Rope Technology
RESEARCH
DEVELOPMENT
TESTING SERVICES
The Rope Technology department conducts application-oriented research and development and implements it in a wide variety of research and industrial projects. The range of services includes a variety of different testing methods, both destructive and non-destructive. Testing is performed on steel wire ropes and fiber ropes in stationary or running applications. Non-destructive rope tests are mainly used in ropeway technology, elevators, materials handling equipment in the industry or constructions.

Another focus is on new and further developments of rope testing devices, test rigs and their components. For rope testing, the IFT’s 1300 m² testing laboratory is equipped with testing machines and devices, most of which were developed in-house.

As a worldwide recognized testing and expert body, the department prepares damage assessments as well as safety and risk analyses. Furthermore, the department advises industrial companies as well as operators of facilities and constructions with regard to the customer-specific application of ropes.
DESTRUCTIVE ROPE TESTING

ROPE LABORATORY WITH TEST EQUIPMENT FOR DESTRUCTIVE ROPE TESTING

The testing facilities for ‘destructive rope testing’ are located in the rope laboratory on an area of almost 1,300 square meters with hall heights of up to 14 meters. In addition to wire tests, such as bending tests, rotating bending tests or the determination of coating layers, static and dynamic rope tests such as tensile, tension-tension and fatigue bending (CBOS) tests can be carried out under laboratory and practical conditions. There are 4 tensile testing machines with a maximum tensile force of up to 2,500 kN (dynamic up to 2,000 kN) available for the tests. For extensive serial tests the IFT has 20 test stands on 15 fatigue bending machines with a rope tensile force of up to 500 kN and rope diameters of up to 60 mm available.
APPLICATION AND TEST METHODS FOR ROPES AND SIMILAR TENSION MEMBERS

Range of activities and services

Calculations are carried out using analytical formulas and the finite element method for the verification and characterization of facts such as stress curves and service life or for the derivation of principles as well as for the optimization of materials.

Bending Fatigue Tests (CBOS)

For the correct dimensioning of ropes, tests with ropes under cyclic bending over sheave (CBOS) are carried out in which the rope is bent over a test sheave over a large number of bending cycles and the number of wire breaks is read off at a regular interval. The bending cycles determined from this up to discard are a fixed value that specifies the operating time in the respective application. The lengthening behavior of the ropes can also be recorded on 13 bending machines during the continuous cyclic bending of the rope.
Rope research

In-house developed specialized test equipment, that can be used for example to investigate the rotational behavior of rope constructions, reverse-bending, the influence of deflection, the pairing of rope and pulley or to analyze the influence of groove profiles in the elevator area, are available for innovative research.

For example, a test stand was developed and constructed to investigate the loads on elevator ropes. The elevator test stand is equipped with five deflection sheaves switched in alternating direction one after the other. Due to these many deflections, the ropes are very quickly damaged and their lifetime is reduced until they are ready to be discarded and until they break. The damage mechanisms that occur are analyzed in order to obtain a better understanding of the arrangements of deflection sheaves that occur in practice. Any arrangement of a large number of deflection pulleys is possible here.
TEST METHODS

Tensile tests

Ropes are tested in tensile tests with a continuous increase of the test load until their complete failure. This determined breaking load is an important parameter, especially for safe dimensioning of ropes. For static tensile tests or dynamic tension-tension tests, IFT has testing machines with tensile forces up to 2,500 kN statically and up to 2,000 kN dynamically. Furthermore, it is possible to carry out strain and creep measurements on ropes while performing endurance tests and to record deformations at the rope end connections using strain gauges. Additionally, the ropes can be monitored during tests with the non-destructive magneto-inductive testing method.

For special cases, the ropes can be examined under conditions simulating the intended application. For example, IFT did already conduct tension-tension tests of over 1 mio. cycles with the sample lying under water.

Tensile testing machine 2,500 kN
Tension-tension tests on ropes

Changing deformations of the rope structure occur for wire and for fiber ropes. Wire ropes in particular are often subject to a stress spectrum consisting of bending and torsional stresses as well as other so-called secondary stresses and pressures. To determine the rope lifetime for this type of load setup or to ensure an economical operating time for rope and end connection, tension-tension tests are necessary. To that end, the rope is cyclically loaded with a specific load amplitude, starting from a constant mean load. For example these tests are used to simulate different traffic loads or wind loads.

The results of the tests are eventually used to make statements about the point of time when the rope needs to be renewed, the so-called point of discard, and can be finally used in the application-dependent dimensioning.
HIGH MODULUS FIBER ROPES

DESTRUCTIVE AND NON-DESTRUCTIVE TESTING

Fiber Ropes

IFT is investigating the usability, service life and discard detection of fiber ropes in a wide range of applications. In research projects, for example, the possible applications of high modulus fiber ropes for storage and retrieval machines or the influence of highly dynamic movements in cable driven parallel robots were investigated. In addition to these publicly funded projects, student projects are regularly carried out in order to gain more detailed knowledge.

Compared to steel wire ropes, fiber ropes have often significantly higher bent fatigue strengths, which means that much higher numbers of bending fatigue cycles can be achieved until discard with the same bend radii. Alternatively, smaller bend radii can be realized without having to accept the loss of service life known from steel wire ropes.

Fiber rope on single layer winch
Additional lubricants are not required due to chemical surface coating of the fibers. This simplifies maintenance and inspection and opens up new fields of application and areas. The widespread use of fiber ropes still faces many questions that have not yet been sufficiently researched. These are processed by IFT within the framework of industrial and funded rope research (e.g. DFG, AiF).

**Destructive and Non-Destructive Testing**

Approaches to non-destructive testing are being investigated at IFT in industrial and publicly funded projects. For example, the Winspect visual rope inspection device developed for ropeways is being further developed for the non-destructive monitoring of highly modular fiber ropes and enables the digital visual surface inspection shown here.
Fields of activity and range of services

The area of ‘non-destructive rope testing’ is mainly concerned with rope testing in passenger transportation technology and is in close contact with operators all over the world due to many years of cooperation and trust. Our work focuses on various new and further developed practice-oriented rope testing methods, the testing and monitoring of installations as well as questions concerning ropeway technology.

As a service, both magneto-inductive rope testing and the calibration of rope testing devices are offered and carried out. The magneto-inductive testing devices and the mobile PC data acquisition and processing, both developed at the institute, are constantly being further developed.
NON-DESTRUCTIVE ROPE TESTING, ROPEWAY TECHNOLOGY

Services

- Magneto-Inductive Testing
- Visual Rope Testing
- Regular Inspections
- New Construction Inspections
- Special Inspections
- Damage Assessments
- Destructive Rope Testings

Approvals

- Recognised Expert Body for Ropeways (according to BayESG)
- Notified Body for Ropeways, Modul G NB 1771

Visual inspection system used to inspect ropeway ropes
For magneto-inductive testing, 7 different standard test devices have been developed so far. They allow non-destructive inspection of wire ropes with diameters from 4 mm to 140 mm as well as of parallel wire bundles as used in bridge construction. The testing devices are distributed by our long-term partner Mesomatic GmbH.

For measurement data acquisition, the SMRT 1.5 add-on box was developed for the previously available test devices. This contains both the measurement hardware and a WLAN module with which the measurement data can be transferred wirelessly to a measurement computer. The electronic measurement data acquisition and processing as well as the automatic analysis software of the rope testing systems offer an immediate analysis of the measurement data on site and thus ensure reliable results. The IFT’s magneto-inductive testing devices have been used successfully for many years by various rope testing centers worldwide for measuring mountain railway ropes, crane systems and shaft hoisting systems.
VISUAL ROPE INSPECTION

The visual inspection of the ropes on site means a high potential danger for the inspection personnel that should not be underestimated. The risk of injury or fall of the inspector as well as the possibility to miss damaged areas due to prolonged monotonous observation are only some of the risks of the procedure used so far. New non-destructive rope testing methods such as the technically supported visual rope inspection developed by the department in a research project offer the possibility of viewing ropes close to the surface in a safe on-screen environment. The diameter and lay length progression of the rope over the entire tested length is also visible to the inspector. The digitization of the visual inspection offers a considerable advantage in terms of security, damage detection, reproducibility, documentation and thus increases the reliability of results.

Visual inspection devices can be used not only in the ropeway but also in shaft hoisting systems and on static ropes. For example, in bridge rope examinations, they may replace cost-intensive and complex use of temporary consoles or use of hydraulic platforms for manual visual inspection.
In magneto-inductive testing, a rope-surrounding coil is usually used as the measuring sensor. However, by this, it is not possible to determine the exact position of the wire breaks on the cross-section of the rope with the rope-surrounding coil. The evaluation of the measurement signals of wire breakage accumulations is also extremely complex.

In comparison, the high-resolution magnetic rope testing method developed at IFT offers the possibility of three-dimensional resolution and display of the measurement data recorded with the aid of Hall sensors. This makes it possible to clearly determine the position of wire breaks in the rope and to assess wire break accumulations more precisely.
Offshore technology has its own requirements when it comes to ropes. In addition to the aspects of destructive and non-destructive basic research, the area of offshore technology addresses the aspects of environmental impact and material behavior in particular.

The rope drives in offshore applications must be differentiated from those operated on shore. The high effort for maintenance requires extraordinary reliability and availability of the ropes. At the same time, the high dead weights resulting from the large rope lengths and diameters used for example for installations on the seabed, lead to very special demands regarding the rope drives. This results in research fields that deal with issues such as rope elongation, multi-layer spooling or the active heave compensation (dynamic rope loads).

Furthermore, the use of high modulus fiber ropes is becoming more and more common. The advantages are the weight reduction and the low density of the fibers which makes them in some cases floatable on the water. There are open questions regarding the tensile, bending, elasticity and failure behaviour of fiber ropes as well as their service life in offshore applications. By developing specific test rigs, these questions are analysed in detail in close cooperation with component manufacturers and end users (e.g. operators of pipeline laying vessels). Real life load cases on the rope are reconstructed and discard criteria are defined.
INDIVIDUALIZED TESTING
PROTOTYPE TESTING

Destructive and non-destructive rope testing

By merging the many years of experience available at IFT and the competence in the field of destructive and non-destructive rope testing, as well as measurement technology, a flexible reaction to individual test requirements is possible.

Specific requirements for the test setup, the required measurement technology, and necessary auxiliary constructions and devices can be flexibly planned and produced in-house. In this way, a large number of special tests could be carried out in the past. Examples include tensile tests with stainless steel wire ropes to determine their breaking load at very low temperatures (with the help of liquid nitrogen), fatigue bending and tension-tension tests in normal water and salt water surroundings, simulations of safety-relevant defects in rope drives such as rope derailment with running ropes or diagonal pull bending and tensile tests with large polyamide deflecting sheaves.

All tests can be combined with non-destructive testing methods such as magneto-inductive or visual testing.

Top right image: Examination of diagonal pull tensile strength of PA sheaves
Bottom right image: Test setup for the determination of the influence of salt water on the tension-tension fatigue for ropes in offshore applications
DA mage Assessments
And rope drive analyses

\[ \lg N = b_0 + \left( b_1 + b_2 \times \lg \frac{D}{d} \right) \times \left( \lg \frac{S}{d^2} - 0,4 \times \lg \frac{R_0}{1770} \right) + b_3 \times \lg \frac{D}{d} + \lg f_d + \lg f_s + \lg f_k \]

Lifetime-formula developed by Prof. Feyrer

Lifetime and stress calculations

Based on the lifetime formula for running steel wire ropes empirically developed at IFT, analysis of real applications of rope drives are done. For this purpose, we can rely on extensive experience from more than 80 years of rope research in the definition of key figures for different rope constructions, rope diameters and materials.

The calculation with the aid of the lifetime formula enables the detection of possible weak points and provides information for a good rope use and at the same time economical design of the rope drives. The range of calculated rope drives extends from hoists and cranes to ship lifts and elevators to amusement facilities. Calculations using other methods, such as those described in the standards, are also possible.

As an independent institute, IFT also deals with damage cases in which the expected rope service life has not been reached or damage has occurred to elements of the rope drive. Among other things, a modern digital microscope is used to perform high-resolution investigations in the micrometer range and is mainly an important tool for fracture analyses.

Images on the right: Simulation of rope derailment of a running fiber rope
The Rope Technology Department constantly develops within the scope of research and industrial projects new methods for destructive and non-destructive rope testing, for example terminations for high modulus fiber ropes. In the field of destructive rope testing, for example, modifications were made to bending machines to perform tests with defined twisted ropes. Furthermore, complete testing machines are designed and developed to meet specific customer requirements.

**Rope production monitoring**

Wire breaks or faults can occur in ropes not only during use, but also during rope production. The rope production monitoring system developed at IFT offers automatic fault monitoring and shutdown of the production unit and thus timely and reliable supervision of the production process. The quality control, integrated in the rope manufacturing process, also provides the user with a decisive advantage in rope production and for the customer due to the reliable and precise documentation.

**Development of an image-based method for detection of discard with high modulus fiber ropes**

Reliable detection of discard is important for the full use of running high modulus fiber ropes in storage and retrieval machines. Unlike steel ropes, for which a point of discard is defined in ISO 4309, there is no such regulation for high modulus fiber ropes. In research projects, the IFT determines the time of discard using a line camera. During operation, this camera takes regular images of the rope in a rope-driven system over its entire service life. These recordings are evaluated on a software basis. The measurement data can help determine and predict the discard maturity of a high-strength fiber rope. The findings of the research project are to be incorporated into a market-ready device.
RESEARCH TRANSFER OF
A MONOLITHIC ROPE TERMINATION
FOR HIGH MODULUS FIBER ROPES

In the near future, high-modulus fiber ropes will play an increasingly important role in materials handling tasks and replace wire ropes in this respect. Conventional rope end connections such as splices, rope clips or knots cannot fully transmit the rope breaking force. For this reason, a novel rope end termination, called ‘HIKE rope end termination’ with integrated sensor technology for high-modulus fiber ropes was researched and developed at the IFT. It is characterized by a lower weight, high resistance to cyclic loadings and the transmission of high relative breaking forces.

The transfer project, based on the HIKE I and HIKE II research projects (Hybrid Intelligent Construction Elements research group), aimed to transfer the research results of the monolithic rope end termination invention to the industry. Numerous tensile and tension - also tension-tension tests as well as bending tests were carried out on ropes with diameters between 4 mm and 50 mm. Continuous development of the manufacturing process and the associated knowledge made it possible to achieve the defined market maturity. Up to a rope diameter of 50 mm, the expected breaking load of the HIKE rope end termination is at least 90% of the minimum breaking load (MBL) of the rope. Tensile threshold strength was also achieved in accordance with the EN 13411-6 standard, which requires a fatigue strength of 75,000 load cycles between 15 % and 30 % of the MBL. Furthermore, a force measurement system was successfully integrated into the HIKE rope end termination. Innovative monitoring of load collectives can thus enable preventive maintenance for fiber ropes in the future.

Tension-tension testing of HIKE
Since 1950, IFT has been certified and recognised as an expert body for ropeways and ski lifts. The recognized field of activity of the expert body include expert advice on all aspects of ropeways technology, the appraisal of installations, their safety components or subsystems, as well as the compilation of damage and condition reports for construction, maintenance and operation of ropeways and ski lifts. The Notified Body (NB 1771) carries out certifications according to Module G of the Ropeway Regulation.

The following services are offered:

- Examination of the technical documents and the operational safety of ropeways and the preparation of corresponding test reports and expert opinions.
- Execute the certification of ropes.
- Examination of the technical documentation of new ropeway installations as well as the acceptance of significant modifications to existing installations.
- Regular inspection of the technical condition of the installations.

Acceptance of the Zipline Astenkick in Altastenberg
NOTIFIED BODY AND TEST LABORATORY FOR PERSONAL PROTECTION EQUIPMENT (PPE)

IFT is approved as a Notified Body (NB 1771) to execute conformity assessment procedures for personal protective equipment against falls from height (PPE) in accordance with the new PPE-Directive (EU)2016/425, valid since April 2018, throughout Europe. This entitles IFT to provide EU type tests on new PPE as well as the recurring tests required within the scope of product surveillance (module C2) of PPE category III. The IFT is also an approved testing laboratory for testing according to the testing regulations of the UIAA, the International Mountaineering and Climbing Federation.

For standard tests in the field of mountaineering, IFT provides, among other things, a dynamic drop tower with a drop height of about 8 m, in which via ferrata sets in particular are tested, in accordance with the 2017 published EN 958, as well as, for example, dynamic mountaineering ropes in accordance with EN 892 or low stretch kernmantle ropes in accordance with EN 1891. In addition, tests are often carried out on ropes, slings and tapes, as well as accessory cords. In the sector of UIAA-additional tests IFT can, for example, carry out measurements of energy absorbed before rupture, and water-repellent tests for mountain ropes according to the current UIAA 101.

Due to flexible conversion and adaptation possibilities of the test stands, new test methods are regularly developed and implemented and evaluated within the scope of initial tests. Through the cooperation of IFT in standardization in the field of mountaineering, newly developed test methods can be incorporated directly into the work of corresponding standardization committees. Thus IFT can offer its customers from the mountaineering and occupational safety industry flexible testing facilities adapted to customer requirements, as well as cooperation in the field of research.
TRANSER OF RESEARCH FINDINGS

COMMITTEES AND CONFERENCES

For application-oriented research, membership in rope technology associations and participation in committees form a platform for professional exchange, cooperation and development. The Rope Technology department is represented in the following technical committees and technical standardization committees and thus plays an active role in shaping innovations and developments:

**Cranes:**
- CEN/TC147 Cranes-Safety
- ISO/TC96/SC3
- Lenkungsausschuss Krane
- VDI Fachausschuss FA 304 „Krane“
- VDI Fachausschuss FA 629 „Seilschwingungen“
- CEN/TC242/WG3 Ropes
- DIN NA 099-00-04 AA Drahtseile
- European Federation of Steel Wire Rope Industries (EWRIS)

**Fiber ropes:**
- European Association of Rope, Twine and Netting Industries (EUROCORD)
- ISO/TC38/WG21 Ropes, Cordage, Slings and Netting

**PPE:**
- CEN/TC136/WG5 Mountaineering and Climbing Equipment

**Ropeways:**
- FSF-DIN Arbeitsausschuss Seilbahnen
- I.T.T.A.B. Internationale Tagung der Technischen Aufsichtsbehörden
- O.I.T.A.F. - Direktionskomitee
- O.I.T.A.F. Studienausschuss Nr.II: Eigenschaften und Prüfung der Seile
- Seilbahnausschuss im Länderausschuss für Eisenbahnen und Bergbahnen

**Notified Bodies:**
- NB 1771 Coordination of Notified Bodies

**General organizations:**
- OIPEEC Management Committee

Imparting and exchanging knowledge – we achieve this with our training for users and industrial customers. We supervise lectures and final theses in the fields of rope technology, safety engineering and passenger conveyor technology at the University of Stuttgart. At conferences and trade fairs we present our research activities and inform us about the latest developments, here are listet some:

- European Lift Congress
- Fachkolloquium Innozug – TU Chemnitz
- IMCA Rope Seminar
- Messe Mountain Planet 2014, Grenoble (F)
- Messe Wire
- OIPEEC Conference
- Seilbahntagung des Verbandes der Deutschen Seilbahner und Schleppfliite e.V. (VDS)
- Sommerbahntagung des Verbandes der Deutschen Seilbahner und Schleppfliite e.V. (VDS)
- Winspect Rope Academy
As a university research institute, the IFT offers a wide range of seminars and opportunities for further training and qualification. These range from the general requirements for ropes and their applications to specific areas such as testing, calculation, design and optimization. In seminars or workshops, the employees of the Rope Technology department impart their knowledge on issues related to ropes.

The Rope End Terminations seminar is held regularly in the Institute’s rooms and laboratories in Stuttgart. In addition to in-depth theoretical content, practical knowledge is also imparted here and put into practice by the participants in a workshop. The current dates are published on the website, desired dates for companies or users are possible.

Seminars with individual training content are also offered, tailored to the respective application or the needs of the target group. The offer ranges from pure lecture units to online offers and workshops lasting several days. Based on the respective content, the seminars can also take place on site or at the company.
## Destructive Rope Testing

<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. Rope Force</th>
<th>Quantity</th>
<th>Range of Rope Sheaves</th>
<th>Deflection possible</th>
<th>Tests under rotation possible</th>
<th>Reverse Bending possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running Ropes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bending machine (CBOS)</td>
<td>0.2 kN</td>
<td>1</td>
<td>30 up to 50 mm</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>2 kN</td>
<td>1</td>
<td>30 up to 50 mm</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>10 kN</td>
<td>2</td>
<td>120 up to 500 mm</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>15 kN</td>
<td>4</td>
<td>120 up to 500 mm</td>
<td>No</td>
<td>No</td>
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<td></td>
<td>30 kN</td>
<td>4</td>
<td>120 up to 500 mm</td>
<td>Yes</td>
<td>No</td>
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<td></td>
<td>100 kN</td>
<td>3</td>
<td>200 up to 1000 mm</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
<td>130 kN</td>
<td>1</td>
<td>200 up to 600 mm</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td></td>
<td>200 kN</td>
<td>1</td>
<td>200 up to 800 mm</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>500 kN</td>
<td>1</td>
<td>300 up to 3000 mm</td>
<td>No</td>
<td>No</td>
<td>Yes (with special construction)</td>
</tr>
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<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. static Rope Force</th>
<th>Quantity</th>
<th>Maximum Test Length</th>
<th>Possible Special Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Test Machines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 kN</td>
<td>1</td>
<td>10 Meter</td>
<td>Testing of Rope Torque, Youngs-modulus, longtime tests, and more</td>
</tr>
<tr>
<td></td>
<td>2500 kN</td>
<td>1</td>
<td>10 Meter</td>
<td>Testing of Rope Torque (up to 1250 kN), Youngs-modulus, longtime tests, and more</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. dynamic Rope Force</th>
<th>Quantity</th>
<th>Maximum Test Length</th>
<th>Possible Special Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension-Tension Test Machine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 kN (static: 75 kN)</td>
<td>1</td>
<td>3.1 Meter</td>
<td>Testing of Youngs-modulus</td>
</tr>
<tr>
<td></td>
<td>640 kN (static: 800 kN)</td>
<td>1</td>
<td>4.7 Meter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000 kN (static: 2500 kN)</td>
<td>1</td>
<td>8 Meter</td>
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</table>

<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. Rope Force/ Loading</th>
<th>Quantity</th>
<th>Maximum Test Length</th>
<th>Rope Diameter</th>
<th>Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction test stand</td>
<td>10 kN</td>
<td>2</td>
<td>8 Meter</td>
<td>bis zu 16 mm</td>
<td>Reverse bending possible</td>
</tr>
<tr>
<td>Multi-layer test stand</td>
<td>29 kN</td>
<td>2</td>
<td>14 Meter</td>
<td>16 mm</td>
<td>Three different D/d-ratios for the drum possible with changes</td>
</tr>
<tr>
<td>S/R-machine for fibre ropes</td>
<td>16 kN</td>
<td>1</td>
<td>8 Meter</td>
<td>16 mm</td>
<td></td>
</tr>
<tr>
<td>High dynamic test stand</td>
<td>8 kN</td>
<td>4</td>
<td>5 Meter</td>
<td>2 und 6 mm</td>
<td>Reverse bending possible</td>
</tr>
<tr>
<td>Drop test tower</td>
<td>150 kg</td>
<td>1</td>
<td>7 Meter</td>
<td>bis zu 14 mm</td>
<td></td>
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<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. Wire Diameter</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse bending test stand</td>
<td>2 mm</td>
<td>1</td>
</tr>
<tr>
<td>Rotary test stand</td>
<td>2 mm</td>
<td>1</td>
</tr>
<tr>
<td>Rotary bending test stand</td>
<td>2 mm</td>
<td>1</td>
</tr>
<tr>
<td>Wire transverse pressure test stand</td>
<td>2 mm</td>
<td>1</td>
</tr>
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## Stationary Ropes

<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. Wire Diameter</th>
<th>Quantity</th>
</tr>
</thead>
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## Special Tests

<table>
<thead>
<tr>
<th>Type of Test Equipment</th>
<th>max. Rope Force/ Loading</th>
<th>Quantity</th>
<th>Maximum Test Length</th>
<th>Rope Diameter</th>
<th>Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magneto-inductive devices</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SMRT 18</td>
<td>6 up to 16 mm</td>
<td>No</td>
<td>No</td>
<td></td>
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<tr>
<td>SMRT 25</td>
<td>10 up to 25 mm</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMRT 40</td>
<td>25 up to 40 mm</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMRT 60</td>
<td>40 up to 60 mm</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<td>SMRT 70</td>
<td>50 up to 70 mm</td>
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<td>SMRT 140</td>
<td>100 up to 140 mm</td>
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<td>Visual devices</td>
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<td>Winspect</td>
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<td>Bridge cable device</td>
<td>90 up to 140 mm</td>
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