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Research on the Calculus of the Equivalent Strain of an Elasto-Tactile System for the Monitoring of the Play / Joint during Welding

The paper aims at bringing contributions to the optimisation of the calculus of the equivalent strain of an elasto-tactile system in order to monitor the welding joint or play. For this purpose one needs specialised installations able to take into account the concrete conditions of the performance of welded seams. These installations are equipped with joint sensors which "see" the parts and the trajectories to follow.

Keywords: *welded seams, strain, measurement, sensors*

1. Introduction

Among the fuse welding procedures, the most spectacular dynamics as regards the volume of application in these past 20 years, i.e. welding in protective gas environment is definitely in pole position.

The necessity to monitor the joint with the highest precision possible is the number one reason in obtaining a quality enhancement and for this purpose a multitude of systems have been developed, more or less used in practice. The frequency of the use of these systems depends on a series of factors such as: type of procedure used, complexity of the welded structure type, position and dimensions of the joint, the cost of the monitoring system and the degree of installation mechanisation.

The most complex and state-of-the-art installations of this type are the welding robotised cells. With all the high precision imposed in the performance of robotised cells, the use of sensors for co-ordinating the movement of the burner tip is indispensable in the light of the discussion above. In the adaptive welding one needs also the optimum adjustment and real-time control of the welding regime parameters during the entire welding process, depending on the results of the continuous measurement of the joint width and section.

The precision of the burner tip positioning in relation with the joint directly influences the quality of the joining. During automated and robotised welding, nevertheless, this precision is influenced by a series of factors related to the execution of parts, the welding procedure and the welding installation / robot. These factors are presented in the table below.

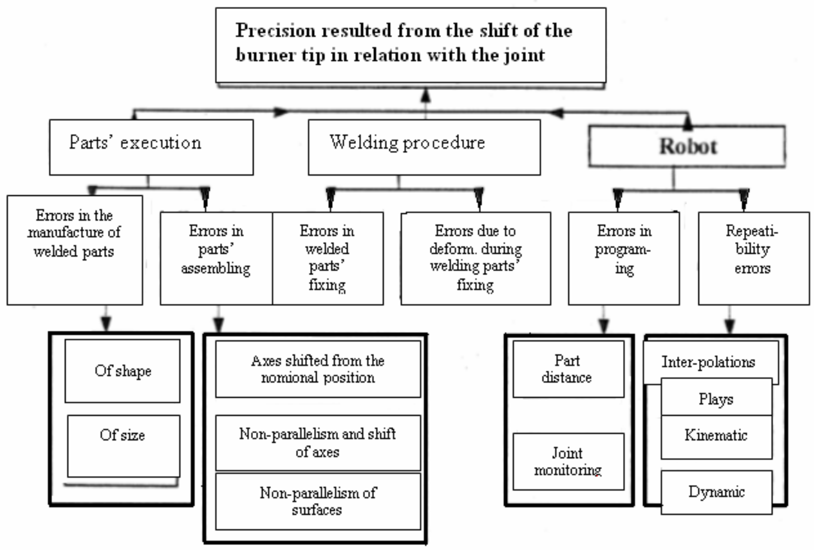

Figure 1. Influence of welding errors resulted form the shift of the burner tip in relation with the joint of the welded seam

2. Tactile systems for the automation of the welding processes

The need to monitor the joint with the highest precision possible is the number one desideratum in order to enhance quality and for this purpose one developed a multitude of systems more or less used in practice. The frequency of the use of these systems depends on a series of factors such as. Type of the procedure used, complexity fop the structure under welding, type, position and dimensions of the joint, cost of the monitoring system and installation degree of mechanisation.

The corner joinings performed with the MIG-MAG procedure require a precise position of the electrode wire in relation with the bisector of the joint angle.

The tactile systems used in the automatic welding represent the oldest and most frequently used categories of systems, used in the monitoring of the spatial characteristics of the welding joint.

A sensor consists in receiver, converter, amplifier and elements for processing the measurement results (figure 2).

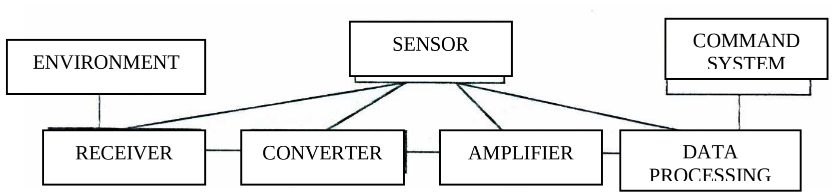

Figure 2. Block diagram of a sensor

3. Calculus of the equivalent strain

The operation principle of the palpator is simple and based on one of the laws of mechanics - that of decomposition of forces along two directions (Figure 3). In the case studied – R – will be the force with which the palpator of the device will press on the components under welding (joint).

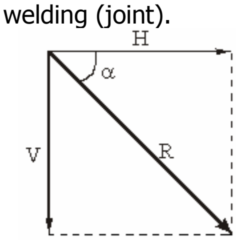

Figure 3. Diagram of forces' composition

R is practically the resultant of two forces that are composed according to the rule of the parallelogram:

V – the force on the vertical – is given by the own weight of the device;

H – the force on the horizontal – is given by a plane spiral arc, being practically a pulling force. The J component should be high enough to be equal with V; but at the same time it should compensate the friction losses from the system translation couples. The realisation of the horizontal component for obtaining the force through the palpator is done by mounting two arcs on the plate of the sledge holder. These arcs are plan spiral arcs.

From the study effected together these arcs should give a 23-kg force.

Taking into account the constructive shape of the elasto-tactile device, one chose for the materialisation of the C_V and C_H kinetic couples a guiding device of the HRW type which in general has a small profile, which leads to a reduced inertia geometric moment, which results in its turn in a high transversal rigidity.

Considering the strain the guiding device is subjected to, one must calculate the equivalent strain according to a special method, which is generally given by the manufacturer. The weight of the elasto-tactile system gives, on the horizontal guiding device, two moments that must be transformed into an equivalent load P.

In the present case, considering the strain to which the guiding device is subjected, we must calculate the equivalent strain with the help of a special method provided by the manufacturer. The weight of the elasto-tactile system gives, on the horizontal guiding device, two moments that must be transformed into an equivalent load P:

$$P_e = M_C \bullet K_C + M_A \bullet K_A + W$$

where: M_c, M_A - moments given by the system's weight

K_C, K_A - coefficients found in tables

W = 310 N – load on the guiding device

$$K_C = 0{,}029$$

$$K_A = 0{,}101$$

$$P_e = 310 \bullet 110 \bullet 0{,}029 + 310 \bullet 30 \bullet 0{,}101 + 310$$

$$P_e = 2238$$

Remark: the co-ordinates of the gravity centre were approximated.

From the tables, for the conditions of use of the elasto-tactile device, we took a safety factor s $f_s = 1{,}5$, in order to verify the report :

$$\frac{C_0}{P_e} \geq f_s \Rightarrow \frac{27200}{2238} = 12{,}15 > 1{,}5$$

The calculus of the life duration of the system

$$L = \left(\frac{f_H \bullet f_T \bullet f_C}{f_W} \bullet \frac{C}{P} \right)^3 \bullet 50$$

$$L = 973013999 \text{ Km}$$

where: **Eroare! Obiectele nu se creează din editarea codurilor de câmp.** - toughness factor

Eroare! Obiectele nu se creează din editarea codurilor de câmp. - temperature factor

Eroare! Obiectele nu se creează din editarea codurilor de câmp. - contact factor

Eroare! Obiectele nu se creează din editarea codurilor de câmp. - load factor

C – rate of the dynamic load

P – weight of the sleigh holder plate

In operation P=70 N= 7 daN= 7 Kgf ≈ the weight of the sleigh holder plate.

For the device used for the positioning of the welding head depending on the axis of the palpating roll, we chose to use two dovetail guiding devices which are generally built with a 55°-angle between the guiding surfaces.

The value of this angle corresponds to a slight processing and an operation of the guiding device in good conditions.

In order to balance the free plays which occur during exploitation and more precisely in order to perform a tightening which should not allow the shifting of the mobile elements during the welding process, we provided the guiding with an adjustment wedge.

For the elasto-tactile device one needs an ark meant to perform a tensioning of the device, in other words to provide a pulling force destined to constitute the horizontal component necessary for the performance of a resulting force R through the palpator.

In order to perform this function we will use two plane spiral arks mounted on the sleigh holder plate. The ends of these arks will be mounted on a stopper (angle profile) mounted by screws at the end of the horizontal guiding device.

4. Conclusion

The use of sensors for the co-ordination of the motion of the burner tip offers safety as regards the correct inscribing of the trajectory of the welded joining and the optimum adjustment and real-time control of the welding regime parameters during the entire welding process, in accordance with the results of the continuous measurement of the joint's width and section.

Beside the command of the motion along a continuous or interrupted trajectory in the case of robotised welding with electric arc, in order to control the shape, position and depth of the welding bath one needs to develop certain systems able to monitor the joint, to measure the welding penetration and to assure the control of the welding bath shape.

It is also absolutely necessary to impose that the positioning of the burner tip be made in accordance with the following factors:

- iterativity of the part positioning by the manipulator or fixing device.
- possible plays of the burner tip fixing on the flange of the last axis of the robot, on the final effector.
- possible deformations of the burner tip and bendings of the electrode wire tip.

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