

Tunnel Inspection System

Simultaneous geometry and moisture measurement

Efficient maintenance for road and railway tunnels

Increasing efficiency in maintenance: The Tunnel Inspection System TIS provides data on geometry and surface moisture in a single measurement cycle.

Road and railway tunnels need to be inspected regularly to ensure safe operation. Water ingress and structural deformations are among the most critical issues regarding tunnel safety. The Tunnel Inspection System TIS is an optical, non-tactile measurement system that measures the tunnel's geometry and surface moisture in the same measurement run.

Maintenance: fast and straightforward

From the data acquired by the TIS, a 3D geometrical representation of the tunnel surface is generated that contains additional information on moisture. The measurement results are visualized, making inspection procedures much easier.

Phase shift technology is used to determine the distance from which the tunnel geometry can be derived. A rotating mirror projects two high-frequency modulated laser beams on the surroundings and detects the returning light. The exact position of each measurement point is calculated from the measured distance value and the angle of the scanning mirror. The returned intensities of the two laser beams,

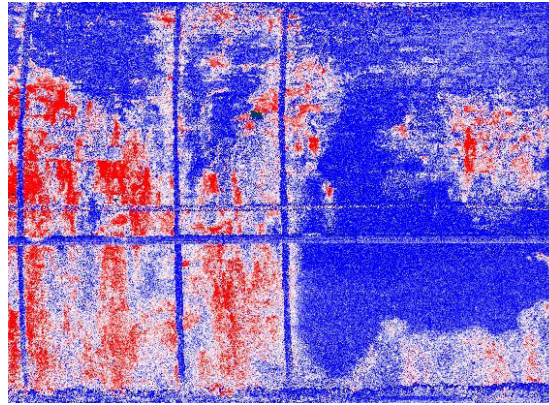
which are of different wavelengths, provide information on the water content on the reflecting surface. Combining the data with the trajectory of the inspection vehicle yields a three-dimensional representation of the tunnel geometry and its surface moisture.

Up to two million measurement points per second

The system works at scanning frequencies in the range of 10 to 200 Hz with a sampling frequency of up to 2 million measurements per second. A computer, located inside the inspection vehicle, evaluates and visualizes the data and transmits it to the inspection vehicle's PC via a network connection.

Railroad measurement systems by Fraunhofer IPM

Fraunhofer IPM develops optical measuring systems for monitoring the condition of rail infrastructure. Experts in measuring techniques and optics, designers, electrical and software engineers work together on supplying turn-key solutions for the special requirements of infrastructure operators and providers of surveying services. The robust measuring systems are deployed throughout the world and are characterized by their speed, precision and reliability.



Left: High density 3D point cloud of a tunnel wall with grey values representing back-scatter intensity.

Right: The same data set with colored areas encoding surface moisture (red: high, blue: low)

Robust housing

The TIS sensor is mounted at the front or back of an inspection vehicle. The sensor unit comprises a fixed optical window and is located in a hermetically sealed housing (IP67). When not in operation, a casing protects the sensor head from dirt or vandalism. Buffered vehicles can have a sensor head mounted on a slide, which is moved automatically into measurement position.

Precise and stable measurement results are achieved thanks to internal calibration before every scan – even at extreme temperatures and over long periods.

Comprehensive solution

The Tunnel Inspection System TIS is based on the established Clearance Profile Scanner (CPS) from Fraunhofer IPM, which has been deployed on mobile systems (trains and cars) for more than 15 years. The system's design is in accordance with DIN EN 60825-1:2008. The TIS is eye-safe according to IEC60825.

Fraunhofer IPM offers individually adapted software packages, e. g. for point cloud generation or further post-processing, to create a comprehensive measurement solution.

Technical specifications

Measurement range	1 – 10 m (up to 30 m using a reduced bandwidth)
Distance resolution	about 1 mm
Intensity resolution	12 bit
Uncertainty at an object reflectivity of 90 %	3 mm at 5 m σ -value)
Uncertainty at an object reflectivity of 10 %	7 mm at 5 m σ -value)
Scanning angle	$\approx 350^\circ$
Scanning speed	10–200 rev./sec.
Measurement rate	up to 2 mio. measurements per sec.
Number of measurements per profile	10,000 (at 200 rev./sec.)
Point distance at 5 m	6.2 mm
Profiling density at 50 km/h	one profile each 7 cm (at 200 rev./sec.)
Ambient temperature	–20 °C to +50 °C (in operation; temp. control incl.)
Moisture resolution	10 levels of moisture

All specifications and features are subject to modification without notice.

CLASS 1
LASER PRODUCT

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