# CONTRIBUTIONS TO THE INFLUENCE OF WELDING PARAMETERS ON MECHANICAL PROPERTIES OF JOINTS WELDED ON PLATES HEAD-TO-HEAD THROUGH MAG PROCEDURE

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**Abstract:** *This paper presents the influence of gas-shielded arc welding parameters (amperage $I_s$ [A], arc tension $U_a$ [V], welding rate $V_s$ [cm/min]) on the mechanical characteristics of welded joints (mechanical resistance $R_m$, breaking energy of impact bending $E_r$, punch bending $I_d$), using the Taguchi method.*

**Keywords**: welding process, welding parameters, joining type, experimental plan

## INTRODUCTION

The welded connection of metallic materials is a wide-spread method used for constructions in various fields of modern technique. The method began developing especially in the last decade of the 20th century, in addition to the development of integrated production systems managed by computers.

The design and simulation of technological processes of virtual welding are developing more and more, in addition to the continuous development of electronic computers. This development assumes creating of complex software that will contain all the information regarding one or the other product welded connection procedures.

Studies from countries with growing industries, such as U.S.A., Japan or European Community, regarding the dynamic of fuse welding procedure development in the last 25 years and its percentage at the end of 20th century and the beginning of the 21st century, have clearly shown that gas-shielded welding with consumable electrode MIG/MAG is the procedure with the most spectacular dynamic and the most used as we speak. The analysis covers the period 1975 – 1992, taking into consideration the following fuse welding procedures: *manual welding with coated electrode (SE), gas-shielded welding MIG/MAG, tubular wire welding (ST) and submerged arc welding (SF)*.

## CASE STUDY REGARDING THE INFLUENCE OF WELDING PARAMETERS ON MECHANICAL PROPERTIES

The quality of welded joints through non-destructive and destructive control has been studied after the construction of 9 welded samples, by modifying the main welding parameters ($I_s$, $U_a$, $V_s$), using the factorial plan in table 1 and Taguchi method. This method offers an instrument for studying the way in which the main welding parameters have a quantitative influence on the welded joints' mechanical characteristics. The welded samples have been made in the assembly room of JLG Manufacturing Central Europe Company in Medias, Sibiu County.

The welding installation was GULLCO type, an automate manipulator with the possibility of varying the welding rate, the wire advance rate (implicit the welding flow) and the arc tension for the MILLER 400S source.

As basic material were used S355 J2+N plates, according to EN 10025/2, with thickness ≠ 12mm, synthetically worked on both sides in order to realize a X type welding slot.

Table 1. Welding parameters scheme

| Experiment no. | $I_s$ $(W_s)$ | $U_a$ | $V_{sud}$ |
|---|---|---|---|
| 1 | +1 | +1 | +1 |
| 2 | +1 | +1 | -1 |
| 3 | +1 | -1 | +1 |
| 4 | +1 | -1 | -1 |
| 5 | -1 | +1 | +1 |
| 6 | -1 | +1 | -1 |
| 7 | -1 | -1 | +1 |
| 8 | -1 | -1 | -1 |
| 0 | R | R | R |

As add-on material was used tubular wire with metal powder Outershield MC 710-H, classified T46 3M M 2 H5 according to EN 758, with width Ø 1,2mm, and the shielded gas was a mix Ar +10% CO2 (M21) according to EN 439, with a flow of 161/min.

Table 2. Welding parameters

| Sample No. (Experiment) | $I_s$ [A] | $W_s$ [inch/min] | $U_a$ [V] | $V_{sud}$ [cm/min] | No of passing |
|---|---|---|---|---|---|
| 1 [+1;+1;+1] | 314 | 558 | 35 | 126 | 12 |
| 2 [+1;+1;-1] | 301 | 534 | 31,7 | 39 | 2 |
| 3 [+1;-1;+1] | 245 | 411 | 20,1 | 68 | 8 |
| 4 [+1;-1;-1] | 230 | 321 | 18,3 | 22 | 5 |
| 5 [-1;+1;+1] | 185 | 230 | 26,4 | 119 | 19 |
| 6 [-1;+1;-1] | 185 | 230 | 26,4 | 22 | 6 |
| 7 [-1;-1;+1] | 175 | 230 | 19,2 | 151 | 21 |
| 8 [-1;-1;-1] | 180 | 230 | 19,2 | 22 | 6 |
| 0 | 296 | 532 | 30,4 | 48 | 4 |

The welding parameters values are shown in the table 2.
Sample 0 is considered to be made with the recommended welding parameters through a qualified and verified welding procedure. $W_s$ is the advance rate of the electrode wire, parameter posted by the installation before the beginning of the welding process.

The values of breaking energies of impact bending $E_r$ [J] at temperatures of -20ºC obtained on 3 test tubes sets are presented in table 3.

| Sample No. | $I_s$ | $U_a$ | $V_s$ | $E_r$ 1 [J] | $E_r$ 2 [J] | $E_r$ 3 [J] | $E_r$ average | Obs. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | **79** | **91** | **75** | ***81.66667*** | |
| 2 | 1 | 1 | -1 | **65** | **75** | **70** | ***70*** | |
| 3 | 1 | -1 | 1 | **23** | **8** | **18** | ***16.33333*** | |
| 4 | 1 | -1 | -1 | **27** | **21** | **33** | ***27*** | |
| 5 | -1 | 1 | 1 | **77** | **73** | **68** | ***72.66667*** | |
| 6 | -1 | 1 | -1 | **52** | **67** | **45** | ***54.66667*** | |
| 7 | -1 | -1 | 1 | **70** | **87** | **50** | ***69*** | |
| 8 | -1 | -1 | -1 | **47** | **66** | **55** | ***56*** | |
| 0 | R | R | R | **84** | **64** | **77** | ***75*** | |

Table 3. The values of breaking energies of impact bending

The values of breaking mechanical resistance for welded joints, obtained on 2 test tubes sets are presented in table 4.

Table 4. Breaking mechanical resistance

| Sample No. | $I_s$ | $U_a$ | $V_s$ | $R_m$ 1 [N/mm2] | $R_m$ 2 [N/mm2] | $R_m$ average | Obs. |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | **501** | **493** | ***497*** | |
| 2 | 1 | 1 | -1 | **531** | **539** | ***535*** | |
| 3 | 1 | -1 | 1 | **512** | **494** | ***503*** | |
| 4 | 1 | -1 | -1 | **228** | **220** | ***224*** | |
| 5 | -1 | 1 | 1 | **533** | **518** | ***525,5*** | |
| 6 | -1 | 1 | -1 | **502** | **511** | ***506,5*** | |
| 7 | -1 | -1 | 1 | **492** | **490** | ***491*** | |
| 8 | -1 | -1 | -1 | **501** | **443** | ***472*** | |
| 0 | R | R | R | **538** | **537** | ***537,5*** | |

## SIMILARITY AND CONCLUSION

In order to obtain conclusions on the measured values, we compare samples made with different parameters.

a) 0 with 2, $I_s$ and $U_a \cong$ const.; $V_s$ decreases
**Conclusion: $K_v$ and $R_m$ decrease.**

b) 6 with 5, $I_s$ and $U_a \cong$ const.; $V_s$ increases
**Conclusion: $K_v$ and $R_m$ increase.**
From a) and b) results that if **$V_s$ increases, $K_v$ and $R_m$ increase.**

c) 8 with 6, $I_s$ and $V_s \cong$ const.; $U_a$ increases
**Conclusion**: **$R_m$ increases, $K_v$ decreases insignificantly.**

d) 4 with 6, $V_s \cong$ const.; $I_s$ decreases and $U_a$ increases
**Conclusion: $R_m$ and $K_v$ increase.**

e) 5 with 7, $I_s \cong$ const.; $V_s$ increases and $U_a$ decreases
**Conclusion: $R_m$ decreases insignificantly (7%) and $K_v$ decreases insignificantly (5%).**

f) 0 with 1, $I_s \cong$ const.; $V_s$ and $U_a$ increase

**Conclusion: $R_m$ decreases and $K_v$ increases.**

g) 4 with3, $I_s$ and $U_a \cong$ const. ; $V_s$ increases

**Conclusion: $R_m$ increases and $K_v$ decreases.**

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