металлических оболочек. Не было подтверждено соблюдение известной зависимости глубины пробивания от динамической и статической прочности материала. В экспериментальных исследованиях СГП получен следующий ряд эффективности торможения (динамической прочности) в сторону убывания: Cu, Al, Ti, Fe.

Заключение

Анализ полученных результатов показал, что основную ответственность за эффективность торможения (динамическую прочность) несут физические процессы при кумуляции энергии в конкретном защитном материале, в том числе, процессы, протекающие при локальных динамических фазовых переходах. Выполнена проверка гипотезы о существовании зависимости СГП от параметров локальных динамических переходов и показана перспективность данного модельного подхода для решения расчетных задач. Можно утверждать, что использование физико-механических характеристик материалов (полученных в статических и в традиционных динамических экспериментах) для создания защиты в условиях СГП нецелесообразно.

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ELECTROSTIMULATED RESTORATION OF RESOURCES DURING FATIGUE TESTS

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In this article the technique of controlling the accumulation of steel failure in the process of fatigue tests with the help of measuring the velocity of ultrasound propagation is discussing. So we found that the dangerous stage of development fatigue failures had appeared at the beginning of the third stage of abrupt decline of the dependence of ultrasound velocity on the number of loading cycles. The way of restoration of workability of products with the help

of powerful pulses of electric current increasing the resources of work up to 20-30% in this report was suggested.

Introduction

The fatigue strength and durability are the most important criteria for estimating the capacity for work and resource of constructions and details. Their role especially increases for the modem high-loaded and very important products, which were under the influence after cyclic loads in low-cycle fatigue. The prediction of the rest resource of details in time of fatigue loading is a complicated problem [1].

The data about the fatigue limit received during the drawing of the so-called Veler curve gave the possibility to estimate only the average characteristics of materials, this essentially restricts progress in increasing the safety of machines and mechanisms [2]. The fatigue failure usually has a sudden character, and its approach was not accompanied by any noticeable outer signs. Microscopic investigation showed that during the fatigue the gradual accumulation of microfailures further lead to the growing of fatigue cracks transmitting into a catastrophic growth of the main failure macrocrack [1,2,3]. The presence of the long preparatory stage was necessary to find the delay of final period of the fatigue process at the presence of corresponding informative parameter those can indicate the approaching of danger stage of structural transformations. In this work the choice of ultrasound velocity has a lot of advantages in characteristic of structural changes in steels and alloys, and method of delaying the development of defects and restoration of their workability is suitable for using on details and products whose were worked out.

Results and discussion

The velocity of ultrasound spreading υ in metals and alloys is the informative parameter of structure change [4,5]. Although it is determined by modulus of elasticity (G is for the longitudinal waves) and density of material ρ i.e. $\upsilon=(G/\rho)^{1/2}$, but practically all structural changes made by that treatment or deformation bring to small but measurable changes in υ. The use of measuring υ for the diagnostics of material during the fatigue loading proved to be useful. The data about the changes in υ during the fatigue tests of samples from steels and alloys of curved vibrations had been given in Fig. 1. Changes were made on ISP-12 device by autocirculation method. This method is accessible to make in real conditions on working units and constructions [4].

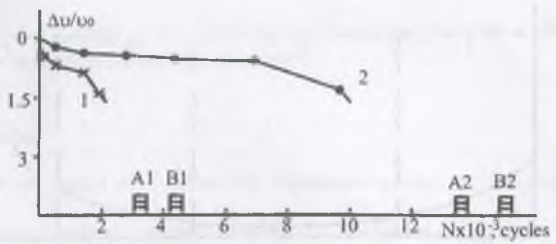

Fig.1. Relative change of ultrasound velocity in time of fatigue tests of samples from steels 70CrMnSi (0,7%C, <l%Cr, <1%Mn, <1%Si) (1, σ =160 MPa), Cr18Ni10Ti (0,08%C, 18%Cr, 10%Ni, <1%Ti) (2, σ =80 MPa) A, B are the ranges of usual and electrostimulated failure.

The dependence of velocity υ on the number of loading cycles *N* consists of three successive stages with different rates of numerable changes. The understanding should be achieved during analysis of microstructural changes in material under the fatigue tests. It shows that during the fast and second stages the accumulation of elastic distortions of a crystalline lattice takes place, it increases in dislocation density, but during the approach of the third stage, the mass sliding of dislocations and activation of surface layers occur. Natural, after the beginning of steep decline of υ(*N*) dependence the signs of sample failure such as microcracks of >10 microns size were observed. So we consider that the transition to the third section of υ(*N*) dependence testifies about the catastrophic stage of fatigue and exhausting of material workability. We may consider that this behavior of υ(*N*) dependence could be used as "prosecutor of refusal" during the individual prognostication of refusals [6]. That is so important for many mechanical products, than the statistical prognosticating of refusals from the mass of products in theory of reliability. So, the indirect definition of resources according to the total informative parameter is the consequent of failures accumulation which does not depend on regime of product loading [7].

U-shaped form of dependence υ/N has been shown in Fig.2 (*N* as it obvious, is in proportion with time of exploitation t) corresponds to U-shaped character of the refusal intensity on time. In theory of reliability the notion of three stages of products exploitation had been characterized by intensity of refusals (λ), i. e. relative velocity of changing the probability of a work without a hitch (Fig. 3) had been used for many times.

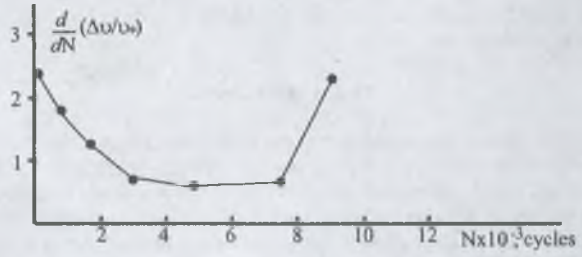

Fig.2. Dependence of ultrasound velocity during I cycle of tests on the number of cycles (υ_0 is the velocity at *N*=0) for steel 70CrMnSi.

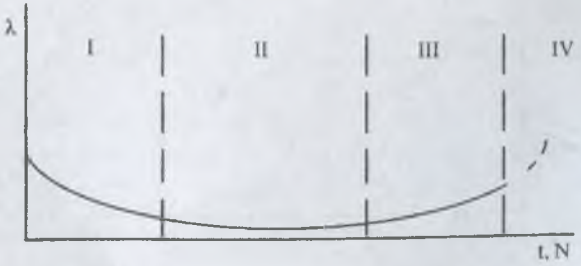

Fig.3. Characteristic view of the dependence of refusals intensivness λ, from duration *t* of exploitation (tests). I is a stage of extra earning, II is a stage of normal exploitation, III is a stage of "worn out" refusals (display of fatigue material), IV is a stage of "avalanche" refusals.

During the process of discovery of the beginning of fatigue critical stage we decided that the possibility of recovering the resource of details on account of treating the microcracks under the influence of any external factors exists, as it was shown in time of their using [8]. The advantage of this idea is the action of the powerful pulses of the electric current [9,10,11]. The main idea of our decision is the fact that the plastification of alloys in condition of electroplastic effect has connection with the treating of microcracks during passing the mass of pulses of the electric current with the density of $\sim 10^3$ MA/m^{-2}. In this work such effect applies to steel samples, those stage are similar to the beginning of the stage 3 of $\upsilon(N)$ dependence, has fixed according to the υ data of changes after the fatigue tests

One-pole current pulses with regular frequency duration and amplitude had been developed by thyristor generator [12]. The optimum characteristics of pulses and regimes of treatment: duration of 100 mcs pulses, 20 Hz frequency, amplitude had been defined by techniques of 250 MA/m^2 [12]. Time of action (25 sec) was started by method of experiment planning. The samples has undergone the treatment at the beginning of critical stage of the third fatigue during the process of decline of $\upsilon(N)$ dependence.

The duration of fatigue tests indicate that this treatment was not only recovered the primary value of υ, that was showed on the return to the primary structure of material but it was creating the samples to withstand 1000-4500 cycles of loading additionally for all kind sort of steels before failure, i. e., the effect was able for observing during the test.

The treatment by current pulses at the first and second stages of fatigue curve did not get statistical meaningful increase of fatigue strength. The attempt to increase the fatigue strength of samples with the help of electric pulses beforehand on account of preliminary treatment by electric pulses, described in was really unsuccessful, and did not get the increase of data scattering [13]. It is possibly to connect with form of current pulses which are high-attenuating sinusoid. It is typical for the discharge of condensators, also it is well known that maximum electroplastic effect had been founded during the tests of one -pole current pulses.

Also, the electric treatment of materials can tangibly increase the quality of samples work after approaching the critical stage of accumulation of the fatigue failures, and in work with products in real conditions it can extend the time of their exploitation. The treating of arousing microcracks was formed in the process of fatigue loading on account of local warming up the materials in zone of concentration of current electric lines near their tops, heating the craters lead to the relaxation of stresses and corresponding decrease of stressing level in this districts is the main reason of resource growing. Such effects were suitable for discussion in literature, because, as we think, it could be helpful to solve some problems of fatigue.

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DISLOCATION SUBSTRUCTURE AND ELECTROIMPULSE SUPPRESSION OF FATIGUE FAILURE IN STAINLESS STEEL

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The change of structure, phase composition and types of fracture of 08Cr18Ni10Ti steel under the conditions of low-cycle fatigue has been studied by the methods of optical, scanning, and transmission electron diffracting microscopy on mesolevel. An increase in safe fatigue life and failure suppression by electroimpulse treatment in the transition to the third critical stage of the dependence of ultrasound velocity on a number of loading cycles have been explained. Attention is given to the process of collecting recrystallization, change in the kinetics of the dislocation substructure self-organization and twinning, and initiation of solid solution decay.

The problem of the fatigue failure of steels and alloys is actual now inspite of its long history of research [1]. It is connected with that, many constructions and products of crucial purpose are used in such modes, but their failure occurs suddenly without marked previous signs. The latest works underlining the complex nature of fatigue phenomenon, connect the development of fatigue failures with self-organization of inner – and interstructural levers of plastic deformation [2-4] and dislocation substructure evolution [5-10]. The deforming solid being unbalanced synergetic system, tends to include the maximum effective dissipation canals of energy.

The failure is the final stage of evolution, appearing after exhaustion by material of its accomodation possibilities.