Zwick / Roell

Testing Systems

Testing Machines and Systems for the Aerospace Industry






FP 746 2.1009

Intelligent Testing

Zwick / Roell

1 Zwick Roell AG – Over a Century of Experience in Materials Testing

Mechanical testing is one of the oldest forms of materials testing. Da Vinci and Galileo were already turning their attention to bending strain and the elastic properties of materials in the 15th and 16th centuries. Time brought new insights, culminating in the appearance of the first testing machines in 18th-century France.

Roell & Korthaus have been involved in materials testing since 1920, while Zwick began building machines and instruments for mechanical materials testing in 1937. Many years earlier, in 1876, Professor Seger had established a chemical laboratory providing scientific advice on a commercial basis to the stone industry. During the 20th century this evolved into the present-day concern Toni Technik, leading specialists in the field of construction materials testing systems.

These companies have comprised the Zwick Roell Group since 1992. July 2001 saw the group become a corporation under the name of Zwick Roell AG, incorporating Zwick, Toni Technik and Indentec Ltd. Between them these companies provide a comprehensive materials, construction materials and function testing program – from manually operated hardness testing instruments to complex systems for process-parallel applications. Acmel Labo, the French manufacturer of laboratory instruments for the cement, lime and plaster industry, has been part of the group since May 2002.

Zwick Roell AG's expertise in sensor technology for load and extension measurement was enhanced and consolidated by the acquisition of German company GTM in 2007 and Messphysik of Austria in 2006.

Zwick's years of accumulated experience are reinforced by a policy of maintaining regular contact with our many customers. This provides a solid platform from which the company supplies a wide range of products – from economical standard machines to customized versions for specialized testing situations. State-of-the-art engineering, powerful electronics and application-orientated software are the keynote of these modern, versatile, highly intelligent testing machines and systems.

Zwick Roell AG is far more than just a manufacturer, however. As long ago as 1994 the company received DIN EN ISO 9001 certification - a guarantee of consistently high product and service quality. In addition, accredited calibration laboratories allow companies in the Group to inspect and calibrate test equipment and provide internationally recognized certification.

Fig. 1: Zwick Roell AG and Zwick GmbH & Co. KG: Administration Building, Ulm, Germany

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2 Faster and more Reliable Test Results for the Aerospace Industry

Don't take Chances with Safety and Reliability

With few exceptions no other industry focuses more on quality and safety than the aerospace industry. Dramatic improvements in airplane construction, including new materials and components, are pushing the technical boundaries in order to achieve greater fuel efficiency and meet environmental challenges.

This is why companies turn to Zwick for materials and component testing products. Together with the industry in general, Zwick's focus on safety, and reliability of testing equipment helps to make sure that products are safe. Whether at the forefront of materials research within universities and institutes or integrated into the quality assurance / production control process you will always find Zwick products in organizations that are serious about the quality and safety of their products.

Allround-Line Supports Materials Development

Around the world great effort is being applied to research and development of new material technologies especially lightweight, or intelligent materials. Allround-Line testing systems use state-of-the-art standard components in a highly flexible modular concept and enable Zwick to work closely with Academia addressing growing demands especially in relation to new developments in materials and component design, testing and associated data analysis. Precision load frames and measurement and control electronics *testControl* are designed and manufactured in Germany. All our product development teams are on the same campus resulting in efficient communication across the complete product portfolio and resulting in fast response to customers' specific support requirements.

Zwick's *testXpert*® software with more than 15,000 copies in use worldwide is the global benchmark for materials testing, and operates with virtually all Zwick products. This improves operator safety and reduces training and support costs in the long term.

Quality First with ProLine

For quality assurance testing a complete range of ProLine testing systems offer superb value for money for laboratories carrying out routine testing, but still using core Zwick technology for high accuracy measurement and control.

High Productivity, Perfomance, and Cost Savings

The roboTest robotic range of testing systems are ideal for testing applications where speed, low cost of testing per specimen, and very high accuracy and reproducibility is important. Unattended testing systems allow you to deploy staff on more important tasks thereby adding value to your testing process.

Fig. 1: Materials testing machine Allround-Line Z250

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3 Varied Applications for Aerospace Industry

Zwick is active in more than 20 different industry sectors, and offers a wide variety of testing systems to suit them all. 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 as a result of Zwick's relationship and collaboration with Academia and Research organizations. This close cooperation ensures that Zwick is actively involved in the latest developments and is also in possession of many patents covering testing machines, grips, tools and fixtures.

Industry Overview

Typical Materials Testing in the Aerospace Industry

Components
- Fasteners (bolted, bonded)
- Structures (external, internal)
- Interiors
- Electronics/Mechatronics
- Springs
- Landing gear (wheels, brakes)
- Engine Parts

Materials
- Composites
- Metals (alloys, titanium, steel)
- Ceramics (exhaust, bearings)
- Acrylic, Polycabonate
- Polymers

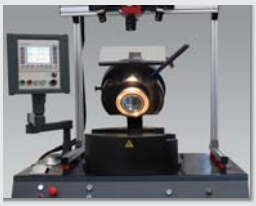
Types of Mechanical Tests
- Static Testing*
- Fatigue Testing (LCF, HCF)*
- Fracture Mechanics (J1C, K1C)
- Creep Tests

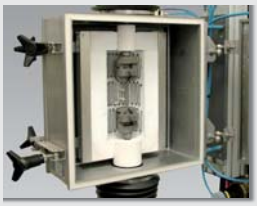
* Ambient, elevated and low temperature

- Shear Tests
- Multi-Axis Testing
- High-Speed Testing
- Impact Testing (pendulum and drop-weight)
- Hardness Testing

Testing of Metals

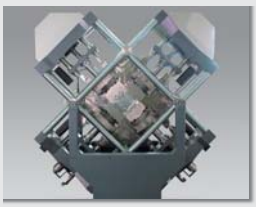

Tensile test


Sheet metal testing


High-temperature testing


Hardness testing


Pendulum impact test


Biaxial testing


High-speed testing


Fracture mechanics

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Testing of Plastics

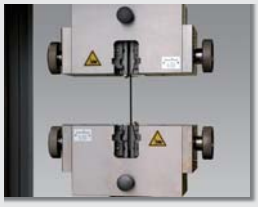

Tensile test


3-point flexure test


Fatigue testing


Hardness testing

Testing of Composites


Tensile test


Compression test


3-point flexure test


Inter laminar shear test


Impact testing


Drop-weight test


Fatigue testing

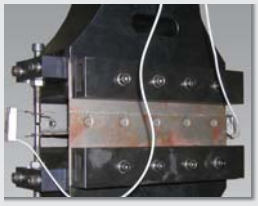

High temperature testing

Testing of Component Parts


Spring testing


Testing of solenoid actuators

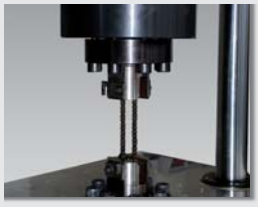

Fatigue test on screws


Fatigue test on H-specimen


Shear test on rivet joint


Tensile test on screws


Fatigue test on T-specimen


Fatigue testing of chains

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3.1 Focus on Composites

Mechanical tests on composite materials and structures are often a time consuming and difficult process. Test results are often operator dependant due to difficulties in handling, measuring, and aligning the specimen at temperatures above and below ambient. The traditional way to measure strain under these conditions is to attach strain gages or a clip-on extensometer to the specimen which can also introduce measurement errors.

Robots Improve Consistency and Increase Throughput

Robotic technology removes many of these problems. Handling becomes consistent, test throughput is increased especially for environmental testing because the specimen can be fed through a small shutter rather than opening the chamber door. Automated extensometers can be used to measure strain, and to eliminate the time needed to attach contact devices. By using intelligent software the cost per specimen can be reduced significantly and at the same time staff can be better employed on more important tasks.

Fig. 1: Temeperature chamber for composite tensile tests

Fig.2: Robotic testing system for automatic flexure tests on composites

Automatic Control of Environmental Conditions

A typical system configuration includes tensile tests at temperatures ranging from -80 °C to +300 °C using a macro sensor arm extensometer. The temperature chamber is connected to the computer system and the temperature can be set independantly for each specimen or batch. The test temperature can be recorded and stored with the stress and strain data offering unbeatable ease of use and data tracability.

For flexure testing a similarly configured system features a flexure test kit with motorized lower supports controlled by the test software. The temperature chamber operating in the range from 23 °C to +300 °C is also software controlled.

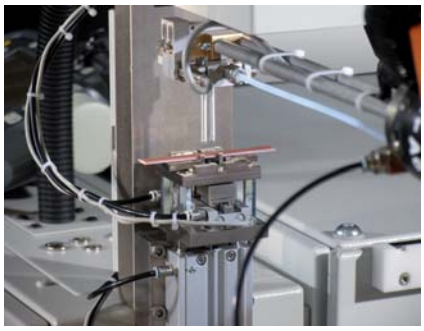

Fig. 3: Automatic specimen handling

Fig. 4: Flexure test device

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Drop Weight Test

Drop weight testers are used to determine the dynamic behavior of materials within a limited speed range from about 3 m/s. The following tests can be performed with the instrumented drop weight tester HIT230F:

- Multiaxial impact tests accordingto ISO 6603-2, ISO 7765-2, and ASTM D 3763 at ambient and nonambient conditions.

- Airbus AITM 1- 0010 /6- 2005, Boeing 7260, DIN6556-1, ASTM D7136 / D7136 M, DIN EN 6038

The drop height of 1m allows impact speeds of up to 4.43 m/s. The plate-type specimens to be tested are held with a pneumatic clamping device and then impacted by an instrumented tup of standardized diameter with hemispherical tup insert. Depending on the standard, different tups and clamping fixtures are available. During the test the load-time signal is measured. The “forcetravel” signal as well as the energy consumed during impact can be calculated from this data by the software.

Compression after Impact

The aerospace industry carries out compression after impact (CAI) tests to different standards (common ones include Airbus Standard AITM 1.0010 and Boeing BS 7260) The CAI test, carried out after the impact test described above, is based on a rectangular plate in which the vertical sides of the specimen are supported, and a compression load is applied to the horizontal edges. The compressive strength is reduced as an effect of the delamination caused by the impact test.

Fig. 1: Drop-weight tester HIT230F

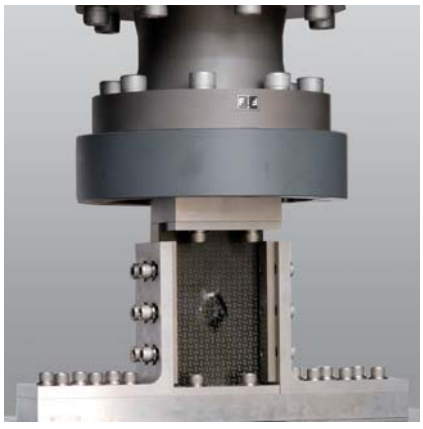

Fig. 2: Compression after impact test device

Compression Tests on Composites

Hydraulic composites compression test fixture, HCCF Zwick offers a new and innovative hydraulic compression test fixture for testing of large numbers of specimen.

Advantages are:
- Time saving, resulting from the improved specimen handling compared to traditional Celanese or ITTRI test fixtures.
- The bending influences during the clamping process are virtually eliminated.
- This test fixture complies with various test standards as well as different specimen geometries. The test is carried out with reference to the procedures in ISO 14126, prEN 2850, DIN 65380 and QVA-Z10-46-38, with the advantage that the following specimen dimensions can be tested:

Specimen width: 6.35 to 35 mm
Specimen thickness: up to 6.6 mm
Max. clamping length: 65 mm each
Max. grip-to-grip separation: up to 35 mm

The compression fixture can be used in shear loading mode, in end loading mode or in a mixed mode combining both.

Fig. 3: Hydraulic composites compression test fixture (HCCF)

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3.2 Focus on Environmental Testing

High-Temperature Tests on Metals

In applications such as engine manufacture, material behavior at elevated temperatures (up to approx. 1600 °C) is of vital importance, calling for high-temperature tensile testing and, to a lesser extent, flexure testing. Zwick's solutions for these tests comprise temperature-controlled furnaces, specimen pullrods, high-temperature strain measurement and other essential accessories for integration into Zwick testing machines.

Fig. 1: High-temperature tensile test up to 1600° C

Fig. 2: High-temperature flexure test in furnace

Creep Test

There is currently a great deal of interest in saving energy and reducing environmentally harmful emissions. This is particularly the case with aircraft turbine blades. One approach to increasing efficiency is to raise operating pressure and temperature, for which the development of new, high-temperature-resistant materials is vital. The creep test is one of the most important experiments for describing the high-temperature behavior of materials (standardized in others ASTM E 139 and ISO 204 and elsewhere), as proven material properties obtained over an extended period are essential for the design and operation of "high-temperature" components.

Fig. 3: Creep testing machine

Fig. 4: Tensile test in temperature chamber up to -70 °C

Testing in Hot and Cold Conditions

Many types of plastic and composite materials significantly change their mechanical properties depending on the temperature. For some thermoplastic materials it is known that the modulus value can change about 3 to 4 % for 1°K. According to the longterm use of materials, especially in automotive and aerospace industries, it is very important to know the behavior of materials in different environmental conditions.

Temperature Chambers

Zwick temperature chambers exhibit the following characteristics:

- Aperture for extensometer sensor arms on the rear left side (except for chambers without cooling)
- Digital temperature control unit with display for actual value and set value.
- Illumination inside the chamber
- Front door with insulated window
- Removable segments for moving the chamber back without removing the grips
- Insulating and electrical design meet the CE requirements for safety

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3.3 High Capacity Testing

High Capacity Fatigue Tests

Large components and aerostructures for aircraft such as the Airbus A380 can be tested using high capacity testing systems with capacities up to 2000 kN.

These systems are designed to perform both quasi-static and fatigue tests on components up to 5 m long, and typically carry out fatigue tests up to a frequency of 15 Hz.

In order to accommodate a multitude of different specimen sizes the upper crosshead can be positioned at any intermediate point and the specimens can be clamped in parallel acting fatigue rated hydraulic grips.

Mounting of complete assemblies or components is simplified by incorporating a T-slot base crosshead.

Fig. 1: High capacity fatigue testing machine HB2000

Fig. 2: Strain gaged specimen undergoing a tensile test

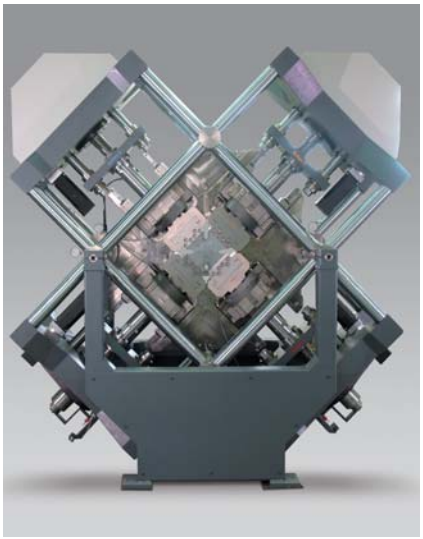

Fig. 3: Biaxial testing machine for metals

Biaxial Tensile Test

The biaxial tensile test is used to determine the deformation characteristics of materials. This test is used primarily for research and development as it allows defined stress values in the intersection area of the specimen to be set up and investigated.

These testing machines are produced to customers' requirements. Strain measurement is performed using non-contact extensometry in most cases and Zwick provides several solutions for this. The measurement of strain distribution is available via collaboration with Zwick's specialist partners

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3.4 Focus on Dynamic and Fatigue Testing

Fatigue Test on Screws/Bolts

In addition to static loading, fasteners are generally subjected to frequent cyclic loadings, including vibrations. Fatigue tests on screws and bolts (and other items) are most quickly and efficiently performed in a Vibrophore, which can apply cyclic loads up to 600 kN in a frequency range up to approx. 300 Hz, using grips tailor-made for screws/bolts and other fasteners. The magnetic drive which generates controlled resonance in the system (and in the specimen) requires minimal electrical power, resulting in highly cost-effective testing.

Fig. 1: Vibrophore with high-temperature furnace

Fig. 2: Fatigue test on bolts/screws

Fracture Mechanics K_{Ic} Determination

Fracture toughness K_{Ic} is an important material property for metallic materials in safety-related applications such as aircraft construction, and is determined using a specimen into which an artificial crack has been introduced. The specimen is loaded until failure and the fracture toughness K_{Ic} is determined from the load-deformation curve and the crack length. Details of the test procedure are contained in the relevant standard (ASTM E 399) and the two-stage test can be performed very efficiently using Zwick Vibrophores (HFP).

Crack formation in the specimen is instigated by the mechanically produced notch followed by cyclic loading. The high frequency used allows rapid generation of a defined crack ('precracking') and the process is highly reproducible, thanks to the high sensitivity of the resonant frequency to crack formation. The specimen geometry most frequently used is illustrated in Fig. 3; the specimen is known as a CT (Compact Tension) specimen. The load is applied through pins inserted into holes in the specimen, giving a mixed tensile and flexure loading.

Fig. 3: CT specimen in Vibrophore (HFP)

Fatigue Tests with Servo-hydraulic Testing Machines

Material properties for fatigue strength and fatigue limit as determined in fatigue tests often have a safety-relevant significance in the choice of material and design of parts. Specimens are tested under cyclic load conditions and through-zero loading. Zwick can supply, as standard, fatigue testing machines up to 600 kN, depending on drive method. The largest Zwick servo-hydraulic testing machine currently in use handles loads up to 5000 kN.

Fig. 4: Servo-hydraulic testing machine Amsler HA

3.5 Focus on Impact Strength Testing

Charpy Impact Test

Notched impact strength is an important characteristic for many applications and can be determined with Charpy specimens in pendulum impact testers. EN10045-1 / ISO 148 / ASTM E23 specifies the test requirements, and notched Charpy specimens can be inserted by hand, simple feeding devices, or fully robotic systems and impacted with energies up to 750 J. If required Zwick can also supply temperature conditioning baths for specimen. Under the Machinery Directive, pendulum impact tester operation is subject to very strict safety requirements, which are met by Zwick's safety housing and safety technology.

Charpy specimens are standardized according to EN10045-1 or ASTM E23. The Notch Vision system measures the complete specimen dimension in 3 to 12 seconds without touching it offering much better accuracy and reproducibility than more traditional systems. Calibration can be performed very easily by using a reference specimens traceable to International Standards though our DKD, UKAS, COFRAC, A2LA accredited laboratories.

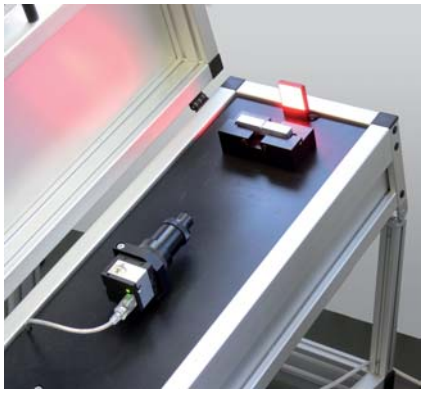

Fig. 1: Optical measurement system notch vision

Fig. 2: RKP 450 pendulum impact tester (Inset: anvil)

High Speed Testing

High-speed testing machines are used especially for high-rate puncture impact and other materials tests requiring high testing speeds.

Examples of applications:

- Instrumented multiaxial impact tests according to ISO 6603-2 and ASTM D 3763
- Determination of tensile properties at high strain rates, ISO/DIS 18872
- Instrumented impact tests on semifinished products and components

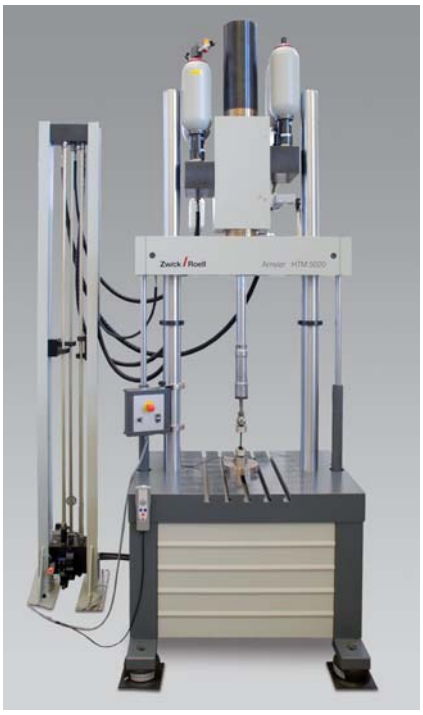

Fig. 3: High-speed testing machine Amsler HTM

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4 Zwick Modular System for Individual Testing Requirements

Static Testing Machines


Materials testing machines


Sheet metal testing machines


Torsion testing machines


Materials testing machines with linear drive

Dynamic and Fatigue Testing Machines


Servo-hydraulic testing machines


Vibrophores


Pedulum impact testers


Drop weight testers

Testing Instruments


Hardness testers


Vicat testers


Extrusion plastometers

Testing Software / Measurement and Control Electronics

testXpert®


testControl

Load Cells, Specimen Grips and Extensometers


Load cells


Specimen grips


Contact measuring systems


Non-contact measuring systems


Temperature chambers


High-temperature furnaces


Specimen preparation


Automation

Individual Testing Solutions

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4.1 Quasi-Static Testing Machines

Quasi-static Allround-Line Testing Systems

The Allround-Line products are specifically targeted at organizations carrying out complex testing applications such as in Research and Development on new materials, and components.

As the flagship of the Zwick product range these systems offer power, flexibility, and virtually limitless possibilities to measure, collect, process and store multichannel test data with very high accuracy and reproducibility. Some of the advantages of these products include:

Patented Measurement Technology with Wide Measuring Ranges

- Very wide measuring range for load and extension (which far exceeds the requirements of the International Standards) typically 0.2 % to 150 % of load cell capacity and from 25 Hm for highest accuracy extensometers

- Patented range of ultra high accuracy – side load resistant load cells

Smart Sensors with Fast Data Acquisition

- Smart sensor technology to recognize and calibrate load cell, extensometers and other connected sensors. Exceeds the requirements of TEDS (IEEE 1541)

- Automatic logging of sensor data (serial number etc.) for complete sensor data traceability

Fig. 1: Allround-Line floor-standing machine Z600

- Digital extensometer strain data is acquired at 10MHz so no test characteristics are missed.

Operator Safety

- Zwick's unique machine environment (limit switches, crosshead position, grip separation, test area / sensor load limits) are all stored as part of the test specification – even when the machine is switched off.

- All products fully comply with CE and EMC regulations and have integrated safety electronics for double interlocked safety shields.

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4.2 Dynamic and Fatigue Testing Machines

Servo-hydraulic Testing Machines

Zwick's servo¬hydraulic testing machines are universally applicable for materials and component testing under pulsating or alternating load, with periodic or random signals. Quasistatic and continuous loading are also easily achieved.

Special Features

- Precisely aligned load frames featuring extremely high stiffness
- Hydrostatic bearings, making the actuators virtually frictionless – and also wear-free
- Linear variable differential transducer extensometer (LVDT) with high resolution and linearity integrated centrally in the actuator rod
- Precision strain-gage load-cell for mounting on actuator rod or fixing to crosshead as required
- Wide range of hydraulic power packs
- Comprehensive range of accessories (specimen grips, extensometers, temperature chambers etc.)

Fig. 1: Servo-hydraulic testing machine Amsler HC10

Vibrophore with Electro-Magnetic Resonance Drive

Zwick are suppliers of the world-famous Amsler HFP Vibrophore, the first version being introduced by Amsler in 1945. It is valued by test laboratories in the automotive sector for its high-level performance and low operating costs.

Special Features

- Minimal energy consumption due to resonance principle
- No hydraulic power pack or other installation outlay required
- Maintenance-free operation
- High testing frequencies, short test times.

Applications

- Dynamic tests to define the fatigue strength of materials, e.g. fatigue tests in accordance with DIN 50100 (S/N curve), in tensile, compressive, pulsating and alternating load ranges
- Fatigue strength and durability tests on components
- Fracture mechanics tests
- Testing under various environmental conditions (temperature, aggressive media)
- Production and quality control of components exposed to dynamic loading during their service life

Servo-hydraulic Testing Machines (STM) Standard versions[1)]

Model[2)]	HC	HB	HA
• Type/version	table	floor	floor
• Load frame nominal force [kN]	5 – 25	50 – 1000	50 - 500
• Test stroke [mm]	100	100/250/400	100/250
• Specimen length [mm]	100 – 700	100 – 1100	250 - 1500
• Hydraulic power pack			
* System pressure [bar]	210/280	210/280	210/280
* Feed rate [l/min]	9 – 30	20 – 270	20 – 270
• Motor nominal power [kW]	5 – 20	11 – 160	11 – 160

[1)] Load frames available with higher rated actuators and different strokes on request
[2)] Testing actuator mounted on upper crosshead of HC and HB frames, base-mounted on HA frame

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4.3 *testXpert*® II – Intelligent and Reliable Testing Software

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

Some of the functions which have proved particularly valuable in the aerospace industry are:

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. It provides a completely open architecture for customers who need to create their own testing sequences and calculate their own test results. The ZIMT editor offers syntax highlighting and context sensitive help.

Fig. 1: *testXpert*® II with synchronized video

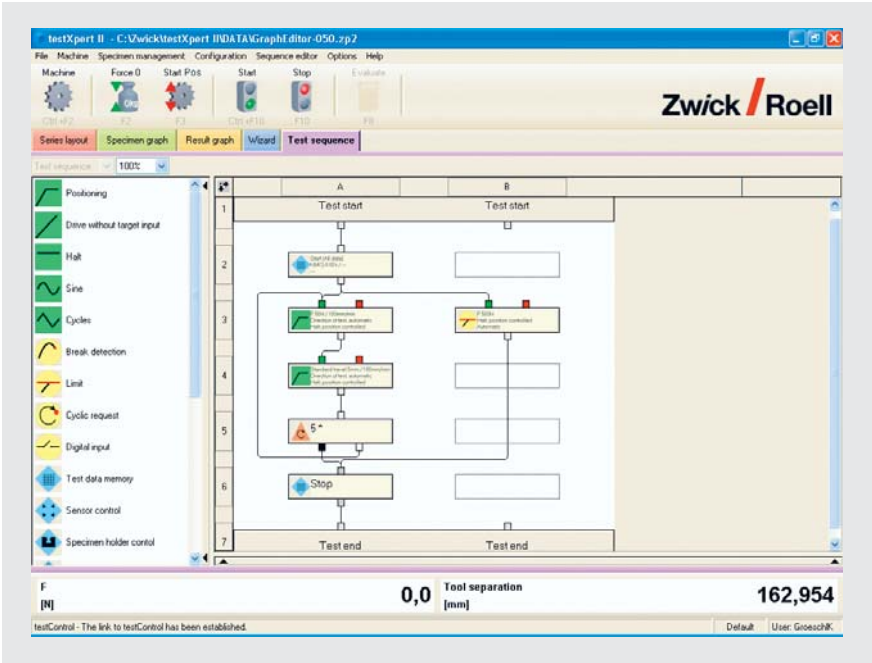

Fig. 2: *testXpert*® II graphical sequence editor program

Sequence Programming

Research in particular often calls for a freely programmable testing machine. *testXpert*® II's graphic sequence editor is a very powerful tool, allowing you to easily configure test sequences using graphical function blocks and 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.

Comprehensive Import and Export Interfaces

Specimen data such as test specification, tolerance data, and other important fields can be read from an external database and used to document or control *testXpert*® II functions. This reduces typographical errors and other time-related activities to a minimum. All data from *testXpert*® can be exported very easily via standardized software interfaces to all common windows applications. The testing machine can also be linked to NI LabVIEW. Below is a selection of programmes with which *testXpert*® II data can be synchronized:

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

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4.4 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 time-synchronous 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 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 gages to a specimen or simultaneously measuring temperature.

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 gages etc.

Control Cube

In collaboration with CaTs[3] (Consultants in Automated Test and Structural-dynamic Simulation Systems), Zwick provides easy-to-use software, measurement and control electronics and data acquisition for single and multi-axis servo-hydraulic testing (up to 32 channels).

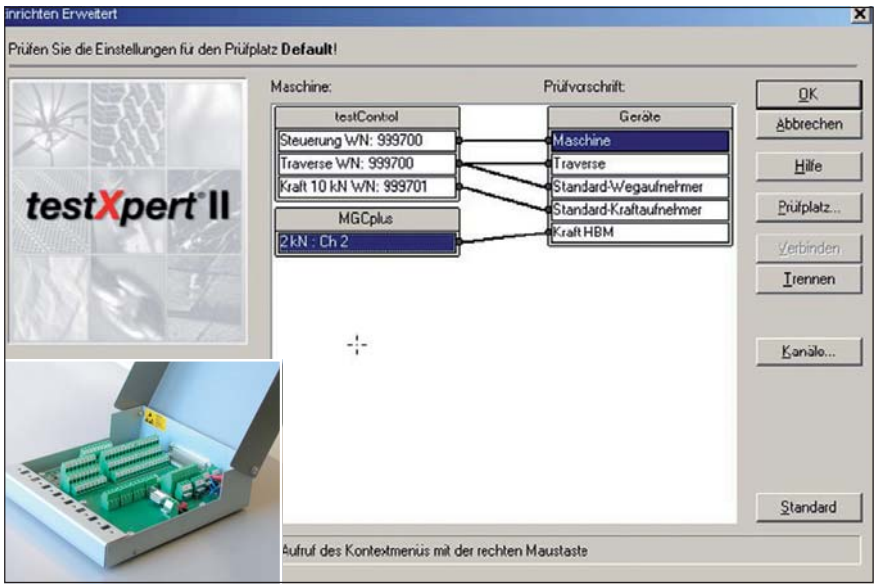

Fig. 1: Full integration of a HBM MGCplus in *testXpert*® II
Small picture: Digital I/O box, additional with two output channels

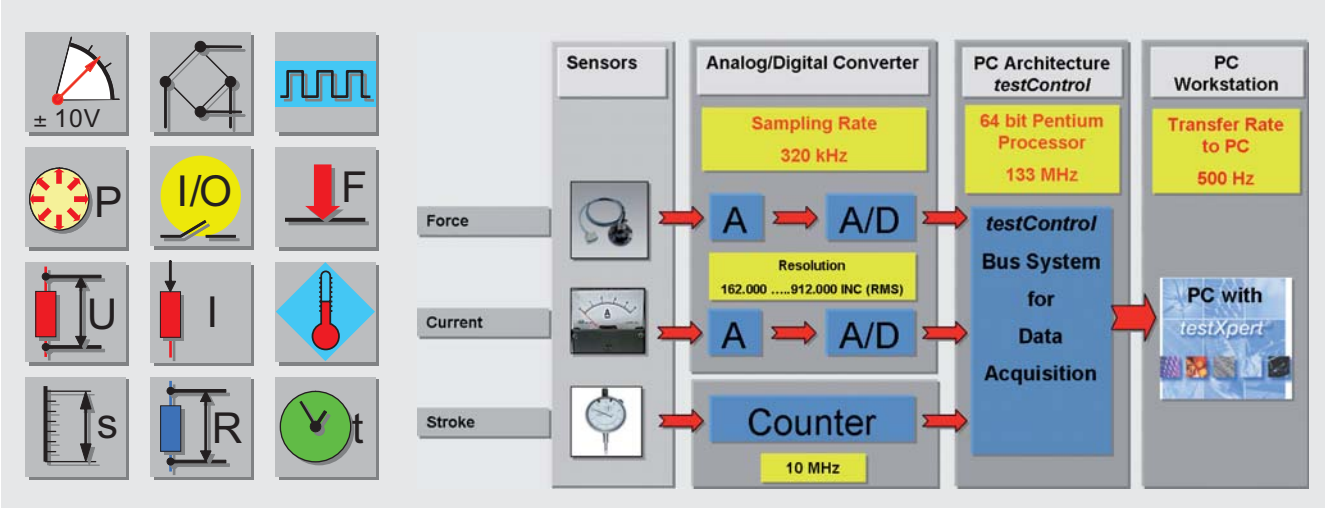

Fig. 2: Analog and digital signals can be connected to *testXpert*® and *testControl*

Zwick / Roell

4.5 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).

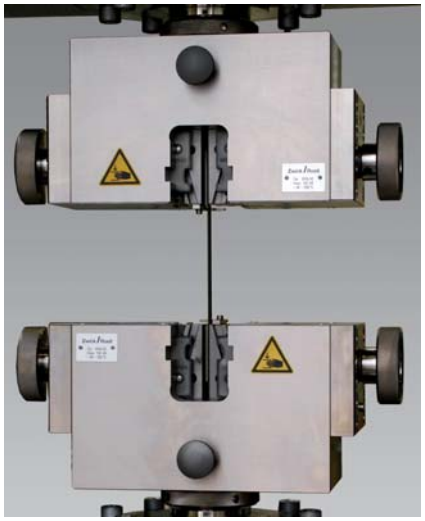

Fig. 1: Wedge-screw grips

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.

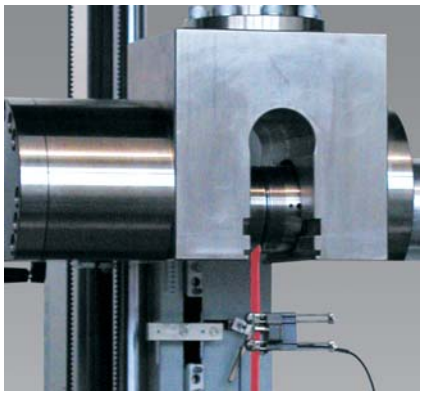

Fig. 2: Hydraulic grips

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.

Zwick / Roell

4.6 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. In 2004 the portfolio of extensometers was extended with the optiXtens and multiXtens.

2007 saw the unveiling of laserXtens, offering high-resolution (down to 0.15 µm), 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.

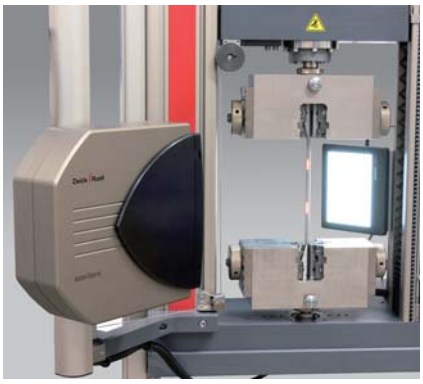

Fig. 3: laserXtens with round specimen

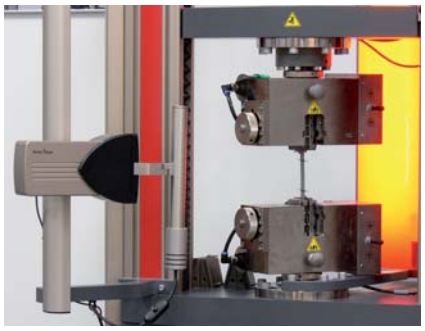

Fig. 1: videoXtens

Fig. 2: multiXtens

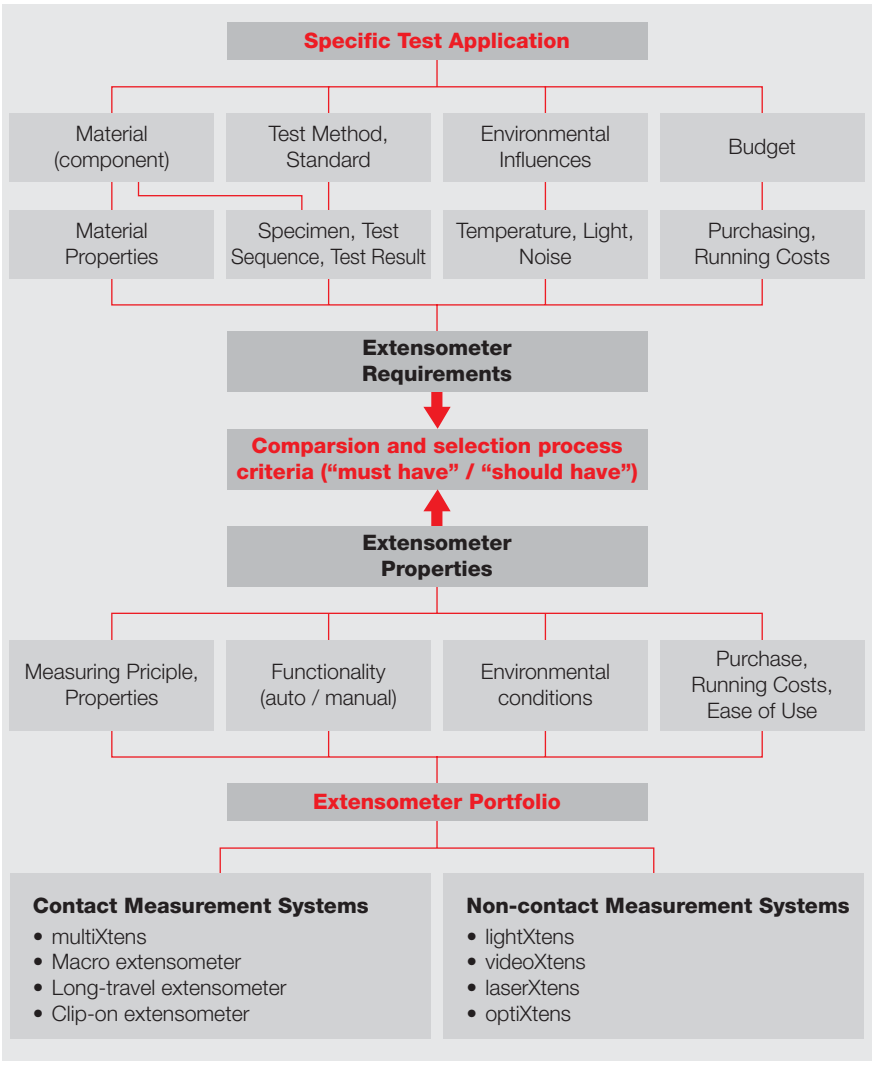

Fig. 4: Selection process of extensometers

Zwick / Roell

5 ZwickService

Worldwide Service

Customer satisfaction is a top priority of the Zwick Roell Corporation. With local service organizations in over 50 countries, we help optimize the return on your investment and to ensure the functionality of your testing machine.

We offer you a portfolio of service products ranging from consultancy support, product demonstrations, pre-testing, contract testing, installation, calibration and after-sales support. You can view our complete range services on our website at www.zwick.com or just contact your local support office.

Specific Calibration for Load Frame Alignment Accuracy

What is Nadcap?
Nadcap program as a part of PRI (Performance Review Institute) was created in 1990 by the Society of Automotive Engineers and is headquartered in Warrendale, Pennsylvania. Nadcap's membership of "prime contractors" convene to coordinate industry-wide standards for special processes and products. Through the Performance Review Institute, Nadcap provides independent certification of manufacturing processes for the industry. PRI's mission is to "provide international, unbiased, independent manufacturing process and product assessments and certification services for the purpose of adding value, reducing total cost, and facilitating relationships between primes and suppliers."

Our Solution for Nadcap Conformity

In relation to materials testing machines one of the main topics is that of specimen alignment verification.

To comply with Nadcap requirements it is necessary to measure and certify the system alignment according to ASTM E1012-05 (Verification of test frame and specimen alignment under tensile and compressive axial force application). This is achieved by using a special specimen fitted with strain gages which is placed in the grips / fixtures and subjected to load. During the verification process any misalignment of the system must be measured and remain within specified limits.

The specimen strain gage signal is conditioned and processed using an electronic signal conditioning system which is connected to a PC software. In the event that the testing system does not meet the required specification it may be necessary to add a special mechanical alignment device into the load string. This together with the software simplifies the labour intensive task of adjusting the alignment so that it is within the specified limits.

Zwick's offers alignment verification as an option in its portfolio of Customer Support Services.

Fig. 1: Configuration for alignment verification

Calibration
Zwick's calibration service is accredited by DKD[1)], UKAS[2)], COFRAC[3)] and A2LA[4)] 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 associated sensors 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

Applications Test Laboratory and Contract Testing
In the last few years Zwick's applications laboratory has become competence-center of materals testing withactive scientific exchange.

Overview of Applications:
- Quasi-static testing (temeprature range: -40 °C to +900 °C)
- Determining impact strength
- Hardness testing
- Melt index testing
- Component testing
- Viscosity testing
- Fatigue testing (temeprature reange: -60 °C to +1200 °C)
- Determining cyclic material behavior (LCF)
- Determining fracture mechanical characteristic values

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