How we build reality

Zoller+Fröhlich

Case Study

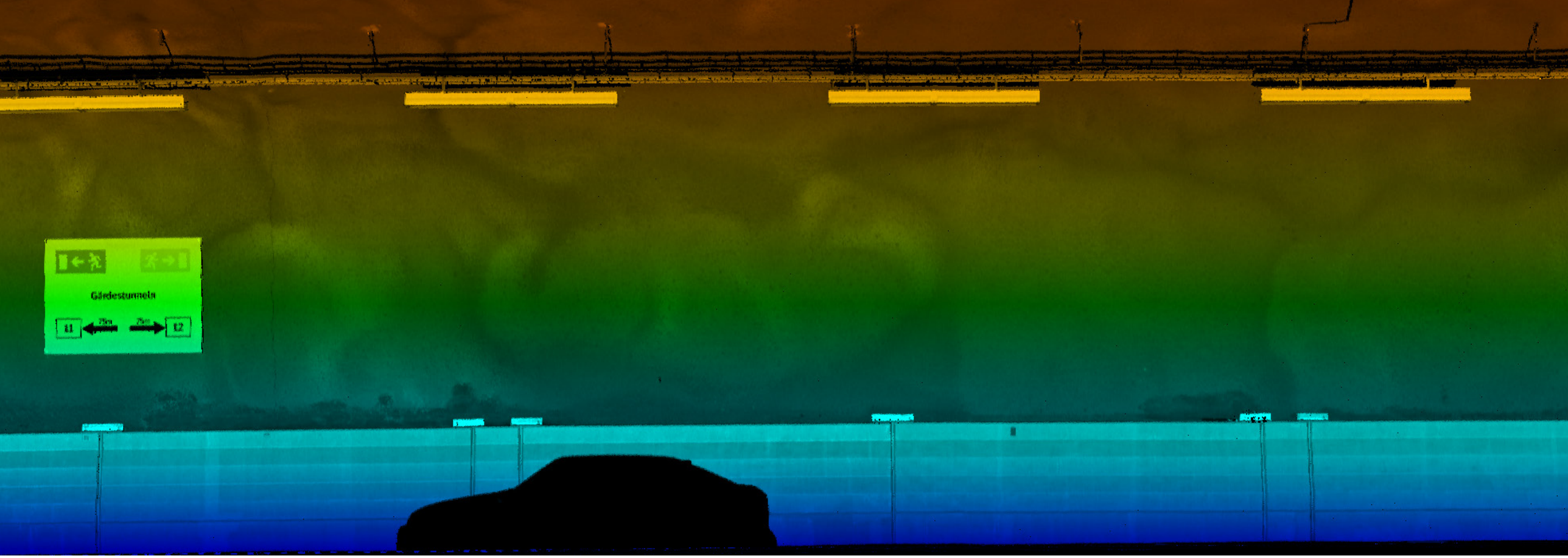
Deformation Analysis
Highway Tunnel “Norra Länken”
Stockholm, Sweden

Company Overview

Z+F is one of the world’s leading manufacturers in the field of non-contact laser measurement technology. Due to years of research, development and numerous successful engineering projects, Z+F is the forerunner in this field with a wealth of knowledge, experience and success.

When it comes to implementing future developments Z+F has always encouraged innovative thinking and open-minds. Our loyal and long-standing customers appreciate our continual innovations, support and the services we provide.

In cooperation with TerraTec.



Our Partner

TerraTec

TerraTec offers an extensive range of services with emphasis on the collection, processing and presentation of geospatial data. We provide aerial photography, LiDAR and Mobile Mapping surveys, surveying, map production, 3D visualization and photogrammetry services. The company documents, analyzes and visualizes our world for government agencies, corporations and organizations to contribute to a society harmonized with the modern age and the future.

Key knowledge is the collection of high resolution geospatial data to provide 3D Asset Management and Facility Management information for numerous applications. TerraTec provides planning and design data for infrastructural and civil engineering projects including DTM's, orthophotos, design maps, 3D and BIM models. High resolution data from our aerial sensors is used for large scale analysis of topographic conditions, location studies and detailed design. The Mobile Mapping solution provides inventory of transport routes for oversized loads and documentation of streets and highways, rail roads and tunnels as a basis for inventory of road side objects, obstacle mapping and clearance checks.

TerraTec was founded in Norway in 2004. The TerraTec Group includes subsidiaries in Sweden, Finland and Estonia. TerraTec Group has 100 staff members and generated a turnover of 13.7 million EUR in 2013. Among the clients are municipalities, government agencies, private and public companies in the Nordic countries, Central Europe, the Middle East and Africa.

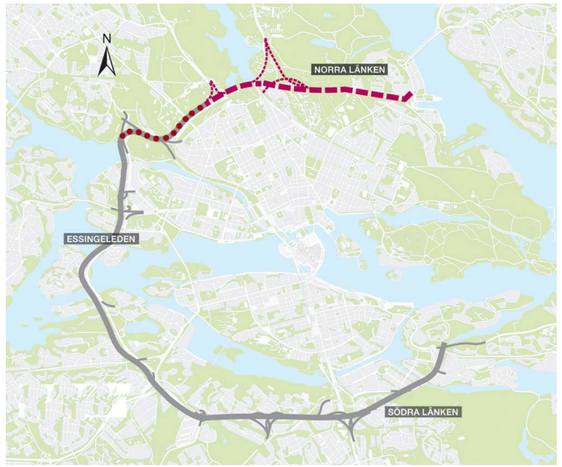
Project & Objectives

On behalf of the Swedish Transport Administration, TerraTec was assigned to carry out an R&D (research and development) project in the newly completed highway tunnel Norra Länken in Stockholm.

The objective of the R&D is to study the possibilities to detect minor deformations in the roof of the tunnel by using mobile data capture. The mobile data capture method has to be able to collect data with very high accuracy.

The following key points were of great importance for the project:

- Survey methodology capable of detecting surface variations < 10 mm
- Display object in the resulting data for presentation and review
- Defined absolute accuracy of the data collected inside the tunnel



Map of the tunnel network
Source: www.trafikverket.se

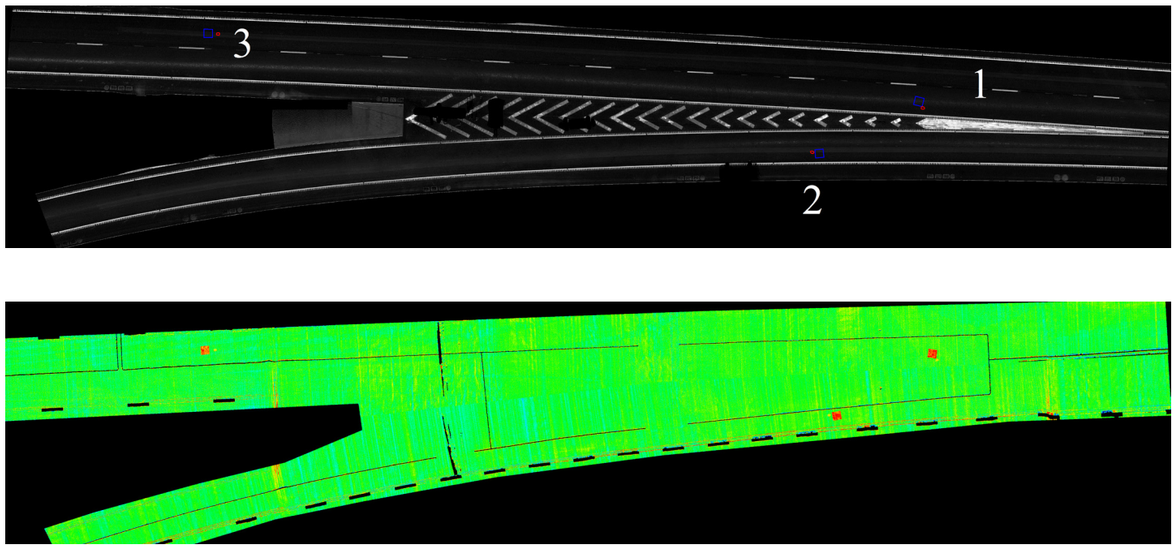
Methodology

Data capture for the R&D project was carried out between November 16th and 17th 2014. TerraTec utilized its existing Mobile Mapping system, mounted on a Volkswagen Caravelle. Due to the very high accuracy requirements Terratec decided to supplement the existing MMS-system with a Z+F PROFILER® 9012. This meant that the data capture could be carried out with two pulse scanners and one phase-shift scanner operating simultaneously.

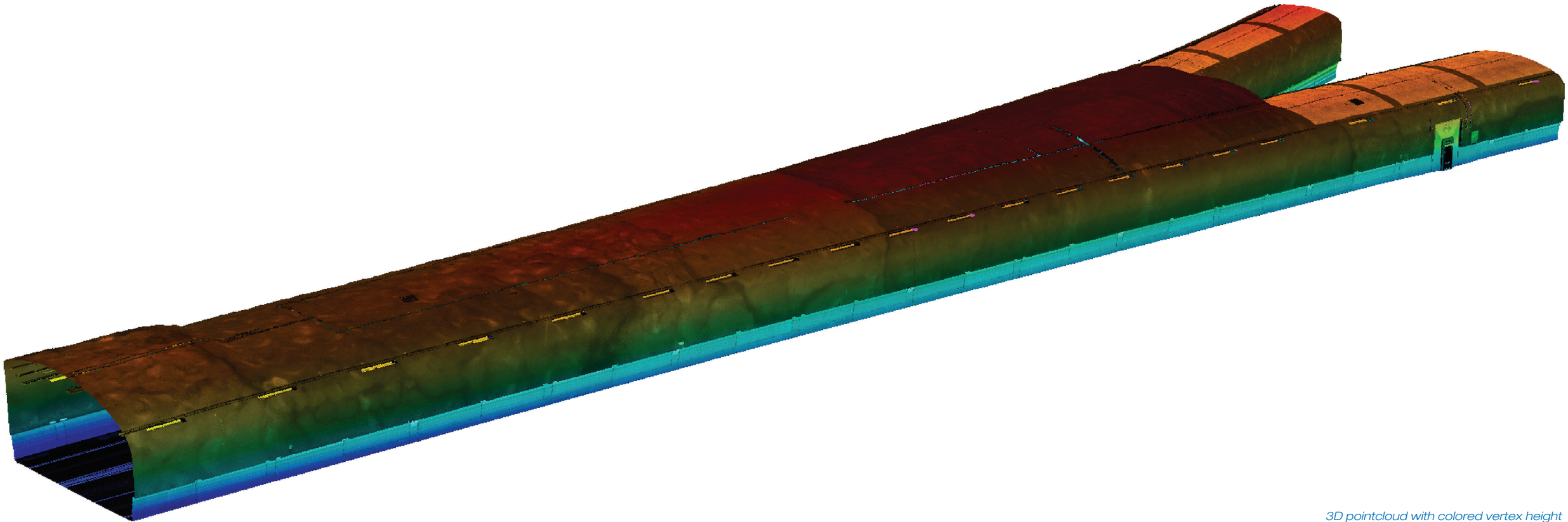
To provide the best possible absolute positioning of the vehicle, TerraTec incorporated the use of TerraPos™ (TerraTec), a GNSS/INS post processing software, not only offering a state-of-the-art Precise Point Positioning (PPP) solution for kinematic platforms, but also providing a tightly coupled INS solution where both control points and tie points measured in the point cloud may be incorporated along with inertial observations, GNSS (PPP and DGNSS), and odometer data, to deliver the strongest possible positioning solution.

The first data capture session was carried out in the newly constructed tunnel on November 16th. The resulting data was captured in in-situ conditions to be used as reference for accuracy verification and control. The second data capture was carried out the following day, on the same tunnel segment, and to simulate deformations, three one by one meter plates and three clay objects (Ø 30 cm) had been installed in different locations of the roof structure.

Based on the two consecutive data capture sessions, two LiDAR data sets were calculated, georeferenced and matched. The two resulting 3D models were compared against each other and the resulting difference could be visualized as a shaded surface model. Due to the very high relative accuracy provided by the Z+F PROFLER® 9012 and the use of TerraPos™ for post processing all six simulated deformations were detected.



Picture, top: Top view, intensity images of asphalt and showing placement of the 3 objects
Picture, bottom: Top view, difference model between day 1 and 2
Pictures: TerraTec



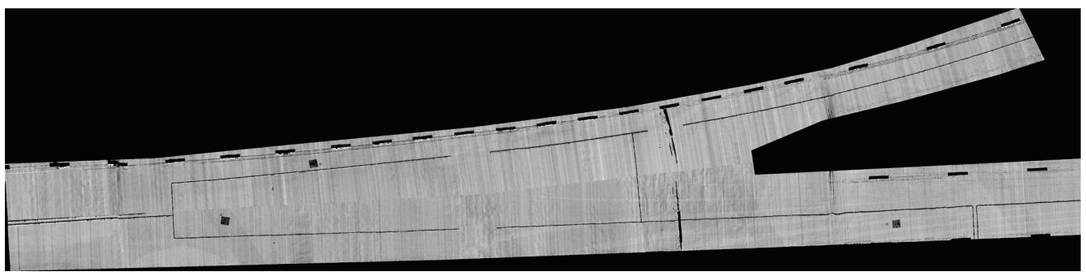
3D pointcloud with colored vertex height
Picture: TerraTec

Results

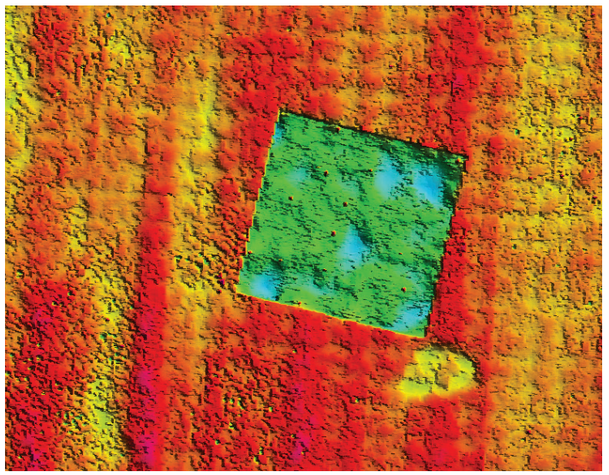
The Z+F PROFILER® 9012 proved to be the ideal solution for this project, due to its very high data sample rate. By providing high density laser data with extraordinary accuracy and limited data noise the simulated deformations, with a reference thickness down to 5 mm, could be detected and verified.

	Plate 1x1 m	Clay ø approx. 30 cm
Area 1	12 mm	5 mm
Area 2	14 mm	9 mm
Area 3	13 mm	7 mm

The project results validate that the Z+F PROFILER® 9012 is a highly suitable solution for documenting, mapping of technical installations and carrying out surface interference checks in tunnels.



Difference model (PAN)
Picture: TerraTec



Difference model (day 1 and 2) on one object (close view)
Picture: TerraTec

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