AUTOMATION PROCEDURES OF CONTROL OF RAILWAY RAILS

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Abstract

Introducing new inspection techniques into the rail industry is a challenge that involves many aspects of accreditation and approvals. It is also necessary to consider the skills level of operators and training requirements specific to that industry. We have done comparison between new SPG 80 and of old handcart NW 60 for examination of mistakes in rails with new and old ultrasonic machine and tandem ultrasonic probe.

Old and new systems were precise and suitable for search and evaluation of mistakes in steel track, critical point is thermite weld. This way of examination searches defect in rails, for search tracks between next to joints of rails.

A number of samples of cracked rail from the network were collected and after inspection with the Walking Stick were sectioned to determine the crack size and shape. This information was then used to develop empirical corrections to the sizing models. Abroad analogous system are used, however still additional ultrasonic probe or used others techniques are added. Such procedures use usually for confirmation of found mistakes round examination of measuring train.

Key words: automation, assuring of quality, condition based maintenance, rails track

1. Introduction

Ultrasonic method has shown by the inspection of the vital element of the railways vehicles as an applicable and reliable method for detecting initial crack or falsies in the material. In »Mostovna« in Ljubljana was in year 1959 purchased the first ultrasonic device Krautkrämer USM 1 for the inspection of the flash-butt welds on the rails. After some years the ultrasonic devices USIP 9 and USIP 10 for the maintenance workshops in Maribor, Dobova, Nova Gorica and Ptuj were also purchased. Prior to this USL 32 device was mainly used. The education of operators was performed in Ravne by Ing. Mitja Špiš, where the basic instructions about the general methods were given. On the controller working place they also had to make the special railway examination in front of the internal commission.

The most merit for widening of not-demolished method has ex-inspector for the welding technology and defectoscopy Ing.-Boris Štefotič, who was collaborated in all control phases from the beginning and till 1981 [1].
In year 1963 was the beginning of thermit welding of unintermittent rails. Regarding to the railway regulations was obligation to make the ultrasonic test. At the beginning this was done by Institute Kirilo Savič from Beograd, than the Institution for welding in Ljubljana. From 1967 on, the Laboratory for defectoscopy in Ljubljana made the control with the USM-1 device. Later they used USM-7 device. The control was made with the normal head 4 MHz and by not completely pure welds also the heads with ultrasonic step out under the angle 45° or 70°.

In 1968 Krautkrämer device SZ 65 for rail testing was purchased, which is shown on the picture 1. These were hand trolley, arrange rail testing for the worker, who was slow walking pushed the trolley and observed the screen of the ultrasonic device. The ultrasonic heads was the tandem version, which means the combination of one normal (rectangular) and two angle heads, opposite inverted ultrasonic heads. Last year Laboratory for defectoscopy in Ljubljana from construction company Ljubljana got the new Krautkrämer ultrasonic device SPG 80 with new ultrasonic device USN 52, which is shown on the picture 1. This was is the laboratory equipped with the contemporary technology with possibility of computer writing out of the signals, which was frozen and saved in the memory for later processing and analyses.

![Picture 1: New device SPG 80 with the trolley and the old device SZ 60 with the trolley for hand testing with the ultrasonic probes tandem](image)

The new and the old system were precise and suitable enough for searching and evaluation of defects in the steel ribbons. The critical place is Thermit joint – Thermit weld. This method of the examination is used first of all for searching of defect in the rails, crack between the boreholes by the rail joints.

In 1971 began the use of penetrates in sprays forms. With them the cracks on the surface which was found by the ultrasonic test were repaired.

**2. Ultrasonic rail control on the Slovenian Railways**

With the law for the security of the railway traffic [2] it is defined, that the railway track and their parts must maintained assure safe railway traffic. It must be also regularly supervised and periodically inspected. In context of regular track maintenance also the ultrasonic inspection of the rails was included. Regarding to the Regulation for conditions of projecting, building and maintenance of railways superstructure [3] it is necessary at least once per year on the entire railway network to execute the »not demolished« ultrasonic inspections of rails.
In the last several years the ultrasonic rail inspections on the Slovenian Railways are made contract by the MAV-Central Rail and Track Inspection Ltd. with the ultrasonic measuring car »Ab25-SDS-Ab35«. The procedure of the measuring is automated and it is performing after the preliminary elaborated measuring plan. For the realization of the ultrasonic measurement on the entire network of Slovenian Railways, which contain cca. 1550 km of the tracks, it is needed to be planed about 13 working days.

Ultrasonic measuring car »Ab25-SDS-Ab35« is the vehicle with the own drive, with the length of 70.5 m and with the common mass of 180 tons. The speed by the ultrasonic control is between 30-50 km/h, it depends upon the track speed, the conditions of the rails and weather condition. The average daily extent of the measurement is about 125 km. The measuring car is equipped with the water tank (10 m³). On the car are installed two measuring system, for each rail one. Each measuring system composed two ultrasonic angle heads 70° in 45° (2 MHz), two vertical 0° ultrasonic heads (4 MHz) what is shown on the picture 4.

Short ultrasonic impulse with low frequency 2-4 MHz are from the ultrasonic heads sent to the rail and after the rebound on the impediment (fault) they are received back. As contact stuff between the ultrasonic heads and rail is used normal water. On the places where the wear of rails are bigger, is needed more water supply to the ultrasonic heads, because of the bigger outflow of the water. The system is supplemented also with two cleaning heads, what is shown on the picture 5.
Because of the easier data processing, some data, such as the name and the official number of the railway line, »km« kilometer position of the basic track elements, speeds on the track, the direction of the »km« position rising, left/right rail, the gradient of the track, etc.[6], are included in the computer data base in advance. The measurements are usually made in spring or in autumn, because the weather condition must be taken into consideration.

The precision of the measuring dates on the place are within 5-10 m, therefore follows also the secondary hand ultrasonic measurement. The measuring system on the measuring car is made so, that it is possible to detect the places, where the rails are welded or connected with the joint plates. (The principal of borehole detecting).

The secondary micro location and evaluation of founded faults are made with hand ultrasonic devices (USK-002). For the hand inspection of the entire network of Slovenian Railways with two separated working groups around 15 working days is needed. On the hand ultrasonic rail inspections the technical workers of the Slovenian Railways company are always presented. All micro located faults are marked with the color and evaluated regarding to the level of criticalness. The average daily extent of the hand ultrasonic rail measurement are about 50 km/day, dependent of the faults number on the line section and the access to the track.

Typical faults are so-called »shelling« type of the fault, regarding the UIC 712 kodex are signed with number 211,111. It is the type of vertical fault (defect) in the rail head. The largeness of the fault is fast getting bigger because of the material tiredness and leads to the break. These faults are often very close to each other because it can happen, that the rail breaks in more pieces. Relatively there are not many of these faults, around 1%.

![Diagram](image-url)  
Picture 5: Review over the setting up of the ultrasonic measuring heads

![Image](image-url)  
Picture 6: The example of the fault type »211« (shelling) regarding the Kodex UIC 712
With the Eddy current is momentarily tested the inspection of the fault on the rail driving edge, which achieve the depth till 10 mm, not-homogeneous and other faults, which are close under the surface and on the surface. On the Picture 7 are shown the measuring area in the rail, which are covered by the ultrasonic and Eddy current measuring heads. (A- rail measuring area with normal ultrasonic head (0°), B- rail measuring area with angle ultrasonic heads, C- rail measuring area with Eddy current measuring heads).

![Picture 7: Rail measuring area with ultrasonic and Eddy current](image)

The advantage of this method is detection of the faults in the very early stage of fault development, because the sending off of this fault is with proceeding of grinding with the grinding train still economical [7].

3. Conclusion:

With the ultrasonic measuring car in average 600 faults are detected, which also includes the faults which are not critical. There are around 4% of critical faults, which are in the first phase insured with the joint – plates, later eliminated with the new wide tips of thermit weld, or with a implantation of the new piece of the rail. Around 55 % of the faults are directly related to the rail; around 45 % of the faults are related to the rail weld (thermit or flash-butt weld).

Some faults, like the notches on the driving rail edge “Head checks” can with the own growth enlarge the possibility of the rail brake. The specialty of the surface faults, and the faults close under the surface is, that they are not able to be detected with the ultrasonic heads which are installed on the ultrasonic measuring car. For this purpose new not demolished method of material test with Eddy current is being used abroad.

For the automation of the rail inspections at the moment we use the Hungarian measuring car. It has also proven to be very reliable in the USA [8]. Beside the electronic and paper note of the automated proceeding, all undefined places which are colored must be inspected also with hand normal and angle heads. The process could be automated with the tandem method and portable computer with corresponding software.
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