DETERMINATION OF THE SERVICE LIFE OF LOCOMOTIVE PARTS AND ASSEMBLIES USING NON-DESTRUCTIVE TESTING METHODS

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ABSTRACT

Modern technological processes for the manufacture and repair of rolling stock railway transport products are in many cases accompanied by intermediate quality control of products. In this regard, non-destructive quality control methods become important, which allow not only to detect defects on the surface or in the thickness of the product, but also to determine their shape and size, as well as the spatial position in the part. The article provides an analysis of the assessment of the resource of parts and assemblies by non-destructive testing methods. This paper presents a variety of non-destructive testing methods.

Keywords: *residual life, rolling stock, static loading, non-destructive, traction, service.*

ОПРЕДЕЛЕНИЕ РЕСУРСА ДЕТАЛЕЙ И УЗЛОВ ЛОКОМОТИВА ПРИ ПОМОЩИ МЕТОДОВ НЕРАЗРУШАЮЩЕГО КОНТРОЛЯ

АННОТАЦИЯ

Современные технологические процессы изготовления и ремонта продукции железнодорожного транспорта подвижного состава, во многих случаях сопровождаются промежуточным контролем качества изделий. В связи с этим важное значение приобретают неразрушающие методы контроля качества, которые позволяют не только обнаруживать дефекты на поверхности или в толще изделия, но и определять их форму и размеры, а также пространственное положение в детали. В статье приводится анализ оценки ресурса деталей и узлов методами неразрушающего контроля. В данной работе приведено разновидности методов неразрушающего контроля.

Ключевые слова: *остаточный ресурс, подвижной состав, статическая нагрузка, неразрушающий контроль, тяга, эксплуатация.*

INTRODUCTION

Technologies of data collection and processing, as well as the use of various methods of data collection, are indispensable in solving a number of questions on reliability and evaluation of technical condition of traction rolling stock. Systematisation of records on reliability of products, operating time to failure is determined by RD 50-204-87 "Collection and processing of information on reliability of products in operation". Collection of information should provide for permanent, periodic and (or) one-time observations of products and is carried out on the basis of: - accounting data conducted by operating and repair enterprises; - results of observations of products in operation; In the process of information collection, the technical condition of the product is examined at the place of its operation, including repair, inspect and, if necessary, examine the failed components, study and analyse data. The basic requirements for processing and analysing information include: - classification and coding of initial data; - control of completeness, reliability and homogeneity of information; - translation of the content of initial information to machine media; - evaluation of reliability indicators; - classification of causes of failures and limit states by types related to manufacturing, repair and operation, and their analysis; - preparation of initial data for the development of measures aimed at identifying deficiencies and improving the reliability of products in operation [1-7]. In recent years, fundamentally new information collection systems (ASUT, KASANT, ASU-P, ASU-SH, ABTCM, KLUB-U, MPC, RPC, DC, etc.) have been created and implemented on the railway network, which laid the foundation for the digital transformation of the railway transport safety management system. During the life cycle of a vehicle undergoes different types of maintenance and repair, and the results of the work performed are entered in the appropriate forms of logs (TU-152, TEU-21, TU-29, TU-28, TU-27, TU-17, etc.). In order to obtain an analysis of instrumental measurements, these forms of records extremely increase the processing time, but today the system Electronic passport of locomotive" has been introduced, which allows at all levels of management, using information technologies and data transmission networks, to control the technical parameters of assemblies, parts and their place of installation on traction rolling stock [8-11]. Pareto analysis was applied in the work to assess the technical condition of units and assemblies according to the results of TC. Pareto diagram is an analysis tool that allows to visualise the contribution of individual factors to the overall result, which establishes that usually 80 per cent of the consequences are the result of only 20 percent of the causes, which are usually called "small but vital part [12-17].

The main sources of fatigue from all the impact loads are the cyclic loads that appear when the rolling stock moves along the uneven part of the road. These dynamic loads depend on a number of factors (unevenness of the rails, wheel wear, changes in road properties, etc.), and as a result, they show a random character. Therefore, the loading mode of the load-bearing constructions of the tortuous movement structure during movement is not stable, and the process of changing the dynamic stresses generated in the constructions is not constant [17-19].

DISCUSSION AND RESULTS

Translated with DeepL.com (free version)It is recommended to evaluate the fatigue life of welded load-bearing structures operating under such loading conditions within the framework of the high-cycle fatigue model based on the generalized linear hypothesis of fatigue damage under unstable loading conditions. The currently used fatigue life assessment methods of load-bearing structures usually do not take into account weld residual stresses. At the same time, residual weld stresses significantly affect the fatigue life of load-bearing welded structures under high cyclic loading [20-23].

In this regard, the main frame of the traction rolling stock, the bogie frame, and their elements are the main nodes that receive strong variable loads during operation. Cyclic experimental testing of frame constructions by testing samples requires the creation of new constructions, the time of testing existing constructions is significantly long and does not always guarantee the choice of a reliable option from the point of view of strength and construction. In addition, it reduces competitiveness in the modern market economy in a period of transition to innovative development. As a solution to this problem, it is possible to introduce into practice the methods of assessing the service life of load-bearing structures, including complex welded joints, as well as to use software tools and computer technologies that allow choosing a reasonable structural or technological option [24].

According to the experience of using the rolling stock, most of the cracks start in the area of the welds. The main reason for the reduction of metal properties in the weld area is wear due to the concentration of thermoplastic welding deformations. These deformations, which accumulate in the area near the weld or in the vicinity of defects similar to technological cracks located in one of the weld layers, cause embrittlement of the material. Such embrittlement of metal in defective areas, combined with residual stress and elongation, reaches the yield point of the material and causes a decrease in the load-bearing capacity of welded structures. Tensile residual stresses and embrittlement of metal in the failure zone lead to failure of metal structures.

Research shows that the main part of the failure of welded joints is due to metal fatigue. During the use of rolling stock, variable loads such as tensile, compressive, tensile, torsional and bending moments affect the welded joints of various joints.

The most common of the welded frame constructions are open or closed-section welded beam constructions from sheets.

Technical diagnostics arose in connection with the accelerated development

modern engineering and in particular the rolling stock of iron roads, which necessitated a deeper assessment of the technical state of the TPS and their components, as the basis of progressive methods of technical inspection and repair. The term “diagnosis” comes from Greek “diagnostikos”, which means recognition, determination. In progress diagnostics, a diagnosis is established, the technical condition is determined system, assembly, part or TPS as a whole.

Technical diagnostics is a field of knowledge covering theory, methods and means for determining the technical condition of objects [25-27].

Diagnostics is one way to check the status and performance technical product in order to detect hidden or obvious defects in it, faulty nodes and elements, deviations from the specified conditions and mode work, representing one of the effective means of ensuring the reliability object.

Technical diagnostics is an integral part of manufacturing, maintenance and repair of TPS. The main task of technical diagnostics is to ensure safety, reliability, durability and efficiency of operation of units and parts of the TPS, as well as reducing the cost of its maintenance and reduce losses from downtime due to failures and unscheduled repairs [28].

Based on the results of diagnostic studies, indicators are determined reliability of a particular product, its condition for a certain period of time (time).

Diagnostics includes the following functions:

— assessment of the technical condition of the product;
— detection and location of faults;
— prediction of the residual resource of the object.

Depending on the diagnostic devices used and diagnostic parameters that are necessary for monitoring, you can make the following incomplete list of diagnostic methods:

— organoleptic diagnostic methods, which are based on use of the human senses (sight, hearing);
— instrumental methods;
— vibration diagnostic methods, which are based on the analysis vibration parameters of technical objects;
— acoustic diagnostic methods based on the analysis parameters of sound waves generated by technical devices;
— thermal methods based on the use of thermal imagers;

— magnetic particle method;
— eddy current method;
— ultrasonic method;
— capillary method.[29]

The problem of technical diagnostics is to ensure the receipt reliable information with acceptable recognition efficiency the true state of the product and the classification of this state.

From the conditionality of the further use of controlled production methods of control are divided into destructive and non-destructive. Destructive testing is used to evaluate quality indicators materials, parts and assemblies of the rolling stock as a whole. These methods used when testing products for reliability (checking the causes of failures).

After destructive testing, the product or assembly is considered unsuitable for subsequent use for its intended purpose. Non-destructive control (NC) is carried out by such methods that do not allow to provide impact on product performance. Due to the NDT, the part is considered to be operational and suitable for further use [30].

In the modern period of development of the repair production of traction rolling stock, NDT methods have found the widest application, since they are high-tech, accurate in determining the discontinuity in the material. Non-destructive testing methods without distorting parameters and structure parts, allow you to identify surface and internal hidden defects, or reveal such features that entail a certain unreliability product. They allow you to explore products in the process of development, production, testing and operation, and can also be used to evaluate the quality of technological processes and the development of products that do not meet requirements of the technical task. NDT methods should meet the following basic requirements: to be truly non-destructive, have sufficient sensitivity and resolution. Under the sensitivity of NDT methods is understood as the ability to reliably, with a given the probability of detecting visually or using special devices, in certain conditions, minimum in size (width, depth, length) defect.

The effectiveness of the use of NDT is determined by its fundamental advantages over visual inspection and destructive parts testing. Control methods based on visual inspection surface of the part, are simple, do not require highly skilled workers and the use of certain expensive devices. At the same time, they are inefficient, cannot be fully automated and are subjective, since the reliability of the results depends on the state health, experience and integrity of the employee conducting the control. Many defects do not have access to the surface of the part or are not visible even when the use of magnifying devices.

The advantage of destructive testing methods is that in during testing, it is possible to measure breaking loads or other indicators that determine the reliability of the part. a certain disadvantage destructive tests is that they are carried out selectively, only on a batch of identical products. In view of the fact that the tested materials and products are destroyed in the process of control, reliability destructive methods depend on the uniformity of the checked properties in materials and products, as well as from the compliance of test conditions with the conditions work details. When compared with NDT, destructive tests are more labor intensive, less productive and more difficult to automate.

When designing and development work to create products, non-destructive testing systems are used: to obtain the necessary data confirming the correctness of the chosen decisions; For reducing the time and volume of necessary research; for selection materials, components and equipment that provide products of the required quality with minimal material and labor costs [5]. At this stage, the optimal methods and means of control are selected, develop basic technical requirements for standards and acceptance criteria details.

At the stage of production and testing of an experimental batch of parts non-destructive testing is used to develop technological processes and designs. According to the results of the control, changes are made to the design with the purpose of reducing material consumption and labor intensity of production, increasing product reliability and durability. At this stage, set necessary technical requirements for the quality of the product. During operation and repair of products and equipment with the help of NDT systems, failures are prevented, reduce downtime and operating costs, increase the time operation and overhaul runs. Based on the results non-destructive testing, rejection, the product is withdrawn from service [11-17].

CONCLUSION.

Analysis of methods of applied diagnostic devices and diagnostic parameters that are necessary when conducting control and subsequent assessment of the technical condition of the parts of the traction rolling stock is a systematic approach aimed at identification of the main technical parameters of the product. Along with the considered instrumental method of control, methods are described in more detail non-destructive testing.

Conducted non-destructive testing of parts allows:

— identify defective products at the production stage and prevent them intro for exploitation;

— identify defective products during scheduled repairs and there by avoid placing the TPS for unscheduled repairs due to failure of parts and reduce operating costs accordingly.

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