Zwick / Roell

Testing Machines and Systems for the Automotive Industry

BB 389.2.07.17

Intelligent Testing

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1 ZwickRoell Group

2 Motors, drives, and electrification

3 Body

4 Chassis

5 Electronics and mechatronics

6 Seats, interior and safety components

7 Products

8 Services

1. ZwickRoell Group

1.1 ZwickRoell—Passion and expertise

Our company philosophy is founded on a passionate commitment to our customers. We work hard to ensure customer satisfaction by having over a third of our employees engaged in service and support.

As a family-owned company with a tradition stretching back 160 years, we place great value on honesty and fairness. Over the years an ethos of close collaboration based on mutual trust between our partners, suppliers, and customers has evolved—something that we all value highly.

Fig. 1: Innovation Center at ZwickRoell's headquarters in Ulm, Germany

The basis of a successful partnership: innovative employees as well as innovative products.

Always at your service

Over 1100 workers are employed at our headquarters in Ulm, Germany. Many of them have been with us for years—decades even. Their knowledge, ability and commitment are what lies behind the worldwide success of the ZwickRoell Group.

We are present in over 50 countries around the world.

The right solutions

Whether for static materials testing or the various forms of fatigue testing—we have the right solutions. We offer products for hardness testing as well as instruments for impact testing and for melt index determination.

And for that rare occasion when we don't have a solution that fits, our experts will find one—from the smallest adaptation to a fully automated testing system or a test bench for special tasks.

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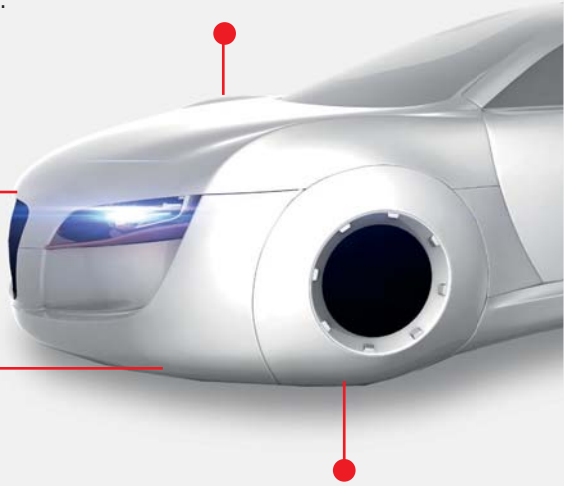
1.2 ZwickRoell—A trusted partner for testing in the automotive industry

Reliable test results in R&D, quality control, and production
Accurate and reliable test results are an important foundation in all development stages of automobiles and components. Testing solutions from ZwickRoell deliver accurate, repeatable, reproducible, and traceable test results.

E-Mobility and lightweight construction—Let us help lead you into the future
The automotive industry is in the midst of changes and faces major challenges driven by the necessity to reduce emissions, which can only be achieved through electrification and consistent lightweight construction. ZwickRoell offers innovative and flexible testing solutions that are the result of close cooperation between research and industry.

Quality management
The standard for quality management systems of organizations in the automotive industry, IATF 16949, is key for processes in the automotive industry. ZwickRoell testing instruments support suppliers and vehicle manufacturers in implementing standard requirements in testing.

UNECE, ISO, SAE INTERNATIONAL, VDA Verband der Automobilindustrie, JIS, ASTM INTERNATIONAL, DIN



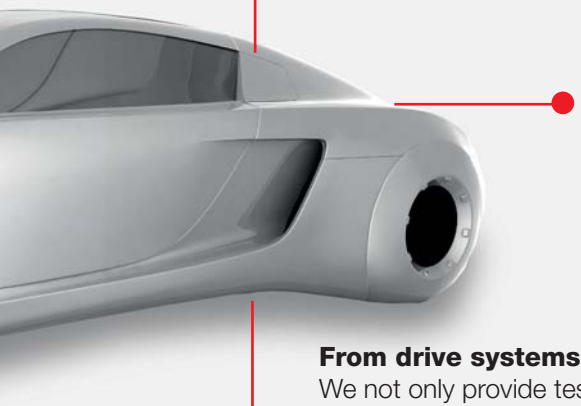
A trusted partner for vehicle manufacturers and suppliers for over 70 years
ZwickRoell began delivering testing systems to the automotive industry in the 1950's and since then has gained the trust of international OEMs, suppliers, research institutes, engineering and testing service providers as well as certification organizations.

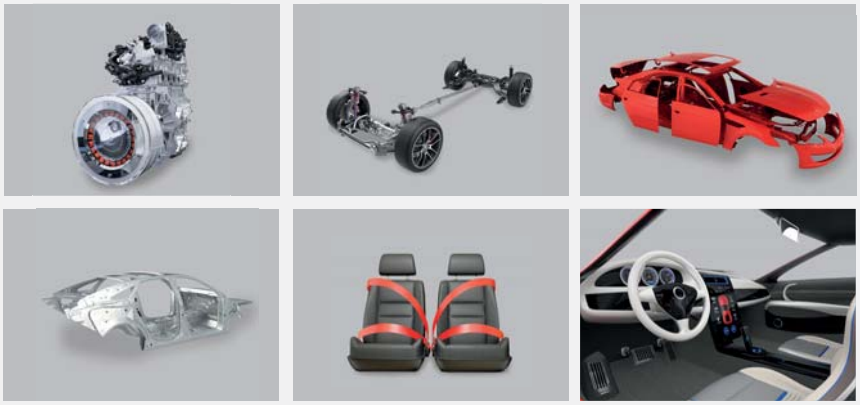
MICHELIN, Johnson Controls, LEAR, Continental, FEDERAL-MOGUL, DELPHI, DENSO, MAGNA, ZF, BOSCH, brose, BRIDGESTONE, Valeo, MAHLE, BENTELER, PIRELLI, faurecia

VW, TATA, BYD, FAW, BMW, TOYOTA, ABTOBAZ, Ford, RENAULT NISSAN, HYUNDAI, Mercedes-Benz, PORSCHE, Audi, JAGUAR, 长安汽车 CHANGAN, GM, VOLVO

Testing solutions from materials to complete components
Most vehicle components must be designed for mechanical loading over the service life of the vehicle and reliably fulfill the component requirements. ZwickRoell testing systems support this requirement from the reliable determination of material characteristics through the functional checking of components.

Intelligent testing solutions—The right product for any application
ZwickRoell's wide range of testing machines is modularly designed and can be optimally adapted to your testing requirements. This enables us to offer various testing solutions for standard-compliant tests via universal testing machines for a number of test tasks to fully automated complex testing systems. All ZwickRoell testing systems deliver reliable test results, easy operation, and high availability.





From drive systems to electronics—Testing solutions for all segments
We not only provide testing systems for fundamental challenges such as the use of materials and joining technology, we offer comprehensive testing solutions for all relevant vehicle segments, from engines to the chassis, body, interior, and safety, to electronics/mechatronics. We work closely with our customers in the development electrical drives and battery technologies.

Worldwide expert network
We support our customers in all countries in which vehicles and components are manufactured. Our qualified team of experts participates in continuous training in order to provide our customers around the world with optimal consultation and support.

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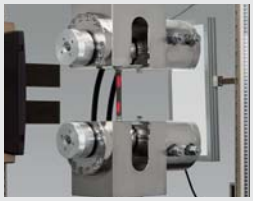
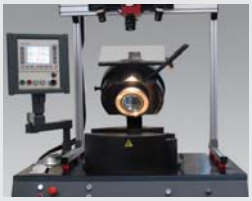
1.3 Mechanical tests on materials

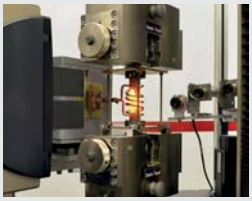
Compliance with strict statutory emission limit values requires that the automotive industry make vehicles more efficient and environmentally friendly. This will be achieved through drastic weight reductions, improved combustion technology and exhaust gas treatment, as well as through the use of alternative drives. Despite more stringent requirements for safety, efficiency, and comfort, it is considerably easier for manufacturers to produce each new generation of vehicles. At the same time, this requires newer or improved materials as well as intelligent material compounds that allow better properties at lower specific weights in their area of application. In addition, weight reduction is systematically implemented in all components of a vehicle, which is required for optimal material utilization.

Reliable determination of mechanical characteristics plays a vital role here. By using diverse test methods the various material properties are determined as realistically as possible. Our universal testing systems can generally be expanded with measurement sensors, specimen grips, test fixtures and environmental simulations. As a result the testing system can be adapted to modified or future test tasks. You can find additional details in our brochures or on our website.

Tests on metals

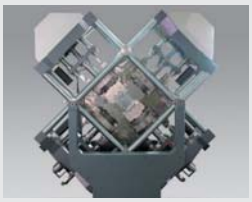

Tensile test


Sheet metal testing


High-temperature testing


Hardness testing


Charpy impact test


Biaxial test


High-speed test


Fracture mechanics

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Testing of plastics and components

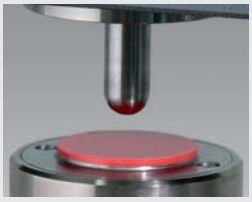

Tensile testing


3-point flexure testing


Compression testing


Hardness testing

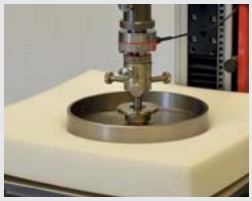

Impact test


Instrumented puncture test


Extrusion testing


Fatigue testing

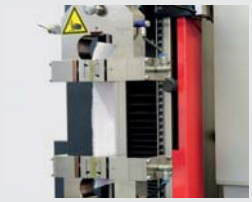
Tests from other application areas


Tests on soft foams


Tensile tests on elasto-mers

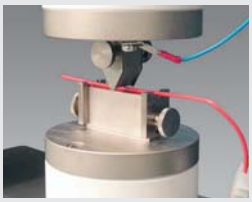

Abrasion tests on rubber


Tensile tests on threads


Tensile tests on textile fabrics


Glass tests


Tensile shear tests on wood joints


Tests on cables

1.4 Joining technology in automotive engineering

In vehicles, various joining methods are used that all have to be characterized mechanically.

Removable threaded connections are used in a range of applications within vehicle manufacturing and increasingly in safety critical applications. The quality requirements that must be met in tensile and fatigue testing are correspondingly high for screws.

In the chassis, linear connections (welded joints) are used overwhelmingly where the focus is on the service life of the component or joining connection. Linear, pointed and flat connections as well as a combination of the individual connections are used in vehicle body shells.

Adhesive bonding has become a popular method for reliably joining various materials and continues to gain popularity in the automotive industry. Modern adhesive materials fulfill the requirements of lightweight construction optimally, since they offer high joining quality at a low weight and can be implemented flexibly.

The focus lies on a crash-safe design of components, while ensuring the required service life. In addition stiffness is a key criterion for designing components in the body shell as well as in the chassis.

Fig. 1: Static tensile test on screws

Fig. 2: Fatigue tests on threaded connections with the Vibrophore

The mechanical properties of the joining connections must be determined under quasi-static as well as under fatigue and impact dynamic loading.

The data calculated during testing (quasi-static tensile tests, fatigue strength tests, and dynamic impact tests) is used for quality assurance and as input for simulating service life and crash behavior.

When using component-like specimens, these can also be used as validation for service life or crash models. The combination of various materials is becoming increasingly important in lightweight construction. Joining metallic and non-metallic materials presents challenges to the manufacturer that can only be solved by using various joining methods. All joining methods combined require that you ensure the stiffness of the compound and its load-bearing capacity in application.

Fig. 5: Push out test for riveted joints

Fig. 1: Point welded specimen

Fig. 3: Shear tests on riveted joints

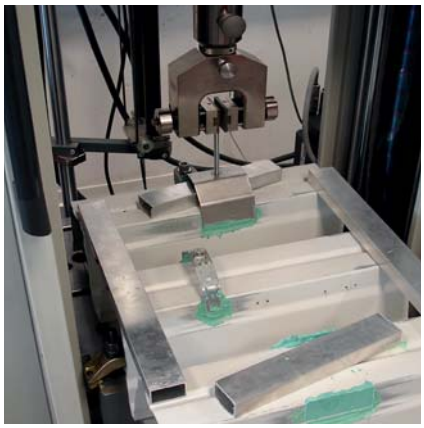


Fig. 6: Peel tests on structural adhesive bonds

Fig. 2: Slotted specimen for adhesive bonding of two fiber composites in shear test

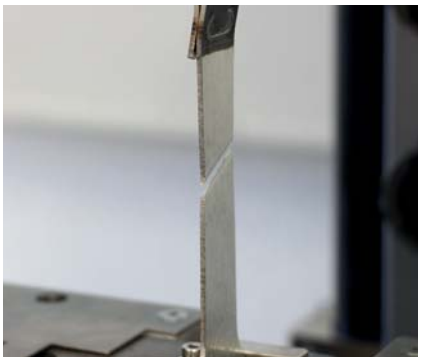


Fig. 4: Laser welded sheet metal specimen after tensile test with failure outside the welding location

Fig. 7: Peel tests on adhesive strips

2 Motors, drives, and electrification

Drive assemblies are the focus of development efforts to provide efficient mobility with reduced emissions. Downsizing plays a large role in achieving the demanding worldwide regulatory goals. On the one hand combustion engines are becoming smaller and lighter, but on the other hand they are also becoming more elaborate and complex due to additional engine features such as supercharging, operating parameter optimization, and the increasing combination with electric drives presenting challenges to the composite materials used. Testing technology from ZwickRoell delivers reliable test results for supporting this development process.

2.1 Tests on electrical drives

To achieve a high degree of efficiency with electric traction motors, unconventional paths are often taken: complex sheet metal stampings, thinner sheet metal, and high performance magnets for permanent excitation. ZwickRoell testing machines are used to measure push-out forces of adhered permanent magnets for example to ensure a secure fit. In addition, assembly and disassembly forces of electric motor components are determined in order to more precisely pinpoint causes of failure.

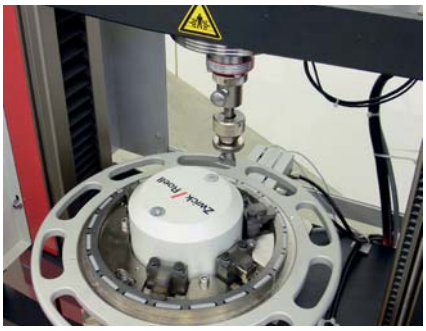


Fig. 1: Traction motor testing

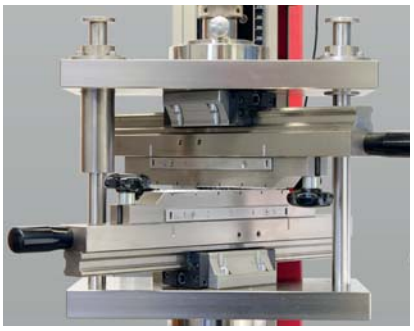


Fig. 2: Testing the bond strength of electrode layers for lithium ion batteries

2.2 Tests on electric energy storage systems

The lithium ion battery is currently the most popular option for energy storage for electric drives in vehicle construction. Its complex design requires high process safety during manufacturing and assembly in the complete battery system. In this manner, the widest range of mechanical tests are performed on cells, battery modules and even complete battery systems. Due to the high energy density, the batteries must withstand mechanical loading up to a triggered short circuit, in order to prevent a hazard to the vehicle occupants. In addition, strict test standards must be adhered to in order to meet the transport regulations for high energy storage systems. Machine control, acceleration of the testing machine and its data acquisition rate must be designed for these quick processes.

2.3 Tests on fuel cells

Fuel cells offer another interesting alternative to fossil fuels and combustion engines by converting hydrogen into energy for electric drives. In addition to undergoing load tests for individual cell layers or the determination of stackability of individual fuel cell modules, the materials for pressurized hydrogen storage must withstand pressures of up to 1200 bar. Plus the materials used must be inspected for any possible negative influences from hydrogen, such as embrittlement.

2.4 Tests on engine components

Connecting rod testing

The load collective acting on connecting rods requires a design and materials that meet the high demands placed on it, such as a fatigue limit of approx. N = 5 x 10^6 cycles. The connecting rod can be divided into three loading ranges and for testing both eyes must be tested under real conditions, i.e. with play and in a temperature range of 90 to 120 °C surrounded by oil.

ZwickRoell's Vibrophore with special forked specimen grips allows to achieve a high testing frequency of up to 250 Hz and an extremely high specimen throughput. Due to to the comparatively low energy consumption operating costs are correspondingly low.

Fig. 1: Fatigue tests on connecting rods

Testing of crankshafts

For fatigue testing on crankshafts, you can use the Vibrophore or a servo-hydraulic testing machine. To determine the S-N curve, individual segments are fatigued through flexural loading in which the mounting table and tools are arranged so that all of the crankshaft's segments can be checked by reclamping them. A fatigue limit of approximately N = 3 x 10^6 cycles is assumed here. Force-controlled sinusoidal cycles are performed according to the staircase method. Fatigue testing via torsional loading can also be performed using the same machine.

Fig. 2: Crankshaft segment under dynamic loading in a Vibrophore

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Testing of assembled camshafts

The nature of camshaft operation requires that they withstand high, continuous torsional loads. Torsion testing machines can be used for production-related quality control. The torque acting on a camshaft at which component connections begin to loosen is determined. Camshaft sections are gripped horizontally in the machine and a torque load of up to 1000 Nm is increasingly applied. Especially interesting is the elastic and plastic deformation of the camshaft components. ZwickRoell's optical laser extensometer measures the rotational angle without making contact.

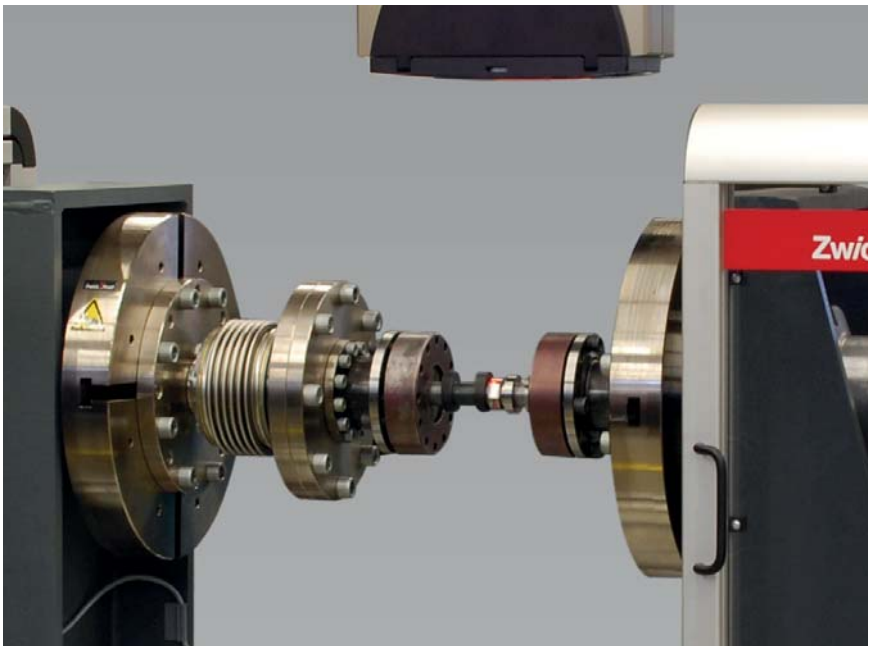

Fig. 3: Torsion tests on camshafts

Additional tests on engine components

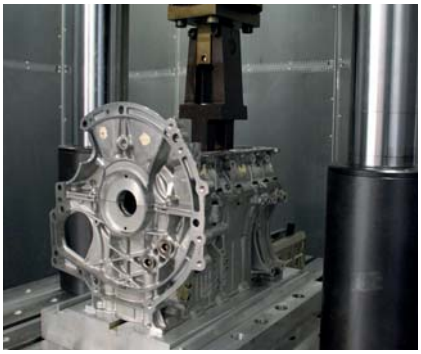

Fig. 1: Fatigue tests on the engine block

Fig. 4: Valve spring testing

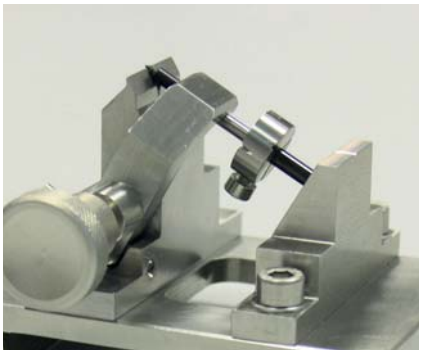

Fig. 6: Testing the coefficient of friction of DLC coated fuel injectors

Fig. 2: Fatigue tests on engine chains

Fig. 5: Hardness testing on valves

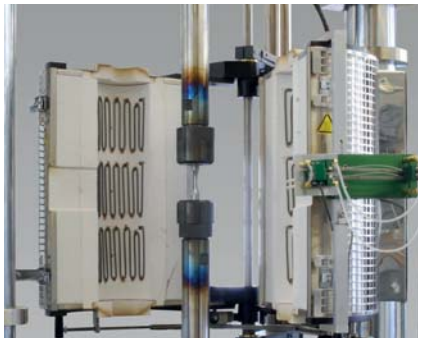

Fig. 7: High temperature testing on engine components

2.5 Testing of engine-related components

Due to their location, these elements are often subject to strong thermal loads as well as vibrations. If not properly designed, these components can fail prematurely. Operational fatigue strength testing based on the actual expected loading is necessary for adequate protection.

Testing of engine mounts

Elastomer mounts fulfill a range of functions in the engine area and chassis. They serve as joints and assist in equalization and vibration isolation and damping. Various test methods are used to characterize and test active and passive mounts.

Fig. 1: Single-axis fatigue testing on engine mounts

Testing of exhaust systems

Exhaust systems are highly stressed, complex components that are subject to thermal loads, jolts, and vibrations, as well as corrosive media. These systems include a large number of sensitive components such as catalytic converters, measurement sensors, and electronics, which must be designed and checked for these requirements. ZwickRoell offers a wide range of testing solutions. In the example, biaxial tests are performed on a complete exhaust system in a servo-hydraulic testing system.

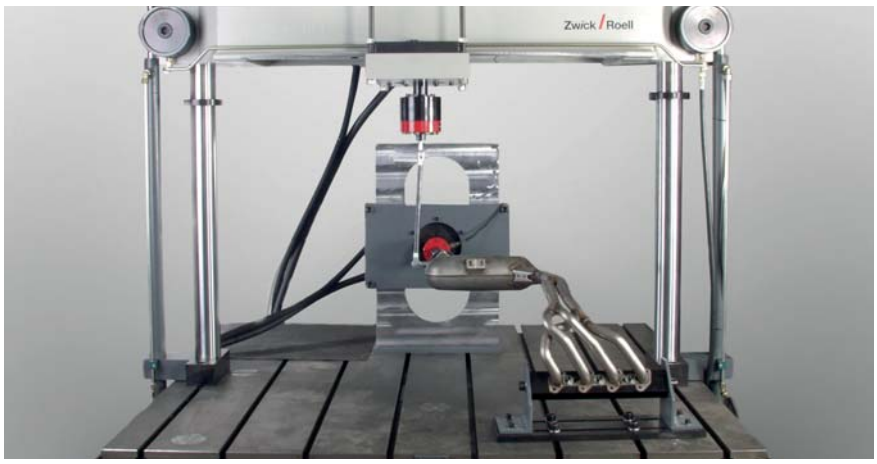

Fig. 2: Fatigue tests on exhaust systems

Testing of catalytic converter mats

Brittle ceramic catalytic converter bodies must be stored safely in the exhaust system for the entire duration of the service life. Determining the stiffness and coefficient of friction at temperature is extremely important for the bearing mats used. For this purpose, a testing machine is equipped with compression platens that can be heated up to 1050°C and apply the vertical test loads. Also, by using an optical displacement transducer, the machine can highly accurately control the compression platen distance.

The temperature specific coefficient of friction can be determined using an additional horizontal test axis.

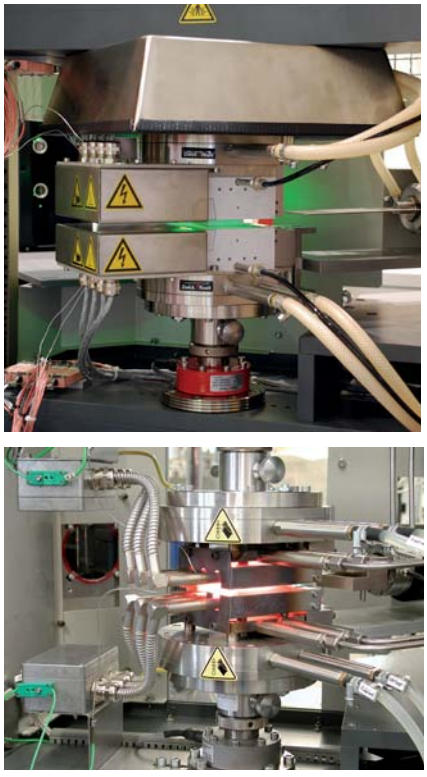

Fig. 3: Testing of catalytic converter mats

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2.6 Tests on drive trains

Wherever power is converted and transferred, tests ensure the reliability of the installed components. ZwickRoell has over 50 years of experience testing engine and drive components. Initially, the load tests performed were simple, but today extremely specific properties must be measured and documented under realistic operating conditions, at high speeds, torques, and real operating temperatures.

Testing of clutches

The characteristic curves of the contact force and travel, as well as release force and travel, are important in both the development and production control of friction clutches. You can also determine the release stroke of the clutch pressure plate and the parallelism of the pressure plate to the clutch plate. The characteristic curves are not only important for comfortable operation but also for safe clutch torque transfer. These tests are performed in new condition and in a defined used conditions.

Axial and torsional measurements on clutch disks

Dry friction clutches are also used to apply and to interrupt the torque flow. In addition to the aforementioned axial characteristic curves, torque characteristic curves are therefore also extremely important, for example, the drag torque, predamper and main damper characteristic curves or the zero crossing.

Fig. 1: Determination of contact force and displacement as well as push out force and displacement of friction clutches

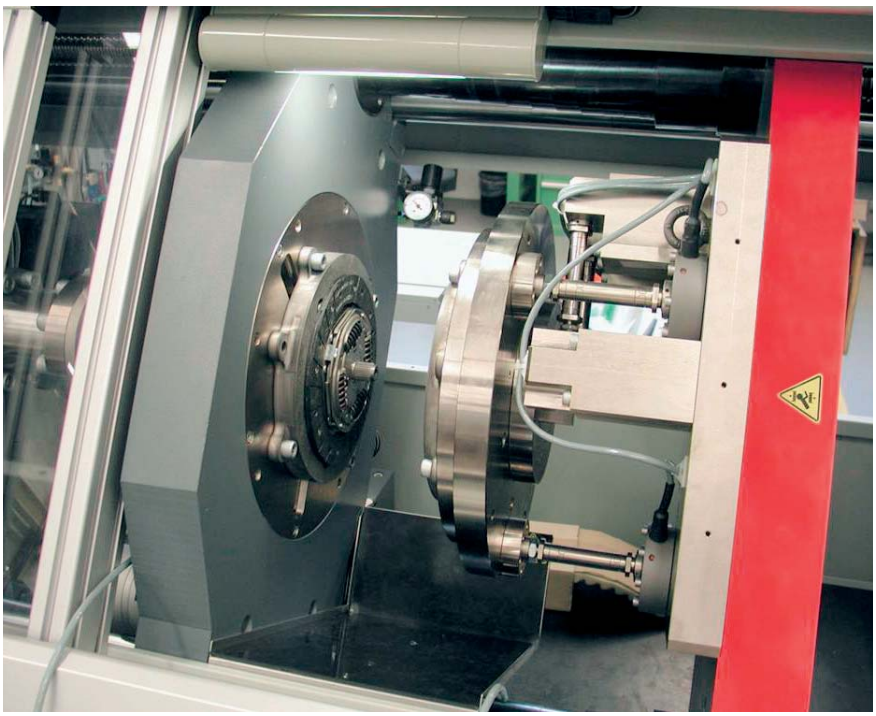
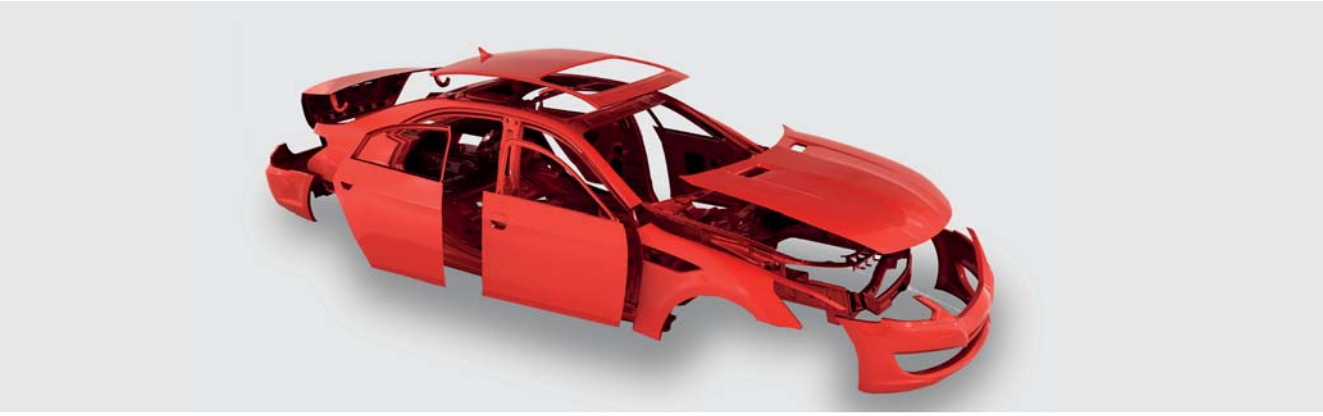


Fig. 2: Axial and torsional measurements on clutch disks



3 Body

To meet the increasing demands on passenger protection, lightweight construction, comfort, and functionality, modern self-supporting vehicle bodies are becoming increasingly complex structures in hybrid construction. That is why today, high strength to ultra-high strength steels, aluminum, and increasingly, fiber-reinforced plastics, are used in addition to classic grades of steel. High-accuracy testing technology from ZwickRoell supports the design of these sophisticated multi-material composites.

3.1 Checking the sheet metal forming properties

Good ductility properties are extremely important for thin sheets in the body. Typical forming processes, such as deep drawing and stretch forming are regulated by standard testing methods. ZwickRoell's BUP sheet metal testing machines test these properties with drawing forces up to 1,000 kN.

Another important but complex test is the determination of the forming limit curve, from which engineers can derive limit strains which should not be exceeded during forming processes. ZwickRoell works in close collaboration with highly specialized partners to offer the optical measurement technology required for recording strains during the drawing process.

3.2 Fracture toughness testing

Fracture toughness K_{Ic} is an important characteristic for metallic materials in safety-related applications such as aircraft construction, power plant construction, and automotive engineering. The fracture toughness is determined by an artificially cracked specimen that is loaded until fracture. The fracture toughness K_{Ic} can be determined from the load-deformation curve and the length of the crack.

Fig. 1: Sheet metal forming testing

Fig. 2: Determination of the fracture toughness K_{Ic}

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3.3 Testing the surface waviness of the body exterior

The surface quality of formed sheets plays an important role for certain coating methods. It is necessary to determine the sheet surface waviness parameters in order to ensure the desired coating quality. A sheet metal specimen is deformed to a defined plastic strain and the waviness determined with a waviness testing instrument afterward.

3.4 High-speed tensile test

Material behavior at high strain rates is critical for applications in the automotive industry. Accidents generate high material deformation speeds which is essential to take into account in automobile design. The necessary material properties are determined using high-speed tensile testing machines from ZwickRoell's HTM series. These testing machines achieve deformation speeds of up to 20 m/s on specimens at forces up to 500 kN.

3.5 Plate bending test

This test determines the bending angle of vehicle body panel sheets determine the deformation behavior and the susceptibility to metal materials failing during forming processes with dominant bending elements (e.g. operations) or during crash loading. The test is performed using a special 3-point flexure device. This allows the bending angle (under load and after unloading, elastic recovery), as well as the inner and outer radius to be measured optically.

Fig. 1: Sheet metal testing machine with videoXtens

Fig. 2: High-speed tensile test with a test speed of up to 20 m/s

Fig. 3: Plate bending test to VDA 238-100

3.6 Testing of crash structures

The energy consumption and deformation of body components are key factors for the safety of vehicle occupants in case of an accident. Low-speed crash tests are therefore performed on body components and complete vehicle structures before typical high-speed tests are run. Even loads generated at low-speeds provide relevant information, which is then channeled back into the modeling and design stage.
In order to define the parameters for crash tests, static compression tests are performed under high loads to understand the beginning of the damage and its progression.

Fig. 2: Flexible clamping area for testing various body and structural elements

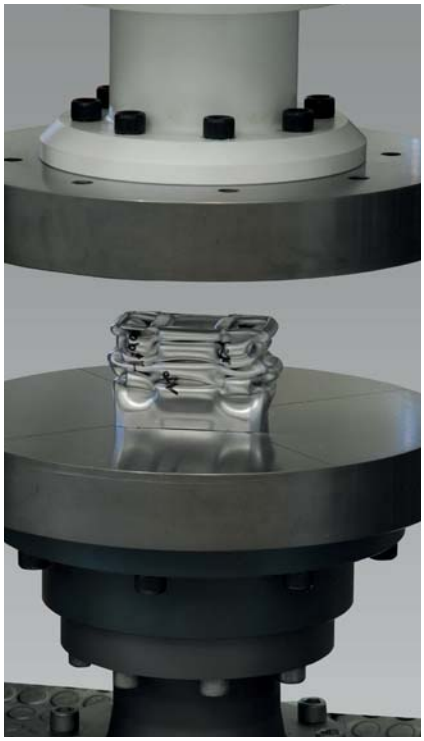

Fig. 1: AllroundLine materials testing machine with two test areas for tensile and compression tests on body components

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4 Chassis

As the link to the road, the chassis defines important features such as dynamics, safety, driving comfort, and fuel efficiency. Due to the safety-critical design of the components, reliability inspections, in particular, are incorporated when developing new materials and new manufacturing technologies.

4.1 Spring testing

Multi-channel spring testing
Multi-channel measuring platforms are used to determine the force vector of the chassis coil springs. Standard testing systems are equipped with a six- or nine-component force measuring platform for this. This enables the specific determination of the spring penetration points, the occurring torques, and the resulting force from the force components when loading the coil spring under compressive force. These characteristic values are important to evaluate the following quality attributes: friction, wear, and service life.

Testing air springs at various temperatures
This testing system determines the viscoelastic properties of air springs as well as their fatigue properties in a temperature range of -80 to +250°C. A special compression unit allows to mount air springs of various shapes and sizes. The entire fixture can be inserted into a mobile temperature chamber.

Multi-axial loading of air springs
This testing system is used primarily for the quality assurance and development of air springs. It consists of a floor-standing testing machine with Fmax 250 kN. It is equipped with an additional horizontal, electromechanical drive and a force measuring platform with five load cells (3 vertical and 2 horizontal). The axial and horizontal stiffness characteristics of air springs can be determined under vertical, horizontal or combined loading.

Fig. 1: Multi-channel tests on suspension springs

Fig. 2: Testing of pneumatic springs

4.2 Testing of wheels, rims, and tires

Testing of wheels

In the automotive sector, wheels are made of steel, light metal, or composite materials and their tires. Tires are complex composite bodies composed of materials with various physical properties. As the link between the roadway and the vehicle, they transfer all forces and torques. ZwickRoell testing systems are used to determine the quasi-static and dynamic properties of wheels and tires. This ranges from standard tests on rubber, textiles, and wires to tests on the entire wheel/tire system.

Testing axial deformations of the rim flange

To determine stiffness properties, compression tests are performed on the rim flange with a special pressure spindle. For this, a floor-standing testing machine with a forward projecting, height-adjustable T-slot crosshead is used. This way the rims can and be positioned at an ergonomically comfortable height in the test area and be affixed. The load cell ensures exact measurement of the axial force, even if lateral forces occur due to the geometric shape of the rim.

Testing of disc brake pads

Disc brake pads are one of the most important parts of a wheel brake. In order to evaluate the quality of the pads, you determine, among other things, the change in pad thickness through one dimensional compression loading in the direction of the disc brake pad's friction surface perpendiculars. To handle this task, ZwickRoell materials testing machines are equipped with a compression test kit featuring an integrated measuring system. Three offset measuring transducers are used to provide a highly accurate deformation measurement. Pressure is applied via an adapted piston replacement compression piece with circular force application.

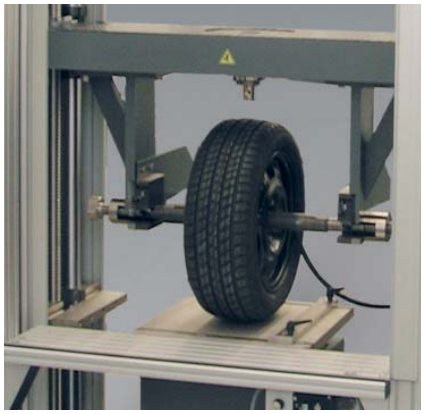

Fig. 1: Test bench for measuring the lateral stiffness of tires

Fig. 3: Testing axial deformations of the rim flange

Fig. 5: Compression tests on brake pads

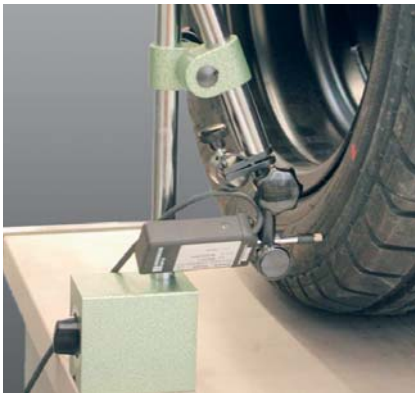

Fig. 2: Axial, horizontal forces and tire pressure are controlled via testControl

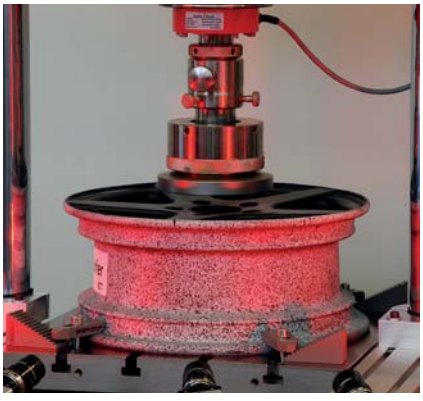

Fig. 4: Measuring full-surface deformations on a CFRP rim

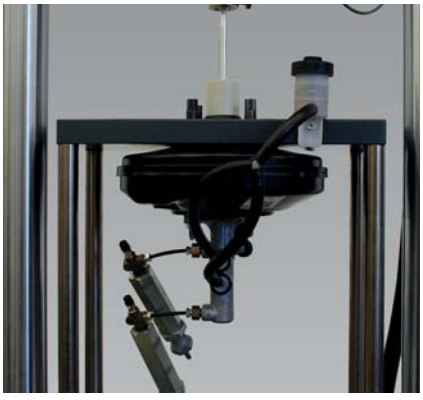

Fig. 6: Load application in a brake booster

4.3 Tests on steering systems

Testing of steering linkages

This testing system is used to determine the friction forces and torques, including stiction, inside and outside the test axis for a steering linkage in mounting position. A horizontal multi-axis testing machine for test loads up to 20 kN is used for this purpose. Various steering linkage designs can be tested optimally using three adjustable test axes. Three separately controlled drive axes (axial, lateral force, and torsion) allow a number of test sequences to be used.

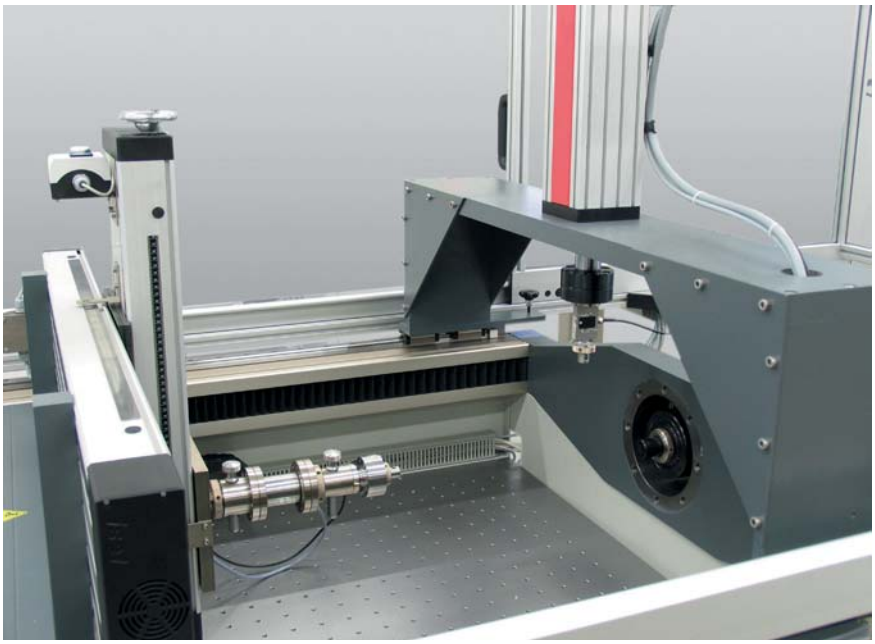

Fig. 1: Test arrangement for mounting the steering linkages

Testing of steering shafts

To facilitate automated production of telescopic steering shafts for trucks, ZwickRoell testing machines can be integrated into a fully-automated assembly line. A testing machine with laserXtens is used to determine the maximum torsion angle in the middle of the production process, allowing process-oriented analysis of the previous assembly steps. A second testing machine at the end of the production line measures the displacement force of the steering spindle.

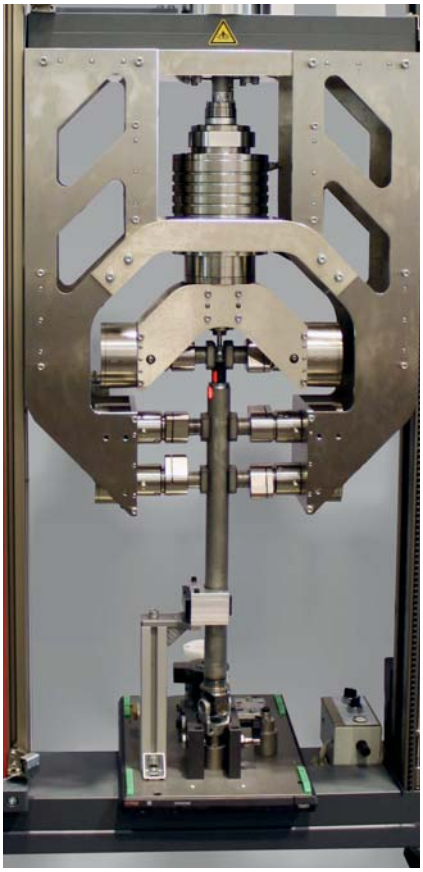

Fig. 2: Testing of truck steering shafts

Testing of rubber-metal dampers

A testing system based on a standard testing machine has been developed to determine, among other things, the static and dynamic stiffness and the loss angle and loss factor of rubber-metal bearings.

Fig. 3: Testing of rubber-metal dampers

5 Electronics and mechatronics

5.1 Tests on switches

To determine the switching characteristics of electronic switches and elements, the measured electrical signals of the tested assembly are assigned synchronously to the respective force and displacement signals. In a hysteresis test (switching on and off), the mechanical force or the torque and the electrical switching point are determined and displayed. Testing machines can also be expanded with torsion drives for torque measurement on rotary switches.

5.1 Function tests on electromagnetic actuators

Proportional and switching magnets are used in several vehicle applications. The force-stroke characteristic curve is determined in the final test during the function testing of electromagnetic actuators. The basic function properties of the actuators can be ascertained from the characteristic curve.

Also, the hysteresis provides information about friction resulting from the quality of the mechanical parts.

Furthermore, for proportional magnets, the force-current characteristic curve that reveals which force the actuator applies in a defined armature position within a current range is verified. The ideal characteristic curve has a linear relationship between force and current around the operating point.

Fig. 2: Function tests on a window lifting switch element

Fig. 1: Testing of electromagnetic actuators

Fig. 3: Acoustic-haptic tests on mult-function rotary switches

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6. Seating, interior, and safety components

6.1 Static seat testing

We offer an array of testing solutions for the wide range of tests that are performed on seats and seating elements. The testing system shown is designed to determine the quality of automobile seats. The loading table is used for ergonomic loading and easy horizontal positioning of seats. The ability to move the load cell simultaneously and laterally to a defined position of the seating surface enables you to determine the axial stiffness of all areas of the seat surface. Installed sensor technology, such as for seat occupancy detection can also be tested in the seat.

Fig. 2: Flexible test bench for characterizing seats

Fig. 1: Determination of indentation hardness of pre-formed flexible foams

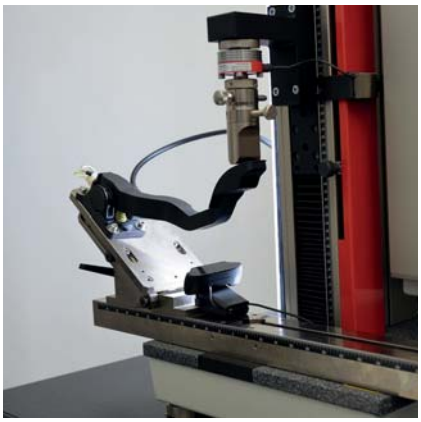


Fig. 3: Determination of the actuation force of gas pedals

Fig. 4: Fatigue testing of an emergency brake lever

6.2 Testing of seat belts

The seat belt has long been the most important passenger restraint system. It must comply with multiple stringent requirements. For example, the test scope is defined in the regulation UN/ECE-R16. In addition to various preconditions for the belt (placement, humidity, temperature, light, drive, etc.) the test must be performed on a testing machine according to very strict specifications. In addition to the maximum force at break, values such as the transverse strain under load are calculated. ZwickRoell testing systems are also used to determine the strength of other seat belt components such as the buckle or belt tensioner.

Fig. 1: Tensile tests on seat belts

6.3 Testing of airbag fibres

Another important piece of safety equipment is airbags, which are installed in various locations in the passenger area. In addition to testing the textiles used to make airbags, their seams and adhesive bonds are also tested in a tensile test. Additional tests are performed on sensors, switching elements, and predetermined breaking points.

Fig. 2: Testing of airbag fabrics

6.4 Testing of sealing sensors

This testing system tests door and window seals with an integrated anti-pinch system. This system switches off window or sunroof motors if a defined force is applied to the seal (in case a passenger's fingers or head is pinched). The system determines the force at which the electrical signal activates the safety system. The electrical signal is measured and displayed in real time in the test sequence. The system also integrates a barcode reader for specimen identification and a horizontal positioning unit for multiple loading.

6.5 Testing of airbag connectors

When mounting airbags, the the airbag connector generates a distinct sound (audible feedback) when it clicks into place. zwickiLine testing machines ensure that safe electrical contact is made with the plug connector through its synchronized, mechanical, electrical, and optical testing.

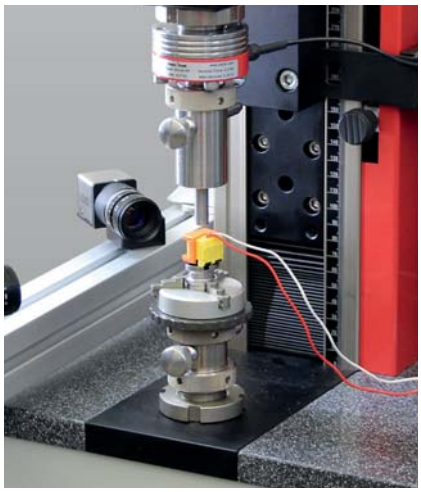


Fig. 3: Testing of airbag connectors

Fig. 4: Testing of sealing sensors

7 Products and accessories

7.1 Testing machines for quasi-static applications

The ZwickRoell Group is the world's leading supplier of static materials testing machines, developed by our experts for use in demanding testing situations and in a wide range of applications. Our static testing machines have been specifically designed for tensile, compression and flexure tests, together with shear and torsion tests, making them ideal for use in the most demanding materials and component testing situations. Our models in the 200 N to 2500 kN force range offer a wide choice of test strokes and speeds, with high-quality load frames combined with intelligent drive systems. All of our testing systems feature simple and flexible integration of load cells, specimen grips and extensometers. Static testing machines are the classic solution if relibles characteristic values of materials and components are needed.

zwickiLine
The single column zwickiLine is part of our testing machine line for loads up to 5 kN and offers a powerful and flexible testing solution for a wide range of materials components. This testing machine is equally ideal for research and development purposes as for routine quality assurance testing. A wide range of equipment options enables the zwickiLine to be used for tests on plastics, elastomers, metals, composites, paper, cardboard, textiles, foams, or parts and components.

zwickiLine und ProLine testing machine

AllroundLine testing machine

Zwick / Roell

ProLine
Our ProLine materials testing machines were primarily developed for performing standardized tests on materials and components in a force range of up to 100 kN. Used in conjunction with our intuitive testXpert III testing software, ProLine materials testing machines offer fast, easy operation.

AllroundLine
The new AllroundLine is suitable for applications from all fields. Whether for test tasks in quality control or for demanding research projects, the AllroundLine is an ideal solution. Our testing machines are available from a force range of 5 kN. Depending on the requirements and force range, you can select between profile- or column-configured machines.

High-capacity machines
High-capacity machines were developed for materials and component tests for which high test loads are required. Test tools for smaller test loads expand the application range and can be adapted easily.

The standard product range consists of several load frame options in the force range of 330 kN to 2500 kN. The load is applied electromechanically or hydraulically. For larger force ranges, hydraulic high-capacity machines can be provided for customized solutions. High-capacity machines are distinguished by their high stiffness, robustness, flexibility and reliability.

ne testing machine with two test areas

High-capacity testing machine

7.2 Dynamic testing machines

For decades the ZwickRoell Group has been successfully providing solutions for fatigue testing systems. Our experts work hand in hand with our customers and guarantee perfect solutions for all industries. From a compact servo-hydraulic table top testing machine to a multi-axis test portal in the mega Newton range—we can meet any of your challenges.

At ZwickRoell we use various physical drive principles for our dynamic testing machines. Each has its own specific advantages and areas of application, allowing us to find the optimum solution for your testing situation in line with your requirements The control electronics are critical to the efficiency of the testing system. testControl II electronics deliver powerful solutions for both simple and complex test tasks.
In addition, Control Cube, designed especially for multi-axial applications and modernizations, allows us to offer you flexible and expandable control electronics.

Electromechanical servo testing actuators
Electromechanical servo testing actuators can be used universally for tensile and compression applications for variable integration into test fixtures, production lines or special assemblies. Available for a force range of 1 to 100 kN, extremely suitable for tests with a testing frequency of up to 1 Hz.

Electromechanical testing actuator

LTM electrodynamic testing machine

HA series servohydraulic testing machine

HB series servo machine

Zwick / Roell

Vibrophore
Vibrophores employ an electromagnetic resonance drive. This enables high testing frequencies, giving short testing times with minimal use of energy. Vibrophore resonance testing machines are available for test loads up to 1000 kN and now also offer the option to perform standard-compliant static tests.

Electrodynamic testing machines
Electrodynamic testing machines with low maintenance linear drives are especially suitable for applications in the lower force range up to 10 kN. ZwickRoell's newly developed patented drive concept enables the LTM to be used for both dynamic and static materials and component testing. The low moving mass of the drive provides ideal conditions for fatigue tests.

Servohydraulic testing machines
Servohydraulic testing machines are extremely versatile. They can be used for both static and oscillating loads, while permitting test speeds up to 20 m/s. Their modular design includes testing systems up to 2500 kN, and even higher with customized versions. Along with testing systems, ZwickRoell's product portfolio includes specimen grips, measurement and control electronics, testing software, and hydraulic components. We offer a wide variety of solutions—from hydraulic power packs and hydraulic piping to single testing actuators—to meet individual testing needs.

ohydraulic testing

Vibrophore

Multi-axis servohydraulic test bench

7.3 Systems for testing at temperature and high temperatures

The wide area of application of vehicles in such varied global environmental conditions requires the determination of mechanical characteristics at low and elevated temperatures.

Temperature chambers
These chambers cover a wide temperature range from -80 °C to +250 °C and therefore also cover the majority of testing requirements on materials and components. Upon request, the chambers can be equipped with an expanded temperature range, air conditioning, media influence or fire protection devices.

High-temperature furnaces
High-temperature testing is used to determine the thermal-elastic behavior, heat resistance and re-crystallization temperature of materials. ZwickRoell offers an array of solutions between +200 °C and +1600 °C. These solutions feature optimal coordination of furnaces (including temperature controllers), the correct specimen grips for tensile and flexure tests, and the appropriate extensometer.

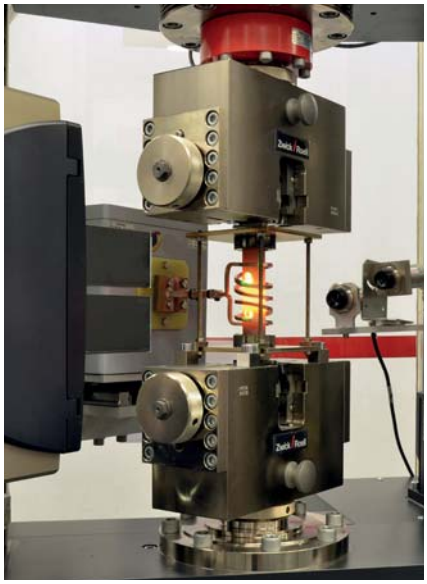


Fig. 2: High temperature tensile test with optical strain measurement (laserXtens)

Fig. 1: ZwickRoell delivers testing solutions for tests from -80 °C to +1600 °C as standard.

7.4 Testing machines for multiaxial stress states

In order to better simulate real, multi-dimensional loading states of components, test data from multiaxial loads will be needed increasingly.

Various test arrangements have proven their value in practical applications to better describe the three-dimensional loading state consisting of normal and shear stresses.

At the same time, various approaches are followed in which stresses and also torsion are superimposed in multiple axes.

Fig. 2: Biaxial testing machine with superimposed torsion

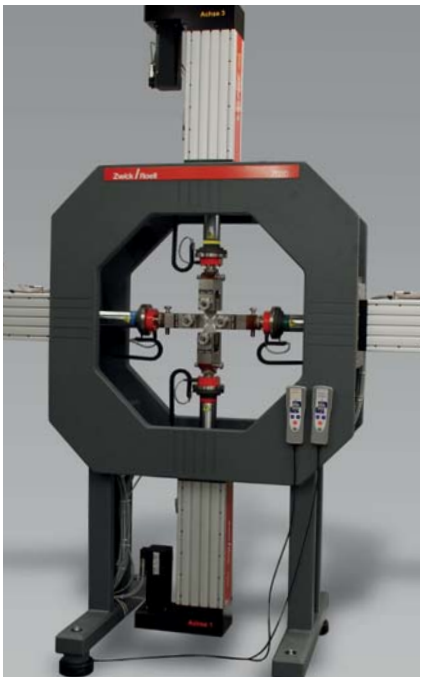


Fig. 4: 30 kN biaxial testing machine

Fig. 1: Tension-torsion testing machine with optical strain measurement

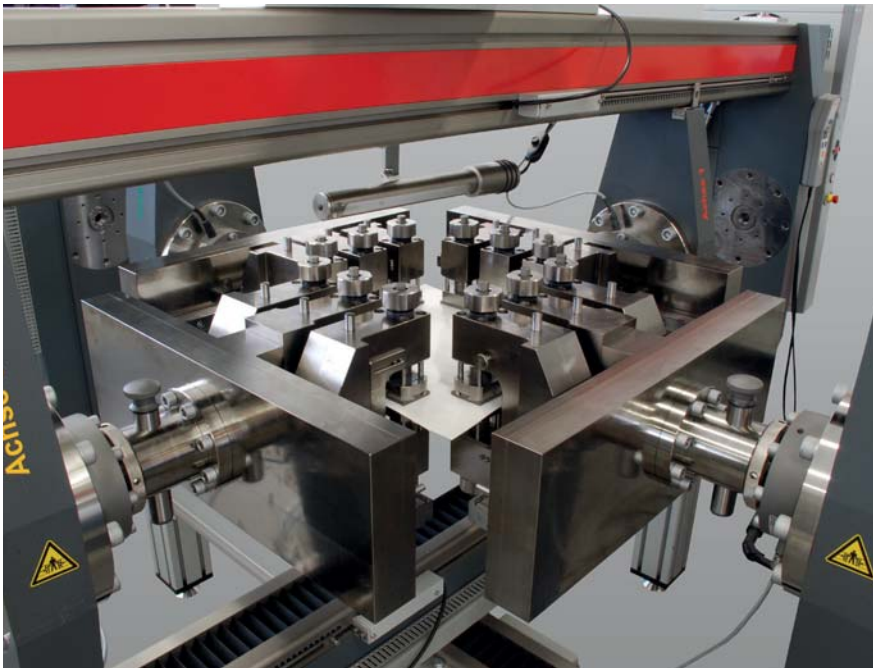


Fig. 3: Horizontal biaxial testing machine

7.5 Special testing systems and instruments

In addition to traditional testing machines, we offer a range of other testing solutions that are used in automotive applications. Good ductility properties are in great demand for thin sheet. Typical forming processes, such as deep drawing and stretch forming are regulated by standard testing methods.

Sheet metal testing machines
ZwickRoell's BUP sheet metal testing machines test these properties with drawing forces up to 1,000 kN. An important but complex test is the determination of the forming limit curve, from which designers can derive limit strains which should not be exceeded during forming processes. ZwickRoell works in close collaboration with highly specialized partners to develop the optical measurement technology required for recording strains during the drawing process.

Hardness testing machines
Our hardness testing machines and instruments are based on our many years of experience supplying a wide range of equipment around the world and maintaining communication with the people who use it. The versatility and high 'intelligence' of our testing systems is achieved with up-to-date mechanical components, powerful electronics and user-oriented software.

The ZwickRoell Group has a DAkkS-accredited calibration laboratory in accordance with ISO 17025 UKAS, based on the National Metrological Standard. This guarantees the traceable certification of ZwickRoell hardness testers, test blocks, and indenters.

Fig. 1: BUP 600 sheet metal testing machine

Fig. 2: ZHU250CL hardness testing machine

Pendulum impact testers
Our HIT pendulum impact testers are benchmark instruments for plastics manufacturers and processors for applications with up to 50 J of impact energy. Accuracy, reliability and ergonomic design are the hallmarks of these instruments that are primarily used for Charpy, Izod, impact tensile and, Dynstat tests.

Moreover, our RKP (≤4 50J) and PSW (≤ 750J) series metal pendulum impact testers can be found in in applications worldwide. These pendulum impact testers allow safe, reliable, Charpy and Izod testing, plus impact tensile testing and testing to Brugger, in compliance with international application standards.

Fig. 1: HIT50 P Pendulum impact tester with automatic specimen feeding

Drop weight testers
Impact testers are gaining increasing importance due to drop weight testing.Therefore, we offer a line of HIT drop weight testers that are designed for standard materials testing, but are also suitable for non-standardized component testing. With the increasing use of plastics in automotive manufacturing, these tests are becoming increasingly important.

High-speed testing machines
Among other factors, the fracture behavior of many materials is dependent on the loading rate. Numerical calculation of crash safety requires relevant data and constitutive equations. ZwickRoell's HTM servo-hydraulic high-speed testing machines allow strain-rate-dependent characteristic values to be determined over a wide speed range.

C-frame testing machines
The cLine materials testing machine series features a test area which is open on three sides. cLine materials testing machines are ideal for component testing and for testing flexible foam materials. Component testing is primarily performed on molded foam products such as vehicle seats and cushions. For materials testing, cubes or slabs of flexible foam are used. Compression tests, cyclic indentation tests and pulsating compressive strength tests (alternating load tests) are employed. When combined with our intuitive testXpert III testing software, cLine materials testing machines are very easy to operate.

Fig. 2: HIT 230F drop weight tester

Fig. 3: HTM high-speed testing machine

Fig. 4: C-frame testing machine

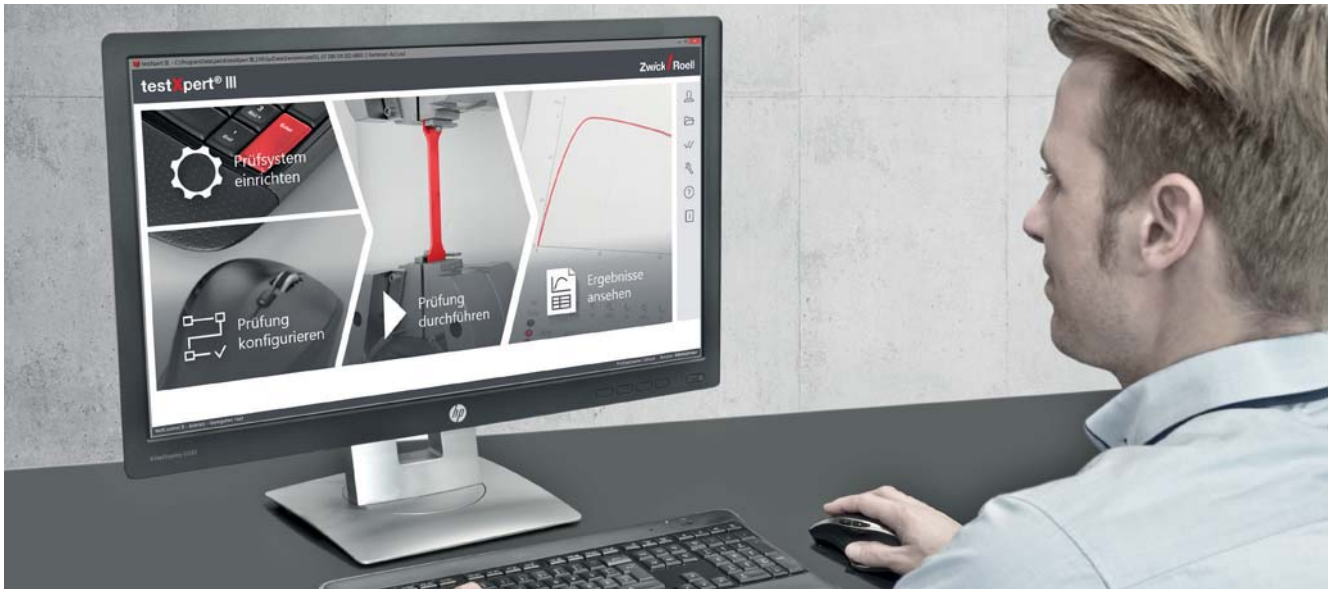


Fig. 1: Workflow based on the user's lab processes from an administrator view with full functionality - www.testXpert.com

7.6. testXpert III testing software

Intuitive and workflow-based right from the start!
testXpert III is the result of close cooperation with software users in the materials testing industry and the experience of over 30,000 successful testXpert installations. From the very start, users can easily and intuitively navigate testXpert III. Meaningful icons and clear visual connections help the user and reduce the number of mouse clicks required.

A workflow based on your lab processes
The software guides you through the various steps of a test, from preparing and running the test to analyzing results.

- Set up testing system—Configure all machine-related settings for your testing application.
- Configure test—Set all test-related parameters, such as selecting results with the intelligent wizard.
- Run test—Experience fast and easy navigation through the entire test sequence.
- View results—Verify all test data, also in secure mode.

Intelligent user management means you can define different user roles or adopt user roles defined in the Windows accounts with LDAP. The user can focus on the task at hand right from the start and avoid input errors. testXpert III is a workflow-based software that keeps training time to a minimum and makes testing efficient and reliable.

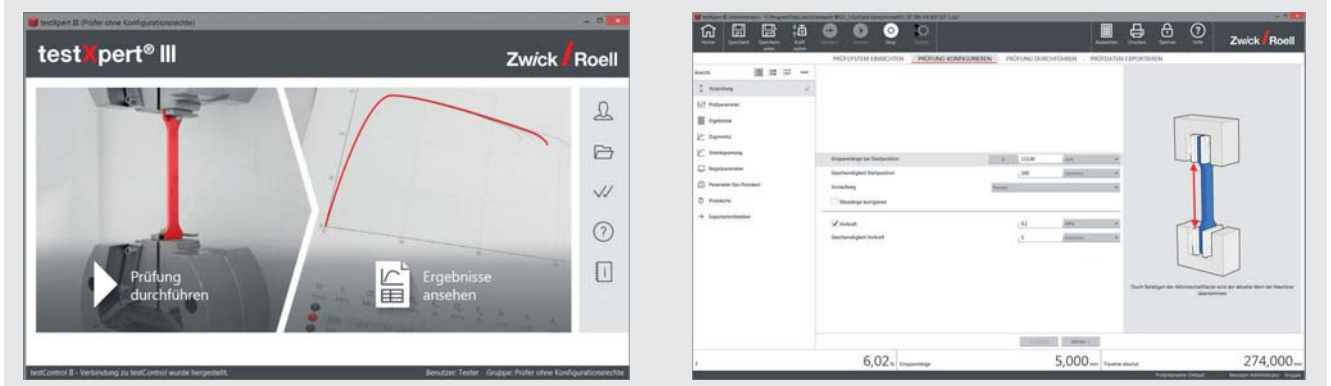


Fig. 2: View optimized for the tester (left) , the intelligent wizard for test configuration (right)

System Configuration Builder — A unique software concept
You can preset and save all relevant testing system and safety settings such as crosshead position, tool separation or sensor configuration with the System Configuration Builder. The saved system configuration checks the connected sensors. You may start the test only once the parameters match the requirements to ensure reproducible test conditions.

Tamper-proof test results
testXpert III logs all testing system and system settings, ensuring traceable results. Due to testXpert III's traceability, at anytime you can answer the question "Who does what when why and who is responsible."

testXpert III guarantees reliable test results and maximum security for users and the testing system.

Reliable importing & exporting
testXpert III can communicate directly with any IT system. All test relevant data is imported quickly and directly from ERP systems, databases, or external devices. Data can be exported into your customary evaluation analysis platform.

Standard-compliant testing
testXpert III offers over 600 prepared Standard Test Programs, preconfigured to test requirements and with integrated results tables and statistics. Users can begin standard-compliant testing immediately. testXpert III will take care of the rest!

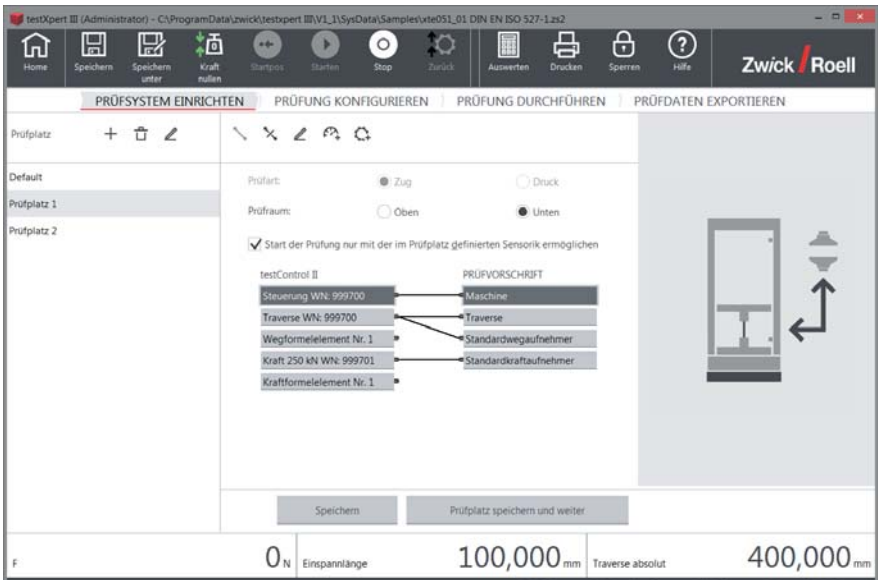


Fig. 1: This means that saved test environments can be recreated following a change of test arrangement, so that tests can be performed using identical settings.

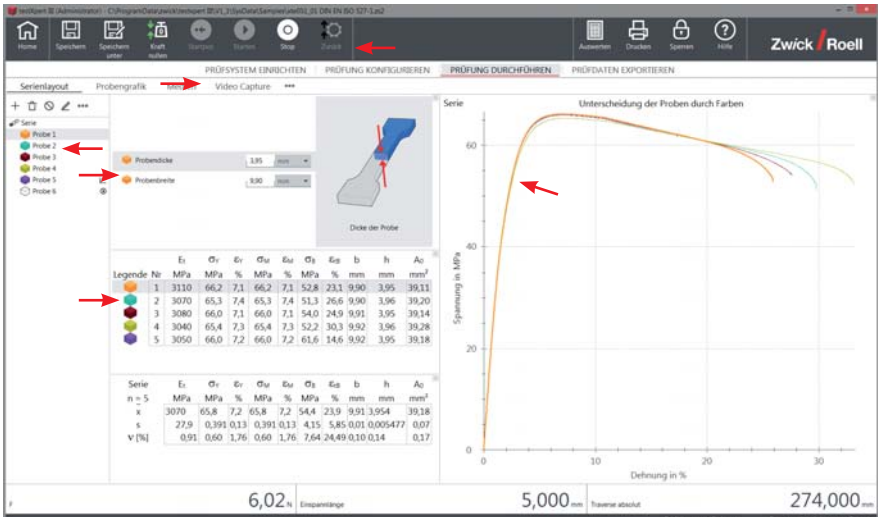


Fig. 2: Structured workflow with clear visual association of related content

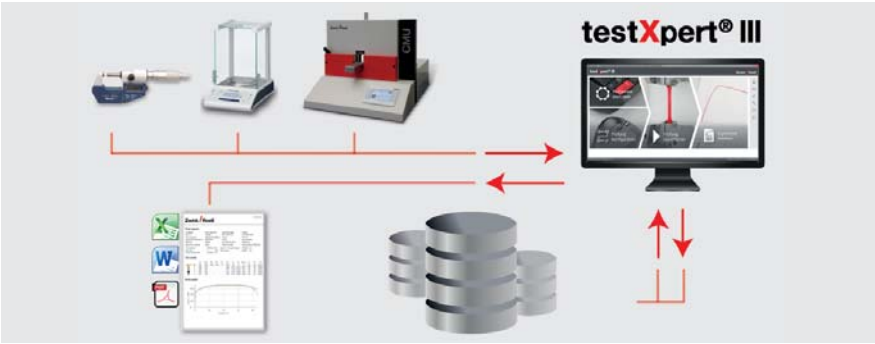


Fig. 3: Reliable and simple interfaces for sharing the test results

7.7 Measurement and control electronics

testControl II control electronics and testXpert® R testing software

The first choice for standard single-axis applications

Due to their design, servo-hydraulic testing machines and Vibrophores have been used exclusively as dynamic materials testing machines for determining the fatigue strength of materials and components with regard to fatigue life and fatigue limit in the tensile, compression, pulsating load and alternating load ranges.

Switching from testXpert R to testXpert III allows ZwickRoell servo-hydraulic standard testing machines and the new generation of Vibrophores to be used for both dynamic and static applications.

These Vibrophores are therefore also referred to as "two in one". A key advantage is that both types of machines can be utilized as static and dynamic materials testing machines capable of exploiting the full scope of ZwickRoell's well-proven testXpert III testing software and application-specific testXpert R dynamic testing software.

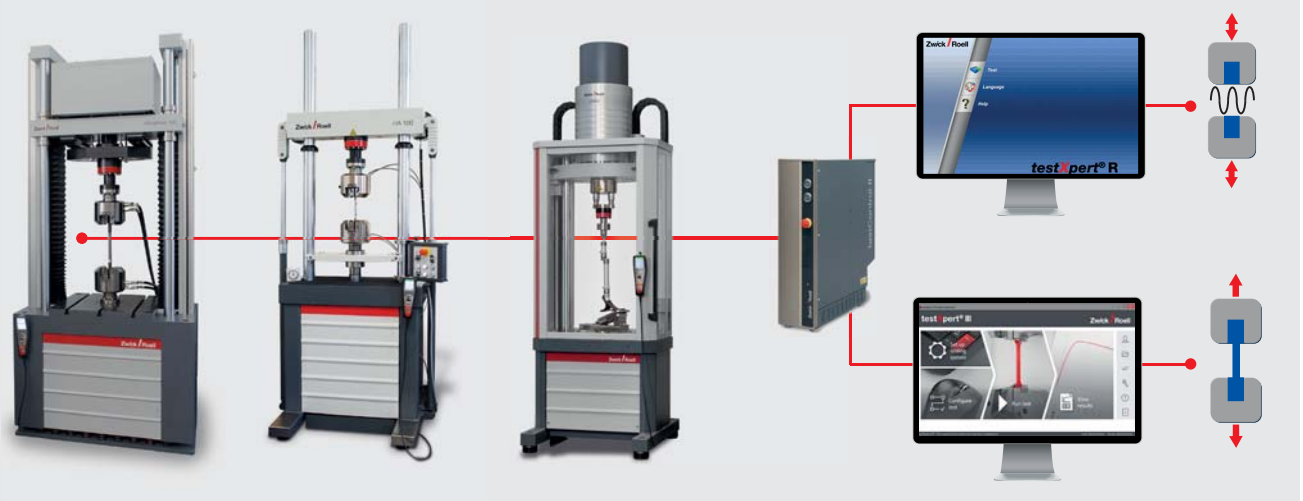
testControl II measurement and control electronics

The first ZwickRoell measurement and control electronics for dynamic testing machines to be developed entirely in-house, testControl II provides a new hardware and software platform for all ZwickRoell testing machines. Users now have access to a uniform testing environment for both static and dynamic testing machines. The intelligent testControl II measurement and control electronics have a control frequency of 10 kHz, providing rapid response to events during tests combined with a high measured value acquisition rate. When combined with the 24-bit resolution, this enables extremely precise measurements.

testXpert® R testing software

testXpert R intelligent testing software for fatigue and component testing provides the user with a uniform operating concept, from sensor calibration, setting PID parameters and specifying set values, right through to the evaluation and report stages. The software's modular design allows easy addition of test programs for specific tests or standardized test sequences as per ISO/DIN or ASTM.

A single testing system for both dynamic and quasi-static tests



ControlCube control electronics and Cubus testing software

The Control Cube servo controller and Cubus testing software are used with multi-channel and/or complex testing systems. The Control Cube servo controller is also the optimum solution where frequent test arrangement changes are involved. As well as established standard tests, Control Cube is also used in conjunction with component and assembly testing. The system's modularity and flexibility make it ideal for multi-channel applications and simulation tests.

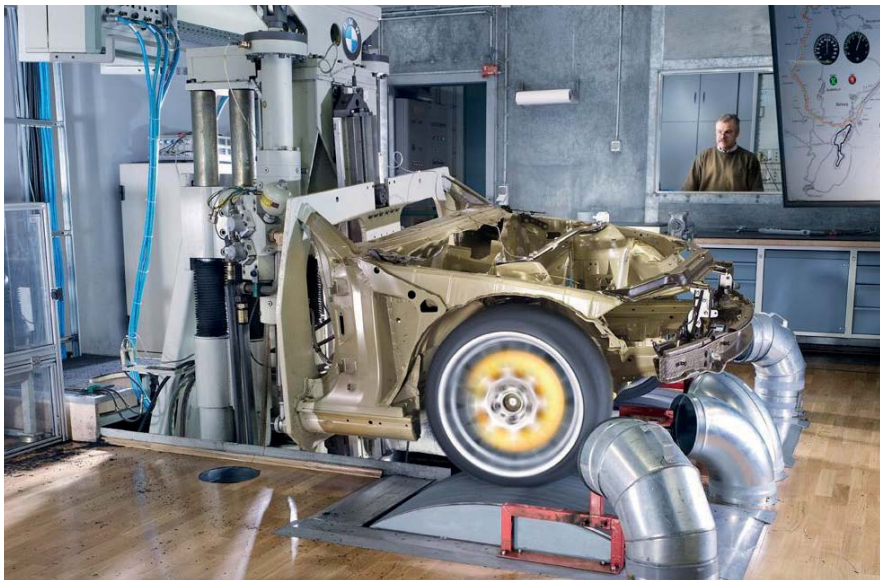


Fig. 2: Multi-axis test stand for follow-up tests (Image: © IABG)

Added to this is a multitude of helpful functions to simplify everyday use of the testing system. These include automatic optimization of control parameters, together with adaptive control which allows control parameters to adapt automatically to changing requirements during the course of the test. There is also a wide range of useful options for data acquisition, measured-value display and data export. To enable interface with the testing environment, connections for servo valves, hydraulic supply, remote control and Emergency STOP are available. These are complemented by universal measurement amplifiers and analog and digital inputs and outputs. These can naturally also be retrofitted.

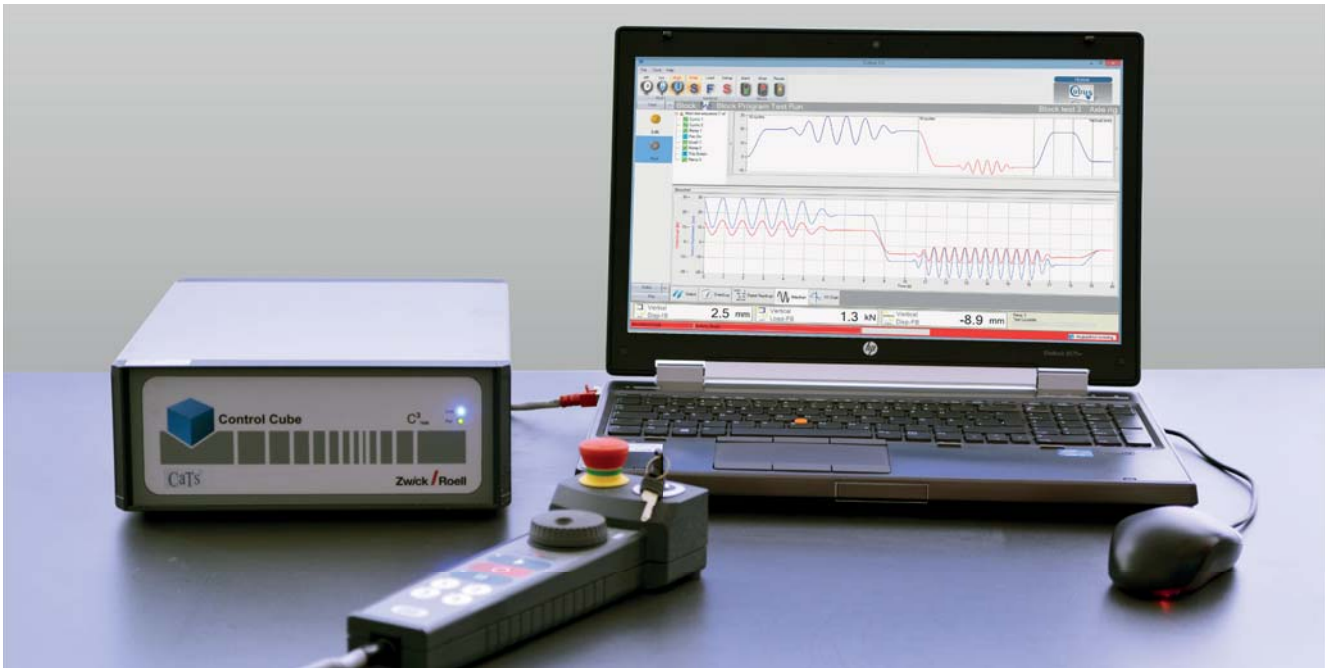


Fig. 1: The Control Cube servo controller and Cubus testing software are ideal for multi-channel applications and follow up tests.

7.8 Modernizing and retrofitting testing machines

RetroLine modernization packages for materials testing machines from any manufacturer

ZwickRoell has modernized several thousand materials testing machines from over 40 different manufacturers with state-of-the-art technology using proven modernization components such as measurement and control electronics, drive technology, and testing software. Modernization packages are available for electromechanical testing machines as well as for servo hydraulic testing machines, resonance testing machines, and hardness testing instruments.

Modernization can take place at the customer site or at ZwickRoell's headquarters in Ulm, Germany per request. In the latter case, a complete overhaul, painting, and CE marking may be performed.

Benefits of modernizing include:

- Spare part availability for a minimum of 10 years
- Use of improved safety components
- Possible retrofitting of new sensors and test tools for a wide range of testing requirements
- Compatibility with current Windows operating systems

Retrofitting

Each year over 3,500 customers upgrade their testing machines with tried and tested products from ZwickRoell:

- Load cells—sensitive and robust with the highest accuracy class
- Specimen grips and test tools. Modularity provides easy and flexible retrofitting
- Extensometers—maximum measuring precision standard-compliant measurement to ISO 9513
- Safety for the operator and the machine. Retrofitting of safety technology such as safety doors on existing testing systems
- testXpert III— keep up with the latest technology. Testing software updates & upgrades ensure you always have the latest features.
- Temperature chambers and furnaces. Retrofitting of temperature chambers and high temperature furnaces up to 1600°C

Fig. 1: Modernization of a static testing machine with testControl II

Fig. 2: Xforce load cell

Fig. 3: Specimen grip and extensometer can be retrofitted at any time

Fig. 4: High-temperature furnaces can also be retrofitted

Zwick / Roell

8 ZwickRoell Services

8.1 Materials and Components Testing Laboratory

If you have a testing requirement but no suitable testing option, the Materials and Components Testing Laboratory will be ready to provide you with expert assistance.

We can also assist in the event of capacity bottlenecks or perform cross-validation tests. It doesn't matter if just a single test is involved or an entire test series. With the latest technology and modern testing machines, we guarantee fast, standard-compliant testing. Naturally we can also perform tests in accordance with factory standards.

Our contract testing laboratories perform testing services of all kinds, on all static and dynamic materials testing machines. Hardness and extrusion tests and torsion and temperature tests can be performed as well.

Our testing is individually tailored for a wide range of components and materials, whether metals, plastics, composites, rubber, or other— you're in good hands with us!

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Fig. 1: Static testing machines and instruments in the ZwickRoell testing laboratory

Fig. 2: An excerpt of the dynamic testing machines in the Materials and Components Testing Laboratory

Fig. 3: Servo hydraulic portal test bench for fatigue tests on large components

8.2 Applications technology

Our technical field consultants and experienced applications engineers are here to provide you with expert consultation. Our qualified engineers will draw on their solid expertise to provide support during the planning and implementation of all or any testing applications.

Our Applications Test Laboratories are equipped with permanent materials testing machines and instruments, including a comprehensive portfolio of accessories such as specimen grips, test fixtures, sensors, and temperature chambers.

8.3 Overview of services

Our service technicians guarantee successful and easy commissioning—from installation to initial calibration to any training instructions.

Customer support
The ZwickRoell Hotline is always here to support customers with questions regarding troubleshooting hardware and software.

Inspection and calibration
Naturally, we will also carry out the required annual inspection and calibration. Our checklist-based inspections and calibrations provide a sound basis for reliable test results. They also extend the life of your materials testing machines and instruments, saving operating costs in the long term.

Fig. 2: Experienced applications engineers will advise you on individually tailored testing options

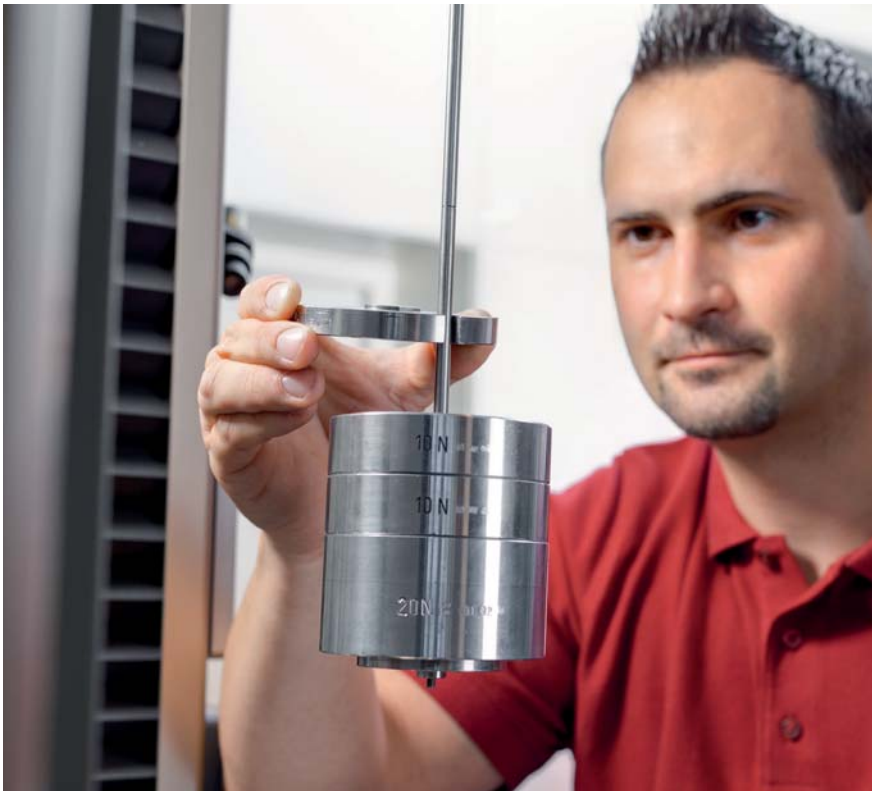

Fig. 1: ZwickRoell operates a DAkkS-accredited calibration laboratory. With over 10,000 calibrations performed annually, this is the largest calibration laboratory in Germany.

DAkkS
Deutsche
Akkreditierungsstelle
D-K-18351-01-00

Software Services

Also after you have purchased your testing software we are available to provide additional software services upon your request— software trials, updates, custom upgrades or training—whatever you need!

Training Courses at ZwickRoell Academy

Our ZwickRoell Academy offers a comprehensive, modular training program, at ZwickRoell's headquarters in Ulm, at a ZwickRoell location near you, or directly on-site at your premises. This ranges from courses on our testing software, to applications courses and workshops, to courses tailored to your company's individual requirements.

Fig. 2: The ZwickRoell Academy offers an interesting and wide-ranging training program, for new students and advanced learners alike!

Other services

If you need to move your materials testing machine to a different location, ZwickRoell's removal and relocation service will assist with technical and organizational planning, together with transport and full recommissioning professional and documented verification of the alignment of your testing machine using standardized alignment transducers (referred to as alignment measurement) is a fundamental component of our service portfolio.

Furthermore, we are able to perform logged measuring system analyses on testing machines and determine the corresponding characteristic capability values.

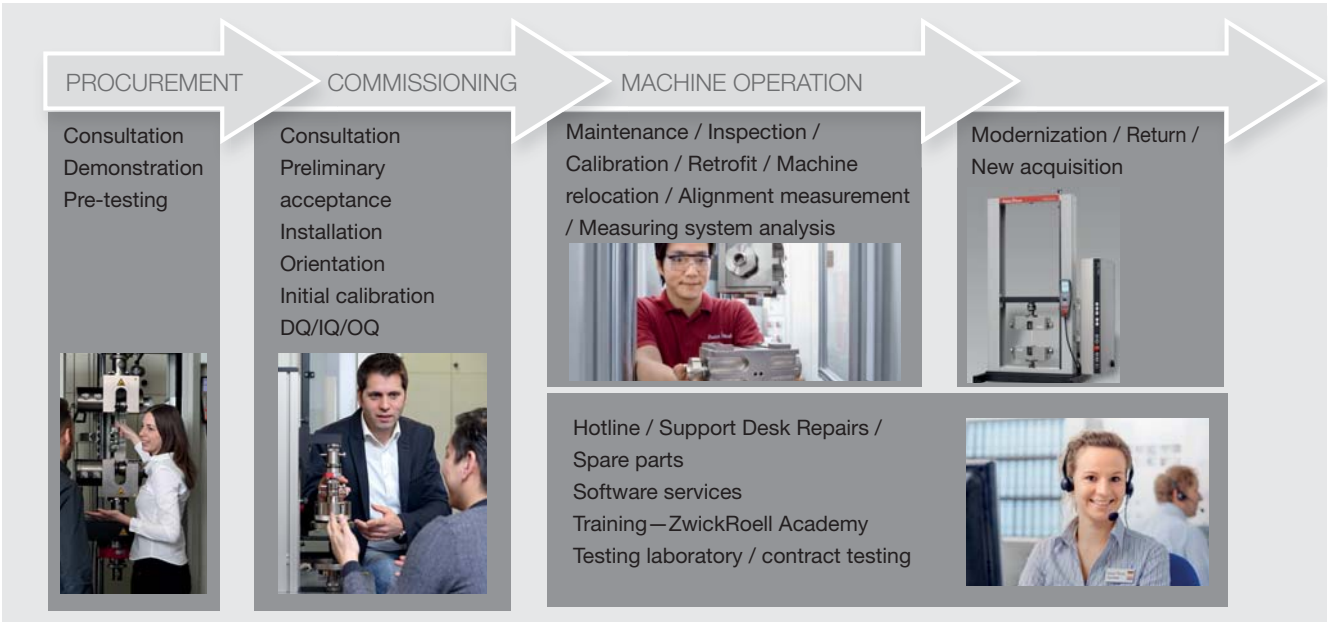

Fig. 1: ZwickRoell provides continuous support throughout the entire life-cycle of materials testing systems

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