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Fatigue Resistance Models of Structural for Risk Based Inspection

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Abstract

The current stage of civil engineering is characterized by special attention to the safety of structures with a long service life. Such objects were designed several decades ago and their safe operation was ensured by significant safety margins. Now this approach to safety has been replaced by the concept of acceptable risk. It forms the basis of a risk based inspection (RBI) maintenance strategy. The transition from preventive maintenance strategies to a technical condition maintenance is substantiated. Complex indicators of technical condition, suitable for RBI- maintenance, are considered. The methodology of the resource safety index (RSI) is proposed. The latter is used as an indicator of risk. Special models of fatigue resistance is required for its control. The purpose of this paper is to build fatigue models for critical structural elements that are serviced according to the RBI concept. Instead of the traditional S-N curve, the lifetime general equation (first model) be used, where by the arguments are the main influence factors. Along with this, a modified ε - N equation is proposed for deformation criteria. The novelty of this equation is that it uses the rate of S-N- curve (slope) obtained in the first model with high cycle fatigue. The second model, combining the results of fatigue tests, is the equation for the dispersion of durability. The third model is the accumulated damage function under overloads. The efficiency of the RSI method is demonstrated by the example of the reliability assessment of the high strength bolts. Thanks to RSI method forecasting, during RBI-maintenance, parts can be used 3-5 times longer than with traditional methods.

Keywords: Risk; Overload; Damage; Lifetime; Safety Index.

1. Introduction

At the contemporary stage of engineering development, fatigue resistance models have begun to be applied to objects whose safety was earlier considered in an absolutely static aspect. These objects began to include bridges, buildings, pipelines, supporting structures of industrial equipment. For example, the crash of a viaduct in Genoa (2018), scientists explain on the underestimated phenomenon of very-high cycle corrosion fatigue in existing civil infrastructures. The brittle destruction of the bridge's cable triggered the collapse of the whole structure. The aggressive environment, as well as the structural size effect, both may change Wöhler's curve (a model of resistance fatigue), translating it downwards and eliminating the horizontal asymptote at the basis of the concept of fatigue limit [1].

Structures whose failures are related with significant consequences can be designed with a large margin of safety. As a result, they have a long, but unfortunately an indefinite (uncertainty), period of operation. The final decision on the issue of service life, as a rule, falls to the stage of exploitation. By the beginning of the XXI century in the circles of specialists engaged in the service of industrial equipment, the look at maintenance was shaped as an integral part of enterprise [2]. The issues of service and repair of mechanical equipment always were important for the industrial sector.

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