THE CALCULATION ALGORITHM FOR SPECIFIC WEIGHT OF DEPOSED METAL DURING THE HEAD TO HEAD WELDING PROCESS OF TIN THICKNESS FROM STEEL

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1. INTRODUCTION

To establish the groove's geometrical shape and weld's thickness in the head to head welding case during the melting process it is necessary to accomplish the weld with less deposed material and consumed energy. On one hand, if it will be considered all the known welded procedures there are a lot of possibilities to achieve them.

The melting process of head to head joins during the welding, one of the essential problem is to choose the opening groove angle that can guarantee the melting of sides.

The range value of opening groove angle (used to diminish the deposed metal and to decrease the welding time) it is reached when the metallic tank is discharged out of groove. The result: the appearance of defects caused by the insufficiency of melting. In this case, it is necessary to diminish the melting operation rate.

The interdependence between the opening angle (α) and the quantity of deposed metal (G) in welding groove is presented in figure 1.

The type (the geometrical configuration) and the groove's sizes during welding process (elements melting) depend of the basic material characteristics, its thickness and the used welding method. The selection of groove configuration depends of realization process.

Figure 2 shows the main groove's shapes used at welding in the head to head melting process of tin thickness. Figure 2 shows that the increasing tin thickness the weld with V groove becomes more problematic than the weld with double V groove. If the tin thickness increases it would be preferred the U and double U grooves, because they are lager and allow a better placement of melted deposed metal during the welding process.

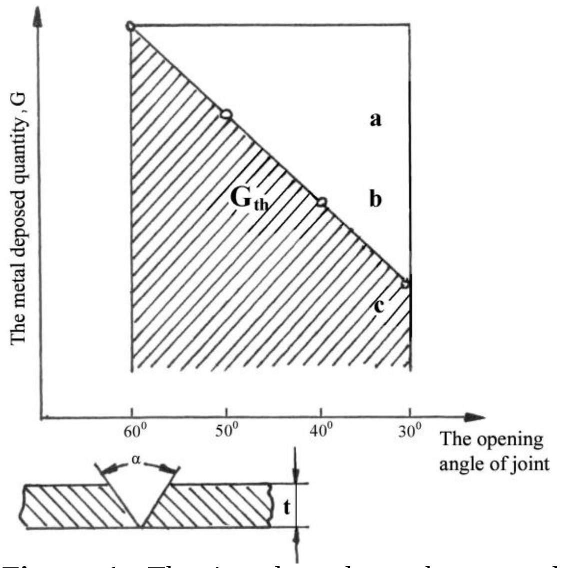

Figure 1. The interdependence between the opening angle (α) and the quantity of deposed metal (G) in welding groove, where: $G_{th} = t^2 \cdot b \cdot \rho_m \cdot tg\frac{\alpha}{2}$ (without distance between plates without ribs. without uplifting); **a**) easy accessible in application; **b**) heavily accessible; **c**) the capacity of weld established with a mathematical formulas.

2. METHODOLOGY

The groove selection for a specific welded tin thickness it's been made according to SR EN 29692. These standards help the researcher, but they don't give accurate numerical values for geometrical grooves elements. The literature in this area [1], [2], [3] indicates that the main parameters that influence the groove design are:

- The type of basic material;
- The elements' thickness that joins;

The access in the welding area (welding in one way or welding in both sides);

- The distance between sides and the root welding on the opposite part;
- The stress and the distortions admitted during the welding process;
- The welding process;
- The execution possibilities of groove.

The paper presents a calculation algorithm for specific weight of deposed metal, which are the basic criteria in optimum groove selection.

A small specific weight of deposed metal during the welding process (proper to optimum groove) insures a minimum manual labor consumption and additional material, simultaneous with small stress and distortions remains after welding process.

The requested stages are:

a) the area calculation of each groove type depending of the geometrical configuration, it is made following the formulas (the abbreviations are the ones used in SR EN 29662; t – plate thickness; b – groove spam; c – groove root):

- Groove area for I-weld:

$$RI = b \cdot t\,; \tag{1}$$

- Groove area for V-weld:

$$RV = b \cdot t + (t - c)^2 \cdot tg\left(\pi \cdot \frac{\alpha}{360}\right) \tag{2}$$

The welding in one way – without turning (excepting welding the root and the opposite part)

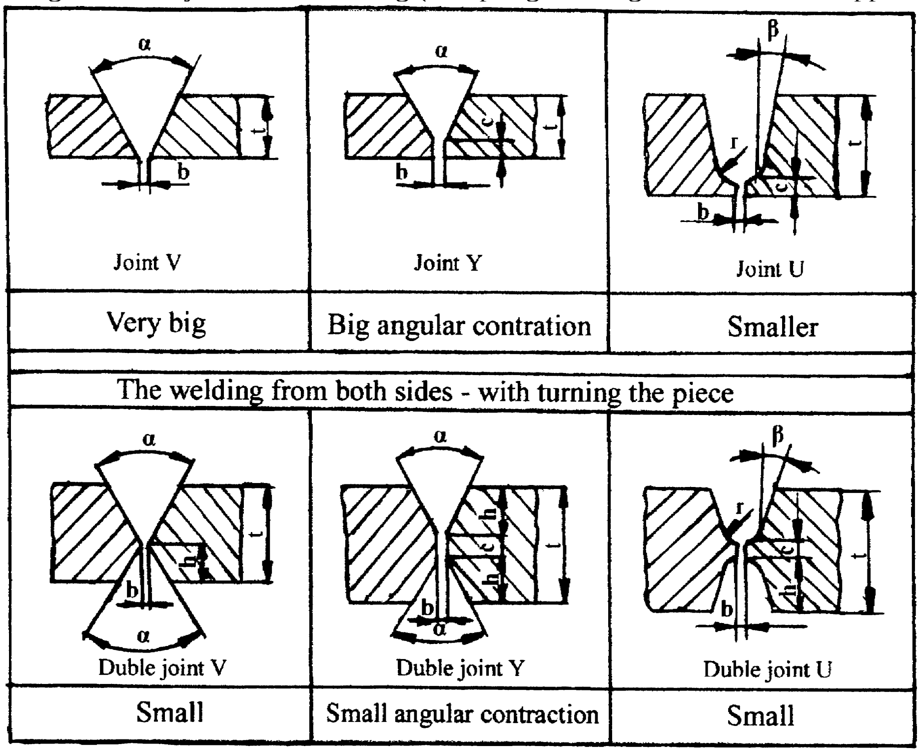

Figure 2. Different groove's shapes used at head to head welding of tin thickness.

- Groove area for Y – weld:

$$RY = b \cdot t + (t - c)^2 \cdot tg\left(\pi \cdot \frac{\alpha}{360}\right) \tag{3}$$

- Groove area for V with V-root weld :

- Groove area for tight V-weld:

$$RV_i = b \cdot t + t^2 \cdot tg\left(\pi \cdot \frac{\beta}{180}\right) \tag{6}$$

- Groove area for X-weld (both sides V-weld):

$$RV_v = b \cdot t + (1.5 \cdot t - c) \cdot (0.5 \cdot t - c) \cdot tg\left(\pi \cdot \frac{\alpha}{360}\right) \tag{4}$$

- Groove area for V-weld:

$$RV = bt + 0.5\pi r^2 + 0.5r(t - r - c) + (t - r - c)^2 tg\left(\pi \frac{\beta}{180}\right) \tag{5}$$

$$RX = b \cdot t + 0.5 \cdot (t - c)^2 \cdot tg\left(\pi \cdot \frac{\alpha}{360}\right) \tag{7}$$

- Groove area for both sides Y-weld:

$$R2Y = b \cdot t + 0{,}5 \cdot (t - c) \cdot tg\left(\pi \cdot \frac{\alpha}{360}\right) \tag{8}$$

b) setting the optimum groove, according to the mentioned reasons, is made selecting the groove that has a minimum area, $A_{min.}$;

c) the minimum specific weight determination of deposed metal M corresponding to minimum area of optimum groove:

$$\boldsymbol{M = A_{min} \cdot \rho_m \cdot l_c} \tag{9}$$

where: ρ_m – the density of deposed metal (g/mm^2);

l_c- the length of welding belt (l_c = 1mm).

3. EXPERIMENTAL RESULTS

The presented calculation algorithm is been tested to head to head welding with V groove of thick tins from steel (t = 4 - 20 mm; b = 1 - 3 mm; c = 0 mm; α = 40, 50 and 60°) with E46B electrodes (with density $\rho = 7.83 \cdot 10^{-3}$ g/mm^3). The results are presented in table 1.

Table 1. The specific weights, determined theoretical and practical during head to head welding in V groove of thick tins from steel

No	The tin thickness, *t* [mm]	The groove's opening, *b* [mm]	The specific weight of deposed metal, M [g/mm]					
			Theoretical			Experimental		
			40	50	60	40	50	60
1.	4	1	0,077	0,090	0,104	0,078	0,091	0,104
		2	0,108	0,120	0,135	0,108	0,121	0,136
2.	5	1	0,110	0,131	0,152	0,110	0,131	0,151
		2	0,150	0,170	0,190	0,150	0,172	0,192
3.	6	1	0,150	0,179	0,210	0,151	0,181	0,210
		2	0,197	0,230	0,260	0,198	0,232	0,262
4.	8	1,5	0,267	0,329	0,384	0,268	0,321	0,387
		2	0,308	0,360	0,420	0,311	0,363	0,423
5.	10	2	0,442	0,524	0,610	0,446	0,528	0,614
		3	0,520	0,600	0,690	0,524	0,603	0,695
6.	15	2	0,876	1,060	1,255	0,815	1,165	1,360
		3	0,994	1,180	1,370	1,000	1,290	1,470
7.	20	2	1,453	1,780	2,130	1,590	1,950	2,230
		3	1,610	1,950	2,280	1,750	2,100	2,500

4. CONCLUSIONS

- Table 1 shows a correlation between experimental and theoretical values (max. deviation is $\pm 1\%$).
- The presented method can be used for different types of grooves;
- The selected optimum groove, according to presented methodology, gives a minimum specific weight of deposed metal. The result: a minimum manual labour consumption during the groove's preparation process and the welding process, as well as a minimum additional material consumption (all these simultaneous with decreases of time welded construction design).
- Technologically, the optimum groove and the minimum specific weight of deposed metal insure remained stresses and distortions that have minimum values after welding process.

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