Automated turnout inspection boosts safety and cuts costs

The TCMS inspection equipment can in principle be fitted to any rail vehicle, and it has already been deployed on several self-powered inspection cars.

An advanced camera-laser scanning system and accurate location positioning allows for more consistent inspection of switches and crossings without the need for line closures or staff on the track.

David Buchbauer and **Omar Mohamed***

With modal shift to rail expected to play a key role in the decarbonisation of transport, infrastructure managers around the world are anticipating a marked increase in the density of train operations over the coming years. Given the long life of rail assets, decisions taken today will have a lasting impact on the efficiency of operations over the coming decades.

Switches and crossings are vital to the smooth operation of a railway network, but they are a critical element in the infrastructure and can be a cost driver. If a main line turnout fails, this can rapidly have a serious impact on passenger and freight movements, leading to disruption and cost.

Regular inspection of turnouts is a key aspect of infrastructure maintenance,

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but traditional methods can be time-consuming and working on the track may pose a significant safety risk for staff. With rising traffic volumes and increasing pressure to keep rail networks open for business, the automation and preplanning of inspection and maintenance processes has the potential to deliver significant savings over the life of a typical turnout.

Automatic turnout inspection

Historically, switches and crossings have been measured by hand at predetermined intervals. Limits are determined using measuring gauges and, in some cases, additional extensions, starting from the turnout entry and at intermediate points as defined by the relevant rules and regulations. The work can be time consuming and requires a considerable amount of organisation, as several people have to be in the track danger zone. Ensuring their safety at all times requires strict provisions, which ties up resources and drives up costs. This can include the provision of lookouts and personal protective equipment, along with regular training and instruction.

High-quality results ultimately depend on the experience of the staff involved. Further effort is then needed to transfer the measured data to databases or lists for assessment and record keeping. In some cases, electronic gauges with storage media can be used, which reduces the effort.

The Turnout & Crossing Measurement System developed by DMA and Plasser & Theurer is designed to inspect any type of turnout fully automatically, measuring key components in line with the appropriate infrastructure rules and standards. Continuous high-resolution measurement under load is possible up to a speed of 60 km/h at a sampling rate of 20 mm. Higher speeds can be achieved with a lower sampling rate. As the measurements are recorded automatically while the vehicle is travelling over the track, it is not necessary to have staff on the ground. And because the inspection vehicle can operate between regular services it does not require a line closure.

Source: TracksNet database / Plasser & Theurer

The inspection system is supported by sophisticated analysis of the measuring and positioning data. This means that recording runs can be carried out without prior planning of the exact route, even in complicated track layouts such as station approaches.

The bespoke system measures the track automatically and compares the turnout positions with a stored digital route map to identify the individual elements. Several different measuring runs can be combined during the analysis to create complete turnout reports, even if different elements were not measured in a single run or even on the same day.

Table I summarises the use of TCMS on measuring campaigns in various countries including Italy and Austria, where the complete system was able to prove its advantages at stations with a large number of turnouts to be measured. Inspection times averaged around 4 min per turnout, ranging from 3 min to 7 min[1].

Fully automatic turnout measurement has several advantages compared to conventional methods:

- no one needs to be on the track, which increases employee safety considerably;
- all test parameters are measured and analysed in line with the infrastructure manager requirements;
- measurement is carried out under load, so the dynamic effects when travelling over the turnout largely correspond to real use and can be taken into account in the analysis;
- no line closure is necessary, as all parameters can be measured during normal traffic and this does not interfere with operational use of the turnout.

Table I. Average measuring time per turnout in selected station areas

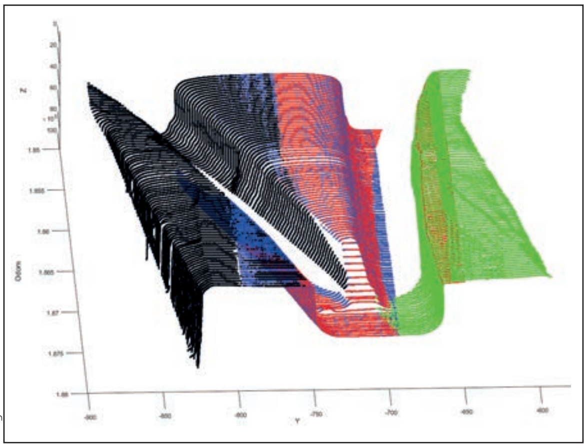
Station	Turnouts	Total measuring time *min*	Average measuring time *min*
A	59	171	3
B	57	157	3
C	158	720	5
D	75	208	3
E	82	428	5
F	78	442	6
G	287	1,258	4
H	42	100	2
I	187	755	4
J	61	431	7
K	59	164	3
L	75	337	5
M	61	240	4

Fig 1. Precise map data allows the travelled route to be recorded automatically.

Technical overview

TCMS can be seen as a complement to and, under certain conditions, as a replacement for manual turnout inspection. It uses an arrangement of several camera-laser units mounted on a vehicle to scan the relevant dimensions. Individual measurements are triggered via an encoder and are strung together and processed by the software. The measurements can be analysed in both the longitudinal and transverse directions. The various recordings are synchronised and located with high precision, enabling measurements and analyses to be carried out with great accuracy and repeatability.

> ‘Switches and crossings are vital to the smooth operation of a railway network, but they are a critical element in the infrastructure and can be a cost driver’



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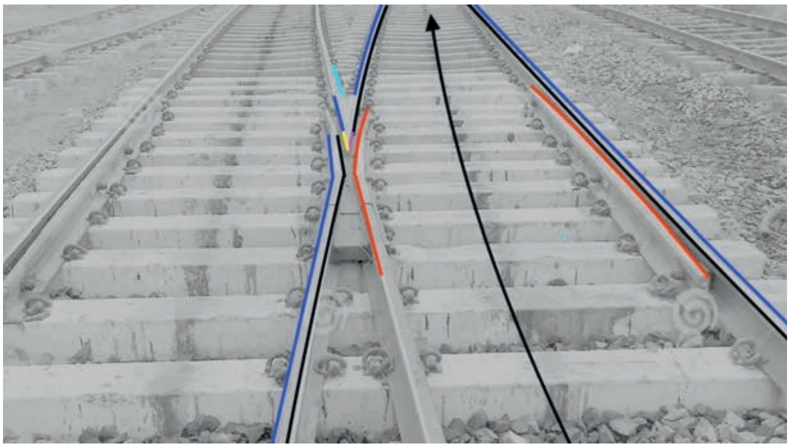

To enable fully automatic measuring, precise digital map data, along with accurate information about the types of turnouts and crossings and the limits are required. This GIS and turnout data contains all the relevant information required to process the raw data correctly. Accurate vehicle location is determined with the aid of satellite navigation (GNSS) and the position of the turnouts travelled through; these are recognised automatically by the measuring system. As mentioned earlier, it is not necessary for the machine to adhere to a specific sequence in travelling over the individual turnouts, so a measuring run can be organised very flexibly[2].

The camera-laser units are used to detect the geometry of the turnout and compare the recorded measurements against the limits specified by the infrastructure manager (Fig 2)[3]. Parameters to be inspected can typically include:

- track gauge;
- flange groove;
- check rail gauge;
- guard rail spacing.

As the arrangement includes an inertial measurement unit, the track geometry through the entire turnout can also be determined in accordance with EN 13848[4]. The measuring system can be adjusted in a variety of ways to suit different measuring methods and standards. However, it is necessary to adapt the assembly on the bogie in order to achieve the required precision for guidance through the turnout (Fig 3).

> ‘No one needs to be on the track for the measurement process, which considerably increases staff safety’

Above: Fig 2. A sample representation of the measured raw data in a common crossing as a basis for automated data analysis.

High-precision factory calibration is a prerequisite for achieving the necessary measurement precision. This ensures that a complete cross-section profile can be created from individual profiles.

Upgrading existing machines

In principle, TCMS can be installed on a wide variety of vehicle types, although the measuring speed may have to be limited depending on the accuracy required. The system has already been successfully integrated into powered track inspection vehicles for several projects.

During the measurement runs, the equipment should be positioned above the rails as precisely as possible, so that all components of the turnout are clearly visible and can be recorded properly. This means that it is necessary to install the equipment close to an axle to ensure correct guidance through the turnout. Additional sensors are also required, such as a high-resolution encoder and a GPS receiver.

Adapting the software

Analysis of the measuring data must be adapted as necessary to meet national regulations or the specific requirements of an individual railway or infrastructure manager. This can be done using the TracksNet software, in which the necessary algorithms and definitions are implemented. Both direct and derived or virtual limits can be defined, and these can be calculated reliably for each measuring run and campaign. If the system is correctly set up and verified, it should ensure high process reliability and reproducibility, even over long periods of time, as the measurements are not influenced by human intervention.

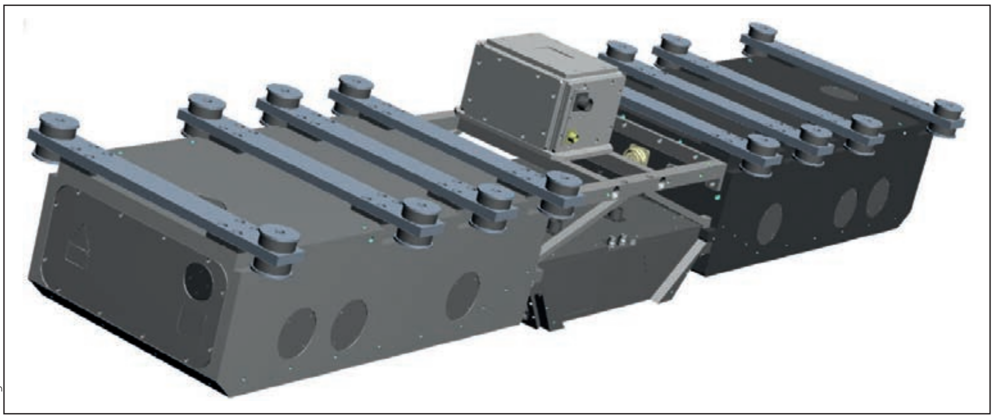

Image: DMA srl

Fig 3. The turnout measuring system consists of several optical units and an IMU.

References

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