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Regular Research Article

Welder Qualification Requirements for Midship Block Assembly of a 3702 GT Barge

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Abstract: Precise and efficient welding is required in the assembly and erection of the 3702 GT barge block system. A mismatch between the number of welders available and actual needs in the field can affect production time and cost efficiency. The purpose of this study is to determine the number of welders and electrodes required in the assembly of the 3702 GT midship barge block, which is expected to serve as a reference in the planning and management of welders and materials in the shipbuilding process. A quantitative approach was taken by collecting technical data, namely welding length, fillet volume, welder productivity, and work efficiency. The data was obtained from technical documents, field measurements, and three-dimensional modeling of the 3702 GT midship barge block. The analysis results show that the total welding length in fabrication reaches 1.361 meters, while in erection it reaches 126 meters. with a welding volume of 31,184 cm³ and an electrode requirement of 326.39 kg. With the application of 35% work efficiency of welders in the field, the requirement for welders for the assembly of the midship barge block was eight welders with a duration of seven days.

Keywords: welding; block system; welder; barge; electrode requirements

1. Introduction

The shipbuilding industry plays an important role in the global economy, particularly as a means of transporting goods and passengers between countries around the world. In the maritime industry, barges (pontoons) are widely used to carry large and heavy loads, especially in waters that are difficult to access by larger ships. The barge assembly process must be designed and built with a high degree of precision to ensure safety and operational efficiency [1].

The fabrication process of the barge hull construction is based on the planning results and adjusted to the facilities and infrastructure conditions of each shipyard. One of the fabrication methods used for barge or ship construction is the block method [2]. The block method is the application of a block system, starting from fabrication, sub-panel assembly, panel assembly, sub-block assembly, to block assembly, until becoming a complete vessel [3].

Furthermore, to produce good ship construction quality, skilled and experienced fitters and welders are needed to avoid deformation that could reduce the structural strength or operational efficiency of the ship [4]. The midship block assembly process of the 3702 GT Barge requires high-quality welding and construction precision because it functions as the structural backbone of the vessel [5], However, the availability of welders in Indonesian shipyards often fluctuates due to non-continuous project demands throughout the year[6]. The welder requirement can be defined as the number of welders needed to complete a certain welding workload within the project time constraints [7].

Based on the above background, this study aims to calculate the requirements of welders, welding electrodes, and time for the assembly

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process of the midship block of the 3702 GT barge. This research is expected to support effective and efficient planning and management of welders, electrode needs, and project duration to optimize shipyard production processes.

1.1. Qualifications, Ectrode and Welder Requirements

Biro Klasifikasi Indonesia (BKI) establishes the qualifications for plate welders and the materials to be welded, which include forged and cast steel. BKI requires welders to be certified at Grade 3 with positions 1G, 2G, 3G, (v-d), 4G, 1F, 2F, 3F, and 4F. For plate welders, the welding positions are divided into several types, namely 1G or 1F for downhand welding on butt and fillet joints, 2F for horizontal-vertical welding on fillet joints, 2G for horizontal welding on butt joints, 3G or 3F for vertical-up welding on butt and fillet joints, 4G or 4F for overhead welding on butt and fillet joints, and (v-d)G or (v-d) for vertical-down welding on butt and fillet joints. [8].

The need for electrodes in ship construction is crucial because it is directly related to cost efficiency, timely execution, as well as the quality and safety of the ship's structure. Accurate calculation prevents material waste, avoids project delays due to lack of stock, and ensures that the weld joints produced are strong, standard-compliant, and defect-free. In addition, proper electrode requirement planning supports quality control, facilitates project supervision, and fulfills the technical requirements of classification bodies and maritime industry regulations. The calculation of welding electrode requirements is performed using Equation (1), where the weight of the deposited metal (W) in kilograms is calculated with Equation (2), the welding volume (V; cm^3) is calculated using Equation (3), with the specific density of carbon steel ($\rho \approx 7.85$ gr/cm^3), and mass (m; gr).

$$\text{Electrode Requirement} = \frac{\text{Weld Metal Weight (kg)}}{\text{Electrode Efficiency}} \tag{1}$$

$$W = \frac{V \; x \; \rho}{1000} \tag{2}$$

$$V = l \; x \; A \tag{3}$$

The calculation of the number of welders aims to determine how many welding workers are required so that welding tasks can be completed on time according to the production target. The number of welders depends on the total workload, individual welder productivity, and available working time.

$$Number\ of\ Welders = \frac{L}{(v \times T \times D \times E)} \tag{4}$$

$$V\ avg = \frac{Le}{te} \tag{5}$$

The main principle is dividing the total work volume by productivity and working time to obtain the optimal number of welders for efficient completion. The calculation of the number of welders can be performed using Equation (4), where L (total joint length; m), v (average welding speed: m/hour) is calculated using Equation (5), T (working hours per day per welder: hours/day), D (project duration: days), and E (welder work efficiency; in %).

2. Materials and Methods

This study is categorized as quantitative research, complemented by data such as the main dimensions of the barge, welding procedure specification (WPS), welding schedule documents, midship construction drawings, and field observation results. The object of the case study for welder and electrode requirements in assembling the midship block of the 3702 GT barge is shown in Table 1 and Figure 1.

Table 1 Main Dimensions of the Barge

Data	Main Dimensions (m)
Barge Name	BG. KLS 16
LOA	87,78
B	25,60
H	6,10

For visualization of the joint connections between supporting construction elements of the panel and block, a 3D design model was created. Field observations were conducted to calculate welder requirements, including average welding duration per electrode, welding length per electrode, welding positions, groove types, number of layers, and joint types.

Figure 1. Barge 3702 GT

The Welding Procedure Specification (WPS) is a planning document for welding execution that includes the construction methods, procedures, and all necessary technical details. WPS serves as a guideline to ensure the welding process meets design and specification requirements [9]. The welding schedule is a structured technical document containing detailed regulations on the welding process, including type, current, voltage, time, pressure, and sequence of operations, designed to ensure weld quality and consistency while minimizing defects.

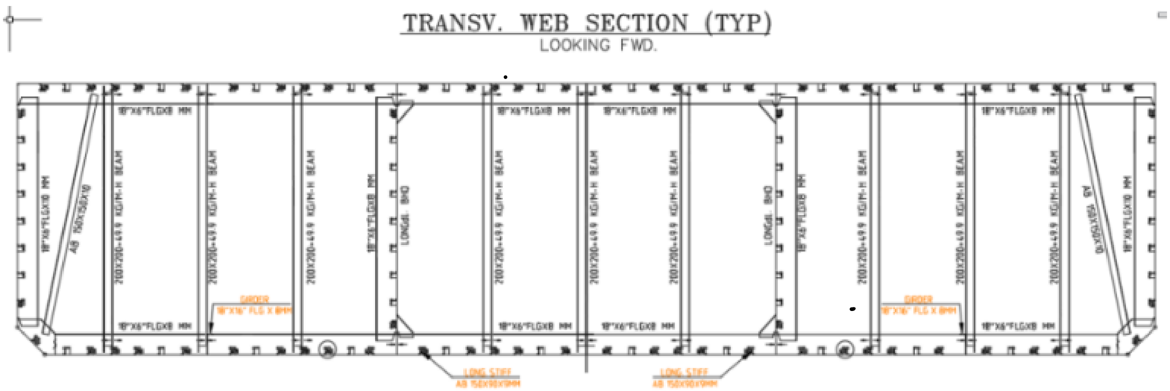
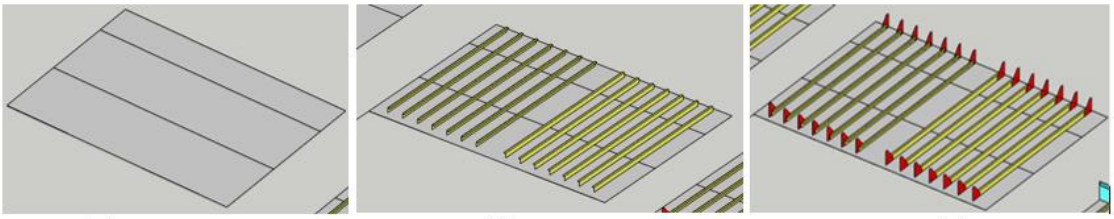


Figure 2. Midship Construction

The welding schedule is a structured technical document containing detailed regulations on the welding process, including type, current, voltage, time, pressure, and sequence of operations, designed to ensure weld quality and consistency while minimizing defects. The 3702 GT barge uses a longitudinal structural system as the main load-bearing framework, combined with transverse structural elements in the after peak (stern) and fore peak (bow) areas. The midship section is reinforced with side shell plates, supporting girders, and other structural elements to ensure rigidity during cargo loading.

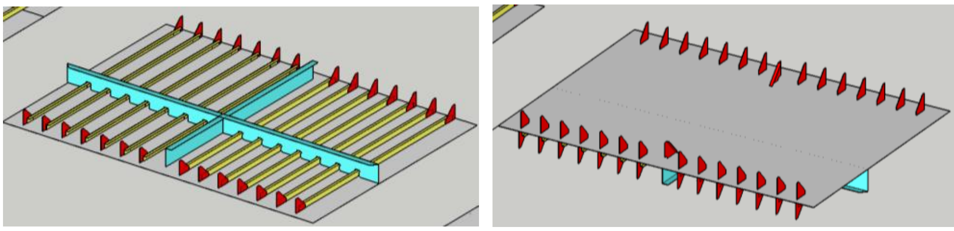
3. Results

3D modeling of the fabrication of the midship block of the 3702 GT Barge was carried out up to the panel assembly stage, namely the transversal bulkhead, longitudinal bulkhead, main deck, and bottom plan, as well as the erection of the midship block. The assembly of the transversal bulkhead panel (center section) begins with the joining of plate components as shown in Figure 3, fitted with butt joints (butt weld type) and a welding length of 1,708 cm on one side. The connection of 14 stiffeners to the bottom plate is performed using intermittent tee joints (fillet weld type) with a total welding length of 8,140 cm on both sides. Next, 28 brackets are welded to the left and right sides of the stiffeners, with a total welding length of 1,856 cm. Horizontal and vertical stringers are then fitted and welded to the bottom and stiffeners with a welding length of 6,090 cm. Finally, the panel is flipped for downhand welding and 28 rear brackets are added to the back side of the transversal bulkhead as shown in Figure 4, with a welding length of 1,994 cm. The total welding length for the transversal bulkhead panel is 395.76 meters, obtained by summing the lengths of bulkhead frames Fr. 21 (19,788 cm) and Fr. 26 (19,788 cm).



(a) (b) (c)

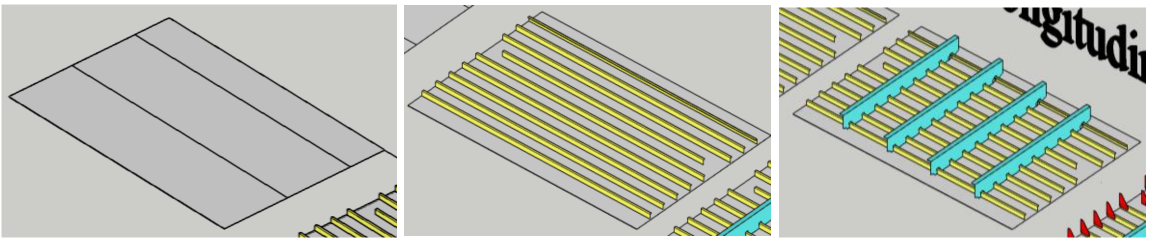
Figure 3. Joint (a) Transversal bulkhead plate, (b) Stiffener to transversal bulkhead plate, and (c) Bracket to vertical stiffener



(a) (b)

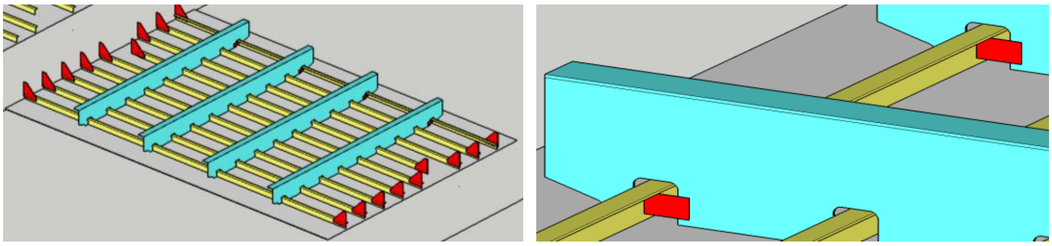
Figure 4. Joint (a) Stringer to transversal bulkhead, and (b) Back side transversal bulkhead

The assembly of the longitudinal bulkhead panel is shown in Figure 5 and begins with the joining of plates using butt joints with a total welding length of 3,660 cm. The installation of longitudinal stiffeners on the longitudinal bulkhead plate uses tee joints with fillet and intermittent welds and a total welding length of 8,278 cm. Next, the vertical web frame frame is fitted and welded to the longitudinal bulkhead and stiffeners, with a welding length of 4,514 cm. The installation of 28 brackets onto the stiffeners, as shown in Figure 6, uses lap joints (fillet weld type) with a welding length of 1,856 cm. A collar plate is added at the ends of the web frame frame construction forming notches to restore lost strength modulus, welded on both sides with a total welding length of 1,325 cm. The total welding length of the longitudinal bulkhead panel for frames 21–26 (center) is 386.66 meters, with each portside and starboard part having a total welding length of 19,333 cm.



(a) (b) (c)

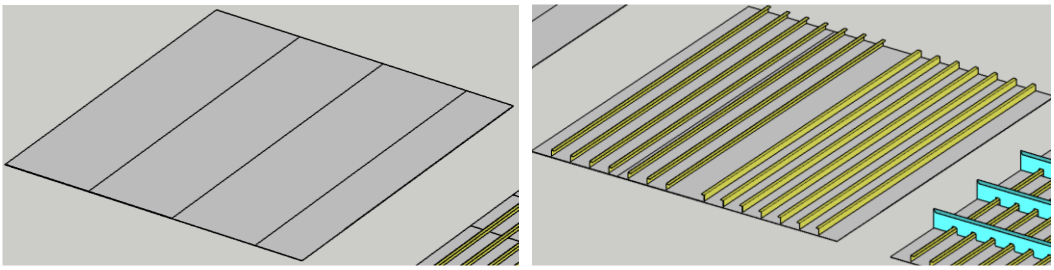
Figure 5. Joint (a) Longitudinal bulkhead, (b) Stiffener to longitudinal bulkhead, and (c) Vertical web frame to longitudinal bulkhead



(a) (b)

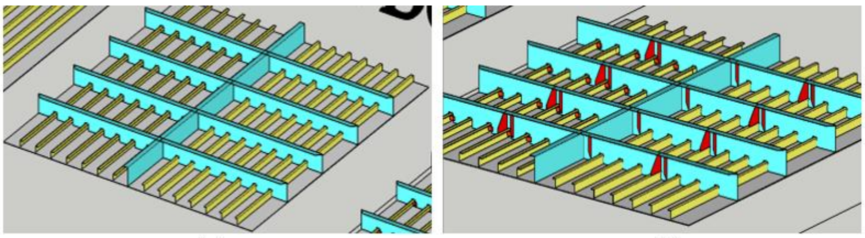
Figure 6. Joint (a) Bracket to longitudinal stiffener, and (b) Collar plate to web frame and stiffener

The assembly of the main deck and bottom plan panels (Figures 7 and 8) involves joining plates with butt joints (butt weld type) and a total welding length of 28,914 cm. The stiffeners are attached to the plates using tee joints (fillet weld type) with a welding length of 12,877 cm. Deck girders and web frames are fitted to the combined plate and stiffener panels using tee joints, with a total welding length of 8,971 cm, and the welding length of web frames at the notches on stiffeners is 974 cm. The installation of 12 tripping brackets for each panel results in a welding length of 1,416 cm, and 40 collar plates with a total welding length of 104 cm. The welding length for each main deck and bottom plan panel is 28,914 cm, giving a total fabrication welding length of 1,361 meters.



(a) (b)

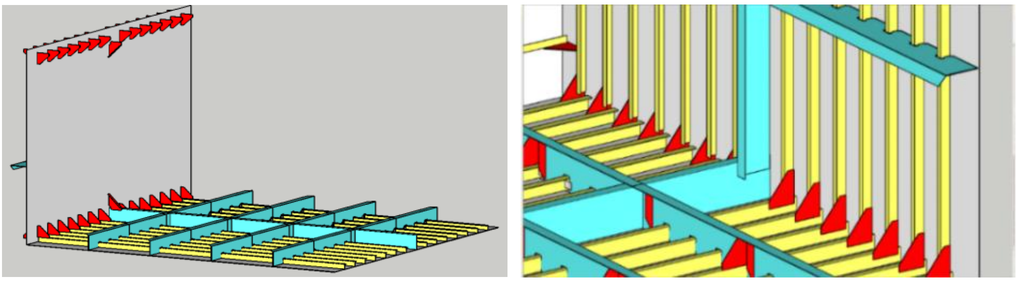
Figure 7. Joint (a) Pelat*,* and (b) Stiffener bottom Plate



(a) (b)

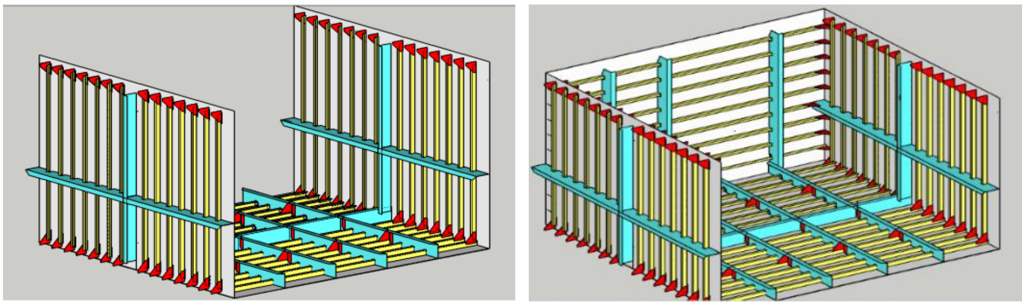
Figure 8. Joint (a) Girder to Plate, and (b) joint collar plate and tripping bracket to web frame

The erection of the barge panels is the stage where previously fabricated panels or blocks are assembled into the complete ship structure on the slipway or dock before the finishing, testing, and launching stages. The installation of transversal bulkhead panels with bottom stiffeners and joint plates, as shown in Figures 9–14, involves welding brackets between the transversal bulkhead and bottom plate using tee joints, with a total erection welding length of 8,863 cm. Center girders and brackets are installed to the transversal bulkhead and bottom panels using lap joints. The erection continues with the installation of the transversal bulkhead frame 26 center and frame 21 center, both with a welding length of 8,863 cm. The longitudinal bulkhead joint to transversal bulkhead and bottom is welded with a total length of 1,476 cm. Corner brackets connecting the longitudinal and transversal bulkheads use lap joints. The web frame bottom joint to the vertical web frame, connecting the bottom panel and the longitudinal bulkhead, also uses lap joints. The vertical stanchion (H-beam) connecting the bottom and main deck structures is then aligned and welded with a welding length of 4,976 cm.



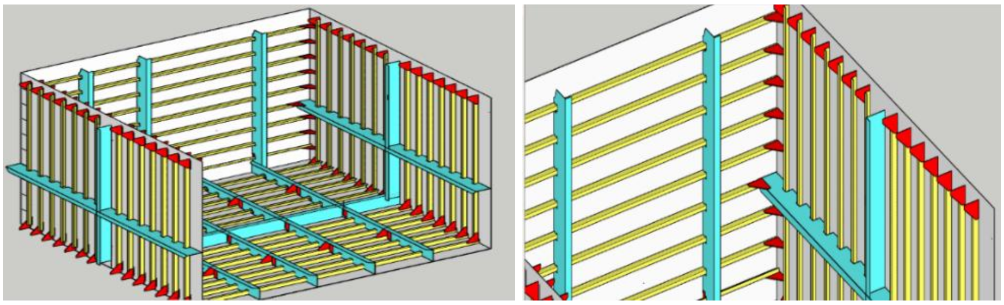
(a) (b)

Figure 9. Erection (a) Transversal bulkhead frame 21 Center, and (b) Center girder joint to vertikal stringer



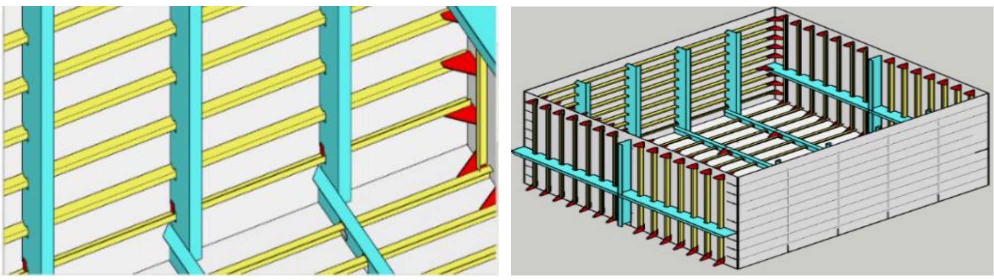
(a) (b)

Figure 10. Erection (a) Transversal bulkhead frame 26 center, and (b) Longitudinal bulkhead frame 21 - 26 portside



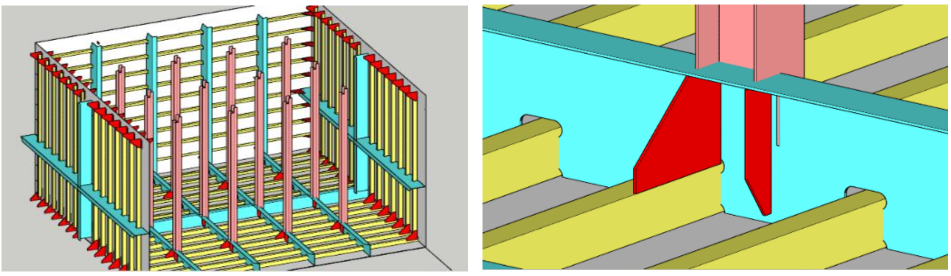
(a) (b)

Figure 11. Erection (a) Longitudinal bulkhead frame 21-26 portside, and (b) Bracket corner



(a) (b)

Figure 12. (a) Web frame bottom joint to vertikal web frame, (b) erection longitudinal bulkhead frame 21 - 26 starboard



(a) (b)

Figure 13. Erection stachion

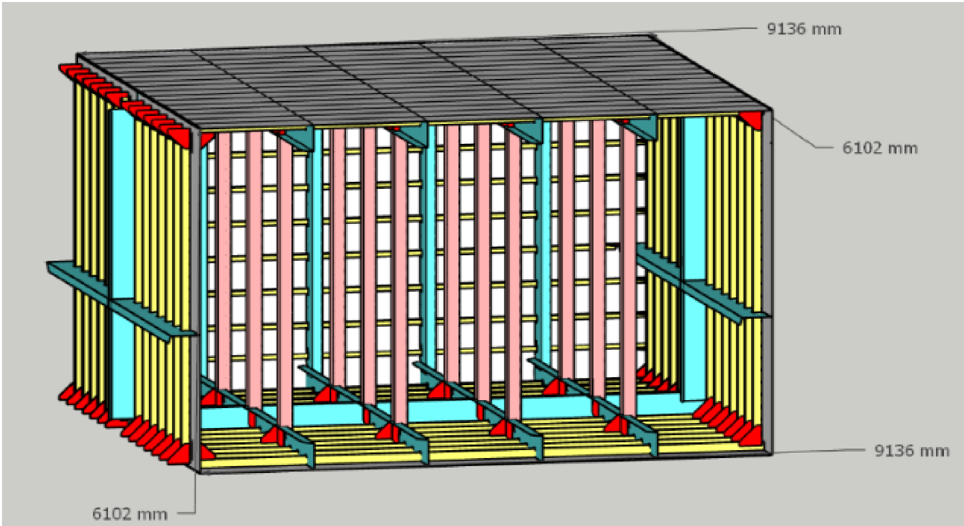


Figure 14. Blok midship barge 3702 GT

4. Discussion

After the installation of all erection panels, the total welding length of the midship (center) block of the 3702 GT barge reaches 12,600 cm. Based on this total weld length, the welding groove volume was calculated for both V-groove butt welds and fillet welds. The electrode requirement was determined using Equation (1), in which the deposited weld metal weight was obtained from Equation (2), while the weld volume was calculated according to Equation (3). The number of required welders was subsequently estimated using Equation (4).

The parameters applied in the calculation of electrode and welder requirements include electrode efficiency, welding speed, working time, project duration, and work efficiency. Electrode efficiency depends on the electrode type, diameter, and working conditions; for AWS E6013 electrodes (in accordance with the WPS), the efficiency ranges between 65–75%. The average welding speed for the downhand position is 9.66 m/hour. Working time is set at 8 hours per day and 5 days per week (40 hours per week), in accordance with Indonesian Labor Law No. 13 of 2003, Article 77(2). The project duration for the midship block assembly is estimated at 7 days per tank, and the work efficiency for SMAW field welding, based on the AWS Welding Handbook, is approximately 35%.

Based on these parameters, the total electrode requirement for the erection of the midship (center) panel of the 3702 GT barge is calculated to be 326.39 kg. When converted into packaging units (1 box = 5 kg), the requirement corresponds to 65.27 boxes, which is rounded up to 66 boxes. Furthermore, to complete the midship block assembly within the planned 7-day project duration, a total of 8 welders is required.

5. Conclusions

The total welding length during the

fabrication stage reaches 1,361 meters, while the erection stage contributes an additional 126 meters, resulting in a combined welding length of 1,487 meters for the midship (center) block of the 3702 GT barge. Based on this total weld length, the overall welding volume was calculated at 31,184 cm^3. From this volume, the deposited weld metal weight and corresponding electrode consumption were determined, yielding a total electrode requirement of 326.39 kg. This value reflects the influence of electrode efficiency, welding position, work efficiency, and operational conditions in field fabrication.

The manpower analysis indicates that, in order to complete the fabrication and erection activities within the planned duration of 7 days, a total of 8 welders is required. This estimation incorporates the average welding speed, effective working hours, and work efficiency factor for SMAW field welding. The result demonstrates the direct relationship between welding productivity parameters and labor demand in ship block assembly operations.

Furthermore, the study highlights the sensitivity of manpower requirements to project duration. A shorter completion target increases the required number of welders due to compressed working time and higher production intensity. Conversely, extending the project duration reduces the number of welders needed, provided that other technical and productivity parameters remain constant. Therefore, proper planning of welding parameters, labor allocation, and project scheduling is essential to achieve cost efficiency, maintain productivity, and ensure timely completion in barge construction projects.

References

[1] Syaban and E. A. Mokodompit, “Strategi manajemen pengembangan industri kapal dalam menghadapi persaingan global: Studi kasus pelabuhan,” *Jurnal Pelabuhan*, vol. 5, no. 2, pp. 236–242, 2024.

[2] F. R. Berlian and I. Baroroh, “Pengaruh tenaga kerja subcontractor terhadap waktu dan biaya pembangunan konstruksi badan kapal perintis,” *Jurnal Teknik Perkapalan*, pp. 79–86, 2000.

[3] J. Jafar, “Desain blok kapal berdasarkan variasi ukuran pelat (Studi kasus: Kapal SPOB 5000 DWT),” Undergraduate Thesis, Departemen Teknik Perkapalan, Fakultas Teknik, Universitas Hasanuddin, 2020.

[4] Purnama and T. Rachman, “Techniques for handling deformation welding of shipbuilding construction supporting elements,” *Zona Laut: Jurnal Inovasi Sains dan Teknologi Kelautan*, vol. 5, no. 1, pp. 112–118, 2024, doi: 10.62012/zl.v5i1.31599.

[5] Siregar, “Analisis proses perakitan kapal berbasis sistem blok di galangan kapal,” *Jurnal Teknik Perkapalan*, pp. 45–52, 2021.

[6] B. Andrianto et al., “Dinamika ketersediaan tenaga kerja di industri galangan kapal Indonesia,” *Cakrawala Maritim*, pp. 55–64, 2022.

A. Salim, “Halaman sampul,” *Math Didactic: Jurnal Pendidikan Matematika*, vol. 4, no. 3, 2018, doi: 10.33654/math.v4i3.272.

[7] Ministry of Manpower and Transmigration of the Republic of Indonesia, *Regulation on Welder Qualification in the Workplace*, 1982.

[8] S. P. P. Warman, “Analisis faktor penyebab cacat pengelasan pada pipa (Studi kasus pada pipa distribusi PDAM Kabupaten Kutai Barat),” *Jurnal Mekanikal*, vol. 8, no. 2, pp. 730–736, 2017.

[9] B. Triatmodjo, *Perencanaan Pelabuhan*. Yogyakarta, Indonesia: Beta Offset, 2009.

A. Djamaluddin, *Port and Terminal Management*. Makassar, Indonesia: UNHAS Press, 2023.

[10] R. Salim and D. Budianto, *Manajemen Pelabuhan dan Transportasi Maritim*. Jakarta, Indonesia: Salemba Empat, 2014.

A. Nurhadi, *Keselamatan dan Kesehatan Kerja*. Yogyakarta, Indonesia: Graha Ilmu, 2018.

[11] J. Piątkowski and P. Kamiński, “Risk assessment of defect occurrences in engine piston castings by FMEA method,” *Archives of Foundry Engineering*, vol. 17, no. 1, pp. 107–110, 2017, doi: 10.1515/afe-2017-0100.

[12] R. J. Rakesh, “FMEA analysis for reducing breakdowns of a subsystem in the life care product manufacturing industry,”

International Journal of Engineering Science and Innovative Technology, vol. 2, no. 2, pp. 218–225, 2013.