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DESIGN AND ANALYSIS OF PRESS TOOL AND BRACKET BY USING SOLID WORKS AND ANSYS

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Abstract:
The design and analysis of press tools is a fundamental aspect of modern manufacturing. This process involves the creation of specialized tools used in shaping and forming sheet metal or other materials to produce precise components. The success of any manufacturing operation often hinges on the efficiency and precision of these press tools. This abstract provides an overview of the key steps involved in the design and analysis of press tools. It encompasses aspects such as defining requirements, material selection, die design, tool steel selection, simulation, optimization, manufacturing, assembly, testing, maintenance, temperature distribution, safety considerations, and documentation. The combination of advanced design techniques and simulation technologies plays a pivotal role in the development of press tools that are not only cost-effective but also capable of delivering high-quality components with tight tolerances.
Keywords: Compound die,material selection,Die design,Modeling,analysis of punch

INTRODUCTION:

Press working is part of sheet metal forming in which mainly sheet metal cutting operations and forming operations are carried out using die & punch assembly to produce sheet metal part on metal working press equipment & support equipments. A punch is the portion of the tool attached to the ram of the press and is inserted into the die. A die is usually the stationary portion of the tool attached to the press bed. It has a cavity to accept the punch. The forming operations were covered in Manufacturing Processes II, while sheet metal cutting and related forming operations will be dealt in this subject. The sheet metal working process in general is known as cold stamping as the sheet during working on it is always in cold state as press working operations are carried out at room temperature. Design and thermal analysis of press tools is crucial in the manufacturing industry to ensure efficient production processes and high-quality output. By leveraging software tools like SolidWorks for designing and ANSYS for thermal analysis, engineers can create robust press tools that are optimized for performance and durability. It encompasses aspects such as defining requirements, material selection, die design, tool steel selection, simulation, optimization, manufacturing, assembly, testing, maintenance, temperature distribution, safety considerations, and documentation.

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PRESS WORKING TERMINOLOGY:

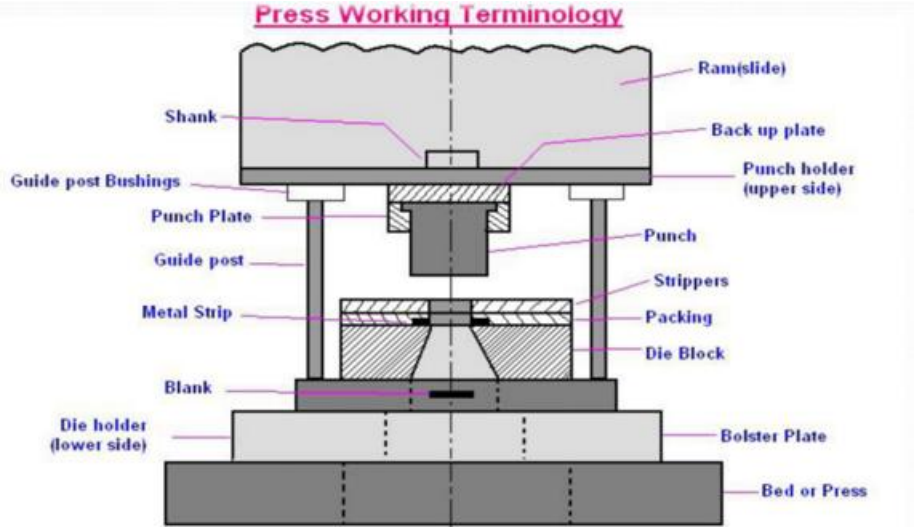

Fig-1: Press working Terminology.

- **Bed:** The bed is the lower part of the press frame that serves as a table to which a Bolster plate is mounted.
- **Bolster Plate**: This is a thick plate secured to the press bed , which is used for locating and supporting the die assembly. It is usually 5 to 12.5 cm thick.
- **Die Set**: It is unit assembly which incorporates a lower and upper shoe, two or more guide parts and guide part bush.
- **Die Block**: It is a block or a plate which contains a die cavity.
- **Lower Shoe**: The lower shoe of the a die set is generally mounted on the bolster plate of a press. The die block is mounted on the lower shoe, also the guide post are mounted on it.
- **Punch** : This is male component of a die assembly, which is directly or indirectly moved by and fastened to the press ram or slide.
- **Upper Shoe**: This is the upper part of the die set which contains guide post bushings.
- **Punch Plate** : The punch plate or punch retainer fits closely over the body of the punch and holds it in proper relative position.as shown in fig-1

PRESS OPERATIONS:

The operations done on the sheet metal can be classified into two types, cutting operations and forming operations. In cutting operations the work piece is stressed beyond its ultimate strength. The stress caused in the metal by the applied forces will be shearing stresses. In forming operations, the stresses are bellow the ultimate strength of the metal. In this operation there is no cutting of the metal but only the contour of the work piece is changed to get the desired product. The cutting operations include: blanking, notching, piercing, perforating, trimming, shaving, slitting, lancing etc. The forming operations include: bending, drawing, redrawing, squeezing etc.

various press operations:

Blanking:Blanking is the operation of cutting a flat shape from sheet metal. The article punched out is called the blank and is required product of the operation. The hole and metal left behind is discarded as waste.

Piercing: It is the cutting operation by which various shaped holes are made in sheet metal. piercing is similar to the blanking except that in piercing hole produced is the desired product, the material punched out from the hole being waste.

Lancing: This is a combined bending and cutting operation along a line in the work material. No metal is cut free during a lancing operation.

Embossing: It is a process of forming a design or letters on one side of metal piece and the impressions are visible on both sides.

Notching: This operation removes metal from either or both edges of the strip. Notching serves to shape the outer contours of the workspace in a progressive die or to remove excess metal before a drawing or forming operation in a progressive die.

Bending: In this operation, the material in the form of flat sheet or strip is uniformly strained around a linear axis which lies in the neutral plane and perpendicular to the lengthwise direction.

Shaving: Shaving is a secondary operation, usually following punching, in which the surface of the previously cut edge is finished smoothly to accurate dimensions. The excess metal is removed much as a chip is formed with a metal-cutting tool.

PRESS MACHINE:

A Press tool is a particular type of tool that is attached to a press brake and is used to produce a high volume of components. These types of tools are predominantly used in mechanical, pneumatic and hydraulic presses to achieve their goals.

Fly press: A Fly Press is a machine tool used to shape sheet metal by deforming it or cutting it with punches and dies. The punch is usually the top (male) tool and the die (female) bottom tool.

Open back inclinable press: A stamping press that has an opening at the back between the two side members of the frame and is arranged to be inclinable to facilitate part feeding and removal by gravity. Can be abbreviated OBI press.

Straight side single crank press:A straight side press is a machine tool designed for various forming operations, such as stamping, punching, blanking, and deep drawing, among others. It consists of a sturdy frame with two vertical columns on each side, providing stability and rigidity during operation.

Double action crank press: Double acting hydraulic presses have two “sliders”one for pressing and one for drawing. The two types of slider arrangements include an inner and outer slider type and an upper and lower slider type.

Hydraulic press: Hydraulic presses are used in forging, molding, punching, clinching and other operations. They can create intricate shapes while being economical with materials. They also take up less space compared to mechanical presses.

LITERATURE REVIEW:

Gaurav.C et. al. [1] Press tool design involves selecting durable materials, such as tool steels or carbide, to withstand stamping stresses. Types include blanking, piercing, bending, and drawing dies, with progressive dies performing multiple operations. Considerations include achieving precise tolerances, maintaining appropriate clearance to prevent wear, and incorporating draft angles for smooth part removal. Efficient press tool design ensures cost-effective and accurate manufacturing processes in industries where sheet metal components are produced.

Prabhakar Purushothaman et. al. [2] Designing a piercing tool for a special-purpose hydraulic press involves selecting materials to withstand forces, optimizing geometry for efficient metal penetration, and considering the unique requirements of the intended application. Analysis encompasses structural integrity, fluid dynamics in hydraulic systems, and ensuring safety. Special features may include adjustable depth control, rapid tool change capabilities, or automatic ejection mechanisms.

Vinay Kumar et. al. [3] Designing a progressive press tool for an Alpha Meter component involves a systematic approach to efficiently produce intricate parts in a single die set. Material selection is critical for durability, considering the tool's repetitive operations. The progressive die design should incorporate stages for blanking, forming, and assembly, minimizing waste and enhancing production

speed. Tolerances are crucial for accurate component dimensions. Special features may include sensors for quality control and mechanisms for part ejection.

Mr. Anil Parmar et. al. [4] The process of press tool design and manufacturing is a crucial aspect of efficient and cost-effective production in metalworking industries. It involves material selection, considering factors like durability and thermal resistance. The design phase includes defining tool geometry, clearances, and features tailored to specific operations. Computer-aided design (CAD) and simulation tools play a pivotal role in optimizing designs. Manufacturing encompasses precision machining and heat treatment. Continuous improvement through iterative testing and analysis ensures tool reliability. The integration of technology, adherence to tolerances, and efficient manufacturing processes collectively contribute to the successful development and deployment of high-performance press tools.

Vinayagamoorthi et. al. [5] The design and fabrication of multiple press tools for sheet metal operations involve a comprehensive process to cater to various manufacturing needs. Initial stages include material selection, considering factors like hardness and wear resistance. The design phase integrates specific features for cutting, bending, and forming operations, utilizing computer-aided design (CAD) tools. Precision machining techniques are employed during fabrication, with each tool tailored for a specific sheet metal operation. Prototyping and iterative testing refine designs, ensuring optimal performance.

Abhijit Ajabrao Tagade et. al. [6] The design and manufacturing of a compound press tool for washers involve intricate processes to produce precise components. Material selection focuses on durability and wear resistance. The tool design integrates features for blanking, piercing, and forming operations in a single die set. Computer-aided design (CAD) facilitates geometric precision. Machining techniques, such as milling and grinding, ensure accuracy during fabrication. Heat treatment enhances tool life. The compound press tool's versatility streamlines washer production, minimizing material waste.

Prashanth Thankachan et. al. [7] The design and analysis of a piercing tool for a specialized hydraulic press involve careful considerations. Material selection prioritizes strength and durability to withstand hydraulic forces. Geometric design optimization ensures efficient metal penetration during piercing operations. Special features, such as adjustable depth control and rapid tool change capabilities, are integrated to meet specific needs. Structural analysis evaluates the tool's integrity under pressure. Fluid dynamics within the hydraulic system are considered for optimal performance. Safety features and automatic ejection mechanisms may be incorporated.

Akshay.P et. al. [8] The design and force analysis of a press tool for sheet metal operations in a plate leveler demand precision and efficiency. Material selection focuses on durability and hardness to withstand repeated operations. The tool design incorporates features for cutting, bending, and leveling operations, optimizing geometric parameters using computer-aided design (CAD). Force analysis ensures that the press tool applies the required force evenly across the sheet, promoting uniform leveling. Rigorous testing and simulation refine the design for optimal performance. The resulting press tool streamlines plate leveling processes, ensuring accuracy, and reducing material waste in the sheet metal manufacturing of plate levelers.The design and force analysis of a press tool for sheet metal operations in a plate leveler demand precision and efficiency.

Suryawanshi Arvind.G et. al. [9] The design and modification of a piercing die aim to enhance tool life and productivity in sheet metal operations. Material selection focuses on durability, and geometric modifications optimize stress distribution. Surface coatings, such as hard coatings or nitriding, may be applied to increase wear resistance. Redesigning the die clearance and incorporating lubrication systems help mitigate friction and reduce wear. Additionally, strategic changes in die geometry can improve chip evacuation and cooling. Simulation tools aid in analyzing stress distribution and performance.

Ferencz Peti et. al. [10] The manufacturing of bracket-type automotive parts using high-pressure die casting technology involves several technological steps. Firstly, the alloy, often aluminum or zinc, is melted in a furnace. The molten metal is then injected into a die cavity at high pressure, creating the bracket's shape. Rapid cooling and solidification follow, ensuring precise part formation. Post-casting processes, such as trimming, shot blasting, and machining, refine the part's dimensions and surface finish. Quality control measures, including inspections and testing, guarantee adherence to specifications.

Huiju Zhang et. al. [11] The design of a multi-station progressive die for an automobile front bumper spotlight mounting bracket involves several key steps. Material selection focuses on durability, considering the bracket's function and the stamping process. The die design incorporates multiple stations for progressive operations such as blanking, forming, and piercing in a single setup. Precision in tool geometry and clearances is crucial to meet tight tolerances. Computer-aided design (CAD) facilitates accurate representation and simulation. Progressive stages ensure efficient material usage, minimizing waste.

Anudeep S et. al. [12] In this paper Design and analysis procedure to develop Blanking and bending press tool for Anchor Bracket component is discussed. Press tool manufacturing is one of the widely emerging trends in production area. Basically sheet metal components are produced using press tools. As the name itself suggests press tool means manufacturing the sheet metal components by applying the predetermined force. The components manufactured using this process possess high dimensional accuracy therefore automobile and aircraft firm depend largely on press tools. Anchor bracket is a part which is used in brake assembly unit of automobiles.

N. Srilatha et. al. [13] With the advancement in technology, there has been an increasing use of sheet metal components and press tools serve as one of the widely used tool for operations on sheet metals. As the name itself suggests, it is used to produce sheet metal components of different sizes and shapes with a predetermined force. Press tools are used for continuous mass production of components. This leads to the requirement for the use of a tool material that possesses high strength which would be able to withstand repeated heavy loads.

Y. V. Thokale et. al. [14] The design and development of a mounting bracket involve a systematic process to meet specific functional and structural requirements. It begins with defining the bracket's purpose and load-bearing capacity. Material selection is crucial, considering factors like strength and durability. Computer-aided design (CAD) software facilitates the creation of precise 3D models, optimizing geometry for stability. Prototyping and testing ensure the bracket meets performance criteria. Manufacturing processes, such as stamping or machining, are employed for production.

Weiwen Jin et. al. [15] Numerical Control (NC) simulation and programming for a SinuTrain five-axis bearing bracket involve advanced techniques to optimize machining processes. The process begins with generating a virtual model using CAD software, simulating toolpaths and assessing feasibility. Programming utilizes SinuTrain software to create CNC code, considering tool selection, speeds, and feeds. Simulation ensures collision detection and validates the program virtually before actual machining. This iterative process refines the program for efficiency and accuracy.

M Subrahmanyam et. al. [16] The design and analysis of a press tool for manufacturing a radiator stay bracket involve critical considerations for efficiency and precision. Material selection focuses on durability, with tool geometry tailored to the bracket's specific shape. Computer-aided design (CAD) assists in creating a detailed 3D model, optimizing for accurate production. Finite Element Analysis (FEA) assesses stress distribution, ensuring structural integrity under pressing forces. Tolerance and clearance parameters are fine-tuned for precision. Iterative testing and refinement enhance the tool's performance. The resulting press tool is optimized for the production of radiator stay brackets, ensuring consistent quality and cost-effective manufacturing in the automotive industry.

Amit Kumar Jharbade et. al. [17] Press working is a chipless manufacturing method used to create different sheet metal components. Another name for this procedure is cold stamping. Press is the

name of the device that operates on presses. A press's primary components are a bed and a frame that hold up a ram or slide. The ram's functioning mechanism is aligned with and consistent with the bed. The die block is fastened to the bed, and the ram has the appropriate punches. As the punch approaches and enters the die block, the ram's downward stroke creates a stamping. Press working processes are typically carried out at room temperature, and the punch and die block assembly are together referred to as the "die set."

N. Ramesha et. al. [18] The design and analysis of a blanking and bending press tool for manufacturing an anchor bracket component involve a meticulous process. Material selection emphasizes durability, considering the bracket's function. Computer-aided design (CAD) facilitates precise tool geometry, incorporating stages for blanking and bending in a single die set. Finite Element Analysis (FEA) assesses stress distribution, ensuring structural integrity during pressing operations. Tolerances are fine-tuned for accuracy, and clearances are optimized to prevent wear.

Lauff, Carlye et. al. [19] The Prototyping Canvas serves as a purposeful design tool for planning prototypes, providing a structured approach. It outlines key elements such as goals, target users, and functionalities. The canvas includes a visual representation of the prototype, detailing user interactions and interfaces. It aids in defining the scope, materials, and technologies required for effective prototyping. By emphasizing user experience and design objectives, the canvas guides the development process.

V.R. Jayasekara et. al. [20] Enhancing the productivity of D-brackets manufacturing involves strategic measures. Firstly, adopting advanced manufacturing technologies, like automated CNC machining, reduces production time and errors. Streamlining material handling and implementing efficient work cell layouts optimize workflow. Utilizing high-speed stamping processes for mass production significantly increases output. Integrating real-time monitoring and control systems enhances process visibility, enabling quick adjustments. Continuous employee training ensures proficiency with new technologies

SUMMARY:

The literature review on press tools and brackets highlights the significance of these components in manufacturing processes. It encompasses studies on various types of press tools and their applications, emphasizing efficiency, precision, and cost-effectiveness. Additionally, the review delves into bracket design considerations, material choices, and structural analysis.

MODELING:

SolidWorks is a powerful computer-aided design (CAD) software widely used in engineering and product design. Developed by Dassault Systèmes, it offers a user-friendly interface for creating 3D models, assemblies, and 2D drawings. SolidWorks facilitates parametric design, allowing users to easily modify and update designs. It's utilized in various industries, from mechanical and aerospace engineering to architecture. The software supports collaborative work, simulation, and rendering, making it a comprehensive tool for the entire product development process.

COMMANDS IN SOLID WORKS:

Extrude: Used to create features by adding material in a specific direction, essential for forming the base shape of components in press tools. This process results in a 3D feature based on your sketch. Keep in mind that SolidWorks may have updates or changes, so it's advisable to refer to the specific version's documentation or user interface for accurate instructions.

Cut Extrude: Removes material from a part, often employed to create openings or clearances in press tool components. This command allows you to remove material from a part to create voids or complex shapes.

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Shell: Shell Hollows out a part, useful for creating thin-walled components that are common in press tool design. This command is useful for creating thin-walled structures or hollow parts in your 3D model.

Draft: Adds a draft angle to faces, aiding in the ejection of parts from molds or dies. Draft is used to make straight, vertical surfaces angled. This is useful mainly for cast parts where "Draft Angle" is key to production capability of a part.

Fillet/Chamfer: Rounds or bevels edges, enhancing the durability of press tool components and reducing stress concentrations. fillets and chamfers are used to ease sharp edges and corners. A chamfer replaces the sharp change in direction with an angled slope, while a fillet makes a smooth curve to join two surfaces.

Forming Tools: Specialized tools for creating features like punches and dies commonly used in press tool design.The Form Tool Feature Property Manager lets you set options for inserting forming tools in sheet metal parts.

MODELING OF PRESS TOOL BY USING SOLID WORKS SOFTWARE:

The main goal of this investigation is design and structural analysis of press tool and bracket under the different types of materials. SolidWorks is a powerful computer-aided design (CAD) software widely used in engineering and product design. Developed by Dassault Systèmes, it offers a user-friendly interface for creating 3D models, assemblies, and 2D drawings.

1.Draw a rectangle using rectangle option in profile tool bar with 365mm as width and 335mm as height. By using thickness of plate is 30mm .

2.Draw a rectangle using rectangle option in profile tool bar with 365mm as width and 335mm as height. By using thickness of plate is 30mm and the hole was placed with 22mm diameter for the bottom plate .

3.Draw a rectangle using rectangle option in profile tool bar with 185mm as width and 165mm as height to create the die housing . By using thickness of plate is 45mm and the counter bore was placed with 18mm diameter for the bottom plate .

4. Draw a rectangle using rectangle option in profile tool bar with 85mm as width and 85mm as height to create the punch. By using thickness of punch is 60mm.the shape of the pattern is as per the bracket for form punch .

5.Draw a rectangle using rectangle option in profile tool bar with 52mm as width and 94mm as length for the guide post brushers. By using thickness of plate is 20mm and the hole was placed with 52mm and 32mm diameter for the brushers and they was extrude by 30mm by the extrude commend.

6.The press tool parts design is created by the SOLID WORKS software.finally we assemble the overall parts modeling of press tool. as shown in fig-2.

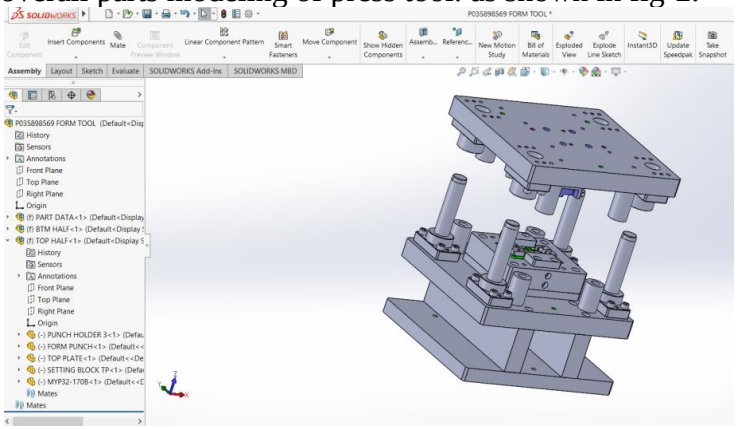

Fig-2: Press tool assemble

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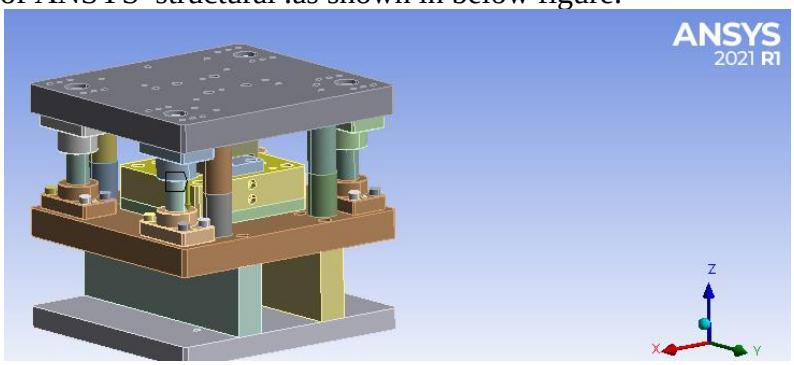
ANALYSIS:

SOFTEARE USED FOR ANALYSIS:

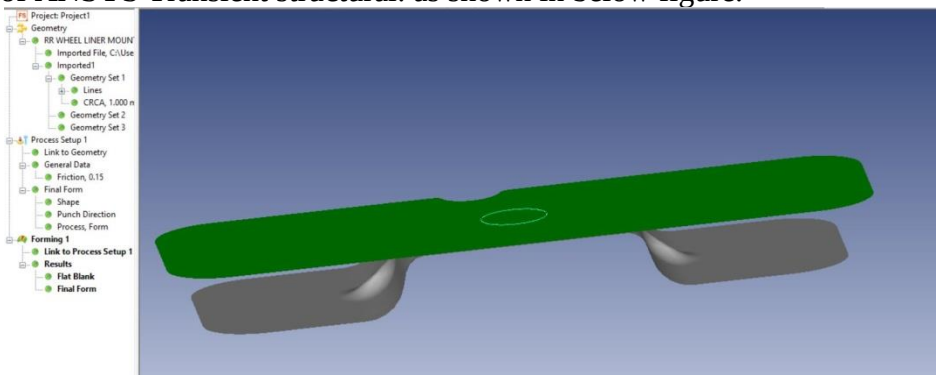
ANSYS is a powerful CFD tool commonly used for design and performance analysis. Its integration with various engineering software, along with CAD and FEA connection modules, allows seamless collaboration in modeling and analysis. ANSYS facilitates the import of CAD designs and enables geometry development in the pre-processing stage for a streamlined workflow.

STEPS USED IN ANALYSIS:

1.Imported the tool design from geometry that built by the SOLID WORKS into Design Workbench of ANSYS structural .as shown in below figure.

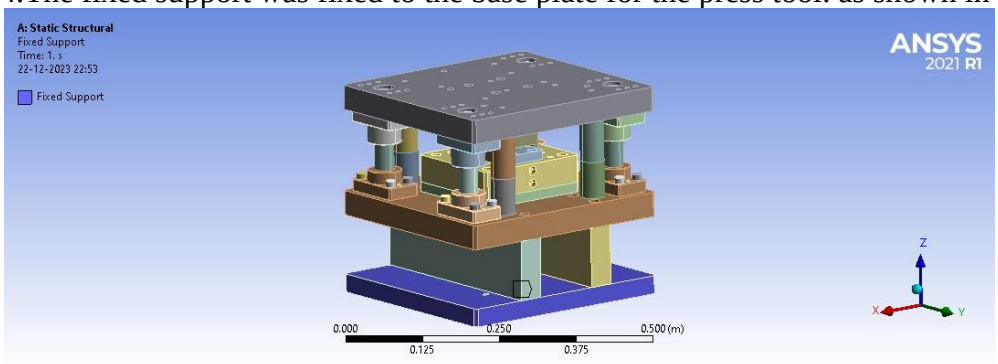


2.Imported the bracket from geometry that built by the SOLID WORKS into Design Workbench of ANSYS Transient structural. as shown in below figure.



3.Material properties was taken from structural steel from the Engineering data book values are taken. Properties of materials that are used to press tool.

4.The fixed support was fixed to the base plate for the press tool. as shown in below figure.



5.The punch displacement was set to be as -100N for the press tool. as shown in below figure.

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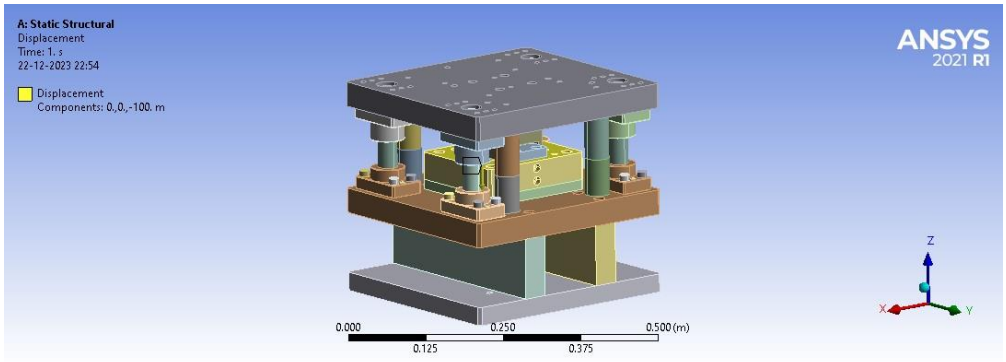
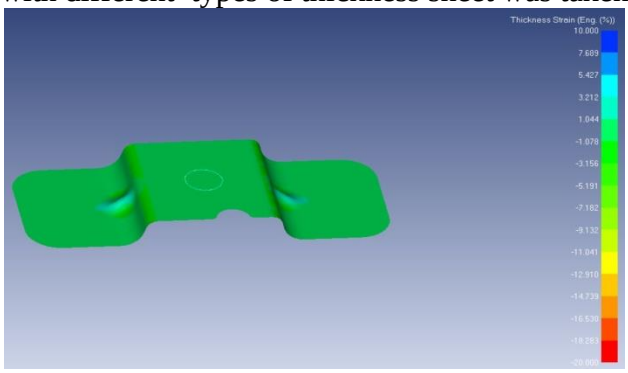


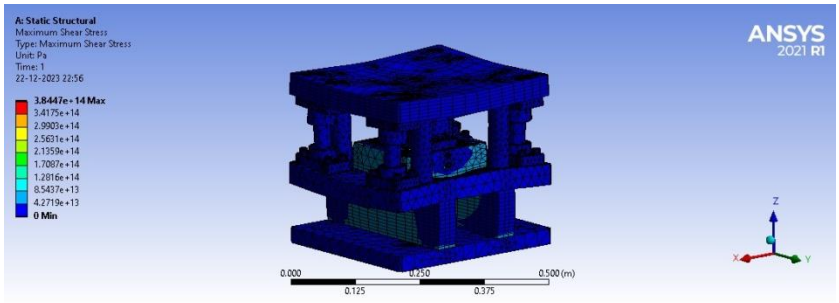
6.The material was taken for bracket was sheet metal was cold role cold acting (CRCA) was taken with different types of thickness sheet was taken. as shown in below figure.



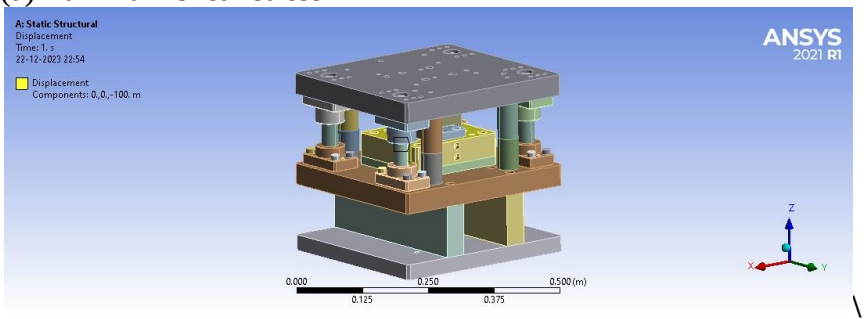
RESULTS:

ANALYSIS FOR THE TOOL:

In this section, the simulation results for the press tool model are analyzed. With a purpose to study the influences of maximum shear stress and total deformation of a model was created by using ANSYS simulation software. The punch displacement was set to be as -100N for the press tool for the x-axis direction. The simulation of the mode has been run with all the given data.



(a)Maximum shear stress



(b)Displacement

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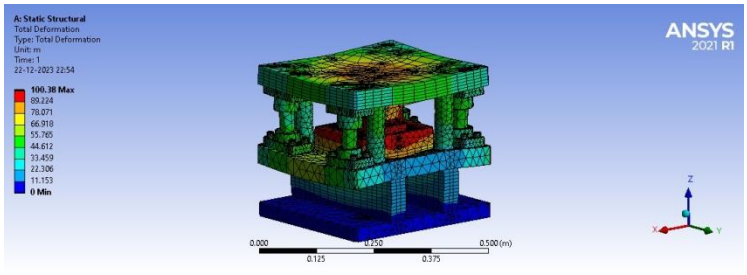


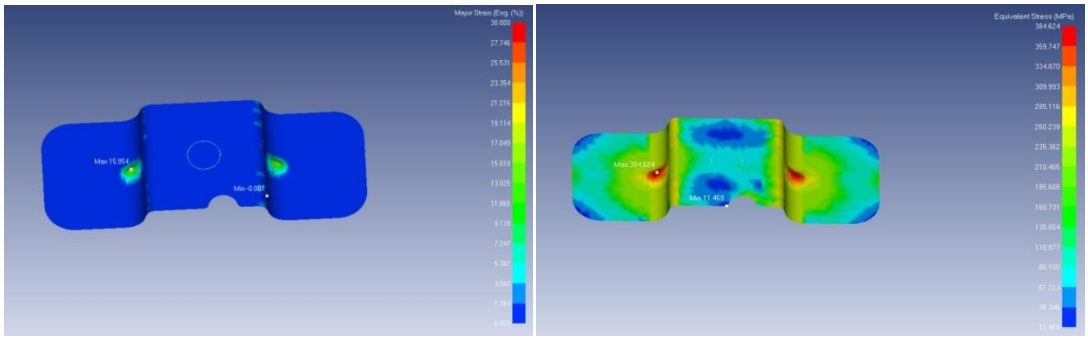
(c)Total deformation

The maximum shear stress reached 3.8447e+14 Pa. The values then decrease gradually to a minimum of 0 Pa. Each value corresponds to a specific time point in your analysis. the structure experienced a maximum deformation of 100.38 meters, and as time passed, it gradually returned to its original state, reaching no deformation after 0 minutes.

ANALYSIS FOR THE BRACKET:

In this section, the simulation results of the Bracket model are analyzed. With a purpose to study the influences of major strain and equivalent stress used for bracket a model was created by using ANSYS simulation software. The different type of thickness of bracket was taken as 1mm,2mm,&3mm as been taken.

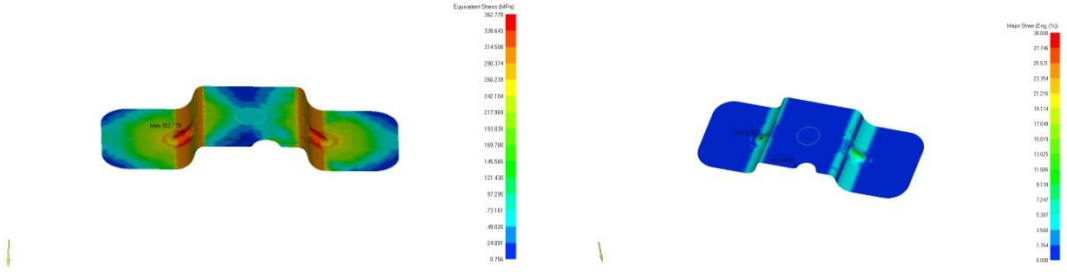
i.1mm thickness of bracket:



(a)Major strain for 1mm (b)Equivalent stress for 1mm

Major Strain" in engineering percentage. It starts at 30.000 and decreases gradually over subsequent values until reaching 0.000. The maximum strain is 15.954, and the minimum is –0.007. The "Equivalent Stress" is given in MegaPascals (MPa), and the provided values range from 384.624 to 11.469. This stress represents the combined effect of different types of stresses on a material.

ii.2mm thickness of bracket:



(a)Equivalent stress for 2mm (b)Major strain for 2mm

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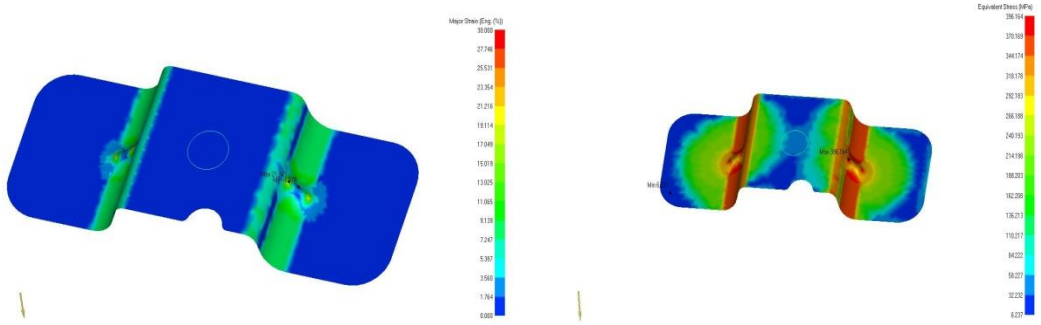
iii.3mm thickness of bracket:



(a)Major strain for 3mm (b) Equivalent stress for 3mm

Table-1: Different types of thickness of bracket and equivalent stress and major strain:

S.NO	THICKNESS OF BRACKET	MATERIAL SELECTION	EQUIVALENT STRESS		MAJOR STRAIN	
			Min	Max	Min	Max
1	1mm	CRCA	11.469	384.624	-0.007	15.954
2	2mm	CRCA	0.756	362.778	0.0002	12.527
3	3mm	CRCA	6.237	396.164	-0.578	21.964

The results to assess factors like stress distribution, deformation, and safety factors for each bracket thickness. Identify the thickness that meets design criteria with optimal performance.as shown in table-1.

DISCUSSION:

A press tool and bracket involves several key considerations.For the press tool, you'll need to focus on factors like material selection, die design, and the type of press operation (e.g., blanking, piercing). Ensuring proper clearances, incorporating features for tool life improvement, and considering material flow are crucial aspects.

In bracket design, structural integrity, load-bearing capacity, and material selection are pivotal. Utilize Finite Element Analysis (FEA) for stress analysis to ensure the bracket meets required safety factors. Also, consider manufacturing processes, such as casting or machining, to achieve the desired geometry.

CONCLUSION:

press tool and bracket involves several steps. In SolidWorks, you'd start by creating detailed 3D models for both components, considering material properties and manufacturing processes.For the press tool, focus on features like punch and die shapes, clearance, and alignment. In ANSYS, perform a structural analysis to ensure it can withstand the expected loads during operation. Similarly, design the bracket in SolidWorks, considering its function, load-bearing capacity, and attachment points. ANSYS can then be used to simulate structural, thermal, or dynamic analyses based on the bracket's application. Throughout this process, iteration and refinement are crucial. SolidWorks and ANSYS provide a powerful combination for designing, simulating, and optimizing mechanical components.

FUTURE SCOPE:

Designing a press tool and bracket using SolidWorks involves creating detailed 3D models, considering material properties, and ensuring functionality. ANSYS can be employed for structural

analysis to assess factors like stress and deformation.Future scope could involve incorporating advanced materials, optimizing designs for additive manufacturing, or exploring automation in the manufacturing process. Integration of IoT for real-time monitoring and predictive maintenance could enhance efficiency and reduce downtime. Continuous improvement in design methodologies and software capabilities will also shape the future of such projects.

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