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SYSTEMS FOR MONITORING AND DISCLOSUREFAILURE ON RAILWAY WAGONS[1]

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Abstract

Increasing complexity of railway vehicles, also demands enlargement road of their reliability and durability.On the other hand, maintenance is usually reduced to a problem when failures occur, to bring the system back into the projected state. Maintenance procedure should be carried out before the failure occurrence and in this way prevent or delay the emergence of cancellation. This kind of maintenance is a preventive maintenance, which appears in the form of preventive planning and prevention according to the state. Maintenance with prevention according to the state is based on the diagnosed state of systems. The increasing possibility of following the real state of the system allows its use quite effectively, because then, the maintenance can be planned in advance.With the help of diagnostic systems we would be able to monitor the status of the vehicle and the parameters of load of thesuperstructure, ensuring constant quality level and the assurance of trusted legal evidence of the values measured.

Key words -rolling stock; superstructure; wheel; maintenance; diagnostic

INTRODUCTION

Overall quality and life cycle of rolling stock, primarily depends on their basic (initial) quality, or the quality of the components that are built into the vehicle during its production. Change of the state of railway vehicles in operation is inevitable and comes as a result of: wear, corrosion, fatigue, aging, errors in its component, the conditions of usage, mishandling etc.

[1] Professional paper

Condition of use (including the entire complex of interconnected events that affect the technical condition of the vehicle), and the main parameters above all are: profile lines, transport load, number of stops the train, qualifications and involvement train drivers, seasonal changes in climate conditions, etc.In addition to these causes, maintenance has a direct impact on the state of change of transport means. National railway administration establishes regulations and standards for vehicle maintenance of its fleet. If the vehicles are used in international traffic, their maintenance must be harmonized with international regulations and standards for the exploitation of these types.

MONITORING SYSTEMS AND DIAGNOSTIC METHODS

The aim of the railway operator is to transport the greatest possible quantity of goods, using and at the same time "cheap" rolling stock (minimum investment in the maintenance), whose performance and condition are worse than it shows. On the other hand, the interest of the owner of the infrastructure, is that each service is properly charged. By analyzing the maintenance cost structure of fixed assets, it can be concluded that a large percentage of income are spent on rolling stock maintenance and key indicator of the state is percentage of immobilization.

Special attention must be paid to the irregularities of Class 4 (major fault - significantly reduce the usable capacity of wagons and can compromise safety) and Class 5 (critical malfunctions – has a significant impact on traffic safety because endangering security can occur rapidly), namely:

- overheated bearings and wheels,
- flat places on the surface of the rolling wheels and
- excessive (or disturbed) axle load.

Dependence of these values are as follows:

$$\frac{l}{L} = \frac{t_p k}{T}$$

Wherein:

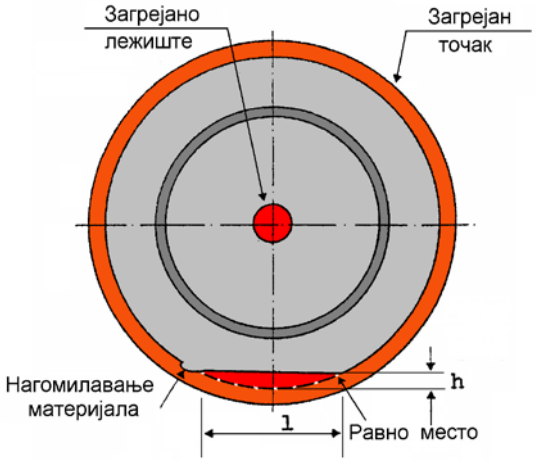
l – the length of the flat spot,

L – length of the measuring section,

t_p – time of the interruption of wheel-rail contact point due to the existence of flat places,

T– Passage time of wheel through the measuring point section

k – coefficient (correction factor), which is in a function of speed (V)



and the axle load (Q).

The first systems were basically tended to define improper contact, flat spot area) with rail, which is attainable and not too noisy at low speeds, but by increasing of speed (more than 40 km/h) contact of the flat spot with rail is lost but the noise increases drastically. By measuring the time of interruption of the rail-wheel contact point with rail, leads to the length of the flat due to which contact was interrupted.

The parameter *h*, which represents the depth of the flat spot, and on the initial stage is not considered, by the time is parameter is defined as well (h max ≥ 1 mm) and is included as a reason for exclusion wagon from traffic, according to the code 1.6.1 Annex 9 AVV-a [1].

As for the overheated bearings and wheels, the main problem was the creation of the conditions for non-contact temperature measurement. The basis of contactless temperature measurement is the fact that everybody which has a temperature above absolute zero emits electromagnetic radiation depending on the condition of its heating temperature.

The intensity of the radiation and the wavelength (λ) in which the intensity of this radiation has a maximum, depends on the appropriate body temperature. Also, nature and characteristics of surface of the emitters, have an impact on the energy emission. Only at higher temperatures (> 500 ° C), part of the radiation is released as visible light. The technology used in overheating detectors of bearings has been developed has from analog system with rapid thermal resistors to digitize signal, from pyro electronic sensors to advanced high speed photon scanners.

a) **b)**

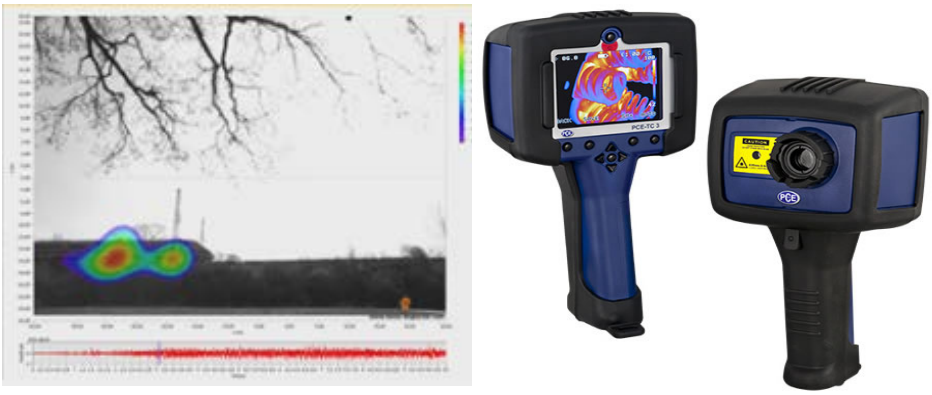


Fig.2. Measurement of temperature a) motor, b) thermo-vision camera

The radiation of heat from the object can be detected with infrared cameras (Figure 2. a) and b), System uses thermos visional and digital processing of images to scan the wheel and predicts whether the wheel will slipping instead of rolling. During normal braking, the speed is reduced and the wheel itself is still rolling and uniformlyheated along the rim wheel.

In the early seventies of the last century in the United States numerous technical institutes were included in the analysis of derailment, damage of wheels, cracked rails, etc. The result of the analysis was the introduction of "Regulations on replacement of wheels" that define the mandatory replacement after the noisy point of impact (more than 400 kN).

"TPD" detectors measures the force wheel/rail by using the sensor unit for measuring deformation due to the effects of the strain on the tracks on the selected "S" curves (Fig.3). In addition, some "TPD" detectors can measure and angle of attack of each axis in relation to the rail. This parameter in combination with the measured vertical and lateral forces provides far greater benefits for the passage of bogies through curves.

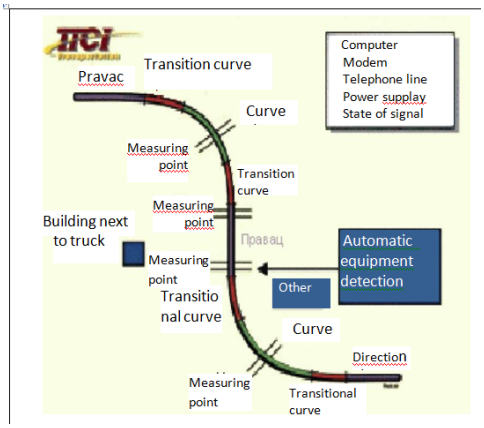


Fig.3. Measuring deflection points deflection in the "S" curve

"TADS" system (Fig. 4)for acoustic detection in the vicinity of the track preventive maintenance system beds and is designed to identify bearings with internal irregularities at an early stage cancellation before the start of catastrophic failure due to increased temperatures during operation. It consists of a series of microphones arranged in the housing on both sides of the tracks recorded weather data on the sound track of each defective bearing.

FUS II EPOS (Progress Rail) [2] is a system where each IC scanner has an infrared line detector, which is capable of scanning at speeds up to 600km/h. Standard configuration of the system consists of three to four modular scanner which cover axlebearings, wheels and brake discs (Fig. 5).

Fig.4. Sound record of each defective bearing

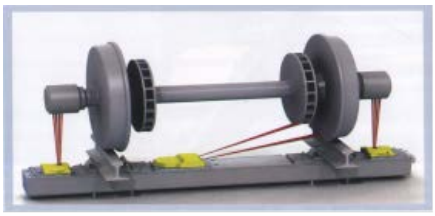


Fig.5. FUS II detector

With the advent of a number of different infrastructure owners and operators, there was a problem how to integrate all systems. Association of American Railways (AAR), started development of an integrated information system of railways (InterRRIC ™) in 2000 (Figure 6). The integrated system provides the ability to use information for monitoring a large number of detectors and the possibility of extending to other systems.

The system allows you to create, the database on the characteristics of the vehicle obtained from individual sources, which is designed to collect measurements from all the detectors condition/feature, and it is in turn linked to a database containing information on maintenance and vehicles.

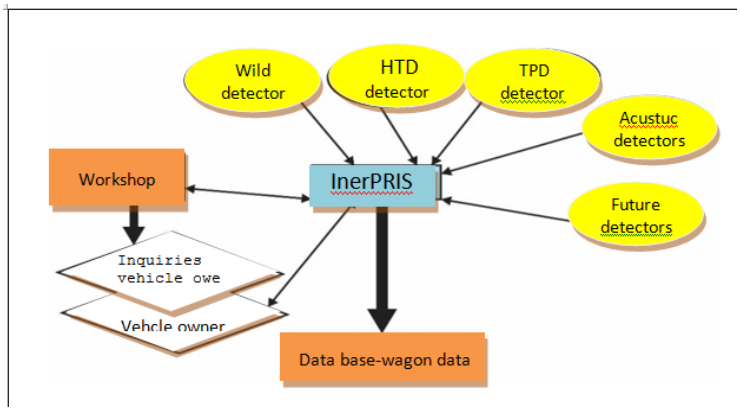


Fig.6. Integratedinformationsystem (InterRRIC ™)

InEurope, theFrenchcompanyCSEETRANSPORT and German Company Signaltechnik conceptualize, develop and manufacture for more than five decades of monitoring systems - detection of overheated axle bearings circuits and overheating of wheels. Extremely positive results were achieved with HOA80, while with the introduction of high-speed train system HOA - FOA/90S represent more appropriate application.

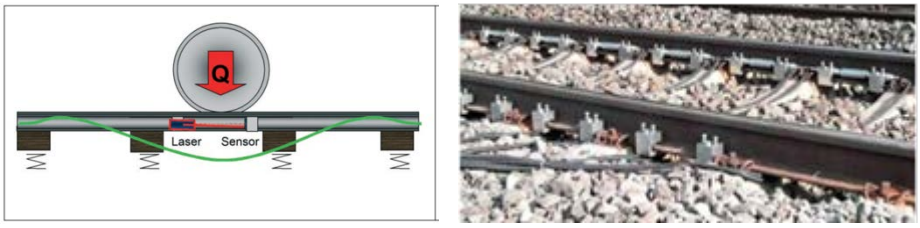


Fig.7. Schematic presentation of the principle of work of Lasca system

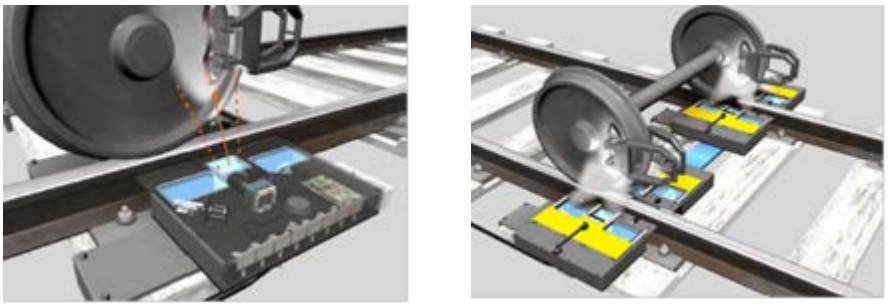


Fig.8. Measuring equipment for an axle set

Lasca system is installed on the railway network of the DB since 2001 and it is based on the same laser scale, which carries the load that the wheel moves along the rail turning into her deflection. The magnitude of this

deflection depends on the force with which the wheel press on rail and its relative position with respect to the sensor. Sensors are attached to the bottom of the rails in the space between the sleepers, and the entire measuring unit consists of 2x6 sensor.**BMW** (BrakePadWearMonitoring), system checks the wear on the brake blocks on the running train or when they are returning to the depot suites.

Fig.9. Device for determining the profile of the train

Fig.10. Installation the (RFI): Line Rome –Naples

Tecnogamma-in system that is mounted on the measuring portal above the tracks and enables verification of functionality of pantograph patterns of all trains passing through the portal and the principle of measurement is based on optical contactless technology, laser distance measurement combined with high scanning frequency.

TCCS is a control system first commercial installation was successfully tested on RFI (Italian Railway Network) in 2009 at the railway line Rome - Naples (F. 10). Laser radars, specially developed for this application based on the high speed measurement and operating time, of laser rangefinder which directs the beam reflected from the polygon measurements, providing 800 scans per second with about 900 measurements[3].

In addition, system can be applied, when necessary, of special restrictive profiles defined for different types of intermodal transport units (containers, semi-trailers, etc.) and for special shipments that exceed the boundaries of standard load profiles.

The system for the detection of overheatedaxle bearings used in Austria by ÖBB Infrastructure consists of track side equipment (scanner), a unit for evaluation and management, data transmission equipment and units with a visual presentation. Equipment next to track arecomposed of rails attached to measuring equipment with infrared sensors for recording the axle box, wheel temperature, axle counters and electronics for the management and evaluation, which is placed in the immediate vicinity of the container [4].

All those systems (Fig. 11) are basically stationary systems for monitoring and diagnostics, and are mostly located in depots and workshops for the repair, by the rails or on the track. Monitoring and diagnostics systems in the context of maintenance of rolling stock can be installed in vehicles/trains, the so-called (on-board) systems. Stationary systems are periodically perform periodic inspection of the condition of the vehicle or its components, while systems in vehicles/trains (on - board) work continuously during operations.

DREAM system is manufactured by Vibro Acoustical Systems and Technology Company, Incorporated of Saint Petersburg, Russia. For rolling stock, the most important values are the values of dynamic forces in areas where vibrations occur.The (ATC) system, is system of automatic train control i.e. by sensors that provide information on the speed and direction of rotation. Temperature measurement is based on termosensors that are adapted to the same electrical circuit as speed/direction sensors. This allows direct detection of bearing temperature.

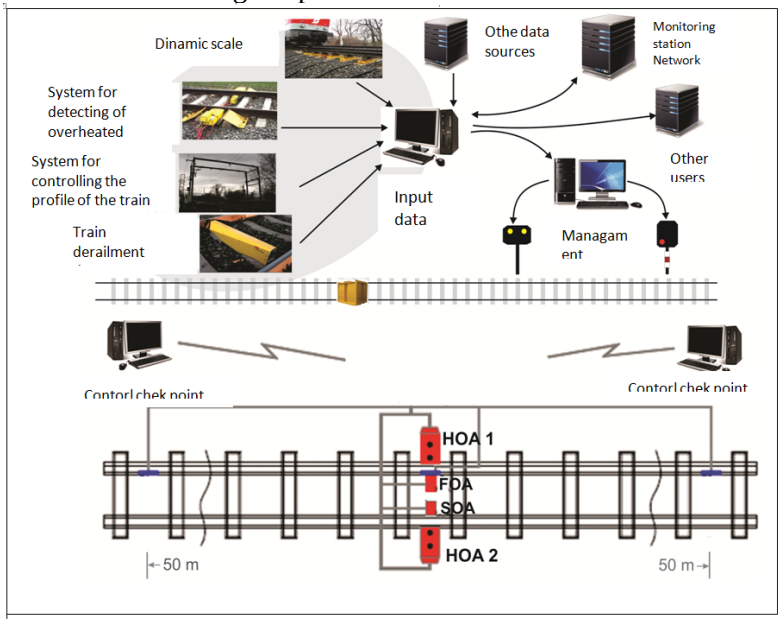


Fig.11. Independent measuring stations preview

As the measuring point are near the bearing**,** this measurement enables detection capability that is superior to systems that are more remote, usually mounted next to the track in order to be used in difficult conditions, highly sophisticated bearings with sensors are offered. Already tens of thousands of bearings are entered in exploitation equipped with various types of integrated sensors. "Pendolino" family of fast trains, with forced tilting body

when passing through the curve, then Italian ETR 500 high speed train, as well as several Italian and Polish locomotives, several types of mass transportation vehicle, use these bearings.

SITE SELECTION AND MONITORING SYSTEM

All offered systems basically have more or less similar components and features with the same aim to detect, and if possible, the measurement of a certain size(Figure 12). Today it is a large range of products for monitoring the state of the rolling stock and products that are directly mounted on wagons or installed next the rails(the so-called rail monitoring systems).

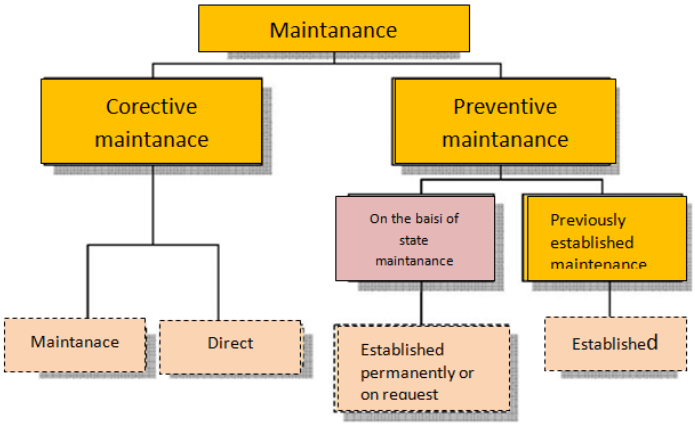


Fig.12. Maintenance concept

Which will be applied to the monitored system will be applied, in which capacity and where it will be located, primarily depends of:

- analysis of rolling stock exclusion(wagons in particular), with special emphasis on the reasons and frequency thereof,
- track features(mountains, plains, specific conditions of use of brake system - braking on long downs),
- climatic conditions (extreme high temperatures, layers of sand or extreme cold and snow layers, etc.)
- characteristics of the type of goods transported (ores, building materials, RID materials, various structures, etc.)
- characteristics of the wagons that operate on these sections,maintenance methods (whether the rolling stock are in the ESM systemor not?) and transport route of the most representative transported goods.

Identification of differences in the dynamic behavior of the vehicle, which was previously mainly used only as a means to protect the infrastructure of major damages, it would now reflected on the

infrastructureaccesscharges, but at the same time, on the planning and maintenance of rolling stock and the infrastructure itself. Controlled condition of the wagons and track, as well as programs for monitor the situation, combined with models for cost prediction, can be used in order to determine maintenancestrategy in order to reduce overall maintenance costs.In addition, the exact declared and promoted system of maintenance of railway vehicles and infrastructure according to their conditions, has been declared and promoted exactly, based on the values of the relevant parameters of the vehicle condition and the infrastructure, primarily obtained by using the stationary system for dynamic monitoring of the vehicle. As support to the new concept of maintenance, it is necessary to design a database for dynamic values measurement results of the respective parameters of railway vehicles, at the level of the railway network [7].

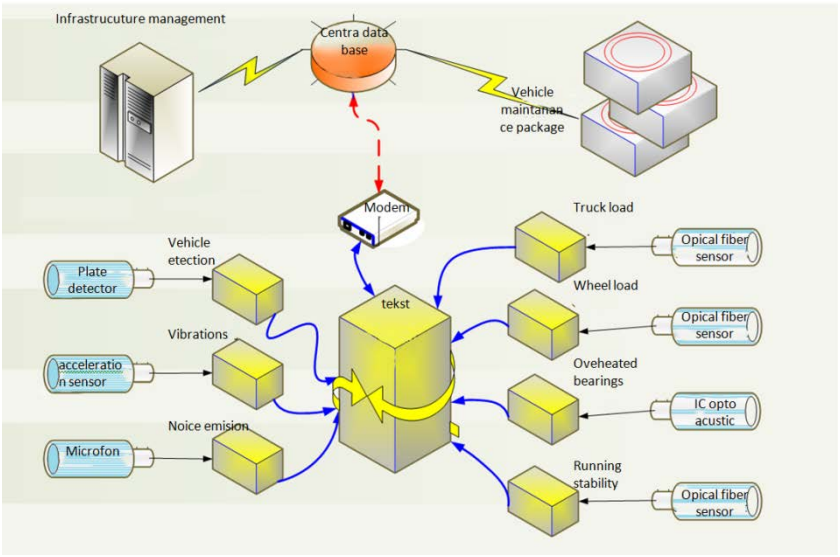


Fig.13. System measuring modules configuration

In order to consolidate and harmonize national railway regulations, European Union established a new system of standardization in the railway sector - *Technical Specifications for Interoperability* (TSI). *European Railway Agency* (*ERA)* is in charge of implementation of activities on harmonization of the existing national railway regulations within the TSI system, as well as for the adoption of new regulations.

Maintaining concept imply the principle by which the plan and maintenance program are implemented. Maintenance program determines the type of activity and scope of works to be carried out, while the maintenance plan defines the moment in which predicted procedures are

conducting, as well as the periodicity of implementation. The main characteristic of preventive maintenance is to implement maintenance procedures, before the failure occurrence and they are intended to prevent or to postpone the occurrence of failure.

Corrective maintenance is carried out when the failure occurred in order of its elimination. In particular it should be borne in mind that in technique of railway vehicles as well as in the field of maintenance new ideas, equipment and devices as well as newer methods and technologies of work are continuously incorporated. The aim of all this: eliminate or reduce the risk of system failure during its use so it will be ensured that all necessary maintenance to carry out be realized in the most opportune moment, without disturbing the defined shiftturn of rolling stock. It has been provided by the concept of preventive maintenance according to the condition [5].

For new types of railway vehicles, which are equipped with diagnostic systems, maintenance interventions are planned on the basis of processing of signals from the sensors of the vehicle.Monitoring of the conditions has been in use for several decades, if we count the man observation,(wagon inspector) and monitoring in service, the ability to assess the situation using the knowledge and experience. With the help of new technology, the possibility of continuous, automated monitoring now exists, as a huge advantage, which is reflected primarily in cases of rapid transition from mistakes to failure or, for example, when it is necessary to observe a large number of units with regard to the railway with a large number of vehicles.

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