

AUTOMATED ULTRASONIC INSPECTION OF RAILS

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Abstract:

The article gives an introduction to some important issues of a rail. The rails are an important and vital part of a railway system and are exposed, during service, to high stresses of different types, frequency and orientation and also to different environmental conditions. A brief description of automated ultrasonic inspection of rails is presented: wheel probe – transducers arrangement – instrumentation DIO2000 – software used.

One part describes the ultrasonic testing of rails in operation and examples are given from STARMANS Electronics (Czech Republic) and NDT do Brazil (Brazil). The principle test is carried out with wheel probes equipped with transducers having a frequency of 4 or 5 MHz. The system operates in immersion technique using 24 transducers.

A special carriage was constructed. In the car, 24 pulse-echo ultrasonic channels are used, together with 70 degree and 45 degree angle probes and normal head distributed on both rails. A speed up to 50 km/h is now available.

Safety requires ultrasonic testing and monitoring of rails in service. Knowledge of ultrasonic testing techniques is an important issue for carry out a qualitative test result. The successful detection of flaws ultrasonically has been established.

Introduction

One of the major problems, that railroads have faced since the very beginning, are failures in track. Defects in rails, as the basic part of track, may result in serious accidents. Rail inspection becomes more and more important today, with increased traffic, higher speed and heavier loads. Since visual inspection can detect only surface defects and sometimes obvious signs of internal problems, ultrasonic defectoscopy has irreplaceable role in rail inspection during operation.

In order to improve the probability of detection of most dangerous defects, straight and angle beams are used in ultrasonic inspection of rails in configurations for pulse-echo technique and tandem (pitch-catch) technique. Different arrangements of transducers provide different possibilities of inspection.

For small sections of rails, manual contact testing technique is applied using conventional portable flaw detectors and conventional contact probes. However, considering large scale of railroads, multi-channel automated system need to be used to allow higher testing speed with on-line evaluation and recording of defects.

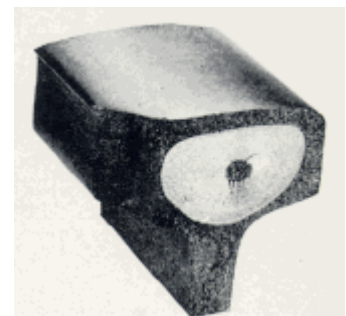


Fig. 1. Transversal crack in the rail – internal defect, which cannot be detected by visual inspection.

Principle of automated rail inspection

In order to provide an acoustic coupling between transducers and the rail, wheels or sliders willed with liquid are used, provided that the acoustic coupling between the wheel itself and the rail is achieved by means of sprinkled water. Such arrangement allows acceptable consumption of water, which is significantly less than using classic immersion technique with water column between the probe and object under inspection. The wheel is equipped with combination of several different transducers arranged under different angles to enable the best possible inspection of rails and detection of internal and surface defects having various orientations. The following figure (Fig. 2) illustrates the arrangement of transducers in the wheel probe.

It is advisable to connect each transducer to separate channel of ultrasonic testing system. Pulse repetition rate for each channel shall be selected accordingly, taking into account the sound path in water within the wheel probe and in the required inspection depth (thickness).

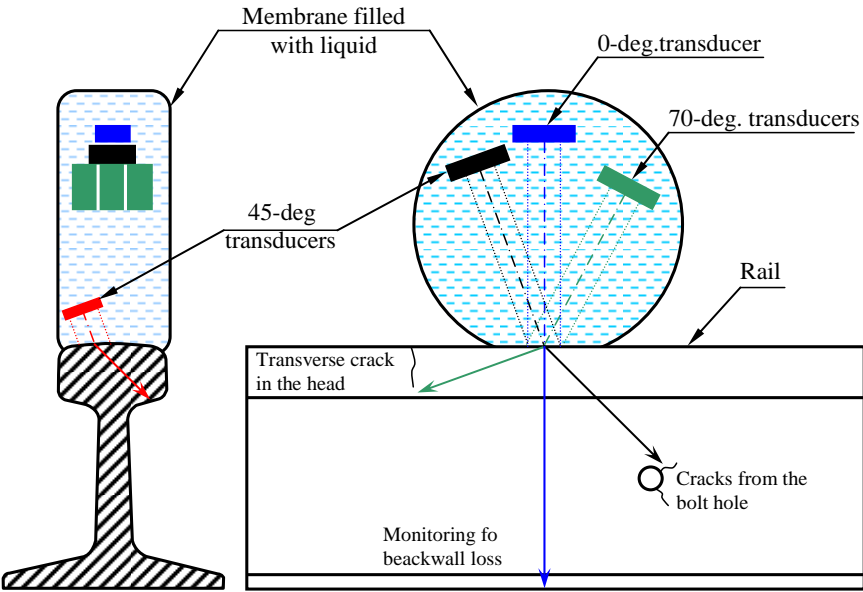


Fig. 2. Wheel probe with several transducers for inspection of rails.

Example of automated inspection system

The company STARMANS electronics, s.r.o., in cooperation with Brazilian company NDT do Brasil, has developed and realized 24-channel automated system for operational ultrasonic rail inspection. The system is equipped with 4 wheel probes (see Fig. 2 and 4), each contains 6 transducers: one 0-deg. transducer for vertical part of the rail and, at the same time, for acoustic coupling monitoring; one 45-deg. transducer along the rail axis for detection of cracks from bolt holes; one 45-deg. transducer perpendicular to the rail axis (side-looker) for detection of longitudinal defects in the head area; three 70-deg. transducers along the rail axis for detection of transverse cracks in the head area.



Fig. 3. Detail of the testing equipment hanging on the truck.

Testing sensitivity is adjusted on the artificial reflectors – side drilled holes 2, 3 or 5 mm diameter drilled in the head area, vertical section and, if required, in the foot area.

Achievable testing speed is up to 50 km/h, depending on specific requirements.

During inspection of both rails simultaneously, two wheel probes are used for each rail in such a manner, that transducers cover both directions along the rail axis.

Automated system for operational rail inspection comprises of the following parts:

- Controlling PC, which serves for setting of testing parameters (all parameters are adjustable independently for each channel), saving and loading setting configurations, data acquisition, processing and archiving.
- 24 ultrasonic channel unit modules.
- Equipment for data transfer and synchronization from the channel units.
- Software for data displaying and processing.
- Mechanical and hydraulic equipment for wheel probes hanging and guiding on the rails.

Each transducer in 4 wheel probes is connected to separate DIO-2000 channel unit. During inspection, each channel executes digital data processing including evaluation by amplitude and location of indications. Data outputs from ultrasonic channels are connected to controlling PC, which further processes, evaluates and displays data on the LCD monitor and archives database in files by sections of inspected rails.

DIO-2000 software uses modified B-scan for presentation of test results, where displaying of indications is synchronized regardless on actual transducers arrangement in all wheel probes – see Fig. 4. Indications from individual channels are separated by colour.



Fig. 4. Wheel probe for rail inspection.

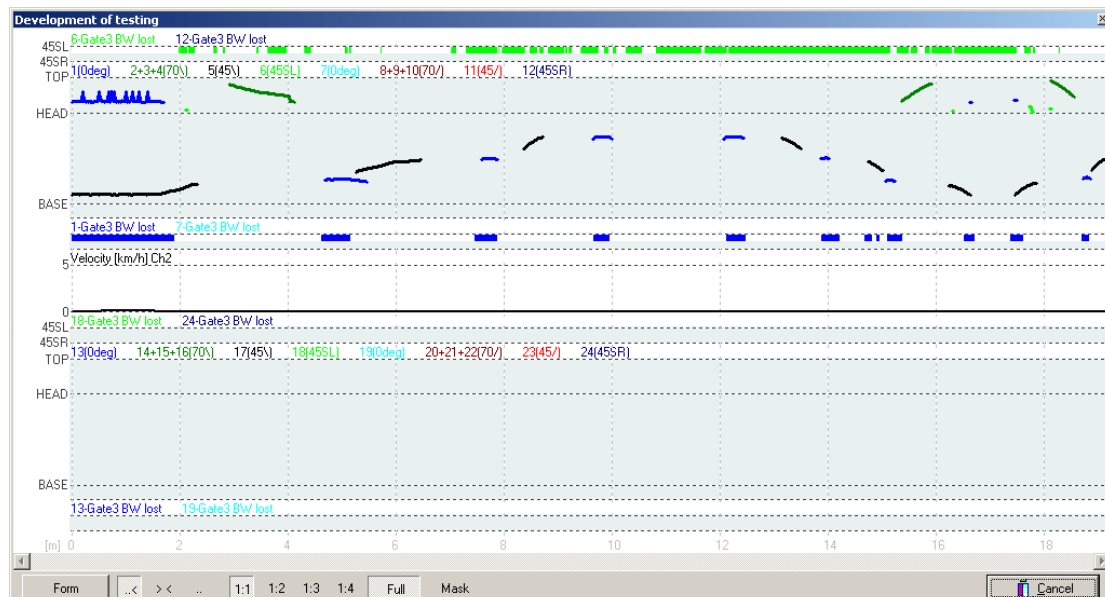


Fig. 5. Graphic presentation of inspection record.

Software DIO-2000 enables monitoring of individual indications development during inspection, acoustic coupling monitoring, actual testing speed and the length of inspected section.

Data about detected indications (registered indications, their number, relative position in the track etc.) are recorded in database. Software enables to record courses of A-scans, which may be played later like “videorecording” and re-evaluated after testing and data acquiring process had been finished.

System enables visualization of A-scans by individual channels or by groups in separate windows – see Fig. 6. Arrangement of windows on the monitor may be customized by user.

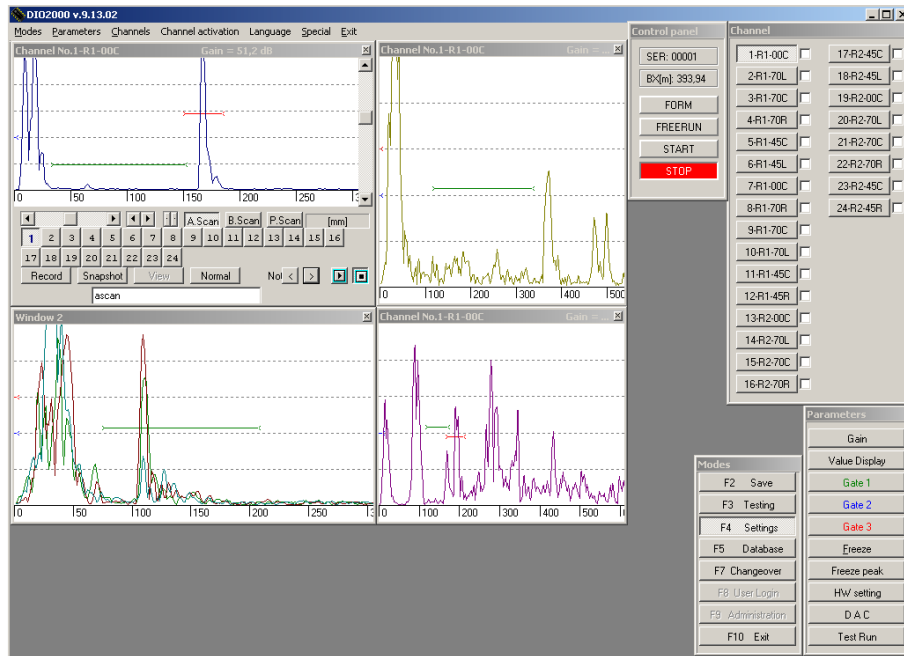


Fig. 6. Monitor display of the DIO 2000 testing system.

After inspection of certain section had been finished, data (including graphs) may be printed out to pre-prepared report form, stating the defects number and location on the inspected track.



Fig. 7. Testing equipment hanged on the modified truck.



Fig. 8. Workplace of ultrasonic inspection operator.

Experience with use of automated testing system STARMANS

Operational safety requires rails testing and monitoring during operation. Above mentioned automated system DIO-2000 is successfully used couple of years, mostly for metro rail inspection in Sao Paulo (Brazil). During that time, several serious defects, which could endanger operational fluency and safety, had been detected using this system and repaired or removed. Due to the accurate recording of indications positions, their finding and re-evaluating by hand flaw detectors with contact probes and following repairs are much faster and reliable, which contributes to provision of operational fluency and safety on the track.