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Microhardness Vickers HV 1 Modifications at PC Position MAG - C Mechanized Welding with Ceramic Backing

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Abstract

This paper presents the modifications in microhardness Vickers HV1 in horizontal pozition on a vertical wall (PC) MAG - C mechanized welding, with tubular flux cored wire, on round ceramic backing. 1.2 mm diameter tubular flux cored wire Fileur ARS 5, CO_2 gas protection welding and 7 mm diameter round ceramic backings were used. Two butt-welded samples were made, in normal asymmetric X joint ($\alpha = 50^0$) *and in thin asymmetric X joint* ($\alpha = 40^0$). *Microhardnesses Vickers HV1 were measured on three parallel directions, on test-pieces transversally sampled to the welding direction, after a proper grinding and metallographic preparation. The paper presents the experimental program research and the final conclusions.*

Key words: *MAG - C mechanized welding, flux cored wire, round ceramic backing*

Introduction

Within the Centre for Advanced Researches in Welding at Dunărea de Jos University of Galaţi within SUDAV Robotics and Welding Department took place experimental researches regarding the replacement of manual electric welding using covered electrodes, with MAG mechanized welding with tubular flux cored wire on round ceramic backing, of the semi-ferrules and ferrules preheat furnaces metallic coating on S.C. Arcelor Mittal S.A. Galaţi platform.

These metal coatings have a cylindrical shape with vertical axis, with a height of 28.857 mm and interior diameter of 8.005 mm, and consist of 13 ferrules. The first two ferrules (basic ferrules) are 22 mm thick, and the other 11 ferrules are 15 mm thick.

The first two ferrules (basic ferrules) are 8.042 mm external diameter, each one of them being made out of 4 semi-ferrules measuring 6.254 mm lenght and 2.000 mm width (ferrule's length being 12.136 mm).

The next 9 ferrules are 8.035 mm external diameter, each one of them being made out of 4 semi-ferrules measuring 6.254 mm lenght and 2.283 mm width (ferrules lenght being 12.136 mm). The last ferrules, 12 and 13, have a 8.035 mm external diameter, each one of them being made out of four semi-ferrules measuring 6.254 mm length and 2.500 mm, respectively 1.760 mm width (ferrule's length being 12.136 mm). The full weight of preheats coating is 90,7 t.

The ferrules are butt-joined in horizontal position on a vertical wall (cornice type PC). Each one of the ferrules is being made out of 4 semi-ferrules butt-joined in vertical up position (PF).

The vertical cylindrical metal coating of the preheater is joining in the lower part with the bed plate and in the upper part with the dome.

The lower ferrule 1, 22 mm thick and processed at the lower part in X symmetrical, is welded in T-joint with the bed plate, 50 mm thick.

The upper ferrule 13, 15 mm thick, unprocessed on the upper part, joins in 1/2 X asymmetrical with a dome, compouned of ronde and petals, 15 mm thick, processed in X asymmetrical.

Presently, the welding of metal coatings is realized through manual electric welding with Nibaz 55 covered electrodes, at the preheating temperature of 120^0C and interpass temperature of 175^0C.

Within the present research program, were realized welded samples, butt-joined in vertical up position (PF) and horizontal position on a vertical wall (cornice type - PC) using 2 welding types, manual electric welding with covered electrodes and MAG with tubular flux cored wire, on round ceramic backing (MAG - C and MAG - M with pulsed arc).

This paper presents only the researches regarding MAG - C welding in PC position.

The Experimental Program

Base material, added material and auxiliaries

The following materials were used in the experimental program research:
- base material: normalized weldable fine grain structural steel plates S355N, 15 mm thick;
- added material: 1,2 mm diameter tubular rutilic flux cored wire Fileur ARS 5;
- gas protection welding: S-type CO_2;
- 7 mm diameter round ceramic backings.

MAG welding stand

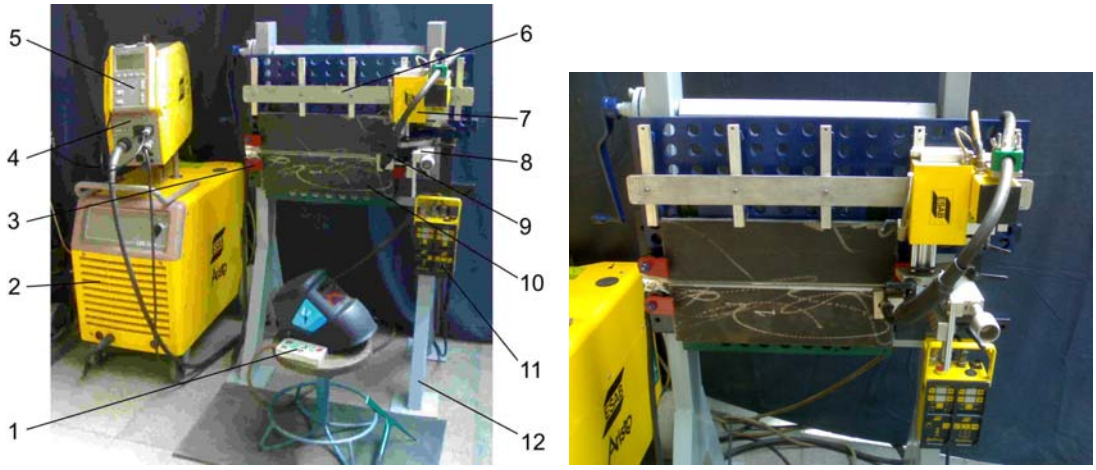
Figure 1 presents MAG - CO_2 welding stand in horizontal position on a vertical wall -cornice type (PC) used in the experimental program research.

The device permits: horizontal welding (PA), overhead welding (PE), vertical up (PF) vertical down (PG) and horizontal pozition on a vertical wall-cornice type (PC).

The Aristo Lud 320 universal welding power source (2) facilitates three types of welding, manual welding with covered electrodes in a protective gas medium with a consumable electrode (MIG - MAG) or non-consumable.

PUA 1 electronic operating seat (8) permits the selection of added & auxiliary materials, of the processing and of the process parameters. The digital programmer (13) of the Railtrac FW 1000

train welder (9) presents two distinct areas: the train welder control on the left and the oscillation system control on the right. The welding equipment remote control (1) allows simultaneous control of the source and train welder.



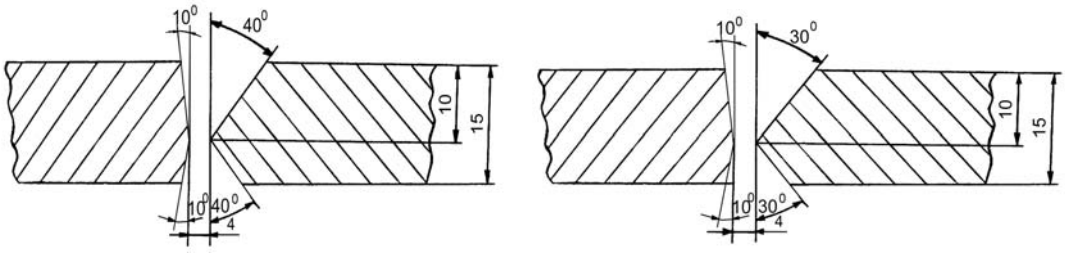
a b

Fig. 1. Horizontal position on a vertical wall experimental welding stand PC: a- over view; b- weld area detailed view; 1- welding equipment remote control; 2- Aristo Lud 320 universal welding power source; 3- ground wire; 4- screw clamps; 5- carriage guide bar; 6- welding gas cylinder tank; 7- MEK 4C wire feed mechanism; 8- PUA 1 electronic operating seat; 9- Railtrac FW 1000 train welder; 10- PSF 315 gun welding machine; 11- oscillation system; 12- welding test; 13- digital programmer; 14- metal frame [2, 3, 4]

Welding conditions

Within the present experimental research program on vertical up position (PC) MAG - C mechanized welding, the 15 mm S355N steel plates were processed for normal and thin welded joint, as shown in figure 2.

For vertical up position (PC) MAG - C mechanized welding were chosen V asymmetric joints on both sides or X asymmetric (normal joint, $\alpha = 50^0$ and thin joint, $\alpha = 40^0$).



a b

Fig. 2. Joints for orizontal pozition on a vertical wall-cornice (PC) MAG - C mechanized welding: a- normal joint; b- thin joint [3, 4]

For the implementation of semi-ferrules vertical up position (PC) MAG - C mechanized welding there were made butt-welded samples, on 7 mm round ceramic backings, using CO_2 as a protecting gas. For the experimental program was used the previously shown experimental bench, the Aristo Lud 320 universal welding power source and the Railtrac FW 1000 train welder.

Figure 3 shows the horizontal pozition on a vertical wall-cornice butt-welding of the samples.

Before welding (after fixing in welding spots, attaching the round cylindrical support on the back of the sample and positioning in parallel with the train welder guard rail) each sample was oxy-gas preheated up to 120 ^{0}C, the preheating being checked with Thermochrome crayons. After checking the pre-heating temperature, the welding train was set on the guard rail and was rechecked the parallelism between the rail and the sample. The interpass temperature was limited to 175 ^{0}C, and was also checked with Thermochrome crayons.

Fig. 3. Horizontal pozition on a vertical wall-cornice (PC) MAG - C mechanized welding of the samples [4]

After giving each welding bead, it is cleaned of slag with a slag hammer and a wire brush.

The MAG - C mechanized welding was made in arc spray, in DC reverse polarity.

During MAG - C mechanized welding, some parameters were kept constant (protective gas flow Q_G = 18 l/min, ramp up time t_{ru} = 3 s, burn-back time t_{bb} = 5 s, the nozzle-beam distance h_{N-B} = 17 mm). Table 1 presents the variable parameters of MAG - C mechanized welding regime of the PF butt-welded samples.

After cooling, a visual control (naked eye) of each butt-welded sample was performed as well as a nondestructive examination (gamma rays), no mistakes being established.

Table 1. The variable parameters of MAG - C mechanized welding regime in vertical up position [3, 4]

Seam no.	Welding regime parameters				
	$I_{s\ cit}$, A	$U_{a\ cit}$, V	$v_{s\ regl}$, cm/min	$v_{e\ regl}$, m/h	$L_{p\ regl}$, mm
Sample CC5					
1 front	160	20,5	30	4,5	2
2 - 3 front	160	20,5	30	4,5	-
4 - 6 front	160	20,5	30	4,5	-
7 - 9 front	160	20,5	30	4,5	-
10 - 13 front	160	20,5	35	4,5	-
14 - 18 back	160	20,5	35	4,5	-
Sample CC4					
1 front	160	20,5	30	4,5	2
2 - 3 front	160	20,5	30	4,5	-
4 - 6 front	160	20,5	30	4,5	-
7 - 9 front	160	20,5	35	4,5	-
10 - 11 back	160	20,5	35	4,5	-
12 - 14 back	160	20,5	35	4,5	-

Microhardness Vickers VH 1 Test Results

Microhardness Vickers VH 1 tests were made on (23 ± 5) ^{0}C ambient temperature, on three impression strings, using the Shimadzu HMV - 2T microhardness tester (Figure 4). Figure 6 present Vickers HV 1 microhardnesses variations in the welded joint areas on the three measurement directions.

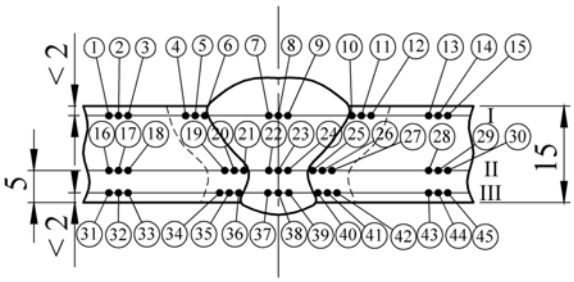
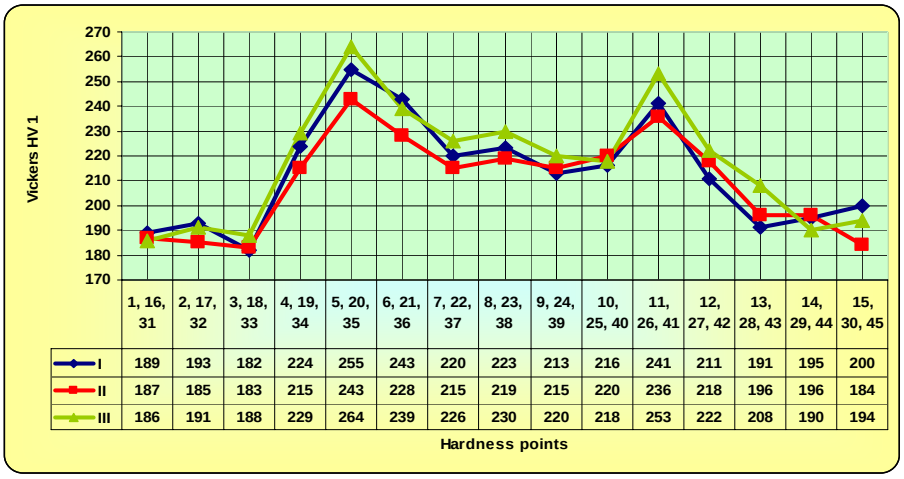


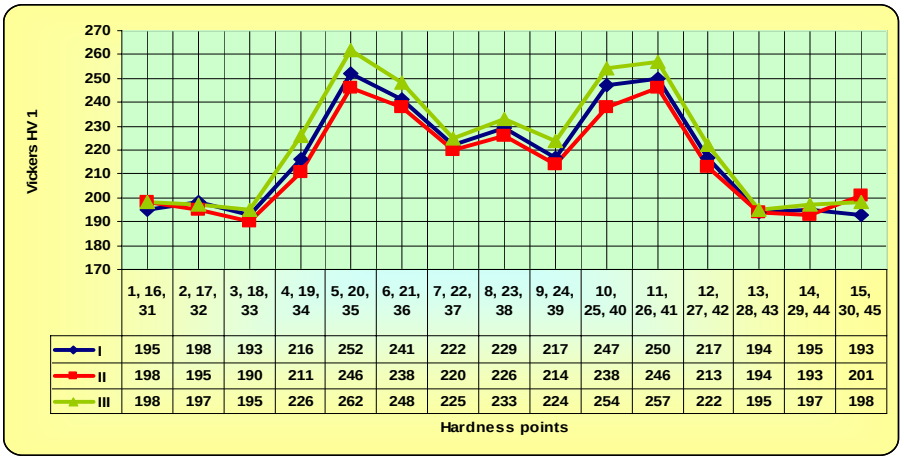
Fig. 4. Vickers VH 1 Microhardness indentation pattern (I, II, III - measurement directions) [3, 4]

Fig. 5. The easy separation of slag on horizontal pozition on a vertical wall-cornice (PC) MAG - C mechanized welding [3, 4]



	1, 16, 31	2, 17, 32	3, 18, 33	4, 19, 34	5, 20, 35	6, 21, 36	7, 22, 37	8, 23, 38	9, 24, 39	10, 25, 40	11, 26, 41	12, 27, 42	13, 28, 43	14, 29, 44	15, 30, 45
I	189	193	182	224	255	243	220	223	213	216	241	211	191	195	200
II	187	185	183	215	243	228	215	219	215	220	236	218	196	196	184
III	186	191	188	229	264	239	226	230	220	218	253	222	208	190	194

a



	1, 16, 31	2, 17, 32	3, 18, 33	4, 19, 34	5, 20, 35	6, 21, 36	7, 22, 37	8, 23, 38	9, 24, 39	10, 25, 40	11, 26, 41	12, 27, 42	13, 28, 43	14, 29, 44	15, 30, 45
I	195	198	193	216	252	241	222	229	217	247	250	217	194	195	193
II	198	195	190	211	246	238	220	226	214	238	246	213	194	193	201
III	198	197	195	226	262	248	225	233	224	254	257	222	195	197	198

b

Fig. 6. Vickers HV 1 microhardnesses variations in the welded joint sub-areas on the three measurement directions: a- CC5 sample; b- CC4 sample [3, 4]

Conclusions

The experimental program research led to the following conclusions:

- The electric arc was stable during butt-welding operation and the welded joints had a good shape. The slag properly covered the interpas and was easy separated after solidification (Figure 5);
- Visual and gamma examinations established a good quality of the MAG - C mechanized welding samples in the difficult PC position (no imperfections);
- The highest values of the Vickers HV 1 microhardnesses were obtained on III - III path, medium on I - I path and minime on II - II path. Regardless of the joint angle (50^0 or 40^0), the highest values of the Vickers HV 1 microhardnesses were obtained in the termomechanical influenced area, at the superheating area, on the back of the last welding pass, path III - III.

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Modificări de microduritate Vickers HV 1 la sudarea mecanizată MAG pe suport ceramic în poziția PC

Rezumat

Această lucrare prezintă modificările de microdurități Vickers HV 1 la sudarea mecanizată MAG - C, cu sârmă tubulară, pe suport ceramic rotund, în poziție orizontal pe perete vertical PC. În acest studiu au fost utilizate sârma tubulară Fileur ARS 5 cu diametrul de 1,2 mm, gazul de protecție dioxidul de carbon şi suporți ceramici rotunzi cu diametrul de 7 mm. Au fost realizate un număr de două probe sudate cap la cap, cu un rost normal în X asimetric ($\alpha = 50^0$) şi cu un rost îngust în X asimetric ($\alpha = 40^0$). Microdurităţile Vickers HV 1 au fost determinate pe trei direcții paralele, pe epruvete prelevate transversal pe direcția de sudare, după o rectificare şi o pregătire metalografică corespunzătoare. Lucrarea prezintă programul experimental de cercetare şi concluziile finale.