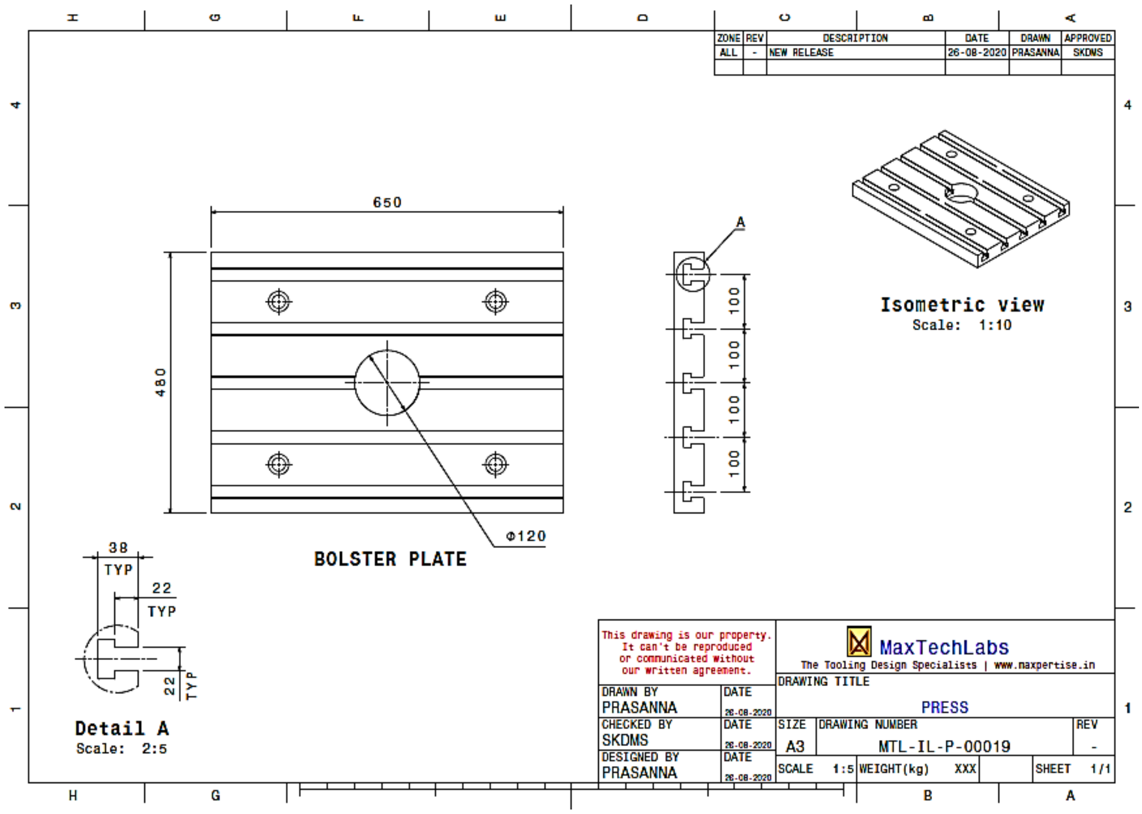


Figure 14: Press Bolster

The press Adapter Plate Drawing is shown below.

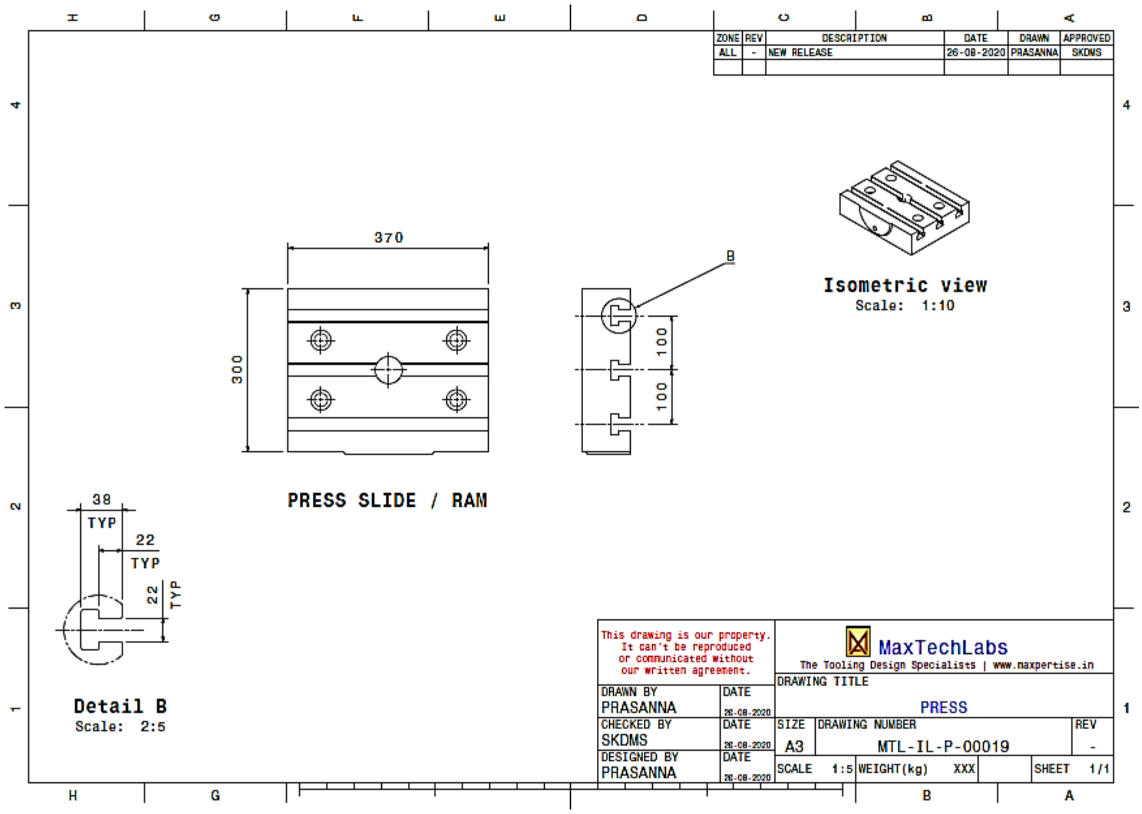


Figure 15: Press Adapter Plate

6.4. Detail Design

The design of the press tool is created using Catia V5 software. All essential calculations related to the press tool design are outlined in this chapter.

6.4.1. Die Plate

The die plate provides the cutting edge for shearing or blanking the sheet metal strip.

The formula to calculate the die plate thickness is

$$T_d = \sqrt[3]{\left(\frac{Fsh * L3}{16 * E * W * \delta}\right)}$$

Die Plate Thickness Calculations					
δ	=	Max. Allowable Die Plate Deflection	mm	= 0.08	
F_{sh}	=	Shear Force	kg	= 14410	
L	=	Length of Die Plate	mm	= 182.5	
E	=	Young's Modulus of Steel	Kg/mm^2	= 21.4×10^3	
W	=	Width of Die Plate	mm	= 144	
T_d	**=**	**The thickness of the Die Plate**	**mm**	**= 28.1**	**≈ 30**

Table 11: Die Plate Thickness Calculations

The 3D design of the Die Plate using Catia V5 is shown below.

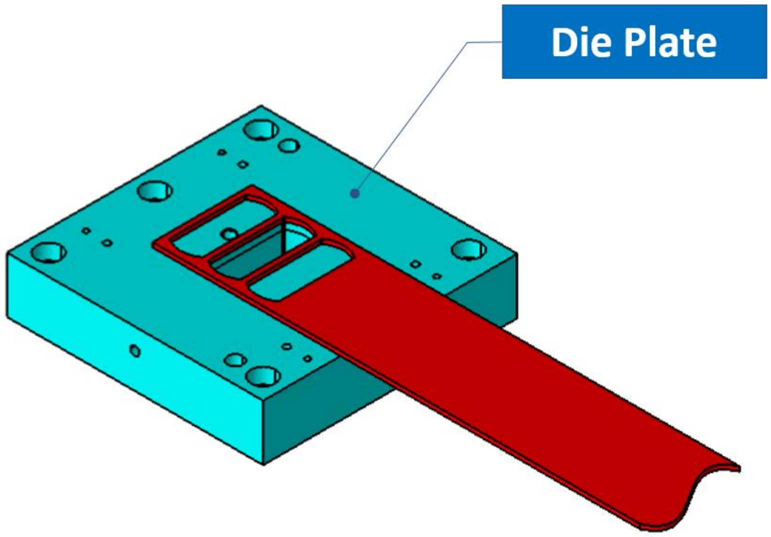


Figure 16: Die Plate

6.4.2. Locator Pin

The function of the locator pin is to locate the sheet metal strip along the feed direction.

The 3D design of the Locator Pin using Catia V5 is shown below.

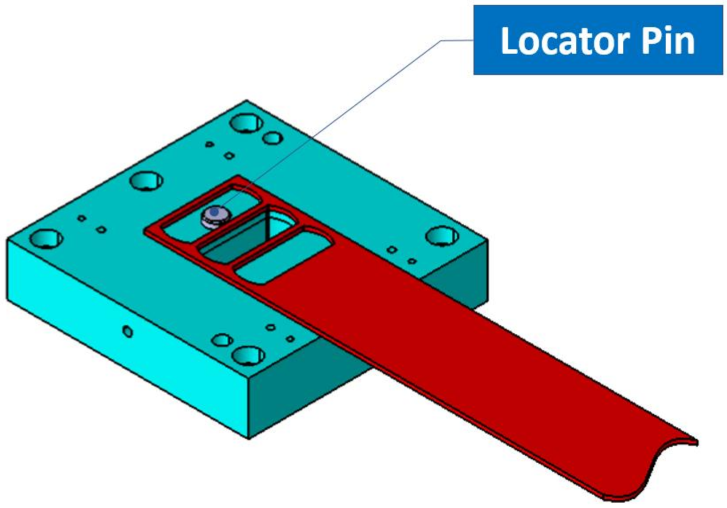


Figure 17: Locator Pin

6.4.3. Strip Guide Plates and the Strip Support Plate

The function of the strip guide plates is to guide the sheet metal strip.

The function of the strip support plate is to support the sheet metal strip.

The 3D design of the Locator Pin using Catia V5 is shown below.

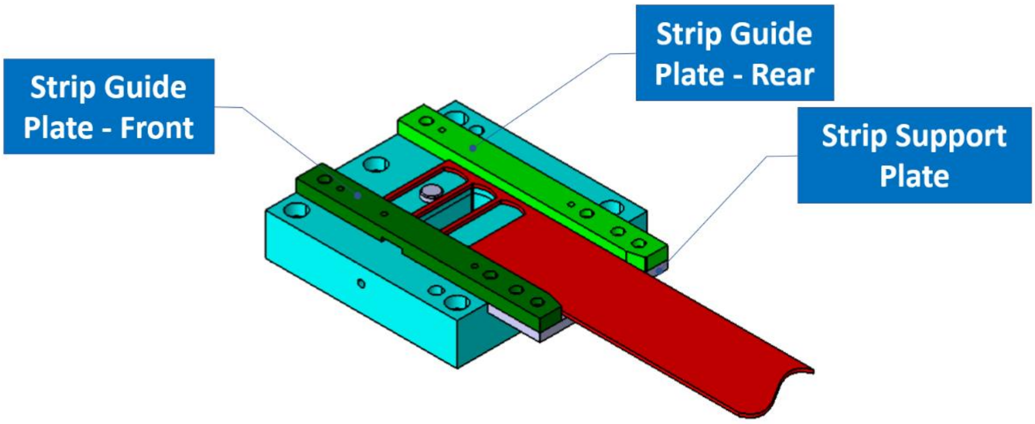


Figure 18: Strip Guide Plates and Strip Support Plate

6.4.4. Strip Pusher

The strip pusher's function is to push the sheet metal strip against the rear strip guide plate. The strip pusher is spring-loaded.

Below mentioned is the procedure for designing the spring.

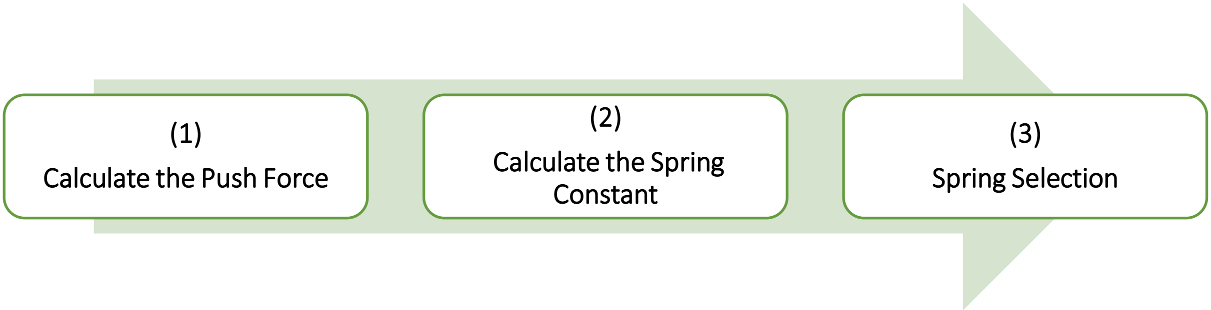


Figure 19: Spring Design Procedure

Strip Weight Calculations	
Strip Width, W	= 71.5 mm
Strip Length, L	= 2500 mm
Strip Thickness, T	= 3.15 mm
Strip Volume, V	= W x L x T = 71.5 x 2500 x 3.15 = 563062.5 mm^3
The density of Steel ρ	= 0.000008 kg/mm3
Strip Mass, m	= V x ρ = 563062.5 x 0.000008 = 4.5 kg
Acceleration due to Gravity, a	= 9.8 m/s^2
Strip Weight, F	= m x a = 4.5 x 9.8 **= 44 N**

Table 12: Strip Weight Calculations

Push Force Calculations	
Strip Weight, F	= 44 N
Co-efficient of Friction (Steel on Steel), μ	≈ 0.7
Push Force, N	$= \mu \times F$ $= 0.7 \times 44$ **= 30.8 N**
The spring force ≥ 30.8N	

Table 13: Push Force Calculations

Spring Length Calculations	
SPACE AVAILABLE	= 28.5mm
SPACE AVAILABLE	90% TO 95% OF THE TOTAL LENGTH (FREE LENGTH)
TOTAL LENGTH (FREE LENGTH)	$= \frac{\text{SPACE AVAILABLE}}{90\%}$ $= \frac{28.5}{0.9}$ = 31.7mm
Generally, Springs are available in steps of 5mm in length.	
TOTAL LENGTH (FREE LENGTH)	**= 30mm**

Table 14: Spring Length Calculations

Spring Constant Calculations	
COMPRESSED LENGTH	= SPACE AVAILABLE - STROKE = 28.5 - 2 = 26.5mm
2mm is the interference that we have designed between the Strip Pusher and the Strip	
We need the Push Force @26.5mm	
SPRING CONSTANT	$= \frac{\text{PUSH FORCE}}{\text{TOTAL STROKE}}$ $= \frac{\text{PUSH FORCE}}{\text{TOTAL LENGTH - COMPRESSED LENGTH}}$ $= \frac{15.4}{30 - 26.5}$ $= \frac{15.4}{3.5}$ = 4.4 N/mm
Select a Spring with Spring Constant ≥ 4.4 N/mm or more.	

Table 15: Spring Constant Calculations

Maximum Spring Deflection Calculations	
MAXIMUM COMPRESSED LENGTH	= SPACE AVAILABLE – MAXIMUM STROKE = 28.5 - 3 = 25.5mm
An additional 1mm is the clearance between the Strip and the Front Strip Guide Plate.	
MAXIMUM DEFLECTION	$= \frac{\text{TOTAL LENGTH - MAX. COMPRESSED LENGTH}}{\text{TOTAL LENGTH}} \times 100$ $= \frac{30 - 25.5}{25.5} \times 100$ $= \frac{4.5}{25.5} \times 100$ = 15%
Select a Spring with an allowable deflection ≥ 15%	

Table 16: Maximum Spring Deflection Calculations

Spring Selection (From Standard Catalogue)	
Inner Diameter, Di	> 10mm
Outer Diameter, Do	14mm
Wire Diameter, d	1.7mm
Free Length, L	30mm
Maximum Force, N	88.3N
Spring Constant, N/mm	4.4 N/mm
Max. Allowable Deflection (% of Free Length)	> 15%

Table 17: Strip Pusher Spring Specifications

The 3D design of Strip Pusher using Catia V5 is shown below.

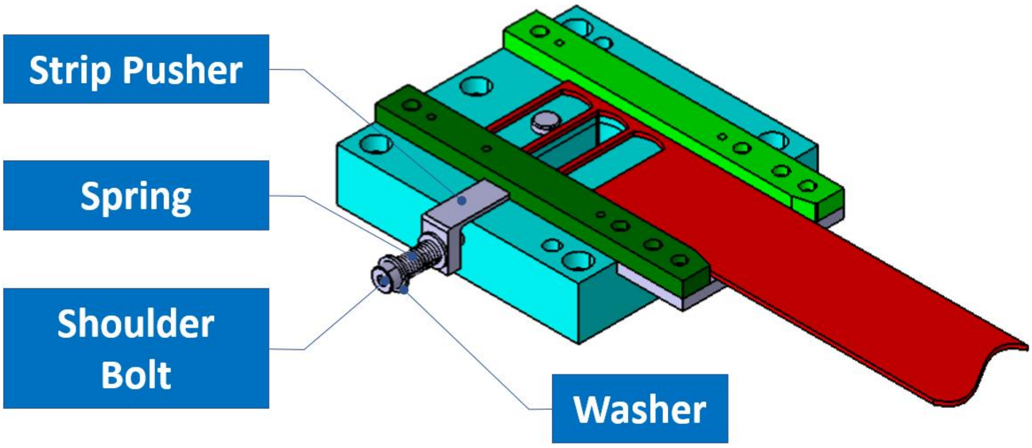


Figure 20: Strip Pusher

6.4.5. Die Back Plate

The function of the die backplate is to absorb energy/force coming from the die plate.

The 3D design of the Die Back Plate using Catia V5 is shown below.

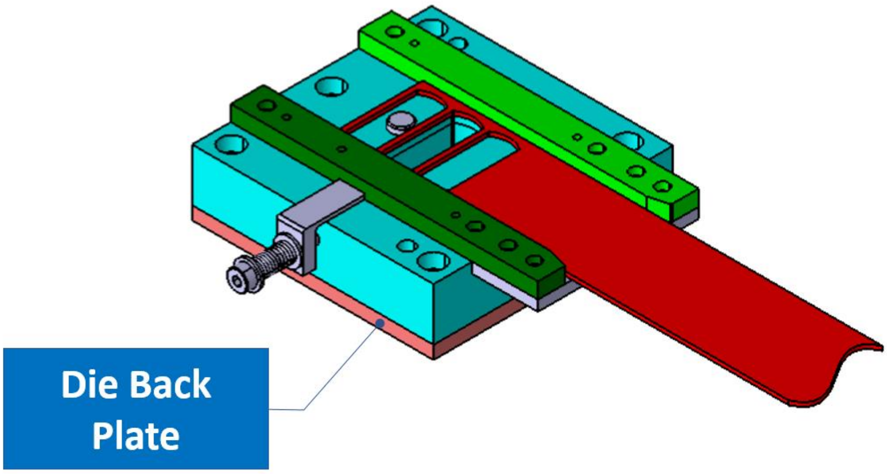


Figure 21: Die Back Plate

6.4.6. Die Shoe

The function of the die shoe is listed below

- Absorbs the Force coming from the Die Plate.
- Used to Fasten the Die Assembly to Press Bolster using U-Slots
- Has Provision to mount the Guide Pillars.

The 3D design of Strip Pusher using Catia V5 is shown below.

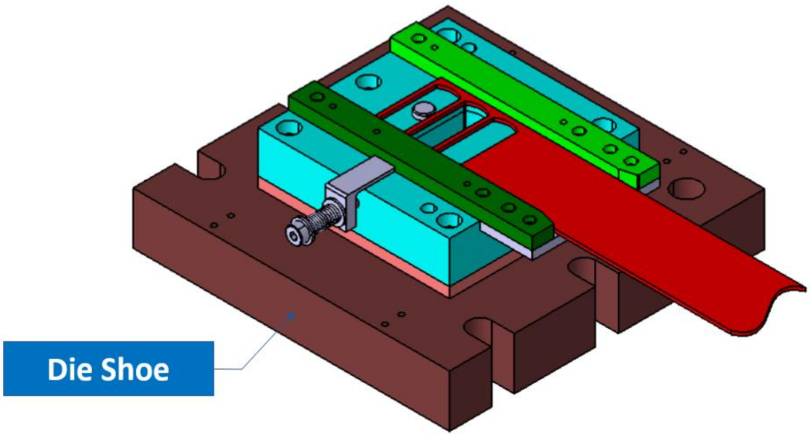


Figure 22: Die Shoe

6.4.7. Guide Pillar

Guide pillars and guide bushes are used to locate the die and punch assemblies.

Below mentioned is the procedure for designing the Guide Pillar.

1. Calculate the Transition Slenderness Ratio	2. Calculate the Slenderness Ratio	3. Calculate the Critical Buckling Stress & Load	4. Calculate the Actual Load, and Finalize Pillar Diameter
a) Calculate the Transition Slenderness Ratio	a) Calculate the C/S Area b) Calculate the Area Moment of Inertia c) Calculate the Radius of Gyration d) Calculate the Effective Length e) Calculate the Slenderness Ratio	a) Calculate the Critical Buckling Stress • Johnson Equation • Euler Equation b) Calculate the Critical Buckling Load	a) Calculate the Actual Load b) If Actual Load < Critical Buckling Load ⇒ Safe Design

Figure 23: Design Procedure – Guide Pillar

The formula to calculate the Transition Slenderness Ratio is

$$TSR = \sqrt{\frac{2\,\pi 2\,E}{Sy}}$$

Transition Slenderness Ratio Calculations				
E	=	Young's Modulus of Steel	N/mm^2	= 210×10^3
Sy	=	Yield Strength of Steel	N/mm^2	= 250
TSR	**=**	**Transition Slenderness Ratio**	**-**	**= 128.8**

Table 18: Transition Slenderness Ratio Calculations

The formula to calculate the Cross-Sectional Area is

$$A = \frac{\pi d2}{4}$$

Cross Section Area Calculations (Guide Pillar)				
d	=	The diameter of the Pillar	mm	= 20
A	=	Cross-Sectional Area	mm^2	= 314.2

Table 19: Cross-Section Area Calculations (guide Pillar

The formula to calculate the Area Moment of Inertia Calculations is mentioned below.

$$I = \frac{\pi d4}{64}$$

Area Moment of Inertia Calculations				
d	=	The diameter of the Pillar	mm	= 20
I	=	Area Moment of Inertia	mm^4	= 7854.0

Table 20: Area Moment of Inertia Calculations

The formula to calculate the Radius of Gyration is mentioned below.

$$R_g = \sqrt{\frac{I}{A}}$$

The Radius of Gyration Calculations				
I	=	Area Moment of Inertia	mm^4	= 7854.0
A	=	Cross-Sectional Area	mm^2	= 314.2
R_g	=	Radius of Gyration	mm	= 5.0

Table 21: Radius of gyration Calculations

The formula to calculate the Slenderness Ratio is mentioned below.

$$\mathbf{SR} = \frac{Le}{Rg}$$

Slenderness Ratio Calculations				
L	=	Length of Pillar	mm	= 230-50 = 180
Le	=	Effective Length of Pillar	mm	= 2 x 180 = 360
R_g	=	Radius of Gyration	mm	= 5.0
SR	=	Slenderness Ratio	-	= 72

Table 22: Slenderness Ratio Calculations

The formula to calculate the Critical Buckling Stress is mentioned below.

$$\sigma_{cr} = \frac{\pi 2E}{SR2}$$

Critical Buckling Stress Calculations				
E	=	Young's Modulus of Steel	N/mm^2	= 210×10^3
SR	=	Slenderness Ratio	-	= 72.0
σ_{cr}	=	**Buckling Stress**	**N/mm^2**	**= 399.8**

Table 23: Critical Buckling Stress Calculations

The formula to calculate the Critical Buckling Load is mentioned below.

$$Fcr = \sigma_{cr} A$$

Critical Buckling Load Calculations				
σ_{cr}	=	Buckling Stress	N/mm^2	= 399.8
A	=	Cross-Sectional Area	mm^2	= 314.2
F_{cr}	=	Buckling Load	N	= 125604.1

Table 24: Critical Buckling Load Calculations

Actual Load Calculations	
Shear Force, F_{sh}	= 14410 kg = 141362.1 N
No. of Pillars	= 2
Actual Force / Pillar	$= \frac{141362.1}{2}$ = 70681.1 N
Critical Buckling Load, F_{cr}	= 125604.1 N
F_{cr} > Actual Force/Pillar **Design is Safe**	

Table 25: Actual Load Calculations

The 3D design of the Guide Pillar using Catia V5 is shown below.

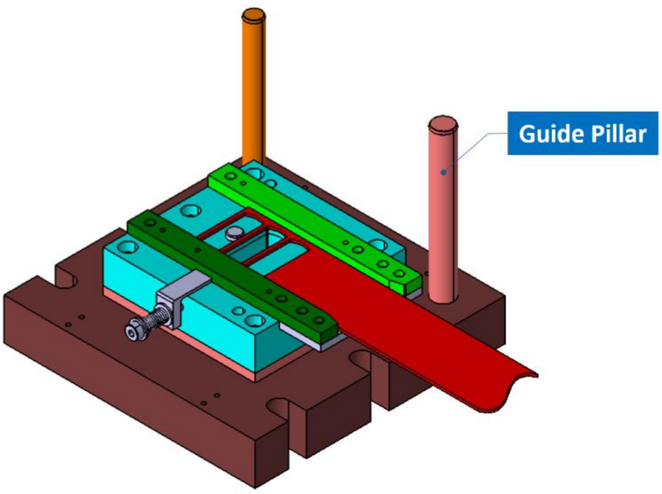


Figure 24: Guide Pillar

6.4.8. Stroke End Block

The Stroke End Block acts as a stopper to indicate the bottom dead center.

The 3D design of Stroke End Blocks using Catia V5 is shown below.

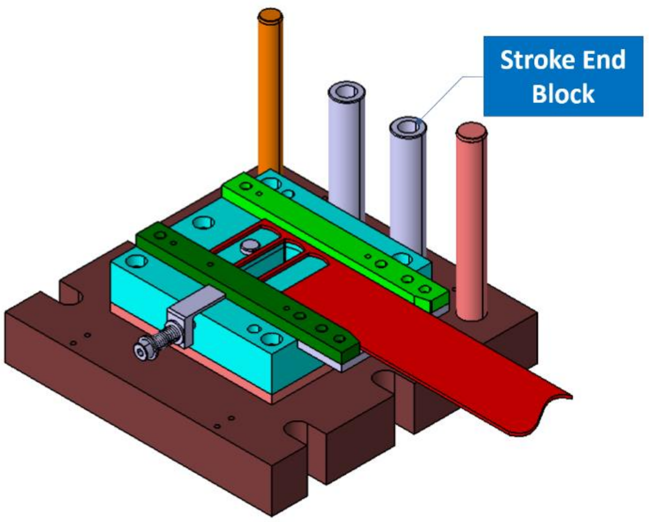


Figure 25: Stroke End Block

6.4.9. Die Assembly Lifting Hooks

The function of the lifting hooks is to lift the die assembly.

The 3D design of Lifting Hooks using Catia V5 is shown below.

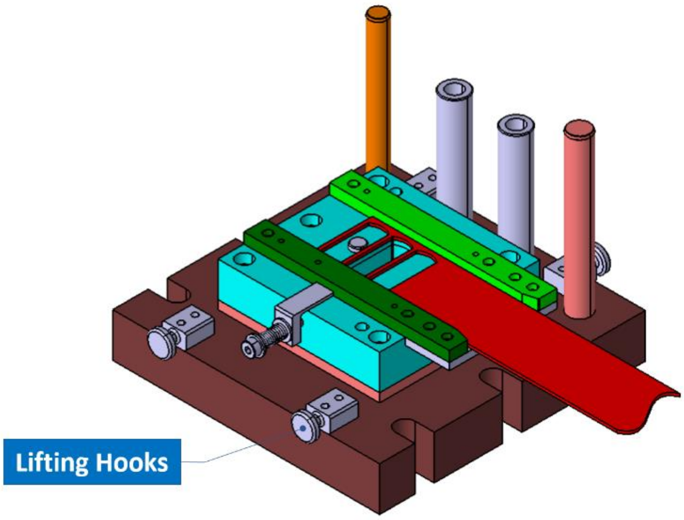


Figure 26: Die Assembly Lifting Hooks

6.4.10. Screws and Dowels for Die Assembly

The screws are used to fasten, and the dowels are used to locate the functionally critical parts.

Catalog parts in Catia V5 are used for the 3D assembly.

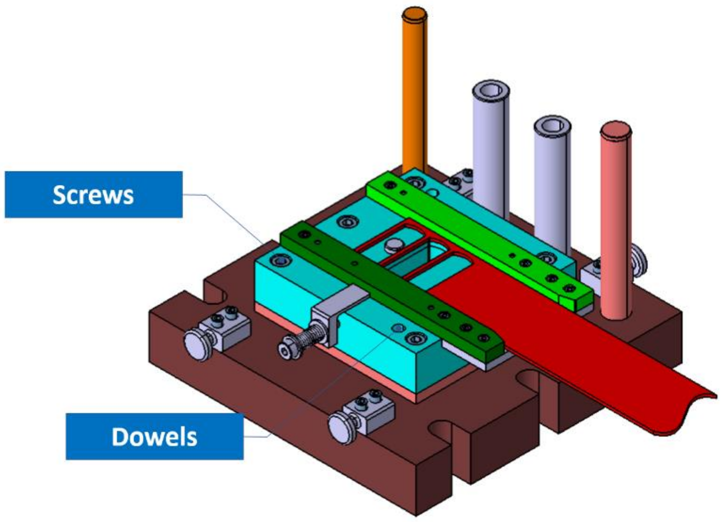


Figure 27: Screws and Dowels for Die Assembly

6.4.11. Blanking Punch

The Blanking Punch is combined with a Die Plate to Blank the sheet metal.

It has the cutting edge to shear the sheet metal.

For the blanking operation, the cutting clearance is provided on the Punch.

Cutting clearance Calculations
= 8% of the sheet metal thickness
= 0.08 x 3.15 = 0.252mm

Table 26: Cutting Clearance Calculations

The 3D design of the Blanking Punch using Catia V5 is shown below.

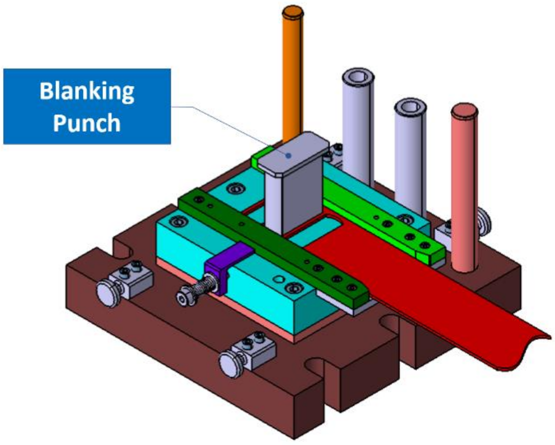


Figure 28: Blanking Punch

6.4.12. Stripper Plate

The function of the Stripper Plate is to Strip the Sheet Metal Strip from the Punch.

The formula to calculate the stripping Force is

$$Fst = 0.1 * Fsh$$

Stripping Force Calculations				
F_{st}	=	Stripping Force	tonnes	**= 1.44**
F_{sh}	=	Shear Force	tonnes	= 14.41

Table 27: Stripping Force Calculations

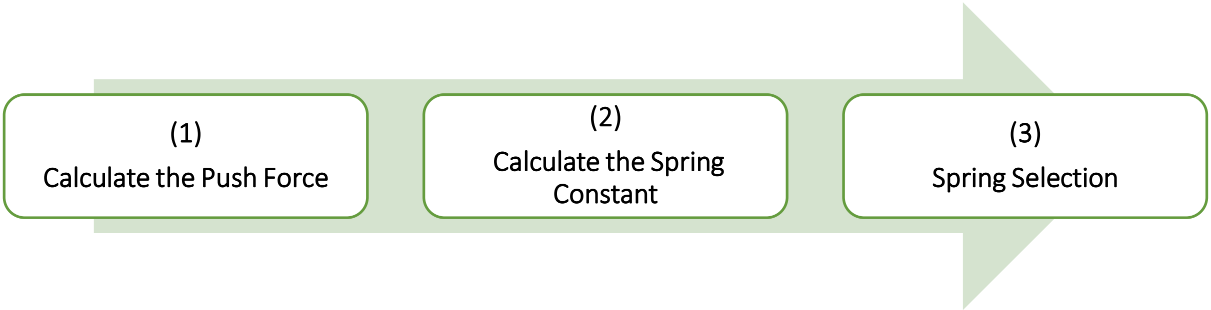
The formula to calculate the thickness of the stripper plate is

$$T_s = \sqrt[3]{\left(\frac{Fst * L3}{16 * E * W * \boldsymbol{\delta}}\right)}$$

Stripper Plate Thickness Calculations				
$\boldsymbol{\delta}$	=	Max. Allowable Stripper Plate Deflection	mm	= 0.08
F_{st}	=	Stripping Force	kg	= 1440
L	=	Length of Stripper Plate	mm	= 182.5
E	=	Young's Modulus of Steel	Kg/mm^2	= 21.4×10^3
I	=	Moment of Inertia	mm^4	
W	=	Width of Stripper Plate	mm	= 144
T_s	=	The thickness of the Stripper Plate	mm	**= 13**

Table 28: Stripper Plate Thickness Calculations

Below mentioned is the procedure for designing the spring.



Push Force Calculations	
PUSH FORCE	**= STRIPPING FORCE** **= 14126.4N**
NO. OF SPRINGS	= 4
PUSH FORCE / SPRING	$= \frac{\text{TOTAL PUSH FORCE}}{\text{NO. OF SPRINGS}}$ $= \frac{14126.4}{4}$ **= 3531.6N**

Table 29: Spring push Force Calculations

Stripper Stroke Calculations	
STRIPPER STROKE	= STRIP THICKNESS + PUNCH ENTRY INTO DIE + 1 = 3.15 + 1 + 1 **= 5.15mm**

Table 30: Stripper Stroke Calculations

Spring Total Length Calculations	
SPACE AVAILABLE	= COMPRESSED LENGTH + STRIPPER STROKE = 60 + 5.15 = 65.15mm
SPACE AVAILABLE	90% TO 95% OF THE TOTAL LENGTH (FREE LENGTH)

TOTAL LENGTH (FREE LENGTH)	$= \frac{\text{SPACE AVAILABLE}}{90\%}$ $= \frac{65.15}{0.9}$ **= 72.4mm**
Generally, Springs are available in steps of 5mm in length.	
TOTAL LENGTH (FREE LENGTH)	**= 70mm**

Table 31: Spring Total Length Calculations

Spring Constant Calculations	
COMPRESSED LENGTH	= 60mm
@60mm, we need the Push Force of 3531.6N	
SPRING CONSTANT	$= \frac{\text{PUSH FORCE}}{\text{SPRING STROKE}}$ $= \frac{\text{PUSH FORCE}}{\text{TOTAL LENGTH - COMPRESSED LENGTH}}$ $= \frac{3531.6}{70 - 60}$ $= \frac{3531.6}{10}$ = 353.16 N/mm
Select a Spring with Spring Constant ≥ 353.16 N/mm	

Table 32: Spring Constant Calculations

Spring Maximum Deflection Calculations	
MAXIMUM COMPRESSED LENGTH	= 60mm
TOTAL LENGTH (FREE LENGTH)	= 70mm
MAXIMUM DEFLECTION	$= \frac{\text{TOTAL LENGTH - COMPRESSED LENGTH}}{\text{TOTAL LENGTH}} \times 100$ $= \frac{70 - 60}{70} \times 100$ $= \frac{10}{70} \times 100$ = 14.29%
Select a Spring with an allowable deflection ≥ 15%	

Table 33: Spring Maximum Deflection Calculations

Spring Selection	
Free Length, L	**70mm**
Spring Constant, N/mm	**≥ 353.16 N/mm**
Maximum Allowable Deflection (% of Free Length)	**≥ 15%**
Inner Diameter, Di	17.5mm
Outer Diameter, Do	35mm
Spring Constant, N/mm	441 N/mm

Table 34: Stripper Spring Specifications

The stripper plate's 3D design, the die spring, and the shoulder bolt using Catia V5 are shown below.

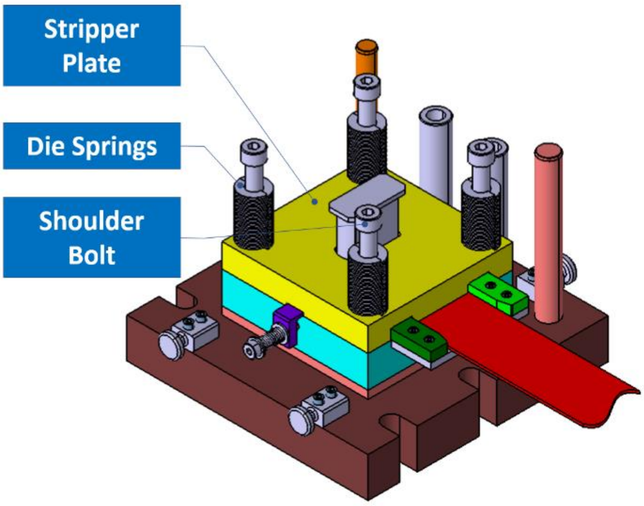


Figure 29: Stripper Plate, Stripper Springs, and Shoulder Bolt

6.4.13. Punch Holder

The Function of the Punch Holder is to Hold and Accurately Position the Punch.

The 3D design of the Punch Holder using Catia V5 is shown below.

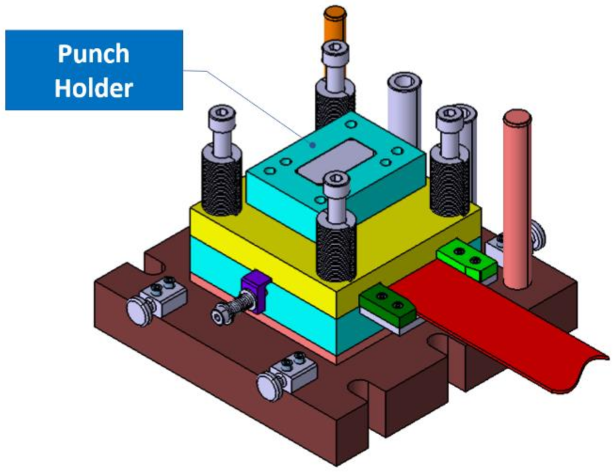


Figure 30: Punch Holder

6.4.14. Punch Back Plate

The Function of the Punch Back Plate is to Absorb the Force coming from the Punch.

The 3D design of the Punch Back Plate using Catia V5 is shown below.

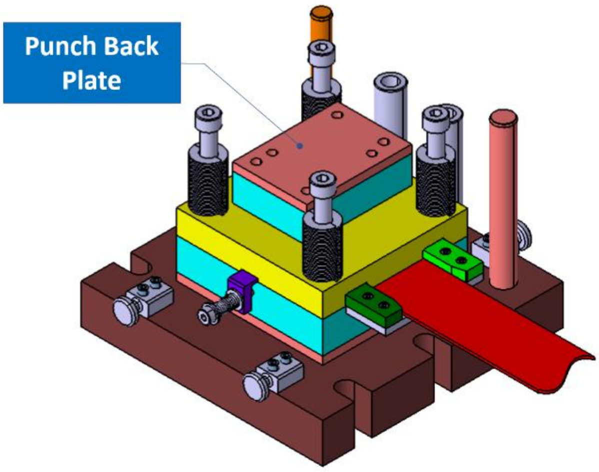


Figure 31: Punch Back Plate

6.4.15. Top Plate

The Function of the Top Plate is listed below

- Holds all the parts of the Punch Assembly.
- Absorbs the Force coming from the Punch and the Punch Back Plate.
- Used to Fasten the Punch Assembly to Press Slide / Adaptor Plate using U-Slots
- Has Provision to mount the Guide Bushes.

The 3D design of the Top Plate using Catia V5 is shown below.

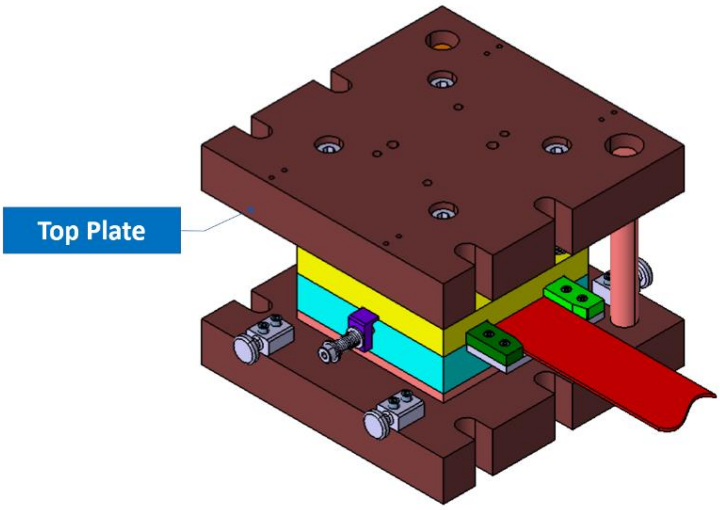


Figure 32: Top Plate

6.4.16. Guide Bush

Guide pillars and guide bushes are used to locate the die and punch assemblies.

The 3D design of the Guide bush using Catia V5 is shown below.

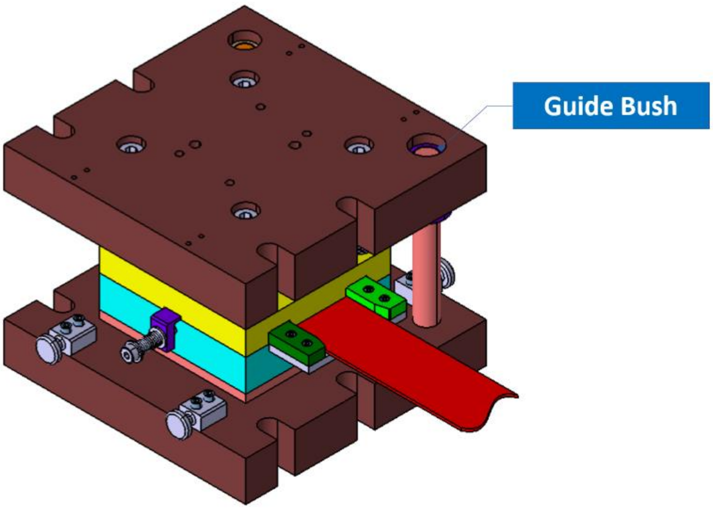


Figure 33: Guide Bush

6.4.17. Punch Assembly Lifting Hooks

The function of the lifting hooks is to lift the Punch assembly.

The 3D design of Lifting Hooks using Catia V5 is shown below.

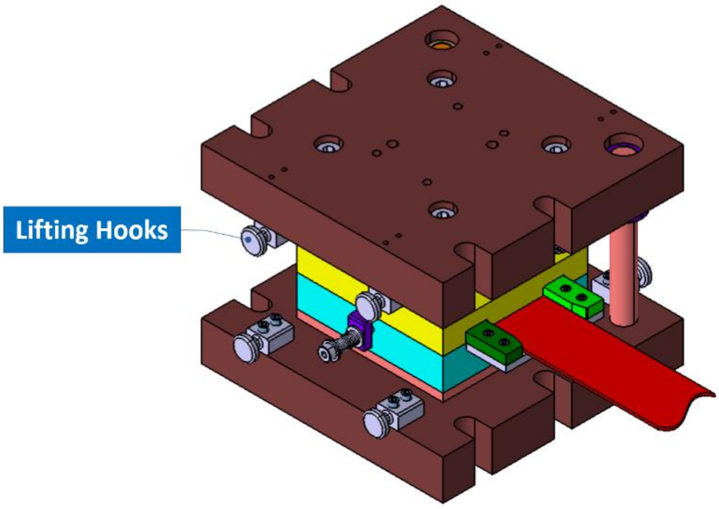


Figure 34: Punch Assembly Lifting Hooks

6.4.18. Screws and Dowels for the Punch Assembly

The screws are used to fasten, and the dowels are used to locate the functionally critical parts. Catalog parts in Catia V5 are used for the assembly.

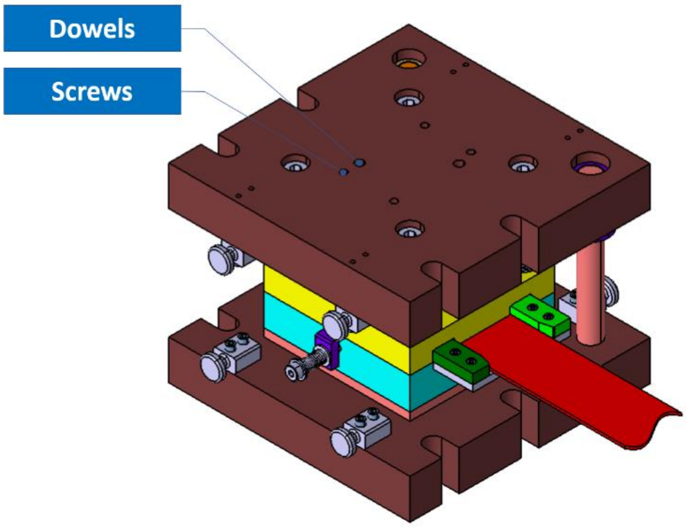


Figure 35: Screws and Dowels for Punch Assembly

7. Manufacturing Drawings

All the manufacturing Drawings, including the assembly drawings of the Press Tools, are shown in this chapter. The drawings are created using Catia V5.

7.1.1. Assembly Drawing (Sheet -1)

Insert the Assembly Drawing in this space

7.1.2. Assembly Drawing (Sheet -2)

Insert the Assembly Drawing in this space