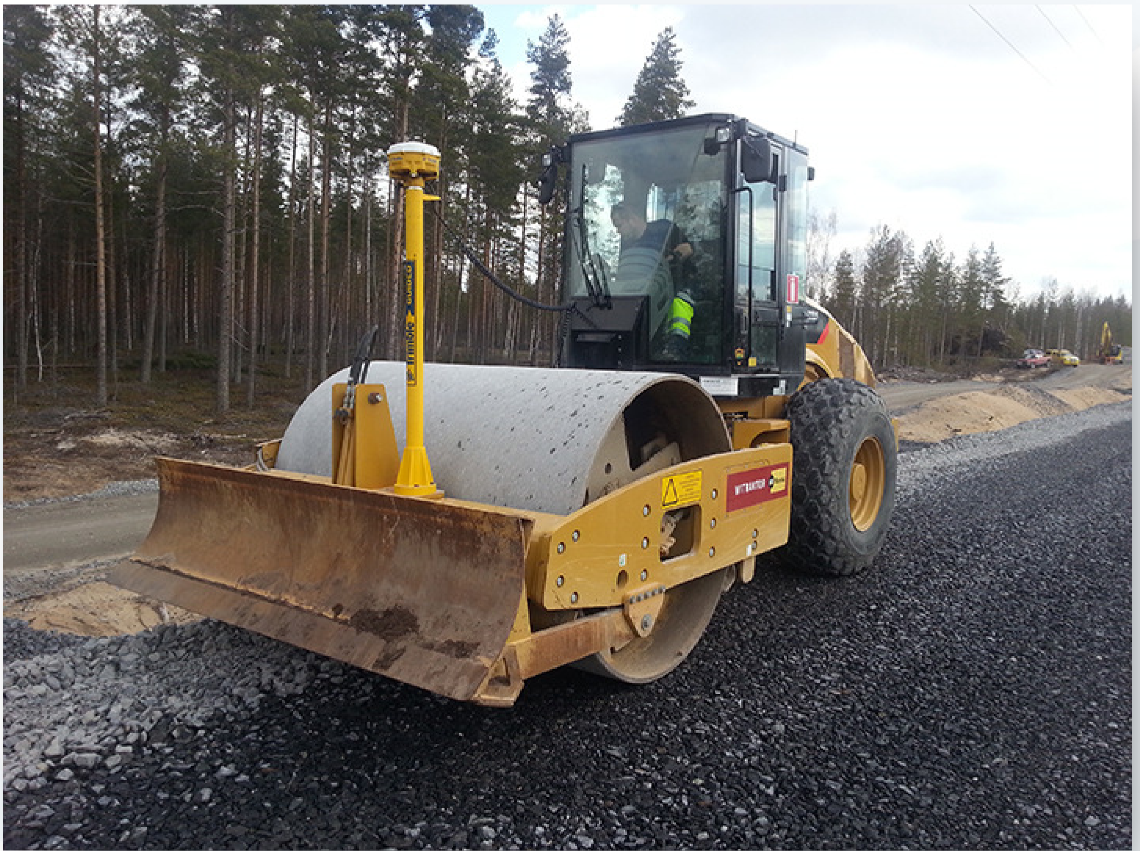
FINNISH RAILWAY BUILD 3D COMPACTION

When tasked with constructing a 60km railway line, Finnish contractor Destia embraced the challenge of creating a smooth surface with the help of 3D machine compaction technology – achieving accuracy with maximum efficiency.



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Contractor:

Destia is a Finnish infrastructure and construction service company. The company provides complete contracting services to build, maintain and design industrial and traffic environments, as well as complete living environments.

Business Challenge:

The Finnish Transport Agency hired Destia as the main contractor in a project to build a second line for the the Kokkola-Ylivieska railway in Finland. The project started in 2013 and consisted of constructing 60 kilometers of new railroad and building several new bridges. Destia was looking to use 3D modelling to improve efficiencies and accuracy on the project and turned to Trimble for help.

Solution:

Trimble® CCS900 Compaction Control System and VisonLink

Benefits:

• Completed a pilot project of 15 kilometers of the rail line in about 10 weeks
• Completed compaction work without needing a full-time professional surveyor
• Produced compaction documentation for completed work directly from the CCS900 machine control system
• Monitored project completion remotely and shared results using VisionLink

The Project:

Located in the province of Western Finland, the Kokkola–Ylivieska rail line spans 76.5 kilometers. The owner of the project, the Finnish Transport Agency, hired Destia as the main contractor to build a second Kokkola–Ylivieska track along this line. Destia was tasked with constructing 60 kilometers of new railroad and the construction of several new bridges. Valued at M€85, the project began in early 2013 and is scheduled to be completed in late 2016. The build was broken into three phases; the first phase involved building the Riippa-Eskola RU2 portion of the rail.

Mika Jaakkola, Technology Development Manager at Destia, explains that there are two significant challenges when compacting soil; first is the time consuming nature of the process, which makes it expensive. The second challenge is maintaining effective documentation throughout the project lifecycle. In fact, of all the stages of earthworks construction, compaction is the one which is nearly impossible to evaluate visually.

In addition, high accuracy is needed to achieve a smooth surface. To meet the project goals and maximize efficiencies, Destia adopted the Trimble CCS900 Compaction Control System and VisonLink software. Jaakkola explains that while 3D design and grading equipment is used frequently in Finland, 3D compaction control is a relatively new technology. To test the effectiveness of the compaction technology, Destia conducted pilot tests for a 15 kilometer portion of the rail: the Riippa-Eskola RU2 rail line.

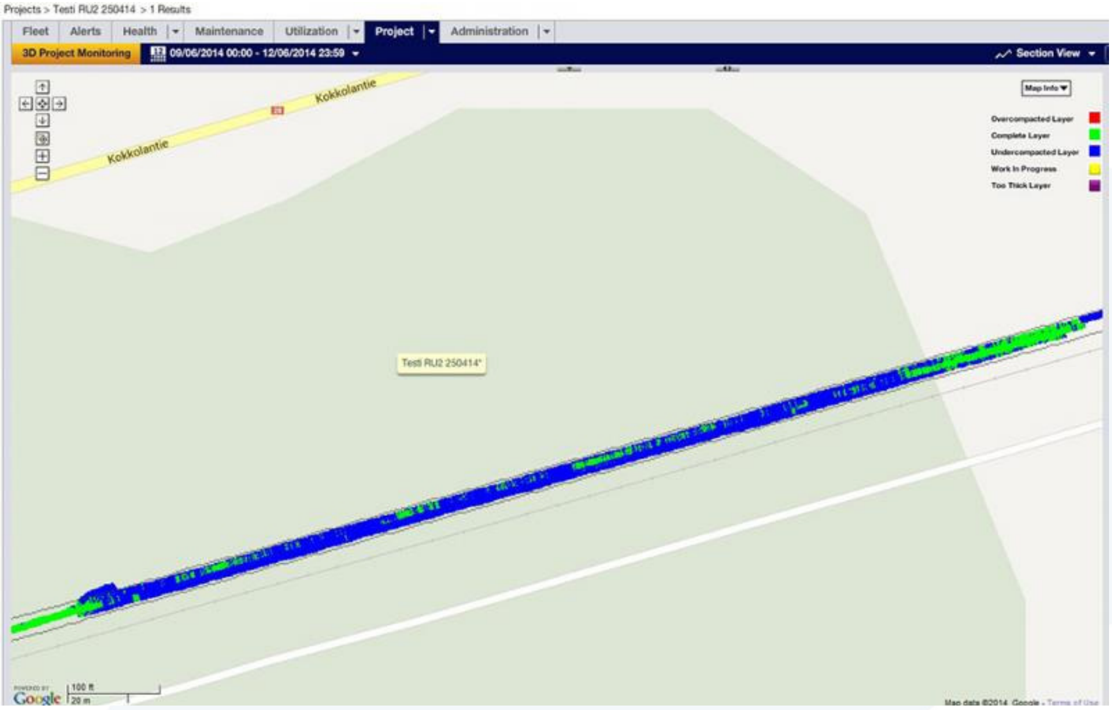
The System:

Trimble's compaction measurement system utilizes real time positioning information to display the number of machine passes on the map inside the machine control box for the operator. The system allows the machine operator to make more uniform and efficient passes and to capture and report compaction production data precisely. CCS900 measures accurately the location and height of the machine and the factors pertinent to compaction management.

The Destia team tested the performance of the compaction system measuring load-bearing capacity using spot measurements with plate load tests. The goal was to use 3D compaction for a majority of the effort and to replace – or decrease – the need for traditional compaction methods.

Operations:

The project scope included spreading the material and shaping the layers with a grader and compacting them with a roller. After that, the same machines were used for quality control measurements. Both had a 3D-machine control system with GNSS-positioning.



The actual verification of the machinery's applicability included the following steps:

1. Five control measurements for every cross section, with 10 meter spacing along the railroad with a total station
2. Three measurements from the same cross sections with the roller
3. Comparison of the total station measurements to the theoretical 3D-model
4. Comparison of the roller measurements to the theoretical 3D-model
5. Statistical analysis (average, minimum, maximum, dispersion) of the measured data

In order to measure the accuracy of the GNSS-positioned machine control systems, the team used statistical analysis of the measurement data. The implementation and control of the soil compactor with 3D-machine control system was closely monitored during the pilot project. It included checking the accuracy of the positioning of the machine control system with a total station twice for every two kilometers of every new layer.

During the compaction, the roller's operator would observe how the newly built surface differs from the theoretical surface. If the differences exceed the tolerance, the operator would report those findings to the supervisor. Once the compaction was done, two quality control measurements were done for predefined cross sections (20 meter spacing along the railroad) and measurements were done while the roller was stopped. The measurement data was transferred from the machine control system to the office wirelessly. Quality was assured by using a total station to measure points every 100 meters on straight areas and densely around curves of the track.

Jaakkola reports that he likes that compaction and production data can also be viewed using VisionLink – a software that integrates site productivity data, fleet and asset management, and materials and volumes movement information. The machine's position is continuously recorded and tracked to create distance and location, exact load, and soil compaction depths. Machine data is sent wirelessly from the machine to the office and aggregated by VisionLink with machine utilization and performance information. Compaction and volume information can be viewed showing near-real time progress.

Results:

Jaakkola explains that the compaction system consistently delivered accurate compaction results, meeting tolerances and performing better than expected. By using the Trimble CCS900 system on the Finland railway build, the was able to avoid excessive rolling. Also, the time it took to perform the contract work was significantly shortened. The accuracy results are outlined below:

Accuracy of GNSS-positioned grader results are shown below: (compared to the theoretical model):
• Station 576-577 km: **98%** of the measurements within ± 20 millimeters
• Station 586-590 km: **99%** of the measurements within ± 20 millimeters

Accuracy of GNSS-positioned compactor: (compared to the theoretical model):
• Station 576-577 km: **85%** of the measurements within ± 20 millimeters
• Station 586-590 km: **90%** of the measurements within ± 20 millimeters

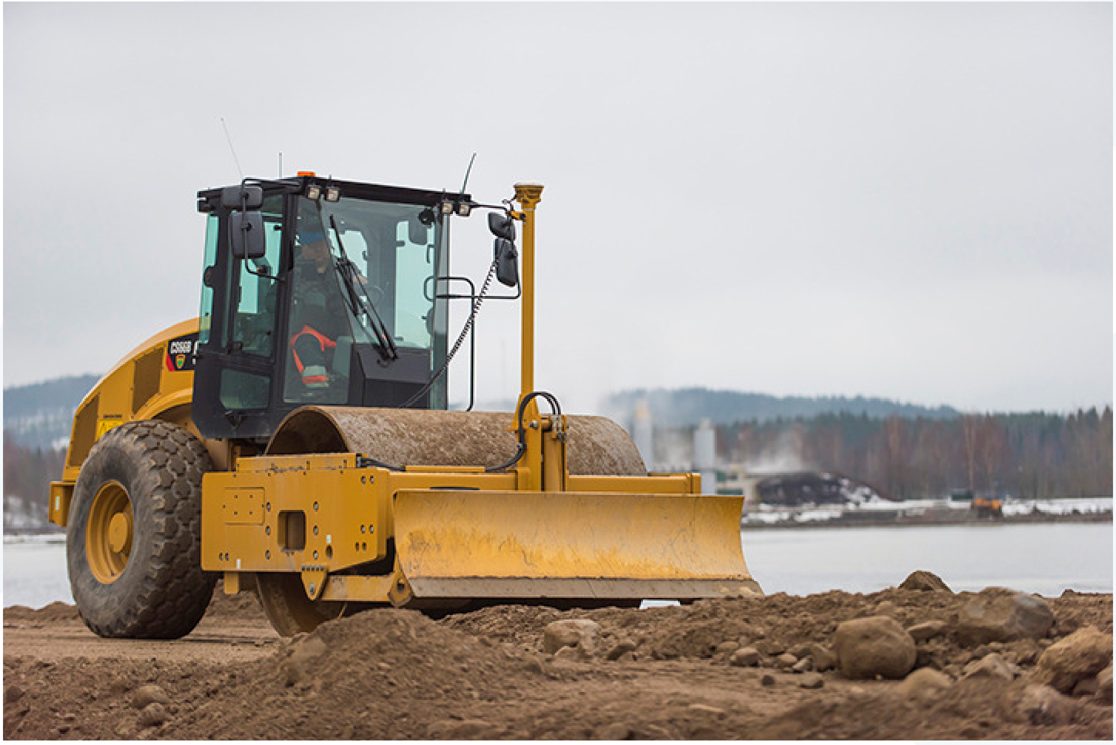
Accuracy of GNSS-positioned compactor: (compared to total station):
• Station 576-577 km: **92%** of the measurements within ± 20 mm,
• Station 586-590 km: **87%** of the measurements within ± 20 mm.

The CCS900 system improves the speed and accuracy of compacting material because it tracks compaction passes in real time and provides colour mapping on the in-cab display to ensure voids are eliminated and layers are compacted to their target density more efficiently. Compaction documentation is generated and shown simultaneously on the machine control display inside the compactor.

The compaction system's in-cab display shows a clear, color-coded chart that represents completed and unfinished work in different colours. The machine control has accurate geographic information, which guides the operator of the machine to complete unfinished work.

"It is significant that the machine measures the passes and changes in compaction value throughout the width of the roller drum," said Jaakkola. "The system allows the operator and the client to make sure that the entire work site is compacted according to plan. And, since the CCS900 provides compaction and guidance to the 3D design data in the cab of the machine, it is possible for the operator to ensure design grade is being maintained during and post-compaction."

The Trimble CCS900 system measures the relative stiffness of the material (compaction value). The compaction monitoring between different passes, which it enables, introduces a whole new angle to ensure compaction is being achieved; essentially, not just in the test-spot areas but across the project.



"We like that the contractor can demonstrate to the client the quantity of actual executed passes in the form of data placed on a map," said Jaakkola. "During the pilot and verification period, it was discovered that the relative compaction data received from the CCS900-enabled roller corresponded to the results of the plate load test. Also, the certainty it gives us that nothing was left undone is an essential feature of this system. Through this system, the client can monitor the progress of the work as it's being completed."

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