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COMPOUND DIE FOR MANUFACTURING OF PLAIN WASHER FROM SHEET METAL SCRAP

Pawan Kumar Singh*1, Dr. Pawan Kumar*2, Dr. Shyam Singh*3
*1,2,3State Institute Of Engineering And Technology, Nilokheri, India.
Corresponding author; (email: pawansietk@gmail.com)
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ABSTRACT

The compound die is utilized in the industry for manufacturing various sheet metal components. This study focuses on the design and development of a compound die specifically for producing plain washers used in different types of bolts. Previously, Plain washers were made using a conventional die, which involved two separate processes requiring two dies, two mechanical power presses and more than one workers. This method was time-consuming, longer production times, quality issues, and higher energy consumption which leading to increased per unit costs. The introduction of the compound die addresses these challenges by allowing blanking and piercing operations to be completed in a single stroke of the mechanical power press. As a result of developing the new die tooling costs and the per-unit cost of Plain washers have decreased, while production rates have increased. The compound die has led to a 75.6% reduction in tooling costs due to significant savings in raw materials. Additionally, production rates have surged by 300%, maintenance costs have dropped by 66.6%, and labor costs have decreased by 75%, all of which positively impact the per-unit cost of the product. Overall, the unit cost has been reduced by 36%. Thanks to the compound die, which has shortened both the cycle time and material handling time and we can produce plain washer from sheet metal scrap which leads raw material cost reduction. The newly designed system allows the operator to easily use the dies with the assistance of a mechanical power press. The main goal is to maintain a straightforward mechanism while ensuring that all necessary requirements are met. The new tool can be used in large-scale manufacturing to create uniform parts with precise geometrical tolerances. The advantages of using a compound die include time efficiency, reduced movement of the part which minimizes operator fatigue, and lower labor and production costs. A one-time investment in the necessary equipment will guarantee a consistent supply of high-quality products, leading to significant profits for manufacturers.

Keywords: Compound Die, Sheet Metal, Plain Washer.

I. INTRODUCTION

Dies are essential in modern manufacturing, enabling the efficient shaping and forming of sheet metal into various products used in sectors like automotive, aerospace, electronics, fasteners, and more. The design and analysis of press tools are crucial for ensuring precision, cost-effectiveness, and production efficiency. A die tool is the material that reshapes sheet metal into different sizes and shapes and sheet metal dies are employed in numerous industrial and commercial production processes. Many everyday products are created using sheet metal press dies, leading manufacturers to innovate and explore new trends. Dies are often tailored to the specific item being produced. They play a key role in industrial manufacturing, as nearly all products with multiple components will include at least one part shaped by a press tool through stamping tool design. This widespread application is primarily due to the low cost of sheet metal and the quick and efficient nature of forming operations.[1]

Categories of Dies

- Simple dies: These dies are made to carry out a single operation, such as blanking, piercing, notching, trimming or drawing using one stroke of a power press.
- Multi-operation dies: These dies are designed to perform multiple operations simultaneously in a single stroke of a power press.
- Progressive die: A progressive die features a series of operations with each station executing a specific task on a workpiece during one stroke of a power press. Each step contributes to the final product, which is completed only after the last operation. This type of die is commonly used in metalworking to efficiently produce a high volume of complex-shaped finished items.[2]

- Compound Die: A compound die is used to create basic flat components, such as washers and other flat sheet metal products. In this method, a metal strip is fed through the compound die, which performs multiple cuts and punches in one stroke, unlike progressive or transfer die stamping that requires several strokes. A compound die can carry out two or more operations at one station and is mainly considered a cutting tool, focusing on cutting tasks.[1]
- Combination Die: A combination die is akin to a compound die, but its main difference is that it can perform multiple cuts, punches, and bends in a single stroke rather than needing multiple strokes. In combination die operations, cutting is combined with non-cutting processes. These dies can switch between progressive and compound operations based on the specific requirements of the final product. This flexibility allows manufacturers to improve their production processes for various part designs and quantities. Combination dies offer a versatile and efficient tooling solution for producing sheet metal parts with different shapes and production volumes, merging the benefits of both progressive and compound dies to streamline production and lower the overall cost of the finished product.[3]
- Power Press Machine :- A Power Press Machine is utilized for shaping metal into specific forms. It features a controlled system designed for processing different types of sheet metal. This versatile machine can both shape and cut simultaneously, making it primarily used in sheet metal fabrication. It is one of the most flexible machines available for sheet metal work and is widely used in various heavy industrial settings. In the past, manually shaping metal sheets required significant labor and effort. However, with a Power Press Machine, cutting, bending, pressing, and forming metal sheets into various shapes and sizes becomes much easier by applying substantial pressure.[4]
- Washer :- Washers are small circular rings that are placed on the shafts of threaded fasteners like screws and bolts. They enhance strength by evenly distributing the weight load across the fasteners, positioned between the surface and the head of the fastener. Made from mild steel or plastic, washers offer corrosion resistance, which boosts the strength and longevity of the fastener.
- **Purposes of using washer:**
- Load Distribution : One of the primary reasons for using washers is to spread the load over a larger area. While threaded fasteners are useful, they can put significant stress on the material around them. For instance, when constructing a shed with wood, driving a fastener into the timber could lead to splintering and compromise the structural integrity of the surrounding area. A washer helps to distribute the weight, reducing potential damage to the material. Although washers may not be necessary for all materials, they are recommended for softer ones like wood.
- Spacing : It may seem unusual to use a spacer when inserting a fastener, but it can be beneficial if the fastener is particularly long. Sometimes, the bolt or screw may exceed the depth of the material. In such cases, a spacer washer is needed to create a gap between the surface of the material and the head of the fastener, ensuring a secure hold without protruding through the other side.
- Vibration Dampening : Washers can also be utilized to absorb the impact or shock from vibrating machinery.

II. HISTORY

S. Vinoth et al. (2016) discussed the design and stress analysis of a compound die washer tool, utilizing high carbon high chromium D2 tool steel for both blanking and piercing tasks. The D2 material, with a hardness of 38 HRC, was suitable for working with soft sheet metals. To address the issue of the compound tool's weakness, they heat-treated it to achieve a hardness of 58 HRC, making it suitable for harder materials. All analyses were conducted using ANSYS software, and they concluded that heat-treated compound tools could effectively handle sheet metal work on harder materials. **Mr. B. F. Satpute et al. (2017)** focused on the design and development of a compound die for bearing caps, emphasizing that press tools are crucial for transforming raw materials into finished products. Various products are produced through press working processes, and accurate design and manufacturing data are essential during this transformation. A compound die is a press tool that performs multiple operations on sheet metal in a single stroke. The design of such a die is influenced by factors such as the type and thickness of the sheet metal, as well as the complexity of the design and operations. This type of press tool is significant for its high production rates and low per-unit costs. The current thesis aims to design a compound die capable of performing two drawing and piercing operations

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simultaneously, with a focus on minimizing costs while maximizing production rates[1]. **Gaurav C Rathod and colleagues (2017)** conducted a study on the design and analysis of press tools, which are utilized for mass-producing components from sheet metals. Various processes such as blanking, bending, piercing, shaping, drawing, isolating, and shaving result from different press tool designs. Metals with a thickness of less than 6 mm are typically referred to as strips, while those thicker than 6 mm are categorized as plates. Press operations are widely employed not only in manufacturing but also in sectors like food processing, packaging, defense, textiles, automotive, and crafts. The researchers developed a press tool capable of piercing and notching simultaneously. Their analysis of these combined press tools shows that they can replace traditional mechanical presses that require separate tools for each operation[7]. **Wael Hekmat Ahmed and colleagues (2019)** focused on optimizing the design of a compound die with double cutting process parameters and conducted stress analysis using theoretical, numerical, and statistical methods. Their findings yielded better results than previously published experimental data. The study concluded that the optimal design of the compound die could be achieved based on three criteria, leading to improved predictions of burr height and more efficient use of compound dies. The results indicated enhanced design models for the compound die, better product quality, reduced burr height compared to existing literature, and minimized stress levels for the cutting tools[8]. **N. Jyothirmayi and colleagues (2019)** worked on fabricating a compound die for producing a hexagonal washer, employing blanking and piercing operations. They designed and developed this compound die specifically for creating a hexagonal washer for an M15 bolt, utilizing SolidWorks software for 2D modeling, and tested it on a Fly press[9]. **Vijay Singh Thau Rathod et al. (2020)** conducted a review on a virtual system for a compound die used in a press machine. They found that this press tool is important for achieving a high production rate while minimizing the cost per product. The thesis focused on improving quality alongside increasing production rates. However, they noted that issues like spring back effects can arise during the design of the compound die[10]. **Pushpak Kalokhe et al. (2021)** analyzed piercing tools, highlighting that different designs of press tools lead to various operations such as blanking, bending, piercing, forming, drawing, cutting off, parting off, embossing, coining, notching, shaving, lancing, dinking, perforating, trimming, and curling, typically for metals with a thickness of less than 6 mm, referred to as strips. Their work involved the real-time design of a simple piercing press tool and the manufacturing of a prototype, along with a static analysis of the punch, which produces a pierced hole and a notch hole. Most research papers focus on either cutting and bending operations or two cutting operations, but the new die is capable of performing three operations—both cutting and non-cutting—using a single stroke of the power press[11].

- Previously, plain washers were made using basic dies separately, which involved two different operations to produce each washer. This approach negatively impacted production rates and the cost per unit. By transforming these simple dies into a compound die while taking design complexity into account, we can overcome many of the previous drawbacks.
- The objective is to create a compound die for manufacturing plain washers used in various bolts and automotive components. Previously, the plain washer was made using a traditional die, which involved two separate processes requiring two die sets, two mechanical power presses for a single output, and multiple workers. This method was time-consuming, leading to increased costs, longer production times, quality issues, and higher energy consumption. The solution lies in utilizing a compound die that can perform both blanking and piercing operations in a single stroke of a mechanical power press. Additionally, we need a die that is adaptable to different raw materials, allowing us to produce plain washers from sheet metal scrap, which is abundantly available in various thickness in Raipur.

III. METHODOLOGY

Stages involved in the complete procedure:

- Choosing a Power Press
- Designing the Die
- Manufacturing the Die
- Conducting Heat Treatment
- Fitting the Die

Choosing a Power Press

Power press selection involves determining the necessary press tonnage for manufacturing. This tonnage represents the maximum load needed during a stamping process, which is the total force required for production.

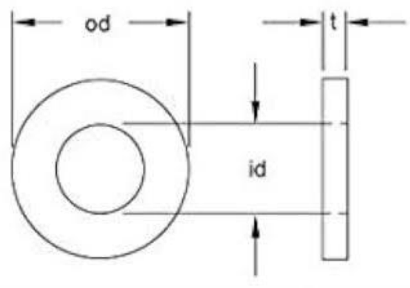

Fig 1: As per IS2016 standard dimension and tolerance for M20 Plain washer : ID - 22.00 to 22.52 mm, OD - 35.70 to 37.00 mm, Thickness – 2.55 to 3.75 mm

Force calculation: We have various sizes of plain washers ranging from M6 to M33, each manufactured according to different standards, resulting in varying force requirements for each size. In this instance, we have calculated the force needed for an M20 plain washer that adheres to the IS2016 standard, with its dimensions provided below.

i. Shear Force for Piercing:

For a piercing punch with a diameter of 22.2mm, the shear force is calculated as follows:

Shear Force = Perimeter x Thickness x Shear Strength = π x 22.2 x 3.3 x 270 = 62166 N

Where T represents thickness in mm and τs denotes shear strength in N/mm^2.

ii. Shear Force for Blanking:

For a blanking size of 36.8mm, the shear force is calculated as:

Shear Force = Perimeter x Thickness x Shear Strength = π x 36.8 x 3.3 x 270 = 103050 N

Again, T is the thickness in mm and τs is the shear strength in N/mm^2.

iii. The stripping force is estimated to be 10% of the total force, calculated as:

Stripping Force = 10/100 × 165216 = 16521 N.

The total force is the sum of the piercing force, blanking force, and stripping force:

Total Force = Piercing Force + Blanking Force + Stripping Force = 62166 + 103050 + 16521 = 181737 N, which converts to tonnage as follows: 181737/9810 = 18.5 tons.

Considering press efficiency at 80%, the required press tonnage is calculated as:

Press Tonnage = 18.5/0.8 = 23.1 tons. Therefore, a 25-ton power press is necessary to produce the M20 plain washer.

Designing the Die

Computer-aided design (CAD) refers to the use of computer technology to assist in the creation, modification, assessment, or improvement of designs. AutoCAD software is utilized to increase design efficiency, improve design quality, enhance communication through documentation, and create a manufacturing database.

Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) tools are used to develop automated die design packages. An automated progressive die design system has been created with twenty-seven knowledge-based modules. These modules were developed using various production rules. The system is designed for user-friendly interaction, allowing for the automation of key die design tasks such as verifying the features of sheet metal components, identifying progressive die parts, and modeling forming tools in progressive dies. The knowledge-based system module uses AutoCAD software, making it cost-effective and accessible for medium-sized industries.

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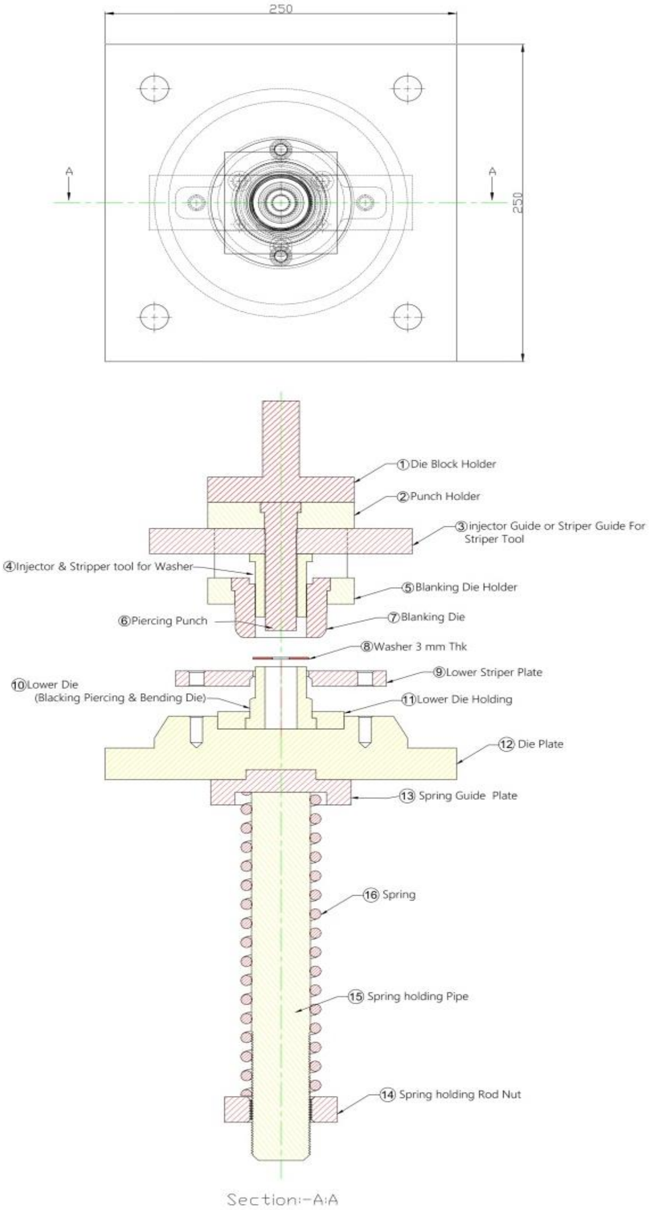
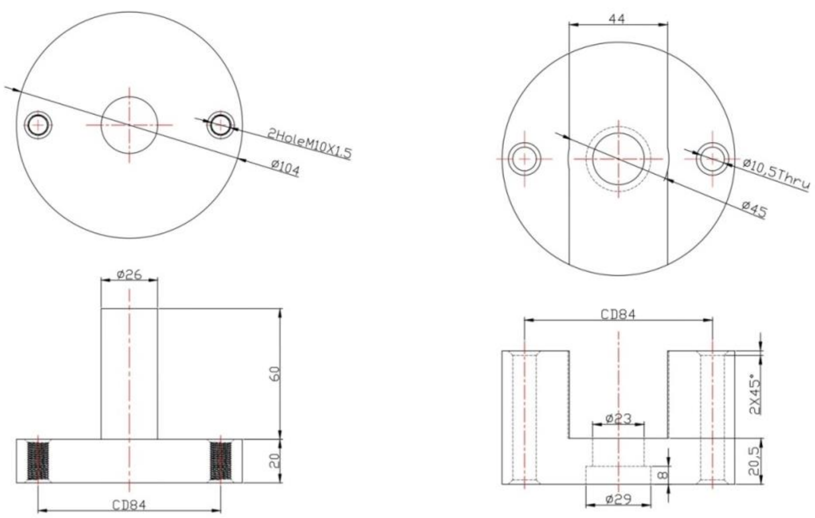


Fig 2: complete die setup of Compound die



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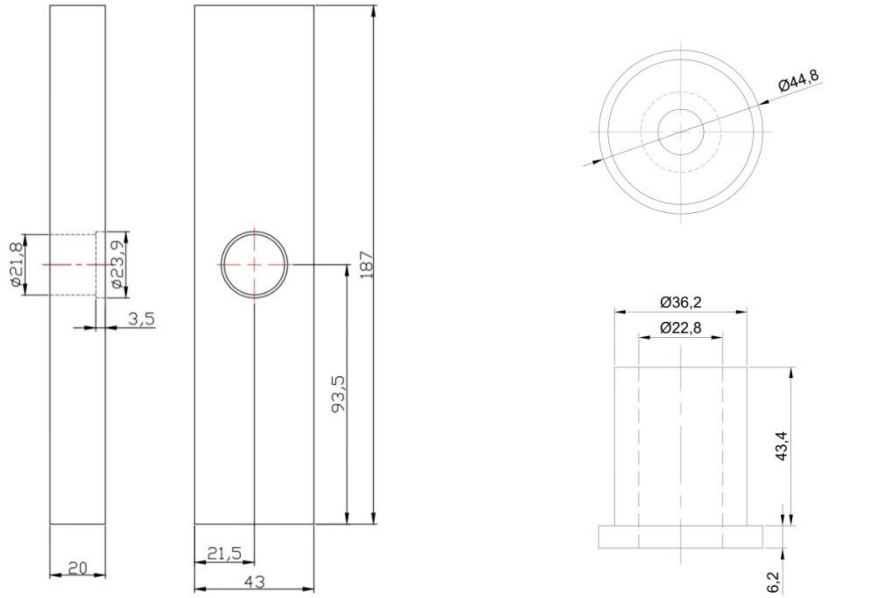

Fig 3,4,5,6: Design of Die block holder, Punch holder, Injector Guide and Injector

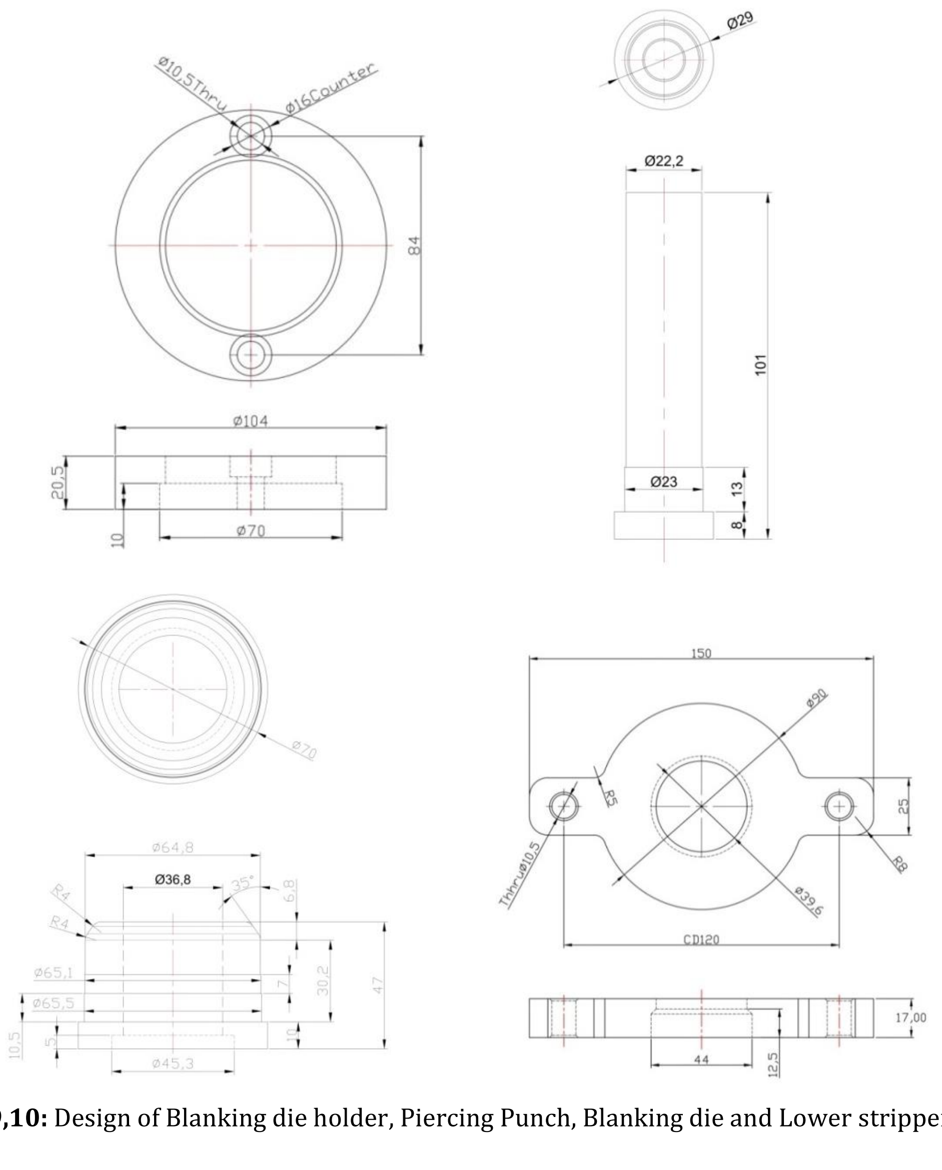

Fig 7,8,9,10: Design of Blanking die holder, Piercing Punch, Blanking die and Lower stripper plate

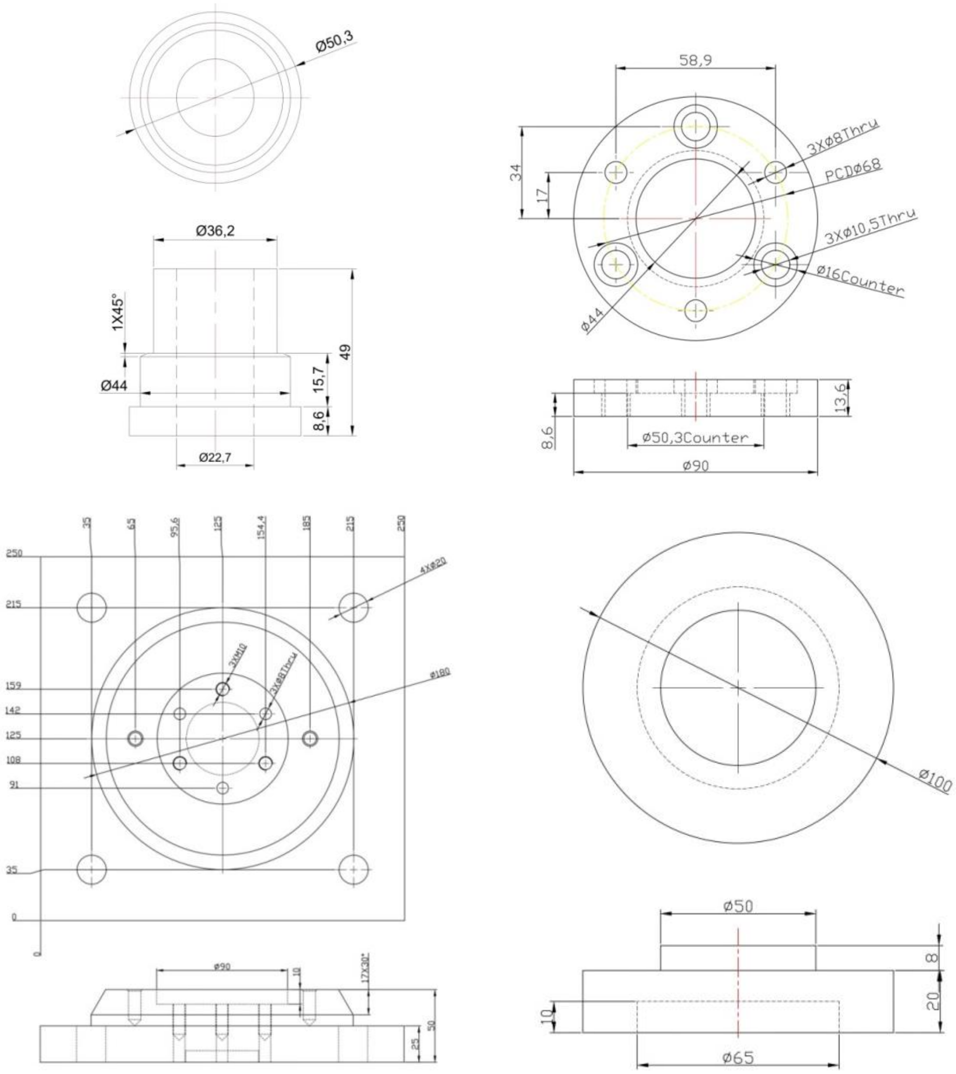

Fig 11,12,13,14: Design of Lower Die, Lower Die holder, Die plate and spring guide plate

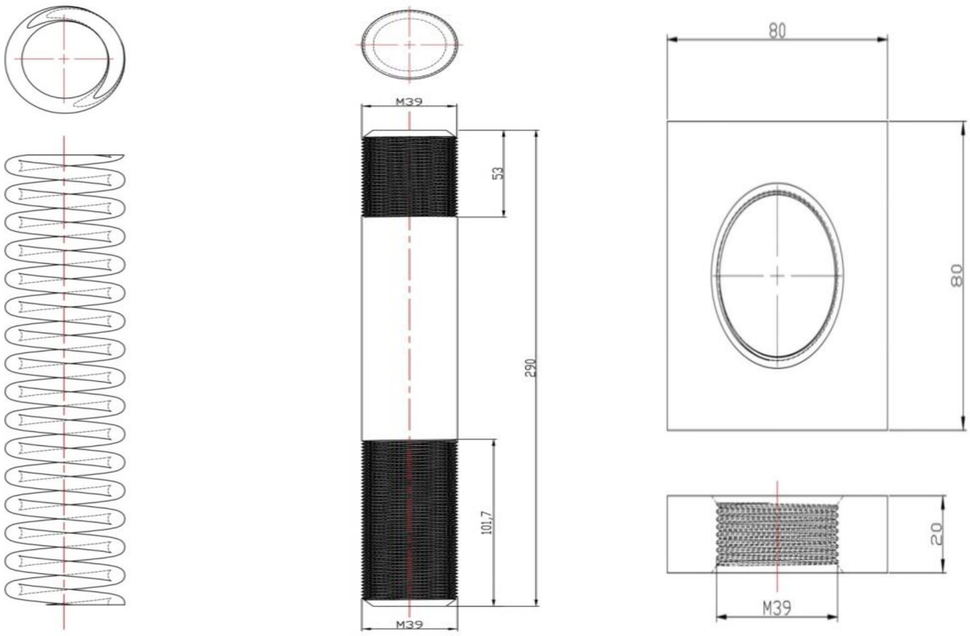

Fig 15,16,17: Spring for deflection, spring holding pipe and spring holding nut

Fig 18: Actual pictures of mechanical power press , die plate, die block and spring holding Pipe

Fig 19: Actual Pictures of Piercing punch, Blanking die, Lower die and Injector

Die manufacturing

Dies are manufactured using CNC lathes, CNC milling machines, and CNC drills. The materials used for the die components include: Mild Steel (M.S.): Mild steel is cost-effective and easy to shape, although it has lower tensile strength. Its surface hardness can be improved through a process called carburizing. When large cross-sections are used to minimize deflection, the likelihood of failure due to yielding is low, making low-carbon steels a suitable choice, such as for structural steel. EN-31: EN31 is a high-carbon alloy steel recognized for its significant hardness, strong compressive strength, and resistance to wear.

D2: Cold-work tool steels are categorized as high-carbon, high-chromium steels, also known as group D steels. This group includes D2, D3, D4, D5, and D7 steels, which have carbon content ranging from 1.5% to 2.35% and chromium content of 12%. All group D steels, except for D3, contain 1% molybdenum and are hardened in air. D3 steel, on the other hand, is oil-quenched, although smaller sections can be gas quenched after austenitization in a vacuum. Consequently, tools made from D3 steel can become brittle during the hardening process. Among the group D steels, D2 steel is the most widely used.[5]

Die parts:

Die Block Holder: This is the upper section of the die block that connects to the power press ram and is made from mild steel (MS).

Punch Holder: Located in the middle of the die block, this part holds the punch and is also made of MS material.

Injector Guide: A flat bar that assists in ejecting the manufactured plain washer from the die block using the injector, made from MS material.

Injector: Constructed from En31 material, this component is responsible for injecting the manufactured plain washer.

Blanking Die Holder: This is where the blanking die is placed.

Piercing Punch: This punch is used to create a hole in the inner diameter of the plain washer.

Blanking Die: This die is utilized to cut the outer shape of the plain washer.

Lower Stripper Plate: This plate is attached to a silver round bar and operates with spring deflection.

Lower Die: This is a multifunctional die that facilitates bending, piercing, and blanking due to its design.

Lower Die Holder: The lower die is secured in this holder, which is connected to the die plate using an L-key bolt.

Spring: The spring provides the necessary deflection to push the sheet away from the lower die.

Heat Treatment

During the heat treatment process for blanking dies, piercing punches, injectors, and lower dies, these components are heated to a specified temperature at a controlled rate to achieve the desired structural changes. They are then maintained at this temperature for a set duration before being cooled in a specific oil at a controlled rate. This process is primarily aimed at increasing the hardness of the dies. The hardness of the blanking die, piercing punch, injector, and lower die should fall within the range of 55-62 HRC. D2 steel exhibits minimal distortion when properly hardened, and the chromium content in D2 provides some resistance to corrosion in its hardened state.[6]

Die fitting

The fitting of the die is a crucial step where we assemble all the die components and verify their alignment. In the fitting section, we first connect the die block parts and adjust the block to minimize errors between the piercing punch and the blanking die. Next, we check if the injector is moving up and down properly. Then, the die plate is secured onto the bed plate of the power press. Following this, the spring holding pipe is attached to the die plate using a threaded connection, and the lower die is fastened with an L-key bolt. A pin from a round bar is then placed in the lower die holder, and the lower stripper plate is clamped to the die plate. Finally, we ensure that all 14 parts of the die are properly aligned.

IV. RESULT & DISCUSSION

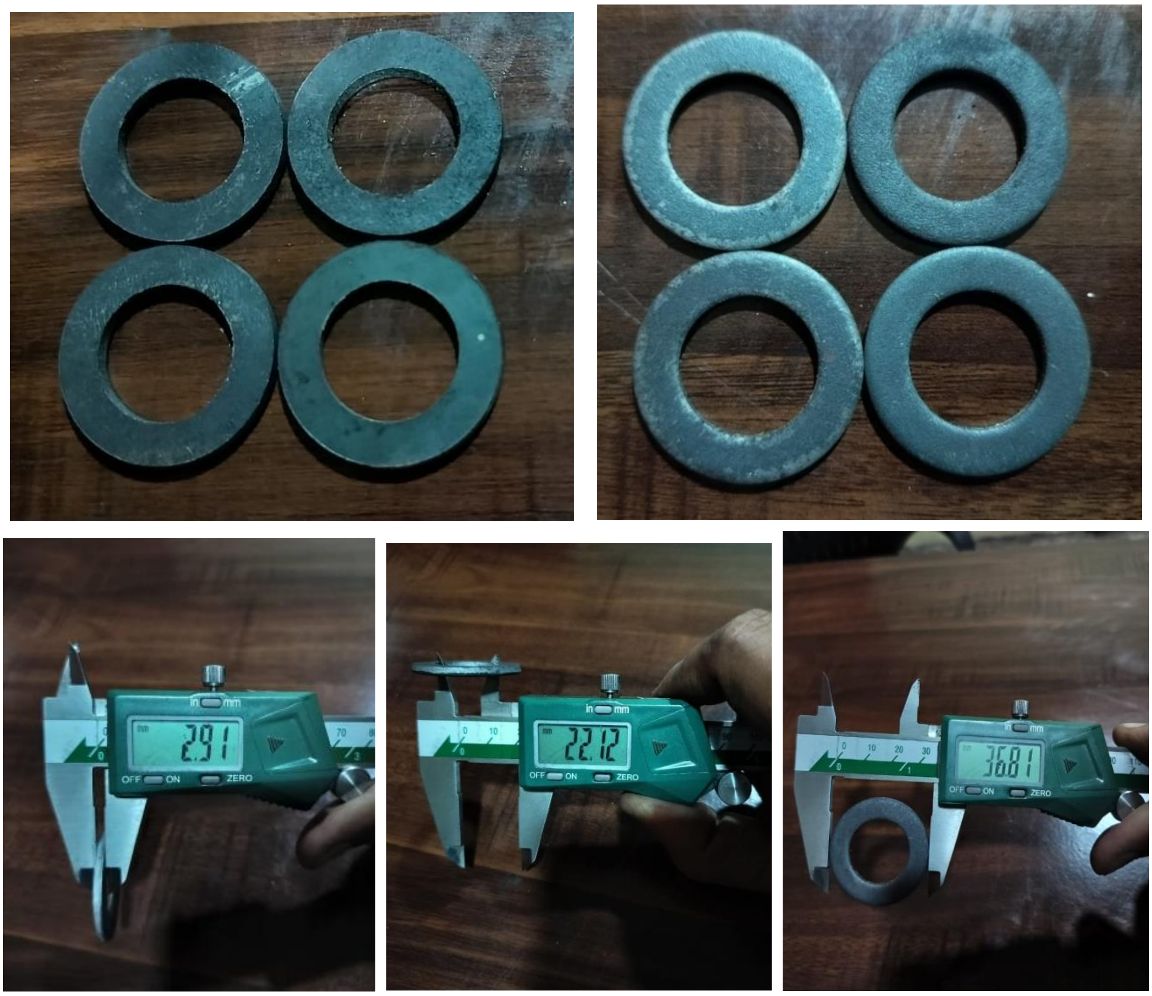

Fig 20: Manufactured product (M20 plain washer) and dimension under IS2016 standard

Cost estimation: In the press manufacturing process, a significant portion of the costs is attributed to expenses related to tools, labor, and maintenance. Tooling costs refer to the expenses associated with the raw materials needed to create the tools. Press tools are made from hard and costly materials, such as oil-hardened non-shrinkage steel and high carbon high chromium steel, which contribute to higher costs. Additionally, because these materials must be machined with precise tolerances, they require advanced and specialized machinery, further increasing tooling expenses. However, the use of compound dies in press machining allows for some control over these costs. The focus here is on finding ways to reduce tooling expenses.

Table 1: Tooling cost comparison

Sr. no	Description	For existing method		For compound die method	
		Weight	Total cost	Weight	Total cost
1	Mild steel for plate and die block Rate of each Kg of Rs 68/- per kg	110 kg	7480/-	55 kg	3740/-
2	High Carbon High chromium steel material for punch and dies (210 per kg)	45	9900/-	5 kg	1050/-
3	Guide piller or Injectors made of high carbon steel	6 piller required/1500 per piller	9000/-	2 kg MS flat bar	140/-
4	Fastners & other things required	6 kg fastners	600/-	6 kg fastner & others	1400/-

5	Manufacturing cost for die, punch and other die parts		18000/-		5000/-
6	Additional charges on die (50% of manufacturing cost)		7500/-		2500/-
	Total cost required for manufacturing of dies		52480		13830

Die cost reduction = (52480-13830)/ 51112 = 32572 / 51112 = 0.7561 = 75.6%

Time Study

Time study is a crucial concept when transforming existing dies into compound dies that perform three operations with a single die. By assessing the actual time taken to manufacture a product using both the existing and compound die methods, we can determine the savings in machining time and material handling time. In power press operations, a significant amount of time is spent on material handling, while machining time is relatively minimal in comparison. Since material handling time is greater, it leads to increased idle time for the machine, which impacts the cycle time for producing a single product. Consequently, the overall production rate is influenced by the time spent on material handling.

Table 2: Time study for existing Die

Sr. No	Stages	Operation	Time(sec)	Quantity/hour
1	First Stage	Blanking of 37 mm circle	1	1200 **(with help of 2 machine)**
		Material handling after blanking	1	
2	Second Stage	Piercing of 22 mm in 37 mm circle	1	
		Material handling after piercing	1	

Table 3: Time study for compound Die

Sr. No	Operation	Time (sec)	Quantity/hour
1	Combine operation (Piercing, and Blanking)	0.5	4800 **(with help of one machine)**
	Material Handling after completion of stroke	0.5	

The introduction of a new die has led to significant savings in raw material handling, as well as the completion of two operations with a single stroke of the power press. This innovation has greatly accelerated the production of plain washers, resulting in higher output compared to using a simple die and requiring only one power press and minimal manpower for production.

% increase in production = ((4800-1200)/1200) ×100 = 300%

Increase in production rate due to compound die is 300 %

Comparison of tool and per unit manufacturing cost

Comparison of tool and per unit manufacturing cost based on dies used during production of M20 plain washer. Observation takes place in BHARAT FASTNERS (M:7643800176), Raipur.

Table 4: Comparison of both die

Die	Existing Die (simple die)	Compound Die
Die cost	52430 INR	13830 INR
Maintenance cost	3 INR per kg	1 INR per kg
Raw material cost	2.4 INR per piece	1.65 INR per piece
Shearing machine cost	6 INR per Kg	2 INR per Kg
Labour cost	12 INR per kg	3 INR per kg

Productivity	1200 piece per hour	4800 piece per hour
Per unit cost	1.68 INR	1.1 INR

V. CONCLUSION

- Significant savings in raw material handling and operations are achieved with a single stroke of the power press, leading to rapid production of plain washers.
- A compound die has been developed for plain washers instead of a simple die, resulting in a 75.6% reduction in tooling costs due to decreased raw material requirements for the compound die.
- The use of the compound die has increased production rates by 300% and lowered maintenance costs by 66.6%.
- Labor costs have decreased by 75%, which directly impacts the per-unit cost of the product.
- The unit cost of the product has been reduced by 36% thanks to the compound die, as it shortens both the cycle time of operations and material handling time, allowing for the production of washers from sheet metal scrap.
- The new tool can be used in large-scale manufacturing to create uniform parts with precise geometrical tolerances. The advantages of using a compound die include time efficiency, reduced movement of the part which minimizes operator fatigue, and lower labor and production costs. A one-time investment in the necessary equipment will guarantee a consistent supply of high-quality products, leading to significant profits for manufacturers.
- This Compound die setup maintain a straightforward mechanism while ensuring that all necessary requirements are met.

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VI. REFERENCES

[1] B. F. Satpute, M.S. Harne 2017. Design and Development of Compound Die for Bearing, IJRERD, Volume No. 02, No. 01, PP. 50-61.

[2] Skampardonis Nikolas, Tsirkas A Sotirios, Grammatikopoulos Spyridon. Design and analysis of an industrial, progressive die for cutting and forming, Research square, GR-26334 Patras, Greece.

[3] Pawan Kumar Singh, Pawan Kumar, DESIGN AND DEVELOPMENT OF COMBINATION DIE FOR CUP WASHER, IRJMETS, Volume:06/Issue:09/September-2024.

[4] Hiren Patel, Vraj Patel, Gaurang Patel, Devang Patel , Kalpesh Parekh. DESIGN & ANALYSIS OF POWER PRESS MACHINE FRAME, IRJMETS, Volume:02/Issue:07/July-2020.

[5] D. Subramani, V. Dinesh Kumar, S. Jamilbasha, 2020. Design and Stress Analysis of Washer Tool, IJARESM, Volume 8, Issue 8.

[6] Kiran Kumar, K Venkatesan, B Saikrishna Srikar, 2019. Design and Modeling of a Single Stroke Compound Die for Concentric Washers, Volume 8, Issue 2.

[7] Gaurav C. Rathod, Dr. D. N. Raut, Samadhan Adlinge.Study and Analysis of Press Tool Design, IJERTV6IS070033,Vol. 6 Issue 07, July – 2017.

[8] Wael Hekmat Ahmed Shaheen, Sangarapillai Kanapathipillai, Philip Mathew. Optimization of compound die piercing punches and double cutting process parameters using finite element analysis, Part B Journal of Engineering Manufacture 234(1-2):3-13.

[9] N. Jyothirmayi , Dr. B. V. S. Rao. The Design and Fabrication of a Compound Die to Make Hexagonal Washer, International Journal of Mechanical and Production Engineering Research and Development, DOI:10.24247/ijmperdaug201951, Jan 2019.

[10] Mr. Vijaysing Thau Rathod, Dr. Brajendra Nath Tripathi, Dr. Nandkishor M Sawai. Review on Virtual design system of compound die for Press Machine, IJERA, Vol. 10, Issue 10, (Series-V) October 2020, pp. 25-29.

[11] Pushpak Kalokhe, Varun Raijade, Piyush Patil, Vikas Patil, Prof. R.S. Patil. DESIGN AND ANALYSIS OF PIERCING TOOLS, IRJMETS, Volume: 03/Issue:05/May-2021.