A DESCRIPTION OF DYNAMIC CREEP AND A FAILURE CRITERION OF THE AlMgSi ALLOY IN BIAXIAL STRESS STATES

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ABSTRACT
In this paper the results of investigations of fatigue are presented. The tests were carried out on tubular samples subjected to tension and torsion with additional cyclic stress into the direction of tension. A description of anisotropic dynamic creep in the fatigue process based on the no-potential theory is presented. This theory was formulated on the assumption of the similarity of the creep velocity curves. The anisotropic character of stable creep and dynamic creep was analysed. Criterion of failure in fatigue is also presented. The verification of Sobyrev’s failure criterion modified for fatigue showed that correct results are obtained with this modification.

INTRODUCTION
In the papers on fatigue strength in complex stress states, failure is mainly analysed. The criterions discussed in them are empirical because they apply to non-homogeneous stress states. They are formulated on the basis of the static stress criterions. The aim of this paper is to choose a failure criterion for asymmetrical cycles in homogeneous stress states and also to investigate and describe stable dynamic creep in biaxial stress states.

EXPERIMENT
The investigations were carried out by tension and torsion
with additional cyclic stresses in the direction of tension, at a frequency of 15 Hz. The tests were carried out on tubular samples \((d_1=17; d_2=14; l_0=60 \text{ mm})\) at room temperature, for stress intensity amplitude coefficient \(A_{\sigma_i} = \sigma_i^a / \sigma_i^m = 0, 0.25, 0.5\) (\(\sigma_i^a\) - stress amplitude intensity, \(\sigma_i^m\) - mean stress intensity). The stress state is characterized by following parameter \(\lambda = \sigma_{12} / \sigma_{11}^m\) (\(\sigma_{12}\), \(\sigma_{11}^m\) - shear and mean stress). The following tests were made: 1) \(A_{\sigma_i} = 0, \lambda = 0, 0.5, 0.9, 2) A_{\sigma_i} = 0.25, \lambda = 0, 0.43, 0.73, 3) A_{\sigma_i} = 0.5, \lambda = 0, 0.16, 0.3.

In the process of creep and dynamic creep, the coordinates \(\varepsilon_{11}, 2\varepsilon_{12}, \varepsilon_{22}\) of the strain tensor and the time of rupture of the samples were determined.

**CRITERION OF FATIGUE**

The fatigue strength was formulated on the basis of the creep strength criterion of W.P. Sdobyrev [1] by a modification [2] which consists in conversion of the constant \(\beta\) to a function as follows

\[
\sigma_{\text{red}} = \beta(A_{\sigma_i}) \sigma_{\text{max}} + [1 - \beta(A_{\sigma_i})] \sigma_i,
\]

(1)

where: \(\sigma_{\text{max}}\) - maximal principal stress, \(\sigma_i\) - stress intensity, \(\beta(A_{\sigma_i})\) - material function dependent on \(A_{\sigma_i}\). The stress \(\sigma_{\text{max}}\) and \(\sigma_i\) were calculated reducing the cyclic stress state to a static stress state by means of a substitute static stress tensor [3]

\[
\sigma_{ij} = \sigma_{ij}^m + p \sigma_{ij}^a,
\]

(2)

where: \(\sigma_{ij}^m, \sigma_{ij}^a\) - mean and amplitude stress tensor coordinates, \(p\) - parameter determined experimentally. The value of \(p\) was calculated as in the paper [3], in a statistically way making a optimization of coefficient \(\beta\) values. This optimization was made by the method of the sum of least squares of the theoretical and experimental differences of function \(G(\sigma_{\text{red}})\) - determined by Eq.(5), i.e. \(1/n[G(\sigma_{\text{red}}) - G(\sigma_{\text{red}})]^2\). In the