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THE INFLUENCE OF PIECES THICKNESS ON METALLOGRAPHIC STRUCTURE OF WELDED JOINTS

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Preliminary Note – Prethodno priopćenje

The main objective of this paper was to establish how the thickness of welded pieces influences the metallographic structure of welded joints. Thus were made a total of 6 samples, and from each sample were taken test specimens for metallographic analysis of the base material, the filler material respective heat affected zone (HAZ). The samples were carried out by welding process: metal active gases (MAG) using a steel E 36-4, and the welded pieces had a thickness between 10 and 24 mm. The welding regime was characterized by parameters I_W = 200 / A, *Uw* = 24 / V. The joint by welding pieces was "T" form and both piece used as the base and the piece used as heart for welded joint were made of sheets with different thicknesses.

Key words: steel, welding joints, thickness parts, metallographic structure

INTRODUCTION

The main feature of each metallic material is the metallographic structure, which influence on properties condition in the largely the use of the material in question.The successive deposition of the layers of filler material realize the regeneration of the microstructure whereas at the melting of a layer is heated the previously filed over AC_3 transformation point, to give, after air cooling, a finer structure, stress relieved. The only unregenerate remaining layers are those which are deposited last [1-3].

Preparing the joint envisages: balancing contraction tensions and the avoidance of deformation in the assembly area. The size of the grains in the base material and the thickness of pieces that are assembled by welding influences the metallographic structure of welded joints [4,5].

In these conditions the constructive design of welded joints should be sought, not only removing the causes which, during execution (the application of specific technologies of welding joints) generate nonconformities, and also how to ensure a homogeneous metallographic structure for welded assemblies.

For the future conception, for the mobile complex metal constructions are necessary chases in exploitation and in the design's activity so as to ensure a larger life which can be achieved with a homogenity of metallographic structure for welded joint [6,7].

The obtaining of more homogeneous metallographic structure in welded joints is possible by applying heat treatments and optimal welding regimens [8-10].

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MATERIALS

The realized researches has followed the T-shaped welding joints of pieces with different thickness using MAG welding process, and the pieces were made of steel E 36-4. The use of this steel is indicated for the fabrication of resistance elements (beams, columns, sections, rails, brackets, etc.). To achieve the desired results in the research, for E 36-4 steel, primarily, was established the mechanical characteristics shown in Table 1.

Table 1 **Mechanical characteristics of E 36-4 steel**

R_m / N / mm^2	R_{p02}/ N / mm^2	Z / %	A / %	K_{CV} 20°C / J	K_{CV} 0°C / J
568	402	23	31	79	64

The welded joints were performed by applying the MAG welding process using a wire type SG2 with the diameter of Ø 1,2 / mm as the filler material; the filler material characteristics are shown in Table 2.

Table 2 **Mechanical characteristics of filler material**

R_m / N / mm^2	R_{p02} / N / mm^2	K_{CV} 0°C / J
535	642	40

RESULTS AND DISCUSSIONS

In order to achieve the welded joints there was used MAG welding process and welding regime was characterized by the following parameters: I_W = 200 / A, U_w = 24 / V. Metallographic sample preparation was done in several steps: sampling of the welded joint, surface samples straightening, finishing samples, chemical attack. Also, 6 samples were prepared by "T" form joint using combinations of thickness of joined pieces, Table 3.

Table 3 **The way of sample preparation for welding joints**

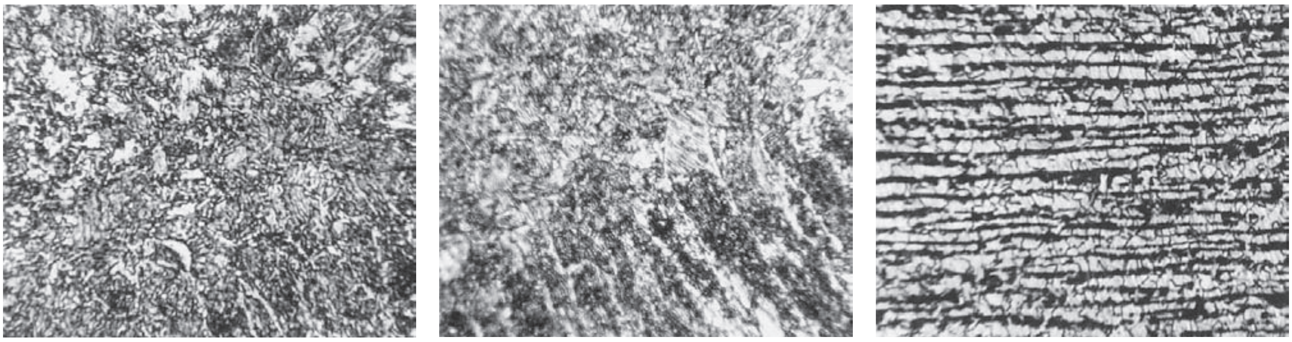
No.	Sample's notation	The thickness of joined sheet
1	1.1	Two sheets with thickness g = 10 mm
2	2.1	Two sheets, sole with thickness g = 16 mm respectively heart with thickness g = 10 mm
3	3.1	Two sheets with thickness g = 16 mm
4	4.1	Two sheets with thickness g = 20 mm
5	5.1	Two sheets, sole with thickness g = 24 mm respectively heart with thickness g = 20 mm
6	6.1	Two sheets with thickness g = 24 mm

There were used sheets with thickness between 10 mm and 24 mm because they are widely used in practice. From each welded joints 3 samples were taken specific to filler material, base material and heat affected zone. Samples taken have followed a technological process that started with debiting and blasting and continued with the preparation of the side, for the hearts that are welded and are in contact with the sole, by machining with removal of material between 3-6 mm: 3 mm to hearts of 10 mm, 4 mm to hearts of 16 mm, 5 mm to hearts of 20 mm and 6 mm to hearts of 20 mm.

Material removal was necessary to remove the decarburized layer and to obtain the perpendicularity between the side which comes into contact with sole and laminated surface of the heart.

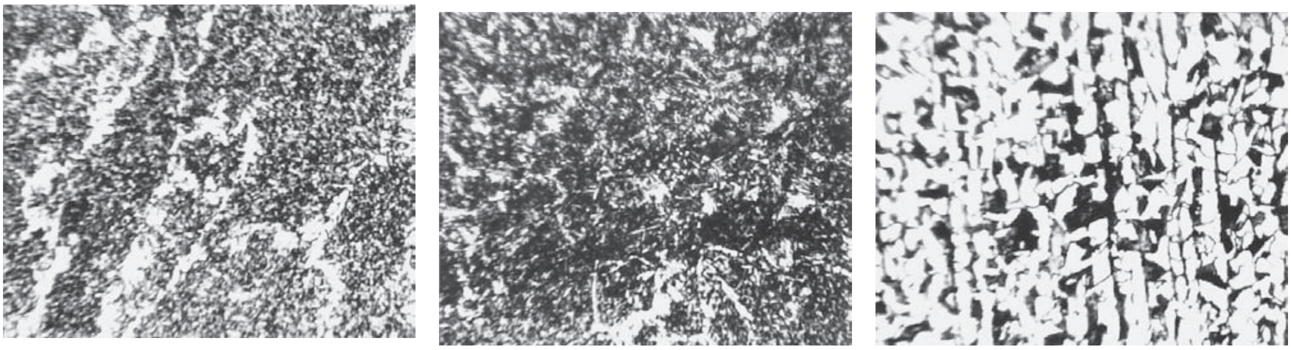
It was made a metallographic analysis for the base material because depending on its thickness there were observed some differences between metallographic structures determined by the way that semi-fabrication process was made.

The metallographic structure for the 6 welded sample's is shown in Figures 1 - 6.



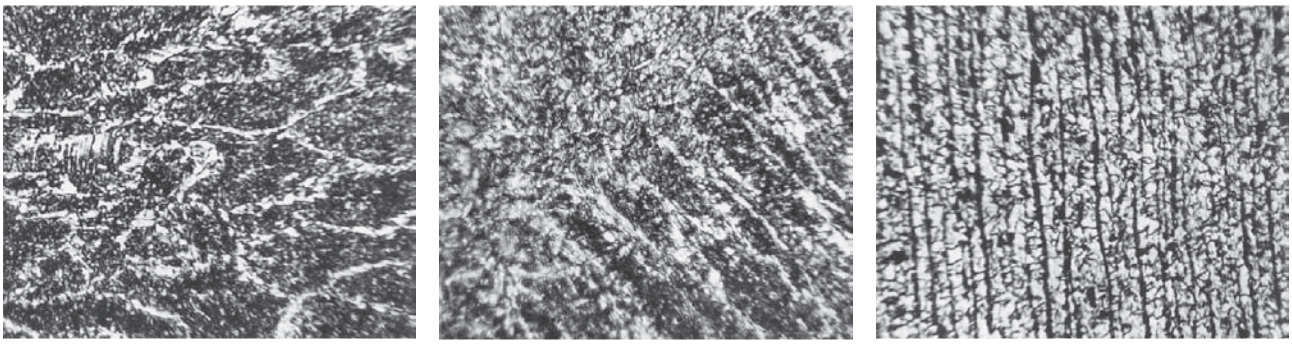
a. b. c.

Figure 1 Metallographic structure for sample 1.1: a - metallographic structure of filler material, b - metallographic structure of the heat affected zone, c - metallographic structure of the base material



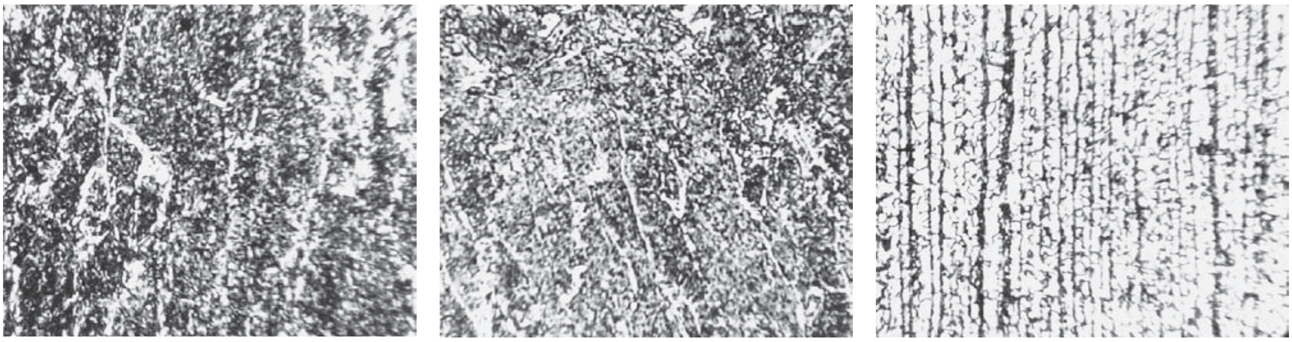
a. b. c.

Figure 2 Metallographic structure for sample 2.1: a - metallographic structure of filler material, b - metallographic structure of the heat affected zone, c - metallographic structure of the base material



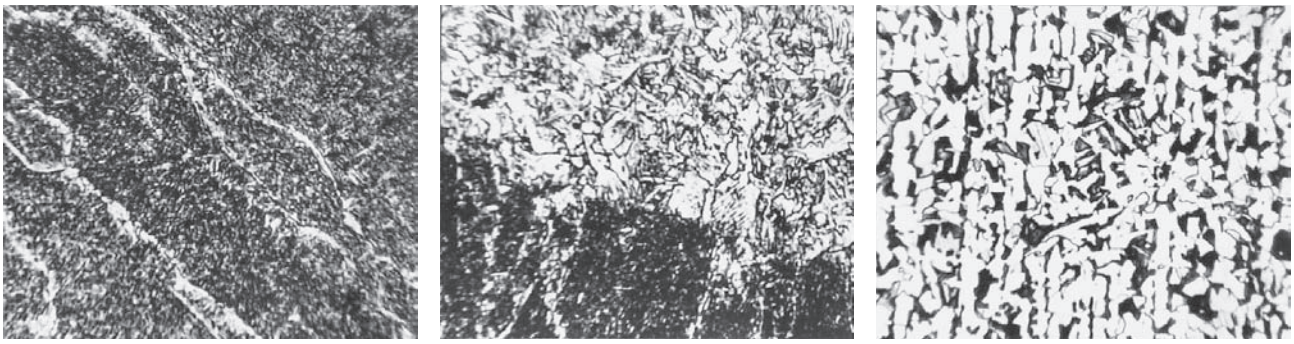
a. b. c.

Figure 3 Metallographic structure for sample 3.1: a - metallographic structure of filler material, b - metallographic structure of the heat affected zone, c - metallographic structure of the base material



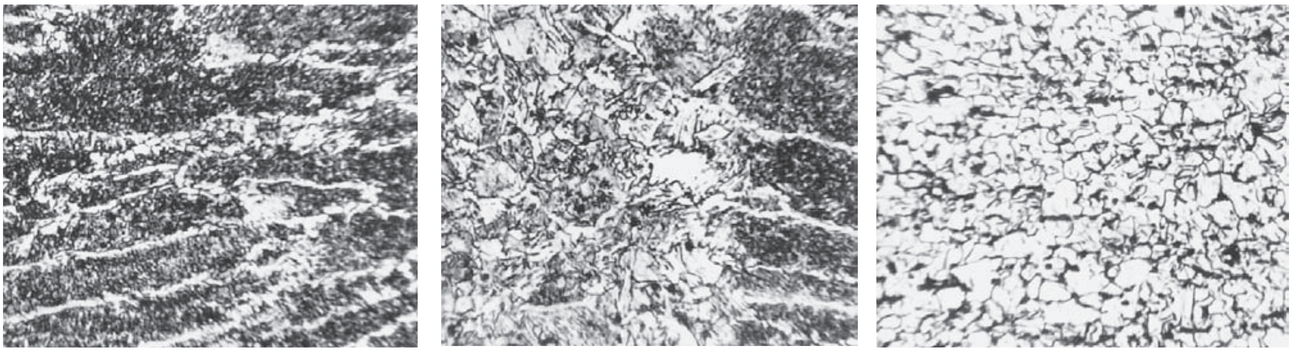
a. b. c.

Figure 4 Metallographic structure for sample 4.1: a - metallographic structure of filler material, b - metallographic structure of the heat affected zone, c - metallographic structure of the base material



a. b. c.

Figure 5 Metallographic structure for sample 5.1: a - metallographic structure of filler material, b - metallographic structure of the heat affected zone, c - metallographic structure of the base material



a. b. c.

Figure 6 Metallographic structure for sample 6.1: a - metallographic structure of filler material, b - metallographic structure of the heat affected zone, c - metallographic structure of the base material

Sample 1.1: Fillet weld in T of two sheets with thickness g = 10 mm, (sole and heart) by MAG process, with SG2 wire. In Figure 1 is shown specific structure of filler material and the report ferrite / pearlite is 50/50 then drops to 35/65 % to outlying areas. In Figure 1 b, the structure shown is pearlite and needle ferrite, grain size 8-10 in proportion 50/50 % specific to heat affected zone. In Figure 1c strings are presented strings of perlite in ferrite clouds with a 2-3 score and a grain size 8 (9), and this structure is specific to base material and at the same time it is observed the direction of rolling.

Sample 2.1 - T welding of two sheets, sole with thickness g = 16 mm and heart with thickness g = 10 mm. In the filler material appears ferrite, pearlite and fine sorbite in the form of elongated grains, Figure 2 a. In Figure 2 b is presented HAZ structure with ferrite, pearlite and needle ferrite with fine bainite, the proportions being between 30/70 to 60/40 % in different areas with real grain size 4-5 and even 8 in overheating subarea. Base material has the metallographic structure shown in Figure 2 c, where ferrite and pearlite are observed in the strings of rolling with the proportion 25-30 / 75-70 % with a real grain size 7-8 (9).

Sample 3.1. T welding, heart and sole are of sheet with thickness g = 16 mm. Filler material has the metallographic structure shown in Figure 3 a, and it has ferrite and pearlite in the strings of rolling with the proportion 35-30 / 65-70 %. Filler material has been achieved through a concave deposition. HAZ structure shown in Figure 3 b shows the sorbite's proximity to the deposited material and fine grain ferrite, then pearlite away from the metal bath which was melted. In the metallographic structure of filler material, Figure 3 c there can be observed ferrite and pearlite that are arranged in rows. The proportion of ferrite / pearlite starts at 30/70 % and reach 50/50 %.

Sample 4.1 T welding of two sheets with thickness T = 20 mm. In the deposited material, Figure 4 a, besides ferrite and pearlite with needle ferrite, fine sorbite appears; same constituents appear in HAZ in proportion between 60/40 to 35/65 and it is observed an increase in real grain size from 5-6 to 8-9 as it moves away from the deposited material. In the base material Figure 4 c, the metallographic structure of the base material, ferrite and pearlite appear in strings in proportion 30/70, with grain size 8-9 and with some needle ferrite insertions.

Sample 5.1 T welding in which the heart thickness is g = 20 mm and sole has thickness g = 24 mm. The metallographic structure of the filler material, Figure 5 a, consists of ferrite and pearlite in rows of rolling in the proportion of 25-30 / 75-70 %. The structure in HAZ, Figure 5 b, consists of ferrite and pearlite in the proportion of 70-60 / 30-40 with a real grain size between 8-9 (10). The base material, Figure 5 c, shows ferrite and pearlite in the proportion of 20-80 % and a real grain size of 7-8.

Sample 6.1 Fillet weld in T of two sheets with thickness g = 16 mm. In the filler material, Figure 6 a, in addition to ferrite, pearlite and needle ferrite, sorbite appears. Heat affected zone, Figure 6 b, consists of ferrite and pearlite with needle ferrite, it appears in the proportion of 50/50-20/80 % depending on the distance from the molten bath. The base material, Figure 6 c, has ferrite and pearlite in rows with a real grain size of 7-8 (9).

CONCLUSIONS

Following conducted researches there could be drawn the following conclusions:

– the thickness of the piece influences metallographic structure even for base material, thus differences are observed between grain size, but different ratios between the proportion of two structural constituents ferrite and pearlite that depending on the thickness of the base material. Also it was found that the metallographic structure of the base material influences the rolling direction and the arrangement of welded piece depending on it;
– filler material has a different metallographic structure depending on the thickness of pieces, thus there are differences both between grain shape and proportion between the two structural constituents, namely, ferrite and pearlite, and for pieces with reduced thickness there was observed the presence of fine sorbite;
– in HAZ, the metallographic structure is different depending on the thickness of pieces, thus there are differences both between grain shape and proportion between structural constituents, namely ferrite, pearlite, bainite and sorbite which is generally made up of fine elongated grains. So if the piece has a less thickness, the real grain size is 4-5 and even 8 in heating subarea as it moves away from the deposited material.

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REFERENCES

[1] V. Petresscu, D. Dobrotă, Influence of parameters of welding regime on metallographic structure of materials from a joint welded in corner in „T” form, Metalurgija 54 (2015) 2, 390-394,
[2] D. Dobrotă, Structural modifications which appear in the area of welds of welded structures made of st 52.3 steel, Metalurgija 53 (2012) 2, 179 – 182.
[3] D. Min, T. Xin-hua, L. Feng-gui, Y. Shun, Welding of quenched and tempered steels with high-spin arc narrow gap MAG system, The International Journal of Advanced Manufacturing Technology, 55 (2011) 5 – 8, 527-533.
[5] M. Schnick, M. Dreher, J. Zschetzsche, U. Füssel, A. Spille-Kohoff, Visualization and Optimization of Shielding Gas Flows in Arc Welding, Welding in the World 56 (2012) 1-2, 54-61.
[6] F. Kolahan, M. Hedari, Modeling and optimization of MAG welding for gas pipelines using regression analysis and simulated annealing algorithm, Journal of Scientific & Industrial Research 69 (2010) 4, 177 – 183.
[6] P. Patel, S. Patel, Prediction of weld strength of metal active gas (MAG) welding using artificial nueral network, International Journal of Engineering Research and Applications 1 (2011) 1, 36 – 44.
[7] Y. B. Chen, J. C. Feng, L. Q. Li, Y. Li, S. Chang, Effects of welding positions on droplet transfer in CO_2 laser–MAG hybrid welding, he International Journal of Advanced Manufacturing Technology 68 (2013) 5-8, 1351 – 1359.
[8] ***Esab Welding Handbook, eighth edition – Consumables for manual and automatic welding.
[9] Information on http://www.esabna.com.
[10] Information on http://www.twi-global.com.

Note: The responsible translator for the English language is Stoicescu Daniela, Bucharest, Romania