RAILPROF - BACKGROUND & WELD GEOMETRY STANDARDS

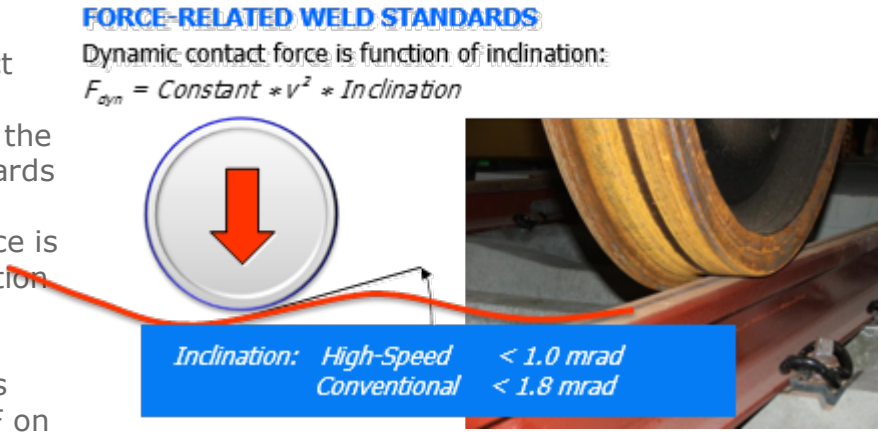
With the RAILPROF device the vertical and lateral rail geometry is measured. The measurement is controlled by a smartphone (Windows Phone), which communicates with the RAILPROF via Bluetooth. The measurement data are transferred automatically to the smartphone, which calculates the QI (Quality Index), a measure for the vertical force, directly related to the first derivative of the recorded vertical rail geometry. The admissible QI in relation to the line speed is presented in the table above, which values are presently the official standards used by ProRail in The Netherlands and the tram and metro companies in Holland.

Standards vertical rail geometry	
Speed [km/h]	**Inclination [mrad]**
250 < V ≤ 300	≤ 1.0
200 < V ≤ 250	≤ 1.1
180 < V ≤ 200	≤ 1.3
160 < V ≤ 180	≤ 1.4
140 < V ≤ 160	≤ 1.6
120 < V ≤ 140	≤ 1.8
100 < V ≤ 120	≤ 2.0
90 < V ≤ 100	≤ 2.2
80 < V ≤ 90	≤ 2.3
70 < V ≤ 80	≤ 2.4
60 < V ≤ 70	≤ 2.6
50 < V ≤ 60	≤ 2.8
40 < V ≤ 50	≤ 3.0
V ≤ 40	≤ 3.2
Standards lateral rail geometry	
Speed [km/h]	**Versine p [mm]**
80 < V ≤ 300	-0.5 ≤ p ≤ 0.5
40 < V ≤ 80	-0.7 ≤ p ≤ 0.7
V ≤ 40	-1.0 ≤ p ≤ 1.0

BACKGROUND INFORMATION

Force relation.

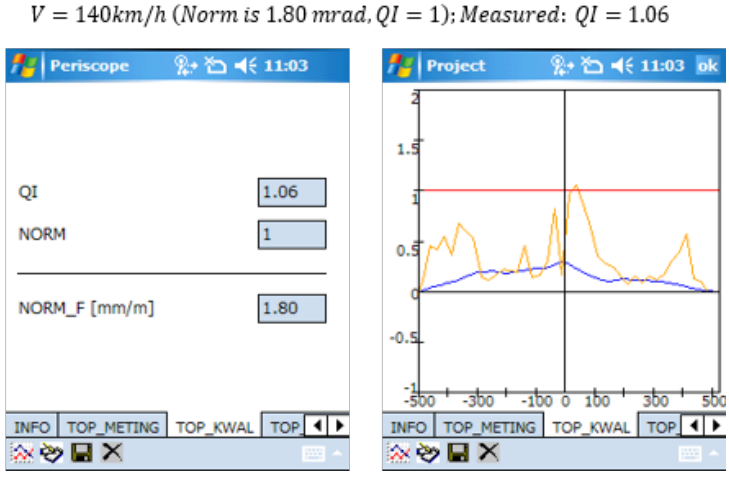
The vertical wheel rail contact force is approximately proportional to the square of the speed. In this way the standards are speed dependent. Furthermore, the contact force is linearly related to the inclination (first derivative dy/dx of the geometry). The inclination is determined from the versines measured with the RAILPROF on a base of 1 m, sampled at an interval of 5 mm.



During data processing the samples are averaged (low-pass filtered) via a moving window of 5 samples. This means that the shortest wavelength in the resulting signal is 25 mm. The calculated QI values are based on this signal. See PDA screen below.

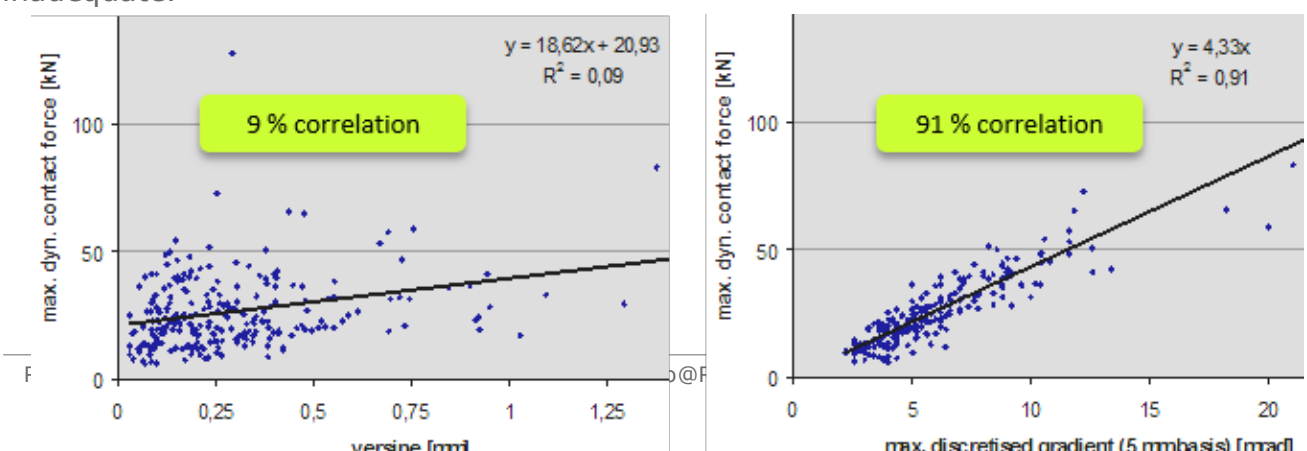
Quality Index (QI) on Smartphone screen

Blue line represents the vertical geometry, orange line is QI. The person doing the finish grinding can immediately see where the QI is exceeding the norm (by definition QI = 1) - in this case 6 % - and which spots should be ground. In the figure it is clearly seen that the slope right of the middle is too large and so the center part should be ground to decrease the inclination and thus the maximum QI.



Gradient rather than versine.

From the right-hand graphs it is obvious that the contact force does not correlate (9 %) with the versine (geometry), whereas the inclination (QI) very well correlates (91 %) with the force. This means, amongst others, that a steel straightedge, as still in use on a wide scale, is absolutely inadequate.



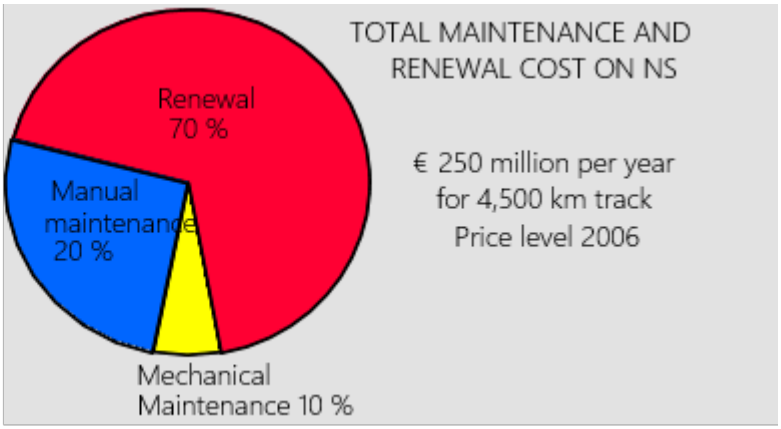
Cost savings.

According to recent ProRail figures the claimed track maintenance cost reductions of 10 - 20 % are too conservative. Present practice reveals that these figures are more in the order of 20 - 40 %!

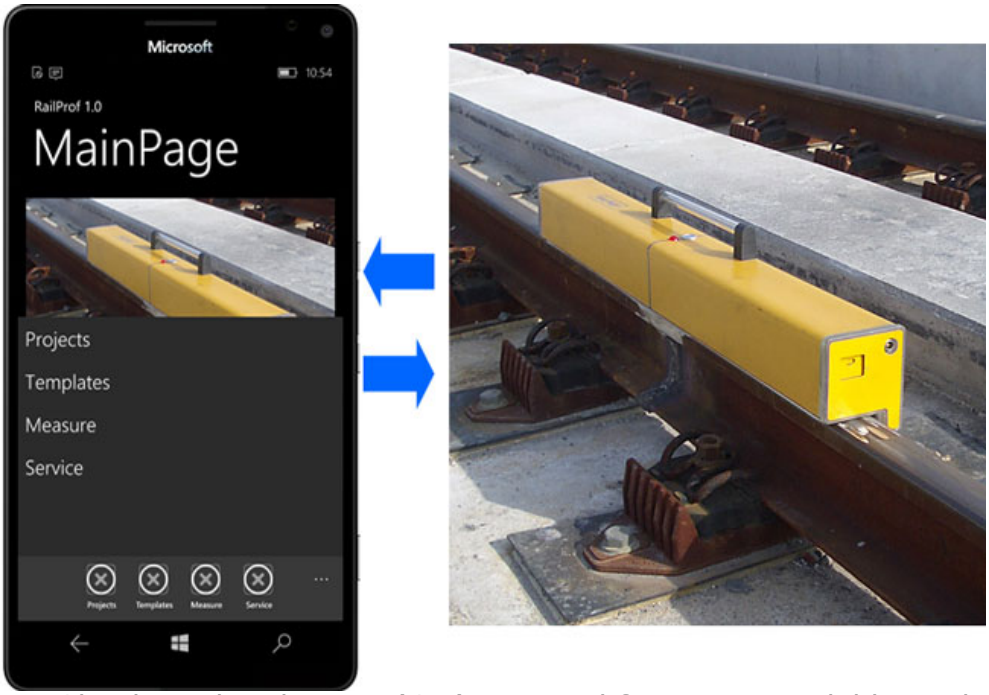
Expected cost savings

Due to impact load reduction at welds:

- 20 – 40 % of annual maintenance budget;
- ProRail budget in The Netherlands: ~ € 250 mio for 4,500 single track;
- Savings: € 50 – 100 mio total, or € 10 – 20,000 per km single track.



RAILPROF - MEASUREMENT OF RAIL WELDS AND CORRUGATION



For Glued Insulated Joints (GIJ) a special feature is available to clip out the part between the rail ends at the joint. The eddy
current transducer sees this area as a large deviation. When the correction is set to 'Yes', the central 10 mm of the
measurement is removed and replaced by values linearly interpolated between the measured values at both ends.
Templates can be created for each measuring job via the Templates menu. The values of the active template are used when the measuring process is started. After tapping the command measure the values of the template are shown and can be altered.
If the weld is measured again or a new weld is measured the previous values are kept..
Freight information:
Total weight of flight case, RAILPROF, PDA and carton protection box: ±19 kg;
Dimensions: approximately 137 x 43 x 17.5 cm.
Measuring length: 1,000 mm in accordance with the EN standards for weld geometry; sampling interval 5 mm. Transducers: eddy current.
Both vertical and lateral rail geometry are measured.

MAIN CHARACTERISTICS

The present RAILPROF configuration is controlled by a Windows Phone running on Windows 10.

On the basis of research at TU Delft, in cooperation with the Dutch Infra Provider ProRail, force-based standards have been developed. The standards are expressed in terms of a quality index QI, which is directly related to the first derivative of the measured vertical rail geometry.

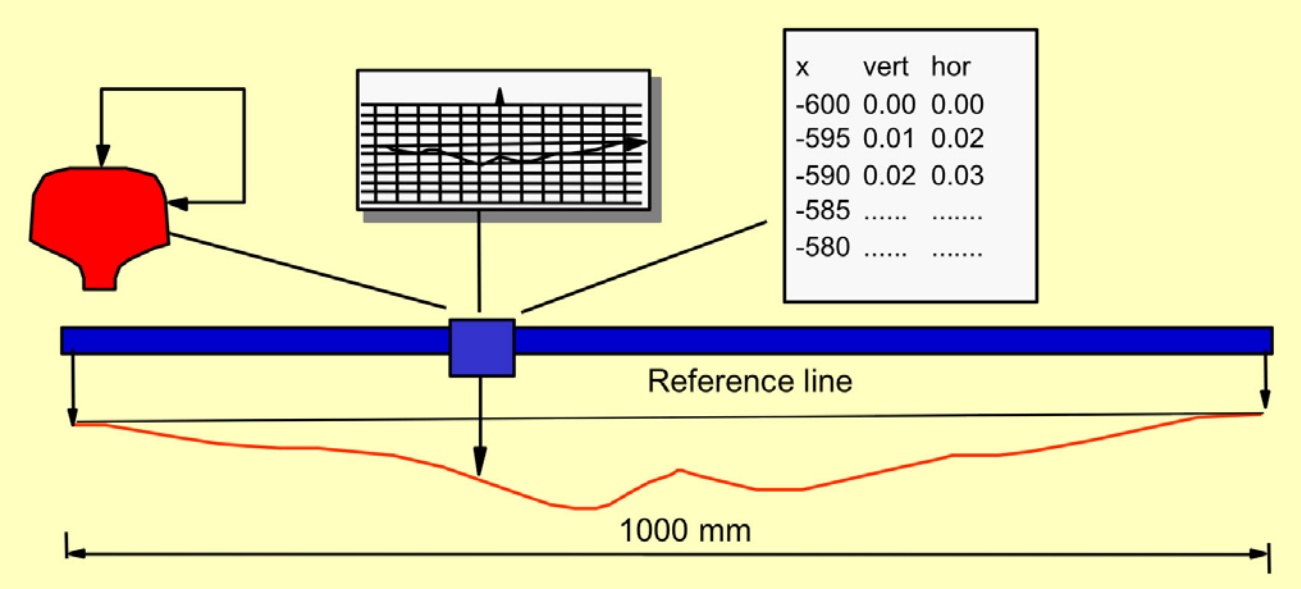
Vertical and lateral geometry are measured simultaneously. The measuring results are automatically sent to the Smartphone, which carries out all the calculations like filtering and computing the first derivative of the vertical geometry, in accordance with the force-based weld standards of ProRail.

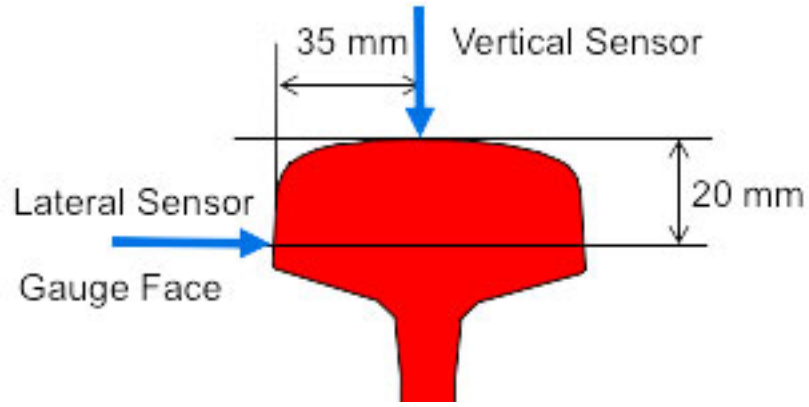
Due to the additional speed classes in the lower speed range the standards are also applicable to metro and tram networks. The RAILPROF will be kept awake as long as the operator is working in the measuring menu on the Smartphone, whereas otherwise the RAILPROF is switches off after 10 minutes of not being used.

MEASURING PRINCIPLE

Measuring length: 1,000 mm in accordance with the EN standards for weld geometry; sampling interval 5 mm. Transducers: eddy current. Both vertical and lateral rail geometry are measured.

- Measuring length: 1,000 mm in accordance with the EN standards for weld geometry;
- Sampling interval 5 mm.
- Transducers: eddy current.
- Both vertical and lateral rail geometry are measured.
- The vertical sensor is positioned 35 mm from the gauge face.
- The lateral sensor is measuring the gauge face at 20 mm below the top of the rail.



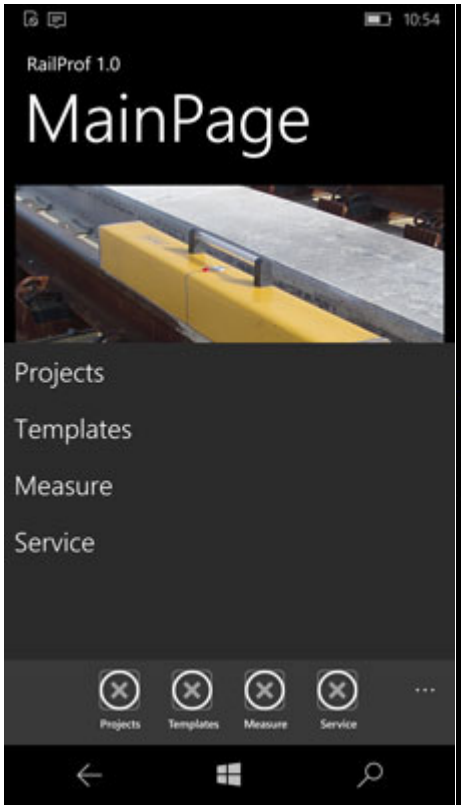


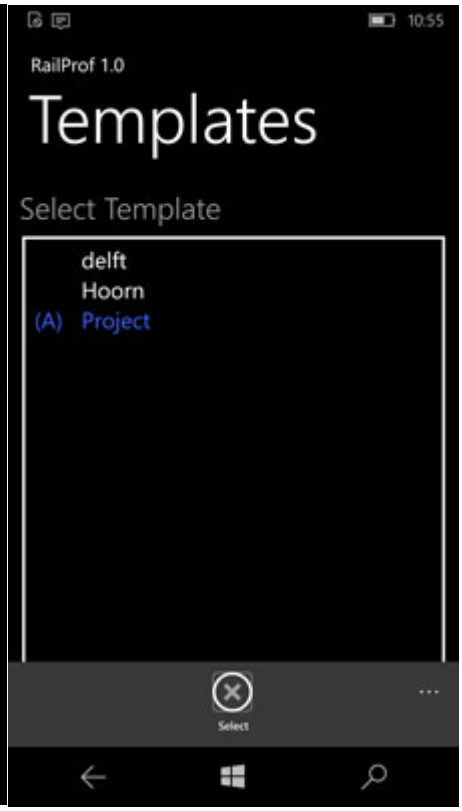
TAYLOR MADE FLIGHT CASES

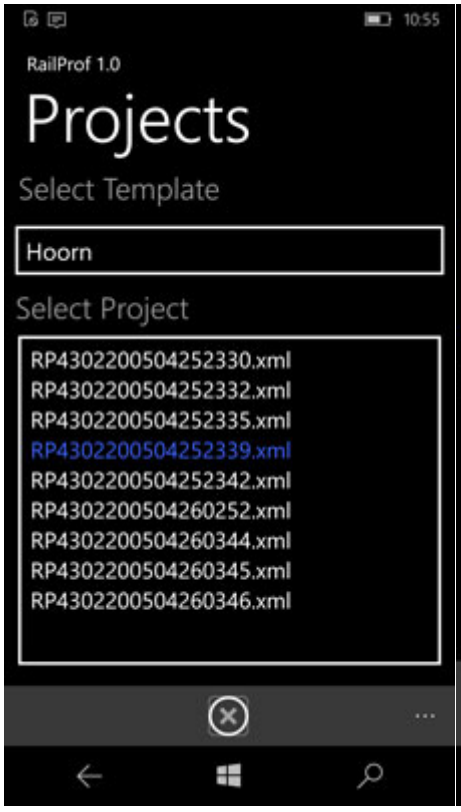
Freight information:
Total weight of flight case, RAILPROF, PDA and carton protection box: ± 19 kg;
Dimensions: approximately 137 x 43 x 17.5 cm.

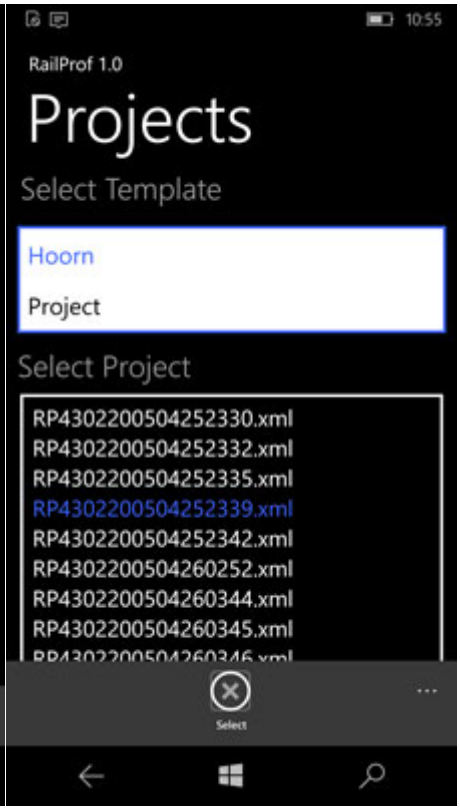
SOME WINDOWS PHONE SCREEN SHOTS

Templates can be created for each measuring job via the Templates menu. The values of the active template are used when the measuring process is started. After tapping the command measure the values of the template are shown and can be altered.
If the weld is measured again or a new weld is measured the previous values are kept.







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JOB
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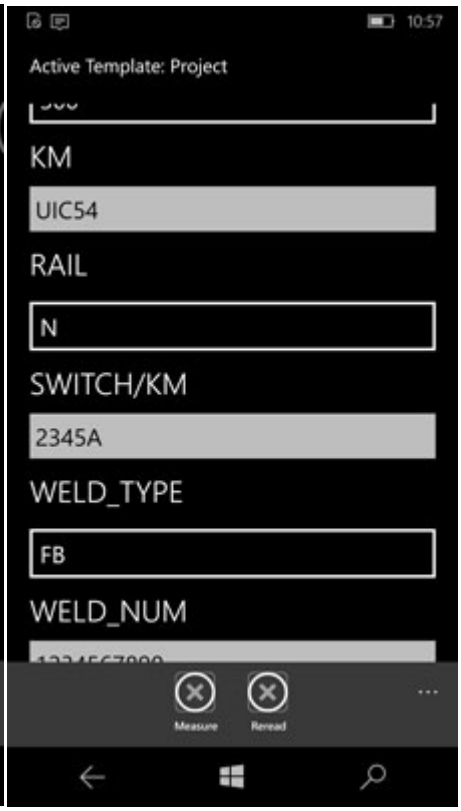
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Active Template: Project
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UIC54
RAIL
N
SWITCH/KM
2345A
WELD_TYPE
FB
WELD_NUM
Measure
Reread


10:58
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RP4184
OWNER
XXX
DATE
29-11-2016
TIME
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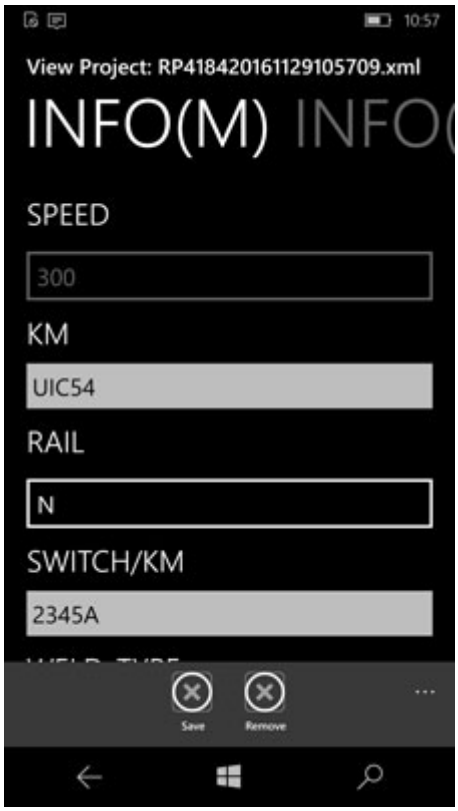
FILE_NUM
RP418420161129105709.xml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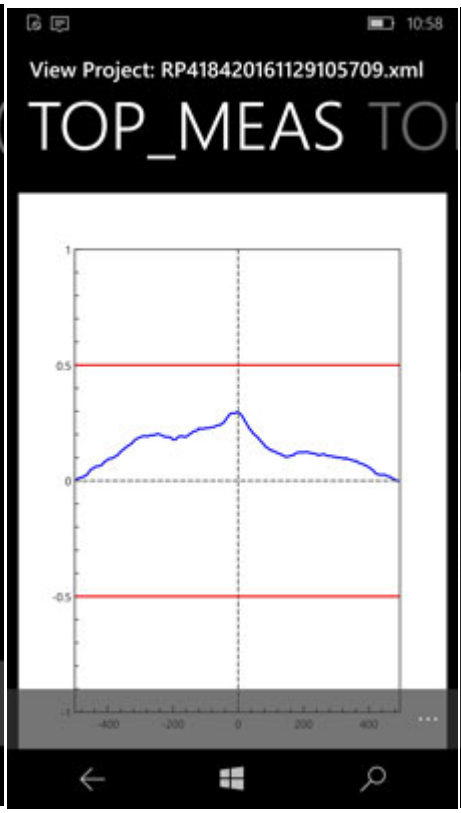
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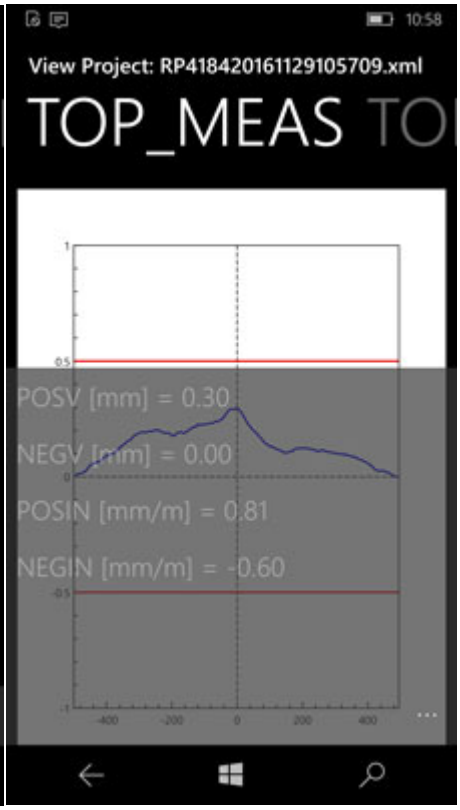
TOP_MEAS TO


10:58
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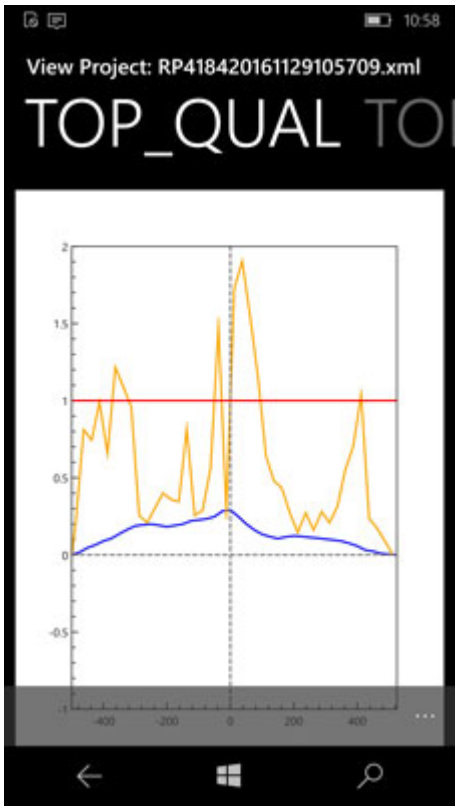
TOP_MEAS TO
POSV [mm] = 0.30
NEGV [mm] = 0.00
POSIN [mm/m] = 0.81
NEGIN [mm/m] = -0.60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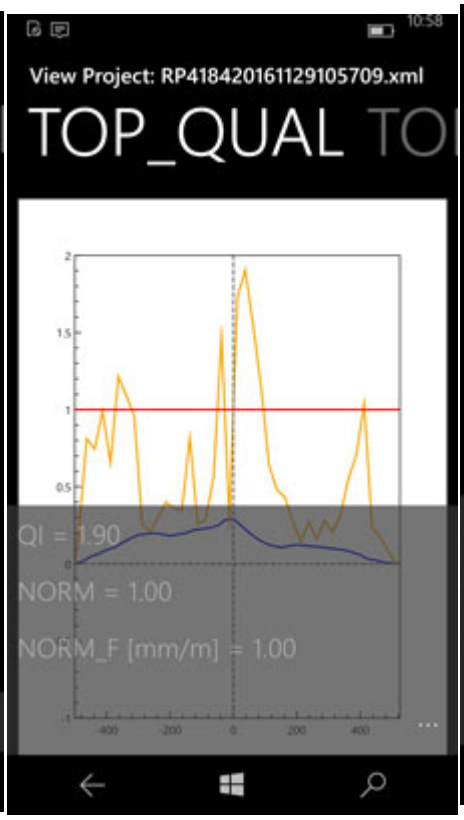
TOP_QUAL TO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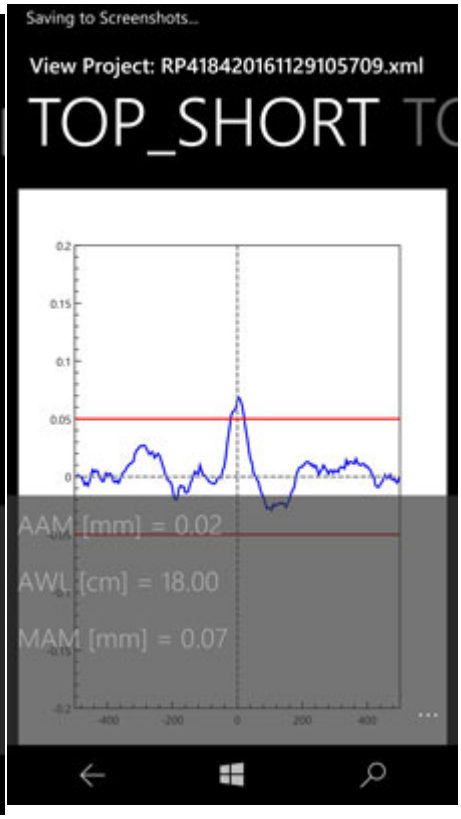
TOP_QUAL TO
QI = 1.90
NORM = 1.00
NORM_F [mm/m] = 1.00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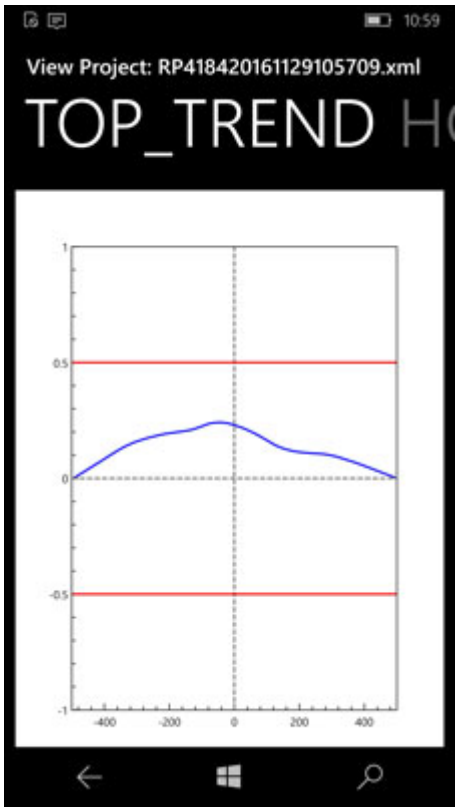
TOP_SHORT TO
AAM [mm] = 0.02
AWL [cm] = 18.00
MAM [mm] = 0.07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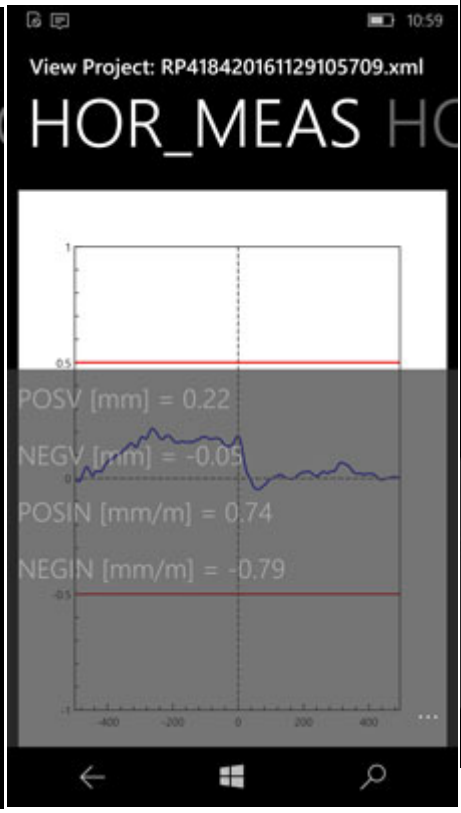
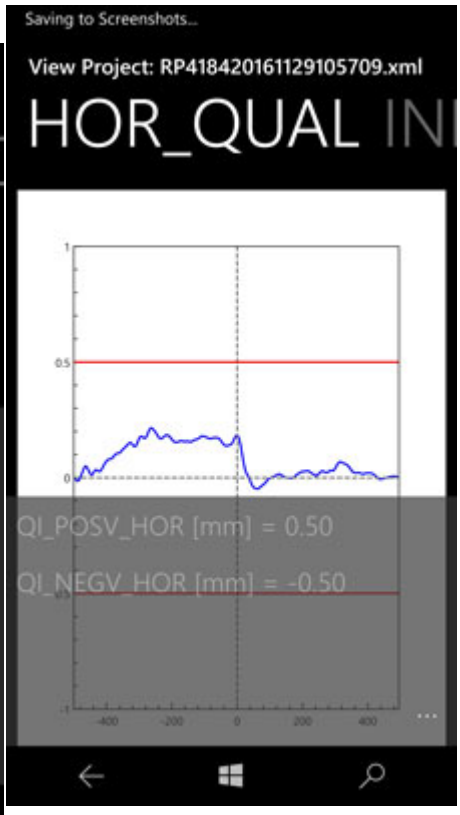
TOP_TREND H


10:59
View Project: RP418420161129105709.xml
HOR_MEAS HO
POSV [mm] = 0.22
NEGV [mm] = -0.05
POSN [mm/m] = 0.74
NEGN [mm/m] = -0.79


Saving to Screenshots...
View Project: RP418420161129105709.xml
HOR_QUAL IN
QI_POSV_HOR [mm] = 0.50
QI_NEGV_HOR [mm] = -0.50

APPLICATIONS

- Checking and acceptance of flash butt welds, thermit welds and glued insulated joints;

- Positioning of rails before welding;

- Production of glued insulated joints;

- Assessment of rail corrugation;

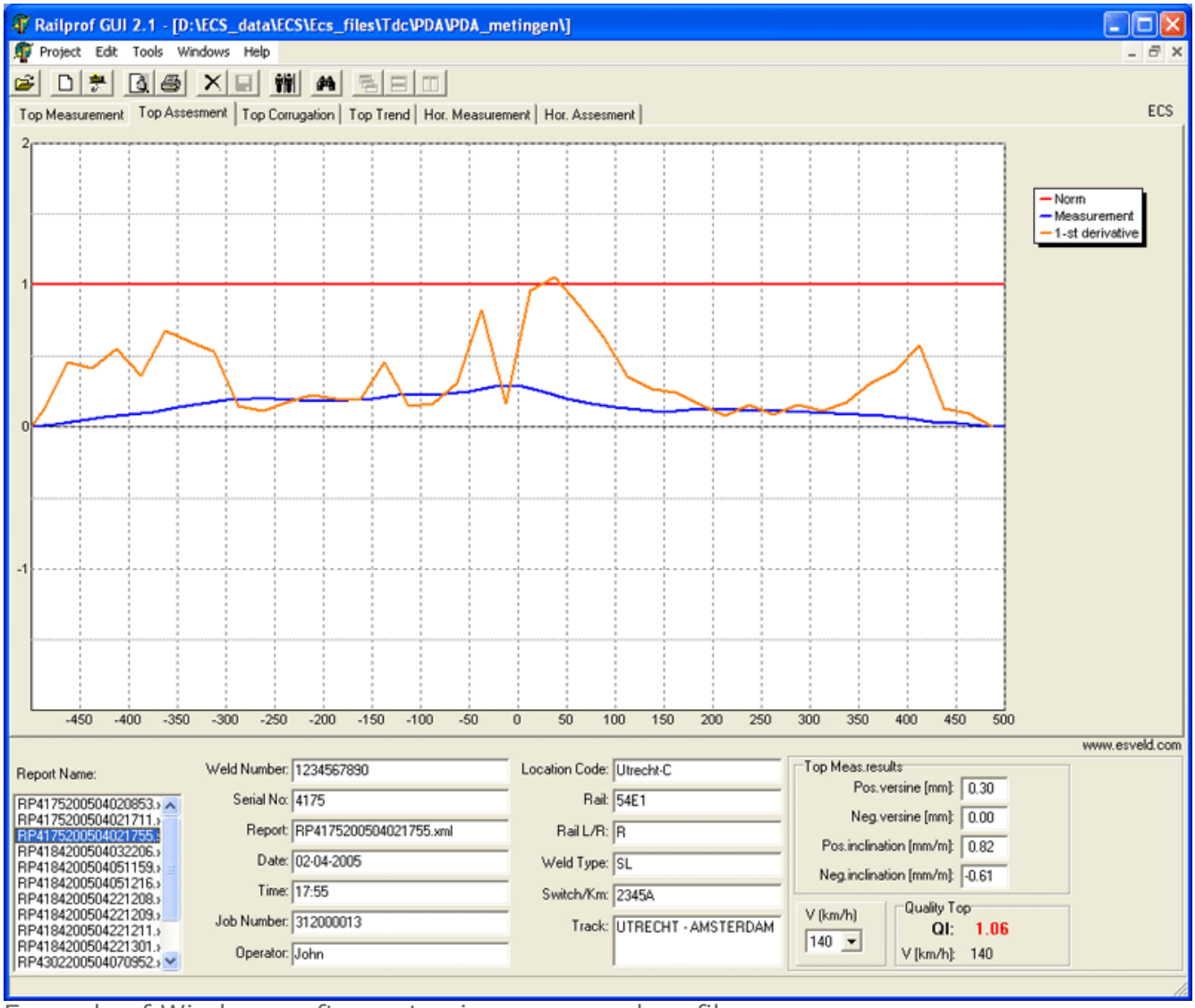
- Monitoring progress of grinding process;

- Acceptance of grinding work;

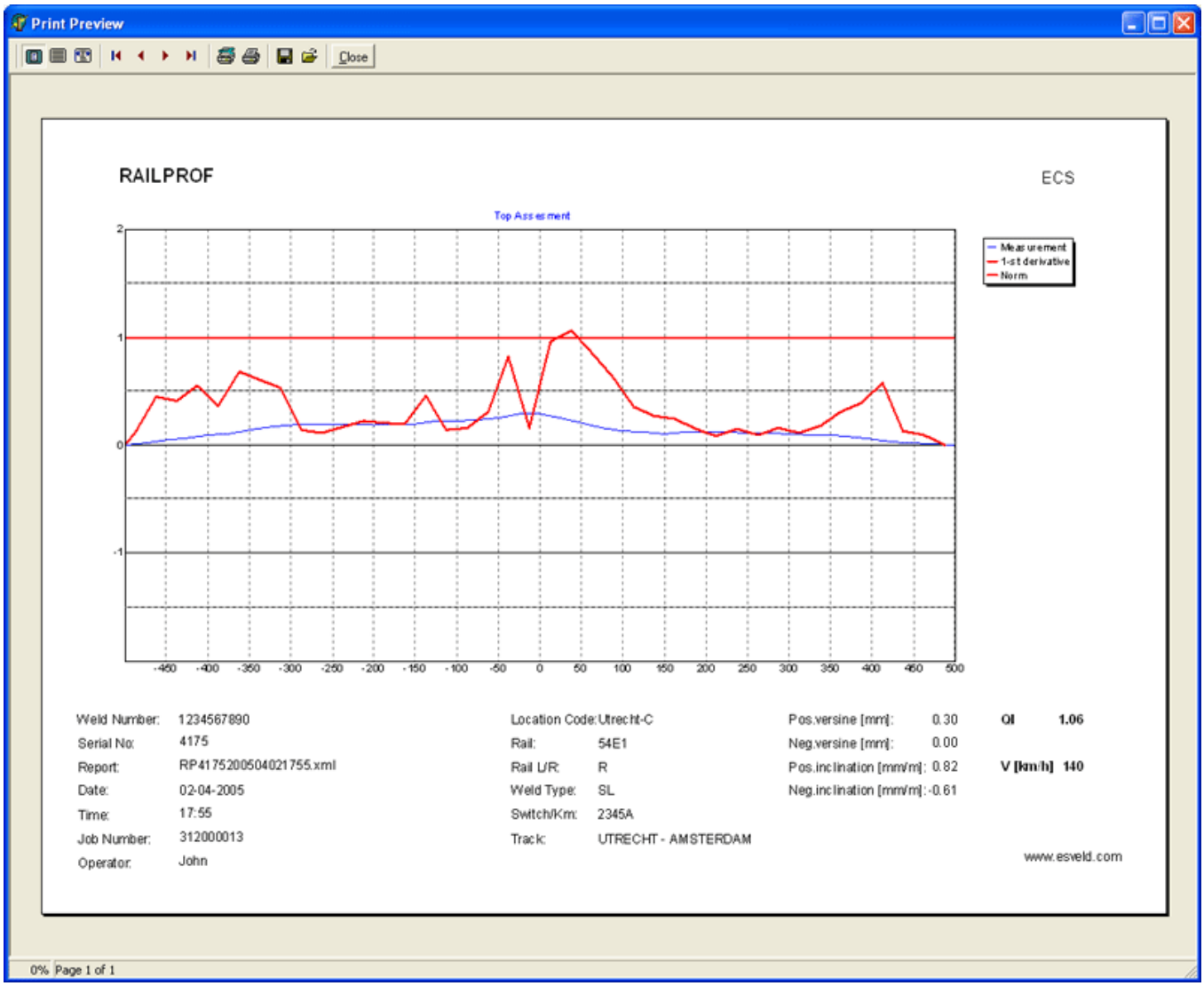
- Acceptance of rails for longitudinal geometry, including straightness of rail ends.

DESKTOP SOFTWARE

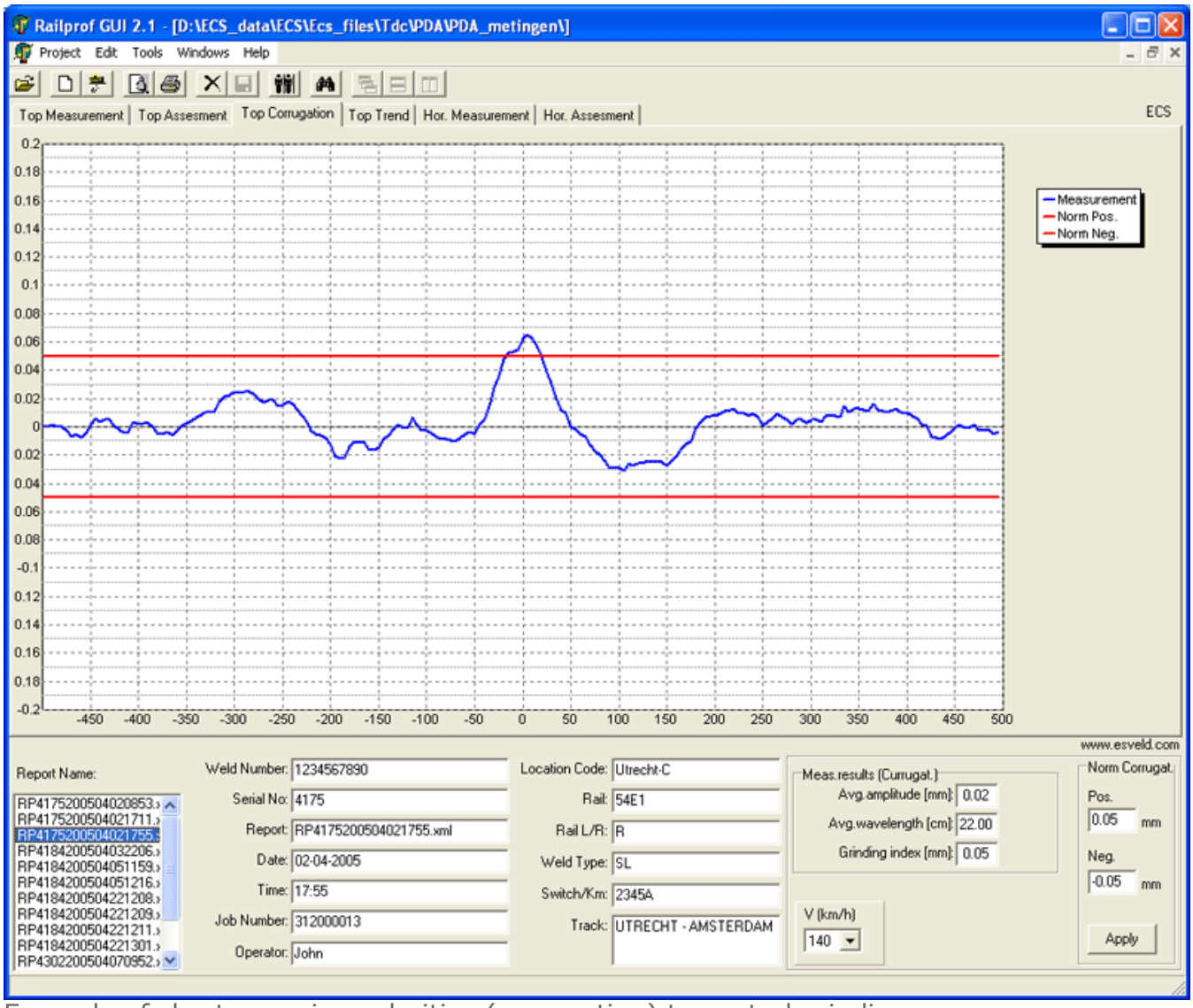
Special Windows based desktop software is provided for viewing, editing, printing and presentation of the measurement results,
as illustrated in the screen shots below.



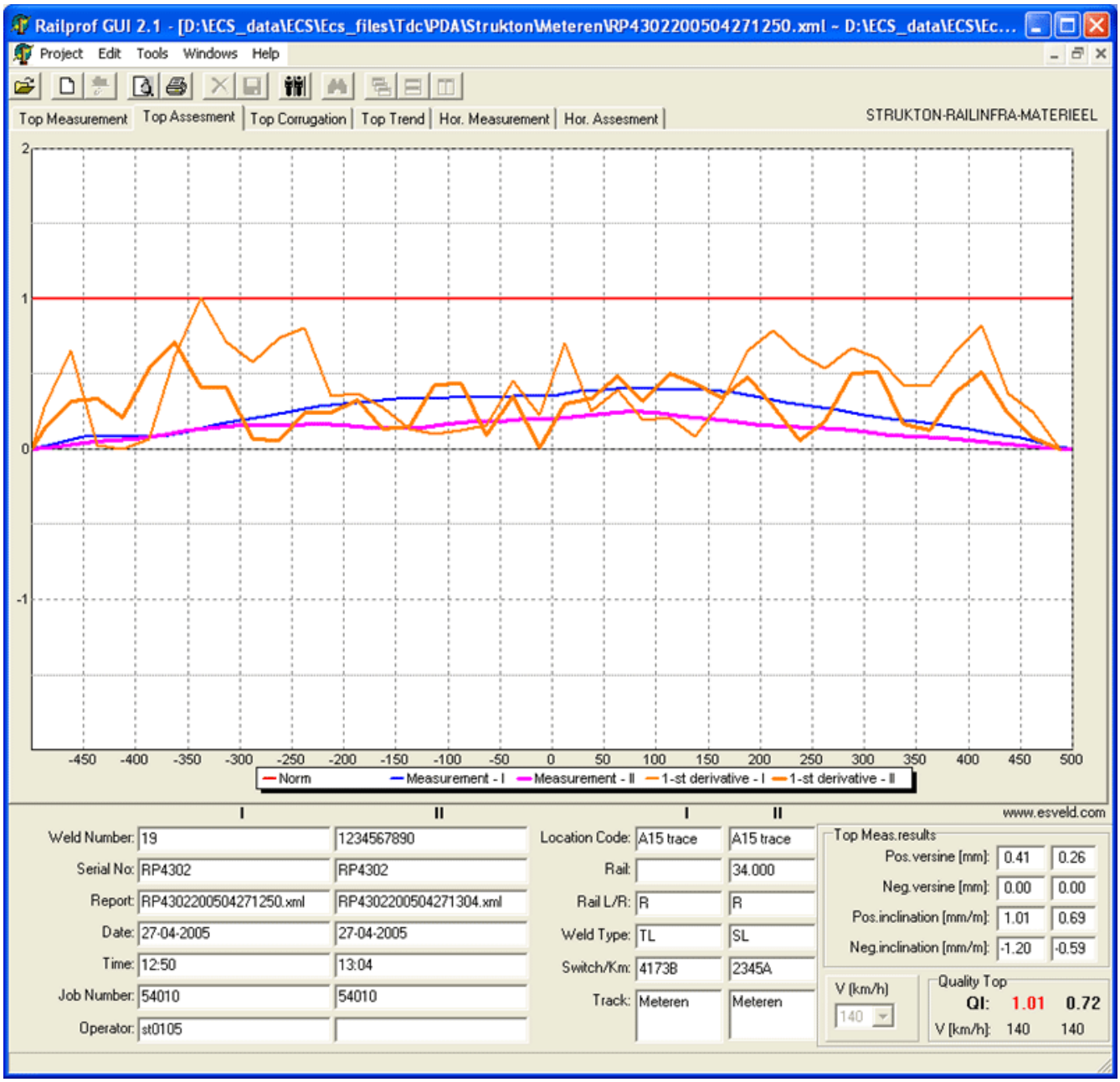
Example of Windows software to view measured profiles.



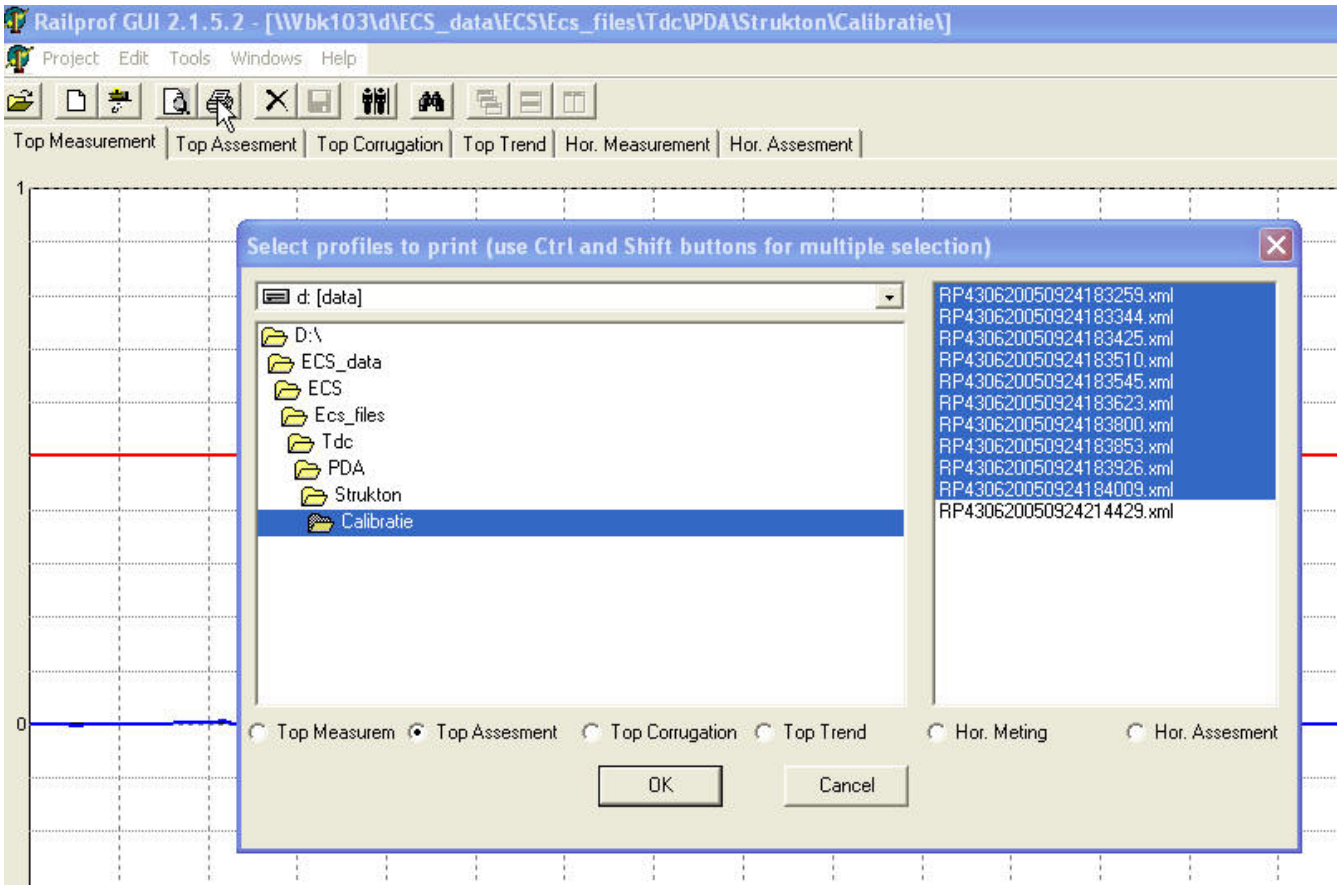
Example of a print preview.



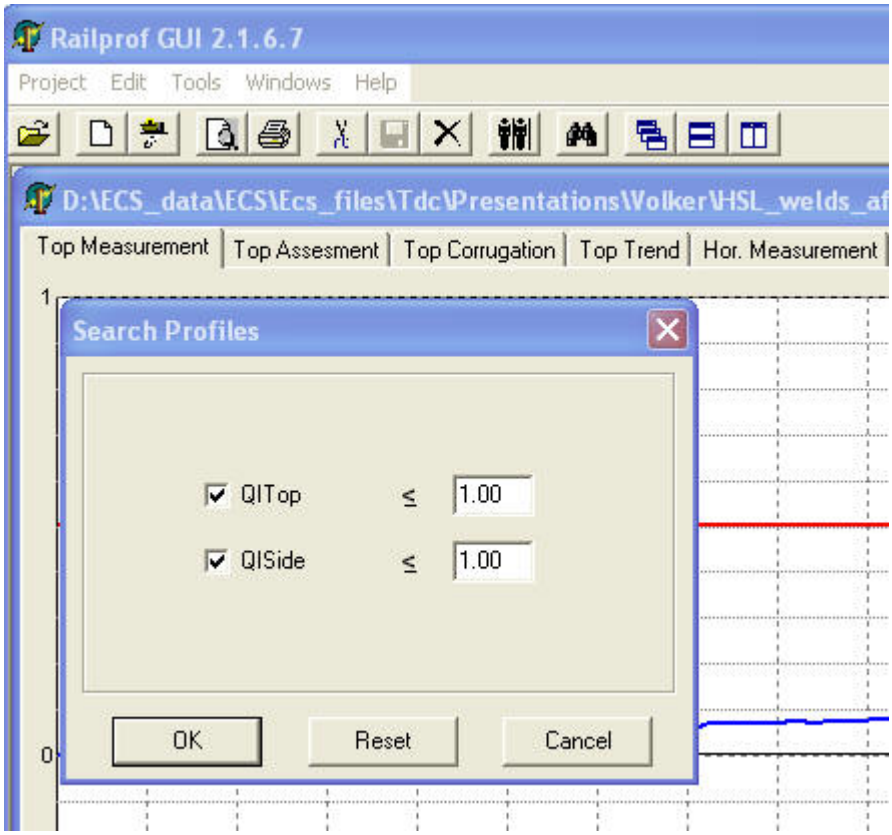
Example of short wave irregularities (corrugation) to control grinding.

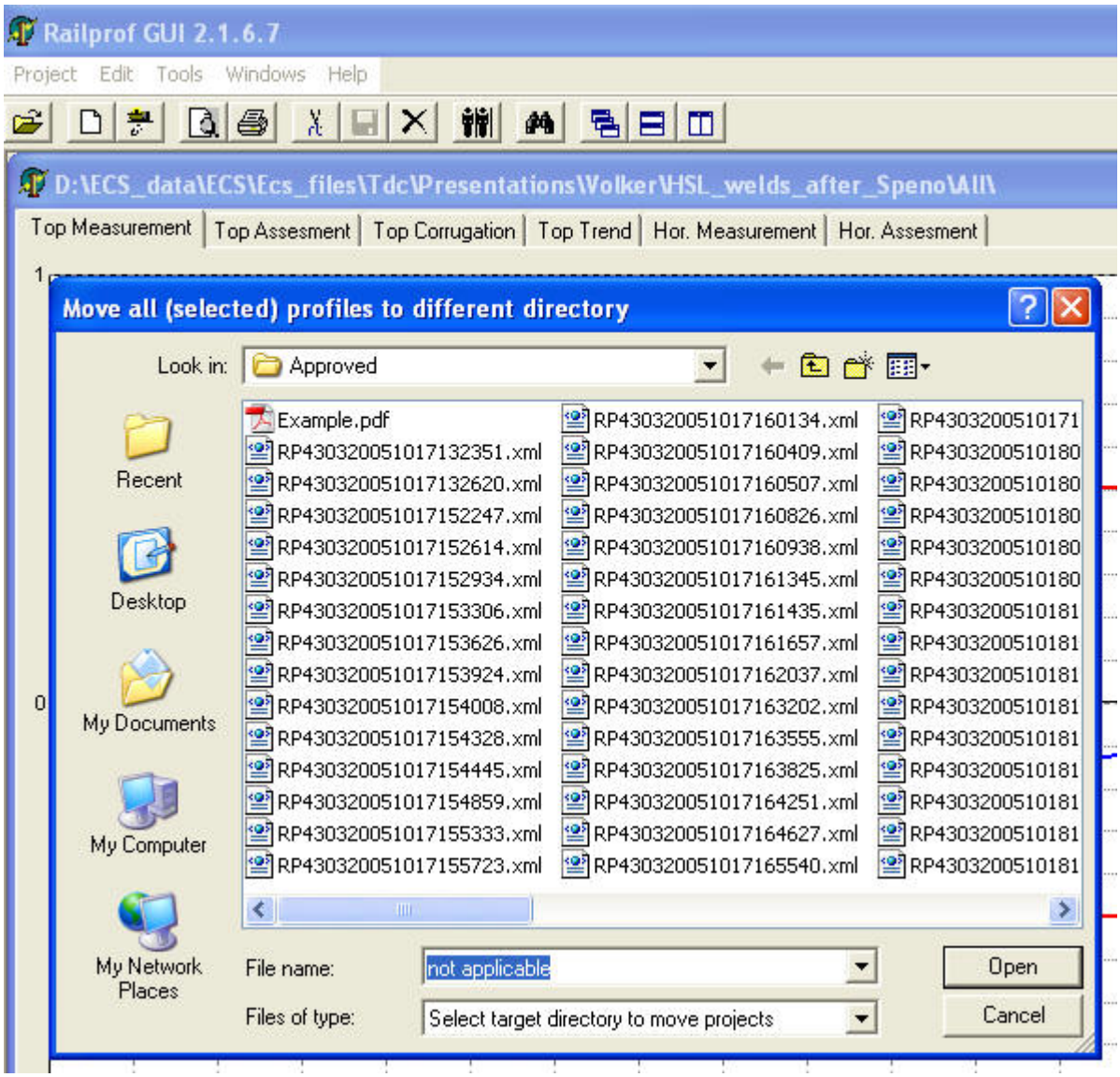


Example of comparing two measurements.

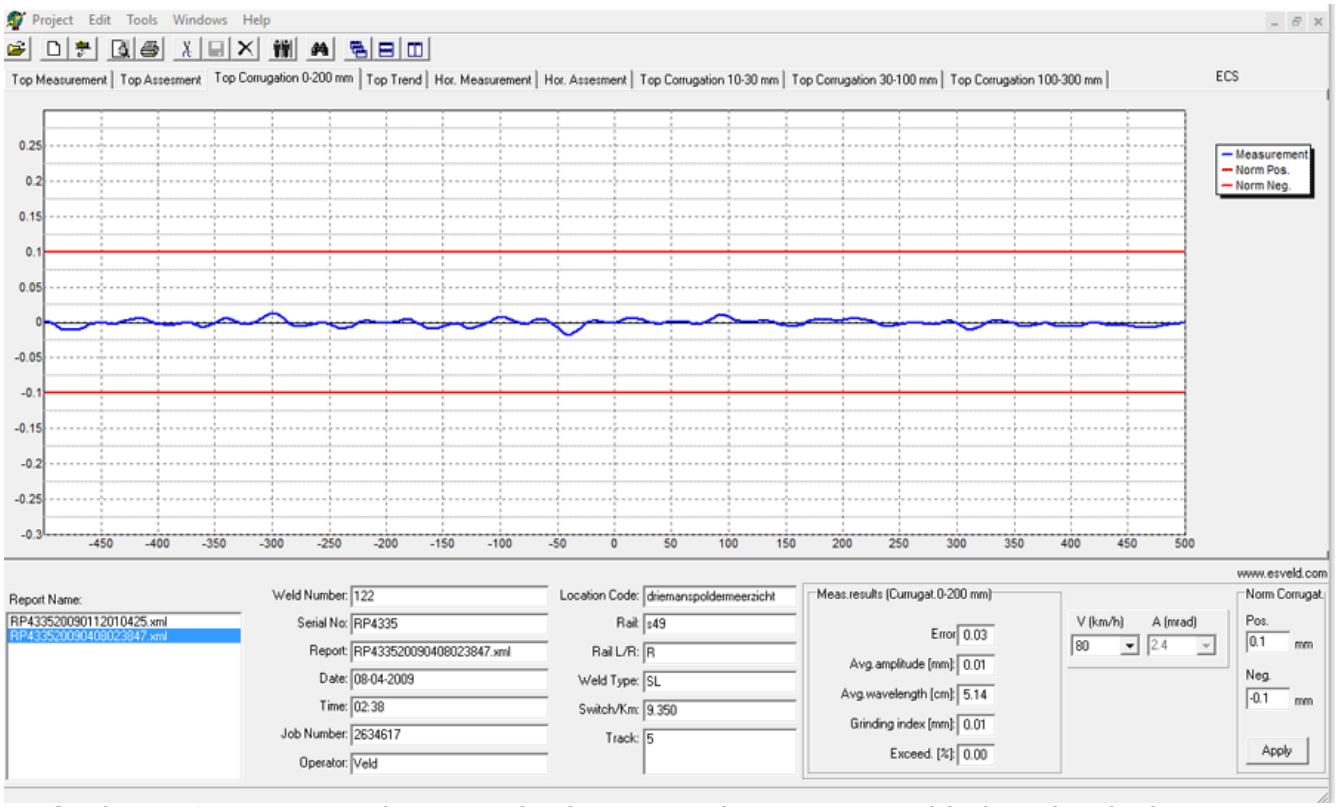


The desktop software offers the possibility to select records on the basis of the quality index QI. Via the find icon a screen is opened in which a choice can be made for QI Top, QI Hor, or both. The selection value is default 1.00, but the user can assign any other value. After OK the screen at the bottom left shows just the selected records, which can be moved now.





The software offers printing facilities to generate one integrated report for a series of measurements. In the above example the reports for Top Assessment are selected and can be printed as one pdf file.



To facilitate German grinding standards a special menu was added to the desktop software. In the wavebands 1-3 cm, 3-10 cm and 10-30 cm the percentage of exceedance of the standard is presented. The standards can be set per waveband as the admissible displacement in mm.
Furthermore, the following grinding indices are produced:
GA = Grinding Amplitude, GG = Average Wavelength, GSD = Average Grinding Depth.

MAIN RAILPROF SPECIFICATIONS

1. Weight: less than 7 kg;
2. Length: 116 cm;
3. Microsoft Windows Phone, with Windows 10:
   - Wireless communication with RAILPROF via Bluetooth to control measurements and data transfer;
   - Data analysis, such as filtering and computing of QI;

4. Measuring length: 1,000 mm in accordance with the EN standards for weld geometry; sampling interval 5 mm;

5. Measuring time: about 10 sec;

6. Data transfer to Smart Phone and analysis: about 6 sec;

7. Data storage: unlimited on Smart Phone internal memory, Secure Digital (SD) card, or in the Cloud;

8. Data transfer to desktop PC via mobile network, wifi, or wired synchronization;
9. Presentation of measurements on desktop PC via Windows menu. Easy generation of reports in pdf format;

10. Accuracy:
    a. High accuracy at ambient temperatures between - 5 ºC and + 40 ºC;
    b. Vertical geometry: +/- 0.020 mm;

c. Lateral geometry: +/- 0.050 mm;
d. Inclination associated with QI: +/- 5 %;

11. Measuring principle transducers: eddy current. The results are not influenced by moisture, rust, dirt and the real metal surface is measured;

12. Bottom of RAILPROF is resistant to temperatures up to 150 ºC;

13. Shipping information:
a. Total weight of flight case, RAILPROF, PDA and carton protection box: ± 19 kg;
b. Dimensions: approximately 137 x 43 x 17.5 cm.

DISTRIBUTORS

- Exclusive distributorship for SOUTH-KOREA
- Distributorship for Asia and Oceania

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