DIGITAL PROFILE MEASURING

by
GREENWOOD ENGINEERING A/S

MiniProf

MUCH MORE THAN A MEASUREMENT!

Full contact - Your way to valid and reliable data
Stay in **full control** of your assets
Choose **full contact** measurements
Why MiniProf BT

The MiniProf BT system is an excellent full contact measurement system with Bluetooth connection for fast, reliable and extremely high quality profile measurements. Combined with a user-friendly and flexible software package which can easily be configured from basic use to in-depth post measurement analysis, MiniProf BT can be used for numerous purposes on all types of wheel, rail and brake profiles. It enables the user to make critical decisions in purchase, maintenance, quality and safety departments etc. and represents a great platform for research and development all over the world.

Area of use

Product design & development
- Material and life cycle test
- Lubrication/friction effect
- Design of wheel, rail, brake disk, boogie

Research & universities
- WRI studies, verification of research and principles
- Reduce noise and wear-rates to extend asset lifetime
- Improve safety, speed, load and travel comfort

Safety regulation
- Inspection check if assets are within regulation
- Accident and derailment investigation
- Analysis and documentation of work

Manufacturing
- Production quality control
- Factory acceptance inspection before shipment
- Verification of production equipment

Quality control
- Verify accuracy of on-site/build-in laser-based gauges
- Verify accuracy of wheel lathes and rail grinding machines
- Verify accuracy of handheld laser-based gauges

Procurement
- On-site field/workshop incoming inspection
- Lifetime/performance monitoring – forecast planning
- Compare quality from different suppliers

Management
- Life cycle wear monitoring
- Trend forecast, planning of on-time maintenance intervals
- Life expectancy / improvements / replacements

Safety regulation

Research & universities

Manufacturing

Quality control

Procurement

Management

Much more than a measurement!
MiniProf BT is based on secure full-contact measurements and has a knife-shaped full contact point directly to the surface of a given profile. The magnetic full contact point minimizes influences from oil, lubrication, dirt and other substances on the profile as it “cuts” through the layers. It ensures constant contact to the actual profile during the complete measuring process and minimizes operator influence.

The accuracy of a MiniProf BT system is very consistent due to the unique measuring principle with a small magnetic measuring wheel and two rotating optical high resolution encoders which ensure that the measurement is performed perpendicular to the surface of the entire profile.

Due to the unique combination of full contact measurements, consistency and outstanding high-resolution optical encoders, MiniProf BT provides the highest accuracy available on the world market today. 20-30,000 collected individual points in one single profile measurement generate outstanding raw material resulting in excellent profile measurements with extremely high accuracies.
A full contact measuring system measures the exact profile. Concerns about dirt, oil and greasy surfaces are minimized thanks to the MiniProf® full contact point which cuts through unwanted layers on the profile.

A non-contact measuring system is not in full contact with the actual profile and therefore provides pictures of a given surface including unremoved dirt, oil etc.

Full contact measuring systems are not influenced by reflecting light on the profile surface or by shiny profile surfaces like a newly turned wheel etc.

Non-contact devices may show inconsistency when used on reflecting surfaces, in bright sunlight, frost, fog and moist climates etc. due to the sensibility of the non-contact data collecting method.
A MiniProf BT instrument is a compact and wireless handheld unit, which can enter very narrow places. It weighs from only 0.7 kg and is delivered in a ready-to-go transport case for safe storage and transportation.

**Features**

**Bluetooth**

MiniProf BT has a strong Bluetooth connection with a standard operating range from minimum 5-10 m. The user is able to perform fast and wireless measurements making the measuring process even more flexible and efficient. Option for USB cable connection is included.

**Top quality components**

MiniProf BT is made of titanium which makes it very temperature and shock resistant and ensures accuracy, stability and a very long lifetime.

**Highest accuracy**

A MiniProf BT instrument provides the highest accuracy available on the market today. The profile accuracy lies between 9 and 11 µm depending on the MiniProf system configuration.

**Consistent accuracy**

The accuracy of a MiniProf BT system is very consistent due to the measuring principle with a small magnetic measuring wheel and two rotating optical high resolution encoders which ensure that the measurement is performed perpendicular to the surface of the entire profile.

**Lightweight and handheld unit**

A MiniProf BT instrument is a compact and wireless handheld unit, which can enter very narrow places. It weighs from only 0.7 kg and is delivered in a ready-to-go transport case for safe storage and transportation.

**Fast and easy to use**

The MiniProf BT is a fast and easy to use measuring system which enables the user to carry out a single profile measurement in less than 5 seconds.
MiniProf BT is supplied with the MiniProf Envision software for standard computers and tablets, which allows for data collection and contains powerful modules for advanced data handling, analyzing and reporting. MiniProf BT also includes the MiniProf Criterion app for Android phones which is designed for easy data collection in the field.

Full software package
MiniProf BT is supplied with the MiniProf Envision software for standard computers and tablets, which allows for data collection and contains powerful modules for advanced data handling, analyzing and reporting. MiniProf BT also includes the MiniProf Criterion app for Android phones which is designed for easy data collection in the field.

Features

- **Long battery life**
  MiniProf BT is the perfect tool for field work. A new fully charged battery contains approximately 1000 Bluetooth measurements or 10 hours of work, which can be even further extended when using the cable connection option.

- **Easy-to-clean design**
  The MiniProf BT instrument has an easy-to-clean design, which reduces the accumulation of oil and dirt. The cleaning of the instrument is easily done just by using a mild solvent and a cloth after use of the instrument.

- **Warranty - 5 years**
  The MiniProf BT systems are founded on 25 years of solid experience. We are therefore proud and confident to offer up to 5 years warranty on all new MiniProf BT instruments as well as discounted loyalty calibration prices.

- **Operation temperature**
  The MiniProf BT instrument can be used for measuring in various types of environments and measures perfectly in temperatures from at least -15°C to +50°C.

- **Full digital profile**
  MiniProf BT uses high resolution optical encoders when measuring a profile. An extreme high amount of data for the total profile is collected and an average of approximately 600 points of the profile is saved digitally for further analysis.

- **Full software package**
  MiniProf BT is supplied with the MiniProf Envision software for standard computers and tablets, which allows for data collection and contains powerful modules for advanced data handling, analyzing and reporting. MiniProf BT also includes the MiniProf Criterion app for Android phones which is designed for easy data collection in the field.
MiniProf 

MiniProf® Rail is a high precision, lightweight and portable tool for performing cross-sectional rail profile measurements in order to monitor and analyze the wear of rails. It is equipped with Bluetooth as well as cable connection option and is supplied in few variations for all types of rails, including grooved rails.

- MP-260: Incl. perpendicular device
- MP-261: Incl. gauge determination, grade, super elevation, also suitable for grooved rails
- MP-262: Incl. gauge determination, grade, super elevation, perpendicular device

Magnetically attached to the top of the railhead using the opposite rail as reference, the rail profile is measured in less than 5 seconds reducing exposure on the track.

Profile accuracy
Better than: ±11 µm
Repeatability: ±2.5 µm

Measuring speed
Speed: < 5 seconds

Weight
MP-260: 0.8 kg
MP-261: 0.7 kg
MP-262: 1.2 kg
Telescopic rod: 0.6 kg
Infrastructure

**Rail wear calculations**
Vertical, horizontal and angled wear is calculated instantly. Numerous additional calculations and alignments for rails are available in the versatile and flexible Envision software package and can easily be added for optimum and customized configuration.

**Gauge measuring**
MiniProf® Rail is equipped with a telescopic rod using the opposite rail as reference. This ensures a correct and stable position and prevents the instrument from tilting. Depending on system configuration, the track gauge is measured simultaneously.

**Super-elevation / Grade**
Super elevation and grade are measured automatically depending on system configuration. The values are stored with the measurement and can be displayed at any time. The range of the measured inclination is ± 30 deg.

**Rail analysis & grinding**
The MiniProf® Envision software can visualize and calculate residuals and areas automatically and provides a functionality which is often used for rail grinding analysis. Measurements can be compared in multiple ways and easily exported to various formats. MiniProf Envision offers you a powerful rail analysis tool as well as user friendly measuring software.

**Perpendicular device**
Depending on system configuration, MiniProf® Rail is equipped with a small built-in perpendicular device which ensures correct alignment to the rail and prevents faulty diagonal measurements.

**Suitable for grooved rail**
MiniProf® Rail, type MP-261, can be used on grooved rails. The full contact magnetic measuring wheel ensures that the measurement is taken all the way down to the groove. Based on a reference, both the horizontal wear and the side wear are calculated.
MiniProf BT Wheel is a high precision, lightweight and portable tool for performing cross-sectional wheel profile measurements in order to monitor and analyze the wear of wheels. It is equipped with Bluetooth as well as cable connection option and can be used on various types of wheels.

Magnetically attached to the backside of the wheel, the wheel profile is measured in less than 5 seconds. A complete railroad car can be measured in less than 5 minutes.

Various calculations and alignments for wheel are available in the versatile and flexible Envision software package and can easily be added for optimum and customized configuration of the MiniProf BT Wheel system.

**Profile accuracy**
- Better than: ±9 µm
- Repeatability: ±2.5 µm

**Measuring speed**
- Speed: < 5 seconds

**Weight**
- Unit: 1.1 kg
Wheel wear calculations
The Sd, Sh and qr values are calculated instantly and numerous additional calculations and alignments for wheels are available in the versatile and flexible Envision software package.

Wheel analysis
The MiniProf Envision software can visualize and calculate residuals and areas automatically. Measurements can be compared in multiple ways and easily exported to various formats. MiniProf Envision offers you a powerful wheel analysis tool as well as user friendly measuring software.

Reprofiling
The MiniProf BT Wheel system is ideal to use before and after reprofiling of the wheels to determine when to reprofile and how much material to take off during the reprofiling process. This leads to precise reprofiling and improved lifetime of the rolling stock due to the unmatched high accuracy of the MiniProf system.

Measuring scheme
When measuring multiple profiles, the MiniProf BT measuring scheme is a very strong tool for clear identification of each profile in advance and for simplifying and reducing the measuring process even further.

MiniProf BT Lightrail Wheel
MiniProf BT Lightrail Wheel is a small instrument, with an only 100 mm backplate, specially designed for use on tramway vehicles. This small and compact instrument can be mounted where only limited space is available and fits all tram wheels.

Profile accuracy
Better than: ±9 µm
Repeatability: ±2.5 µm

Measuring speed
Speed: < 5 seconds

Weight
Unit: 0.7 kg
MiniProf BT Wheel 400 is equipped with a wide 400 mm backplate instead of the standard 250 mm backplate. The extremely high profile accuracy remains unchanged. Due to the increased width of the backplate, the diameter reading is improved significantly and is three times less sensitive to the state of the wheel and the measuring process.

Profile accuracy
Better than: ±9 µm
Repeatability: ±2.5 µm

Diameter accuracy
800 mm: 30 µm
1000 mm: 50 µm
1200 mm: 80 µm

Measuring speed
Speed: < 5 seconds

Weight
Unit: 1.4 kg

The calculation of the diameter is based on the versine measuring principle and an assumption of an ideal wheel without local deformations. The state of the wheel, including defects on the top of the flange and incorrect positioning of the instrument, will impact the diameter reading and should be considered carefully as per below illustration.

Error amplification factor

250 mm instrument
400 mm instrument
Wheel diameter (mm)
MiniProf BT Brake is an excellent tool for measuring the important wear parameters of brake discs and for calculating the brake hollowing and brake thickness. MiniProf BT Brake provides instant calculations of the brake hollowing and brake thickness. The MiniProf Envision software can visualize and calculate residuals and areas automatically. Measurements can be compared in multiple ways and easily exported to various formats. MiniProf Envision offers you a powerful brake analysis tool as well as user friendly measuring software.

Profile accuracy
Better than: ±11 µm
Repeatability: ±2.5 µm

Measuring speed
Speed: < 5 seconds

Weight
Wheel mounted: 0,9 kg
Axle mounted: 1,2 kg

Wheel mounted
The wheel mounted MiniProf BT Brake instrument is attached magnetically to the vertical part of the wheel, either on the backside of the flange or on the outer side of the rim. This part of the wheel is used as a reference for the measurement.

Axle mounted
The axle mounted MiniProf BT Brake instrument is mounted on the outer diameter of the brake disc and is attached using magnetic rollers. These also align with the wear marker on the disc which act as reference points for the measurement.
The MiniProf BT TwinHead Rail and MiniProf BT TwinHead Wheel systems are portable wireless instruments designed to produce fast and exact measurements of track and rolling stock. Opposed to normal single head instruments, the TwinHead measures both left and right profile together, obtaining a highly accurate relationship between the two profiles. This is especially important in analyzing running characteristics for rolling stock using for instance equivalent conicity studies.

The system consists of two measuring heads on a fixed beam. The two profiles are measured consecutively one by one. Each profile measurement will be done as by the single-head system. The measurements are stored on the computer and are accessible as individual profiles and together in pairs in one common coordinate system.

This provides a high accuracy on the gauge and a precise knowledge of any rotation of the profiles with respect to each other. This information is only possible to gather if you measure with a TwinHead instrument and is a crucial part of any wheel/rail interaction study.

The TwinHead system includes extra software modules for MiniProf Envision, namely TwinHead Package and MiniProf Contacts for doing Equivalent Conicity analysis.

**Profile accuracy**
- Better than: ± 11 µm
- Repeatability: ± 2.5 µm
- Gauge: ≤ 100 µm

**Measuring speed**
- Speed: < 5 seconds per profile

**Weight**
- TwinHead Rail: 1.9 kg
- TwinHead Wheel: 2.7 kg
The MiniProf Switch & Crossings system is a portable wireless instrument designed to measure multiple profiles on switches and crossings. The instrument extends to the opposite rail through a fixed rod, offering stability, gauge and track relative measurements. These give precise information on the physical placement of multiple rails, both useful for maintenance, investigation of problems and for quality control of new installations.

**Profile accuracy**
- Better than: ± 11 µm
- Repeatability: ± 2.5 µm
- Gauge: ≤ 200 µm

**Horizontal movement**
- Range: 300 mm
  - 100 mm towards gauge side
  - 200 mm towards field side
- Displacement: ≤ 100 µm

**Measuring speed**
- Speed: < 5 seconds per profile

**Weight**
- Unit: 5.5 kg
- TwinHead Rail: 1.9 kg
- TwinHead Wheel: 2.7 kg

**Contact studies**
The TwinHead systems are primarily designed for contact studies. This is more than ever a vital area in railways and fully supported through the advanced Contact module available for the MiniProf Envision software.
MiniProf Envision

Complete data analysis toolbox

MiniProf BT is supplied with an extensive software package usable for all variations of our MiniProf BT instruments. It is highly flexible and customizable to the individual customer requirements and can be used to perform measurements as well as in-depth post measurement analysis. The software package includes measurement schemes, trending and a lot of other analysing possibilities.
Software

Measuring scheme

MiniProf Envision features a measuring scheme system to perform large sequences of wheel, rail and brake profiles efficiently. An intelligent scheme wizard enables the user to make customized scheme solutions.

User-friendly design

A MiniProf system is supplied with modern and user-friendly software package MiniProf Envision. Its smart configuration wizard makes setup process easy and provides a simplified user learning curve.

More than a profile

MiniProf Envision has features such as logging of GPS locations and attachment of photographs to measurements. It can also measure temperature, super-elevation and grade with relevant MiniProf instrument.

Presentation and portability

Data and results can be extracted and easily used in third-party applications. Customizable templates allow attention to details when creating reports, which can be saved as PDF, Windows Metafile or printed.

Examine trends

You can perform trend analysis on your data which can show alarm and failure warning levels and estimates. These are imperative for safety requirements and decision making for your company.

Intelligent cursors

Profile cursor runs smoothly through the data points which allow readings between the points. The advanced functionality also gives instant residuals and area results to the user by highlighting the area between the profiles.
Evaluation Module

The Evaluation module is probably the most powerful tool in the MiniProf Envision software package, as it brings all major functionalities together to transform your data into valuable information.

- Import measurements from all MiniProf instruments
- Backwards compatible with all MiniProf generations
- Filter measurements based on any recorded information
- Overview of wear parameters with live alarm information
- Graphical overview of results to highlight areas of special interest
- Open data to view details on the original profiles and perform trending
- Edit meta data to correct mistakes and unify displayed information
- Recalculate results in case of changes to settings
- Extract data and results for third-party applications

Contacts Module

Wheel/rail interaction is vital for railway safety and comfort. The Contacts module adds functions for calculating equivalent conicity on MiniProf TwinHead measurements.

- Implemented in accordance with international standards
- Shows graphs for equivalent conicity, contacts points, tangent angles and rolling-radius difference.
- Comes with an integrated construct function which allows creation of sophisticated TwinHead reference profiles.
- Includes automated batch processing of TwinHead data sets
MiniProf Criterion

MiniProf Criterion is an application designed to run on modern Android based phones and similar devices. The software provides easy installation and setup to carry out data collection in the field and workshops.

**Highlights of MiniProf Criterion:**

- Compatible with various types of mainstream Android phones and similar devices
- Fully compatible with MiniProf BT line of instruments
- Easy data collection
- GPS location recording
- Attach pictures to your measurements
- Integrates directly with MiniProf Envision

MiniProf Envision Coach

MiniProf Envision Coach is a self-training video tutorial software package supplied with all new MiniProf BT instruments and available for MiniProf Envision users for download on request. The software includes tutorials for:

- Software and license installation
- Instrument setup & measurement configuration
- Measuring with different instruments
- Measuring & functionality on handheld devices
- Analysis functions of the software
- Batch processing and reporting
- Additional modules and tools
- And much more…
Calculations

Common calculations

Angles
Calculates the tangent angle, measured in degrees, at each point of the selected profile. The angles for a reference profile are calculated and displayed along with the angles of the measured profile if a reference is selected.

Curvature
Calculates the curvature in every point of a profile by fitting a 2nd degree polynomial to a small part around each point. If a reference profile is available, the curvature will also be calculated for this and the result displayed as a reference for the curvature of the measurement.

Residuals
Calculates the distance (D) to a measured profile perpendicular to a reference profile at each point of the reference profile. The calculation assumes that the points in the measured profile can be connected with straight lines.

Vertical residuals
Calculates the vertical distance (D) to a measured profile at each point of the reference profile. The calculation assumes that the points in the measured profile can be connected with straight lines.

Horizontal residuals
Calculates the horizontal distance (D) to a measured profile at each point of the reference profile. The calculation assumes that the points in the measured profile can be connected with straight lines.

Wheel calculations & alignments

Wheel wear
Calculates the flange thickness (Sd), flange height (Sh) and the flange gradient (qR) for a wheel profile.

Wheel flange width
Calculates the width of the flange (W) for a wheel profile at a specific distance (L) from the top of the flange.

Wheel flange back wear
Calculates the flange back wear (W) for the selected profile.

Maximum residuals
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

Wheel flange radius
Calculates the radius of the wheel flange (R) for a wheel profile.

Wheel flange width (Tram)
Calculates the width of the flange (D) for a wheel profile.

Wheel flange back wear (Tram)
Calculates the flange back wear (D) for the selected profile.

Wheel flange root radius
Calculates the wheel flange root radius (R) at a given point defined from the taperline (L1). The radius is determined from the curvature of a 2nd order polynomial fitted to a specified area (D).

Wheel flange angle maximum
Calculates the maximum flange angle (A) and the position (X) for a wheel profile.

Wheel flange angle minimum
Calculates the minimum flange root radius (R) and position (X) for the selected profile. The calculation determines the radius using the precalculated curvature values.

Wheel flange back wear (Tram)
Calculates the flange back wear (W) for the selected profile.
Calculations

Wheel taperline angle
Calculates the taperline angle (A) using the average for a distance (L2, L3) around the taperline (L1) for a wheel profile.

Wheel hollowing
Calculates the maximum wheel hollowing (H) and position (X) for a wheel profile.

Wheel thread wear maximum
Calculates the maximum thread wear (W) and position (X) between the measurement and the reference in an area set from the flange backside (L1) to the outer thread (L2).

Wheel gauge flange
Calculates a number of wheel dimensions and gauge values given two measured wheel profiles.

Align wheel on taperline
Aligns a measured wheel profile on a given taperline. This alignment only moves the profile in the vertical direction (dy). No rotation is performed.

Align wheel on diameter
Aligns a measured wheel profile using the diameter information stored with the profile.

Wheel wear difference
Calculates the difference between the wheel wear on a measured profile and a reference profile.

Wheel hollowing maximum
Calculates the highest wheel hollowing (H) and position (X) for the selected profile.

Wheel volume loss
Calculates the volume between the measurement and a reference. This is done using either the measured diameter (if available) or the diameter entered as a parameter for the calculation.

Align wheel
Aligns a measured wheel profile to the reference profile at the top of the flange. This alignment only moves the profile in the vertical direction (dy). No rotation is performed.

Align wheel on flange back
Aligns a measured wheel profile to the reference profile at the flange back. No rotation is performed.

Align wheel on outer thread
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile in the vertical direction. No rotation is performed.

Align wheel on flange top
Aligns a measured wheel profile to the reference profile at the top of the flange. This alignment only moves the profile in the vertical direction. No rotation is performed.

Wheel thread wear
Calculates the thread wear (w) as the distance between the measurement and the reference at a given point (L) defined from the backside of the flange.

Wheel diameter difference
Calculates the difference between the diameters on wheels in a bogie.

Wheel diameter from tyre
Determines the wheel diameter using the inner diameter and a field containing the tyre height, measured separately.

Wheel diameter on flange top
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile. No rotation is performed.

Wheel diameter on outer thread
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile. No rotation is performed.

Wheel hollowing
Calculates the difference between the wheel wear on a measured profile and a reference profile.

Wheel hollowing maximum
Calculates the highest wheel hollowing (H) and position (X) for the selected profile.

Wheel volume loss
Calculates the volume between the measurement and a reference. This is done using either the measured diameter (if available) or the diameter entered as a parameter for the calculation.

Align wheel
Aligns a measured wheel profile to the reference profile at the top of the flange. This alignment only moves the profile in the vertical direction (dy). No rotation is performed.

Align wheel on flange back
Aligns a measured wheel profile to the reference profile at the flange back. No rotation is performed.

Align wheel on outer thread
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile. No rotation is performed.

Wheel diameter difference
Calculates the difference between the diameters on wheels in a bogie.

Wheel diameter from tyre
Determines the wheel diameter using the inner diameter and a field containing the tyre height, measured separately.

Align wheel on flange top
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile in the vertical direction. No rotation is performed.

Align wheel on outer thread
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile. No rotation is performed.

CMA: Core, Measurement & Analysis module (included in the standard software)
Wear pack (to be purchased separately)
Calculations

**Rail calculations & alignments**

**Rail wear**

This function will calculate the vertical (W1), horizontal (W2) and 45° (W3) wear. The wear is calculated as the difference between a measured profile and a reference profile.

**Maximum residuals**

Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**Rail gauge angle maximum**

Calculates the maximum gauge angle (A) and position (Y) for the selected profile. The calculation determines the angles either as the tangent angle in each point, as the angle between two points on each side or as the average of the tangent angles in a certain area (D).

**Grooved rail geometry**

This function calculates a number of geometrical features for a grooved rail profile: Groove width (W), groove height (H), crown radius (RC) and radiuses for the different parts of the groove (R1, R2, R3 and R4).

**Align rail (CEN)**

Aligns a measured rail profile against a reference by minimizing the wear parameters W1 and W3. No rotation is performed on the measured profile.

**Align rail for grinding (High)**

Aligns a measured rail profile against a reference according to the CEN grinding standard for the high rail in curves. No rotation is performed on the measured profile.

**Align rail for grinding (Low)**

Aligns a measured rail profile against a reference according to the CEN grinding standard for tangent track and the low rail in curves. No rotation is performed on the measured profile.

**Rail crown radius**

The rail crown radius (R) is calculated as the radius of the circle that gives the best fit at the top of the rail head in an area determined by the distance parameter (Dist).

**Railhead angle**

Calculates the angle of the rail head (A) for the selected profile.

**Rail height**

Calculates the remaining height of the rail head (H) for the selected profile.

**Grooved rail wear**

This function will calculate the vertical (W1) and horizontal (W2, W4) wear for a grooved rail. The wear is found as the distance between the measurement and the reference.

**Align rail on wear**

Aligns a measured rail profile against a reference by minimizing the wear parameters W1 and W3. No rotation is performed on the measured profile.

**Align rail on top**

Aligns a measured rail profile so the profile intersects the horizontal axis at the top point. This alignment only moves the profile in the vertical direction. No rotation is performed.

**Align rail centered**

Aligns a measured rail profile against a reference by using both sides of the profiles and the top point. This alignment is particularly useful for aligning measurements of new rails for quality control.

**Align rail for grinding (Low)**

Aligns a measured rail profile against a reference using the field side face and the lower corner. The alignment can optionally use the gauge side face if desired.

**Align rail for grinding (High)**

Aligns a measured rail profile against a reference using the field side face and the lower corner.

**Rail head width**

The rail head width (W) is the distance from the field side of the rail head to the gauge side measured at L millimeters from the highest point of the rail profile. Setting the L parameter to 0 makes the calculation return the largest width.

**Rail gauge angle**

Calculates the gauge angle (A) at a given point defined from the top of the railhead (L). The angle is determined either from the tangent in the point, the angle between two points on each side or as the average of the tangent angels in a certain area (D).

**Align rail centered**

Aligns a measured rail profile against a reference by using both sides of the profiles and the top point. This alignment is particularly useful for aligning measurements of new rails for quality control.

**Align rail for grinding (Low)**

Aligns a measured rail profile against a reference according to the CEN grinding standard for tangent track and the low rail in curves. No rotation is performed on the measured profile.

**Align grooved rail**

Aligns a measured grooved rail profile against a reference using a point on the inner side of the check part and the bottom of the groove.
Brake calculations & alignments

**Brake volume loss**
Calculates the volume between the measurement and a reference. This is done using either the measured diameter (if available) or the diameter entered as a parameter for the calculation.

**TwinHead wheel gauge**
Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange. Default values for the parameters are: L1 = 70 mm and L2 = 10 mm.

**Align brake on top edge**
Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.

**Align brake on scale**
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**TwinHead rail gauge**
Calculates the gauge between two rail profiles made with a TwinHead rail unit. The two profiles must be linked together for the calculation to succeed. Default value for the parameter is: L = 14.

**Brake volume loss**
Calculates the brake-disc wear (W) and the remaining thickness (T).

**TwinHead wheel gauge (AR)**
Calculates the wheel gauge value (AR) for a set of TwinHead wheel profiles. AR is the gauge found at the backside of the wheels at a point relative to the flange top. Default value for the parameter is: L = 32 mm.

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear (No reference)**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear (No reference)**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**TwinHead wheel gauge**
Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange. Default values for the parameters are: L1 = 70 mm and L2 = 10 mm.

**Align brake on top edge**
Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.

**Align brake on scale**
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear (No reference)**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**TwinHead wheel gauge**
Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange. Default values for the parameters are: L1 = 70 mm and L2 = 10 mm.

**Align brake on top edge**
Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.

**Align brake on scale**
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear (No reference)**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**TwinHead wheel gauge**
Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange. Default values for the parameters are: L1 = 70 mm and L2 = 10 mm.

**Align brake on top edge**
Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.

**Align brake on scale**
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear (No reference)**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**TwinHead wheel gauge**
Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange. Default values for the parameters are: L1 = 70 mm and L2 = 10 mm.

**Align brake on top edge**
Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.

**Align brake on scale**
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.

**Align grooved rail (Flat)**
Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.

**Brake wear (No reference)**
Calculates the brake-disc hollowing (W) and the remaining thickness (T).

**TwinHead wheel gauge**
Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange. Default values for the parameters are: L1 = 70 mm and L2 = 10 mm.

**Align brake on top edge**
Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.

**Align brake on scale**
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).

**Maximum residuals**
Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.
Globally used by thousands of MiniProf users

References

Australia
ARC Infrastructure
ARTC (Australian Rail Track Corporation)
BHP
Central Queensland University
Dowman Ed Rail
FMGL (Fortescue Metals Group Ltd)
Gencos Rail
Government of Southern Australia
IRT, Monash University
John Holland Rail
Linnag Rail
Loram Australia
MTM (Metros Trains Melbourne)
Pacific National
Plateway
Queensland Rail
Rio Tinto
Siemens
Spengo Rail Maintenance Australia Pty Ltd
Sydney Trains
TransAdelaide
Transport for NSW
TVR Trans

Austria
Bahnbau Wels
Bombardier Transportation
Cityteam
ELT Austria
Graz-Köflacher Bahn
Graz Verkehrsbetriebe
Knorr Bremse
Linsinger Maschinenbau
Linz
Lucchini
Növog
Salzburg AG
Siemens
Svitavitiska
TU Wien
TUV
Universität Innsbruck
Vienna University of Technology

Voest Alpine Schienen
Wiener Linien
Wiener Lokalbahnen
OBB Infrastructure
OBB-TS Komterfel
Baku Metropolitani
Belgium
Bombardier Transportation
Do Lijn
Infrabel
NMS/STIB
Ri Do Coxo International
TEC
Brazil
CBTU MetroRec
FG Rail Eng. Ferrov. Ltda.
JFE
Metro Rio
Metro Sao Paulo
MRS Logistica
Rio University
Rumo
Universidade Lattuaba Vales
UJC (FCA)
Canada
B.C Rapid Transit
Bird Kiwett
Bombardier Transportation
Canadian National
Canadian Pacific Railway
Edmonton Transit
Go Transit
IOC
Kilian Technologies Corp.
L.B. Foster
National Research Council
Quebec Cartier Mining Company
Resco Engineering
Siemens
TTC - Ashbridges
TTC - Toronto Transit Commission
Chile
Alstom

Empresa de los Ferrocarriles del Estado (EFE)
ICII-lifeal S.A.
Ingenieria Reyes
Metro de Santiago
China
Anting Bauri Company
Beijing Airport Line
Beijing High Speed Track
Beijing KOTC Technology
Beijing Metro Line 1
Beijing Metro Line 6
Beijing Metro Line 8
Beijing Metro Line 9
Beijing Metro Line 13
Beijing Metro Line 16
Beijing Metro Line Yanfang
Beijing MTR Line 4
Beijing MTR Line 14
Beijing Nankou Division
Beijing Railway Bureau High Speed Vehicle
Beijing Tijiu
Beijing Train
Beijing University of Civil Engineering and Architecture
Beijing West EMU Depot
Bombardier Sifang (Qingdao)
Transportation Ltd.
Changchun Highspeed Track Dep.
Changchun Light Rail
Changchun Metro Line 1
Changchun Metro Line 6
Changchun Metro Line 8
Changchun Metro Line 9
Changchun Metro Line 11
Changchun Metro Line 12
Changchun Metro Line 16
Changchun Metro Line 19
Changchun Railway Vehicles Co.
Changsha EMU Depot
Chengdu EMU Depot
Chengdu Metro Line 1
Chengdu Metro Line 2
Chengdu Metro Line 3
Chengdu Railbang
China Academy of Railway Science
Chongqing Metro
CNR Changchun
CRRC Switch
CRRC Beijing
CRRC Chengdu
CRRC Jinan
CRRC Wuhan
CSR Minshan
Dalian EMU Depot
Dalian Metro Line 1
Dalian Metro Line 2
Dongguan Lilin EMU Depot
Enp Factory
Fengtai Track Department
Fuzhou EMU Depot
Fuzhou Extension EMU Depot
Fuzhou Metro Line 1
Fuzhou South EMU Depot
Fuzhou Track Depot
GE Transportation System
Goldschmidt Thermen
Guang Nanning Subway Line 1
Guanggu Raji
Guangzhou Metro
Guangzhou Railway Bureau
Guangzhou South EMU Depot
Guangzhou Track Depot
Guilin EMU Depot
Hangzhou MTR Metro Line 1
Hangzhou Metro Line 2
Hangzhou EMU Depot
Harbin Industrial Company
Harbin Railway Bureau
Harbin Track Depot
Hasco
Hengyang Track Depot
Huzhou North EMU Depot
Jasontech
Jiangang Yangtzi
Jinjin Railway Bureau
Jining (Jinan) Engineering Machinery
Kunming EMU Depot
Lanyu Railway
Lanzhou EMU Depot
Lanzhou Railway Bureau
Maanshan Steel
Mechanical Track Depot of Xi’an
Nanchang Railway Bureau
Nanjing Metro Line 3
Nanjing Metro Line 4
Nanjing Metro Line 5
Nanjing Metro Line 6
Nanjing Metro Line 7
Nanjing Rail
Nanjing & Sanya EMU Depot
Nanning EMU Depot
Nanning EMU Depot
Nanning Railway Bureau
Ningbo EMU Depot
Ningbo MRT Line 1
Ningbo Metro Line 3
Qingdao EMU Depot
Qingdao Metro Line 13
Qiqihar Locomotive
Sanya EMU Depot
Schlad Heife
Shanghai EMU Depot
Shanghai Metro
Shanghai Railway Bureau High Speed
Shanghai University of Eng. Science
Shanghai Yangtze Track Depot
Shenyang EMU Depot
Shenyang Metro Line 1
Shenyang EMU Depot
Shijiazhuang Metro Line 1
Sichuan Kunxinda
Sifang Railway Vehicle Co. Ltd.
Southwest Jaistong University
Taiyuan EMU Depot
Taiyuan Railway Bureau
Tangshan Railway Vehicle Co. Ltd.
Tianjin EMU Depot
Tianjin Metro Line 2
Urumqi EMU Depot
Urumqi Railway Bureau
Vossloh AG
Wuhan Fanya
Wuhan Hanyang Team
Wuhan Railway Bureau
Wuxi Metro Line 1
Wuxi Metro Line 2
Xi’an EMU Depot
Xi’an Metro Line 4
Xi’an Railway Bureau
Xining EMU Depot
Yanan Track Depot
Yanchengbei Highspeed Train
Zhejianghu EMU Depot
Zhejianghu Railway Bureau
Zhejianghuoqiao Track EMU Depot
Zhuzhou Highspeed

Colombia
Metro de Medellin

Czech Republic
Dopravni podnik hlavnho mista Prahy a.s.
LERO Express a.s.
METRANS DYKO Rail Repair Shop s.r.o.
Plzeňské městské dopravní podniky a.s.
Škoda Transportation a.s.

Danmark
Baxedanmark
DSB
Lokaltog A/S
Metro Service

Estonia
Estonian Railway Inspectorate

Finland
Bombardier
HSL-Motoköönnönen
Tampere University of Technology

France
Alstom
Bombardier
CEP
Chemins de fer de la Corse
Cigellerie
Colas Rail
Eurotunnel
Keolis Bordeaux
Keolis Lyon
La Cabine
Logitrade (Amay)
Nancy-Train
RATP
RTM
Scotrail
Semistad
SNCF
TARIF
Transpole
Volunteer SAS

Germany
Adler
Atlassian
Chrysler Rail Systems
Alstom HLB Sabagibi
Bahntransporte
Bayrische Oberlandbahn
Becton GmbH
Berliner Verkehrsbetriebe
Bochumer Verein
Bogestalt
Bombardier Transportation
Brunel
Chemnitzer Verkehrsgenossenschaft
DB AG Berlin

Greece
STASY S.A.
Urban Rail Transport S.A.

Ireland

Pakistan

Poland

Portugal

Romania

Serbia

Slovakia

Spain

Sweden

United Arab Emirates

USA

Ukraine

USA

Venezuela

Vietnam

Washington D.C.

Yemen

Zambia

Zimbabwe

Authors

R. Koeppen

Editors

R. Koeppen

Prepared by

R. Koeppen

ISBN

210-000332-9

Publisher

R. Koeppen

Year

2009

Printed in

R. Koeppen

342 West 47th Street

New York, NY 10036

www.miniprof.com

© 2009 R. Koeppen

All rights reserved

No part of this publication may be reproduced in any form without the written permission of the publisher.

Printed in

R. Koeppen

342 West 47th Street

New York, NY 10036

www.miniprof.com

© 2009 R. Koeppen

All rights reserved

No part of this publication may be reproduced in any form without the written permission of the publisher.
The MiniProf systems are used globally in various combinations by thousands of users, and are distributed and supported locally by a vast agent network covering more than 50 countries. A complete list of MiniProf agents and users can be found on www.greenwood.dk
Greenwood Engineering A/S

With more than 25 years of international experience, a representative office in China and local agents in more than 50 countries, Greenwood Engineering is the leading manufacturer of highly specialised measuring equipment for monitoring and condition surveys in the global road and railway sector.

The wide product range spreads from the handheld and lightweight MiniProf ™ units for measuring and analysing the cross sectional profile of train wheels, rails and brakes to the big-size Traffic SpeedDeflectometers (TSD) for network level bearing capacity measurements on roads while driving at normal traffic speed.

Since the establishment of Greenwood Engineering in 1992 by Leif Grønskov, the basic premise for all marketed products has been an uncompromising high technological level, a wish to be at the frontier in the business and to present top of the range solutions operating with the least disturbance to environment and traffic and with the highest safety to the user of the equipment.

With thousands of various measuring systems distributed and used all over the world, Greenwood Engineering has a strong position on the world market! The continuous focus is to maintain close customer relations, to develop products in an on-going process and to keep and always strive towards reaching even higher technological levels.
Head Office

Denmark

Greenwood Engineering A/S
H. J. Holst Vej 3-5C
DK-2605 Brøndby
Denmark

Phone: +45 3636 0200
Fax: +45 3636 0001
E-mail: miniprof@greenwood.dk

Find your local agent and more information at www.greenwood.dk

Full contact - Your way to valid and reliable data