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Design and Static Structural Analysis of Press Tool Using Ansys

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ABSTRACT:-

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."

Keywords: Press tool, Catia V5, modelling, optimization, static structural analysis, ANSYS.

1. Introduction:-

In the realm of modern manufacturing, the efficiency and precision of production processes are of paramount importance. One critical element in the manufacturing industry, particularly in sheet metal forming and stamping operations, is the press tool. These instruments, also referred to as stamping dies, are in charge of moulding and turning raw materials into elaborate and accurate parts. Press tool design and analysis is essential for streamlining production lines, guaranteeing product quality, and cutting expenses.

Finite Element Analysis (FEA) has emerged as a indispensable tool in the field of engineering and design. It enables engineers to simulate and analyze the behavior of complex mechanical systems and components under varying conditions. In the context of press tools, FEA offers a virtual laboratory for assessing their performance, predicting stress distributions, identifying potential design flaws, and optimizing their geometry for optimal results.

2. Objectives of the Study:

The primary objectives of this study on the design and analysis of press tools using Finite Element Analysis are as follows:

- **Geometric Optimization:** Through FEA, we seek to investigate and refine the geometric design of press tools. By analyzing stress concentrations, deformation patterns, and material flow, we aim to develop tool designs that maximize efficiency and minimize the risk of failure during production processes.
- **Performance Prediction:** FEA allows us to simulate the entire press tool operation, from material feeding to forming and ejection stages. By virtually testing the press tool and workpiece interaction, we can anticipate potential issues such as material thinning, wrinkling, or tearing, thus enabling proactive design improvements.
- **Material Selection and Durability Assessment:** The selection of appropriate materials for press tool construction is critical. FEA facilitates the evaluation of material properties, fatigue life, and durability, ensuring that the press tools can withstand repeated cycles of operation without degradation.
- **Cost and Time Optimization:** The iterative design process made possible by FEA reduces the reliance on physical prototypes and costly trial-and-error approaches. This not only saves time but also minimizes material waste and production costs.

3. Literature Survey:-

- **Amol Bhanage, et al. [1]** used basic die design equations to design and build a die for the Rear Engine Anti-Drive bracket (R.E.A.D.), which is used to install shock absorbers, in order to carry out the design of a combined press tool. They claimed that the combination of these press tools led to increased productivity, a more cost-effective production process, and a cheaper final product cost.

- **Anudeep S et al. [2]** created a design and analysis process for a press tool for blanking and bending anchor brackets, which are utilised in car brake assemblies. He completed the press tool's design and modelling. Computer Aided Engineering (CAE) software is used to do further punch and die analysis. According to his findings, using integrated computer-aided design or computer-aided engineering software reduces design process time and improves design accuracy when compared to conventional design methods.
- **Bhatt Raghav H et al. [3]** had created a combination tool for the piercing and depression processes carried out in the rim production facility. These procedures are carried out in order to install the valve stem that extends from the wheel and is used to inflate tyres and tubes. When this combo tool was used in the rim production facility, the rejection %, rim cost, toll downtime, and other metrics decreased.
- **Gaurav C Rathod et al. [4]** Developed press equipment to create a specific component from sheet metal in big quantities. The entirely distinct types of press tool constructions lead to distinct operations, such as drawing, isolating, blanking, bending, piercing, shaping, and so on. Generally, metals thicker than 6 mm are regarded as strips. If a sheet is thicker than 6 mm, it is regarded as a plate. Press operations are widely used in a variety of sectors, including the food processing, packaging, defence, textile, automotive, craft, and many more, in addition to the manufacturing sector. They have created and examined a press tool that combines the piercing and notching operations. The combined press tool analysis demonstrates that it can work with the current mechanical press, which uses a different tool for every task.

4. Methodology:

The methodology for this study involves the following key steps:

- **Geometric Modeling:** Press tool designs are created and detailed using Computer-Aided Design (CAD) software, ensuring all critical features and dimensions are accurately represented.
- Mesh Generation: The CAD models are imported into FEA software, where they are divided into finite elements to enable precise simulation of the press tool's behavior.
- Material Properties: Material properties, including elastic modulus, yield strength, and Poisson's ratio, are defined for the chosen tool material.
- Boundary Conditions: The FEA simulation involves applying realistic boundary conditions, including constraints and loading scenarios, to replicate actual operating conditions.
- Analysis and Post-Processing: FEA software performs the simulation and generates results such as stress distribution, deformation, and safety factors. These results are thoroughly analyzed to assess press tool performance.
- Iterative Design Optimization: Based on FEA results, design modifications are iteratively implemented to enhance press tool performance, and the simulation process is repeated until desired performance goals are achieved.

5. Design of intake manifold:-

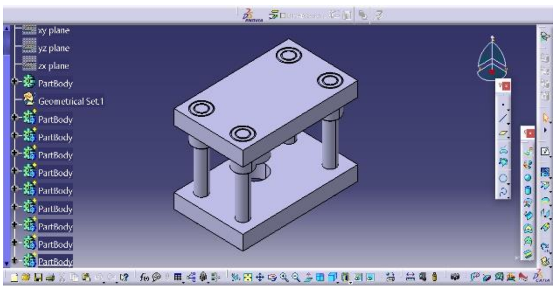


Figure 1: Press Tool Catia V5 design

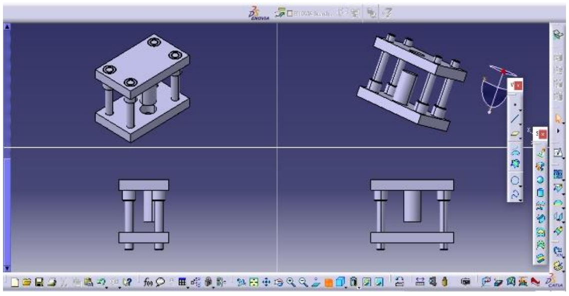


Figure 2: Multi- View of Press Tool

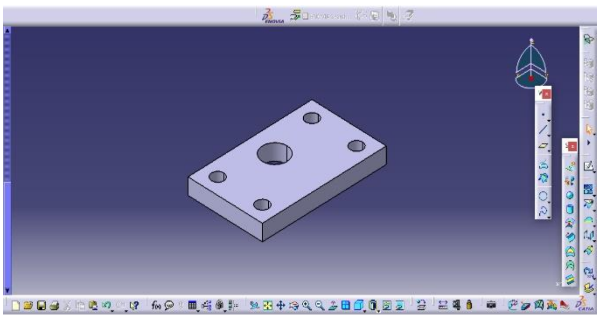


Figure 3: Lower Plate

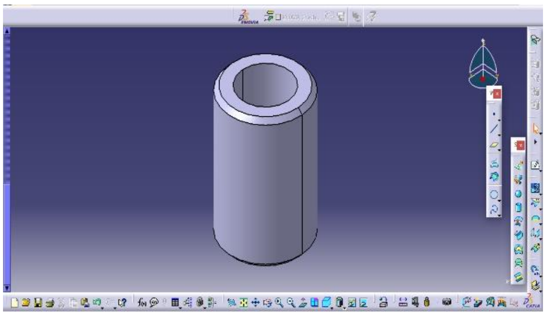
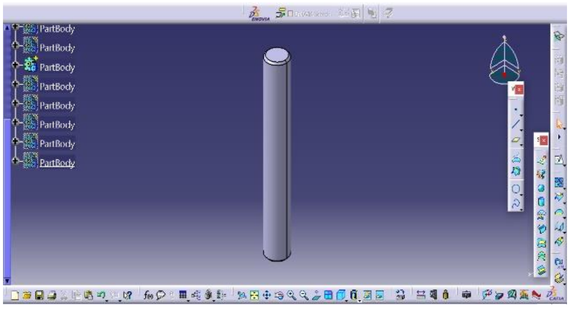


Figure 4: Bush Design



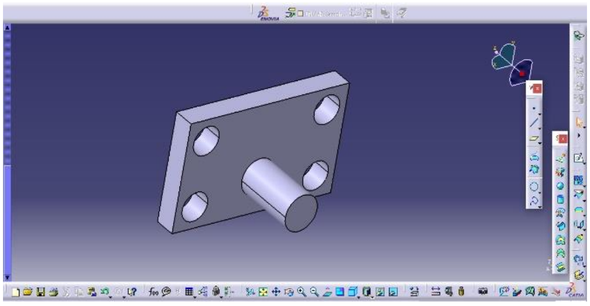


Figure 5: Guide Pillar **Figure 6:** Upper plate design

6. Static structural Analysis of Press Tool:-

6.1 Meshing and boundary condition of Press Tool

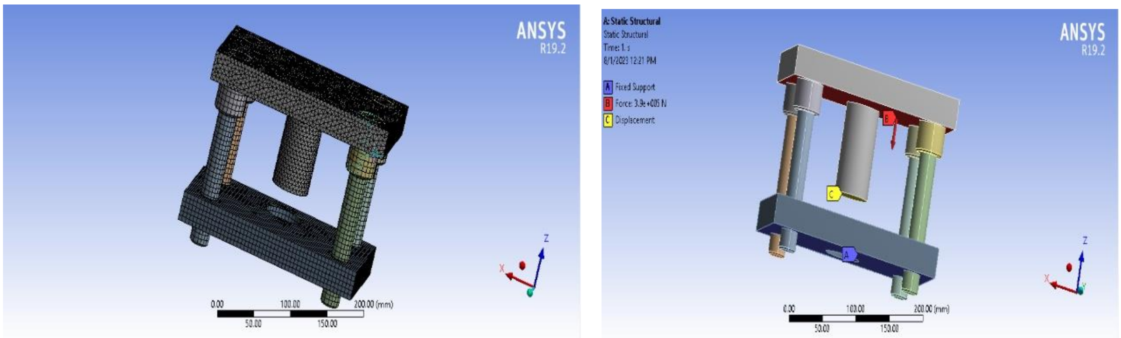
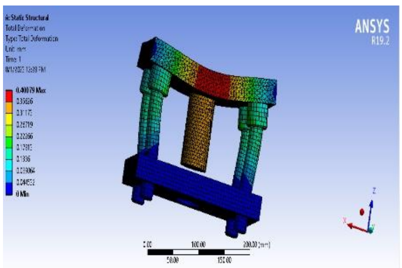
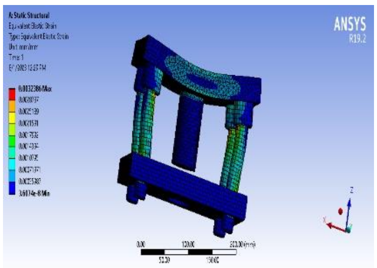


Figure 7: Meshing of Press Tool

Name	**Press Tool**
Node	139509
Element	60890

6.2 Analysis of Press Tool – Mild Steel





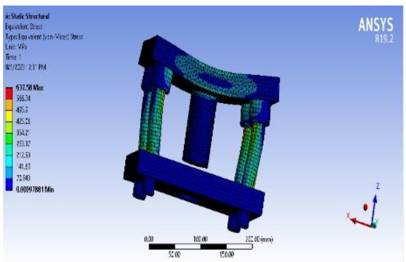


Figure 8: Total Deformation

Figure 9: Equivalent Elastic Strain **Figure 10:** Equivalent Stress

Figure 11: Graphical Representation of deformation, strain and stress Results

6.3 Analysis of Press Tool – Cast Iron

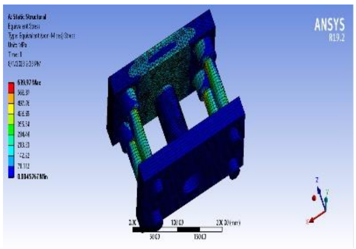


Figure 12: Total Deformation

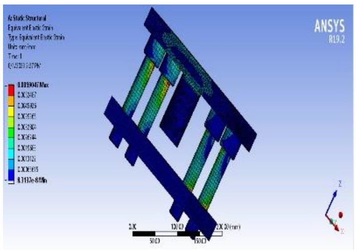


Figure 13: Equivalent Elastic Strain

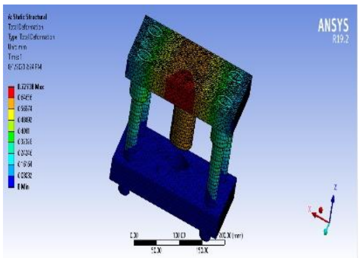
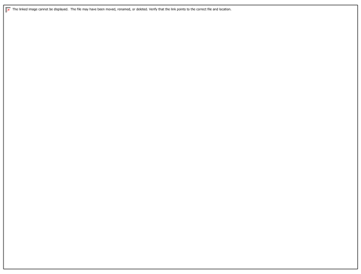
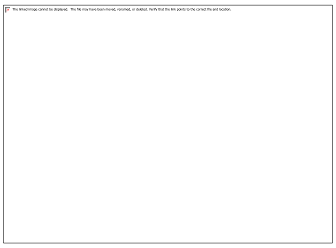


Figure 14: Equivalent Stress





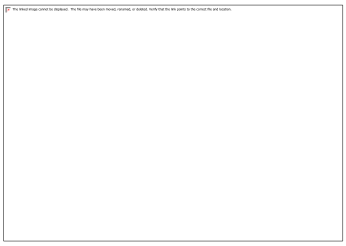


Figure 15: Graphical Representation of deformation, strain and stress Results

Result Summary

Table 1: Mild steel press Tool Result summary

Results	Minimum	Maximum	Units	Time (s)
Total Deformation	0.	0.40079	mm	1.
Equivalent Elastic Strain	3.6074e-008	3.2386e-003	mm/...	1.
Equivalent Stress	9.7881e-004	637.58	MPa	1.

Table 2: Cast iron press Tool Result summary

Results	Minimum	Maximum	Units	Time (s)
Total Deformation	0.	0.72738	mm	1.
Equivalent Elastic Strain	8.3137e-008	5.9047e-003	mm/...	1.
Equivalent Stress	4.5767e-003	639.97	MPa	1.

Conclusion:-

This study endeavors to demonstrate the significant role of Finite Element Analysis in the design and analysis of press tools. Through the power of FEA, we can optimize press tool geometry, predict performance, select suitable materials, and ultimately enhance the efficiency and reliability of these tools in sheet metal manufacturing and related processes. The findings of this study have wide-reaching implications for industries reliant on precision metal forming techniques, promising improved product quality, cost-efficiency, and competitiveness in the global manufacturing landscape.

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