MECOMARE, 14 (2) (2025) pp. 57-64

Published by: TRIGIN Publisher

International Journal of Mechanical Computational and Manufacturing Research

Journal homepage: www.trigin.pelnus.ac.id

Solid block to assembly block conversion on a welding

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ARTICLE INFO

Article history:

Received Aug 4, 2025
Revised Aug 10, 2025
Accepted Aug 18, 2025

Keywords:

Assembly;
Machine Grinding;
Machine Mash Weld;
Stopper;
Welding.

ABSTRACT

Block damage often occurs due to the pressing process and the presence of residual welding dirt on the slug so that a repair process is needed by means of grinding. If there is damage to the solid block, repairs are carried out on all sides of the block so that this is less effective and efficient in repair time. This research was conducted by changing the design of solid blocks into assembly blocks which aims to make the process of repairing blocks effective and efficient. To find out the results of the differences between solid blocks and assembly blocks, a trial was carried out by calculating the repair process time using a grinding machine with a depth of 0.04 mm. The results of the solid block repair process trials obtained an average of 397 seconds while the assembly blocks obtained an average of 248 seconds. Thus cutting the repair process time by 149 seconds. With this design change, the effectiveness and efficiency of block repair time is obtained.

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1. INTRODUCTION

The swift advancements in technology within the manufacturing sector today have resulted in more intense competition among firms. To stay competitive, businesses must consistently innovate and efficiently produce high-quality products (Rahmadhani et al., 2014; Sinambela, 2020). This has compelled the manufacturing sector to enhance machine tooling to optimize the production process and uphold the quality of the final product. Maintaining machine quality necessitates productivity enhancements that can influence the efficiency and effectiveness of a machine and tooling, allowing for more effective and dynamic operation (Toasa Caiza et al., 2025). For instance, PT.X enhanced the block on its welding press machine to save on repair time and consequently lower production expenses for welded parts. The block acts as a device that provides a space for the slug to be pressed in the welding zone (Miao et al., 2025). Block damage often occurs due to the pressing process and the presence of residual welding slag on the slug, necessitating a repairing process invloving grinding. If this in not taken into account, it will affect the quality of the production because it has the potential to cause defective products. Welding is an integral part of the manufacturing process. Welding is a metal joining technique that involves melting a portion of the base metal and filler metal, with or without pressure, and with or without additional metal, resulting in a continuous joint (Haryanto et al., 2011; Kolokas et al., 2024)

Manufacturing processes, for example welding, are often carried out in companies that produce machine components and others (Sreerag et al., 2024). PT X is a manufacturing firm focused on producing mechanical components for the aerospace sector, including spare parts for different types of aircraft, with seals being one of the items manufactured. Seals are a sealing or coating arrangement made up of components like metal, and this main seal is combined with additional system parts including flanges, clamps, adjusters, and valves to form a comprehensive sealing system that stops leaks (Haider et al., 2022) (Łastowska et al., 2025). Seals are frequently utilized in hydraulics, cylinder block connections, and various other applications (Tijs et al., 2024). Seals are frequently utilized in cylinder block connections, hydraulics, and other fields. For instance, a pneumatic system comprising an air compressor, directional valves for control, and an air service unit was used to design, produce, test, and run an automatic stamping machine (Jagadeesan et al., 2019).

The surface of a large stainless-steel sheet shippedfrom a steel mill is not glossy and polishing is essential to reach a practical surface finish. The process of mechanically polishing steel sheets can be roughly divided into two processes. The first processis a “roughgrindingprocess” that removes the work-hardened layer of the steel sheet while improving the flatness of its surface (Mizobuchi et al., 2022). The process of seal production includes multiple steps, beginning with mold creation, blending raw materials, followed by shaping and finalizing (Dvirna, 2024). Seals frequently utilized in diverse applications, including the automotive and manufacturing sectors, demand high precision and quality materials. During the creation of these seals through various methods, one of which involves the welding pressing machine method (Roh & Kim, 2025).The primary technical factors causing damage to solid blocks include thermal stress accumulation, repeated mechanical loading, and material fatigue due to continuous operational cycles. In many production environments, solid blocks are subjected to high localized heat during machining or welding, which induces microstructural changes and can lead to cracking. Additionally, vibration and impact loads from adjacent machinery contribute to gradual wear and deformation. Another significant factor is surface abrasion caused by constant contact with workpieces or cutting tools, which accelerates dimensional inaccuracies and surface degradation (Sabry, 2024). This welding pressing technique occurs when the seals have not yet created a profile or are still in a slug form in the pressed item with a solid block (Dzulfian Syafrian, 2025). It is noted that the pressed seals generate considerable slag, necessitating time for cleaning the slag through a grinding process (Rahman, 2019) (Maierhofer et al., 2024).

The main issue addressed in this study is enhancing the welding press machine by transforming the solid block into an assembly block, which aids in decreasing the time needed for repairs when utilizing a grinding machine. Damage frequently occurs in areas like striped and dent blocks; when a block area is striped, the slug intended for the welding press process will be rejected, as the slug may also have stripes (Ardiansyah et al., 2024). This research aims to modify the solid block's design into an assembly block and perform repair tests on both the solid block and assembly block to assess the repair time's effectiveness. (Diah Larasati et al., 2024)

2. RESEARCH METHOD

This type of research is part of qualitative research, involving direct observation in the field. This research was conducted by changing the design of solid blocks into assembly blocks which aims to make the process of repairing blocks effective and efficient. To find out the results of the differences between solid blocks and assembly blocks, a trial was carried out by calculating the repair process time using a grinding machine with a depth of 0.04 mm. The study was carried out at PT. X, a company in the aerospace sector. The conversion of solid blocks into assembly blocks was the subject of the study. The image's flowchart illustrates the phases of the research.

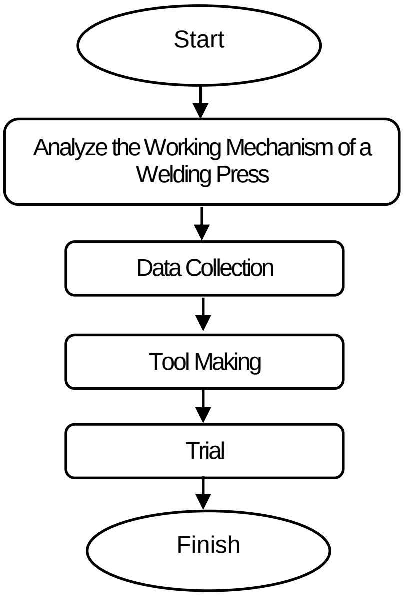

Figure 1. Flow chart

The first stage was to examine the welding press machine's operation in order to pinpoint regions that were vulnerable to damage. By segregating the regions where damage usually occurs, this served as the foundation for the tool's design (Chen et al., 2024). The block assembly is then fabricated, and repair trials were carried out by grinding the block's damaged core section. Additionally, the repair times of block assemblies and solid blocks were compared (Mosora et al., 2024).

Problem Identification

By exerting pressure, the welding press machine flattens the welding results (Galingging & Arif, 2022). Damage frequently results from pressing the blocks. This necessitates ongoing block improvement. The solid nature of the existing block design makes it less effective and necessitates a lengthy repair process because grinding must be done on both sides of the block.

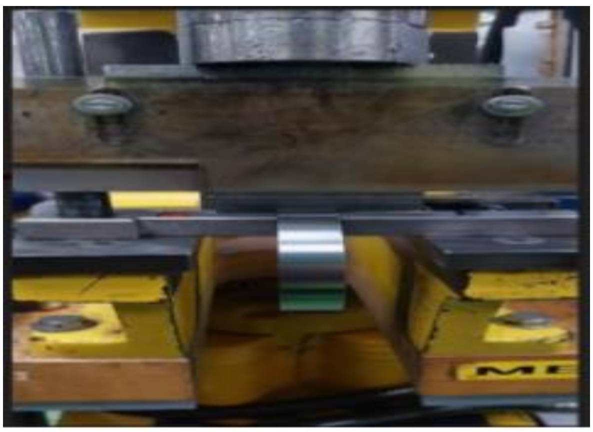

Figure 2. Welding press machine

Seals are one of PT X's products that are made with a welding press machine. When the seals are still in slug form or have not yet been profiled, this procedure is carried out. However, welded products are generally not resistant to corrosion. Therefore, a proper production process will produce products that are not affected by corrosion after the welding process is carried out, so that the production process is carried out as expected (Rodrigues et al., 2019).

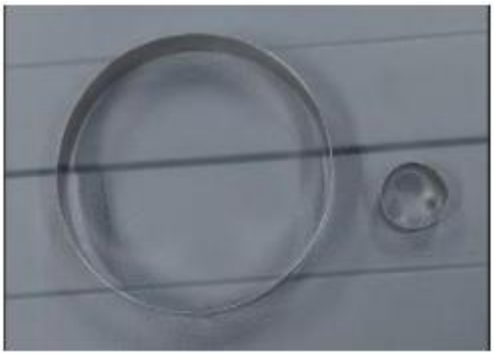

Figure 3. Slug

Data Collection

The research conducted involves changing solid blocks into assembly blocks on the machine to make it more effective and efficient during repairs. In the initial stage, the author will calculate the time during the solid block repair process using a grinding machine. The tools used in this initial stage are a stopwatch, writing materials, and a grinding machine. The next step is to identify the blocks that are frequently damaged due to uneven welding residue causing dents. In this stage, the author attempts to analyze the working mechanism of the welding press to determine which parts are most prone to damage. This research focuses on the block areas that are frequently in contact during the pressing process. The identification stage has already obtained damage data from the next block section, and the next step is the design process. The design change in the tooling for this study involved separating the block areas that frequently experienced damage from the other areas. At the design stage, the principle that must be met is to speed up the block repair process. The tools or software used in the design process are SolidWorks and the measuring tool, the vernier caliper. The solid block whose design will be changed is as shown in Figure 4.

Figure 4. Solid block

Tools Design

The design of this block assembly was changed by separating the frequently damaged block area from the rest, resulting in two parts: the core block and the holder block. The core block is 63.5 mm long and 12.573 mm wide, and it is the area where damage frequently occurs and where the slug sits during the welding process. The holder block is 129.54 mm long and 25.40 mm wide, with a hole in the center for the core block to sit in. There are also additional parts like screws, springs, and pins, which are used to center the core block with the top block. The block assembly design can be seen in Figure 5.

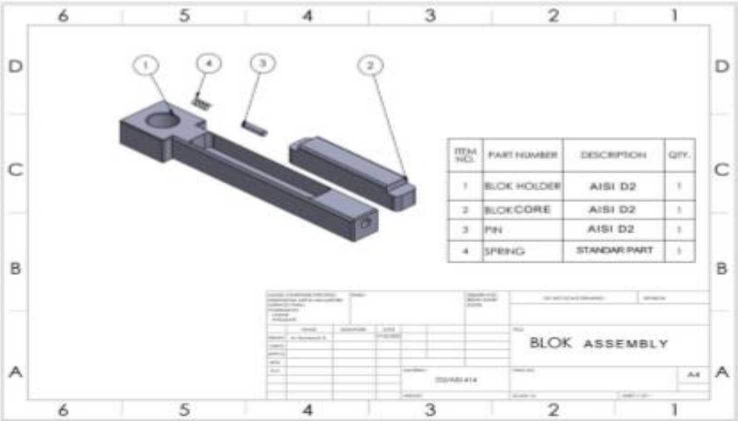

Figure 5. Design of assembly block

3. RESULTS AND DISCUSSIONS

Block damage can potentialyly lead to product defects. This defect can compromise the integrity, strenght, and esthetic appearance of welded structure. It can arise from various factors, including improper welding techniques, material issues, or environmetal conditions. Defects can weaken the structure, potentially leading to failure. Ensuring the quality of welding is crucial for the safety or structures and equipment.

In the tool manufacturing process, the material used is AISI D2. The reason for using this material is that it is readily available at the company and is commonly used for tooling production. And this type of steel is suitable for applications such as cold work, hot work, shock resistance, molds, high-speed and special-purpose tool steels. This AISI D2 steel has a high carbon and chromium composition (Kim et al., 2023). The next step is the fabrication of the tool. Once the proposed and simulated design has been approved by the company, the fabrication process can begin. After that, the completed tooling must undergo a trial process. For long-term analysis, production data is collected over a minimum period of six months after full adoption of assembly blocks. This data includes the number of rejected products per production cycle, documented weld defect rates, and reasons for rework or disposal. Statistical analysis is then applied to determine whether the assembly block conversion results in a sustained improvement in weld quality and a reduction in product rejection rates. This approach ensures that the assessment covers both the immediate technical performance and the extended operational reliability of the new design. The block assembly can be seen in Figure 6.


Figure 6. Assembly block

During the trial, the researchers performed several processes, such as adjusting the stoppers according to the block dimensions for solid blocks, using a stopper spacing of 65x100 mm with a depth of 0.03 mm, as shown in Figure 7.

Figure 7. Setting the stopper using a solid block

For the assembly block, use a stopper distance of 45x50 mm with the same depth of 0.004 mm, as shown in Figure 8.

Figure 8. Setting the stopper using an assembly block

To determine the difference in results between solid blocks and assembly blocks, a testing phase will be conducted with 2 trials, calculating the repair process time using a grinding machine at a depth of 0.04 mm. The comparison of time during the repair process of solid blocks and assembly blocks using the grinding machine is shown in Table 1.

Table 1. Comparison results of profile point specifications before and after modification

Experiment	Solid Block Repair Time (Seconds)	Assembly Block Repair Time (Seconds)
1	411	249
2	384	247
Average	397	248
Comparison of Repair Time Results: 149 Seconds		

It is evident from Table 1's test results, which were obtained using a 0.04 mm depth grinding machine, that the assembly block may be repaired 149 seconds faster than the solid block.

4. CONCLUSION

The repair process takes less time when solid bricks are swapped out for assembly blocks. According to the testing, repairs with solid blocks took an average of 397 seconds, whereas repairs utilizing assembly blocks took an average of 248 seconds, resulting in a 149-second reduction in repair process time. A grinding machine with the same depth of 0.04 mm is used in this repair. The block repair time is made more effective and efficient with this design modification. This research could be continued by collecting more data after converting the solid block to an assembly block. To ensure the assembly block design can be widely adopted on production lines without disrupting existing workflows, several implementation strategies should be considered. First, gradual integration through pilot runs on selected production lines can help identify potential adjustments before full-scale deployment. Second, providing technical training for maintenance and production personnel will facilitate a smooth transition and minimize errors during the repair process. Third, standardizing the assembly block specifications and ensuring compatibility with existing machinery will prevent bottlenecks and eliminate the need for major equipment changes. Finally, establishing a feedback and monitoring system during the early adoption phase will enable continuous improvement of the design and its integration into standard operating procedures. This research could be extended by collecting more operational and maintenance performance data after the full conversion from solid blocks to assembly blocks. For further research, it is recommended to conduct a comprehensive cost–benefit analysis over a full fiscal year to quantify the impact of the assembly block design on annual production costs. This should include measurements of labor savings, reduced downtime, and potential changes in spare part consumption. In addition, long-term monitoring of machinery that uses assembly blocks should be performed to assess any effects on machine service life, including wear patterns, maintenance intervals, and component replacement frequency. Combining these economic and technical evaluations will provide a more complete understanding of the assembly block design's overall value to production operations.

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