Results of the experimental research of dynamic vibration processes of the rail for rolling stocks fault diagnostics

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Abstract. The paper discusses the preconditions of the methodology development of diagnosis system for assessing dynamic impact of the rolling stock on the basis of processing and analysis of data obtained in operation on the results of measurement of parameters that characterize dynamic vibration processes of the mechanical system of "rolling stock-track". On the basis of usage of the processing methods of time series and stochastic processes there has been established the relationship between these dynamic processes and wheel defects, and designed experimental data processing algorithms, which in the future will be an integral part of the intellectual systems of decision making when assessing the impact level of the rolling stock on the track.

Keywords: rolling stock with the wheels defects, acceleration of the rails, the statistical signal processing techniques.

1. Introduction

The modern systems of monitoring of the dynamic condition of vehicles intended to detect faults fundamentally use concepts and hypothesis, which are based on in-depth filtration methods and the time series analysis [1]. The practical implementation of such systems is carried out on the basis of evaluation of the dynamic behavior of both the rolling stock [2-4] and the track structure during passing of the train [5, 6].

The modern monitoring systems, which are installed on the track, were analyzed by Brickle B. etc. [7] commissioned by the Rail Safety and Standard Board (RSSB) UK and have been classified by the functional categories, where as a separate group there has been allocated the wheel impact load detectors (WILD), which detect the presence of a defective wheel by measuring the magnitude of the load (amount of force the wheel exerts to the rail) and comparing it to the specified threshold.

The instrumental basis of the monitoring systems can be optical sensors, accelerometers, load sensors or strain gauges. The available systems in market are GE Transportation's MATTILD, DeltaRail's Wheelchex, Teknis' WCM and Salient System's WILD [1]. However, according to authors [1, 7], these systems are not that reliable and in most cases the inspection of railway vehicles takes place in the depot before it leaves for operation. Such inspections are time-consuming and prone to human error. A difficulty for such systems is to determine the threshold limit values of the measured magnitude which characterizes the force the wheel exerts to the rails.

And, if the threshold limit values of stresses on the rail base are standardized [8], then there arise some difficulties concerning justification of the thresholds limit values of accelerations of the rail or the data for optical sensors under conditions of the necessity to assess different types of the rolling stock, the axle loads and the technical conditions with availability of only the output equipped with accelerometers in 8 measurement cross sections, and comparison of the results with the standard method for determining the impact of the rolling stock on the rail by identifying the stress in the rails. For experimental research there has been used experimental train consisting of the shunting locomotive CHME3 and the gondola car. The train passed through the experimental section in forward and reverse directions at speeds from 10 to 40 km/h with an in increments of 5 km/h.

Comparison of the statistical parameters of the stress of the rails and of acceleration during passing of the shunting locomotive showed that the speed in the range of 10-40 km/h had no significant effect on statistical parameters of magnitudes of edge stress of the rails both during passing of the empty gondola car and the loaded one, the maximum possible value of which varies in the range of $max_\sigma =$ 66-106 MPa. In contrast to stresses, the magnitude of the rails acceleration during passing of the shunting locomotive is linearly dependent on the speed. This trend is observed in both the vertical (magnitude $max_a Z$ reaches 227 m/s^2), and the horizontal (magnitude $max_a Y$ reaches 283 m/s^2) directions.

Analysis of statistical parameters of stresses of the rails and accelerations during passing of the gondola car has showed several times exceeding of the permissible value of the max_σ for all wheels of the loaded gondola car at individual speeds.

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