ONLINE PROGRAMMING POSSIBILITIES FOR WELDING ROBOTS

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SUMMARY: The paper presents the possibility of online programming of welding robots, in particular the programming of a Fanuc robot type ArcMate 100iC, making 6 different samples to highlight the differences between them at different values and parameters. The necessary steps of programming in order to make the welded joint will be presented.

KEYWORDS: industrial robot, welding

1. Introduction

Welding is a technological process of joining two or more parts together in a non-detachable manner by means of a welding process, in such a way as to obtain a metallic connection of equal strength, which is safe in execution and operation. [1]

1.1 ROBOTIC WELDING.

The word robot originates from the Czech word "robota" which means work. According to the definition in the encyclopaedic dictionary, it is an automatic machine whose program contains a complex system with inverse links (reaction) established to certain external signals, being capable of directed and controlled actions. [2]

Welding robots are generally referred to as fully automated systems for performing welding operations with the possibility of programming.

The main tasks pursued by robotics are the removal of a person from the welding area, the complete automation of production, and hence the increase in productivity. [3]

1.2 MIG/MAG WELDING

The MIG/MAG welding process is one of the most popular welding processes. The process also has the highest utilisation rate. It is used in several fields: [4]

- Machine building industry;
- Metal fabrication;
- Shipyards;
- Welding of gas mains;
- Car workshops for repairs (paintwork, exhaust pipes, etc.);
- Bicycle manufacturing;
- Repairs;
- Welding of weldments.

MIG/MAG welding is an electric arc welding process in a shielded gas environment with a fusible electrode. The shielding gas has the function of protecting the molten metal bath from the unwanted actions of oxygen and nitrogen in the atmosphere. [4]

- MIG (Metal Inert Gas) - examples of inert gases: argon, helium or mixtures of these gases, and are used to weld aluminium, copper, titanium or magnesium parts.

- MAG (Metal Active Gas) the shielding gas used is carbon dioxide or mixtures of this gas with argon. Active gases are used to weld ordinary, construction or high-alloy steels.

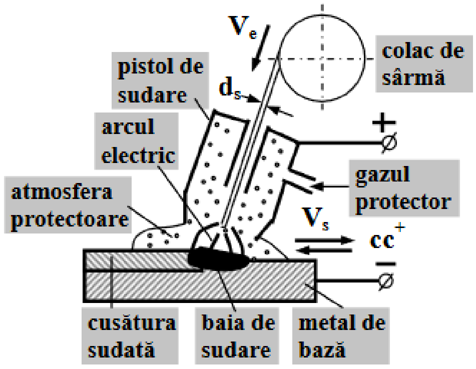

FIG. 1.2.1. MIG/MAG PRINCIPLE DIAGRAM [5]

Advantages of the MIG/MAG welding process: [4]

- It has a high degree of universality;
- Welding of all materials;
- Possibility of automation or robotization depending on the application;
- High deposition rate;
- High productivity;
- Obtaining very high quality joints;
- Low smoke emissions;
- Possibility of welding in any position.

Disadvantages of the MIG/MAG welding process: [4]

- Larger and more expensive welding equipment;
- Loss of filler material through spatter;
- Sensitive to air currents (avoid welding in open space);

1.3. PURPOSE OF THE WORK

The purpose of the work is to observe the differences between joints welded under different conditions.

In order to observe the possible differences, 6 tests with different parameters were performed, namely: welding at 30, 45 and 60 with intensity I = 260 A, welding at 45 and intensity I = 160 A, and two push-pull tests at 45 and 15 with respect to the feed direction.

2. MATERIALS AND METHODS

2.1. EQUIPMENT USED

For the practical part of the work, the FANUC ARC 100iBe robot and the FRONIUS TSP 4000 source were used as equipment.

FIG. 2.1.1. FANUC ARC 100iBe [6]

FIG. 2.1.2. FRONIUS TSP 4000 [7]

Robot specifications:

Axis	6
Payload	6 kg
Repeatability	± 0,08 mm
Robot mass	238 kg
Structure	Articulated
Floor mounting	

Source specifications:

Mains voltage	3 x 400 V
Mains voltage tolerance	+/- 15%
Mains frequency	50/60 Hz
Mains safety	35 A slow
Continuous current in primary circuit	(100% DA) 26 A
Efficiency 88% Efficiency	
MIG/MAG welding current range:	3 - 400 A

2.2 MATERIAL

The materials used were:
- Basic material: S275JR
- Additive material: G3Si2

TABLE 2.2.1. CHEMICAL COMPOSITION S275JR [8]

C	Mn	P	S	N	Cu

max 0.22	max 1.5	max 0.04	max 0.04	max 0.012	max 0.55

TABLE 2.2.2. CHEMICAL COMPOSITION G3Si2 [9]

C	SI	MN	CR	NI	S
0,06-0,14	0,7-1	1,3-1,6	≤0,15	≤ 0,15	≤ 0,025

2.3 EXPERIMENTAL DATA

For the practical work, 12 pieces of S275JR steel plate were used with dimensions: width 9 mm and length 24 mm with thickness 6 mm.
They were placed in "T" profiles and welded in wells at the ends by the SMEI (Manual Welding with Coated Electrode) process to provide support.
After welding was completed, slag was removed by successive hammer blows and the surface was cleaned with a wire brush.

FIG. 2.3.1. POSITIONING OF TABLES

FIG. 2.3.2. FIXING PARTS BY SPOT WELDING

FIG. 2.3.3. REMOVING SLAG WITH A HAMMER

FIG. 2.3.4. CLEANING THE SURFACE WITH A WIRE BRUSH

The 6 problems were moved into the robotic cell to be MIG welded, using G3Si2 as filler material and Ar+18%CO2 as shielding gas.

The parameters used were:

SAMPLE 1: I = 180 A	SAMPLE 2-6: I = 260 A
U = 18.5 V	U = 26.2 V
Vane = 4.4 m/min	Vas = 8,1 m/min

2.4. RESULTS

Following robotic welding, the following were obtained:

TEST 1: Welding was carried out at an angle of 45° with intensity I = 180 A.

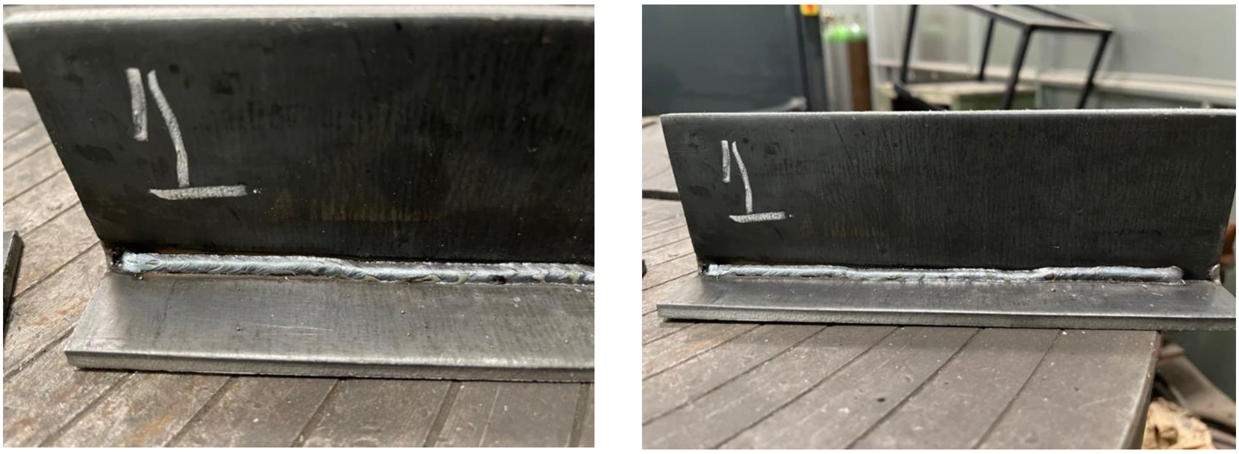

FIG. 2.4.1. WELDED JOINT SAMPLE 1

TEST 2: Welding was carried out at an angle of 45° with intensity I = 260 A.

FIG. 2.4.2. WELDED JOINT SAMPLE 2

TEST 3: Welding was carried out at an angle of 60° with intensity I = 260 A.

FIG. 2.4.3. WELDED JOINT SAMPLE 3

TEST 4: Welding was carried out at an angle of 30° with intensity I = 260 A.

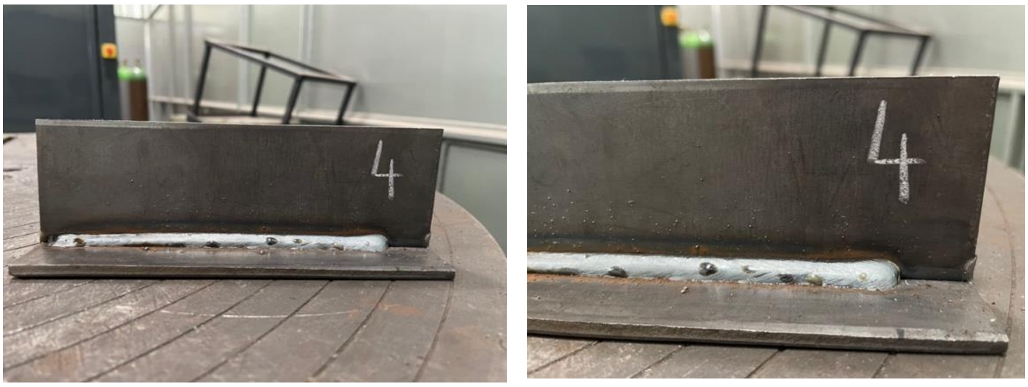

FIG. 2.4.4. WELDED JOINT SAMPLE 4

TEST 5: Welding was carried out at an angle of 45° with intensity I = 260 A.
Pushed at an angle of -15° to the direction of travel of the gun.

FIG. 2.4.5. WELDED JOINT SAMPLE 5

TEST 6: Welding was carried out at an angle of 45° with intensity I = 260 A.
Firing at an angle of 15° to the direction of travel of the gun.

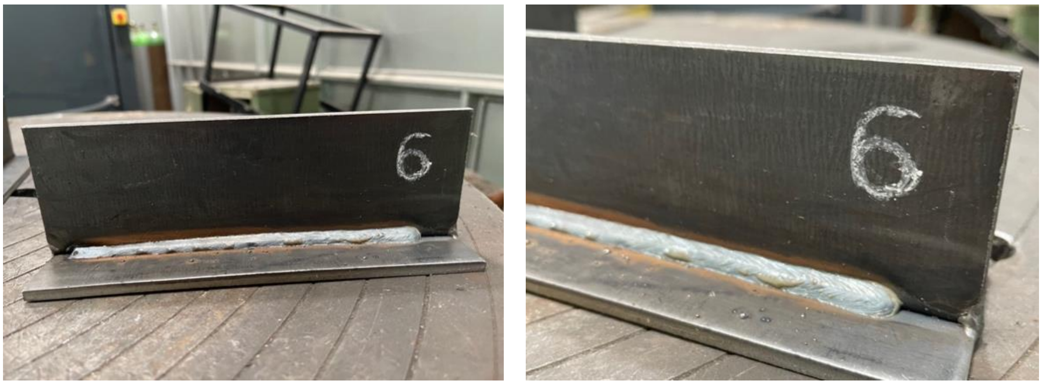

FIG. 2.4.6. WELDED JOINT SAMPLE 6

In the first test the intensity value was low, which led to an inadequate deposition in terms of the geometrical characteristics of the weld bead.
The position of the welding head was corrected and the intensity was modified in order to increase this value, which resulted in a bead with satisfactory geometrical characteristics.

3. CONCLUSIONS

The online programming and testing of the welding technology gives us the possibility to effectively visualize the obtained ropes and to make possible corrections caused by the incorrect choice of welding parameters.

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