Measurement of Rail Profiles

Time-optimised recording of the condition of the rails is becoming increasingly important. Measuring vehicles equipped with OPTImess laser sensors developed by Dr. D. Wehrhahn Meßsysteme, Hannover (Germany), and mobile instruments like the Railmonitor RML300 measure the transverse rail profile quickly and highly exact.

The interaction of wheel and rail has always been an important criterion with regard to safety and comfort. Due to new, simpler measuring and analysis methods it is also becoming increasingly important in the area of cost reduction by wear optimisation. Only a perfectly matched wheel/rail system can offer optimum results with regard to wear, comfort and safety of course.

There are many different methods for measuring transverse and longitudinal rail profiles for the inspection and repair of rails. The main distinction is made between the online measurements on the vehicle when in motion and the manual measurements with mobile measuring systems.

The measurements on the vehicle can be made both with point laser sensors for high speed travel and with line lasers for slower speeds. Mobile measuring systems usually operate with point sensors which are moved with a linear guide and scan the rail profile very accurately.

1 Structure of a triangulation sensor

The triangulation method comes from the geodetic measuring technology. The angles to an object point are measured from the ends of a base line and its distance is determined from these. In the triangulation sensor the base line is now moved into the sensor housing and active lighting is used (Fig. 1).

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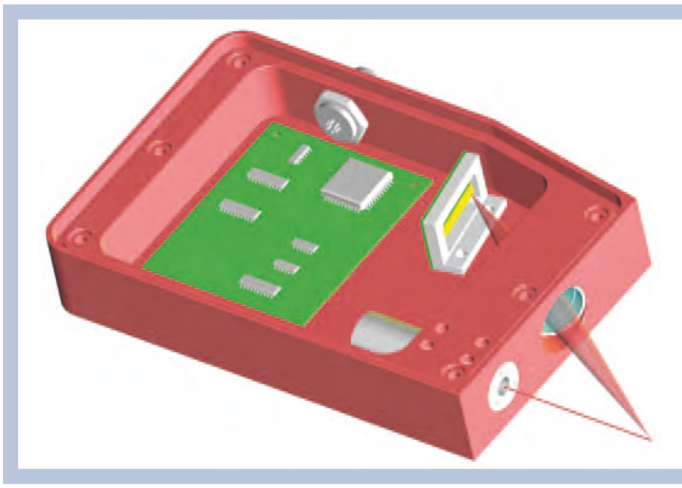

Fig. 1: Structure of a triangulation sensor

The object for which the distance from the sensor is to be measured is exposed to light from a light source through a focusing lens. The light spot is projected onto a detector by a projection lens and its point of impact is measured. The object must scatter the light diffusely so that part of it reaches the detector. The position of the light spot on the detector is a measure of the distance of the object surface from the sensor.

2 High speed measurement with spot sensors

Time-optimised recording of the condition of the rails is becoming increasingly important in view of the growing traffic congestion on new railway lines. Measurements on the rail network should therefore be integrated into the operating process if possible or be achievable by special measuring vehicles in the course of normal rail traffic, i. e. at speeds between 120 and 250 km/h. Here too, the laser sensors hold an exceptional position due to their non-contact measured value recording, small size and high measuring frequency.

For quick classification of the wear condition of the rail head to assess necessary repairs, measuring vehicles were equipped with laser sensors in which 5-8 OPTImess sensors per rail side are positioned around the rail head. At these points, measured values are recorded every 20 cm and compared with the nominal profile in the computer. The computer classifies the deviations according to specified tolerance values. The movements of the measuring vehicle superposed on the measured values are compensated mathematically in the computer.

3 Measurement of the rail geometry with sheet of light sensors

Another method for measuring transverse rail profiles at slow speed is to record them with an OPTImess 2D line laser according to the sheet of light measuring principle. The laser sheet of light method also works with the triangulation principle but the laser point is extended into a line by an additional optic and this is projected on a CCD matrix. Distances are determined along this line according to the resolution of the CCD matrix which then gives the profile. The sensor is mounted on the vehicle so that the line of the laser strokes over the running edge, the running surface and, if necessary, also the rail base (Fig. 2).

A large number of measuring points are measured along the projected laser line and output as X/Y co-ordinates via an interface. The OPTImess 2D sensors also offer the possibility of pre-processing the meas-

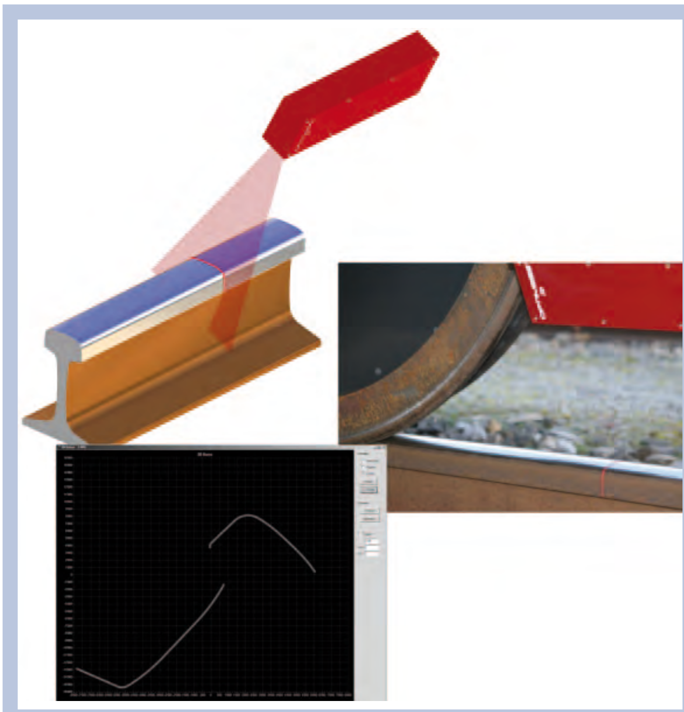

Fig. 2: Transverse rail profile measurement with OPTImess 2D light section sensor

ured data on the measuring head itself already to reduce the data volumes. Customised and application-specific processing routines are installed in the measuring head for this.

This method is particularly suitable for high-resolution measurements for more accurate analysis of the wear. By arranging several line sensors per rail head, wear characteristics can also be measured on stock rails, check rails, switch blades and cores. This applies for both grooved and Vignole rails. These wear characteristics can partly be output online with the graphical nominal/actual analysis. The measured data are transferred to a PC and edited later for further analyses and generation of reports.

4 Mobile transverse profile measurement

The mobile Railmonitor RML300 measuring instrument is suitable for making spot measurements of the transverse rail profile in the railway network (Figs. 3 and 4). The Railmonitor is a mobile instrument for static rail measurements and is approved by the calibration and test office of the Deutsche Bahn for the speed class up to 280 km/h. The modular concept enables various parameters of Vignole and grooved rails and points including the crossing to be recorded accurately and quickly. The transverse profiles, combined with rail cant, gauge width and height plus wear, give the complete rail condition at a certain point. The transverse profile is measured by laser and visualised graphically. A laser sensor traverses the rail and scans the rail head without contact according to the triangulation principle. The lateral profile is scanned simultaneously by a deflector mirror which additionally allows laps, head height and height ablation to be determined reproducibly. The rail cant is calculated indirectly from the gauge width and by the absolute inclination measured by an inclination sensor.

The individual measuring points can be parameterised locally on the measuring instrument or in advance on a PC in the office. Pre-measurements document the usually insufficient initial condition, the post-measurements on the other hand the improved final condition of the rail. The instrument can therefore make two measurements per measuring point which are stored as before and after measurements and later serve as a reference (quality assurance) for executed grinding work. A graphical nominal/actual comparison over the whole angle range indicates whether the errors are within the valid tolerance range. Rail characteristics such as the groove depth, the head height or the transition radius to the running edge are also of interest with regard to maintenance. Process characteristics such as the width of the grinding facet and grinding angle can also be measured directly.

Alternatively to the spot rail measurement with the Railmonitor the RPM measuring instrument designed for mobile wheel profile measurement can also be used for manual measurement of rail profiles. Here the laser unit is adapted to a conventional track gauge by simple conversions (Fig. 5). After making entries such as line identification and rail position in the battery-powered hand-held instrument, a traversing triangulation sensor scans the rail head. In this measuring method the rail profile is scanned in a grid of 0.1 mm and saved on the hand-held instrument. The saved rail

Fig. 3: Railmonitor RLM300

Fig. 4: Turnout Measurement with Railmonitor

profiles can then be transferred to the PC for further evaluations. The rail measurement with the RPM is a useful addition for wheel profile measurement for users who are concerned with calculation of conicities and simulation of real data of the wheel/rail system. These simulations are performed with specially developed software.

5 Measurement of points and point components

Another prominent feature of these systems is the possibility of exact measurement of points and point components. Once the rail or point profile has been measured, regardless of whether this has been done as a point measurement campaign with the Railmonitor or as a continuous measurement with OPTImess 2D sensors, the objective evaluation of points is just one small step away.

Thorough evaluation of points requires a full series of measurements in the switch blade tip area, the area between the rails and the crossing. The matured methodology based on the three well known gauges «1», «2», and «3» are now digitally represented in the measuring computer, offering more transparent results than the former master plates. In addition to just a "go", a warning statement and a clear "no-go" given by experienced parameters such as the exact position of the tip of the tongue provide significant numbers to immediately analyse the state of the switch geometry at the push of a button. The measurement strategy itself is implemented as individual series of profiles in a measuring campaign. This allows standardising specific knowledge according to established quality standards. For companies that are new to points measuring, out-of-the-box "best practise" templates are provided. For individual measuring spots, the corresponding profile type (stock rail, tongue, crossing, guide rail, etc.), the appropriate gauge (1, 2 or 3) and specific centring method can be parameterised. A points session is prepared in a PC software, loaded into the device, measured in the field and finally visualised and reported back in the office.

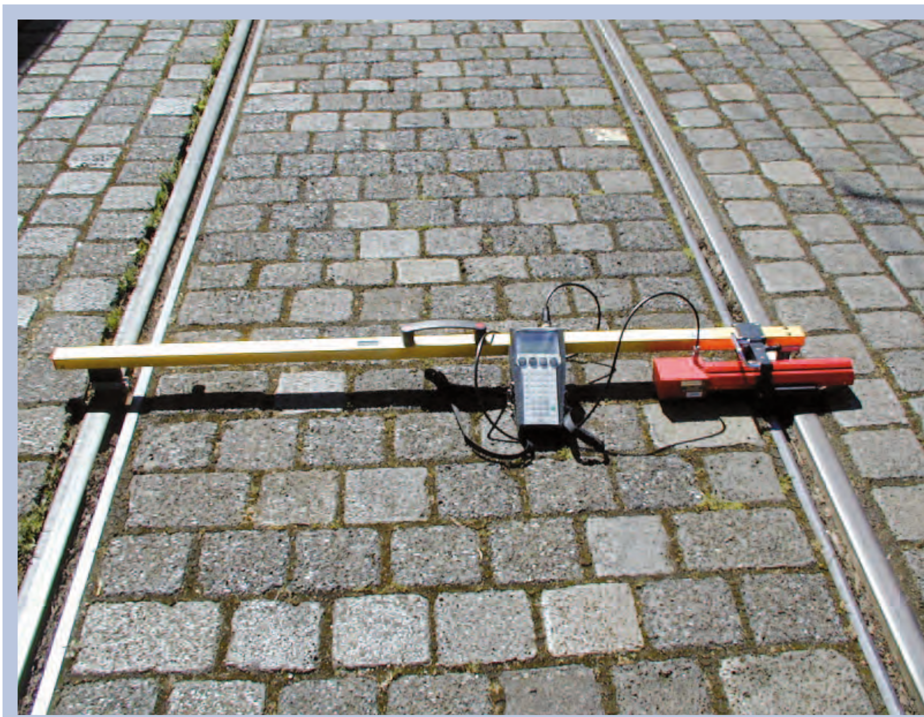

Fig. 5: Rail measurement with RPM

The gauge "1" (Figure 6 left) simulates the profile of a steep-edge flanged wheel that has been worn down to the permissible limit. This could cause derailment if the blade tip has impermissible high irregularities. If the crest of the wheel's flanged wheel comes into contact with track components, there is also danger of derailing. This can also occur in case of an impermissible wear state of the blade mechanism, which is why only limited wear is permitted in the contact area. The gauge "2" (Figure 6 middle) corresponds to the profile of a new flanged wheel. A new, low flanged wheel can derail if the switch tongue geometry contains breakouts of certain impermissible lengths and depths, which can be analysed with this gauge. The qualification of breakouts (max. permissible length of 200 mm) and other important observations such as the presence of burrs and undercuts are supported as well. Finally, the rail edge angle of the stock rail or switch tongue is checked using gauge "3" (Figure 6 right hand). The leg of the gauge is 30°...32° from the vertical axis which happens to be the critical parameter for derailing due to a flat contact angle between wheel and rail.

The user can adapt the system to his own requirements with a wide range of parameterising possibilities from type of rail to determination of the template profiles and tolerances. There are no longer any limits to the evaluation possibilities by recording real measured values by the usual procedure. ■

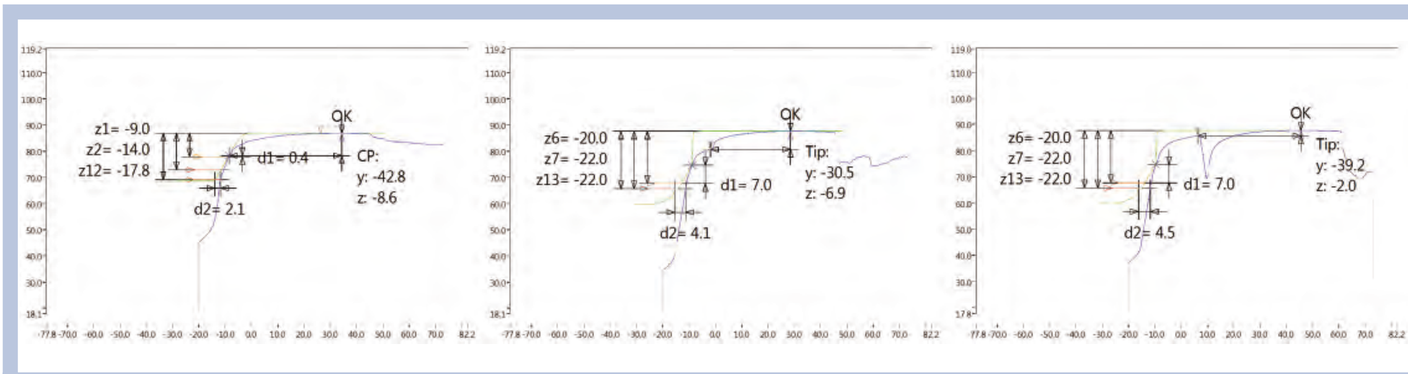

Fig.6: Analysis of stock rail and tongue geometry of points with the aid of three standardised electronic gauges "1" (left hand), "2" (middle) and "3" (right hand)