GEOSPATIAL WORLD FORUM

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BIM Based Paving by LiDAR

An Example Case from Finland

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By courtesy of Mr. Markku Pienimäki

from Finnmap Infra

Terra solid

POINT CLOUD INTELLIGENCE

About Terrasolid

- Founded in 1989, based in Finland
- 20+ years of software development for infra design
- 15+ years of point cloud software development
- Customers in 50+ countries
- Global market leader in processing airborne and mobile laser scanned point clouds *(TerraScan, TerraModeler..)*
- Customers: national land surveys, mapping operators, engineering companies, municipalities..
- Final products: ground height models, orthophotos, 3D-city models.
- Solutions for mapping and cadasters, infra design, transmission line surveying, forest inventory, housin and environment monitoring, flooding prevention

Terra solid
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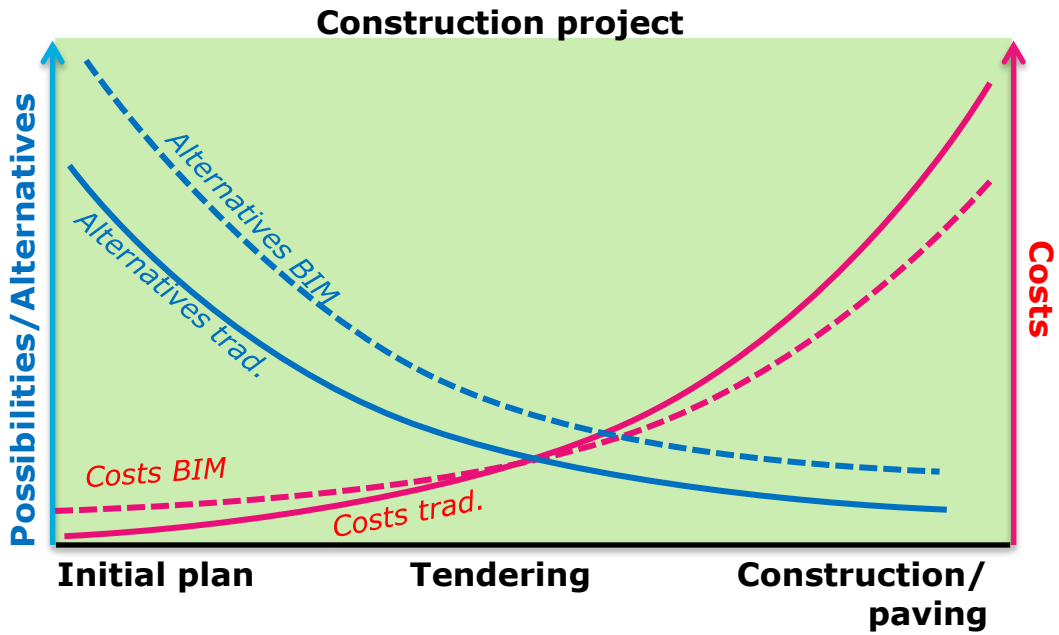
Determination of paving costs

The traditional costs fixing dilemma in construction process:

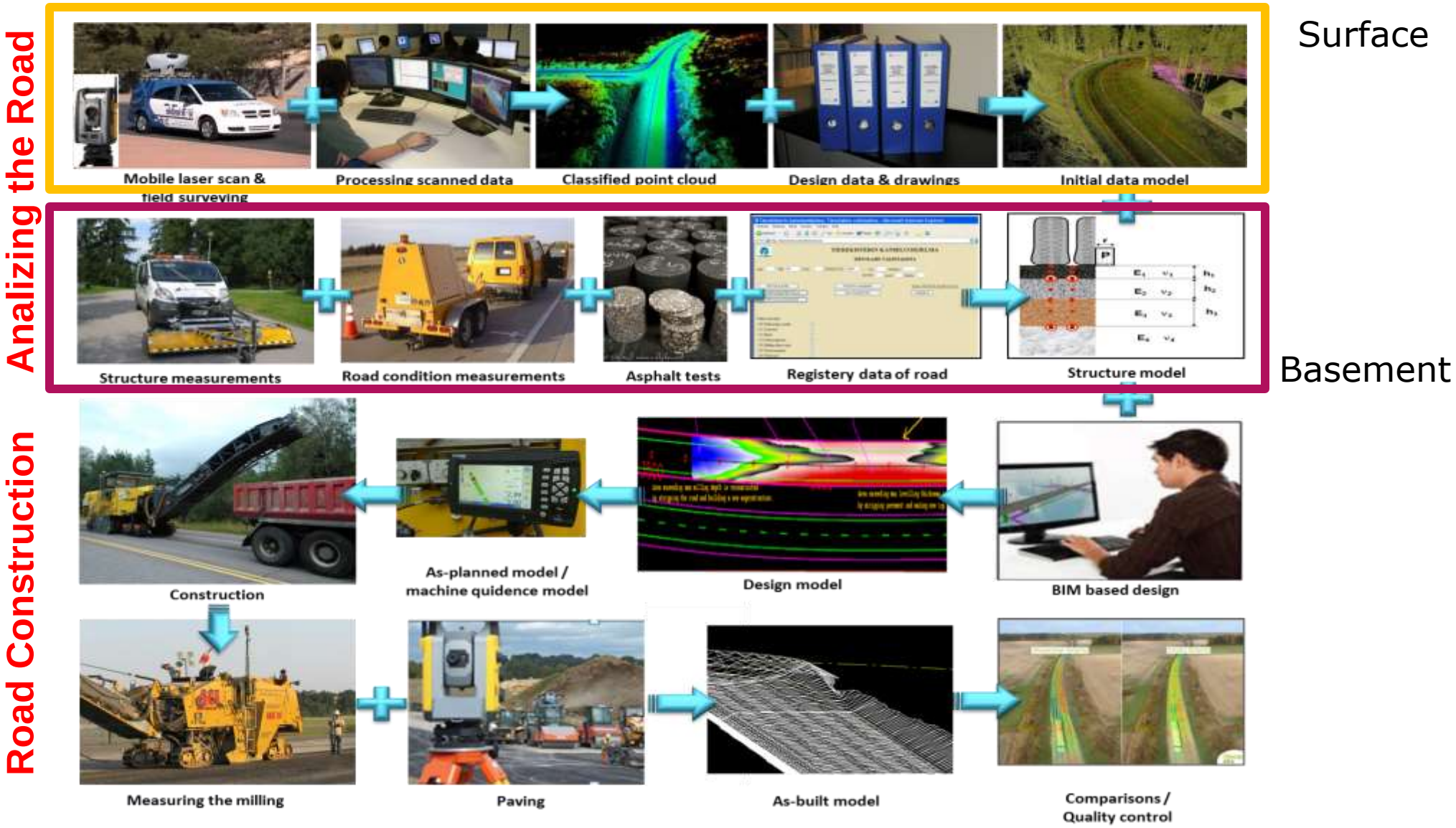
- Possibilities to affect costs and results are mainly fixed at early phases in a project.
- Costs (for changes) are formed during construction.



Costs in paving project:

- Paving is essential in road maintenance.
- Paving is expensive action in maintenance
- Traditionally paving is rather poorly designed.
- BIM is good tool to make changes in traditional process

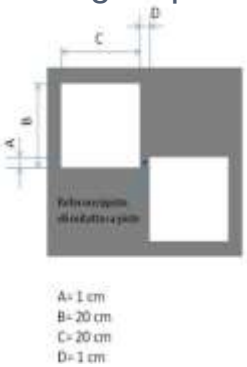
"BIM-based paving" method



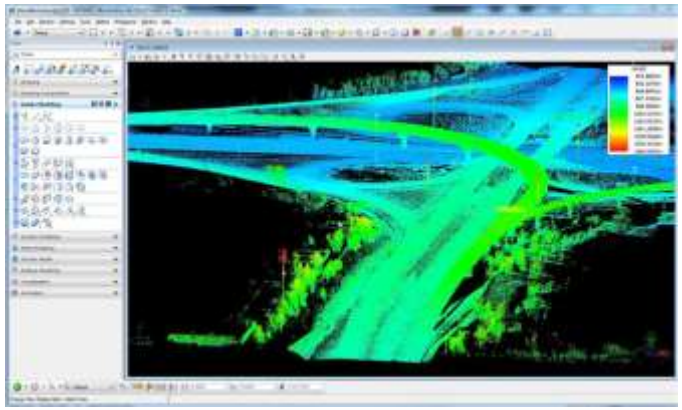
Mobile laser scanning

Measurement

- Mobile laser scanning (land mobile mapping)
- Several devices and types (e.g. Trimble, Riegl, Lynx…)
- Absolute and relative methods
  - absolute (global) – global coordinate reference signal points
    → automated machine control system
  - relative – in relation to the existing surface
    → "assisted" machine control system



Ajokerta 1. Mismatches:
Average 3d mismatch: 0.00285 m
Average xy mismatch: 0.00016 m
Average z mismatch: 0.00285 m
Ajokerta 2. Mismatches:
Average 3d mismatch: 0.00323 m
Average xy mismatch: 0.00066 m
Average z mismatch: 0.00323 m



Processing the mobile scanning data

- Raw point cloud after measurement
- Classifying the points
- Matching several measurements
- Searching and digitalizing road lines

➔ Road surface model

Road basement structure conditions

Measurements

GPR, FWD / TSD

Common coordinate system for all data

- global is best but well-defined and clearly marked local system is sufficient
- To check measurement results some core samples are needed
- Old, design drawings and historical information of road maintenance tasks would be v

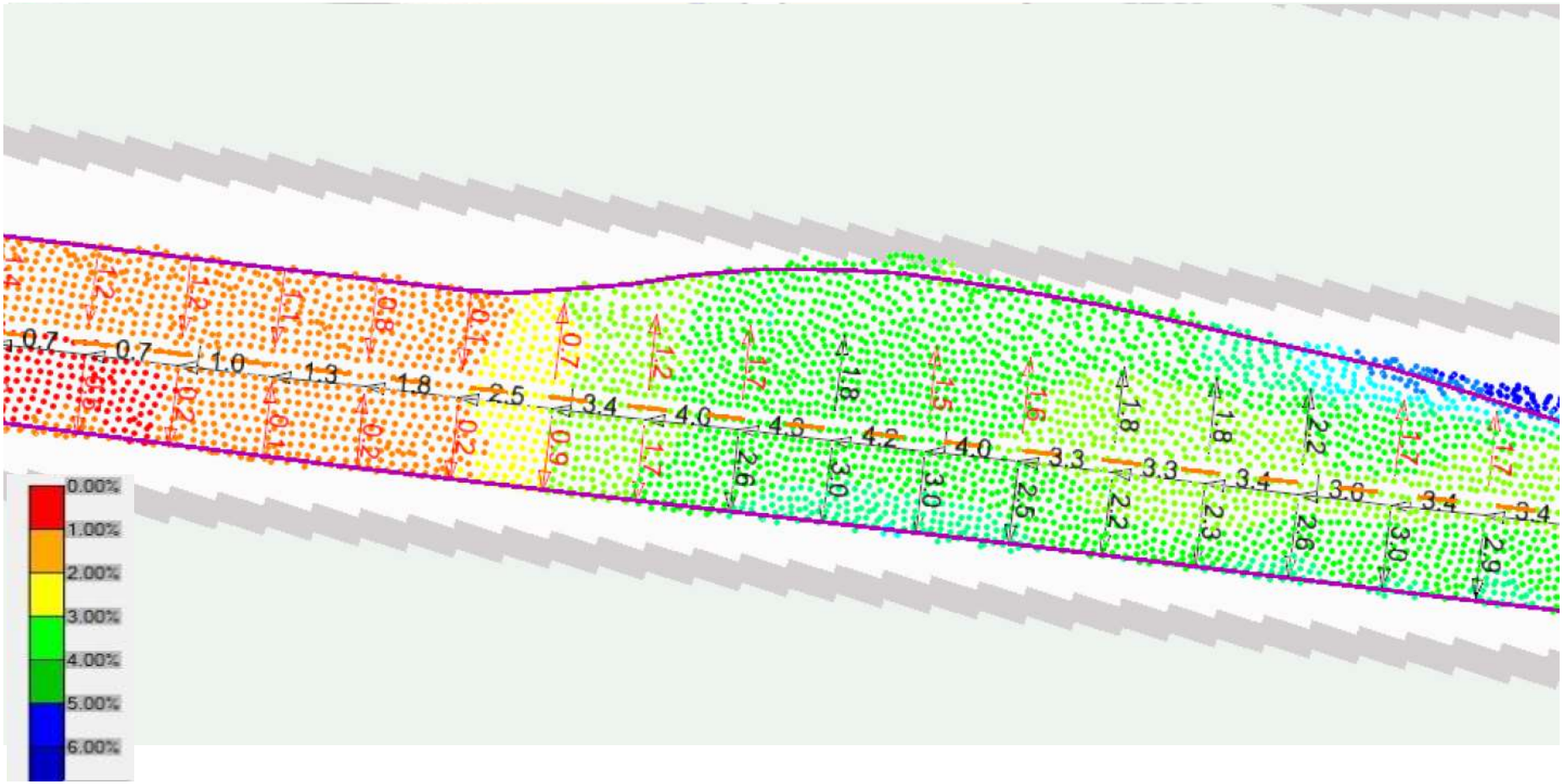
	A	B	C	D	E
1	Kt 55 Päällystepaksuudet 1 m:n keskiarvo				
2					
3	AET	LET	Oikea	Keskilinja	Vasen
538	2018	2019	298	256	272
539	2019	2020	300	272	272
540	2020	2021	298	276	266
541	2021	2022	295	289	249
542	2022	2023	293	316	251
543	2023	2024	296	336	274
544	2024	2025	305	345	310
545	2025	2026	321	370	344
546	2026	2027	339	390	359

Handling the results

- The "bottom surface" of asphalt layers are designed/mo
some margin of certainty
- As a result there are surface models of asphalt layers (a
structure)
- Layer surface models are used as initial data for BIM mo
check the possibilities to realize the BIM designed actior

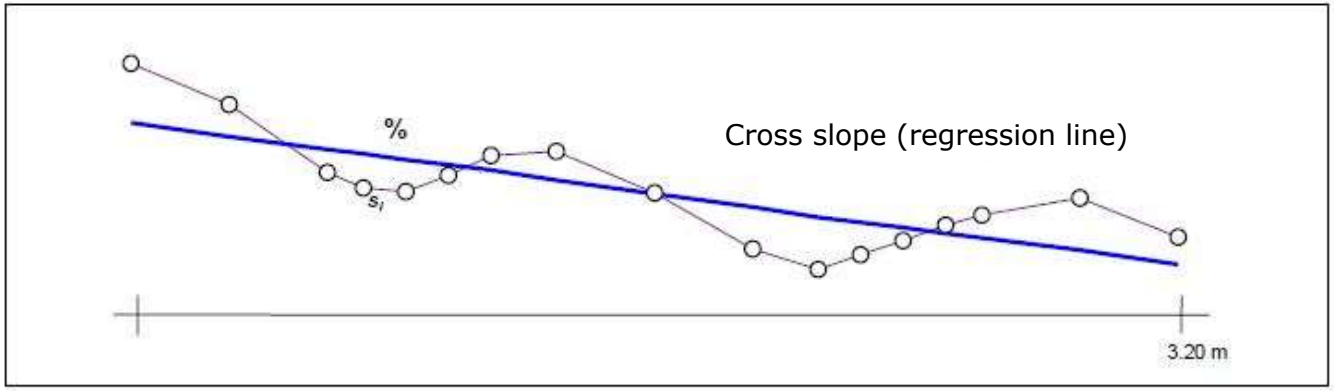
Analizing the surface conditions

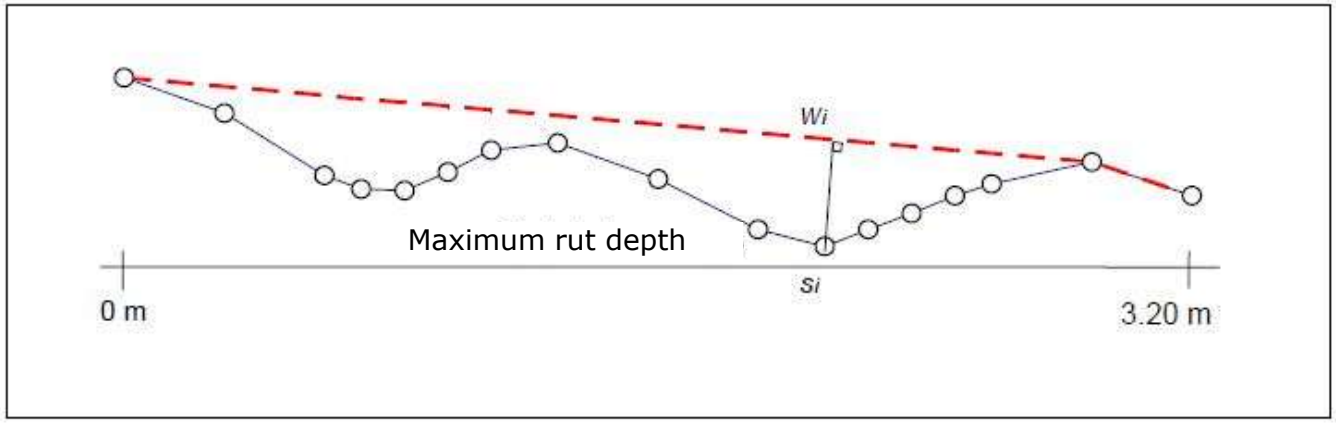
Graphical views



Analyzing the prevailing condition

Calculating the critical values in road section





BIM-based design

Software

- Bentley InRoads, Microstatio
- Terrasolid TerraScan

Process

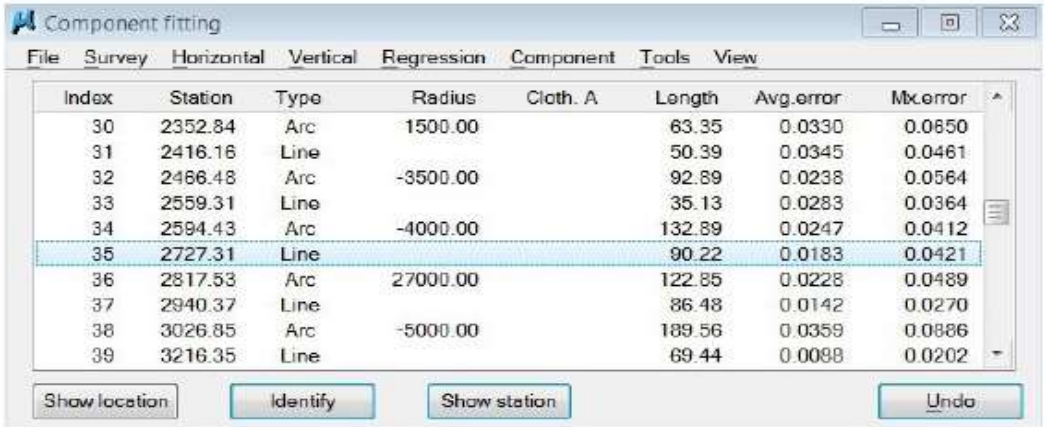
- Digitalizing horizontal geometry (border lines, middle line)
- Designing vertical geometry (according InRoads / Excel regression analysis)
- Designing cross slopes
- Combining geometry designs and iterating the solution

TerraScan Component Fitting

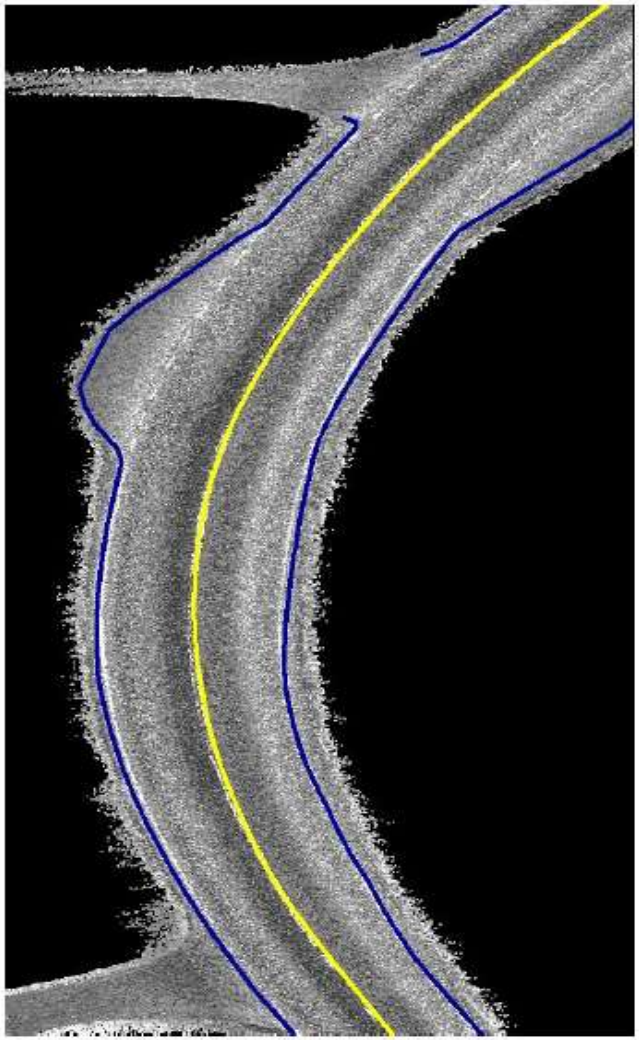
From a survey vector

- Road features (e.g. center line)
- Rails
- Vehicle trajectory
- ....

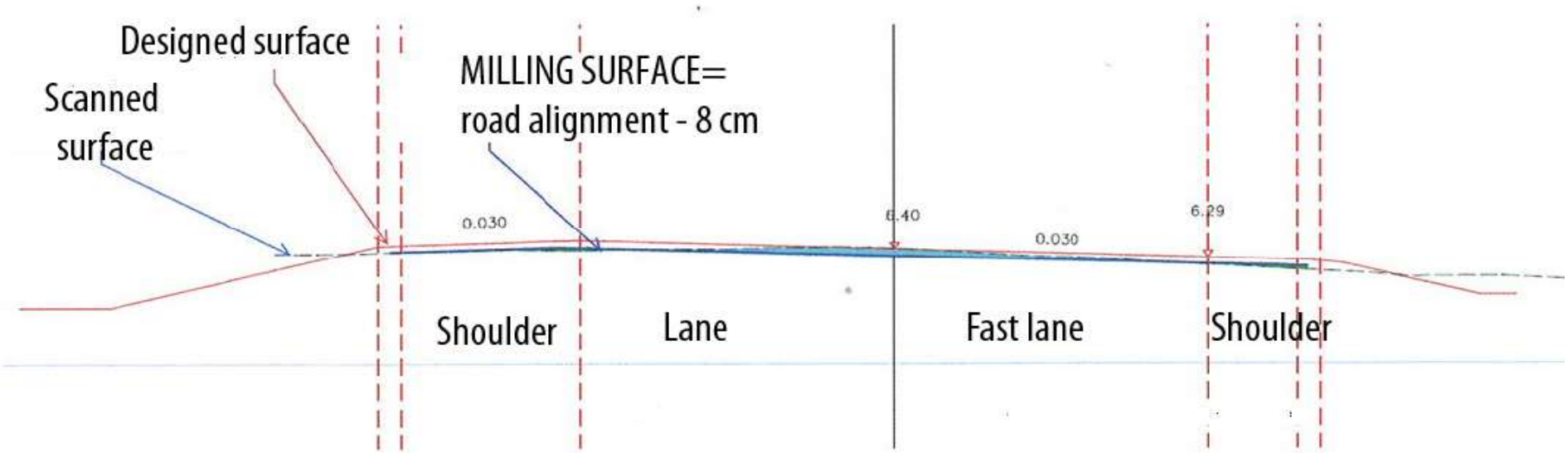
to geometry components for design software e.g. with LandXML



Index	Station	Type	Radius	Cloth. A	Length	Avg.error	Mx.error
30	2352.84	Arc	1500.00		63.35	0.0330	0.0650
31	2416.16	Line			50.39	0.0345	0.0461
32	2466.48	Arc	-3500.00		92.89	0.0238	0.0564
33	2559.31	Line			35.13	0.0283	0.0364
34	2594.43	Arc	-4000.00		132.89	0.0247	0.0412
35	2727.31	Line			90.22	0.0183	0.0421
36	2817.53	Arc	27000.00		122.85	0.0228	0.0489
37	2940.37	Line			86.48	0.0142	0.0270
38	3026.85	Arc	-5000.00		189.56	0.0359	0.0886
39	3216.35	Line			69.44	0.0088	0.0202



Example Design *(Sito Engineering / Trimble)*



- VT6 road improvement – length 22 km
- Starting point – valid surface
- Each road component were adjusted one by one to get an optimised solution (mill and fill)
- Follow standards of road geometry
- Deliveries to construction phase: breaklines, visualised 3D models, cross sections

Volume Calculation

View 1 - Top, Default

Compute Quantity

Calculation

Upper surface: Laser points 27

Lower surface: Milling 2

Limit: None

Limit surface: Close Centerline

Inside fence

Step: 0.500

Surf cut limit: 0.000

Results

Display: No display

Draw as: Vertical lines

Done:	100	%
Cubic cut:	2.4	m^3
Fill:	15.3	m^3
Surf.cut area:	0.0	m^2
Surf.cut volume:	0.0	m^3
Calculated area:	606.3	m^2

Calculate | Reporting... | Print

TerraModeler - Surfaces

File Edit Utility Tools View Help

Name	Points	Elevations	Status
Milling	25739	+58.580 .. +75.850	Modified
Close Centerline	10862	+59.336 .. +74.587	Saved

View 3, Default

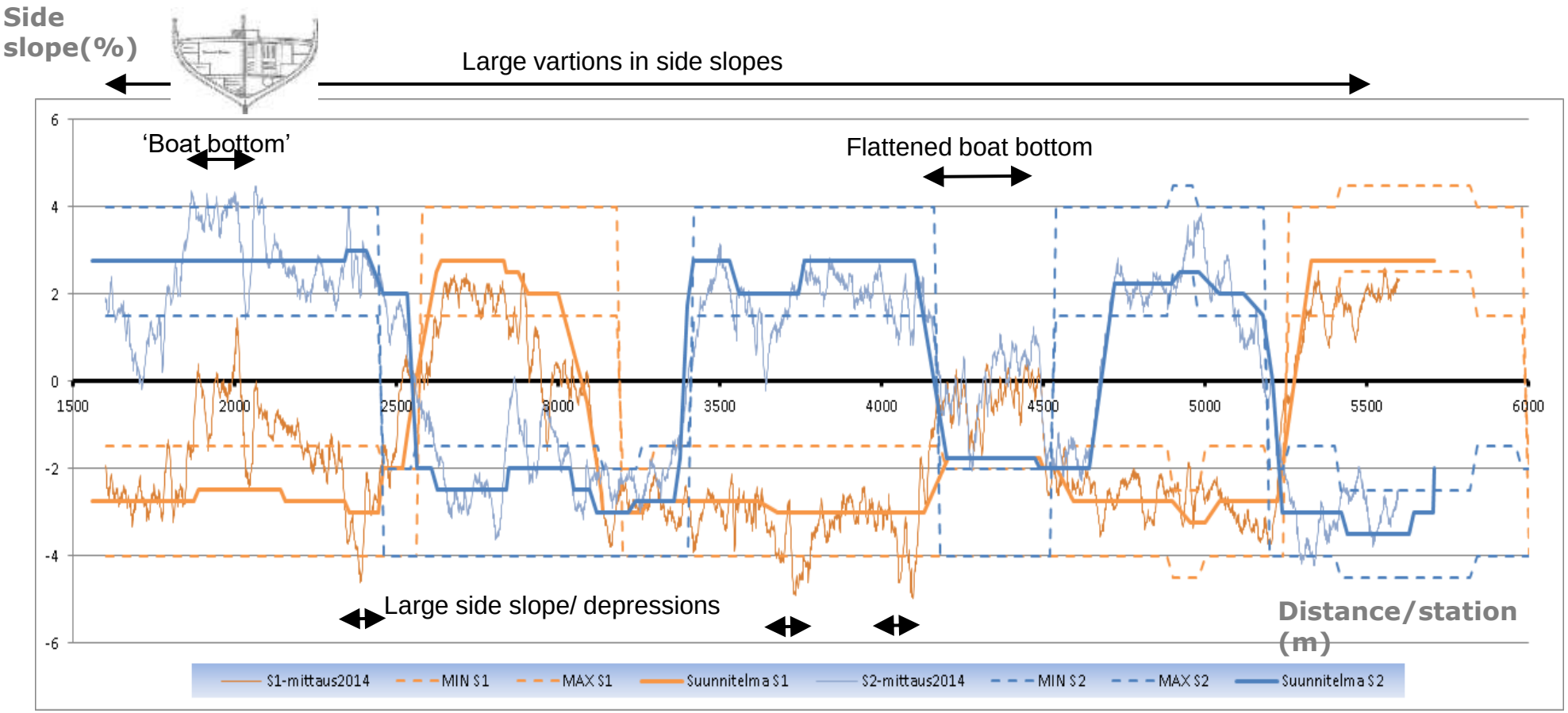
Output

File

```
Quantity report by region
Fill & mill vt 13
Upper surface: Laser points
Lower surface: Milling
```

Region	Fill volume	Cut volume	Area
0-10	2.9	0.2	102.3
10-20	2.7	0.7	101.3
20-30	3.6	0.5	101.3
30-40	2.9	0.6	100.3
40-50	2.2	0.3	101.0
50-60	1.0	0.2	100.3
Total	15.3	2.4	606.3

Surface sloping in cross sections



Right side

S1 MLS survey

After standard

As designed

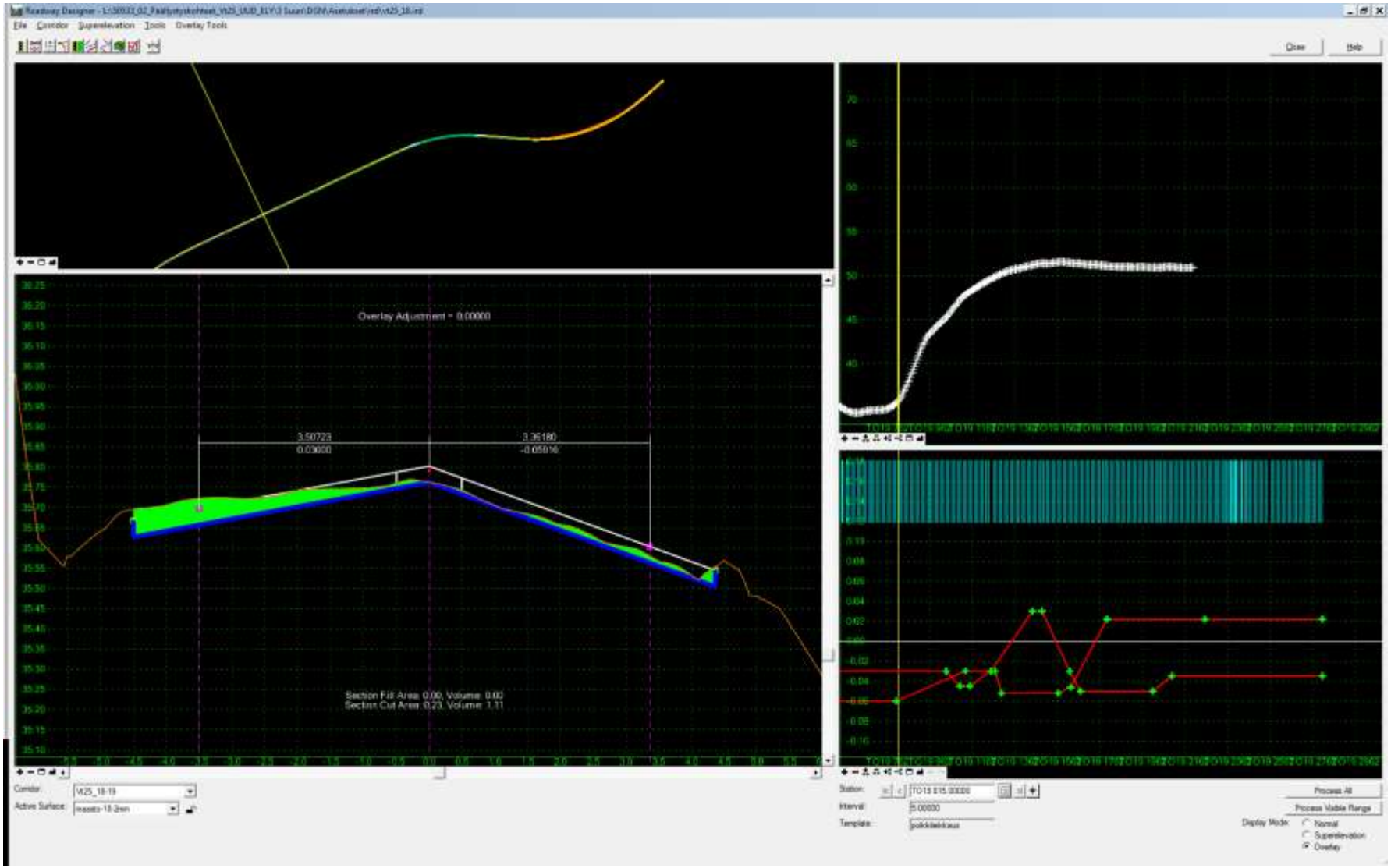
Left side

S2 MLS survey

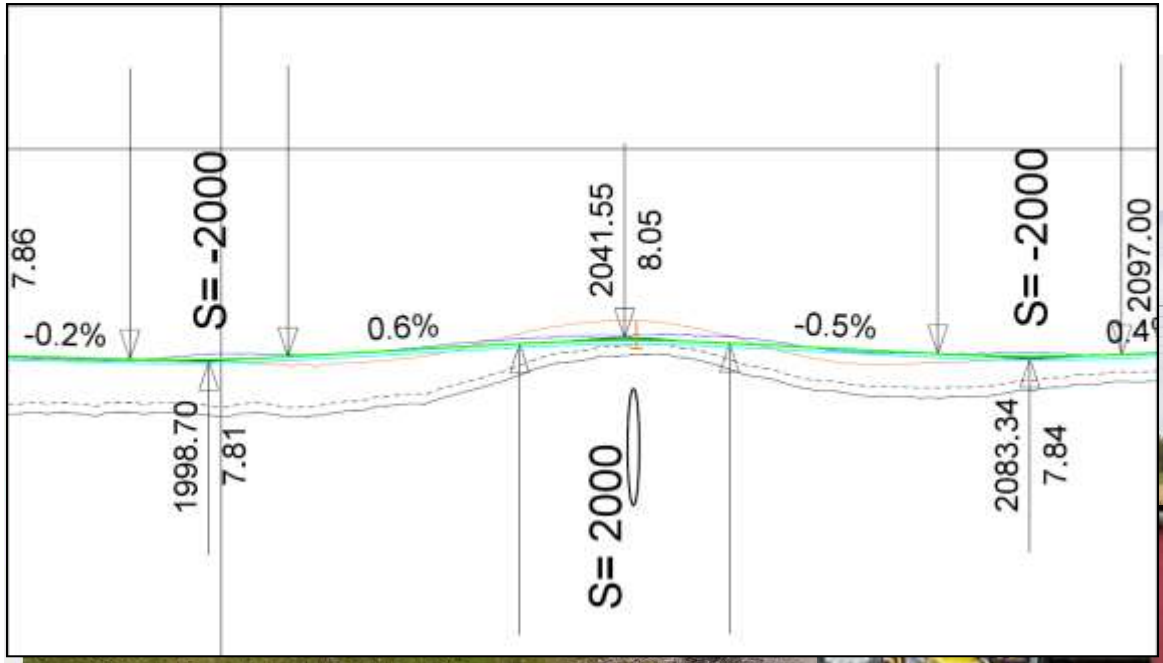
After standard

As designed

Monitoring the design

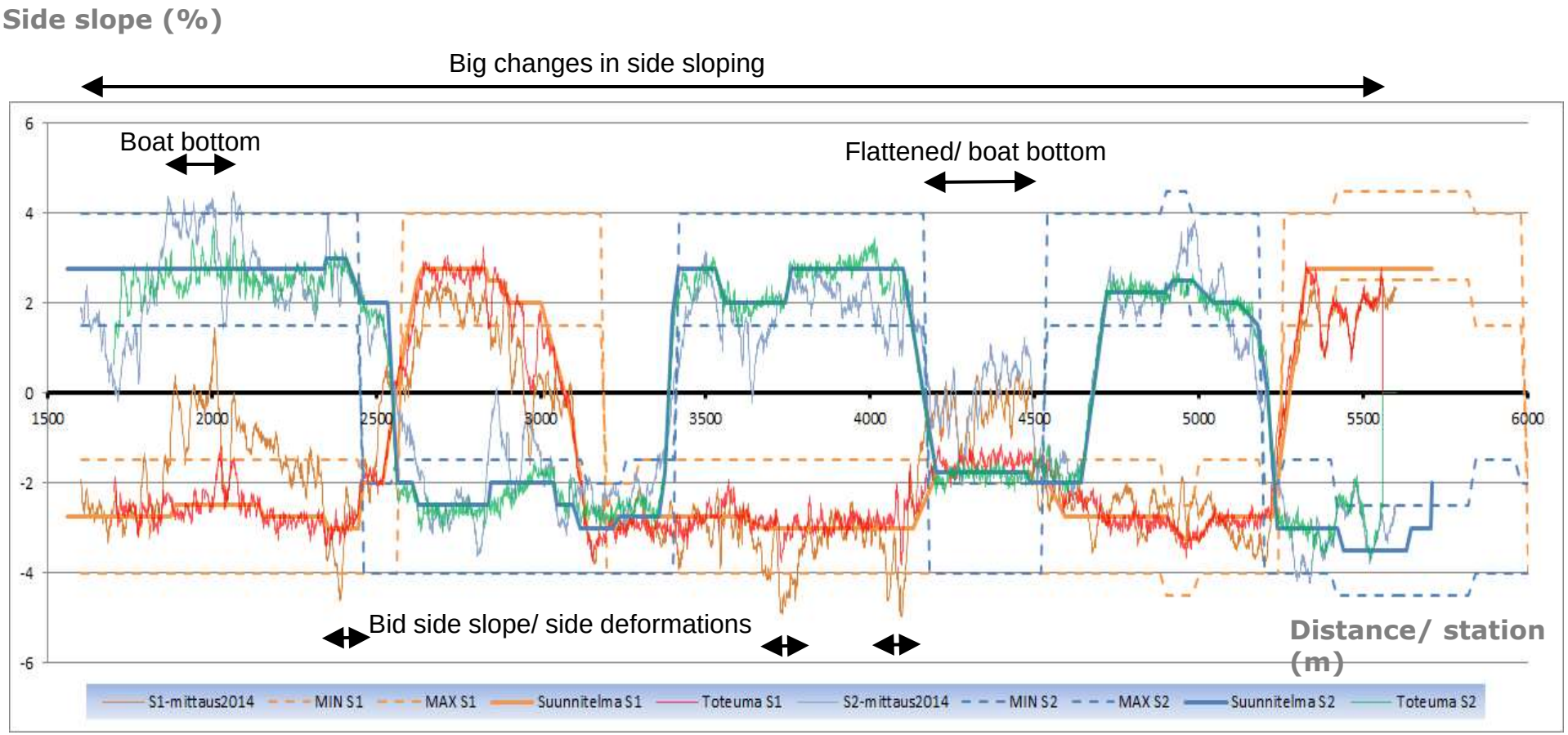


Asphalt works



Lähde: Manu Marttinen, NCC Roads

Work monitoring by comparing original versus 'as-build' / side slope



The renovation improved the quality and the safety of the road remarkable

Many thanks for Your interest

Terra solid
POINT CLOUD INTELLIGENCE

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