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Research

Design of a 0.50 mm Al-Zn Sheet Metal Product and Development of Progressive Stamping Tool Design

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Abstract: The design of progressive stamping dies for sheet metal products is essential for achieving high-quality manufacturing with minimal waste. This paper provides a comprehensive analysis of the critical aspects involved in progressive die design, including material selection, die component optimization, strip layout, and efficient progression through multiple stations. By employing design-for-manufacturing (DFM) principles, the paper emphasizes the importance of streamlining processes to reduce part count, optimize material usage, and enhance product quality. Key elements such as pilot hole guidance, part ejection, and scrap removal systems are explored in depth to ensure reliability and cost-effectiveness. Advanced computational techniques, including computer-aided design (CAD), are utilized to simulate and optimize the stamping process, reducing production time and potential errors. The study further provides detailed calculations of blanking, punching, and bending forces, along with considerations for die plate deflection, stress, and strain. This analysis demonstrates the potential of progressive stamping dies to enhance manufacturing efficiency and product consistency, positioning the methodology as a crucial factor in modern sheet metal fabrication. The findings contribute to the growing body of knowledge on die design, offering practical insights for reducing downtime and improving operational precision.

Keywords: Progressive stamping dies, Design-for-manufacturing (DFM), Computer-aided design (CAD), Material selection, SolidWorks.

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Introduction

Progressive stamping die design for sheet metal manufacturing represents a highly specialized and intricate process that plays a crucial role in modern industrial production. Achieving optimal efficiency, precision, and cost-effectiveness requires not only a deep understanding of material behavior but also advanced methodologies in tool design and fabrication. As manufacturing processes continue to evolve, the importance of robust and adaptable progressive stamping dies has become increasingly significant in achieving consistent product quality while minimizing material waste and operational downtime [1] [2] [3].

This study provides a comprehensive exploration of the design and development of progressive stamping dies for 0.50 mm Al-Zn sheet metal, focusing on the fundamental principles that underpin high-performance tool design. It examines key aspects such as material selection and its influence on tool wear and durability, precision in die layout and station arrangement, and the engineering of efficient strip progression systems [4] [5]. Additionally, the research addresses the role of auxiliary systems, such as pilot hole guidance, part ejection mechanisms, and scrap removal, in ensuring uninterrupted production and maintaining product integrity [6] [7].

By integrating advanced design considerations with practical manufacturing constraints, this paper offers a detailed analysis of the interplay between die design elements and production outcomes. The findings emphasize the need for precise engineering decisions to enhance product reliability, reduce cycle times, and ensure cost-effective operations. The insights presented aim to contribute to the broader understanding of progressive stamping tool design, advancing both academic inquiry and industrial application [8] [9] [10].

2. Design for manufacturing (DFM):

Design for Manufacturing (DFM) is a set of principles and methodologies aimed at optimizing the product design process to ensure easy and cost-effective manufacturing. DFM focuses on simplifying the design, reducing part count, using standard components, and considering manufacturing capabilities and assembly requirements. By incorporating DFM principles early in the design phase, companies can reduce costs, improve product quality, and shorten time-to-market. Collaborating with manufacturers and planning for material efficiency, tolerances, testing, and serviceability are also essential aspects of successful DFM implementation.

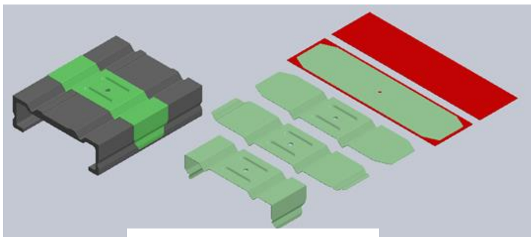


Figure: DFM

3. Strip Layout Optimization for Progressive Dies:

The optimization of strip layouts in progressive dies is critical for maximizing operational efficiency and product quality. Although individual operations within a progressive die may be straightforward, their combination across multiple stations demands a comprehensive approach. Achieving an optimal strip design requires meticulous attention to the sequencing of operations and the integration of tool movements. The following is a refined process for developing strip layouts, applicable to both manual and computer-aided design (CAD) methodologies [18] [20].

Step 1: Part and Material Analysis

Material and Thickness: Accurately assess the type and thickness of the material to anticipate tool wear and ensure operational compatibility.

Critical Dimensions: Identify and prioritize critical hole dimensions, form surfaces, and tolerance requirements[18].

Carriers and Material Flow: Strategically define where carriers can be attached and analyze the material grain direction to minimize distortions during forming operations.

Step 2: Tooling Requirements Evaluation

Production Volume: Establish production targets (monthly, annually, and lifetime).

Press Capabilities: Align die design with available press specifications, including bolster area, shut height, stroke rates, and other critical parameters.

Safety Protocols: Incorporate necessary safety measures to ensure operator protection and equipment longevity.

Step 3: Initial Dummy Drawings

Develop intermediate drawings that capture all key stages of part formation. These drawings should guide material flow and ensure that each forming stage facilitates the next with minimal material stress or distortion.

Step 4: Strip Layout Design

Design the strip layout to optimize material usage and station transitions. Properly account for metal flow, alignment, and the interaction between tools and material. This ensures continuous, error-free operation through successive stations[18].

Step 5: Peer Review and Validation

Present the preliminary strip layout for expert review. Conduct a thorough assessment using a standardized checklist to verify alignment, material flow, and tool wear considerations.

Step 6: Final Layout and Alignment

Refine the strip layout by tracing the part positions at each station and overlaying punch paths to ensure precision. Alignment between punches and dies should be flawless to reduce scaling errors and mechanical stresses during operations.

Step 7: Communication of Design Intent

Prepare detailed technical documentation, including plan views and annotations, for the die maker. Clear communication ensures that the design intent is fully understood, reducing the risk of misinterpretation during manufacturing.

Step 8: Critical Problem Areas

Proactively identify and address potential problem areas such as material misfeed, inadequate punch clearance, or excessive scrap generation. These issues should be mitigated in the design phase to prevent operational inefficiencies.

Step 9: Preliminary Design Approval

Obtain formal approval of the preliminary strip layout and associated design documentation before proceeding to final detailing. This ensures all stakeholders are aligned on the design specifications.

Step 10: Final Design Detailing

Complete the design with detailed specifications, including final part drawings, die assembly layouts, and component tolerances. Ensure the die is ready for tool fabrication with all aspects of operation and maintenance addressed.

Multi-operation in Layout: A layout of the sequence of operations for producing an actuator bracket is shown in Fig. Streep layout. In the first station the center hole is pierced. The hole is used to guide the strip for each successive operation and Side Cutting. In the second station, is forming around this Middle part, and the strip is Forming to a midline. In the third station Trimming for the right leg and the left leg occur. In station 4, similar slots are Notching and the central Position, as well as the completed the left leg and right leg is completely Notching. 5. They have Two Operations A. Piercing this hole again to guide the strip B. Two sides are forming in the sixth station Again completed the left leg and right leg is Forming. In station 7 the part is Bending the strip, the carrier tab on the left side is Bending, and the legs are Bend. In the 8 Station Again completed the left leg and right leg is Down bending. And The last 9 Station Notching the product and finally it's Released [19].

The layout is designed according to the notching forming bending process. Considering the convenience of operation and the simple structure of the mold, the waste layout design is adopted, the manual feeding method is adopted, and the guide pin and the retaining pin are used as the positioning elements.

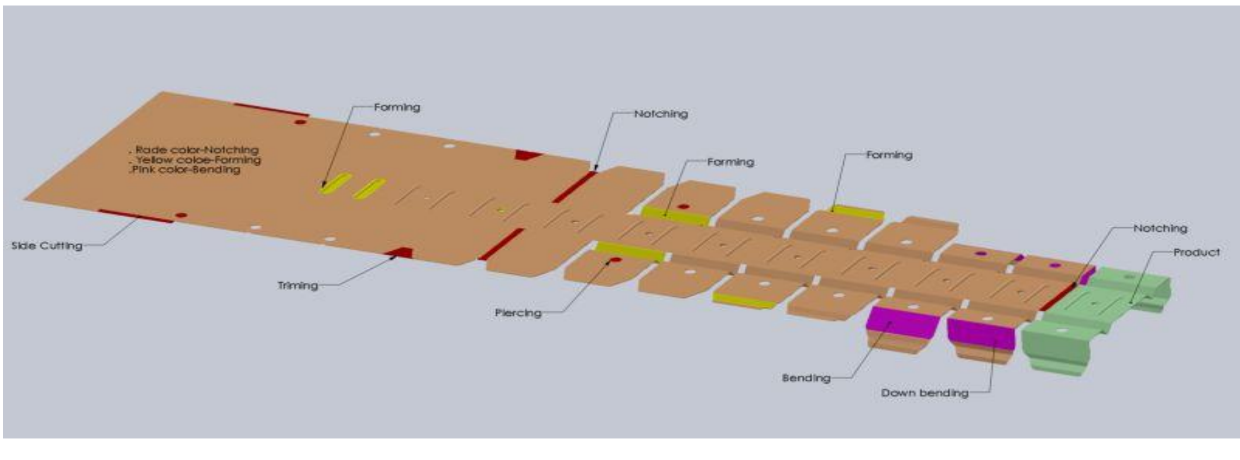


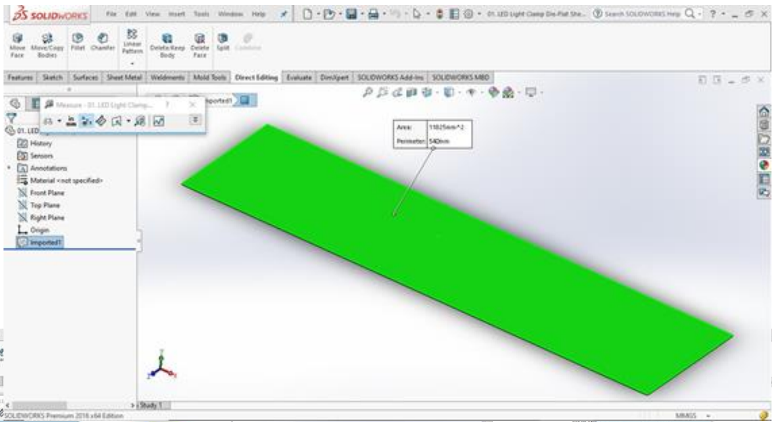
Figure: Streep layout

According to the Streep
Sheet Streep Wide: 215 mm
Feed length:55 mm
Sheet thickness: 0.5 mm

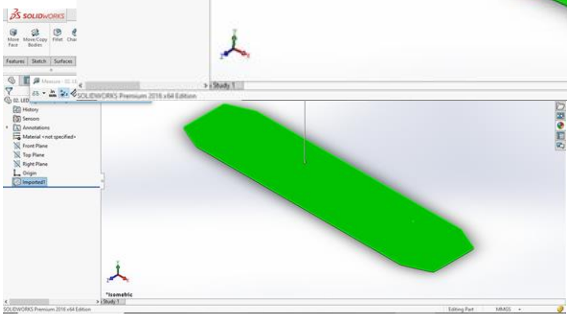
Strip width B: B=215+2*.5*1=216mm, strip step S: S=11+1.5=12.5mm [3]

Material selection: select a MS Sheet size of 55mmX215mm

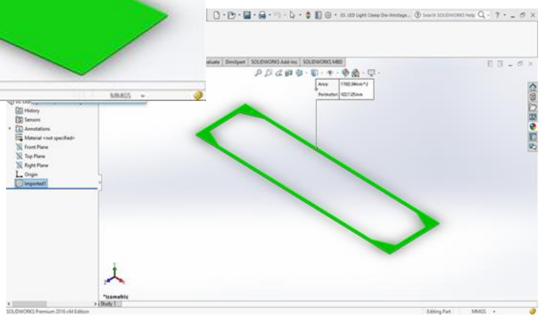
4.Economy Factor (West Calculation)



Area of Unit Product: 11825mm^2



Area of Unit Product : 10044.06mm^2



Area of Wastage: 1780.94mm^2

Flat Area (Fa)	Product Area (Pa)	Westage Area (Wa)
11825	10044.06	1780.94

% Of Westage	**15.1**	**%**

% of wastage calculate by ar-

Formula: $$\frac{Fa \times Pa}{Fa} \times 100$$

ea:(Thickness is same for sheet metal so no need to consider thickness)

5. DIE Calculation's:

5.1 Calculation of blanking force

According to, the blanking force F is:

F=1.3Lt τ （3-1）

L - outer contour circumference of the work piece, L=2 × (a+b) =2 × (725+347.5) =1072.5mm；

T - material thickness, t=0.5mm;

τ— The material shear strength (MS) τ= 350MPa;

F drop=1.3 × 2145mm × 0.5mm × 350MPa=487.98 kN。

5.2 Calculation of discharge force

According to the unloading force F can be obtained:

F unloading=K unloading F dropping (Streep)

K unloading - unloading force factor, K unloading=0.05;

F unloading=0.05 × 487.98≈24.4kN。

5.3 Punching force calculation

According to the punching force F can be obtained:

F impulse=1.3Lt τ

L - perimeter of the inner contour of the work piece, L=3.14 × 3=9.4mm；

F impulse=1.3Lt τ= 1.3 9.4 0.5 × 350≈2.14kN

5.4 Calculation of pushing force

According to [4], the pushing force F can be obtained:

F push=nK push F punch (3-4) [7]

K push - push force factor, K push=0.05;

N - number of work pieces stuck in the die;

F push=11 × 0.5 × 2.14= 1.18 kN

5.5 Calculation of impulse pressure

According to the above data, the impact pressure F is:

Flotel= Fdrop+Fimpact+Funload+Fpush=487.98+2.14+1.18+0.13=491.3 kN

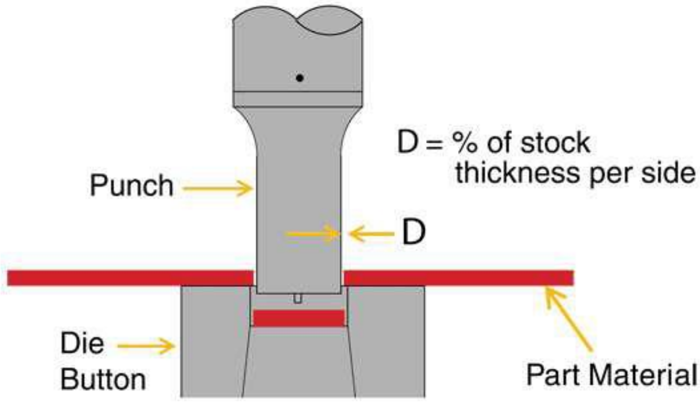
5.6 Pressure center

The shape of the part is rectangular symmetrical, and its pressure center is its geometric center

5.7 Cutting Clearance

The proper cutting clearance between the punch and die opening is necessary for the tool's long life.

A visual inspection of the punched components will indicate the amount of clearance and whether the punch Die have optimum cutting clearance or excessive clearance or misalignment.



Clearance Calculation

Clearance per side = C * t * √ (η max/10) [8]

Where C = constant

C = 0.005 (very accurate component)

C = 0.01 (normal component)

t = sheet thickness = 0.5 mm

Clearance per side = 0.01*0.5*√ (360/10)

Clearance per side = 0.03 mm per side

5.8 Plate thickness Calculation

Thickness of Die Plate, td = 3√Fs

Where Fs = Shear Force in Tones [5]

td = 3.569 cm

td = 35.69 mm

Thickness of Punch Holder Plate, = 0.5 * td =0.5*35.69

Thickness of Punch Holder Plate = =17.85mm

Thickness of Stripper Plate, = 0.75 * td=0.75*35.69

= 26.77 mm

Thickness of Bottom Plate, = 2 * td=2*35.69

= 71.92 mm

Thickness of Top Plate, = 1.5 * td =1.5*35.69

= 53.94 mm

6. Design of progressive die main plats

Progressive die CAD modeling is a precision engineering process used in manufacturing to design and create intricate metal or plastic components with high efficiency and accuracy. This method involves a series of tightly integrated stations within a single die, each performing distinct operations on the workpiece as it moves along the production line [11] [12].

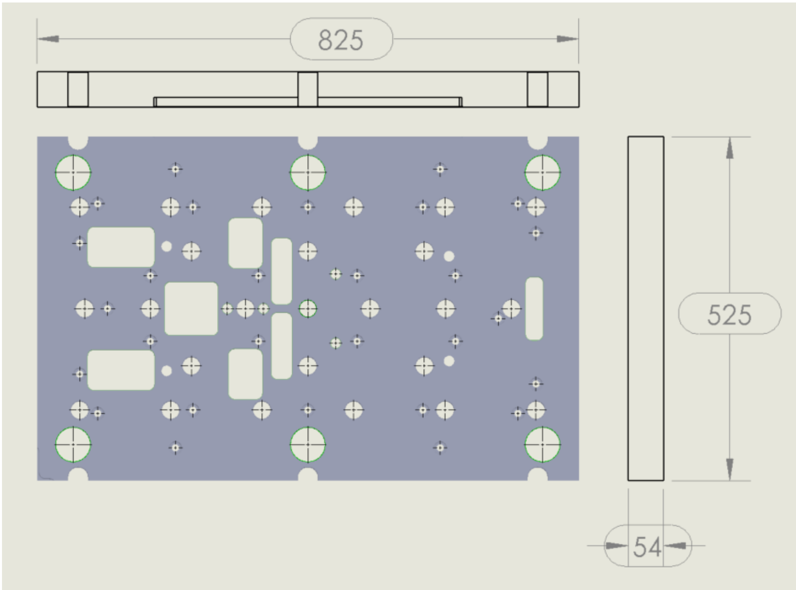
In CAD modeling for progressive die design, advanced software tools are employed to create a detailed virtual representation of the die and its components. Engineers use these models to define the layout of stations, the path of material progression, and the sequence of forming, cutting, bending, and other processes [13].

Key design considerations include optimizing material usage, reducing waste, and ensuring the dimensional integrity of the final product. The CAD model aids in simulating the entire production cycle, allowing for analysis and adjustments before physical production begins. Collaborative features of CAD software enable teams to work concurrently, enhancing overall design efficiency.

In conclusion, progressive die CAD modeling streamlines the manufacturing process, resulting in consistent, high-quality components while minimizing production time and costs.

Top/Bush Plate

Material : P20 Steel Plate
Thickness : 54mm
Plate X,Y : 825*525mm
Hardness : 62

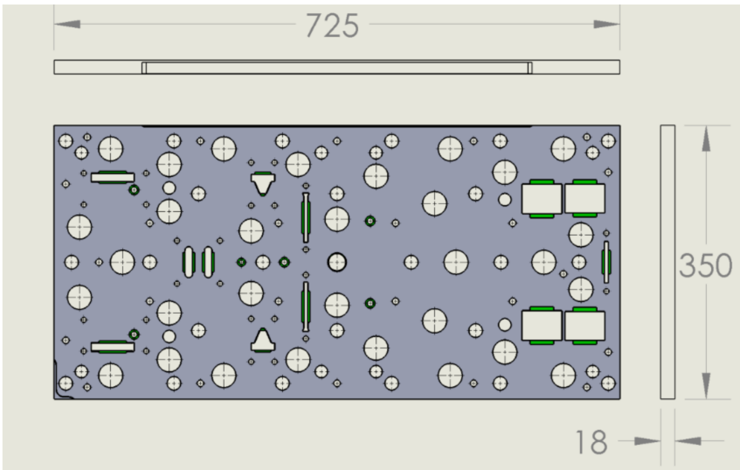


In a progressive die, the term "bush plate" is not commonly used. However, it is possible that you are referring to the plate that holds the guide bushings in the upper die set. The guide bushings work in conjunction with the guide pillars (also known as guide posts) to ensure proper alignment and stability between the upper and lower halves of the die during the stamping process. The working principle of the bush plate in a progressive die can be described as follows:

1.Guide bushing support
2.Alignment and stability
3. Smooth sliding motion
4. Consistent force transfer

Punch Plate

Material : P20 Steel Plate
Thickness : 18mm
Plate X,Y : 725*350mm
Hardness : 62

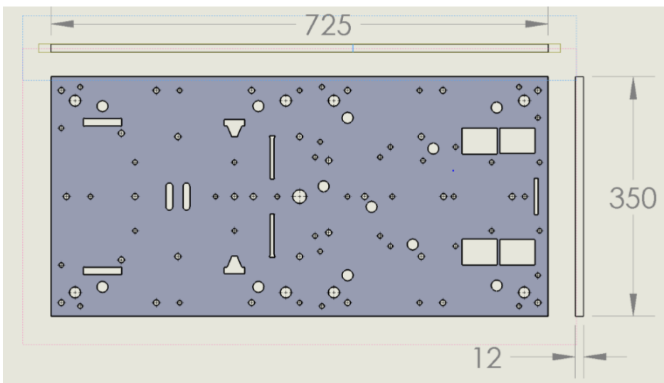


In a progressive die, the punch plate, also known as the punch retainer plate or punch holder, is an essential component that holds and supports the punches during the stamping process. The working principle of the punch plate in a progressive die can be described as follows:

1. Punch support and retention
2. Alignment and guidance
3. Force distribution
4. Punch mounting and retention
5. Structural integrity

Stripper Back Plate

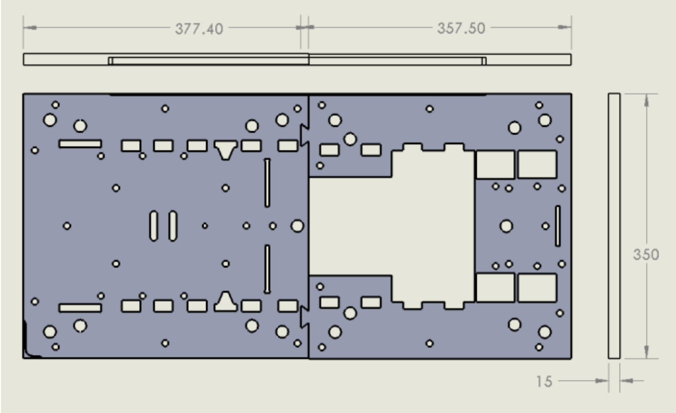
Material : P20 Steel Plate
Thickness : 12mm
Plate X,Y : 725*350mm



Hardness : 62

In a progressive die, the stripper back plate, also known as the support plate, is an essential component that provides support to the stripper plate during the stamping process. The working principle of the stripper back plate in a progressive die can be described as follows:

1. Support for stripper plate
2. Force distribution
3. Alignment and guidance
4. Spring or gas spring support
5. Structural integrity



Stripper Plate 01,02

Material : P20 Steel Plate

Thickness : 15mm

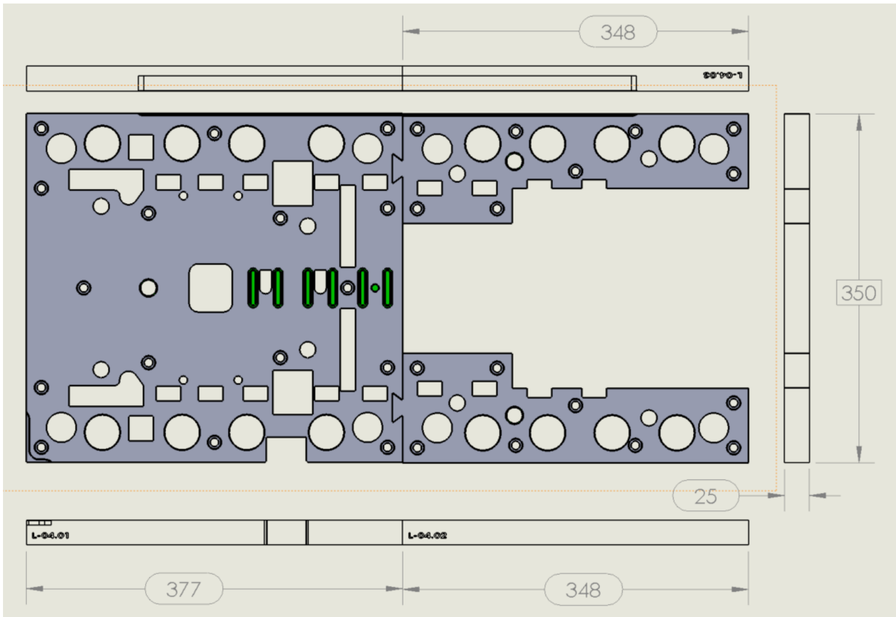
Plate 01 X,Y : 377*350mm

Plate 02 X,Y : 357.50*350mm

Hardness : 62

The stripper plate, also known as the blank holder or strip retainer, is an essential component in a progressive die. Its primary function is to hold the metal strip in place and prevent it from lifting or springing back during the stamping process, especially during cutting or forming operations. The working principle of the stripper plate in a progressive die can be described as follows:

1. Strip retention
2. Spring-back prevention
3. Ejection assistance
4. Punch guidance
5. Adjustable pressure



Die Plate 01,02,03

Material: P20 Steel Plate

Thickness: 25mm

Plate 01 X, Y: 377*350mm

Plate 02,03 X, Y: 348*350mm

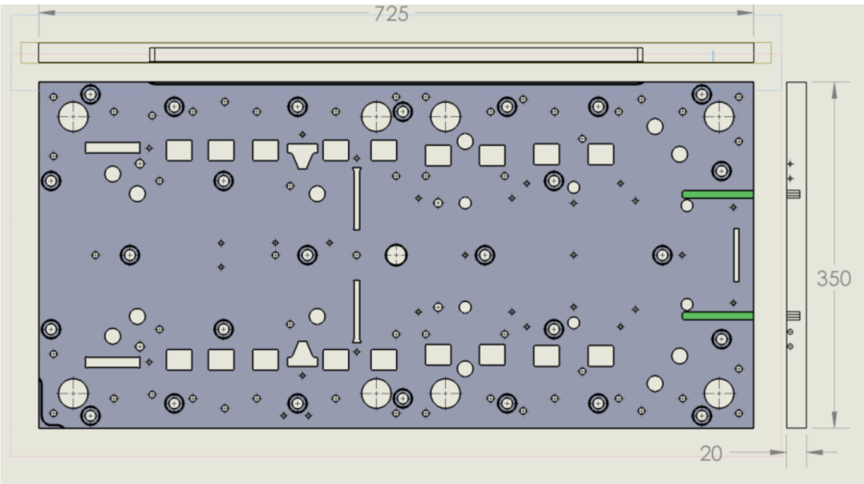
Hardness: 62

The die plate is a crucial component of a progressive die. It's a flat piece of material, often made of steel, where the various cutting and forming components are mounted. The die plate holds the different cutting and forming dies, punches, and other tools necessary for each station's operation.

Die back Plate

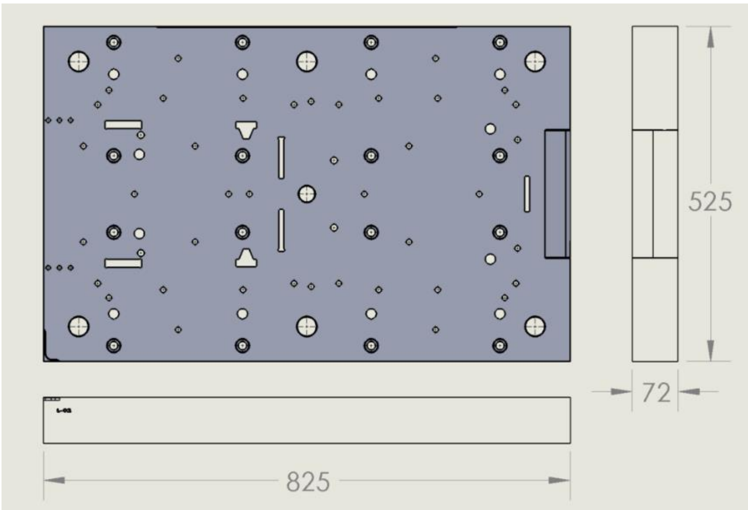
In a progressive die, the die back plate, also known as the die retainer plate or pressure plate, is an essential component that provides support and stability to the die components during the stamping process. The working principle of the die back plate in a progressive die can be described as follows:

1. Support and stability
2. Force distribution
3. Alignment and guiding
4. Component mounting and retention
5. Material support



Material: P20 Steel Plate
Thickness: 20mm
Plate: X, Y : 725*350mm
Hardness: 62

Bottom Plate

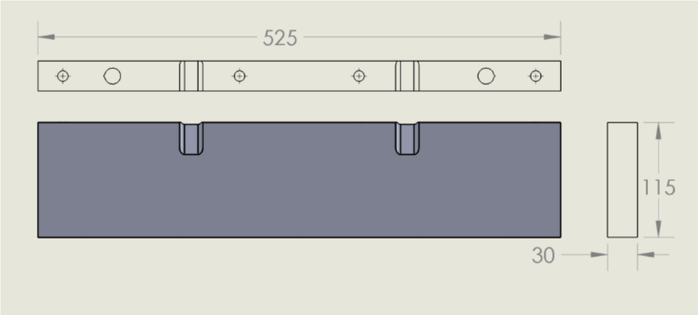


Material : P20 Steel Plate
Thickness : 72mm
Plate : X,Y : 825*525mm
Hardness : 62

In a progressive die, the term "Bottom Plate" typically refers to a component that is part of the guiding system, which includes guide pillars (also known as guide posts) and guide bushings. The guiding system ensures proper alignment and stability between the upper and lower halves of the die during the stamping process.

1. Alignment and stability
2. Smooth sliding motion
3. Consistent force transfer
4. Minimizing lateral movement

Foot Plate



Material: MILD STEEL
Thickness: 30mm
Plate 1,2,3,4: X,Y : 525*115mm
Hardness: 52

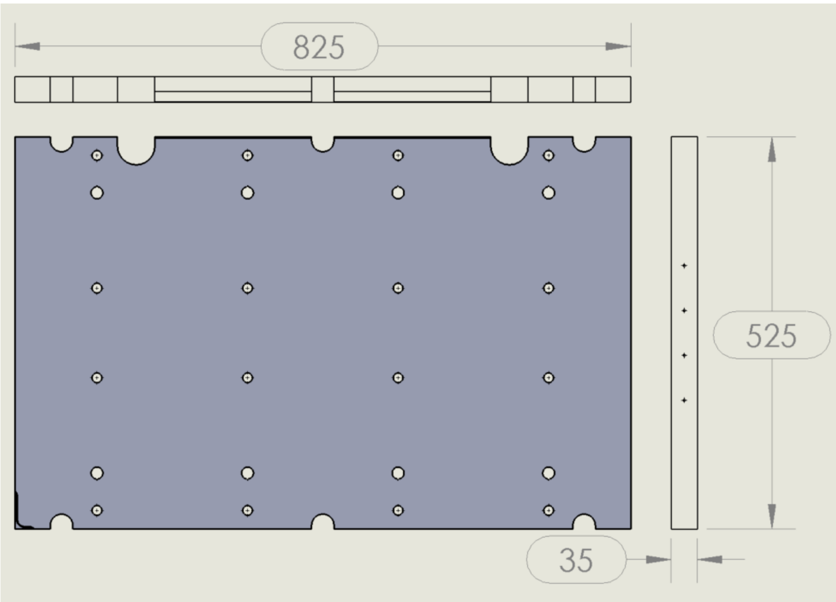
The foot plate, also known as the kick out plate, is an essential component in a progressive die. Its primary function is to eject finished parts or scrap material from the die during the stamping process. The working principle of the foot plate in a progressive die can be described as follows:

1. Ejection of Notching parts
2. Scrap removal
3. Timing and synchronization
4. Adjustable force and stroke

Lower Base Plate

In a progressive die, the lower base plate, also known as the die shoe or lower die set, plays a crucial role in ensuring proper alignment, stability, and support during the stamping process. The working principle of the lower base plate in a progressive die can be summarized as follows:

1. Support and stability
2. Alignment
3. guidance and progression
4. Scrap and slug removal
5. Die mounting



Material: MILD STEEL
Thickness: 35mm
Plate: X,Y : 825*525mm
Hardness: 52

Calculation for Cutting Force:

Sheet thickness, t = 0.5 mm

Material, M.S (Component)

Shear Strength, η = 360 N/ mm2
Perimeter of component, P = 372.10 mm
Cutting Force, F = η * P * T
= 66978 N
Safety Factor = F * F.O.S
= 66978 * 1.2
= 80373.6 N
= (80373.6/9.81) Kg
Weight of Component = 8.19 TONNES

Calculation for Bending Force:

The correct option is A 4
Die opening W =55mm

thickness of sheet, t =0.5mm

For a wiping die, K = 2.66

Length of the bent part, L=725mm

Bending force, Fb=kLσt2W=2.66××725×(0.5)55=3506.36 kN
= 0.3575 tn

Calculation for Theoretical Stress Strain and Deformation for Die Plate:

Die plate is considered as a fixed supported beam and therefore,
DEFLECTION, δ = (F L3) / (192EI)
Where,
F = 80% of the Cutting Force
F = (Shearing Strength Factor * Cutting Force)
F = 53582.4 N
SHEARING STRENGTH FACTOR = Cs = 0.8
L = Length of the die plate = 725mm
E = Young's Modulus of elasticity = 2 * 10^5 N/mm2
I = Moment of Inertia = (b*h3)/ 12
b = Width of Die plate = 347.50
h = t = thickness of Die plate =20 mm
I = (bh3)/12 = 231666.67 mm4
Deflection, δ = (53582.4 * 725) / (192 * 2 * 105 * 231666.67)
δ = 2.30 mm
Stress, ζ = F/A = (80% of cutting force) / (cross sectional area of Die set)
ζ = (53582.4) / (251937.5)
ζ = 0.21 N / mm2

Strain, ε = deflection / length of Die plate

ε = 0.21/725

ε = 2.93 * 10-4

7.Inserts Tool's

Tool of notching: Notching punch: A notching punch is a cutting tool used in the sheet metal fabrication process to create notches, cutouts, or slots in a work piece. It is typically made of hardened tool steel or carbide to withstand the cutting forces and resist wear. The notching punch works in conjunction with a die to shear away material from the sheet metal. Key components and aspects of a notching punch include:

Punch body: The main structure of the punch, designed to withstand the cutting forces and transmit them to the sheet metal work piece.

Punch tip: The cutting edge of the punch, responsible for shearing the material. The geometry of the tip, such as its cutting angle and sharpness, is critical to achieving clean, precise notches.

Punch clearance: The gap between the punch and the die, which allows the sheared material to pass through. Proper clearance is important for minimizing burrs, reducing cutting force, and prolonging tool life.

Punch alignment: The alignment of the punch and the die is crucial for ensuring accurate, consistent notches. Misalignment can result in uneven wear, poor cut quality, and increased cutting force.

Material selection: The punch material should be strong, wear-resistant, and able to withstand the cutting forces. Common materials include SKD 11.

Press type: Notching punches are used with various types of presses, such as mechanical, hydraulic, or pneumatic presses, which provide the force necessary for the punching operation. To ensure the best results with a notching punch, it is important to properly maintain and sharpen the punch tip, select the appropriate punch material and geometry, and ensure proper alignment with the die. By doing so, you can achieve clean, precise notches in sheet metal parts with minimal defects and optimal tool life

All Notching Upper Tool Here,

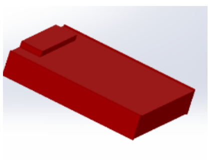


Figure: Step 01 Left Notching Punch

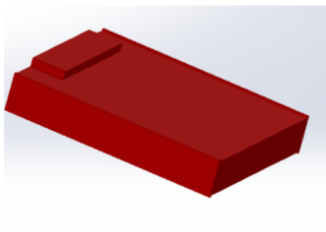
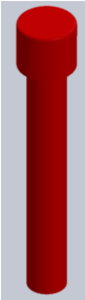


Figure: step 1 right notching punch

M6x3 Folding Notching Punch



M8 Locating Pin Notching Punch

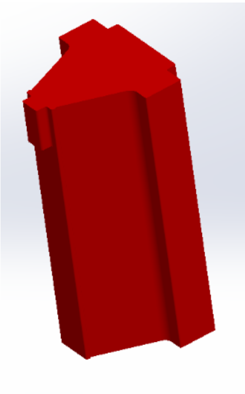
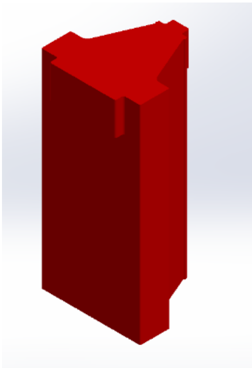


Figure: Step 04 Right Notching Punch



Step 04 Left Notching Punch

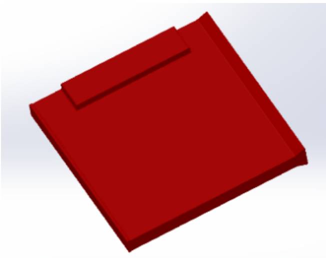


Figure: Step 05 Right Notch Punch

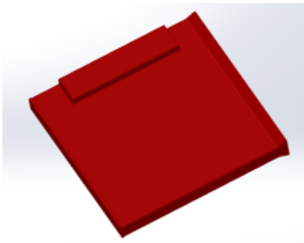
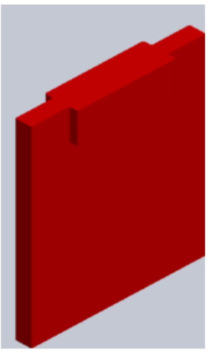
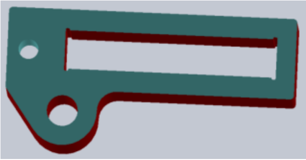


Figure: step Left Notching Punch

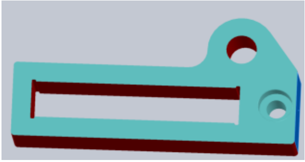


Final Parting Notching Punch

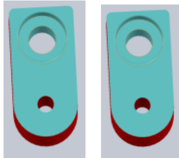
All Notching Lower Tool Here



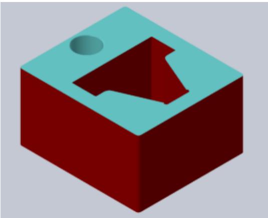
Step 01 Left Punch Die Insert



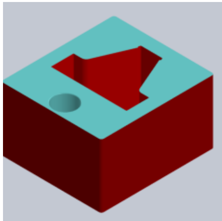
Step 01 Right Punch Die Insert



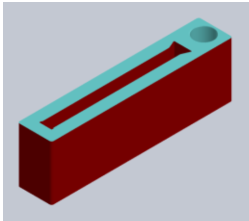
Step 03 Middle Folding Punch Die Insert



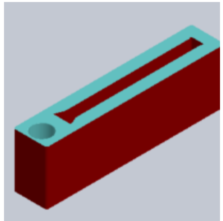
Step 04 Left Punch Die Insert



Step 04 Right Punch Die Insert



Step 06 Left Punch Die Insert



Step 06 Right Punch Die

The primary purpose of a middle forming die insert is to shape or deform the sheet metal work piece into the desired geometry. Forming operations can include bending, drawing, flanging, or any other process that changes the shape of the sheet metal without cutting it. Key aspects of a middle forming die insert include:

Insert material: The die insert material should be wear-resistant, strong, and able to withstand the forming forces. Common materials SKD11

Insert geometry: The geometry of the insert should be designed to match the desired shape and dimensions of the formed part. This may include features such as radii, angles, and contours specific to the forming operation.

Surface finish: The surface finish of the insert is crucial for achieving the desired quality of the formed part. A smooth and polished surface can help reduce friction, minimize material sticking, and improve the overall appearance of the formed part.

Alignment and fit: Proper alignment and fit of the insert within the die assembly are essential to ensure accurate and consistent forming results.

Ease replacement: Since die inserts are subject to wear and may need to be replaced periodically, it is important to design the insert and the die assembly to allow for easy removal and replacement.

Using a middle forming die insert as part of a multi-stage stamping process allows for greater flexibility and customization, as the insert can be easily replaced or modified to accommodate different forming operations or part geometries. Proper design, material selection, and maintenance of the insert are essential for achieving optimal forming results and prolonging the life of the tooling.

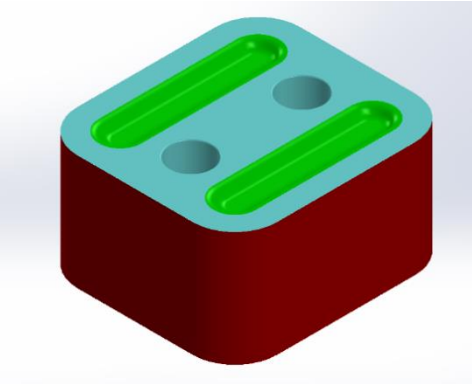
All Mid

Forming

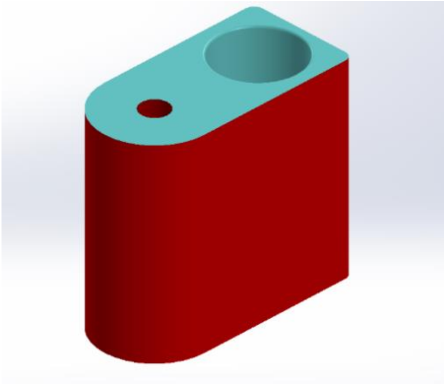
Punch Tool:

Capsule Forming Punch 01 M8x5.2 Folding Punch Capsule Forming Punch 02

Mid Forming Lower Tool



step 2 Middle forming die insert



step 2 Middle forming die insert

Middle **V** bending die insert: A middle bending die insert in a progressive die refers to a removable and replaceable component within a die assembly specifically designed for the bending operation in a multi-stage stamping process. The term "middle" indicates that this insert is used in an intermediate stage of the process, rather than at the beginning or the end. The primary purpose of a middle bending die insert is to bend or fold the sheet metal work piece into the desired geometry during the stamping process.

Key aspects of a middle V bending die insert in a progressive die include:

Insert material: The die insert material should be wear-resistant, strong, and able to withstand the bending forces. Common materials include SKD11

Insert geometry: The geometry of the insert should be designed to match the desired bend angle and radius for the specific bending operation. This may include features such as V-shaped grooves, channels, or other forms that guide the sheet metal during bending.

Surface finish: The surface finish of the insert is important for achieving the desired quality of the bent part. A smooth and polished surface can help reduce friction, minimize material sticking, and improve the overall appearance of the bent part [17].

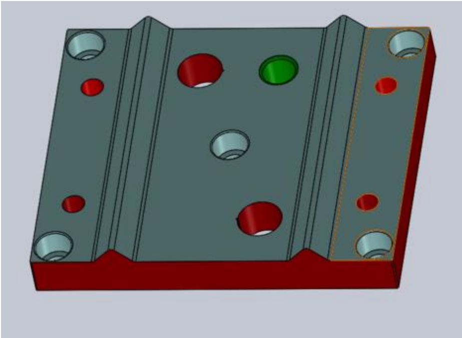
Insert coatings: Some inserts may be coated with materials like titanium nitride (TiN) or titanium carbonatite (TiCN) to improve wear resistance, reduce friction, and extend tool life.

Alignment and fit: Proper alignment and fit of the insert within the die assembly are essential to ensure accurate and consistent bending results.

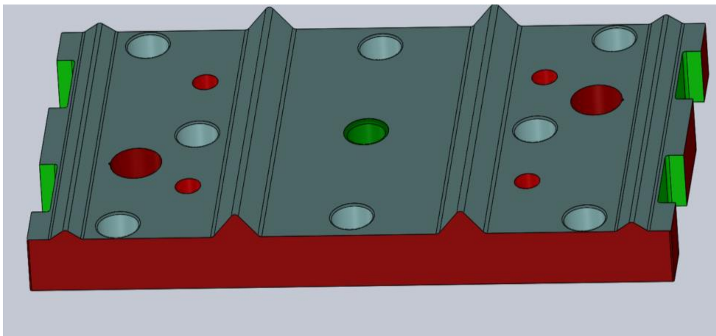
Ease of replacement: Since die inserts are subject to wear and may need to be replaced periodically, it is important to design the insert and the die assembly to allow for easy removal and replacement.

Using a middle V bending die insert as part of a progressive die allows for greater flexibility and customization, as the insert can be easily replaced or modified to accommodate different bending operations or part geometries. Proper design, material selection, and maintenance of the insert are essential for achieving optimal bending results and prolonging the life of the tooling.

Mid V Bend Punch Tool Here,

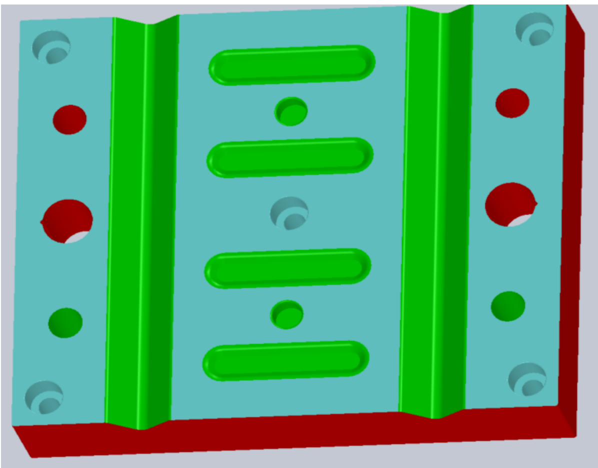


Stripper Insert for 1st V bend

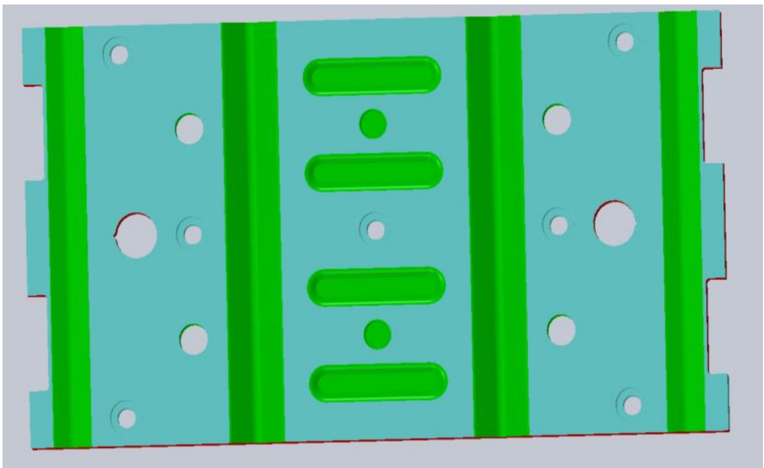


Stripper Insert for 2nd V bend

Mid V Bend Lower Tool



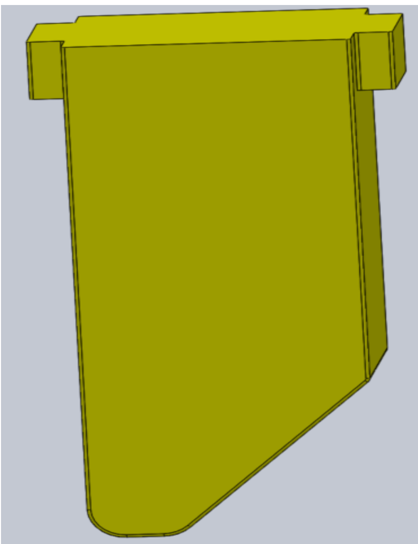
Step 07 Middle Bending Die Insert

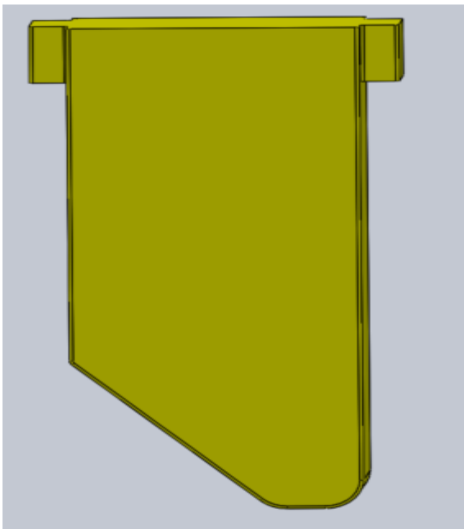


Step 08 Middle Bending Die Insert

FINAL Bending punch: A bending punch in a progressive die is a specific tool used for bending or folding sheet metal work pieces within a multi-stage stamping process. The punch works in conjunction with a die to create the desired bend angle and radius. This tool is an essential part of the progressive die assembly, which is designed to perform multiple operations, such as cutting, forming, and bending, on a sheet metal work piece as it moves through the various stages of the die [16].

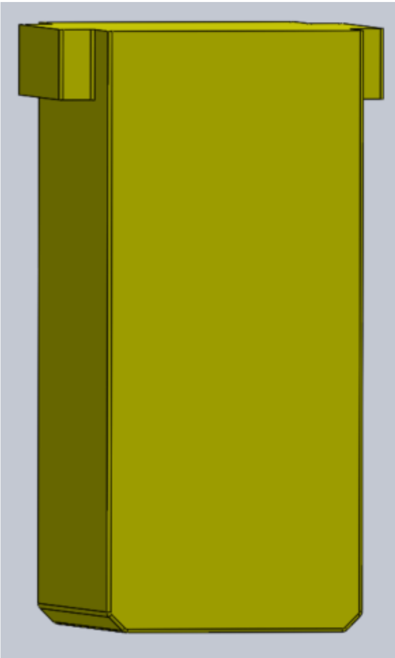
Using a middle bending die insert as part of a progressive die allows for greater flexibility and customization, as the insert can be easily replaced or modified to accommodate different bending operations or part geometries. Proper design, material selection, and maintenance of the insert are essential for achieving optimal bending results and prolonging the life of the tooling.



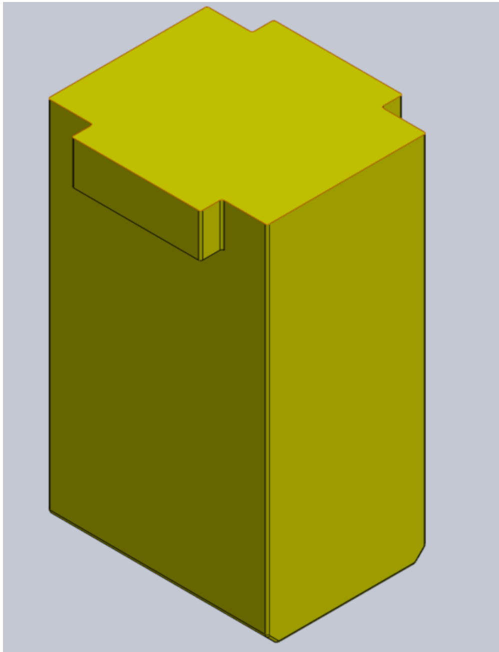


Step 08 Right Bending Punch

Step 08 Left Bending Punch



Step 09 Right Bending Punch



Step 09 Left Bending Punch

Progressive Die full assembly description:

After completing the complete tool design we start the assembly the die. A complete die is divided by following way: -

Chapter 01. Metal Plates

Main metal plates are divided by following way (from lower to upper)

1. Die Shoe/Lower/Bolster Shoe
   - **1.1** Lower Base (Bolster) Plate
   - **1.2** Foots/Lower Die Height Plates
   - **1.3** Pillar Plate
   - **1.4** Die Back Plate (s)
   - **1.5** Die Plate (s)
2. Upper/Slider Shoe
   - **2.1** Stripper Shoe
     - **2.1.1.** Stripper Plate (s)
     - **2.1.2.** Stripper Back Plate (s)
   - **2.2** Punch Shoe
     - **2.2.1** Punch Holding Plate (s)
     - **2.2.2** Punch Back Plate (s)

2.2.3 Bush Plate

2.2.4 Foots/Upper Die Height Plates

2.2.5 Upper Base (Slider Plate)

Chapter 02. Accessories

Accessories help complete the die with joining each other plates.

Chapter 01. Metal Plates:

A figure below shows the main portions of a progressive stamping die

Fig 1.1: Progressive Stamping Die (Front View)

1. Die Shoe/Lower/Bolster Shoe:

Die Shoe/Lower/Bolster Shoe contain the lower part of die which is attached with lower base of the press machine and its fixed part and no movement of this part during operation. Some ejector pin and strip may move but as a whole part, this portion is not moving. It contains some plates with accessories.

Fixing mechanism:

1. Lower base (Bolster) Plate is connected with Foots/Lower Die Height Plates with Ø16 mmx75 mm Dowell pin and M16x50 cap head screw.
2. Pillar Plate is connected is connected with Foots/Lower Die Height Plates with Ø16 mmx75 mm Dowell pin and M16x50 cap head screw.
3. Die Back Plate (s) is connected with Pillar Plate with Ø16 mmx40 mm Dowell pin M12x40 cap head screw.

4. Die Plate (s) is connected with Die Back Plate (s) with Ø12 mmx30 mm Dowell pin M10x30 cap head screw.
5. Die Insert (s) is connected with Die Plate (s) with Ø10 mmx40 mm Dowell pin M6x40 cap head screw.

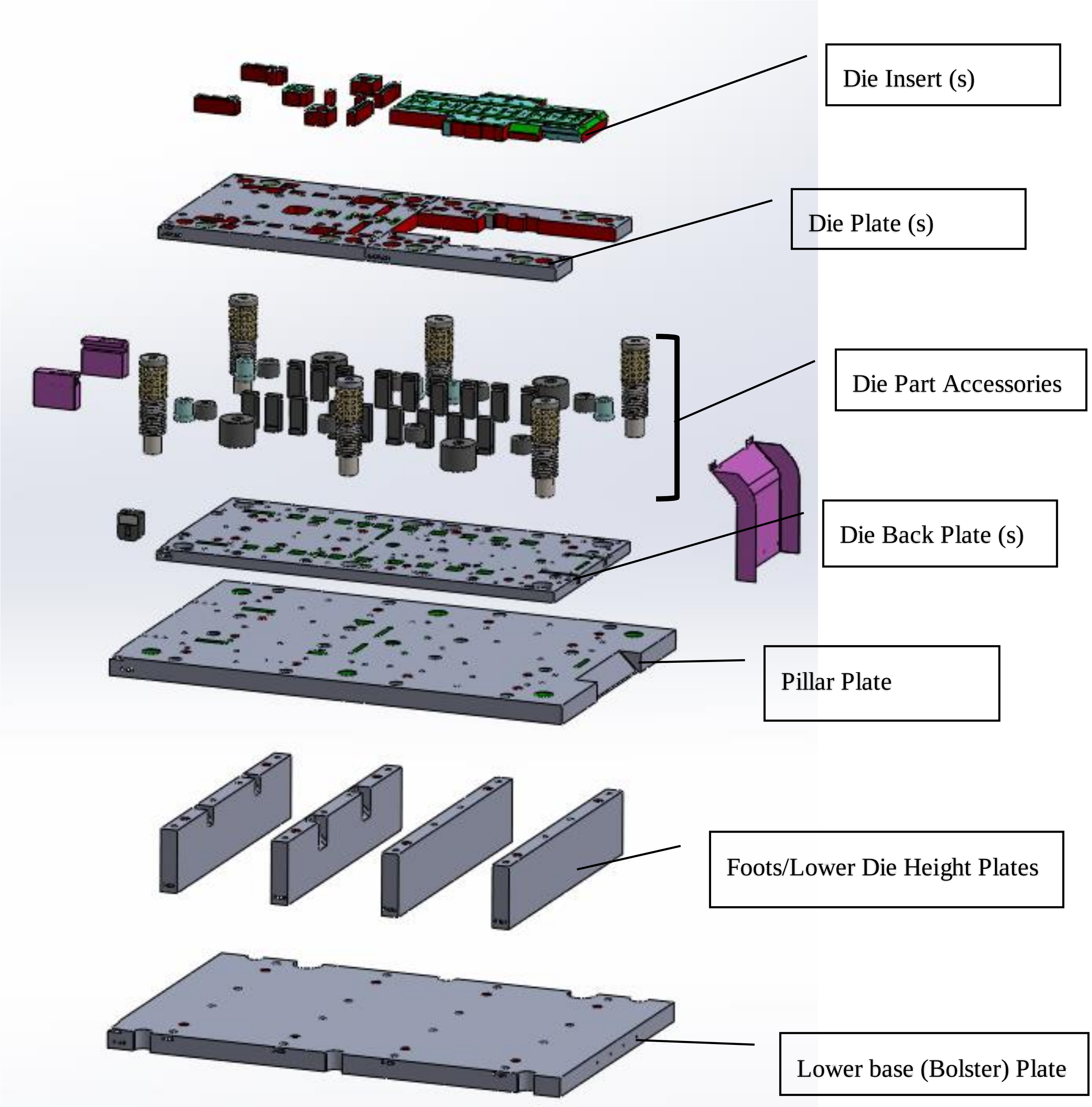


Fig: 1.2: Assembly of Die Shoe/Lower/Bolster Shoe

2. Upper/Slider Shoe

2.1 Stripper Shoe: Stripper shoe is moving with upper/slider shoe and hanging with punch shoe. Some springs contains in between stripper back plate and punch holding plate. Spring creates pressure one stripper plate and level up the punches before stroke and when Top dead center (TDC) goes to Bottom dead center (BDC) stripper plate touches the strip upper surface and strip goes down to die surface to complete a working stroke. When striper plate placed the strip on die surface then press is going on and spring is compressed and all punches activated for operation. After that punch shoe goes down till the limit touches and stripper shoe act as fixed plate in die plate.

Fixing mechanism:

1. Stripper Back Plate is connected with Stripper Plate Plates with Ø10 mmx50 mm Dowell pin and M10x50 cap head screw.
2. Stripper Plate Inserts is connected is connected with Stripper Back Plates with Ø8 mmx50 mm Dowell pin and M08x50 cap head screw.

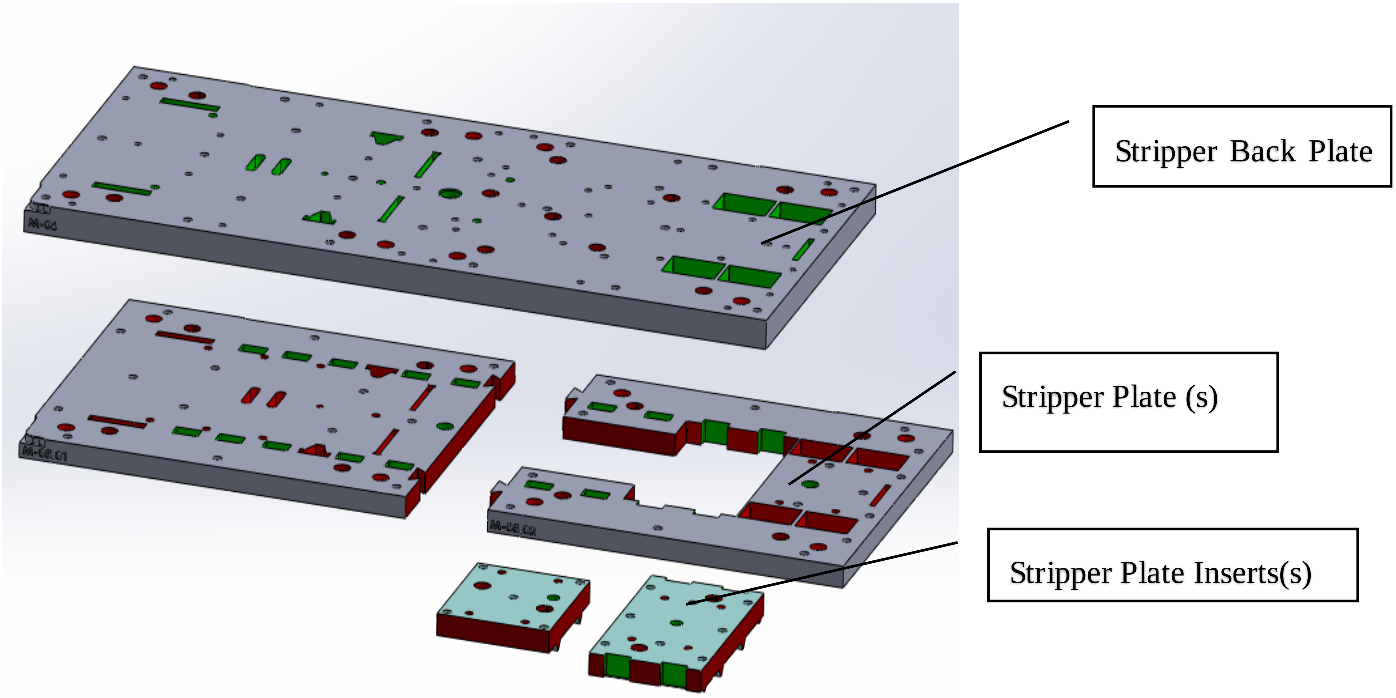


Fig: 1.3: Assembly of Stripper Shoe

1.1 Punch Shoe:

Punch Shoe contains the upper part of die which is attached with slider base of the press machine and its moving part and always moves up and down direction to complete a successful stroke during operation. All the punches move up and down with this shoe.

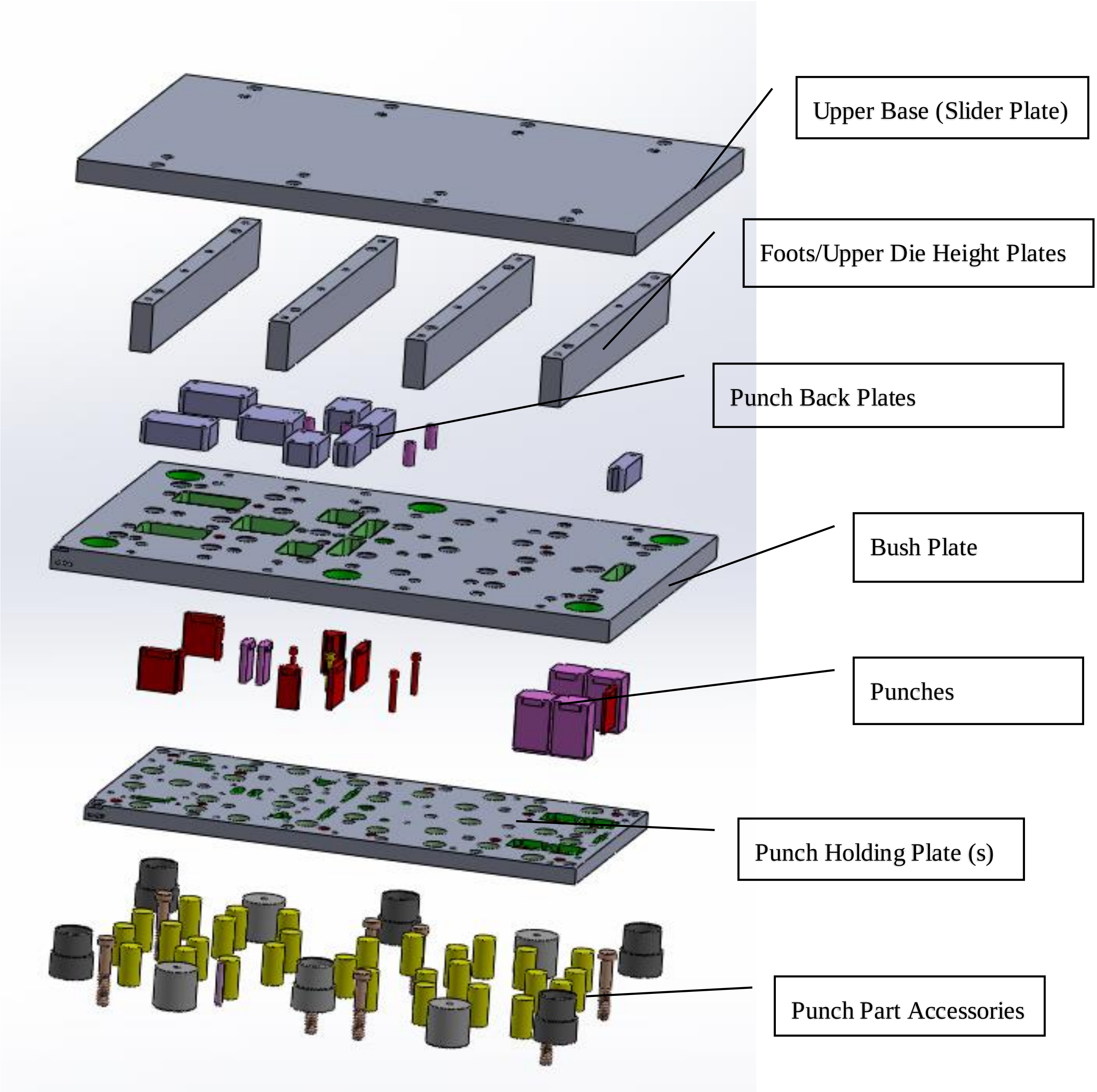


Fig: 1.3: Assembly of Stripper Shoe

Fixing mechanism:

1. Upper base (Slider) Plate is connected with Foots/Lower Die Height Plates with Ø16 mmx75 mm Dowell pin and M16x50 cap head screw.
2. Bush Plate is connected is connected with Foots/Lower Die Height Plates with Ø16 mmx75 mm Dowell pin and M16x50 cap head screw.
3. Bush Plate is connected with Punch holding Plate with Ø12 mmx40 mm Dowell pin M10x40 cap head screw.
4. Punch back plate (s) relates to Punch holding Plate with Ø10 mmx50mm Dowell pin M8x50 cap head screw.

Finally Stripper Shoe is connected with Punch shoe by a bush and a M10 cap head screw.

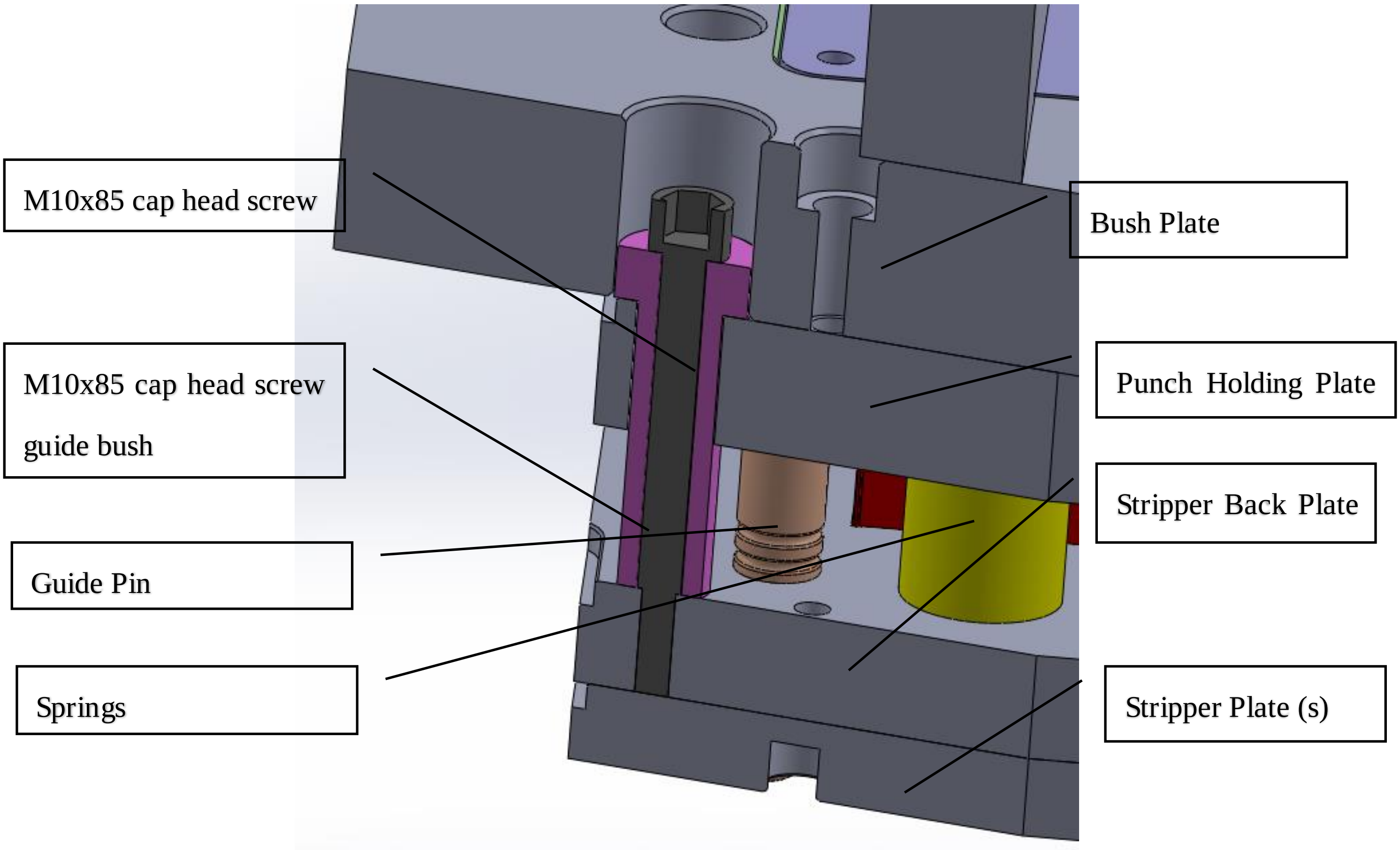


Fig: 1.4: How stripper shoe hanged with punch shoe

Accessories:

Start guideway

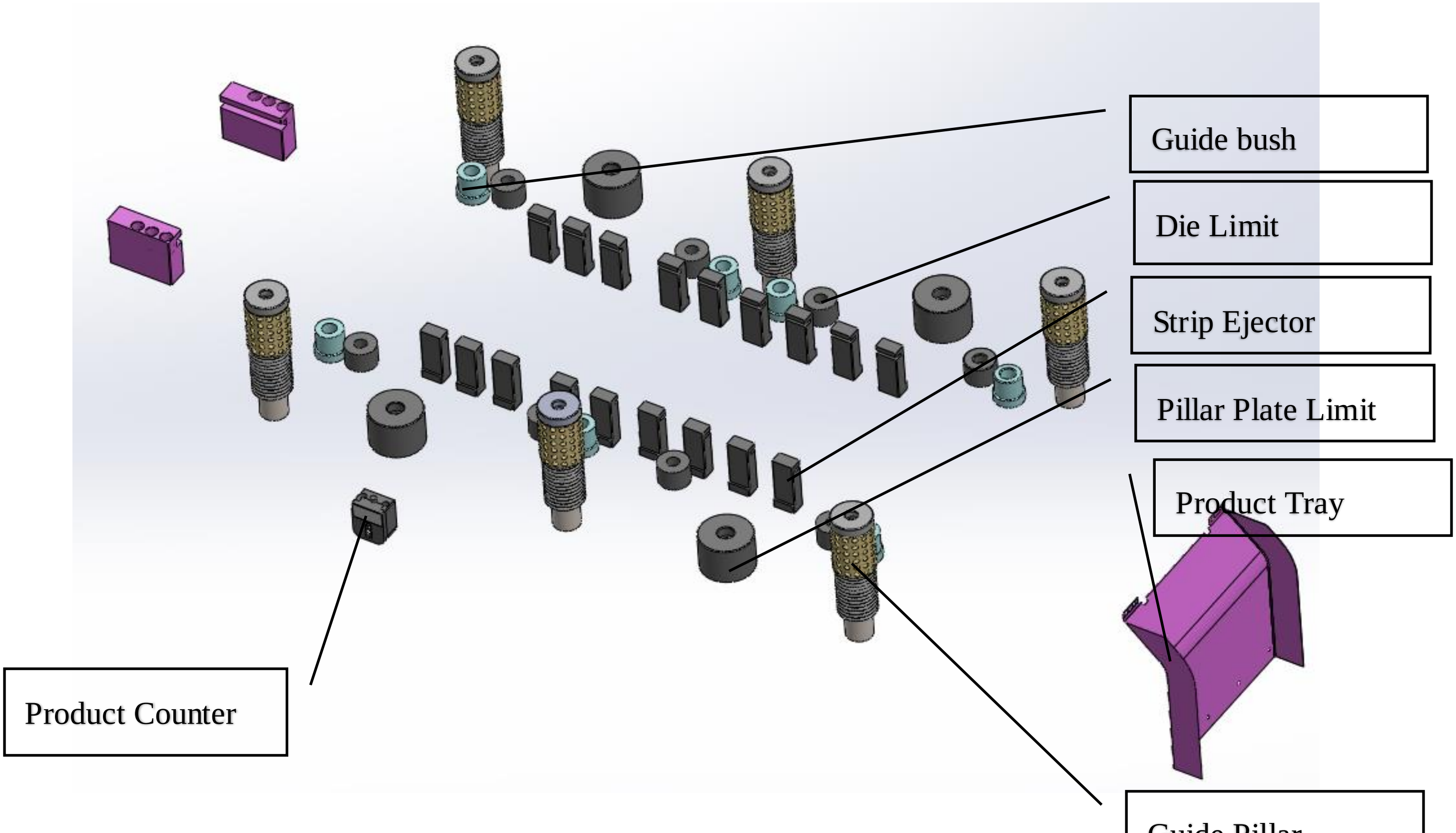


Fig: 2.1: Die Shoe Accessories

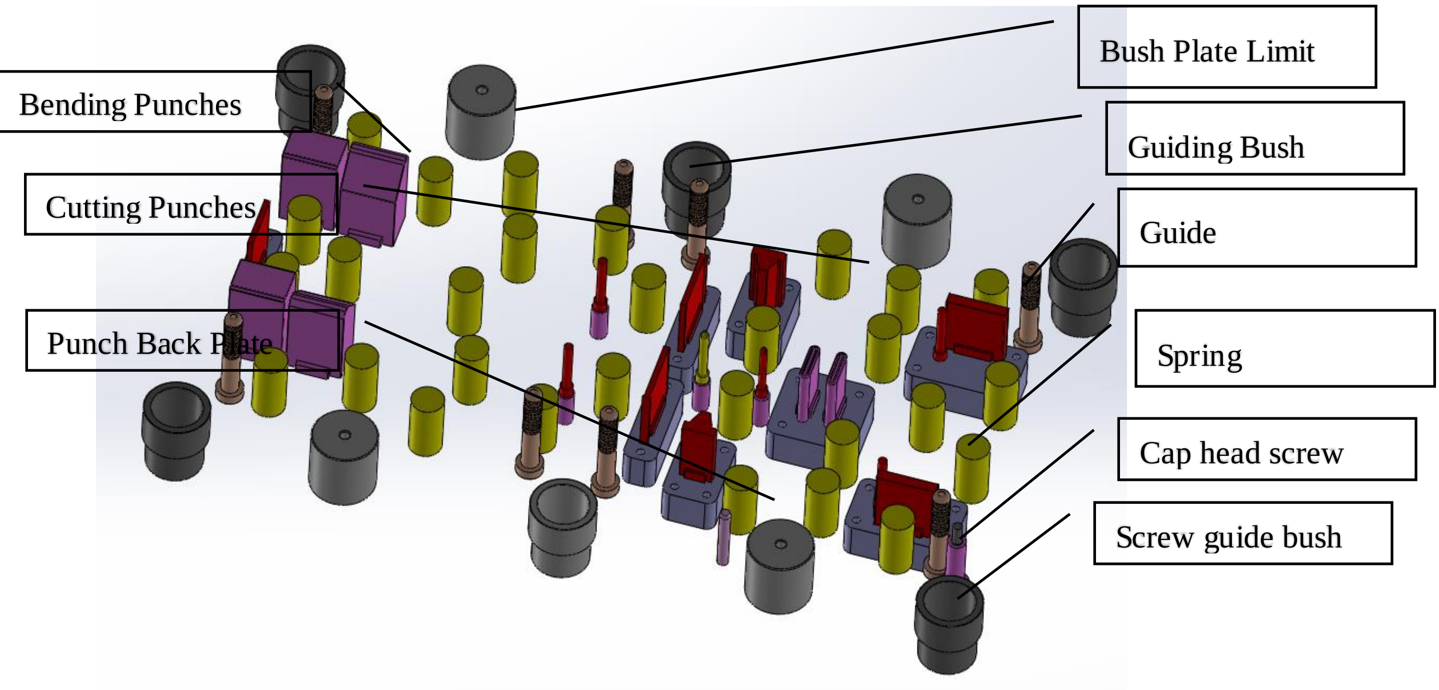


Fig: 2.2: Punch Shoe Accessories

DIE closing height

Closing height of DIE H= 350 mm

Selection of stamping equipment

According to the total punching pressure, the closing height of the die, the size of the punch table, and in combination with the existing equipment, J23-6.3 open double-column tilting press. The main technical parameters are as follows:

Nominal pressure: 200 Ton

Slide stroke: 35 mm

Maximum closing height: 315mm

Closing height adjustment: 25mm

Handle hole size: 50mm

Maximum inclination of bed: 5 Degree

Conclusions:

This study provides an in-depth exploration of the design and optimization of progressive stamping dies for sheet metal manufacturing, offering significant insights into the interplay between material selection, die component design, and the application of Design for Manufacturing (DFM) principles. By meticulously analyzing strip layout, force calculations, and component alignments, the research highlights the critical role that precise die design plays in enhancing production efficiency, minimizing material wastage, and ensuring product quality. The integration of CAD-based modeling and simulation techniques underscores the potential for reducing design errors and improving operational reliability, offering a pathway to more cost-effective and scalable manufacturing processes [14].

The detailed force and stress analysis, alongside considerations for die deflection and cutting clearance, provide a robust framework for addressing common challenges in die manufacturing. Moreover, the focus on innovative die elements, such as pilot hole guidance and efficient part ejection systems, enhances the overall reliability of the progressive die process [15].

This work contributes to the broader discourse on advanced manufacturing technologies, proposing a refined methodology that balances precision, efficiency, and sustainability. Future research should explore further refinements in CAD-based simulations and material innovations, aimed at extending die longevity and performance. The findings presented here lay a foundation for advancing progressive die technology, positioning it as an indispensable tool in high-precision sheet metal fabrication, essential for industries requiring both high throughput and strict quality control.

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