WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review of Design and Analysis of Press Tool

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ABSTRACT

This article provides a summary of the research done on mechanical press tool design and analysis. Mechanical press frame analysis and design are the subject of this study. The press frame was modeled using CAD software, and a failure study was conducted using a FEA program. Analytical and simulated approaches have been used to determine stress distributions in press tools. A new press structure is modified using reference data to inform the design process. Recent design and development in press tools are centered on design specification, stress distribution, deflection, optimization, ergonomics, stiffness, and rigidity, all of which are derived from structural components of press machine frames.

Keywords: Press Tool, CAD modelling, Catia V5, ANSYS, Finite Element Analysis (FEA), and Optimization.

1. Introduction:

Press tools are essential components in modern manufacturing industries, enabling the efficient shaping and forming of sheet metal into various products used in automotive, aerospace, electronics, and countless other sectors. The design and analysis of press tools have become paramount in achieving precision, cost-effectiveness, and production efficiency. This paper delves into the intricate world of press tool design, structural analysis, and optimization techniques, aiming to contribute to the advancement of manufacturing processes.

In recent years, the demand for high-quality, intricately designed components has surged, driven by consumer expectations and industry requirements. Achieving these standards necessitates not only the mastery of press tool design principles but also a profound understanding of how these tools behave under various operating conditions.

The primary objectives of this research are to:

- Explore the fundamental principles of press tool design, including considerations related to die and punch selection, material choices, and geometric design.
- Utilize finite element analysis (FEA) techniques to assess the mechanical behavior, structural integrity, and stress distribution within press tools under diverse operational scenarios.
- Address critical issues surrounding tool wear, fatigue, and tool life, aiming to enhance tool longevity and reduce operational costs.
- Investigate optimization methods, such as genetic algorithms and mathematical modeling, to improve the overall performance and cost-effectiveness of press tools.

2. Literature Review

Dharshan, B, Ananthapadmanabham, B & Hareesha [1], The press is by far the most often used machine for creating sheet metal parts. When it comes to tiny components like those found in watches and huge aircraft parts, the difficulties of hand production of sheet metal components with complicated geometries and dimensional importance in their applications become even more apparent. Nowadays, press tools and various combinations of techniques are used to manufacture the vast majority of sheet components of any form. Stampings are manufactured goods that are cut and formed from metal sheets. Press tool development and production need a high level of expertise and specialized knowledge. These sheet metal stampings have replaced several components that were formerly cast or machined. Due to material economy's benefits—lower production costs, more efficiency, greater utilization of low-skilled labor, and greater precision—press work has become indispensable for many mass-produced items. Vehicles, airplanes, home furnishings, electronics, and electrical appliances are just a few examples.

Amol Bhanage, et al. [2] They developed the die for the Rear Engine Anti-Drive bracket (R.E.A.D.) used in the shock absorber mounting process by applying the basic equations of die design to the construction of a combined press tool. Productivity was boosted, they said, and the production process was made more cost-effective thanks to the combination press tool.

Anudeep S et al. [3] Detailed technique for designing and analyzing a press tool for blanking and bending an anchor bracket used in a car's braking system. Press tool design and modeling were also tasks he undertook. Punch and die analysis is taken to the next level with the help of CAE software. His findings point to a considerable improvement in design correctness and a shorter design cycle time when compared to the conventional design process that does not make use of integrated CAD/CAE software.

Bhatt Raghav H et al. [4] has created a hybrid machine for use in the depression and piercing processes of rim production. These procedures are necessary for installing the valve stem that projects from the wheel, allowing the tube and tire to be inflated. The rim manufacturing facility used this combo tool, which decreased the rejection rate, the cost per rim, the amount of time the plant was shut down, and other metrics.

Gaurav C Rathod et al. [5] performed press tools to mass-produce a component from sheet metals. Blanking, bending, piercing, shaping, drawing, isolating, shaving, and countless more processes are all the results of distinct press tool constructions. metals thinner than 6 mm are often considered strip. If a sheet's thickness is more than 6 millimeters, it is classified as plate. In addition to the manufacturing sector, several other sectors make extensive use of press operations, such as the food processing, packaging, defense, textile, car, craft, and many more. They've designed and studied a press tool that can pierce and notch in one fluid motion. The examination of the combined press tools demonstrates that they are interchangeable with those of conventional mechanical presses that use individual tools for each process.

Nilesh N. Patil et al. [6] performed a variety of metal-forming processes, including stamping, punching, shearing, and bending; investigated the steps involved in shearing, including perforating, lancing, notching, punching, and splitting; and so on. There are many different types of forming procedures, such as roll forming, stretching, bending, and drawing. They have learned how to utilize a mechanical press, punch or ram, and a series of dies in the process of sheet metal fabrication. They employed a V die and a wiping die, two standard bending operations. AutoCAD and visual-LISP are utilized as add-ons in this case. The researchers found that elongation, yield point elongation, residual stresses, spring back, and wrinkling were all crucial sheet metal forming features.

Pawan Kumar Rai et al. [7] have isolated the several sources of burr in sheet metal, including blanking, punching, and notching. The Pareto chart they presented illustrated how taming burr was crucial to cutting down on rejection rates. They utilized a cause and effect diagram to figure out what was going on with the burr. Operator knowledge, operator competence, raw material quality, and raw material thickness are among the recognized parameters. Finally, they drew the conclusion that improved component quality and longer tool life might be achieved by paying attention to things like press machine alignment and so on.

Pritam B. Bhawar et al. [8] has created a stepped die for the blanking/piercing operation. The blanking and piercing procedure is another technique he has simulated. According to his findings, components made with a progressive die are quite precise. AutoCAD was used for the modeling of the progressive die components. The aforementioned progressive die was put to work in a hydraulic press with a 250KN capacity.However, a capacity of 237.08KN was necessary, with a safety factor of 1.25. Progressive dies often employ Working Tool Steel (WPS), Mild Steel (MS), or Oil Hardening Non-shrinking Steel (OHNS) as their base materials.

Pratik Phadnis et al. [9] die-entry single-stroke configurations have been explored for their potential to streamline processes that are now performed in three distinct places, each of which slows down assembly and adds cost.

Ramegowda D et al. [10] study of the press as a machine for mass manufacturing sheet metal components by use of an external force. There were three distinct types of press activity: cutting, non-cutting, and crossover. Vehicle components, aerospace manufacturers, etc. may all benefit from the great dimensional accuracy this method ensures for their products. The goal of the study was to increase productivity without increasing costs associated with trial and error.

Ram Jogannavar et al. [11] researched a press tool for design that might replace horizontal milling. Clamping and running the machine take more time in horizontal milling. Their production went up, so they bought a prèss tool. Physical parameters such as Poisson ratio, young modulus, shear modulus, thermal conductivity, and specific heat, as well as chemical properties including carbon, silicon, vanadium, and magnesium, were investigated. When comparing annual costs, the press tool operating technique is more cost effective than the horizontal milling procedure.

Rupali Chavan et al. [12] The usage of a progressive die, which can execute many operations in rapid succession with a single stroke, is discussed in this study as it relates to an industrial component. For 3D rapid prototyping, they relied on SolidWorks 2013. Die clearance varies according on the material, with small clearance for ductile materials and wide clearance for brittle materials being part of the design for a progressive die. Finite Element Analysis (FEA) was carried out, and within the acceptable range results were obtained for the essential components of the die, including the piercing punches, bending punches, bottom plate, top half plate, pillars, and piercing blocks.

Subramanyam Pavuluri et al. [13] uses a variety of materials, including mild steel, HcHcr, and a high-carbon steel alloy, to conduct a punch investigation and analysis. Defects in the press tool, such as cracks in the punch or corrosion of the die, cause less-than-optimal interactions between the punch and the die, hence increasing the damage of the press tool and, by extension, the cost. Blanking is a mechanical process that is performed by machine. Mechanical presses may range in size from 1 to 3 tons. Solid works software is used to analyze the punch for the blanking procedure.

3. Conclusion

Press tool design and analysis are crucial in manufacturing. This literature review covered design principles, material selection, simulation, tool wear, automation, and environmental considerations. Leading researchers have contributed valuable surveys and publications in this field, providing essential insights for industry professionals. As manufacturing evolves, staying updated on the latest advancements is vital for meeting industry demands.

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