NUMERICAL SIMULATIONS BY FINITE ELEMENT METHOD OF STRESS STATE
ESTABLISHING AND EXPERIMENTAL RESEARCH REGARDING THE ELASTO-
PLASTIC DEFORAMATIONS OF SOME STEELS ALLOYS

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1. Introduction

Developing mechanical constructions for the pressure vessels industry, aircrafts, construction equipment or shipbuilding calls for the investigation of the characteristics of the materials subjected to a small number of tension loads cycles close to the material elasticity limit (Karpenko, 1977).

To get a deeper insight into some aspects related to damage process of the materials used in the machine manufacturing variably subject to pure bending.

The materials used for the samples have the features given in Table 1.

<table>
<thead>
<tr>
<th>Steel</th>
<th>(\sigma_c) [MPa]</th>
<th>(\nu)</th>
<th>(E) [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>OL 50</td>
<td>210</td>
<td>0.30</td>
<td>2.10(\cdot10^5)</td>
</tr>
<tr>
<td>10TiNiCr180</td>
<td>205</td>
<td>0.26</td>
<td>1.93(\cdot10^5)</td>
</tr>
</tbody>
</table>

The FEM method was applied, to analyze the pressure states at the given moment, under forced deformations subject to pure bending.

The materials used for the samples have the features given in Table 1.

2. Real structure meshing. Description of FEM and the model used.

The real structure meshing process consists in replacing the given structure, which is continuous, by a discrete one. Thus, the elastic element in Figure 1, which represents the type of sample to be used for fatigue tests at high tensions and small number of cycles, has the shape of a plate.

The finite element used is an iso parametric rectangular thick shell of six degrees of freedom across each node and 24 degrees of freedom across an element which simulates the membrane and bending plate effects.

<table>
<thead>
<tr>
<th>Nr</th>
<th>Steel A [OL50] E=2.1(\cdot10^4) [MPa]</th>
<th>Steel B [10TiNiCr 180] E=1.93(\cdot10^4) [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(\sigma_{\text{max}}) [MPa]</td>
<td>(z) [mm]</td>
</tr>
<tr>
<td>2</td>
<td>230</td>
<td>0.84</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
<td>0.91</td>
</tr>
<tr>
<td>3</td>
<td>270</td>
<td>0.99</td>
</tr>
</tbody>
</table>

The paper presents the tension states at pure bending load for one sample only, at an imposed deformation, of alloyed steel currently used for the pressure vessels manufacture.

Figures 4-5 illustrate the results of the FEM analysis for the alloyed steel OL50 (for 3 layers).

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Fig. 1: The type of sample used for fatigue tests.
3. Experimental data

Samples made from the above mentioned steels were tested on the universal machine at 50 tf hydraulically-driven. In figure 6 is presented the component elements of the mashing.

From the experimental results, the diagram of the austenite alloyed steel 10TiNiCr180 was plotted in Figure 7.

At the Tensometry Laboratory of ICEPRONAV bending testing, each sample was installed on a device.

The point for forces application is 100 mm from the central reference of the tensometric mark according to the diagram. The applied forces were obtained with calibrated weights (order 4) of 0.5 and 1 kgf respectively, which allow for calibrations higher than the accuracy class 0.5. After the experiments and calculations performed the curve in Figure 8 was plotted.

4. Conclusions

From the analysis of Figures 4-7 it can be seen in the area concerned tensions are uniform over a stress layer while linearly varying across the layer thickness (Navier model of tension distribution is complied with).

5. References

