10th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

DETERMINATION OF STRESSES IN AREA OF TWO PARALEL WELDING CORDONS

Marcu Fratila, Galaftion Sofonea
“Lucian Blaga ” University of Sibiu
“Herman Oberth” Faculty of Engineering
Str. Emil Cioran nr.4, 5500025-Sibiu
Romania

ABSTRACT
The work presents the analysis of the distribution of stresses in the elements of the assemblage and of the welding cordons by numerical determination of stresses in the area of welding cordons in two welded universal irons.
Keywords: welding cordons, numerical determination of stresses.

1. INTRODUCTION
The improvement of the performance of welded assemblages involves besides the improvement of the technological process of welding also a knowledge of the way in which the stress, under the action of loads, of a welding cordon and the welded elements operates.
That is why we considered as a necessary condition the knowledge of both the way in which a welded assamblage is solicited and the way in which the transmission of loads between the welded elements is aclueved.

2. CALCULATION OF STRESSES
The analysis of the distribution of stresses in the elements of the assemblage and of the welding cordons has been carried out by using the method of calculation with finite elements.
The results obtained by using the method of the finite element have been compared with the ones determined by using some analitical relations taken over form the expertise literature. The welding cordons are placed parallel with the longitudinal axis of the universal irons as in figure 1
The assemblage is solicited with a force $F=500[N]$ whose direction is parallel with the longitudinal axis of symmetry of the assemblage. The following variants of loading have been taken into consideration:

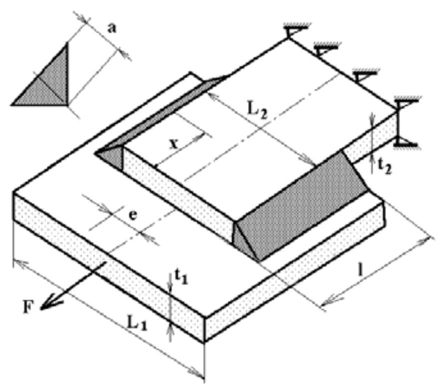

Figure 1. Elements of the assemblage

- force F has its application point on the longitudinal axis of symmetry of the assemblage;
- force F has the application point unwedged compared with the axis of symmetry having the distance $e=5; 15; 25$ *[mm].*

The dimensions of the elements that make up the welded assemblage, as of figure 1 are: $L_1=70$ *[mm],* $L_2=40$ *[mm],* l=*40 [mm],* $t_1=t_2=10$ *[mm].*
The distribution of stresses in the welding elements and in the two universal irons have been analysed.

In figure 2, 3, 4 there are presented the diagrams of the variation of equivalent stresses calculated according to the criterion of Tresca in the inferior universal iron and the superior one, respectively and in the welding cordon.

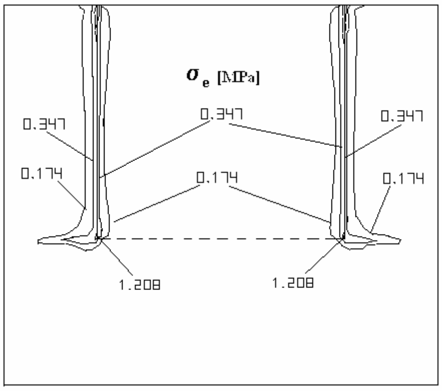

Figure 2 Equivalent stresses of Tresca in the inferior universal iron

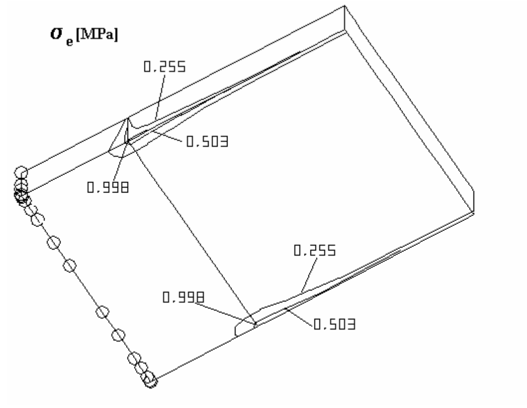

Figure 3 Equivalent stresses of Tresca in the superior universal iron

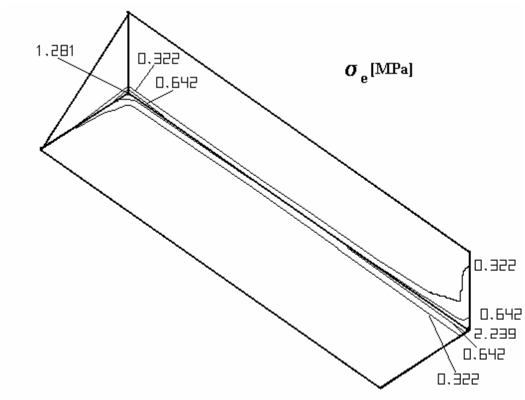

Figure 4 Equivalent stresses of Tresca in the cordon welding

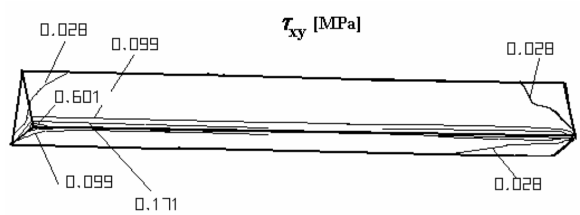

Figure 5. Tangential stresses wary, in the dangerous sections

Figure 5 presents the way in which the tangential stresses vary in the dangerous sections having the thickness “a”, as in figure1, of the welding cordon.

The values of stresses and the way in which the welding cordon varies, determined according to method of element finite, have been compared to the values of stresses determined with the relation (1) taken over from [1].

$$\tau_x = \frac{F}{2a}\cdot\frac{m}{\left(A_1 + A_2\right)\cdot sh(m\cdot l)}\cdot\left[A_2\cdot ch(m\cdot x) + A_1\cdot ch(m\cdot(l-x))\right] \tag{1}$$

where:

- F - is the force that solicits the welded assemblage (see figure1);
- a - is the thickness of calculation of the welding ;
- $A_1=l_1\cdot t_1$, $A_2=l_2\cdot t_2$ - are the transversal area sections of the universal irons;
- l - is the length of the welding cordon;
- $m=\sqrt{\frac{K}{E\cdot A_1}\cdot\left(1+\frac{A_1}{A_2}\right)}$;

- K - is elastic constancy of the welding cordon;
- E - is Young's module.

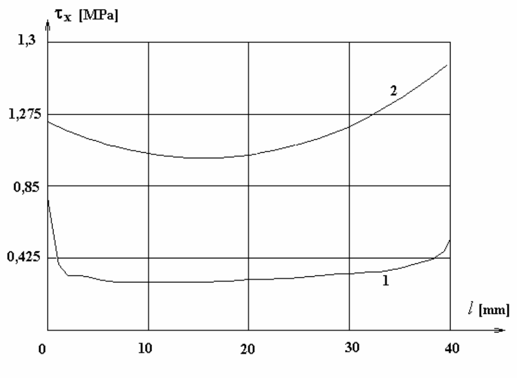

Figure 6. Diagram of sreesses τ_x.

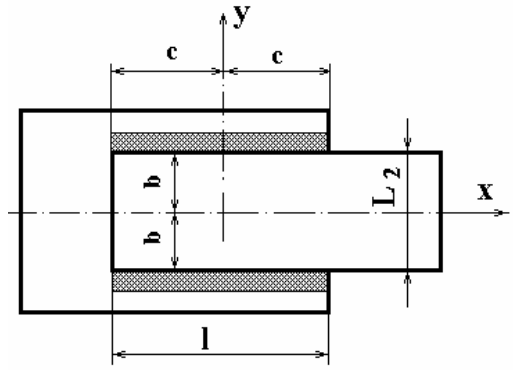

Figure 7. Geometry of welding

Figure 6 presents the variation diagrams of tangent stresses τ_x determined with the two methods. Diagram (1) presents the variation of tangent stresses τ_x determined with the method of the finite element and diagram (2) presents the variation of tangent stresses τ_x determined with relation (1).

The variation of normal stresses σ_x in the inferior universal iron through the method of the finite element and through making use of the relation (2), taken over from [1].

$$\sigma_x = 3C_1 \cdot y^2 \cdot (l - x) + C_2 \cdot x^2 + C_3 + C_5 \cdot x^2 \qquad (2)$$

where (see figure 7):

- $C_1 = \frac{F}{A_1} \cdot \frac{1}{l \cdot b^2} \cdot \frac{K + \mu}{2(K + \mu) + (\beta + 1) \cdot \alpha^2}$;
- $C_1 = -\frac{F}{A_1} \cdot \frac{1}{l^3} \cdot \frac{(\beta + 1) \cdot \alpha^2}{2(K + \mu) + (\beta + 1) \cdot \alpha^2}$;
- $C_3 = -C_2 \cdot l^3 \cdot \frac{\beta}{\beta + 1}$;
- $C_5 = C_2 \cdot l \cdot \frac{\beta - 1}{\beta + 1}$;
- $\alpha = \frac{l}{\beta}$, $\beta = \frac{t_1}{t_2}$;
- μ is constant of Poisson.

In figure 8 there are represented the diagrams of the variation of normal stresses σ_x for the local area y=-b in $x \in [-c, c]$ determined through the analytical method, curve 2 and the method of the finite element, curve 1.

There have been analysed the distribution of normal stresses σ_x in the area of soldering between the welding cordons and the inferior universal iron for the case in which the point of application of force F is changed of its place with the *"e"* value given the longitudinal axis of symmetry of the assemblage

In figure 9, there are represented the variation diagrams of the stresses σ_x in the inferior universal iron for the case in which eccentricity *"e"* has the values *e=5 [mm], 15 [mm]* and *25[mm]* respectively. We can notice from the diagrams a diminishing of stresses σ_x in the right side, diagram

1 and an increase of stresses on the left side diagram 2 together with the increase of "e" from *e=0* to *e=25 [mm]*.
The linear increase of *"e"* doesn't produce a linear increase of stresses σ_y in the immediate proximity of the application point of force *F* because of the bending moment which takes place in this case.

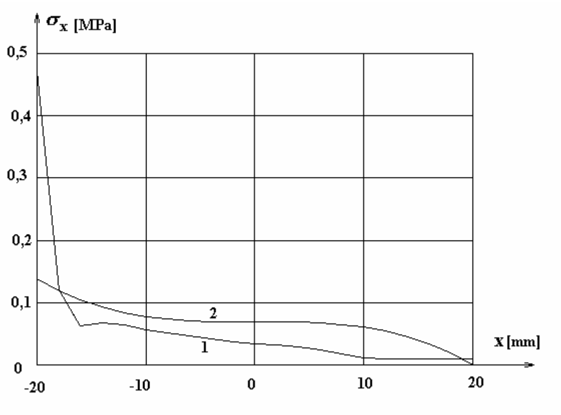

Figure 8. Diagrams of the variation of normal stresses σ_x for the local area y=-b in $x \in [-c,c]$

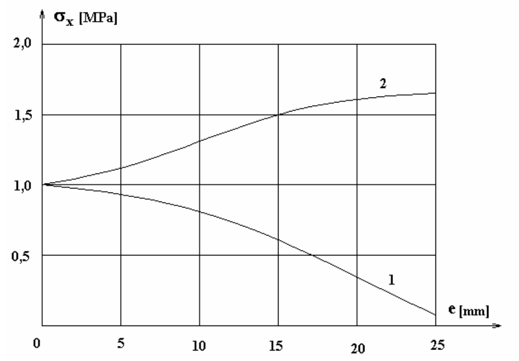

Figure 9. Variation diagrams of the stresses σ_x in the inferior universal iron for the case in which excentricity "e" is variable

3. CONCLUSIONS

Analysing the diagrams presented above we care draw the following conclusions:

- the area round the root of the welding with a radius of 1 – 1,5mm takes over around 95-98% of the loads transmitted through the welding cordon;
- across the welding cordon there is a variation of the longitudinal stresses σ_x resembling "the necklace chain" with the observation that in the terminal and end area of the welding there exist concentrates of stresses;
- by changing the place of the point of application of force *F* on a transversal direction of the longitudinal axis of symmetry of the welding there takes place a loading or an unloading of the welding cordons whose variation is not linear;

the variation of stress σ_x across the welding cordon is not linear as it was considered in [1], but it has a variation according to a curve whose incline is very high in the terminal area of the welding.

4. REFERENCES

[1] C. C. Teodorescu, D. R. Mocanu, M. Buga – *"Îmbinări sudate"*, EDITURA TEHNICÃ Bucureşti 1972;
[2] I. Száva, V. Ciofoaia, D. Luca-Motoc, I. Curtu- *'Metode experimentale in dinamica structurilor mecnice'* EDITURA UNIVERSITÃŢII TRANSILVANIA din Braşov 2000;
[3] S. D. Ponomariov., şa., - "*Calculul de rezistenţã în construcţia de maşini*", vol. I-II, EDITURA TEHNICÃ Bucureşti 1963.