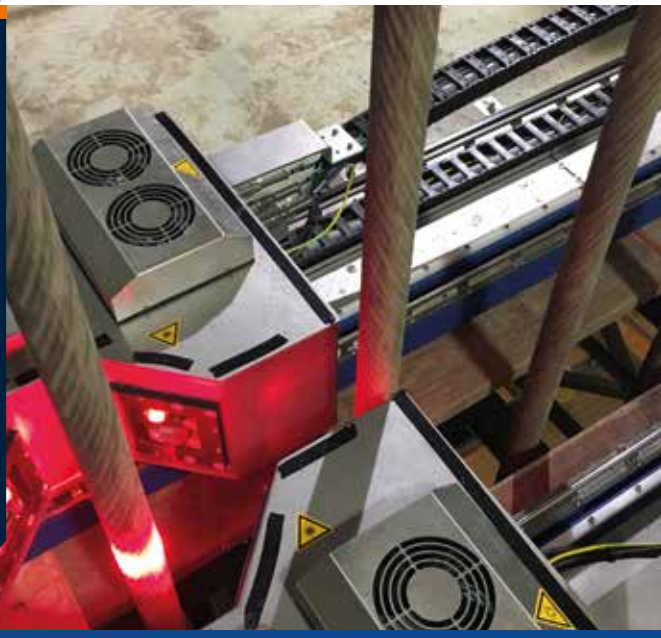
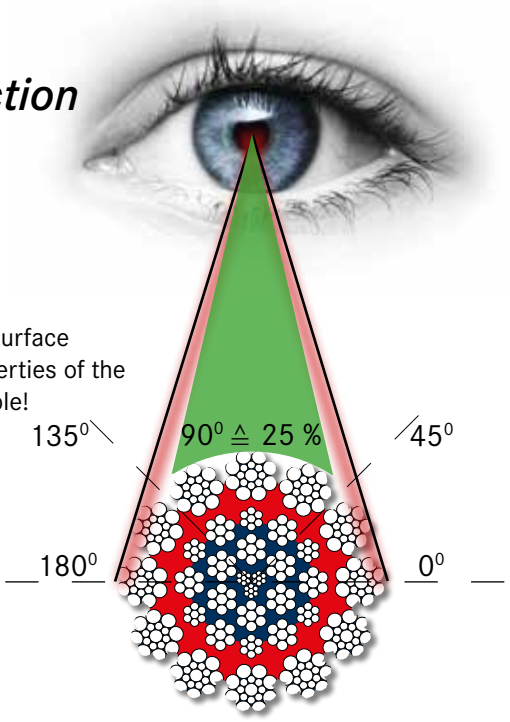
CRIS

CAMERA-SUPPORTED ROPE INSPECTION SYSTEM



The weaknesses of conventional rope inspection carried out with the naked eye...



Rope inspection by a human observer

Theoretical visibility of the rope surface: 180° or 50 % of the rope surface
Although because of the curved surface and the physiological properties of the human eye demonstrably only 25 % of the rope surface is truly visible!

Restricted field of vision

- One person can inspect only 25 % of the whole circumference of the rope

Working conditions

- Poor ergonomics, damp, dusty, draughty, dark, cold
- Danger from moving parts
- Harsh conditions for highly qualified personnel
- Great and protracted concentration by the inspecting personnel is required

Poor reproducibility of inspection results

- Diameter reductions and fluctuations in lay length are difficult to detect
- Wire breaks: type, number, distribution and time of occurrence are not documented
- High rope speed and rope number lessen the likelihood of fault detection by human inspection.

Reduced hoisting rate

- Visual inspection by human inspector at a rope speed of approx. 0.5 m/s
- Cessation of hoisting for at least 60 minutes to enable inspection of a rope 1,500 mm long
- Daily rope inspection means reduction of hoisting capacity by about 4.2 % (60 min/24 hrs)

Types of rope damage

- **Broken wires protruding from rope**
- **Basket/bird-cage formation**
- **Change in diameter**
- **Change in lay length**

Wire break with protruding wire pieces

Basket/bird-cage formation

The principle of camera-supported rope inspection with check of the whole rope circumference by means of four cameras ...

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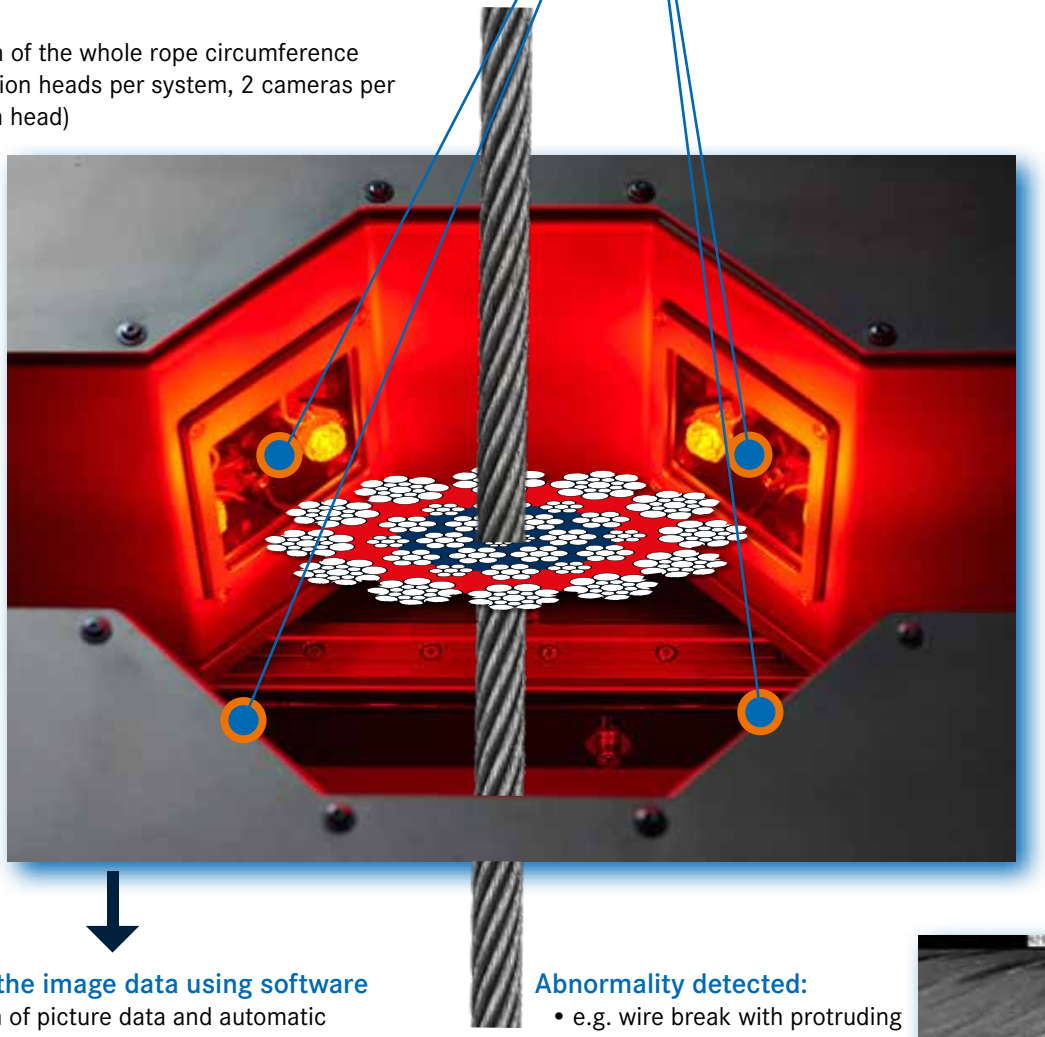
Rope inspection by means of four high-performance cameras

- Inspection of the whole rope circumference (2 inspection heads per system, 2 cameras per inspection head)

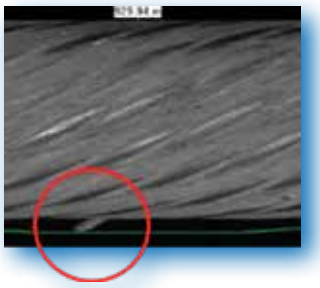


Analysis of the image data using software

- Evaluation of picture data and automatic detection of anomalous rope sections
- Preparation of an abnormality report

Abnormality detected:

- e.g. wire break with protruding piece of wire



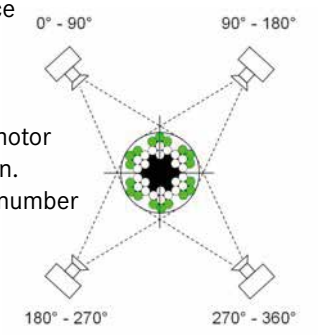
Assessment of abnormalities by qualified specialist personnel

- Final expert assessment by an inspector of all abnormalities detected by the system and assessment of the relevance of each abnormality (e.g.diameter, lay length, protruding wire breaks)

CRIS Syste

Inspection units

- Two inspection heads per system, two cameras per inspection head
- Photographic recordings at rope speed of up to 20 m/s
- Visibility of the whole rope circumference thanks to four cameras
- Lighting by means of high-performance LEDs that are fitted into the housing
- Each inspection head contains its own motor to shift the unit into the required position.
- A rail system enables CRIS to inspect a number of parallel ropes one after the other.



Terminal box for encoder

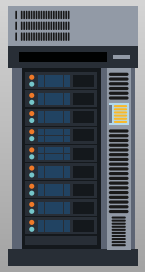
- Power supply
- Conversion of encoder signal into an optical signal
- Suitable for rope sheaves up to 8.2 m in diameter

Encoder

- Fastened to the axle of the rope sheave of the rope to be inspected
- Over 12,000 signals sent to the CRIS software per revolution of the rope sheave to determine the position of a rope section to the nearest centimetre

Control cabinet

- Power supply to the inspection heads
- Computer with switching and control units
- KVM extender for keyboard, video and mouse; max. lead length 500 m (fibre-glass)
- USB ranger for transmission of data; max. cable length 500 m (fibre-glass)



- Transmission via KVM/USB extension of rope recordings from CRIS computer in the control cabinet to the PC on which inspection of the image data is to be carried out

Cooling

- System designed for ambient temperatures of between -10°C and +45 °C
- Control cabinet and both inspection heads are each fitted with a heating and a cooling unit.
- At higher or lower temperatures remedial measures must be taken by the customer to enable an inspection to be conducted.

m Overview

Control system

- I/O interface for digital communication with the higher-level hoisting control system
- Offering various transmission options, e.g. Profinet or Profibus

Input to CRIS and others

- Start/stop acquisition
- Request for the desired rope position
- Request for parking position
- Request for position change

Output from CRIS and others

- System ready
- Recording in progress
- Feedback on recording status
- Active rope position

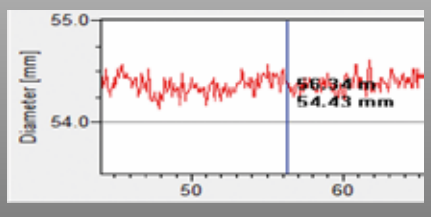
Manual control: enables changeover between manual control and external control (hoisting control system).

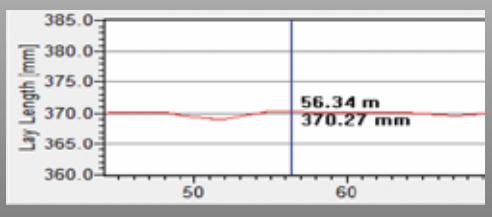
Hardware diagnosis: shows general information about system status. Transmitted signals from the hoisting system control can be traced.

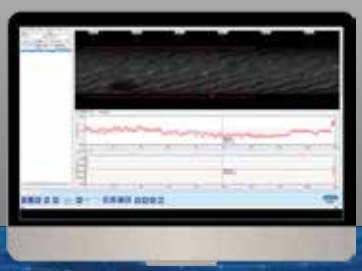
Temperature diagnosis: observation of temperature inside the control cabinet and inspection unit.

Evaluation software (CRIS computer in the switch cabinet)

- Analysis of image data by means of software
- Analysis conducted independently of the time and place of picture data recording
- Automatic detection of anomalous rope sections (output in a list with localisation)
- Generation of plots for the factors „Diameter“ and „Lay length“ together with detection of diameter changes and changes in lay length along the whole length of the rope
- Preparation of an abnormality report: anomalous image points are continuously added to the abnormality list during the inspection run of the evaluation software.







Benefits of camera-supported rope inspection

Qualitative benefits

- Comprehensive and reproducible inspection results
- Higher hit ratio when detecting fault points as compared with visual inspection with the naked eye
- Monitoring of ropes during the whole of their service life: Starting condition and abnormalitiess
- Preparation of an inspection record
- Better plannability of maintenance work
- Digitisation of rope inspection and so integration into an increasingly digitised mining environment with hoisting system monitoring

Financial benefits

- Reduced personnel requirement
  - Amortisation of system purchase after just a few inspections
  - Personnel can concentrate on their regular tasks.

- Operative benefits
  - Inspection of a number of ropes without the need for conversion work
  - Extended service life of ropes and lifting gear

- Less restriction of daily hoisting capacity
  - Gain in hoisting time per day: **+2,2 hrs**

Example calculation:

4-rope Koepe winding machine

Rope inspection length:	1,000 m
Hoisting operation/day:	24 hrs

Conventional rope inspection 0.5 m/s

Time needed for regular maintenance:	1.0 hr
Time needed for regular inspection:	2.2 hrs
Remaining hoisting time:	20.8 hrs

Camera-supported rope inspection 20 m/s

Time needed for regular maintenance:	1 hr
Time needed for inspection with CRIS:	0 hr
Remaining hoisting time:	23 hrs

Safety benefits

- No persons in the danger zone of the operating ropes
- Minimised danger to and stress on the inspection personnel
- Less worry for persons responsible for personnel
- Less trouble with occupational health & safety personnel (OH&S) in emergencies
- Control from mine control centre
- Easy system management
- Better detection of faults that fall under the criteria for the discarding of ropes

Personal rope inspection is always bound up with considerable personal danger. Insurance companies recommend avoiding dangerous activities and danger zones in particular.

CRIS supports the operator in the implementation of this recommendation: CRIS enables time spent in areas where there is danger from moving ropes and the risk of falling down the shaft to be reduced.

Hoisting system analysis

New installation and retrofitting on both SIEMAG TECBERG hoisting systems and other makes
To ensure the best possible preparation for carrying out a project a hoisting system analysis to be conducted by one of our experts on site is arranged.

After exhaustive preparation at the main works specially developed inspection equipment is despatched for the shaft hoisting system. Over the course of altogether three days on site, after presentation of the system and explanation of further procedure for the benefit of staff that you have designated for this work, first of all the inspection equipment is installed and trial recordings made with the camera system.

At the same time an inspection of the hoisting system and an examination of the technical documentation and documentation components are conducted jointly with your designated experts who have the required information relating to the mechanical, hydraulic and control systems of this hoisting machine and their installation in the shaft hoisting system.

All the necessary information is exchanged among experts in order to work out the best possible concept and its subsequent implementation. The data obtained in this process is evaluated in the main factory and processed for the subsequent positioning and assembly of the system, as well as the fine adjustment of the camera optics.

Procedure for analysis of the hoisting system

Step 1
- Safety briefing of operator
- Presentation of CRIS
- Clarification of technical requirements for installation of CRIS
- Presentation for persons concerned (project manager, operator, etc.)
- Explanation of procedure over the following two days
- Expert assessment of possible installation points
- Recordings of the ropes under different operating conditions

Step 2
- Installation of test equipment

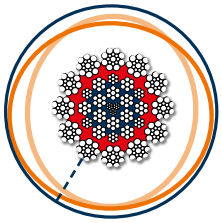
On-site requirements for analysis of the hoisting system

- Electrical system
  Power supply for camera system and notebook (110 V up to 240 V/50 Hz)
- Space
  Space for inspection heads on the rope 850 x 850 x 550 (mm)
  No objects between inspection heads and rope
  Sufficient space for wiring of the inspection heads and the flight case (provisional switch cabinet)
- Tools
  Hand drill; wood screws dia. 5 x 80; wooden board as underlay for the inspection heads with U cut-out
- Documentation
  Image documentation of possible installation sites for the encoder; completion of design and layout data (diameter of deflection sheave); analysis of rope condition, analysis of critical rope sections
- Installation
  Flight case, 2 inspection heads, notebook

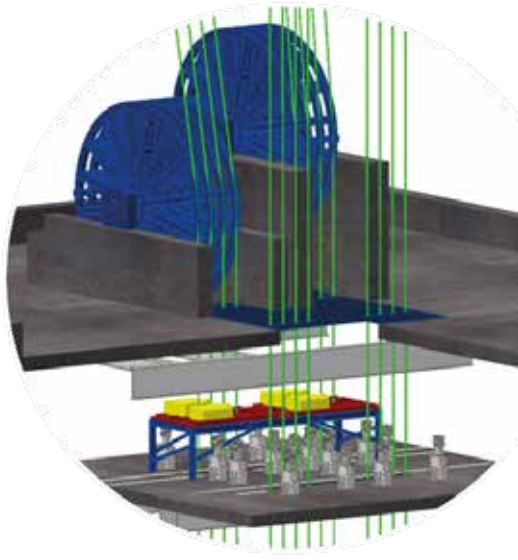
Installation

General requirements for the installation point
The system must in all cases be installed close to a rope guide such as a deflection sheave or a traction sheave. The closer the inspection system is installed to the rope guide, the weaker rope vibration will be. The permitted displacement range of the rope is fixed at a radius of 12.5 mm. The rope may move within this range.

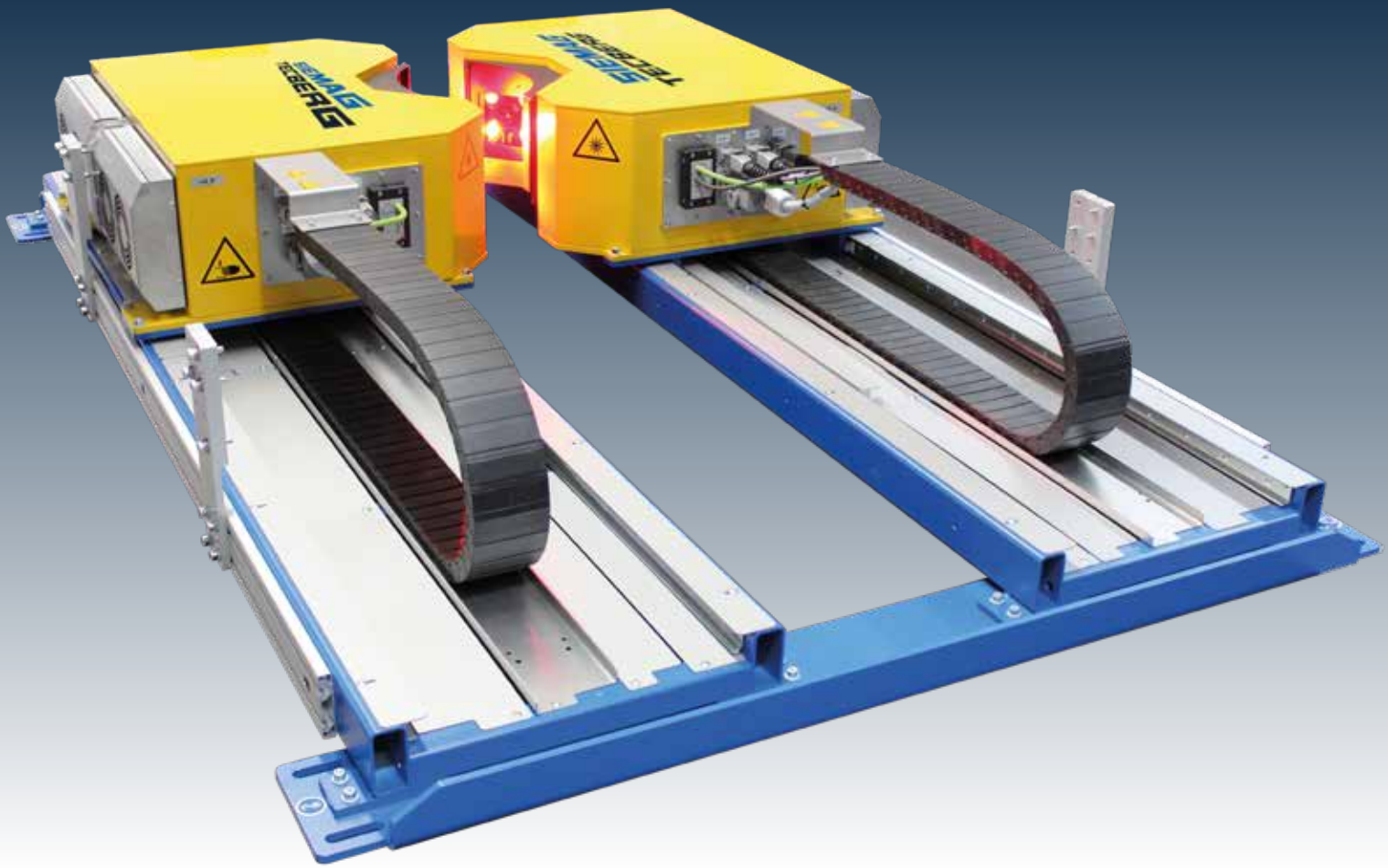
The inspection heads must be set at an angle of 90o to the rope. If necessary, a platform must be provided for this by the customer. This platform must enable wear on the rope sheaves to be compensated for by sidewards movement of the platform



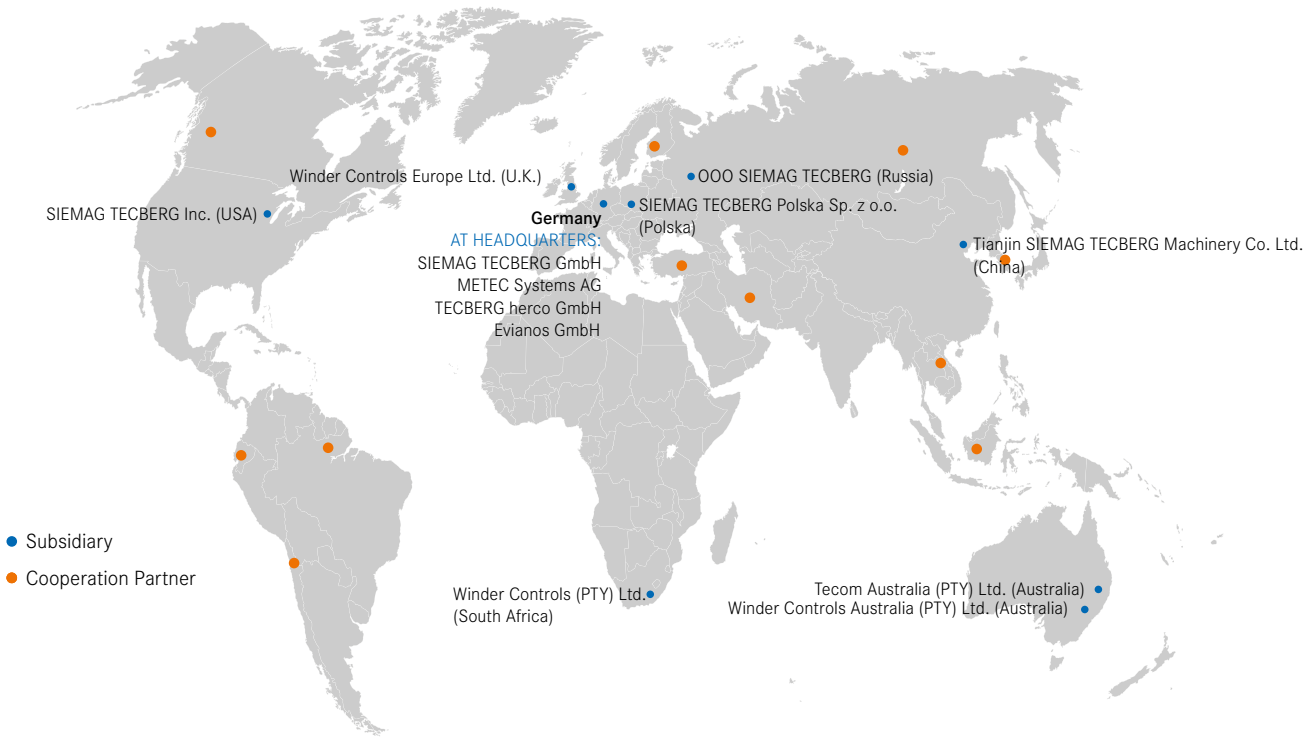
Maximum radius of the rope displacement range: 12.5 mm



Maximum cable lengths between components of the system
- 9 m cable length between rail system and switch cabinet
- 10 m cable length between encoder and terminal box



Locations and collaborative partners of the SIEMAG TECBERG Group



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