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EFFECT OF SINGLE OVERLOAD ON THE DEVELOPMENT OF A FATIGUE CRACK

Abstract. In this paper we present the results of studies on the effect of a single overload on the kinetics of fatigue crack growth rate (FCGR), and the reasons leading to the delay of fatigue crack growth in flat steel specimens with an edge notch. It is known that the presence of stress concentration, and defects in cases of fatigue cracks may occur in the early stages of operation, which lowers the fatigue resistance characteristics of the structure. In these cases, to solve the problems of strength and its increase is necessary to study the kinetics of fatigue crack growth methods applied fracture mechanics. To do this, in this paper are tested and characterized based cyclic crack flat specimens with a cross section 10x60 mm with a notched edge on a universal electrohydraulic machine with servo control of the company «Instron» (England). Changing the FCGR in the impact zone overload evidence of the heterogeneity of plastic deformation zone caused by overload. Slowing and acceleration of crack growth can be affected by the ratio skazat sizes of plastic zones formed before and after the overload and stress distribution in these areas, which leads to the closure of fatigue cracks. For an explanation of these factors during the test were measured closing fatigue cracks to determine the effective scope of the stress intensity factor ΔK_{eff}. Effect of single overload the delay in development of fatigue cracks is dependent on the degree of overload Rq. Based on this study researches developed methods to assess and reasonably extend the survivability of parts, thus enhancing the reliability of the machines.

Keywords: stress, defect, fatigue crack growth rate of a fatigue crack, the stress intensity factor, overload, endurance and reliability.

1. Introduction

Operational reliability and durability of many structures associated with the cyclic strength of their elements, such as, in particular, the operation of the hydraulic turbine impeller blades is on the railway wagon is the half-rails, crankshafts in the engine are exposed to variable loads.

If there is a concentration of stresses and defects in cases of fatigue cracks may occur in the early stages of operation, which reduces the reliability of the structure.

In these cases, to solve the problems of strength and its increase is necessary to study the kinetics of fatigue crack growth (RTH). When operating the machine parts on the kinetics of RTA affect single or multiple overload. They can lead to a delay in the development of a fatigue crack. This phenomenon is of great practical importance for the development of methods to assess the survivability of machine parts.

In this paper we present the results of studies on the nature of the effect of a single overload on the kinetics of fatigue crack growth rate, and the reasons leading to the delay of fatigue crack growth in flat steel specimens with an edge notch.

2. Materials and methods

The starting material for the manufacture of the samples were platen 200 mm thick, the last full-time modes of heat treatment. Samples of cut rolled steel in the rolling direction.

Tests for studies of fatigue crack propagation after a single overload was conducted on flat specimens with a cross section 10h60 mm with one edge notch on the universal machine with servo elekrogidravlicheskoy company «Instron» (England).

As is known, the test to determine the properties of materials under cyclic loading are made in a consistent measurement for the given parameters load cycle of length l of a growing fatigue crack and the number of loading cycles N, and on the basis of these data is determined by the rate of fatigue crack growth: V = dl / dN as average increase its length of one cycle at specified test conditions [1].

After that, find the relationship between the FCGR dl / dN on the scope of the stress intensity factor - $\Delta K = K_{max} - K_{min}$, ie builds a so-called kinetic diagram of fatigue failure (KDUR). KDUR are S-shaped curve that has three distinct areas: the near-threshold (I), middle (II) and third (III). Our research is mainly quoted at the junction of I and II sites.

Initsiruyuschy cut edge for initial cultivation of a fatigue crack was performed using a fine mill (thickness = 1 mm) to a depth of 2 mm, then the method elektroerozivnym adjusted length cut to 4 mm. The result is a cut corner radius of about 0.15 mm. It is possible to reduce the load and reduce the time to the initial nucleation of fatigue cracks.

Test samples were carried out at room temperature under a sinusoidal loading frequency of 50 Hz. After the achievement of the fatigue crack length l = 6mm once handled the sample with an equal degree of overload:

$$R_q = \frac{K_{max}^{ïåð}}{K_{max}} = 1{,}5$$

Where $K_{max}^{ïåð}$ the overload load. After this test continued with the former regime. Results of the study RTH shown in Figure 1.

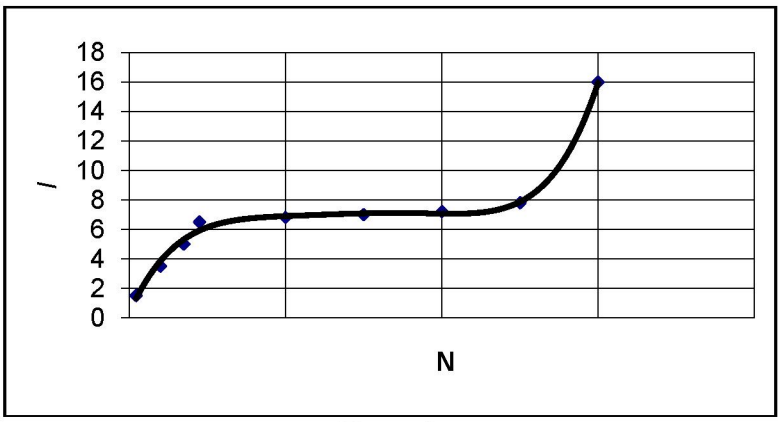
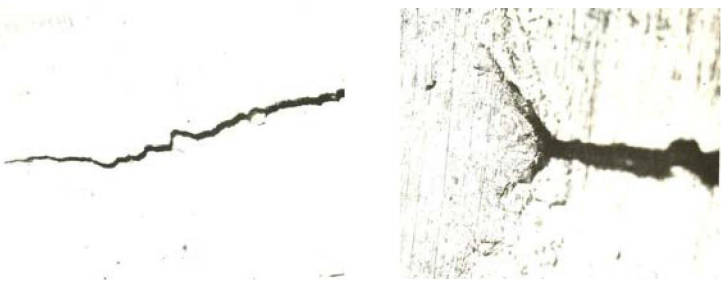


Figure 1

As seen in Figure 1 after the overload crack growth ceases to certain loading cycles.

Why stops the growth of cracks and what happens when you overload a single?

Rezults and discussion. Overload leads to a significant disclosure to the crack tip blunting and vetvlieniyu Usti cracks in the vicinity of which is highly developed plastic zone (Figure 2).



a) *b)*

a) before the overload b) after overload

Figure 2: The top of the fatigue crack