

Solutions for Academia













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The Zwick Roell AG – more than a century of experience in materials testing

Mechanical-technological testing is one of the oldest disciplines of materials testing. As early as in the 15th and 16th century, Leonardo da Vinci and Galileo Galilei were already considering the flexural stressing and elastic behaviour of materials. In the course of time further knowledge was obtained. In the middle of the 18th century the first testing machines finally appeared in France.

Since 1920 the company Roell & Korthaus was involved in the materials testing business. In 1937 Zwick built its first testing machines and systems for mechanical testing of materials, and many years prior to that in 1876, a Professor Seger had founded a chemical laboratory as part of a scientific technological consulting company for non-metallic materials. During the 20th century the present company, Toni Technik, has evolved from these origins and is now considered a leading expert in test systems for building materials. MFL (Mohr & Federhaff) – a company that was founded in 1870 – became part of the Zwick Roell group and interestingly, Carl Benz (of Mercedes Benz fame) was one of their employees.

Since 1992, these companies have formed the Zwick Roell group, and in July 2001, the company group was converted into a stock corpo-ration: the Zwick Roell AG. Part of this stock corporation are the companies Zwick, Toni Technik, Indentec Ltd., and since may 2002 Acmel Labo. These companies supply an extensive program for materials, component, and functional tests – from the manually operated hardness tester up to a complex robotic test systems for the twenty-four-seven production control.

By acquisition of the German company GTM (2006) and the Austrian company Messphysik (2007) the know-how of the Zwick Roell AG in the field of force and elongation measurement has been safed and enriched.

Zwick has many years of experience, combined with a multitude of supplied systems, and this experience is continuously supplemented by constant communication with customers. On this solid base the company supplies a wide range of high-performance products - from the economical standard quality control machine up to customised solutions designs for specific test requirements. Modern mechanics, high-performance electronics and the application-oriented software are the prerequisite for the versatility and the high "intelligence" of these modern testing machines and systems.

The services of the Zwick Roell AG go far beyond the supply of products. In 1994 the company received its certification ISO 9001 accredited helping to guarantee a consistently high product and service quality. With its accredited calibration laboratories, the companies of the Zwick Roell AG are able to verify and calibrate test systems and to issue internationally recognized certificates.



Fig 1: The headquarter of the Zwick Roell AG and the Zwick GmbH & Co. KG at Ulm, Germany



2 Research and Training Solutions for Higher Education

Zwick has a long-standing global commitment to close involvement with both research and training.

Throughout the ages the development and application of new materials has played a vital role in our lives. More effective materials and the products made from them have repeatedly given sustained technological and economic momentum to our modern industrialized societies.

Around the world great effort is being put into the research and development of new material technologies such as lightweight construction materials, intelligent materials, biomaterials and composites, to name but a few.

This development is also reflected in education, with ever greater demands placed on materials specialists, whether in higher education or industry.

A highly flexible, modular approach allows Zwick standard components to be used for the simplest machine or in complex research applications.

Zwick's effectiveness in providing solutions specifically for higher education is based on:

- Optimized hardware solutions, powerful and flexible software plus virtual teaching software specially developed for training – all ideally suited to your requirements
- A team dedicated to this sector and always ready to assist with planning your laboratory, selecting suitable equipment or finding a partner from our worldwide network

This special support underlines the outstanding importance attached by Zwick to higher education, in the light of the challenges which new materials present to research and materials testing.

One of the primary aims in the development of new materials is the reduction of energy consumption and a corresponding decrease in CO² emissions. To achieve this calls, among other things, for lighter materials which can withstand high temperatures. Reliable, flexible testing systems are also essential for the development of new, modern materials.

Countless successful projects in both research and training confirm Zwick's credentials as the ideal partner for your requirements. We are constantly working with universities and testing institutes to develop special testing applications; the continuing success of products born out of this collaboration contributes in no small measure to Zwick's outstanding position today.

Become a part of this successful and internationally active network and reap the benefits of our state-of-the-art equipment and wide-ranging expertise.



Fig 1: testXpert® Education Module

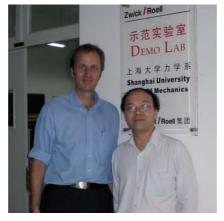


Fig 2: Zwick is your partner for individual laboratory equipment



Fig 3: Special testing machine for R&D

Varied Applications for Higher Education

Zwick is active in more than 20 different sectors, with testing systems to suit all of them.

With its own applications laboratory and trained specialists in all relevant fields, Zwick can provide sophisticated solutions for any application.

Many of the testing applications used in these sectors were developed in collaboration with universities. This close co-operation ensures that Zwick is actively involved in current developments.

In this way Zwick contributes to the exchange between industry and higher education.

Zwick's many patents testify to our innovative drive.

In addition to this commitment to universities, Zwick is represented on numerous international standards committees, where our state-of-theart expertise is applied to standardized industrial applications.

This wide-ranging experience from a broad spectrum of applications can be used to advantage in your labora-

Industry Overview





Paper



Metals



Food/Packaging





Mechatronics





Building Materials





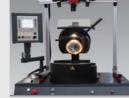
Aerospace

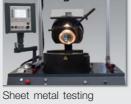
Testing of Metals



Pendulum impact test

Tensile test







Biaxial testing



High-temperature testing



High-speed testing



Hardness testing



Fracture mechanics

Testing of Plastics



Tensile test



3-point flexure test



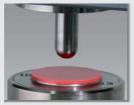
Compression test



Hardness testing



Impact testing



Puncture test



Extrusion test



Fatigue testing

Testing of Other Materials



4-point flexure test of cardboard



Indentation test on toast



Viscosity test



Fatigue testing of a rotor blade



Fatigue testing of asphalt



Shear test of wood



Tensile test of textiles



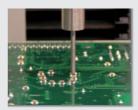
Compression test of springs



Testing of syringes



Horizontal testing of catheters



Testing of soldered pins



Testing of actuators



3 Zwick Modular System for Individual Testing Requirements

Static Testing Machines



Material testing machines



Sheet metal testing machines



Servo-hydraulic testing machines

Machines



Vibrophores

Dynamic and Fatigue Testing



Testing Instruments

Hardness testers



Vicat testers



Torsion testing machines



Pedulum impact testers



Drop weight testers



Extrusion plastometers

Testing Software / Measurement and Control Systems



testXpert®



testControl

Load Cells, Specimen Grips and Extensometers



Load cells



Temperature chambers



Specimen grips



High-temperature furnaces



Contact measuring systems



Specimen preparation



Non-contact measuring systems



Automation

Individual Testing Solutions



Zwick testControl Measurement and Control Electronics

Measurement and control electronics are an essential component of any testing machine. Their design and features determine which drive can be operated, which measuring system connected and which functions controlled.

Zwick's powerful testControl measurement and control electronics have up to 10 digital or analog high-resolution inputs available for timesynchronous data acquisition.

Any commonly used analog or digital signal can be connected to these standard interfaces. All signals are processed in real time and transmitted to the PC in high resolution at 500 Hz.

Many research applications require additional measurement signals as well as the usual channels such as force and elongation.

testControl offers the flexibility demanded of measuring systems in such applications, whether for applying additional strain gauges to a specimen or simultaneously measuring electrical resistance. In addition to these direct interfaces to *testControl*, external measurement systems such as the HBM MGCplus can be linked.

This gives the further option of quarter, half or full-bridge measurement of resistances, pressures, temperatures, accelerations, and single strain gauges etc.

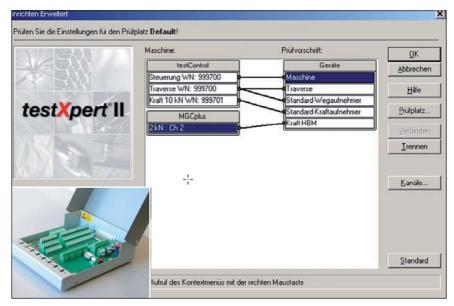


Fig 1: Full integration of a HB MGCplus in testXpert® II Small picture: Digital I/O box, additional with two output channels

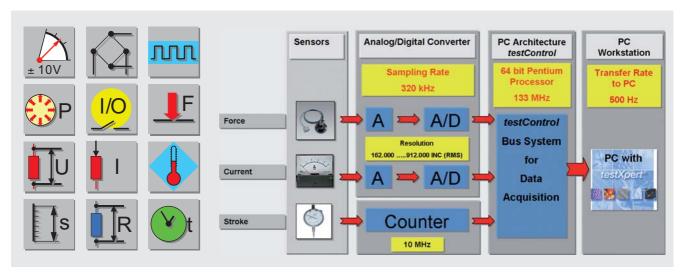


Fig 2: Analog and digital signals could be connected to $\textit{testXpert}^{\texttt{@}}$ and testcontrol

Zwick Extensometers

Measuring elongation and/or strain places extremely high demands on a modern testing system. For many years Zwick has been leading the field in developing digital extensometers for a wide range of applications.

Today Zwick has the most comprehensive range of analog and digital extensometers, both contact and non-contact. In 1998 Zwick had developed and introduced the worlds first digital clip-on extensometer.

2007 saw the unveiling of laserXtens, offering high-resolution (down to $0.15 \mu m$), contact-free elongation measurement without the need to attach gage marks to the specimen.

This system makes completely new applications possible, such as the testing of small specimens with gage lengths down to 1.5 mm.

This technology and heritage allows Zwick to provide the optimum extensometer for every application.



Fig 3: laserXtens with round specimen

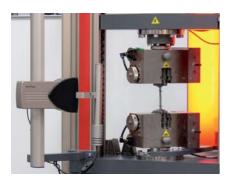


Fig 1: videoXtens



Fig 2: multiXtens

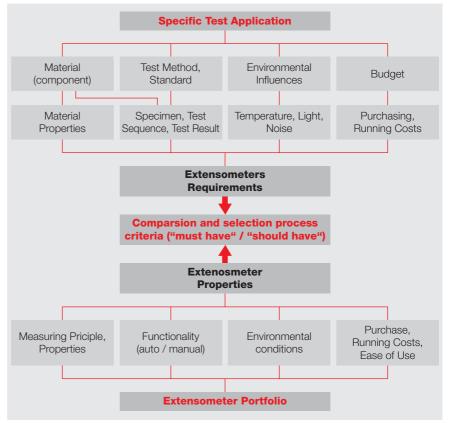


Fig 4: Selection process of extensometers



Zwick Specimen Grips

Zwick's comprehensive range of specimen grips of various designs and for differing test load ranges and test temperatures covers a wide field of application. The specific application range of a specimen grip is largely determined by its operating principle and maximum permitted test load; for tests in a temperature or climatic chamber the temperature range in which it can be used is also of significance.

Load Transfer between Specimen and Grips

With most specimens the test load can only be transmitted indirectly i.e. by friction. This means that the frictional force between the specimen ends and the jaws of the specimen grips must always be greater than the test load. The gripping forces (perpendicular to the test load) required for this are generated externally (e.g. by pneumatic pressure) or derived mechanically from the test load (self-tightening specimen grips).

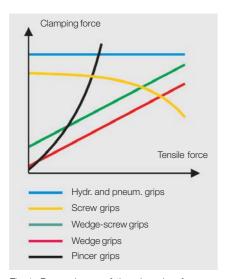


Fig 1: Dependence of the clamping force on the test load for different types of specimen grips

Gripping Force

Specimen grips with externally generated gripping force apply the set force level throughout the test. Especially with thick or soft specimens, however, specimen material can flow out of the grips under the influence of the test load, reducing the specimen thickness. With hydraulic and pneumatic specimen grips the gripping force remains constant, because the pressure generator supplies more pressurised oil or compressed air. The gripping force of screw grips decreases to some extent depending on the stiffness and resilience of the grips.

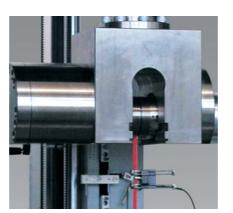


Fig 2: Hydraulic grips



Fig 3: Pneumatic grips



Fig 4: High-temperature grips

Gripping Surfaces

The frictional force depends on both the magnitude of the gripping force and the coefficient of friction of the contact surfaces. For this reason interchangeable jaws or jaw inserts with different gripping surfaces (shape, surface structure, material etc.) are provided for many specimen grips.

Grip Travel and Opening Width

Specimen grips with external gripping force generation have long grip travel and thus a large opening width, leaving a large free area for convenient specimen insertion, even for thick specimens, and eliminating the need for interchangeable jaws for different specimen thicknesses.



testXpert® II - Intelligent and Reliable

With testXpert®, Zwick has set the standard for intelligent and sophisticated materials testing software used for the most in-depth research applications. By using testXpert® II you will reap the benefits of more than 80 years' experience of materials testing and over 15,000 successful testXpert® installations worldwide.

The special All-In Suite Education package gives you access to all available *testXpert*® II programs, features and options.

Below are some of the functions which have proved particularly valuable in both research and training.



Fig 2: testXpert® II with synchronized video

Prepared Standard Test Programs

For almost every international testing standard, $testXpert^{\circ}$ II contains a ready-made standard test program. Students can be sure of testing in compliance with standards during their training and will gain a better understanding of the standard in question by working with this standard test program.

Synchronized Video Recording

A test can be recorded with an ordinary video camera and the video images synchronized with the test data from the testing machine.

When the video is played back inside $testXpert^{\otimes}$ II, a crosswire highlights the associated point on the x-y curve.

Result Evaluation

In addition to calculating standard results the results editor provides easy access to all typical algorithms. Easy-to-follow software-wizards are guiding you to define new reference values, maxima, slopes or peak values.

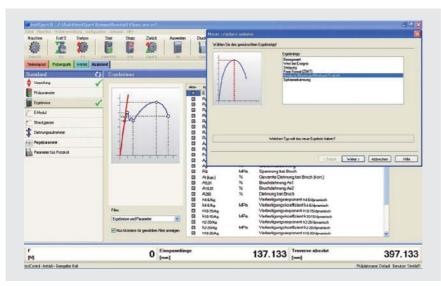


Fig 1: Result assistant in testXpert® II



ZIMT Integrated Macro Language

ZIMT (Zwick Interpreter for Materials Testing) is a flexible programming language which is integrated into testXpert® II and which gives you access to all test data and many other functions, making it easy to produce your own calculations, displays and macro functions.

The ZIMT editor offers syntax highlighting and context-sensitive help.

Free Sequence Programming

Research in particular often calls for a freely programmable testing machine. testXpert® II's graphic sequence editor is an extremely powerful tool, allowing you to program desired test sequences using a graphic user interface using simple function blocks based on a flowchart principle.

Statistical Evaluations

All common statistical values are available for evaluation, with an integrated option for displaying them as a histogram.

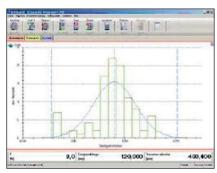


Fig 1: testXpert® II histogram

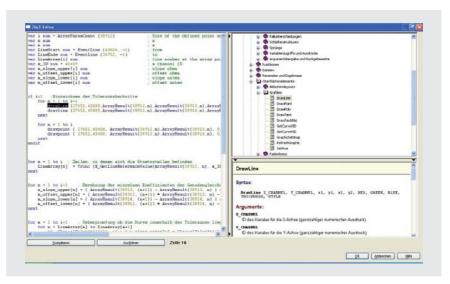


Fig 2: testXpert® II ZIMT-Editor

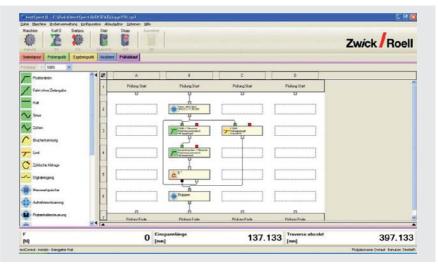


Bild 3: testXpert® II graphical sequence editor program

Comprehensive Export Interfaces

All data from testXpert® can be exported very simply via standardized software interfaces to all common windows applications. The testing machine can also be linked to NI LabVIEW and its comprehensive options via testXpert® II – an ideal combination.

Below is a selection of programmes with which *testXpert*[®] II data can be synchronized:

- LabView
- MS Excel, Access, Word
- SAP
- Oracle
- ASCII

4 Research and **Development Solutions**

The following selected applications are based on the standard components described above.

Fatigue Test

The S-N-curve is still an important source for many calculations of the fatigue strength of components intended to be loaded between their tensile strength and fatigue limit. The aim here is to design components of minimum weight which can be depended on to fulfill their intended function for the planned period of service.

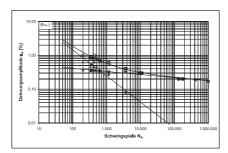


Fig 2: S-N-curve

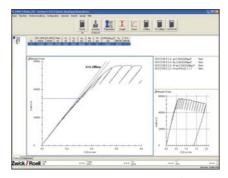


Fig 3: K_{1C} demonstration in testXpert®

Fracture Mechanics

Stress intensity K_{1C} is an important characteristic value for metallic materials in safety-relevant applications such as aircraft manufacture, power station building and automobile construction. This two-stage test can be performed very efficiently using Zwick vibrophores (HFP). The first process, called pre-cracking, produces a defined crack in the compact tension (CT) specimen. This can be performed quickly and with high reproducibility via the resonance drive system. The tensile test can then be carried out using the vibrophore's electromechanical drive.



Fig 1: Fatigue testing machine Amsler HB 250



Fig 4: CT specimen in vibrophore (HFP)



Applications for Servo-Hydraulic Testing Machines

Servo-hydraulic testing machines can be used for all materials and component testing under pulsating or alternating loads with periodic or random signals. Quasi-static and continuous loads also present no problem.

Servo-hydraulic testing actuators are extremely flexible in use. A test arrangement with the test frame fitted to a T-slot platform is ideally suited to component testing in particular.



Fig 1: Servo-hydraulic testing machine for combined tensile/compression-torsion tests

High-Speed Test

Most tensile, compression and shear tests are carried out under quasistatic loading at deformation speeds of approx. 0.01s⁻¹, although in practice materials and components are subjected to significantly higher loading rates in everyday use. Many mechanical characteristics are, however, dependent on the loading rate.

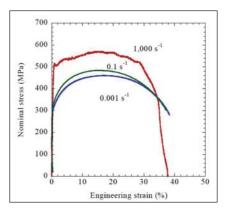


Fig 3: Materials characteristics depending on the loading rate



Fig 2: Servo-hydraulic test bench with hydraulically clamped and moveable crossboard. The actuator can be moved horizontally. (Fmax 100 kN)



Fig 4: High-speed testing machine HTM

High Temperature Test

The optimization of materials at high temperatures serves among other things to raise the efficiency of heat engines. It is known from thermodynamics that the maximum efficiency of these machines is represented by $(1-T_{\min}/T_{\max})$. In a contemporary gas turbine, temperatures up to 1500 °C occur at the first vane. To develop such high-temperature materials, an exact knowledge of their mechanical characteristics at these temperatures is required.



Fig 1: Fatigue strength testing under high temperature

Multi-Axis Test

In addition to purely single-axis loadings, multi-axial loadings are of interest as they allow testing under more realistic operating conditions. Static tensile loadings in two or more directions, together with tensile and torsion loadings can be superimposed.

Ductility Tests

The development of ever lighter and more resilient materials, especially in the automobile industry, also demands sophisticated methods in the area of ductility.



Fig 2: Sheet metal testing machine Fmax 1000 kN with camera to determine the FLC (forming limit curve)

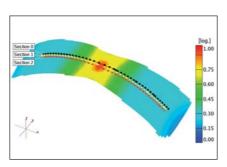


Fig 3: Schematic demonstration of determining the FLC

Instrumented Indentation Test

The classical hardness testing methods such as Vickers, Rockwell or Brinell were joined a few years ago by a further standardized method (ISO 14577, instrumented indentation, Martens hardness).

The instrumented indentation method uses the measured values of test load and indentation depth during loading and load removal, which – in contrast to the classical methods – are continuously recorded and evaluated. In addition to hardness values, indentation energy and indentation modulus can also be derived. The method can be used for almost all materials and possesses a uniform hardness scale on which the various materials can be shown.



Fig 4: Hardness testing machine Zwick ZHU2.5/Z2.5



5 Solutions for Education

Education Module

The testXpert® II Education Module is the ideal complement to classical teaching methods such as lectures, seminars and practical laboratory work.

In the first stage the principal types of test for various materials are presented in video sequences synchronised with test data from the materials testing machine.



Fig 1: The video picture and the data curves are exactly synchronized

On-screen captions provide information regarding what is taking place in the video at key moments.

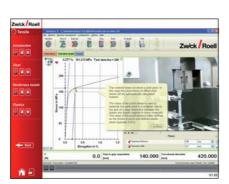


Fig 2: Speech bubbles explicate the video pictures

In this way students receive a visual impression of a test reinforced by written explanations.

A short quiz after each video sequence reviews what has been learned.



Fig 3: Multiple-choice quiz questions

The next step involves working with $testXpert^{®}$ II – with all data available for detailed analysis.

It is at this stage that teachers can integrate the <code>testXpert®</code> II Education Module into their individual curriculum – with access to all <code>testXpert®</code> II functions.



Fig 4: Analyse of the test data in testXpert® II

After completion of these steps students will be able to carry out tests independently using Zwick's unique Virtual Testing Machine (VTM).

Many different materials and sensors can be simulated with the VTM, which can be enhanced using your own materials, making the *testXpert*® II Education Module an ideal fit for your individual curriculum.



Fig 5: testXpert® II with faded in virtual testing machine

The Virtual Testing Machine opens up completely new opportunities for virtual training.

You can use it to create your own virtual specimens and make these available to your students. If for example you wish to explain to your students the link between the carbon content of steel and its mechanical properties, simply prepare the relevant specimens for the VTM and let your students find the connection.

The Education Module is the ideal complement to your curriculum.

6 Solutions for Existing Machines

The modernization of a testing system can be an economical alternative to buying new, particularly where high capacity, special load frames or complex peripherals are involved. Many of the existing components such as extensometers and specimen grips can be adapted to the new technology.

Zwick has modernised many different brands of testing machine and is well experienced at handling customized solutions. Regardless of the original manufacturer of your testing machine, Zwick will find the right solution.

Zwick supplies modular modernization packages which can be tailored to a wide range of requirements.

Modernization packages for materials testing machines with electromechanical drive

The testControl modernization package brings quasi-static materials testing machines (with electromechanical or hydraulic drive) up to state of the art.

Modernization comprises the following basic elements:

- testControl digital measurement and control electronics
- testXpert® testing software
- Maintenance-free, precisioncontrol AC drive
- Adaptation of existing sensors.

Additionally for hydraulic testing machines:

- Proportional or servo valves
- New hydraulic power pack or adaptation of existing hydraulic components.

Modernization packages for servo-hydraulic testing systems

Zwick's HydroWin 96 and Control Cube modernization packages provide numerous options for modernizing servo-hydraulic testing systems from a wide range of manufacturers and designs.

The retrofit kits consist of the following components:

- HydroWin 96 and Control Cube digital measurement and control electronics
- testXpert®/ Workshop 96 testing software
- New hydraulic power pack or adaptation of existing components.

In addition Zwick supplies special modernization options for vibrophores, high-speed testing units, creep testing machines and pendulum impact testers.

New from old

We only use components from the current production ranges, providing your newly modernized machine with the same technology as a brand new machine.

testXpert® is our standard software, so both new and modernized machines are equipped with the same operating platform.

Modernization means renewed longterm reliability, guaranteed sparepart availability and access to the entire Zwick accessory range.



Fig 1: Servo-hydraulic testing machine Zwick REL2041 after the modernization with Hydrowin 96XX



Fig 2: Materials testing machine Zwick 1455 after the modernization with *testControl*



Service and Support

SupportDesk

For additional application-related advice or software support, the Zwick Support Desk is in many cases a better option than an onsite visit.

Drawing on their extensive knowledge, our experienced service specialists deal with your enquiries quickly and effectively.

Worldwide Service

Customer satisfaction has the highest priority at Zwick Roell A.G. Local service organizations in over 50 countries ensure optimum utilization and maximum availability of your testing systems.



Servicing / Preventive maintenance

Zwick Service helps operators and users to reduce downtime significantly through regular servicing of the testing machine.

During the service the condition of the machine is recorded. Necessary maintenance and exchange of wear parts are attended to immediately if possible. At the same time the service engineer will recommend preventive measures and precautionary steps.

Repair

If, despite careful servicing and maintenance a fault develops in a testing machine, an engineer from the large Zwick Service Network team will be with you in the shortest possible time. Many spare parts can be despatched within 24 hours.

Calibration

Zwick's calibration service is accredited by DKD¹¹, UKAS²¹, COFRAC³¹ and A2LA⁴¹ to DIN EN ISO/IEC 17025 for on-site calibration of materials testing machines. The reference measuring equipment used is regularly recalibrated. Depending on the customer's requirements, either a works calibration (Zwick calibration certificate), ISO calibration (Zwick certificate with documentation showing measuring equipment supervision to ISO9001) or DKD calibration (DKD certificate) is performed.

If necessary, the testing machines and their associated equipment will be adjusted during calibration.

¹⁾ DKD: Deutscher Kalibrier-Dienst

²⁾ UKAS: United Kingdom

Accreditation Service

3) COFRAC: Comité Français

d'Accréditation

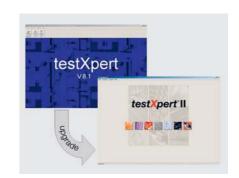
⁴⁾ A2LA: American Association for

Laboratory Accredition

Software Upgrade/Update

An update gives you access to the ongoing development of *testXpert*® software and opens the door to an expanded range of functions. Changes to testing standards are also incorporated into the latest versions.

Upgrading from an old DOS operating system to the latest Windows equivalent provides a secure, reliable route to the new technology. Upgrade from testXpert® to testXpert® II and enjoy access to all the latest testXpert® evelopments, with their many benefits for everyday use



7 Individual Offers for Universities

A comprehensive range of testing machines with favourable prices is now available to the higher education sector.

Make sure your university requests the special Zwick offers.

If your testing machine is primarily used for student training, you will be entitled to special conditions when ordering. The <code>testXpert</code> II Education Module and the <code>testXpert</code> II All-In-Suite Education are free for all your students when used with the machine.

All users of the *testXpert*® II Education Module who register via our webpage are automatically entered into the draw for a *testXpert*® II laptop.

Zwick can provide you with the necessary specimen material for practical exercises on a real testing machine



Fig 1: Zwick provide you with the necessary specimen sets



Fig 2: Laboratory with Zwick machines at the NTU Singapore, school for mechanics and aerospace

References from Education and Training

Over 300 installations annually in R&D and training/education make this one of the most significant fields within the Zwick Roell Group. Future users can profit from the experience gained by Zwick in the past. Zwick frequently works in close collaboration with universities to find joint solutions to current issues.



Fig 3: Laboratory with Zwick equipment at the technical university of Nanjing



Fig 4: Zwick supports with the planning and conception of educations labs. For example ${ t GUC}$ German University Cairo



References from Research

Strong Floor with Double Test Frame, Fmax 2000 kN

Clamping frames allow flexible, costeffective erection of various testing arrangements.

This makes full-scale specimen testing a realistic option; typical civil engineering applications include testing walls, beams and columns, while from the automotive field complete automobile and aircraft assemblies can be tested.

Suitable test rigs, test frames, corner brackets, joints, actuators, load cells etc. are available from our comprehensive modular range.



Fig 1: Strong floor with double test frame at the Fachhochschule Brandenburg, Germany

Fatigue Testing on Construction Components



Fig 2: Fatigue testing machine at the RWTH Aachen, Germany (Fmax 5000 kN, static, Fmax 4000 kN dynamic)

Hardness Test under High Temperature



Fig 3: Forschungszentrum Karlsruhe, Germany: Hartness testing in hot cell

Biaxial Tests on Metals

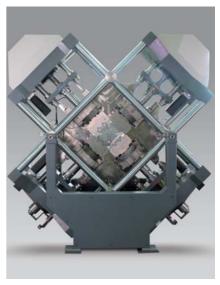


Fig 4: Fraunhofer Institut IWU Chemnitz, Germany: Biaxial tensile tests of metals

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