1.10.37. STATE AND DEVELOPMENT TASKS OF METHODS AND MEANS FOR 100% EN-ROUTE TESTING OF RAILS

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Rails nondestructive testing (NDT) system existed on railway roads of Russia from the end of XX century and based mainly on double-strand ultrasonic (US) trolleys without data recording systems has depleted practically its possibilities. With growth of cargo traffic intensity and passenger trains driving speed, special part in the rolling stock re-equipment program adopted in the Russian Railways is assigned to the problem of cardinal increasing of the rail NDT system reliability with simultaneous reduction of the operators number and testing costs.

Researches and scientific-technical developments performed for the last years by industry research institutes and companies manufacturing flaw detection equipment are devoted to solution of this problem. In particular, JSC “Radioavionika” being the head entity of the Russian Railways on designing and manufacturing of NDT means for rails has performed works directed toward development of methodology and creation of rail testing means of new generation:

1. With application of mathematical models of the process of elastic oscillations propagation in the railway rail profile, ultrasonic testing methods are proposed, which detect the most hazardous transverse cracks within the whole section of rail head (“mirror” and “rhombus” schemes) and radial cracks from bolt holes at early stage of development (“double-beam” insonification scheme).
2. Construction principles for multi-channel mechanized and automated US flaw detectors with recording signals of 100% testing are substantiated. In order to improve trustworthiness of detection of internal and external defects by automated mobile systems (flaw detecting railway motor cars and trucks), US methods are supplemented with magnetodynamic testing method.
3. Requirements are elaborated with regard to recording and unified presentation of the rail NDT signals in multi-channel flaw detectors within the wide range of scanning speed, which allow simplification of signal decoding procedure. Multi-threshold recording systems for US testing signals are implemented in testing practice. These systems make it possible to recover echo-signal amplitudes and to display amplitude envelopes of bottom signals.
4. It is shown that improvement of the rail NDT systems efficiency requires combined usage of flaw detection data obtained by different testing means at specific sections of a rail track. Construction ideology was substantiated for software-hardware complex of nondestructive testing (SHC NDT) providing acquisition, accumulation and analysis of data from various means of nondestructive testing and diagnostics of rails.
5. Compression of conventional defect size at high speeds is revealed. Necessity of this phenomenon to be considered at high scanning speeds ($v_s \geq 10$ m/s) is demonstrated. Adjustment methods reducing probability of defect omission are proposed.
6. For further increasing of probability of defect detection in rails, it is proposed to supplement traditional flaw detection methods with synchronized data of rolling surface video recording and results of measurement of vertical (dynamic) rail track irregularities.

Basing on achievements of modern microelectronics, performed researches and proposed principles, serial production of the following equipment is developed and mastered: micro-processor removable double-strand flaw detectors of AVIKON type; flaw detecting trucks on the basis of ultrasonic, magnetic and visual inspection testing methods; portable means of secondary testing; and multi-channel (up to 70 channels) flaw detectors for testing rail welded joints. Removable US flaw detectors (trolleys) are equipped with built-in processors and provide recording of 100% testing in all channels (up to 20 channels) with data recording discreteness through 2–3 mm along the track and 1 mm (0.3 – 1.0 μs) by the rail height. On-board systems of mobile means (railway motor cars and trucks) make it possible to record and process the considerable (up to 8 Mb per 1 km of rail track) flow of law detection data in the real time (fig. 1).

These researches, as well as efforts of equipment manufacturers and industry research institutes have resulted for the last years in tangible accomplishments. New flaw detecting trolleys on railroads of the JSC "RZD" detect in two-three times more defects than flaw detectors of previous generation. Repeated analysis of testing signals by means of stationary PC's contributes to compliance with technological discipline in the process of testing and increases defect detectability additionally by 15 – 30%. As a result, number of en-route rail breakages has reduced for the last decade in more than 10 times.

At the same time, there are tasks and problems requiring solution in the nearest time.

They include introduction of automatic decoding of signals for multi-channel flaw detection means. Currently, this task has no rigorous solution in the world practice.

Increasing of quality of 100% testing of rails by means of improvement of search systems of removable and mobile testing means is another matter requiring the quickest solution.

In future, it is certainly necessary to pass from emergency replacement of defective rails to scheduled one. Modern testing means with results recording provides possibility of transfer to en-route rail monitoring.

Flaw detecting trucks operated both on railways of Russia and abroad do not provide required productivity at testing operational speed within 30 – 60 km/h. With introduction of high-speed train operation, said testing speeds will be restrictive ones for the whole technological chain. Conceptually another approach to the problem of increasing trustworthiness of testing at high scanning speeds is considered. It consists in transfer from pulse mode of ultrasonic oscillations omission to continuous one. In this case, it becomes possible to separate echo-signals from defects taking into account Doppler's effect, which manifests itself clearly at such scanning speeds.

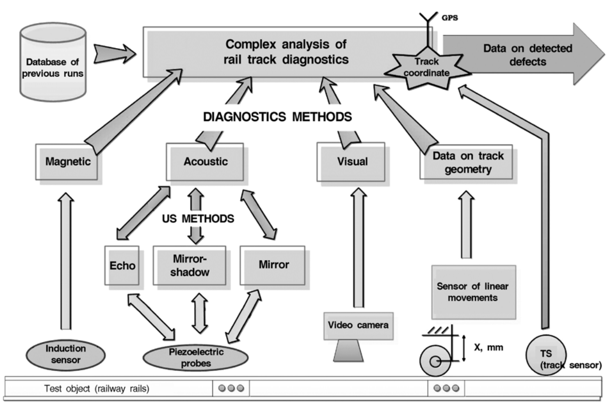

Fig. 1. Complex acquisition and analysis of diagnostic information on the board of flaw detecting truck