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STRUCTURAL MODIFICATIONS WHICH APPEAR IN THE AREA OF WELDS OF WELDED STRUCTURES MADE OF ST 52.3 STEEL

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Using metal construction made of St 52.3 steel is very large and in these conditions an area of interest to use them is represented by the equipments which work in difficult conditions. Due to the heavy conditions of such welded structures, and also the working environment action on these welded structures, in practice it is necessary to know any structural modification that is produced in both the base material and the filler material. Research has followed in the main the analyze of structural modifications of the materials in the area of welded joints by corner, and also in the heat affected zone.

Key words: construction welded, structural modifications, welds, corner welding

INTRODUCTION

Knowing the evolution of material's structure in a welded construction is very important in order to assess their lifetime. Due to this reason the analyze of welded constructions are from the category of used in mining and present a long duration of use [1].

To increase the efficiency of the tehnological process of welding must take into account first of all the behavior of the couple which consist of layer of filler and how it make the homogeneous connection between atoms of the two materials in the contact area, but also the structure of the materials in the welds area. Homogeneous connection formation is the result of technological steps for submission of filler material over the material support.

The most important technological step of welding process are: the coressponding processing of the surface on which it is deposited filler material, cleaning, pickling, degreasing in order to create optimal conditions of adherence of the filler material to the base material in order to reduce the temperature gradient; the depositation, ensuring the conditions of solidification and avoiding the appearence of cracking, the application of coresponding heat treatment with desired exploring characteristics and machining to operating size [2].

Welded constructions have become more used in recent years because of the advantages they have, in comparison with other structures from other technological processes. By its nature, the realization of the technological process of products in welded construction presents a number of disadvantages resulting primarily from working with a liquid material [3].

Welded structures used in mining are very strong requested from mechanical point, but at the same time they are subject to the action of specific agents and work environment. A big problem of these equipments is represented by the metal welded construction which over time has not been modernized and has suffered a number of modifications to the structure and chemical composition of the material [4].

The lifetime of these welded construction is very much influenced by the evolution of the structure of materials from these. Thus an important analysis which must be made relates to the evolution of the structure of the base material and the filler.

Steels for general use for construction of type St 52.3, compared with carbon steels, have become widely used in construction machinery used in the exploitation of mining, due to the characteristics they have and allowing proper behavior at combined requests and mechanical with corrosive environment. However, these steels tend to hot cracking, cracking tendency accentuated by weakening. Hot cracking occurs at temperatures of 1250 / °C, at the cooling of the metal bath and it appears like solidification cracking or melt cracking, when layers are overlapping and over a layer of solodifi carecooling is overlapping a liquid layer, in certain areas of the thermal overlapping favoring cracking [5].

How to prepare the edges of elements at the merge process, influences primarily the amount of filler material deposited and the amount of heat that is introduced into the piece at welding operation, being preferred symmetrical joints to reduce stress and strain, but also to obtain a homogeneous structure of the material of the welded joints [6].

MATERIALS

The research who has been made has mainly aimed to determine the structure of the material from welded joints

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made of steel St 52.3. At the same time, the research was focused on those welded construction which are on the edge of life, and through this analysis we aimed to establish the possibility of safe use of such construction. The use of this steel is indicated in the fabrication of resistance elements (beams, columns, sections, rails, brackets, etc.). To achieve desired results, in the research, was initially determined the chemical composition of steel St 52.3 which is presented in Table 1.

Table 1 **Chemical composition of steel St 52.3 / %**

C M	n	Si	S	P	Al	Ni	Cr
0,136	1,22	0,365	0,017	0,017	0,011	0,022	0,027

The welded joints analyzed were obtained from semi-fabricated elements with sheet type with a thickness of 10 / mm. Materials structure analysis was performed for welded joints in corner T-shaped respective cross-shaped (double T). Were analyzed such welded joints because they are characterized by a wider heat affected zone and through several inhomogeneities of material of weld. Getting welded joints was performed using MAG process, in continuous current with reverse polarity, when power source is external and rigid. The application of process of welding MAG, it was made to adjust the following parameters of welding:

- Welding current: $I_s = 215$ / A;
- Welding voltage: $U = 24$ / V.

Filler material is used as the electrode wire produced in coils by type S10Mn1Si with diameter $\Phi = 1{,}2$ / mm. Chemical composition of wire - electrode used is presented in Table 2.

Table 2 **Chemical composition of filler material / %**

C	Si	Mn	Cr	Ni	Cu	Ti
0,096	0,83	1,52	0,143	0,30	0,017	0,025

RESULTS AND DISCUSSIONS

All samples analyzed were taken from the metal construction of machinery used in mining.Thus the two types of samples were taken, namely a sample for corner joints in T, Figure 1, and a sample for cross corner joints (double T), Figure 2.

Metallographic structure analysis of materials from the area of welds was made for each of the areas shown

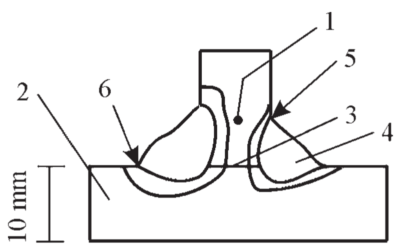

Figure 1 Corner weld T-shaped
1, 2 - Base material; 3 - impenetrable area of the weld between basic materials; 4 - Āller material deposited (weld); 5 - oxidized zone at the edge of melting crater; 6 - heat affected zone of the base material

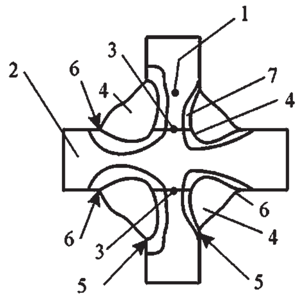

Figure 2 Fillet weld in a cross (double T)
1, 2 – base material; 3 – impenetrable area of the weld between basic materials; 4 – Āller material deposited (weld); 5,6 – oxidized zone at the edge of melting crater; 7 – heat affected zone of the base material

in Figure 1, welding corner in T. Thus in Figure 3 is shown the structure of the base material in zone 1 or zone 2 in Figure 1. In Figure 4 is shown the structure corresponding to zone 3 in Figure 1 the corresponding to the impenetrable area of the weld in the base material. The metallographic structure of filler material, zone 4 in Figure 1, is shown in Figure 5. At the edge of the melting crater has been identifi ed in an area with strong oxidation, zone 5 in Figure 1 and the corresponding metallographic structure of this area is shown in Figure 6. Structural modifications are produced in the heat affected zone, zone 6 Figure 1, as appropriate material metallographic structure of this area is shown in Figure 7.

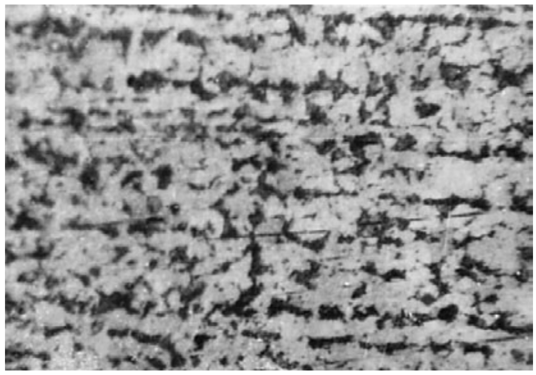

Figure 3 The metallographic structure of the base material

Figure 4 Metallographic structure of the material in the impenetrable area of the weld between the base materials

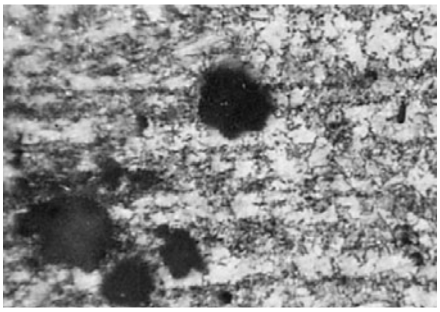

Figure 5 Metallographic structure of deposited fi ller material

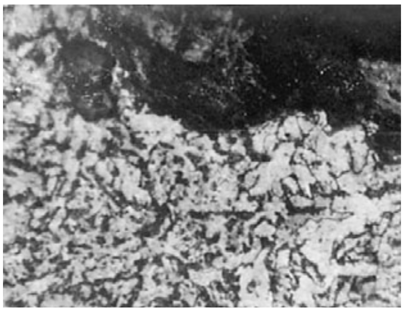

Figure 6 Metallographic structure of the oxidized zone at the edge of melting crater

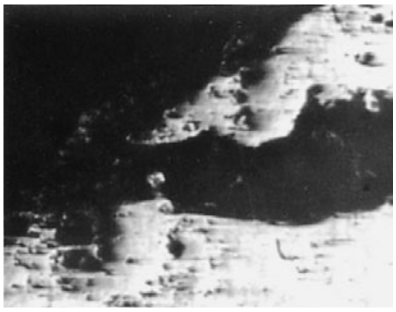

Figure 7 Metallographic structure of the heat affected zone and the presence of corrosion

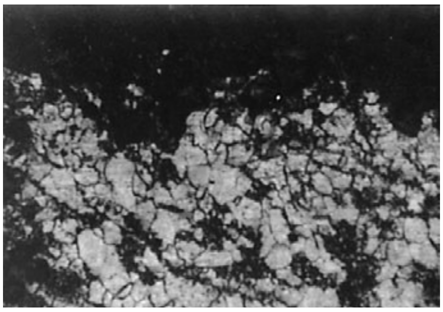

Figure 8 Metallographic structure of the base material and appearanceof the corrosion in the base material

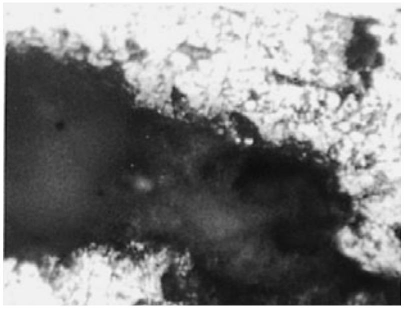

Figure 9 Metallographic structure of the material in the impenetrable area of the weld between base materials and corrosion

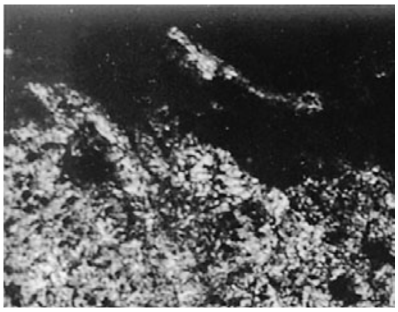

Figure 10 Metallographic structure of deposited fi ller material and appearance of corrosion in this material

Metallographic structure of materials from the welds was determined for each of the areas shown in Figure 2, cross corner welding (double T). In Figure 8 is presented the metallographic structure of base material in zone 1 or zone 2 of Figure 2. In Figure 9 is shown metallographic structure corresponding to zone 3 in Figure 2 the corresponding to the impenetrable area of the weld in the base material.   The metallographic structure of filler material, zone 4 in Figure 2, is shown in Figure 10.At the edge of the melting crater has been identifi ed in an area with strong oxidation, zone 5 and zone 6 in Figure 2, and the corresponding metallographic structure of this area is shown in Figure 1 1. Structural modifi cations are produced in the heat af fected zone, zone 7 Figure 2, so the material metallographic structure corresponding to this area is shown in Figure 12.

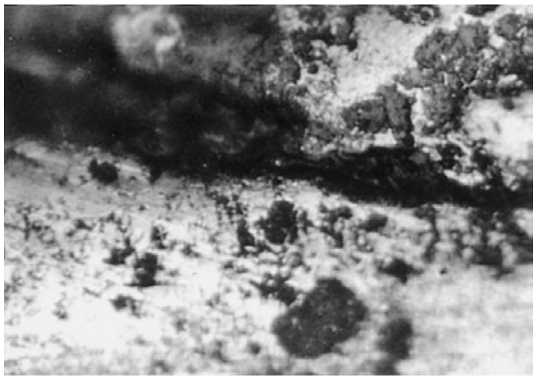

Figure 11 Metallographic structure of the oxidized zone at the edge of melting crater

CONCLUSIONS

The structure of basic materials consists of ferrite and pearlite with the proportion 20 / 80, Figure 3 and Figure 8, with the grain size real 4 - 5 and 7 - 8 (about 20 / μm and 40 / μm). Filler material deposited, Figure 5 or Figure 10, has a structure consisting of ferrite, pearlite and ferrite little needle with elongated grains and slag inclusions and oxides, at the same time it present ferrite-pearlite ratio 40/60 and a size of a grain real 2 - 3 (about 25 to 20   μm). Slag inclusions have a spherical shape and the freeform oxides. On the surface,

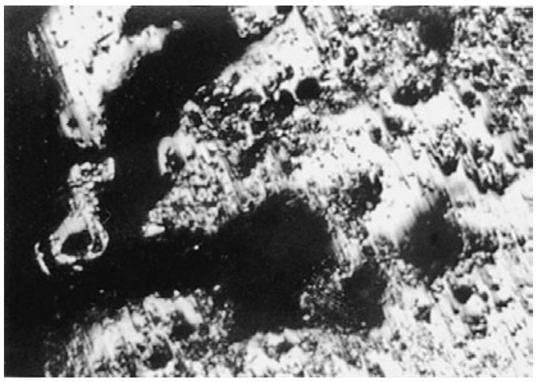

Figure 12 Metallographic structure of the heat affected zone and the presence of corrosion

strong oxidation with craters and projections deformation occurred as a result of mechanical action. Metallographic structure of the material in the impenetrable area of weld, Figure 4 and Figure 9, shows the oxidation craters in both base materials.

From metallographic analysis for materials weld area result that due to terms-of-process welding technology but also because of operating conditions occur welded slag inclusions and oxides in welding cord and unbalance respective nepătrunderilor uniform depth the heat affected zone of 1 - 2 / mm. So, defects of impenetrable and lateral craters with the heat affected zone, promotes parity corrosion which causes a reduction in the life of welded construction. The seams of surface oxidation occurs with craters and forming strong projections that have occurred as a result of mechanical action. Craters tend expansion oxide so that the assembly is strongly afected by the point of view of mechanical strength.

The exterior surface of corner weld cross is strongly affected chemically and oxidized showing erosion of 1,2 – 2,1 mm and openings of 5 - 8 mm with an approximate breakdown of 18 - 20 %. In case of the corner weld cross was found that in the filler material don' t present more slag inclusions but the oxides are present, the grain size is 4 - 8 (35 - 75 μm) has the structure composed of ferrite and perlite in the ratio of 45 / 55.

When welding corner are possible both the lack of protection from corrosion and internal tensions from the deposited and base material due to thermal phenomena occurring in welding, resulting an increase in external corrosion phenomena and intercrystalline. It was also found that an increase in size of crystalline grain accentuate external corrosion and intercrystalline corrosion.

The impenetrable area of the weld between the base material is continuing and is advancing in tim e and in the deposited material (exterior areas). Cracking and brittle fracture affects all metal construction even if the starting point is the heat affected zone. Following experimental research it can be concluded that rehabilitation of such welded structures must be repaired by replacing or restoring the affected areas so as to not afect the strength of the entire whole, and thus functioning machine.

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Note: The responsible translator for English language is S.C. PURTRAD S.R.L., Targu Jiu, Romania