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Analysis Welding Types Pipe Fabrication Process in Missile Fast Attack Boat Construction

Sunarso Sugeng[1*], Samuel Febriary Khristyson[2]
[1,2] Department of Industrial and Technology, Vocational School, Diponegoro University,
Jl. Gubernur Mochtar, Kampus Undip Tembalang, Semarang, Indonesia 50275

ABSTRACT: The equipment in the piping system consists of pipes, valves, flanges, filters, fittings, pumps, and others. The installation schedule for this piping system begins after the connection between blocks. Pipes as part of a ship's system have several steps in their installation procedure, one of which is welding. Welding on pipes is carried out by professional welders who have met more complex competency requirements than welders in general, such as flat position welders, vertical welders, or overhead welders. The purpose of this study was to determine the welding process and types of welding in pipe fabrication for the construction of the Missile Fast Attack Boat. Result comparison between the diameters of the welded pipes, the greater the value of the welding volume formed. The largest volume is 426 mm^3, with a pipe length for the fabrication process of 4,3 m. On the other hand, the shortest fabrication is for welding pipes with a diameter of 2,5 m, which has a volume of 127 mm^3. While the welding process using GTAW / Gas Tungsten Arc Welding (TIG) is very appropriate for welding in small areas and thin pipes. The TIG welding process has an average volume of below 150 mm^3.

KEYWORDS: Missile Fast Attack Boat, Pipe Fabrication, Welding, Shipyard.

1.0 INTRODUCTION

The production process in the industrial world is divided into several stages. Specifically in the shipping industry, there are several stages of new ship building production, namely starting from the design stage, fabrication, sub assembly, assembly, erection, outfitting, painting, to launching. Outfitting is the stage of installing ship support equipment such as windlass, bolter, and crane on the deck, while inside the ship there are generators, pumps, and pipes. Outfitting work in the shipping industry is inseparable from the process of assembling or connecting materials, both non-steel materials (aluminum, stainless steel, PVC) and steel which is the main basic material of a ship. This material connection work can be done in various ways, starting from nut and bolt connections, threaded connections, rivets, adhesive glue, to welding connections. Of the many connection methods above, the most widely used is welding.

Welding is the most efficient way to join metals in the shipping industry. So many types of welding have been created, including electric arc welding, tungsten welding, carbide welding, MIG welding, MAG, FCAW, and others. Among the many types of welding above, welders are required to use the most efficient welding method and in accordance with the requirements (Bušić et al., 2024; Tong et al., 2024). This is because the quality of the weld will be influenced by three things, namely welding equipment, welding procedures, and the competence of the welder. In addition, the welding results must pass the hydrotest as conducted by Shipyard . Welding requirements generally include the type of welding to be used, initial treatment of the material, welding process (position, method, and welding angle), and final treatment including welding repair. Generally, these requirements are summarized in a WPS or Welding Procedure Specification book. Unfortunately, the work of the welder is often not in accordance with the guidelines that have been published. In fact, WPS has been made based on welding theories, company interests, and the wishes of the owner. Therefore, the author chose this title as the focus of the discussion, so that readers know how important it is to follow the applicable procedures in welding. With the limitation of the problem only on pipe welding and a little about seat welding as a comparison. The object observed is the Missile Fast Attack Boat.

Figure 1. Missile Fast Attack Boat

The equipment in the piping system consists of pipes, valves, flanges, filters, fittings, pumps, and others. The installation schedule for this piping system begins after the connection between blocks. This piping system begins after the connection between blocks. The first piping system installed is the bilge and ballast system, sea chest and its cross pipe and this system is centralized in the engine room and then the cooling pipe system, fire extinguishers and others. The stages of pipe installation start from the preparation of the weld surface, adjustment (fit-up), and welding (L. Li et al., 2022). The connection between pipes with flanges must pay attention to the neatness of the welds around the flange and the ends of the connected pipes, ground so as not to increase fluid flow resistance and reduce the corrosion rate in the area. The function and tightness of the valve are tested individually before being connected to the piping system (H. Li et al., 2024). For pumps, capacity and head tests are carried out in accordance with pressure testing regulations. The purpose of this study was to determine the welding process and types of welding in pipe fabrication for the construction of the Missile Fast Attack Boat.

2.0 REVIEW OF PAST WORK

Previous studies of floating structures on marine structures subjected to variable loads and the calculated response leads to a long-term stress range distribution with many small stress ranges (Kumar et al., 2023b). This also affects the welding that occurs if the cracks are small, the resulting stress intensity may be smaller than the threshold stress intensity factor and the cracks do not grow during this stress cycle, or grow at a reduced crack growth rate near the threshold region (Feng & Zhang, 2024; Raj et al., 2024). Tests using simulations in previous studies showed that further simulation and experimental results showed that internal axial defects can also be detected and measured by certain modified methods (Mingchang et al., 2024; Shen et al., 2024). Furthermore, it also shows the effect of pipe curvature on the modified structure discussed through simulation (Bao et al., 2024; L. Li et al., 2023). However, the results of the study showed that the severity of defects in pipe welds increased to various levels after testing under simulated conditions, with the initial sample containing defects showing a more significant level compared to the initial defect-free welding sample (Guo et al., 2024; Zhou et al., 2024). The main reason for the damage to the structural integrity of pipe welds under simulated conditions is the synergistic effect of welding defects, installation pre-tension, vibration load, and media corrosion (Kumar et al., 2023a). The inferred inherent strain results are used to estimate the welding distortion in the ship's pipe structure is still complex (Lv et al., 2024; Tan et al., 2024). In order to reduce the welding distortion in the pipe, the influence of the welding sequence on the local deformation is examined in the circular direction (G et al., 2024). In addition, the difference in distortion in each welding pass is shown. Various welding strategies (rotation and symmetry) for the subsequent welding rods are used according to the rolling action of the pipe after one welding (Yan et al., 2023). The distortion results show the optimal welding sequence based on the distribution of welding distortion characteristics (Wang et al., 2023).

3.0 MATERIALS AND METHODS

Pipes as part of a ship's system have several steps in their installation procedure, one of which is welding. Welding on pipes is carried out by professional welders who have met more complex competency requirements than welders in general, such as flat position welders, vertical welders, or overhead welders. However, before welding work is carried out, there are several procedures that must be carried out on the pipe material so that the results obtained are maximized. The following is a simple diagram of the work process on pipe outfitting in a pipe workshop. Steel pipes are the most common type of pipe used in building a ship. This is because of its strength and ductility which are suitable for the needs of ship operations. When sailing, the ship will experience continuous shocks, either caused by waves or from the vibrations of the ship's engine itself. In addition, the ship will also be hit many times by high waves which are commonly referred to as hogging and sagging. The above things have the potential to cause the pipe to shift, bend, or even crack due to continuous impacts between the pipe and other materials on the ship. Therefore, steel is used which tends to be stronger than other types of metal.

Figure 2. Pipe Fabrication

Mathematically, the calculation of the weld volume is done using an approach,

$$V = ((2\pi r)) \text{ x a x T} \quad (1)$$

Where (V) is the volume of the welding process, requiring the component of the circumference of the circle and (a) the cross-sectional area of the ship's welding multiplied by (T) which is the thickness of the pipe, referring to mathematical equation 1. In general, the calculation approach is obtained from geometric calculations such as, see Figure 3.

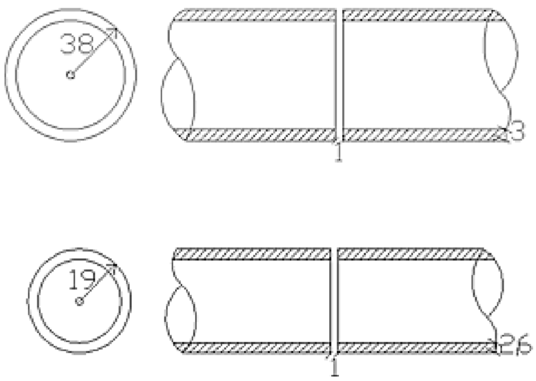

Figure 3. Pipe Geometry

In general, Figure 3 shows the calculation form of the pipe dimensions to be welded. The process flow of pipe welding in the shipyard refers to Figure 4. Shows the fabrication process occurs after the material is received on time.

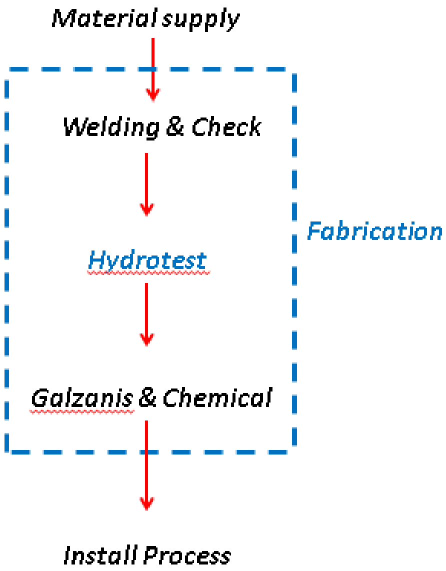

Figure 4. Flaw Process

Then if seen from the fabrication process there is a sequence where each assembly or welding activity is checked using the Hydrotest procedure. Likewise with the chemical process given to provide resistance to corrosive processes.

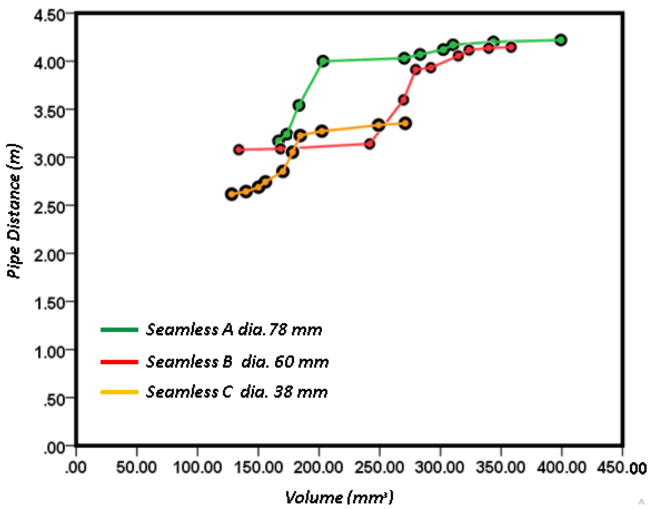

Figure 5. Comparison diagram of welding volume with pipe geometry

In line with previous research, the amount of weld metal formed is proportional to the length of the fabricated pipe. This means that the longer and more elbows on the pipe, the greater the welding volume. See Figure 5, showing a comparison of each welding process. What is interesting is the comparison between the diameters of the welded pipes, the greater the value of the welding volume formed. The largest volume is 426 mm^3, with a pipe length for the fabrication process of 4,3 m. On the other hand, the shortest fabrication is for welding pipes with a diameter of 2,5 m, which has a volume of 127 mm^3.

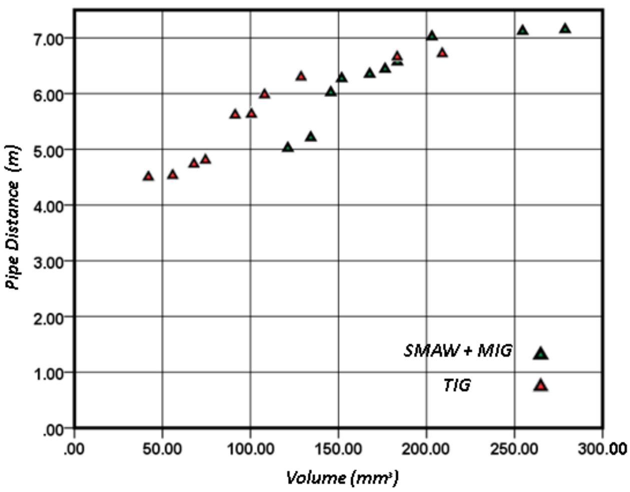

Figure 6. Comparison diagram of welding proces with pipe distance

The distribution of the number of welding processes is almost dominated by combination welding, namely welding with the SMAW / Shelded Metal Arc Welding (MMA) and GMAW / Gas Metal Arc Welding (MIG) methods. This welding is very suitable for volumes with larger capacities. As seen in Figure 6, it shows the combination welding process at a length of 7,23 m producing a welding volume of 266 mm^3. While the welding process using GTAW / Gas Tungsten Arc Welding (TIG) is very appropriate for welding in small areas and thin pipes. The TIG welding process has an average volume of below 150 mm^3.

CONCLUSIONS

From the research results, it was found that the pipe welding process requires proper planning, based on the calculation data, it can be concluded that for pipes with the largest diameter in the shipbuilding process, a large number of electrodes are also required depending on the welding deposit. The type of welding in pipe fabrication for the construction of the Missile Fast Attack Boat uses SMAW, GMAW and GTAW types depending on the use of the type of material and the thickness of the material required. Meanwhile, when it is necessary to connect between the steel metal holder, with the ship's equipment made of non-steel metal, which must be carried out several series of preheating processes first. Pipe and seat welding errors are errors that occur around simple procedures, such as choosing a welding method, and pre-heating or preheating actions. Therefore, the prevention method is not too difficult, namely by supervising the work of the welder at all times so that he always follows the WPS and other procedures imposed by the company.

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