Leica TMS Tunnelscan
Complete tunnel documentation

- when it has to be right
Tunnel construction technologies are continuously evolving to achieve better performance. The latest developments allow tunnelling projects to be successful in increasingly challenging engineering and commercial environments. State-of-the-art machines, tight deadlines and budget constraints put the highest demands on the tunnelling process and all parties involved. Smooth construction is the key to successful project realisation.

More importance placed on tunnel surveying
Continuously on-call, highest flexibility and availability combined with fast and precise surveying – a real challenge for the surveyor and the surveying technology.

Leica TMS – the universal tunnel measurement system for tunnelling professionals
With powerful modules for:
- Tunnel guidance
- Tunnel setting out
- Profile measurement
- Tunnel scanning
- Structure dimensions

Leica TMS customers benefit from
- “24h surveyor” for the highest standard of automatic tunnel guidance
- Use of Leica standard hardware components – robust, precise, exchangeable on demand
- Intuitive software for tunnel surveyors
- Automatic evaluation routines
- Pinpoint accuracy of results in real time
- Highly detailed as-built records
- Relevant results at a glance

Developed as a result of the close co-operation between Leica Geosystems and Amberg Measuring Technique, Leica TMS embodies the unique synergy of tunnel construction and surveying know-how. Practical software modules ensure the highest production rates in challenging tunnel projects, and have won the trust and respect of the industry over recent years.
Leica TMS Tunnelscan
Comprehensive tunnel as-built analyses
Fast, precise, meaningful

Leica TMS Tunnelscan is the powerful data collection and evaluation software for laser scanner measurements in tunnel projects. Together with the Leica HDS4500 high-performance imaging scanner, TMS Tunnelscan forms the most powerful system solution on the surveying market for tunnel as-built documentation and analysis. TMS Tunnelscan supplies reliable information for the tunnel contractor, client, designer, and not least the surveyor. Based on more than 25 years experience in the development of measuring technology for tunnel construction, Leica TMS Tunnelscan is the tunnel measurement system designed by tunnel experts for tunnel experts.

Powerful software routines
- Record the geometry and image of the entire tunnel structure during each construction phase
- Determine all areas of under and overbreak
- Calculate detailed excavation quantities
- Compare measurements taken at different times for determination of sprayed concrete layer thicknesses and spatial deformations
- Check the conformity of undulation of tunnel surface layer
- Process geo-referenced scanning data from other scanner types through standard PTS data interface

Leica TMS Tunnelscan users benefit from:
- Automatic data acquisition and evaluation software specially designed for tunnelling works
- Highest performance with up to 500,000 measured points per second (Leica HDS4500)
- Unique measuring speed at highest data density – up to 10’000 times more powerful than conventional methods
- One set of data for geometric and digital image documentation of the tunnel
- Mobile, autonomous and modular system design for optimal integration into the construction process

Leica TMS Tunnelscan – an integral part of the Leica TMS system solution. Smooth interaction of all TMS modules for the highest measuring performance and optimum support of tunnelling works.
Leica TMS Tunnelscan
Scanner technology for tunnel construction

Tunnel excavation
- Excavation profile control
- Documentation of support measures (e.g. steel supports, rock bolts)
- Excavation volumes

TMS Tunnelscan
- Extremely fast and flexible measuring system
  - Leica HDS4500: Typical survey < 2 min.
  - Complete data collection for profile, volume and image documentation
  - Direct evaluation of individual profiles
  - Central project geometry data – as basis for guidance and as-built documentation
  - Tunnel-optimised positioning method

Customer benefits
- Minimum impact on tunnelling operations during measurements
- Results of profile controls directly on site
- Optimised sprayed concrete operations (quality, cost)
- Precise calculation of quantities for billing
- Comprehensive construction data for optimum progress
- Objective record of applied construction materials – for client and contractor.

Completion of excavation support
- Profile control of sprayed concrete
- Determination of sprayed concrete layer thickness
- Undulation checks of tunnel surface
- Image documentation of excavation support
- Tunnel surface deformation measurements

TMS Tunnelscan
- Typical 1 x 1 cm point grid on tunnel surface
- Genuine one-man system using APM™ geo-referencing method
- Automatic analysis of entire tunnel surface (profile, undulation)
- Comparison of two different scans for spatial analyses (sprayed concrete layer thickness, spatial deformation)
- On-screen digitalisation of non-compliance areas (e.g. underbreak) for set out preparation

Customer benefits
- Complete record of the constructed tunnel
- Tunnel scanning performance of up to 130 m per hour (Leica HDS4500, APM™, trolley, automatic tripod)
- Flexible operation without additional supporting infrastructure (e.g. lighting, external power supply, additional reference points)
- Intuitive, automatic evaluation software for tunnel surveyors – not only for scanner experts.
Acceptance of primary lining
- Lining acceptance check before installation of waterproofing and secondary lining
- Complete profile approval
- Final documentation of undulation of sprayed sealing
- In-situ concrete volume calculation for logistics

TMS Tunnelscan
- Undulation checks according to standard sphere or bar method
- Volume calculations section by section according to station intervals
- Fully automatic documentation of results with colour-coded tunnel mapping (isoline map)
- Scaled grey-scale image of the tunnel surface - provides additional information layer for assessing potential critical tunnel sections

Customer benefits
- Objective facts about performance and quality of the tunnel structure
- Cost savings and improvements in quality through optimised construction planning and logistics
- Well structured and scaled presentation of results
- Accepted as-built record formats

Tunnel commissioning
- Acceptance checks of profile dimensions and secondary lining thickness
- 3D documentation of tunnel equipment
- Handover documentation of concrete lining

TMS Tunnelscan
- Complete 3D as-built documentation
- Scaled image
- Interactive export of detailed point data including attributes such as 3D coordinates, deviations from theoretical profile, etc.
- Image data interface for transfer of existing structural data, e.g., to an asset management system

Customer benefits
- Highest assurance of structural quality
- Objective documentation of the condition of the structure
- Savings in tunnel maintenance costs
Leica TMS Tunnelscan
Complete documentation and analysis

Leica TMS Tunnelscan – the powerful tunnel scanning module is an integral component of the Leica TMS Tunnel Measurement System – one surveying solution from tunnel guidance to as-built documentation.

- Powerful measuring and evaluation modules
- Tunnel-optimised measuring process
- Intuitive software for tunnel surveyors
- Automatic analysis, meaningful results

TMS ScanControl
Using the fastest scanner system Leica HDS4500 means tunnel surveying with up to 500,000 points per second. An outstanding performance in the demanding tunnelling environment that allows surveying without obstructing tunnelling works.

<table>
<thead>
<tr>
<th>Typical point grid</th>
<th>1 x 1 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured points per set-up</td>
<td>12.5 million</td>
</tr>
<tr>
<td>Measuring duration per set-up</td>
<td>≈ 2 min.</td>
</tr>
<tr>
<td>Performance per hour</td>
<td>up to 130 m</td>
</tr>
</tbody>
</table>

TMS ScanControl is the module to obtain the most efficient tunnel as-built survey with the Leica HDS4500 Scanner using the Amberg Positioning Method (APM™). The measuring system is referenced with a total station, optionally with a TMS motorised laser. Advantages include:
- Highest measurement performance of up to 130 m/h
- One-man operation
- Highest flexibility during measurements
- Additional reference points in scanned area not required

Optionally scanner measurements can also be carried out and referenced using manufacturer’s standard software.

TMS ScanRex
TMS ScanRex is the module for the geo-referencing of measurements in accordance with the APM™ process and the extraction of individual profiles directly from the scanned point clouds. Intelligent algorithms reduce the number of measured points from millions directly into individual cross sections, whilst retaining the critical profile sections.

- Fully automatic individual profile extraction directly from referenced scanned point cloud
- Individual profile extraction with freely-definable point density, profile intervals and critical point detection
- Transfer directly into TMS ProFit module for as-built analysis – ideal for evaluation on site

TMS ScanRex Automatic geo-referencing process
TMS ScanCloud

TMS ScanCloud is the powerful analysis module for geo-referenced scanned data. Operation is designed to meet the requirements of the tunnel surveyor. Expert knowledge of complex scanned data handling or 3D CAD operation is not required. TMS ScanCloud is the basis for highest productivity and reliability in the challenging tunnelling process.

TMS ScanCloud provides the following analyses:
- Profile control of the entire tunnel shell
- Comparison of two independent scans to determine:
  - Layer thickness
  - Spatial deformation
- Scaled image documentation of the tunnel surface
- Detailed calculation of quantities
  - including section by section in-situ concrete volumes
- Undulation check of the tunnel waterproofing layer
  (requires TMS ScanSurf module)

The user benefits from:
- Intuitive operation of complex data analyses
- Smooth data flow and processing
- Flexible PTS data interface for the analysis of geo-referenced data of other scanner types, e.g. Leica HDS3000
- Direct access to central project geometry data in TMS Office module
- Automatic linking of individual point clouds
- Automatic comparison of scanned data against the theoretical tunnel model according to the project specifications
- Data filters for automatic and intentional exclusion of specified areas in the tunnel cross section
  (e.g. ventilation in the roof, service ducts)
- Practical on-screen digitalisation for preparation of setting out of non-compliance areas on the tunnel surface

TMS ProFit

TMS ProFit is the proven TMS analysis module for tunnel profile measurement data. Deviations of the measured profile from the theoretical profile are displayed in real time. TMS ProFit provides:
- Direct analysis of the extracted tunnel profiles from TMS ScanRex and TMS ScanCloud
- Powerful reporting features

Strategic cooperation between Leica Geosystems and Amberg Measuring Technique

For over 20 years Leica Geosystems and Amberg Measuring Technique have cooperated closely on the development of rail and tunnel measurement systems. This unique combination of industrial knowledge and engineering expertise has produced innovative and flexible systems, based on practical designs and user-friendly software. With worldwide support and service, these solutions have won the trust and the respect of both the rail and the tunnelling industry.
Whether measuring a tunnel profile to a high degree of accuracy, guiding the tunnel excavation, conducting 3D profile controls with the need for real time results, or carrying out a comprehensive analysis of the dimensions and condition of a tunnel project: The tunnel measurement systems from Leica Geosystems provide the optimal solution to meet the project requirements. Thanks to the modular system design, Leica tunnel measurement systems offer universal and efficient solutions for even the most challenging tunnel construction projects – from everyday surveying tasks to the most demanding measurements.

When it has to be right.