

Clearance MEASUREMENT

Measuring tunnel clearances faster

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AN ACCURATE knowledge of loading gauge clearances is critical if a rail operator is to be certain that loads can be carried safely. But over time the clearance along a line can change for several reasons. The track can move out of position, perhaps being lifted during maintenance, and tunnels can deteriorate.

There are several ways to measure lineside clearance, of which the two most widespread are mechanical and laser. An improved laser design jointly developed by Plasser American Corp and Riegl GmbH of Austria is now in use with New York City Transit and Taipei Metro.

With older equipment, users had to stop the recording car to measure



The rugged laser sensor can be bogie-mounted, with rubber mounts. The scanner itself is filled with inert gas

This meant the task could take several days, if the line could not be closed for such a long period. Modern equipment can achieve the same quality of data in milliseconds, cutting the time for an equivalent task to just 42 sec.

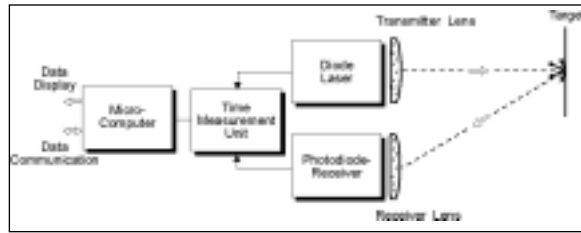
Measurement is carried out using a 'time-of-flight' technique. A periodically-driven laser diode is used to send out infra-red light pulses. These are reflected by surrounding objects, and the echo is picked up by a photodiode. The interval between the transmitted and received pulses is measured using a quartz-stabilised clock (Fig 1).

The laser beam is scanned around a 350° arc, producing almost a full circle (the 10° looking vertically down is reserved for calibration).

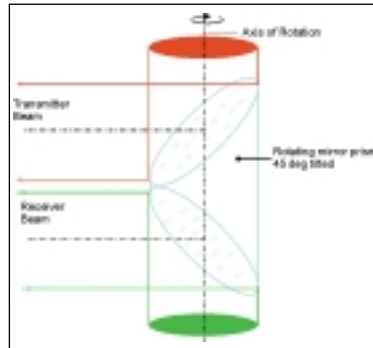
Measurement around this circle can be taken up to 40 times per second. The speed at which measurements can be carried out is inversely proportional to the number of points measured during each revolution and the accuracy required (Table I). There is also an option to measure individual points without rotating the beam. It is possible to calculate average measurements by taking two or more cross-cuts in one sampling interval, which is usually 250 mm.

Using the survey data, the distance between the laser and the target is calculated. The computer also records the position of the rotating mirror prism and the intensity of the back-scattered light from the target. All the measurement options are set from within the Plasser Computer Measuring & Analyser System, so the user does not need to interact directly with the software. Data is transferred via a TCP/IP ethernet. The control system gets a pulse every data sampling interval, keeping the data synchronised with the car's other measuring systems.

Plasser has produced a software package called TunnelClient, to



Above: Fig 1. Signal and data paths in the measuring and analyser system



Left: Fig 2. Laser light is transmitted and received using a prism with mirrored surfaces at 90° to each other and 45° to the laser and photodiode

Table I. Adjustable measuring modes

Rev/sec	Measured Points per Revolution	Accuracy mm
0 (no rotation)	—	Determined by travel speed
10	1001	± 12.5
20	1001	± 12.5
24	1001	± 12.5
40	501	± 25.0

each cross-section, which took up to 5 min. Even with a 'fast' recording time of 1 min per cross-section, it took nearly 17 h to measure a 1 km tunnel with one section every metre.



Fig 3. TunnelClient in standard mode. The current header, location and track geometry parameters are shown, with the actual measured data and the corresponding clearance diagram. The measured data violates the clearance in the lower right corner, and therefore this part of the profile is shown in red. As this profile is of a curve, the clearance diagram is enlarged on both sides to adjust for radius and superelevation

evaluate the measured cross-sections.

It can display and print individual sections, including automated printing of profiles at a pre-settable distance. There are 10 different user definable clearance diagrams, analysis of sections against a clearance diagram, with adjustments for curvature and superelevation. The system can also display the minimum clearance between two locations. Data can be output in ASCII and database upload formats.

With additional software, the equipment could also measure the distance to the neighbouring track or the height of the used ballast. ■

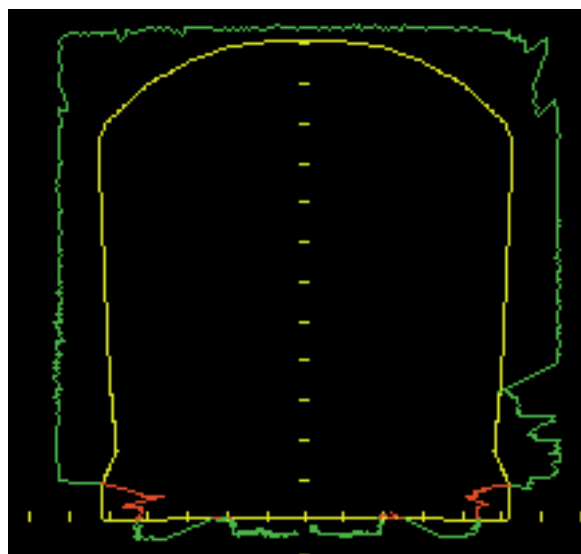


Fig 4. TunnelClient in minimum mode. At the end of a measuring run the program will display the overall clearance by assembling the smallest distance to the laser scanner for every measured angle. The ASCII data file will provide the location where each minimum was measured