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RESIDUAL STRESSES RELAXATION IN WELDED PIPES USING VARIABLE TORSION STRAINS

Parts II: EXPERIMENTAL RESULTS

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Abstract-In the first part of paper both theoretical analysis and experimental equipments have been presented. This paper includes some experimental results concerning residual stresses relaxation in welded pipes using variable torsion strains.

1. Introduction

The level of the residual stresses in the welded pipe has been determined by different methods, namely, the cutting metod (determining of the deflections of the longitudinal cut strips by electroerosion [2], the drilling metod by using proper tensometric transducers [2] for the differenly loaded samples.

The parameters of the loading cycles are presented in Table 1. and Fig.1.

The loadings have not exceed 10^5 cycles due to the samples cracking tendency in the intented areas at the ends (part 1).

This paper presents only some of the results obtained after the drilling metod application.

Tabelul 1

Nr. crt.	Sample cod	Parameters of vibration processes fig.1					Supplementary force Fz [N]	Obs.
		$a \cdot 10^{-5}$ [rad/mm]	$b \cdot 10^{-5}$ [rad/mm]	p [Hz]	$t \cdot 3600$ [s]	τ_{max} [MPa]		
1	20	0	3,36	8,7	1	41	0	fig. 5
2	21	0	3,36	8,7	3	41	0	fig. 6
3	22	3,36	0,26	8,9	1	44	0	fig. 7
4	23	3,36	1,35	8,9	1	57	0	fig. 8
5	24	3,36	1,35	8,92	3	57	0	fig. 9
6	26	3,36	1,35	8,92	5	57	200	
7	27	3,36	1,35	8,92	0,5	57	500	
8	28	3,36	1,35	8,92	0,5	57	1000	

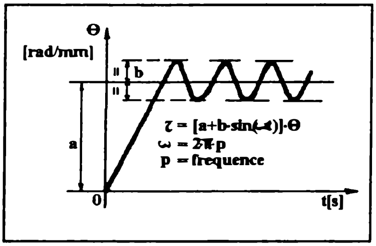

Fig. 1 The parameters of the loading cycles

2. **Measuring Equipments** The accomplishing of device suitable for the drilling alignnnment and performing has been imposed for the drilling method (**RY 21 Hottinger Baldwin Messtechnic Gmbh** transducers have been used), Fig.2. The apparatus includes a device for the pipe positioning, a driving a dial indicator for the feed measuring, an electronic equipment for the electric driving of the motor and for noticing the milling cutter contact with the pipe.

3. **Experimental Results**

The dynamic loadings in the resonance regime have been done it the elastic domain $(\tau_{mav} = \tau_{0\,2} / 3)$ from two reasons, firstly, to protect the vibrator and, secondly, to render evident the number of loading cycles. Although the level of the applied stresses is relativey reduced, hower, after approximately 2500 loading cycles, the residual stresses $\tau_{xy}^{R}, \sigma_{x}^{R}, \sigma_{z}^{R}$ -Fig.3, have the tendency to change their sign, from compression stresses becoming thrust stresses, a fact unfavourable from the view point of the fatigue strength. As a whole, the equivalent residual stresses (the case of the symmetrical alternating cycles) are decreased wiyh approximately 15-20%. From a view point of the vibration regime there have been noticed phenomena characterized by reductions of both the maximum amplitudes and of the correspoding loading frequencies from 8,9Hz to 8,0Hz. These time vibrations of the frequency and of the amplitude are the result of the fatigue phenomenon. The superimposing of some torsion static loadings ower the dynamic symmetrical

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alternating ones-samples codes 22,23,24,25-Tables 1, determines the increase of the average loading stresses, a fact mentioned in the specialized literature as having direct implications on the damage, irrespective of the material nature.

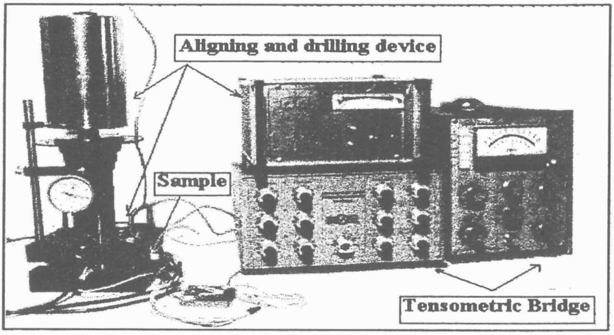

Fig.2 Aligning and drilling device

This damage process can be rendered evident by analysing the microhardness distibutions [6]. It is possible (as an assumption) that this phenomenon should be produced by the intensification of the microcracks iniation process on stating with the most loaded material physico-mechanical parameters. On taking into account the above mentioned facts, the samples codes 22,23,24,25 have been used to render evident the role of the loading

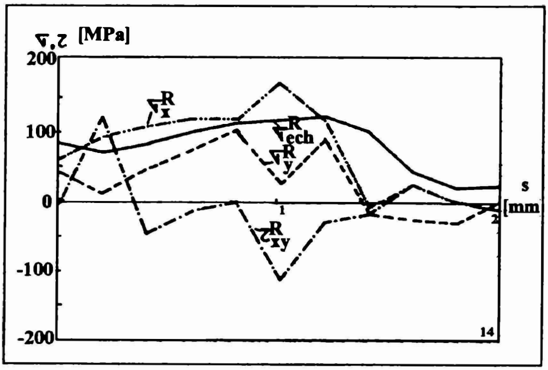

Fig.3.
The distributions of the level 1 residual stresses in a point from the welded area of a Ø38×2 pipe (unloaded)

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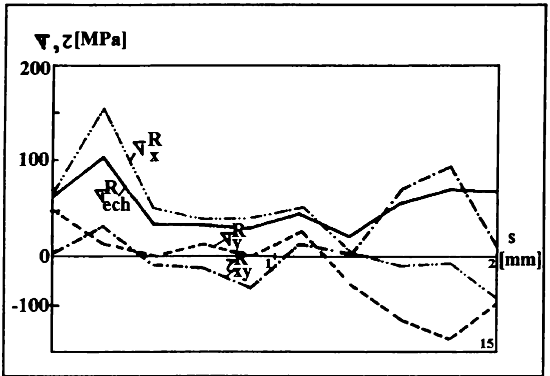

Fig.4.
The distributions of the level 1 residual stresses in a point from the basic material of a ∅38×2 pipe (unloaded)

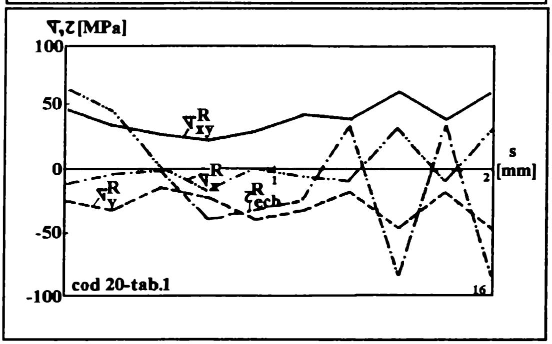

Fig.5
The distributions of the level 1 residual stresses for a ∅38×2 dynamically loaded pipe accordind to Table 1 by the drilling method (in welding)

For the first parameter there have been kept constant samples codes 24,25,26) the loading parameters of a " relaxation " cycles on doing experiments for three loading time intervals in an increasing order (3600, 10800, 18000 cycles). The torsional loading according to the " relaxation " cycles determine as well the reduction of the maximum equivalent stresses from the outer and inner surface, respectively, of the pipe. The superimposing of some rather reduced thrust axial stresses over those corresponding to some torsional cycles loadings (" relaxation " cycles) has determined an accleration of the process of reducing the residual stresses, samples codes 26,27,28-Tables 1.

The increase of the axial stresses determine modifications in the distribution of the applied stresses as well cracking tendences in the joint areas.

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As expected, the increase of the average applied stress, of the loading amplitude and of the number of cycles, directly favours the reduction of the residual stresses from the presure welded longitudinal pipes.

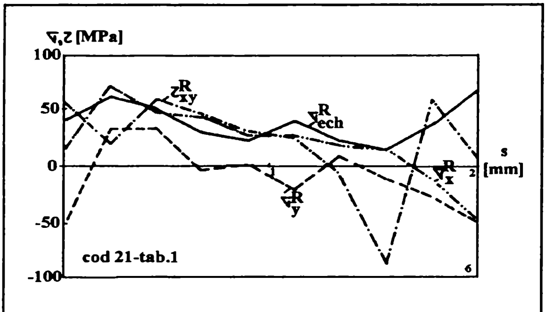

Fig.6
The distributions of the level 1 residual stresses for a Ø38×2 dynamically loaded pipe accordind to Table 1 by the drilling method (in welding)

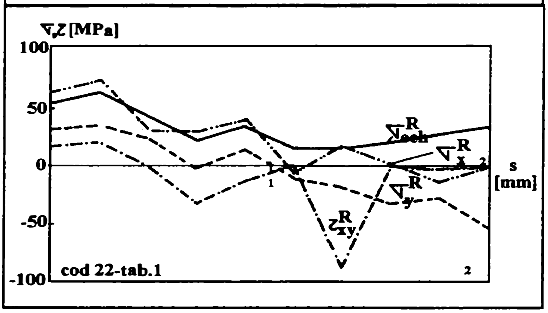

Fig.7
The distributions of the level 1 residual stresses for a Ø38×2 dynamically loaded pipe accordind to Table 1 by the drilling method (in welding)

5.Conclusios:

- the reduction of residual stresses by torsional cyclic loadings is posible, the complexity of the phenomenom beign dependent on the level of the applied stresses, the average applied stress, the number of cycles, the magnitude of the applied axial stress and less on the loading frequency;
- due to the shape of the used sample there have not been successful tests with high applied loads or up to grat number of cycles because of cracks which appear in the clamping ends areas;
- one can consider that the " relaxation " phenomena of the residual stresses are due to the " relaxation " phenomena of the residual stresses are due to the intensification of the microcracks initiation process on starting with most loaded material volume.

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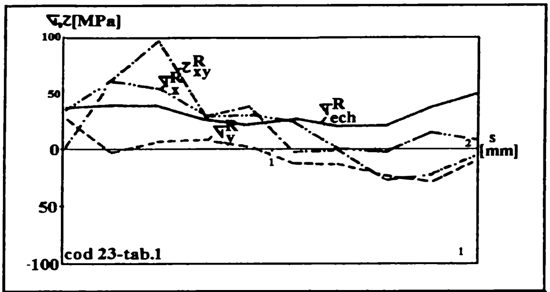

Fig.8
The distributions of the level 1 residual stresses for a ∅38×2 dynamically loaded pipe accordind to Table 1 by the drilling method (in welding

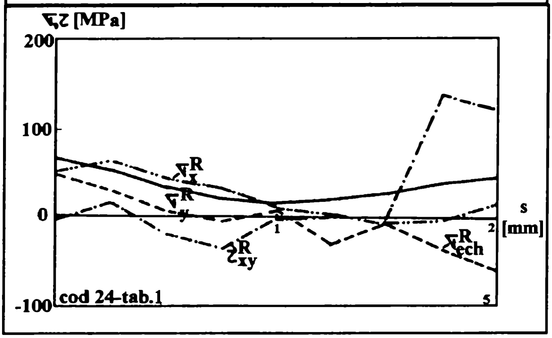

Fig.9
The distributions of the level 1 residual stresses for a ∅38×2 dynamically loaded pipe accordind to Table 1 by the drilling method (in welding)

6.Bibliography

1.- Lieurade H.P. -La rupture par fatigue des aciers. I.R.S.I.D.-France R.F.P., mars 1986, pag.

2.-*** -Standard Test for Determination Residual Stresses by the Hloe/Drilling Strain Gage Methods, ASTME,837- 85

3.-Bercea M. -Cercetări cu privire la posibilităţile de reducere prin vibraţii a tensiunilor remanente din elemente metalice îmbinate prin sudură,Teză de doctorat -Universitatea Tehnică "Gh.Asachi" Iasi-1994

4.-Vohringer O. Wohlfahrt H. -Abbau von Eigenspannungen in "Eigenspannungen und Lustspannungen"- Beiheft der Hartereit- tech- Mitt Hanser Verlag 1983, Munchen, pag 144-156.

5.-James M.R. -Relaxation of Stresses on Overview Treatments.Advances in Surface Treatments, Int. Guidebook on Residual Stresses, Vol.IV, Pergamon Press, pag 349-365.

6.-Bercea M. Dia V. -Analiza deteriorărilor materialului şi a tensiunilor remanente in zona îmbinării prin sudură, din ţevi sudate longitudinal, prin presiune-Partea I-a, Rev.Metalurgia nr.8.1995

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