The dependences represented in Figs. 1 and 2 in the frequency range \( \omega < 3 \) agree well with the results obtained in [1].

Calculations show that in loading an infinite body with a crack harmonizing in time with the external load, there exist vibration frequencies which are unfavorable from the point of view of strength of a cracked body at which a considerable increase in the stress intensity factors is observed compared with the action of a static load.

**LITERATURE CITED**


**A METHOD OF DETERMINING THE CRACK RESISTANCE OF THIN-SHEET TUBE STEELS**

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Investigation of the resistance to fracture of low-alloyed tube steels of ferrite-pearlite class permits a better evaluation of the working capacity and reliability of gas and oil pipelines made from these materials. The wall thickness of trunk pipelines is usually 6-20 mm. In such cases it is practically impossible to determine the reliable values of the characteristic of resistance to fracture \( K_{lc} \) since the specimen sizes, indispensable for correct determination, increase the tube thickness. If for a low-carbon steel 17G15-U the value of \( K_{lc} \) is determined from an empirical equation [1]

\[
K_{lc} = 63 \cdot 10^{-4} \sigma_T^{-1.5},
\]

then for a yield limit \( \sigma_T = 360 \) MPa on the basis of equation \( l, B (w - \ell) \approx \alpha (\frac{K_{lc}}{\sigma_T})^3 \) the minimum thickness and width of the specimen as well as the crack length will be found to be within the range 50-100 mm which considerably exceeds the wall thickness and the size of defects for large-diameter tubes. In addition, the pipe steels retain high plasticity characteristics at climatic temperatures, which prevents the creation of plane strain conditions in breaking the specimens.

An important place among the criteria of nonlinear mechanics of fracture which have more recently been extensively developed, is occupied by the power criterion of J-integral which can be used in the investigation of the regularities of the stress-strain condition at the crack tip in the case of considerable plastic strain and general yielding of the material [2]. Use of the J-integral makes it possible to extend the method of nonlinear mechanics of fracture to pipe steels and to obtain single-parameter relations between the load applied to the specimen and the critical condition of the material in a pipeline with defects.

For an application of the calculation method of evaluation of resistance of the material to crack propagation in trunk gas pipelines, an experimental assessment method was developed for the evaluation of the work of crack propagation [3, 4] in the base metal and in pipe welds, a method which is based on the data obtained in testing specimens of various widths according to the loading scheme which combines bending with tension (Fig. 1). The advantages of the method are imitation of the stress-strain condition at the crack tip in the piping, the presence of a wide area with constant parameters of crack edges, a constant crack speed and of the work of crack propagation along the width of the specimen, and elimination of the effect...
of the scale factor and edge zones in the specimen on the results to be obtained. However, for this specimen there is J-calibration.

A theoretical analysis of the stress-strain conditions at the crack tip carried out by Cherepanov [5], Rice [6], and Macclintok [7] using an invariant contour J-integral made possible its use as fracture parameter [8]. An experimental determination of the J-integral is possible when it is represented as the release rate of the potential strain energy $\Pi$ per unit area of fracture surface $F$:

$$ J = \frac{\partial \Pi}{\partial F}. $$  \hspace{1cm} (1)

Using relation (1) a direct method was developed for determining the J-integral (method of Begley-Landes [8]) in which testing of a series of specimens with different initial crack lengths is proposed. Further investigations involve the development of analytical relations for calculating the J-integral in its application to the specimens of various types and with the development on their basis of methods for experimental determination of the critical values $J_{1C}$ [9-12].

More recently, the J-integral is used as the crack resistance parameter for conditions of plane-stressed situations [13]. With increasing size of the specimens value $J_{C}$ shows the tendency to growth and to subsequent stabilization for thin-sheet plastic materials [14]. Here as initial information for calculation serves the loading diagram $P-V_p$, where $V_p$ is the displacement along the line of load action.

An analysis and a comparison of various methods [2, 9, 14-17] made possible the selection of the most effective methods and to make proposals for their standardization [18]. However, there are still many unsolved methodical problems concerning the tests and their practical use. The shortcomings of the known methods of determining critical value of $J_{1C}$-integral includes the need to initiate in each specimen a fatigue crack as well as the difficulties associated with the determination of the moment of its start [19]. The realization of these methods calls for a complex apparatus and equipment as well as for highly qualified specialists.

In paper [20] a correlation link was established between crack propagation work $a_p$ and limiting load $P_{ij}$ in testing tube steels by a scheme of bending-tension. This approach is not new. In order to provide for the determination of parameters of the linear fracture mechanics for aluminum alloys, correlation relations were obtained between $a_p$ and $K_{1C}(K_C)$ [21]. Similar results confirming the relations between $a_p$ and $J_{1C}$ are given in [22] for ferrite-pearlite steel 20GF.

The above considerations show that the crack resistance parameter, the J-integral, for tube steels is a promising fracture characteristic. The unsuitability for use in manufacture of the now generally accepted methods of investigation of crack resistance characteristics results in a need to develop methods permitting a simplified determination of these characteristics [23].