**6th International Conference**
**ðComputational Mechanics and Virtual Engineering ð**
**COMEC 2015**
**15-16 October 2015, Braşov, Romania**

# WELDING OF ALUMINUM ALLOY WHEELHOUSE

**Polixenia Iuliana Simion (Dorcea)[1], Camelia Boboc[2], Nicolae Joni[3], Gheorghe Solomon[4], Carmen Alexandra Turcu[5]**
[1]University POLITEHNICA of Bucharest, Romania, e-mail: dorcea_polixenia@yahoo.com
[2]University POLITEHNICA of Bucharest, Romania, e-mail: camelia.boboc2000upb@yahoo.com
[3]Robcon SRL, Timisoara, e-mail nicolae.joni@rabcon.ro
[4]University POLITEHNICA of Bucharest, Romania, e-mail: ghe.solomon@gmail.com
[5]SC Shipyard ATG Giurgiu SRL, Giurgiu, e-mail turcu_camy@yahoo.com

***Abstract:*** *In this paper are, presented the aspects of MIG welding procedure of aluminium alloy wheelhouse which are used in shipbuilding. There are used 5083 aluminium alloy and 6060 aluminium alloy profiles.Also in this paper in presented the MIG welding technology using protective gas Ar of laminate 5083 and 6060 according with standards.*
***Keywords:*** *wheelhouse, aluminium alloy , MIG welding technology, ZIT.*

## 1. INTRODUCTION

Naval field is a dinamic and competitiv having a big economical-social importance, involving also other fields such as transport, security, research, etc. Shipbuildings are an important and stratecical industry.
In the shipyards are builded vessels which aspire to better performances. An important role own the Clasification Society's which are responsible with their surveillence from the beggining project to delivery of the vessels, such as: Bureau Veritas, Det Norske Veritas, Lloyds Register, etc.
To the shipbuilding industry the laminate represents a main component, and they are stiffened by means of profile in both directions: longitudinal and transverse.
Due to of the development of new materials there is a tendency to use thinner tickness of laminated glass.
To achieve wheelhouse at self-propelled vessels is used more and more aluminum alloys, in figure 1 is shown a wheelhouse.
Due to of the development of new materials there is a tendency to use thinner tickness of laminated glass. To achieve wheelhouse at self-propelled vessels is used more and more aluminum alloys, in figure 1 is shown a wheelhouse.

**Figure 1:** Aluminium alloys wheelhouse

Welding aluminium alloys is different from welding steels within due oxide coating (AL2O3) in the area of joints which has the melting points arround $2000^{0}$C. Un removing of aluminium oxide film may will cause defects after cooling down. Film of aluminium oxide can be removed using chemical active substances or mechanically by grinding.

According to EN 573, the aluminim and its alloys are named using a number of 4-digit, this standardization is in accordance with American Standards. In this paper are presented the experimental researches used for the preparation of the welding technology laminates 5083 and profiles 6060, figure 2.

**Figure 2:** Welding of a luminium profiles

## 2. EXPERIMENTAL DETERMINATION OF WHEELHOUSE WELDING

Further will be presented the elaboration stage of the MIG technology (Metal Inert Gas) pulsed welding, of butweldings (BW), welding in vertically upward position (PF) and the corner (FW) in over head position (PD) of alluminium alloys wheelhouse from naval field.

Welding in the vertical direction can be performed in both directions: vertically downward and vertically upward. To obtain a good quality the welding arc must always be driven as before the metal bath, to provide support and intrusion, whilst avoiding leakage of molten material. The process requires a lot of skill and speed to ensure a sufficient welding. [1, 2].

Basic material used are:

- laminate 5083 (Al – Mg alloy), 8mm thickness, where the main alloying element is magnesium:
- profiles 6060 (Al – Mg – Si alloy), 5mm thickness, major alloying elements are magnesium and silicon.

To achieve the experimental part were prepared two laminated plates of 5083 with the following dimensions 8X150X500mm 5083 material and for filet welding were prepared a plate size 5083 5X150X150 and a profile 5X50X50X150mm 6060 material.

The aluminum and its alloys are relatively common materials used for welded structures. The best results are obtained by pulsed MIG welding. Pulsed MIG process is a method that creates a stable welding arc. Pulsed welding current is a method by extending the transfer in the spray arc welding current low levels.

### 2.1. Filler materials

The filler materials used in the experimental in manual welding aluminum alloy MIG : 5083 and 6060 ER 5183 are welding wire diameter 1.2 mm and protective gas is used in experiments should type 260, with 99.99 % purity .

Welding wire ER 5183 is Alufil AlMg4,5Mn type, produce by Oerlikon Company with chemical composition shown in Table 1 and in Table 2 mechanicalproperties [3].

**Table 1:** Chemical analysis of wire Alufil AlMg4,5Mn

| Al | Si | Mn | Mg | Cr | Ti | Cu | Fe |
|---|---|---|---|---|---|---|---|
| | 0,3 | 0,8 | 4,5 | 0,1 | 0,1 | 0,1 | 0,1 |

**Table 2:** Mechanical properties

| Thermical treatment | Rm [N/mm$^2$] | $Rp_{0,2}$ [N/mm$^2$] | A5 [%] |
|---|---|---|---|
| Welded condition | ≥ 125 | ≥ 275 | ≥ 17 |
| | | | |

## 2.2. Welding equipment and accessories

In experimental determinations were used the following equipment and accessories:

- MIG/MAG welding installation transPlusSynergic 4000 type, cooling liquid (figure 3) [4];
- Brenner manualAW5000F++/3,5m, equipped with bowdwn Combi, Fronius1,2/3,5m, special for alluminium welding [4];
- Pressure reducer for Ar used for tubes;
- Tomahawk 1025 [5] cutting plasma equipment;
- Abrasives, hand rotary brushes and stainless steel wire, aluminum calipers for measuring and bevel angles, etc. figure 4
- Mobile pneumatic or electric grinder machines.

**Figure 3:** FroniusWelding plant

**Figure 4:** Accesories

## 2.3. Welding preparation

Cutting boards and profiles is to achieve plasma samples and chamfering the edges to achieve joint geometry is made by grinding, shape and dimensions after chamfering the edges butt are shown in Figure 5 and figure 6.

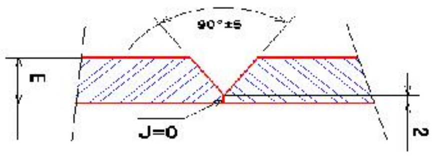



**Figure 5:** The geometry of the joint welding

**Figure 6:** Polishing components

After inserts chamfering for butt welding, adjacent joint is grinded with mobile grinder, this polishing is done on both sides over a minimum width of 25 mm. The same operation is done when the fillet welding.
Chamfered edges of the plates and polished areas are cleaned before welding by wiping with acetone. Areas adjacent to joints and joints edges must be cleaned, free of oxides, moisture or other impurities.
In order to eliminate defects like deformations or cracks has to apply for butt welding few temporary plates from same material.
The welding parameters used for butt welding are shown in Table 3, and for fillet welding in Table 4

**Table 3:** The parameter values for butt welding

| Layer | Parameters | | |
|---|---|---|---|
| | Welding current intensity [A] | The welding arc tension [V] | Feed rate of wire [m/min] |
| 1 | 118 | 18.8 | 7,5 |

| | | | |
|---|---|---|---|
| 2 | 124 | 18,8 | 7,8 |
| 3 | 127 | 18,8 | 7,8 |
| 4 | 127 | 19,5 | 7,8 |

**Table 4:** The parameter values for fillet welding of joint welding

| Layer | Parameters | | |
|---|---|---|---|
| | Welding current intensity [A] | The welding arc tension [V] | Feed rate of wire [m/min] |
| 1 | 140 | 20,5 | 9,2 |

## 3. RESULT EVALUATION

After welding, the samples are cleaned with stainless steel wire brush and visual examined. Following that examination samples were accepted.

For butt welding NDT examination was used penetrating X ray and the sample was declared accepted.

From the welded samples were collected representative samples of their central areas for metallographic examinations. Metallographic examination is part of the research quality of welded joints.

Metallographic examination sampling is done according to STAS 4203-78, ASTM 883-86, E3-89, necessary to examine all areas of the joint characteristic (MB, HAZ, SUD).

In firure 7 are showm the result of butt welding macrospcopic examination results, resolution 2,5X.

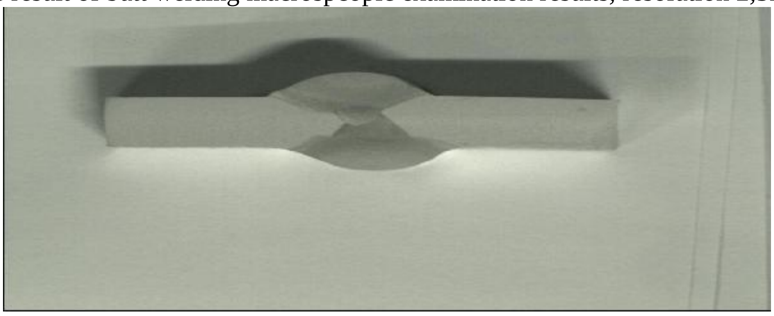


**Figure 7:** Sample of macroscopic examination

The macroscopic examination results for fillet welding in PD position are shown in figure 8. Resolution 2,5X.

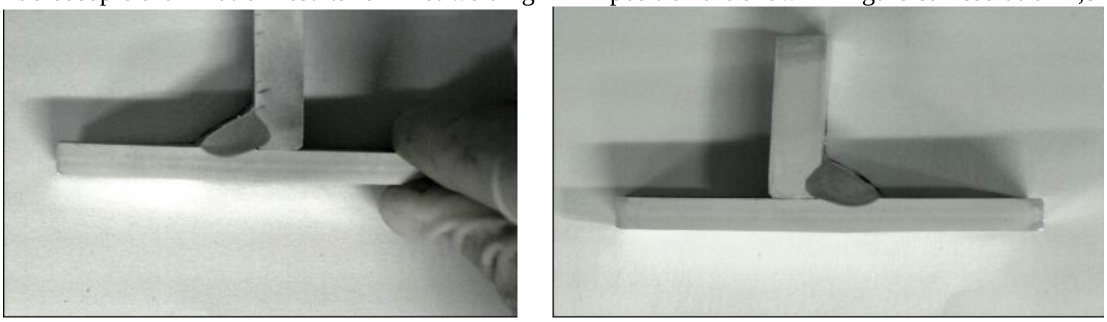
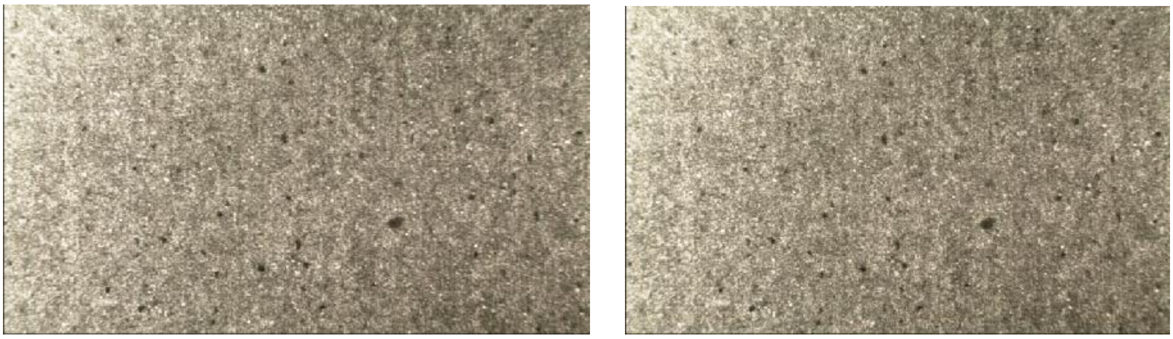


**Figure 8:** Macroscopic examination joint sample

Microscopic examination of joints also extends to all areas characteristic constituents following the detection and identification of structural defects. Areas which are usually microscopically examined for butt joints and fillet are: MB, and weld HAZ site (SUD).

Basic material is also macroscopic examinated and the metalographic structures must be in accordance with standard product. It can be seen in figure 9 the microscopic structure for both basic material from butt welding. Also can be seen solid solution type a rich in aluminum and AlMg. Equipment resolution is 100X.

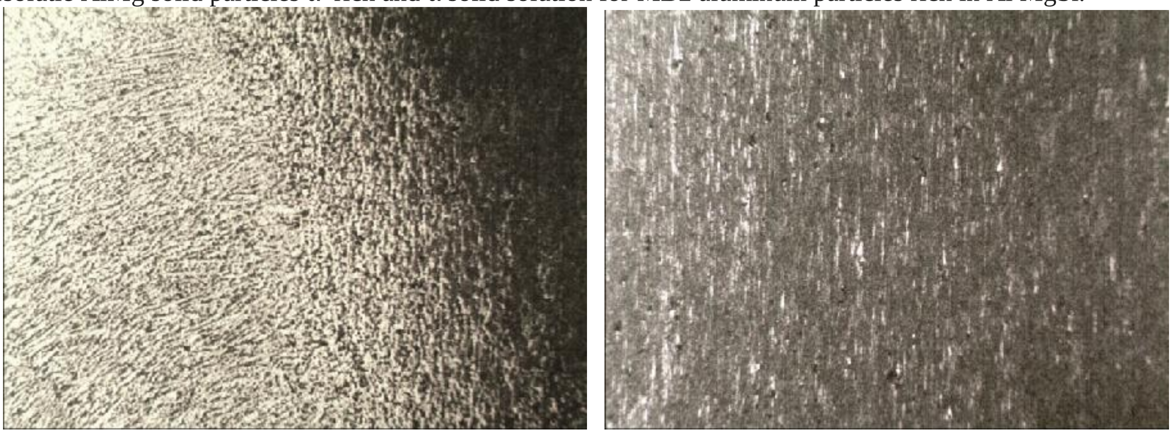


a) b)

**Figure 9:** Butt welding microscopic examination, resolution 100X

a) MB1-material 5083; b) MB2- material 5083

Figure 10 shows the microscopic examination for the two basic materials of fillet joints. It can be seen for MB 1solutie AlMg solid particles α rich and α solid solution for MB2 aluminum particles rich in Al MgSi.

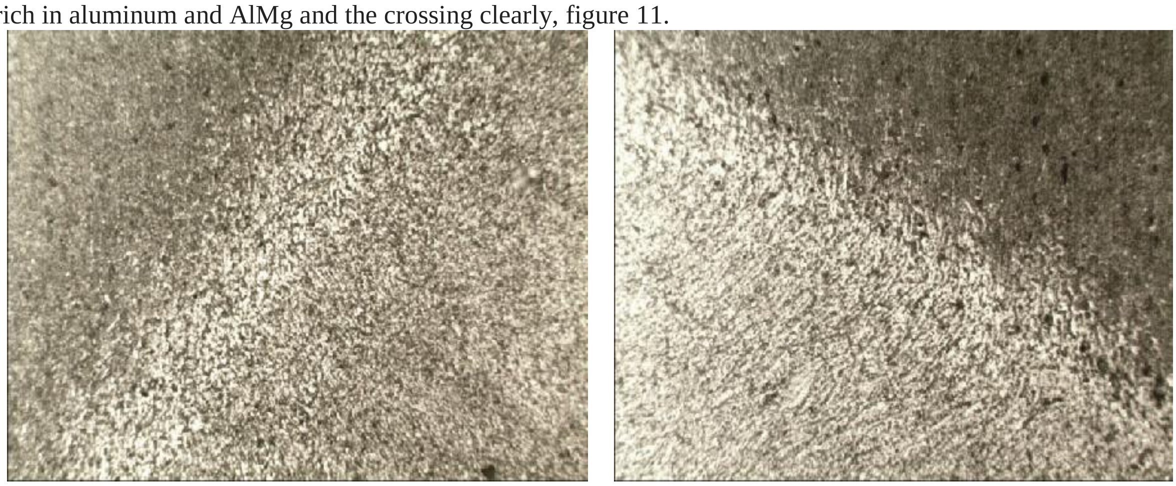


a) b)

**Figure 10:** Butt welding microscopic examination, resolution 100X

a) MB1-material 5083; b) MB2- material 6060

Microscopic examination for butt joint in the heat affected zone, where it can be seen solid solution α particles rich in aluminum and AlMg and the crossing clearly, figure 11.



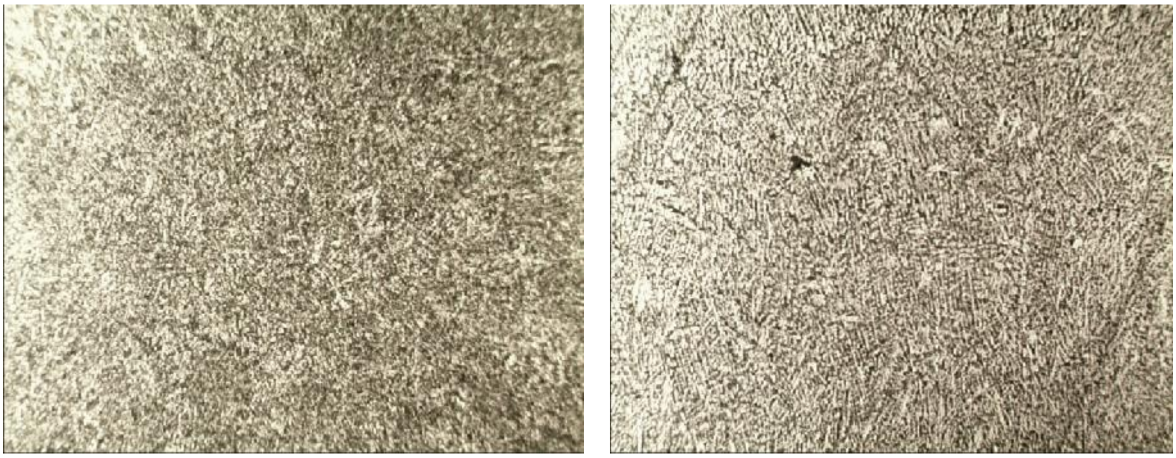
a) b)

**Figure 11:** Butt welding microscopic examination, resolution 100X

a) ZIT 1; b) ZIT 2

In figure 12 can be seen the heat affected zone for fillet joint at a resolution of 100 x. The transition zone clearly visible.

Macroscopic examinations of welds in those two cases shown a casting structure. In Figure 13 can be seen this structure.



a) b)

**Figure 11:** Butt welding microscopic examination, resolution 100X
a) Butt welding; b) joints

## 4. CONCLUSION

The document present aspects of pulsed MIG welding butt joints and fillet -type aluminum alloy 5083 and 6060. The experimental results will serve as a starting point for a larger study, which will perform a comparison between pulsed MIG welding and double pulse

## ACKNOWLEDGMENT

The work has been funded by the Sectoral Operational Programme Human Resources Development 2007-2013 of the Ministry of European Funds through the Financial Agreement POSDRU/159/1,5/S/134398

## REFERENCES

[1] Gh. Zgură, G. Iacobescu, D. Cicic, C. Rontescu, Tehnologia sudării prin topire, Editura Politehnica Press, 2007, Bucuresti
[2] M. Burcă, St. Negoițescu, Sudarea MIG/MAG, Editura Sudura, 2004, Timișoara
[3] Catalog de echipamente Oerlikon;
[4] Catalog de echipamente Fronius;
[5] Catalog de echipamente Lincoln Electric;