Zwick / Roell

Testing Systems

Testing Machines and Systems for Metals

FP 253 2.1104.202

Intelligent Testing

Zwick / Roell

This catalogue provides an overview of devices, machines and systems of the Zwick Roell AG for the testing of metals in the corresponding industries, research and development, test institutes and training centers. This is only a part of the extensive product portfolio of the Zwick Roell AG.

The Zwick Roell Group – More than a century of experience in materials testing

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

Since the middle of the 19th century the company Amsler (formerly in Schaffhausen, Switzerland) has been involved in materials testing and the company Roell & Korthaus since 1920. Since 1937 Zwick has been building devices, machines and systems for mechanical-technological materials testing. Long before that time, i.e. in 1876, Prof. Seger had already founded a chemical laboratory as a scientific-technological consulting company for the industry of non-metallic minerals. During the 20th century, the present company Toni Technik has developed from these fundamentals and is now considered a leading expert for test systems for building materials. Excellent performances were also supplied by the company MFL (Mohr & Federhaff) – a company that was founded in 1870. By the way, Carl Benz was one of the employees.

Since 1992, these companies have formed the Zwick Roell company group.

List of contents

Photos front cover: DaimlerChrysler, Lloyd Werft, Hydro Aluminium, ThyssenKrupp

Zwick / Roell

In July 2001, the Zwick Roell company group was converted into a stock corporation: the Zwick Roell AG. Part of this stock corporation are the companies Zwick, Toni Technik, Indentec Ltd. and Zwick Roell Controllers Ltd. These companies supply an extensive program for materials, component and functional tests – from the manually operated hardness tester up to a complex test system for the process-accompanying application. Since May 2002, Acmel Labo, French manufacturer of laboratory devices for the cement, gypsum and lime industry is also part of the Zwick Roell AG.

Headquarters of Zwick Roell AG and Zwick GmbH & Co. KG at Ulm, Germany

Zwick has many years of experience, combined with a multitude of supplied systems. This experience is continuously supplemented by the constant communication with our users. On this solid basis, the company supplies a wide range of high-performance products – from the economical standard machine up to special versions and designs for special test jobs. Modern mechanics, high-performance electronics and the application-oriented software are the prerequisite for the versatility and the high „intelligence“ of these modern testing machines and systems.
However, the services of the Zwick Roell AG go far beyond the supply of products. Already in 1994 the company received the certification according to DIN EN ISO 9001 and thus guarantees a consistently high product and service quality. With accredited calibration laboratories, the companies of the Zwick Roell AG are in addition entitled to verifiy and to calibrate test systems and to document that with internationally recognized certificates.
.

Zwick / Roell

Metals – Application and properties

Metallic materials – metals and metal alloys – have a very large spectrum of properties. In addition to the two characteristic features of structure and function, a difference is also made between structural and constructional materials (e.g. materials for mechanical engineering and terotechnology, precision mechanics and engineering) and functional materials (e.g. materials for electrical engineering, electronics and communication media engineering).

Decisive for constructional materials are the mechanical properties strength, ridigity (elasticity) and deformability (plasticity) at a given temperature. These properties define the configuration (e.g. max. test force required for load frame and load cells) and the equipment (e.g. high-resolution extensometers for the determination of the Young's modulus of elasticity) of the testing machines.

In case of a mechanical stress e.g. of steel, first – as opposed to rubber for example – the high rigidity immediately takes effect. This means considerable force increases with very little deformations, often less than the thickness of a hair, and an elastic resilience during the reduction in force. Only if the force continues to increase, then a plastic, i.e. permanent deformation is overruling the elastic deformation.

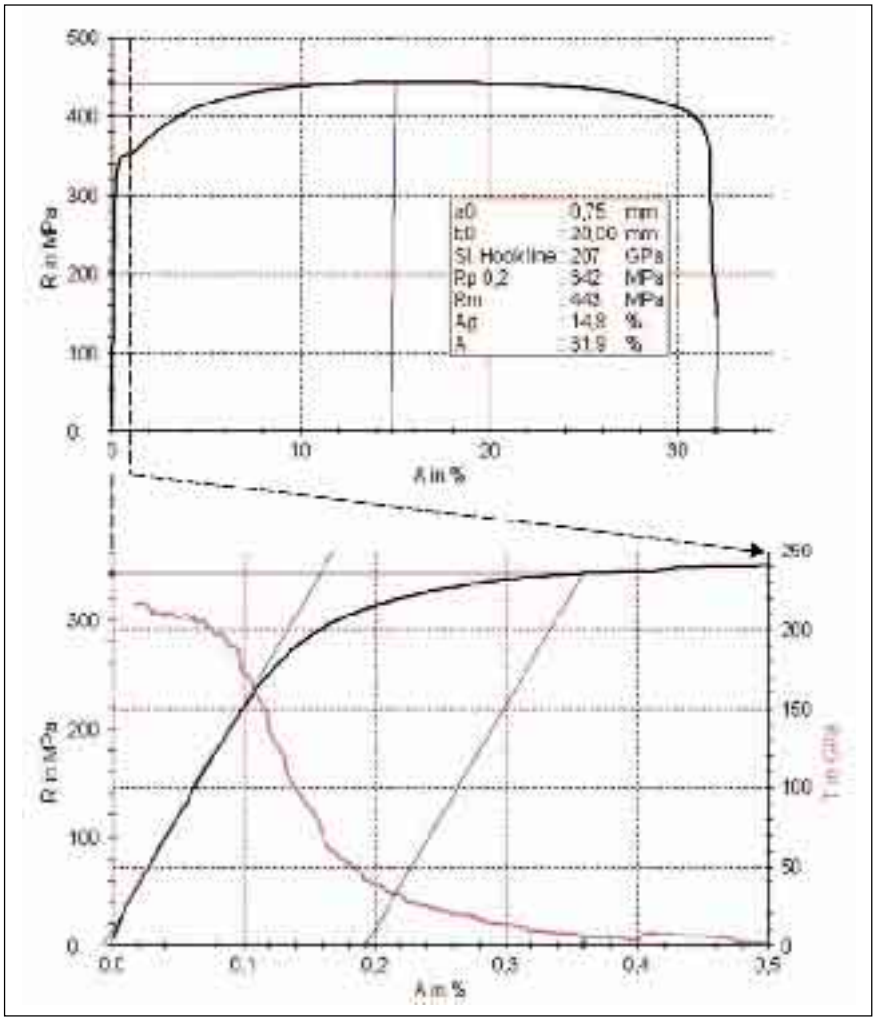
Specimens made of very brittle materials (e.g. cast iron) or soft steel subject to low temperatures break all of a sudden and nearly without any plastic deformation once having reached the tensile strength (i.e. without prior necking).

When using tenacious materials, the (local) rigidity considerably decreases once having exceeded the yield stress and can even have values of zero or below (increasing deformation without force increase or even with a reduction in force).

The characteristic curve of a tensile specimen made of sheet steel (gauge length L_0 = 80 mm) clearly proves the changing rigidity during increasing deformation. The mere elastic strain up to the yield stress is only approx. 0.06% (approx. 50 µm),

Table: Comparison of specific material properties

Material properties	Metals	Concrete	Plastic mat.
(without extreme values)			(non-reinforc.)
• Tensile and compr. strength, MPa	100 ... 2000	200 ... 500	20 ... 160
• Young´s modulus, GPa	70 ... 210	15 ... 40	0.06 ... 6
• Density (specific weigth), g/cm³	2.7 ... 7.8	2.1 ... 2.4	1 ... 2



Characteristic stress/strain curve of a tensile specimen made of sheet steel (see above illustration) and enlargement of the section until shortly after the 0.2 %-proof stress with illustration of the local gradient T via "virtual" measuring channel (see below illustration)

the plastic strain up to the break is nearly 32 % (approx. 26 mm), i.e. more than the 500-fold! This behaviour makes particularly high demands on the deformation measuring systems which are to be used to determine the Young's modulus of elasticity, proof stress, strain at maximum force and strain at break in the same test (i.e. high resolution and long test travels). Moreover, the measuring system must not be damaged either during a sudden specimen break.

Under the influence of the test force, not only the specimen is deformed, but there is also an elastic deformation of all testing machine components (load frame, load cell, specimen mountings and specimen parts outside the gauge length) located in the flux of force. Due to the large rigidity of the specimens, the elastic deformation of the testing machine is mostly clearly higher than the deformation of the specimen (up to more than the tenfold). For the measurement of these small deformations, e.g. for the determination of the Young's modulus of elasticity and the proof stress, the indirect measurement via crosshead or piston travel is therefore practically impossible.

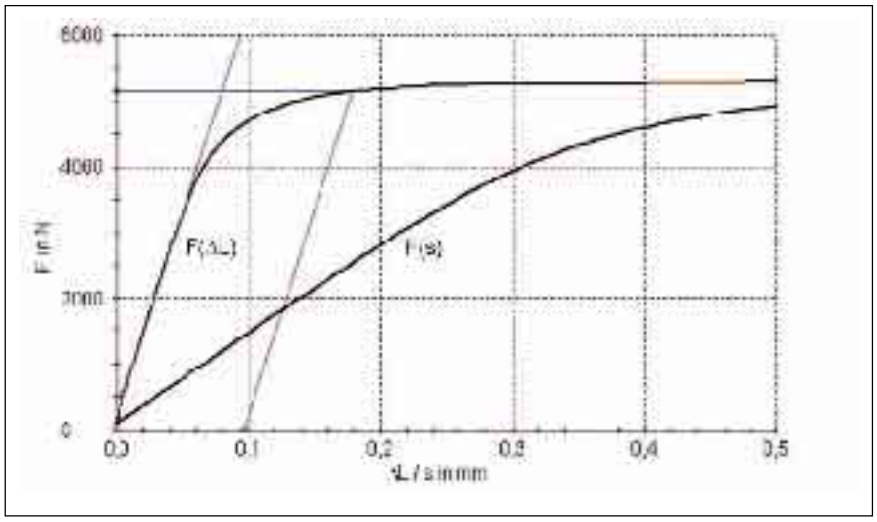
The crosshead or piston travel of the testing machine is according to the ratio between specimen and machine rigidity classified into specimen and machine deformation. Therefore, the deformation speed does not only depend on the crosshead and piston speed, but also on the specimen dimensions (rigidity, geometry) and the machine configuration.

But the deformation speed influences the characteristic values to be determined, in particular less rigid materials. Therefore a comparability of the test results of specimens of different dimensions and of different machines can only be guaranteed if the crosshead or piston speed can be controlled based on the measured values of force and deformation.

Test standards – Prerequisite for comparable results

One of the main tasks of the test standards is to create the same conditions for specimen and test sequence regardless of time and place of testing and of the tester. The international standards replacing more and more the national standards are an important step to further improve the comparability of test results. The most important national and international standards applied today for the testing of metals are summarized in the following tables.

In general, the standards are verified and adapted every five years provided the corresponding requests are available and a majority of the Standards Committees is given. Employees of Zwick Roell are active in several Standards Committees. Thus, they contribute their knowhow and experience of the manufacturer of testing machines and they are informed about the product development and the professional consulting of the customers.



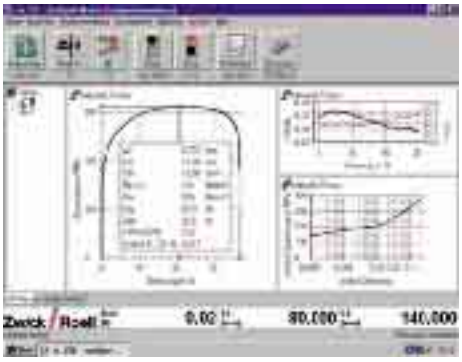
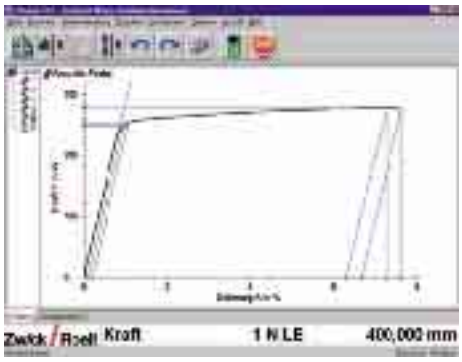
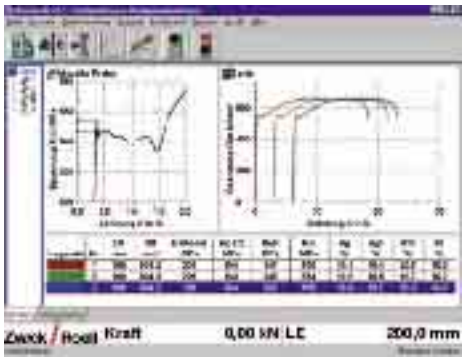
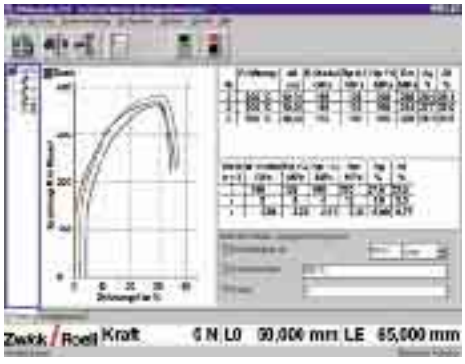
Characteristic force/extension/crosshead travel curve of a tensile specimen made of sheet steel (tested with a Zwick Z100 materials testing machine with hydraulic specimen grips)

Zwick / Roell

Standards and Testing Machines

Zwick / Roell

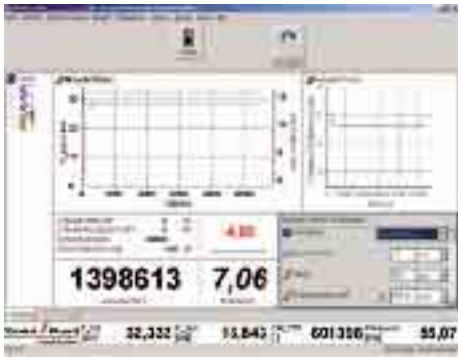
Zwick / Roell

Application	test-curve in *testXpert*®	Example of mounting
Tensile test Standard: EN 10001-1, ISO 10275 ISO 10113 Type of test: Tensile test with determ. of r- and n-value Material: steel sheet Extensometer: Macro with reduction in width monitor Grips: Wedge-screw *testXpert*®: B069008		
Standard: EN 10138 Type of test: Tensile test Material: Strand Grips: Hydraulic *testXpert*®: B069008		
Standard: DIN 488, EN 10080 Type of test: Tensile test Material: Steel wire for the reinforcem. of concrete Extensometer: Macro Grips: Hydraulic *testXpert*®: B069008		
Standard: EN 10002-5 Type of test: tensile test Material: steel Extensometer: HT-Extensometer Grips: Thread *testXpert*®: BX069008.00xx-08		

Zwick / Roell

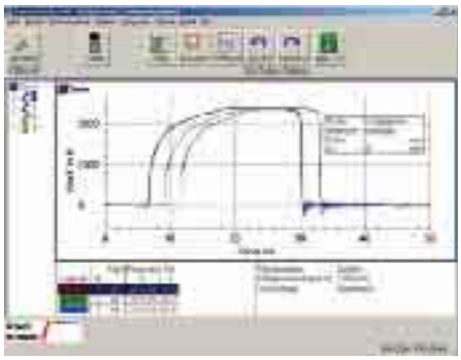
Application	test-curve in *testXpert*®	Example of mounting

Fatigue test



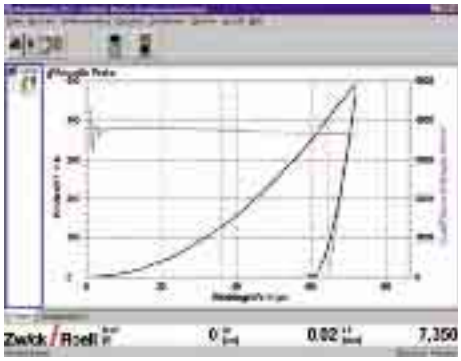
Standard:	DIN 488
Type of test:	Alternating tensile test
Material:	Steel wire for reinforcem. of concrete
Grips:	Special grips for steel wires
test frequency:	80 Hz
testXpert®:	RAB06942000

High-speed test

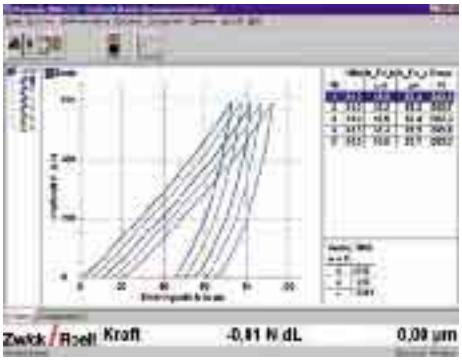


Type of test:	High-speed tensile test
Material:	Aluminium
Grips:	Special grips for flat specimen
Test speed:	max. 20 m/s
testXpert®:	RAB0694100

Instrumented indentation test for hardness



Standard:	EN ISO 14577
Type:	Martens Hardness
Specimen:	Component
Testing machine:	Z2.5/TS1S
Hardness measur. head:	2.5 KN
testXpert®:	B06914.X0.X0



Standard:	EN ISO 6508
Type:	Hardness acc. to Rockwell A
Specimen:	Reference block
Testing machine:	Z2.5/TS1S
Hardness measur. head:	2.5 kN
testXpert®:	B069014.X0.X0

Zwick / Roell

Specimen preparation

Specimen blanking presses
for the economical manufacture of tensile specimens from sheet steel. Due to the low cutting speed and the shape of the blanking tool, the work-hardening of the cut edge amounts to max. 10 % of the specimen thickness. The slight punch oversize – and thus the work-hardening – is removed with the specimen grinder.

Cutting force *P* in kN

$$P = \frac{L_s \times a \times \sigma_B \times 0{,}64}{1000}$$

if $P \geq 650$ kN, then

$$P = \frac{L_s \times a \times \sigma_B \times 0{,}8}{1000}$$

L_s = Circumference of spec. in mm
σ_B = Tensile strength in MPa
a = Thickness in mm

Specimen blanking presses for cutting force from 200 to 1.500 kN

Series/Type	RZ50	RZ65	RZ100	RZ150
Structural shape	C - frame	O-frame	O-frame	O-frame
Cutting force, kN	500	650	1,000	1,500
Specim. throughput, 1/min	6	6	6	6
Specim.thickness, mm	0.2 - 6	0.2 - 6	0.2 - 6	0.2 - 8
Max. power cons., kVA	4	4	4	10

Typical flat specimens for the tensile test

Standard	Dimensions, mm						
	a	b	L_0	B	L_c	L	Δb
DIN EN 10002, type 1		12,5	50		75	165	0,003
DIN EN 10002, type 2		20	80	30	120	≥250	0.052
DIN 50 114	≤3	20	80	30	120	≥250	
DIN 50 125	3	8	30	12	38	≥115	
	5	16	50	22	65	≥175	
	6	20	60	27	80	≥210	
	8	25	80	33	105	≥260	
JIS Z 2201 (13A)		20	80	30	120		
JIS Z 2201 (13B)		12.5	50	20	60		
JIS Z 2201/ 5)		25	50	30	60		
JIS Z 2201/1B)		25	200	30	220		
JIS Z 2201/1A)		40	200		220		
ASTM E8		12.5	50	20	60	≥200	0.05
		40	200	50	225	≥450	0.1

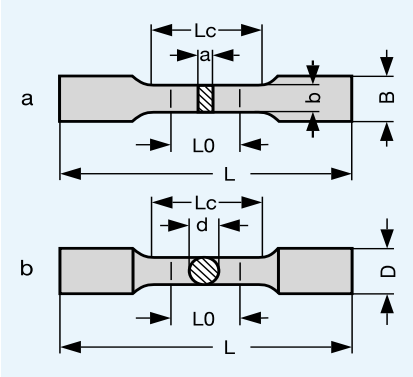
Typical round specimens (Figure „specimen types“, b)

Standard	Dimensions, mm				
	d	L_0	D	L_c	L
DIN EN 10002 (Annex C)	≤4	100/200		L_0 + 50	
DIN 50125, shape A	10	50	12	≥60	≥140
	12	60	15	≥72	≥160
	16	80	20	≥96	≥205
ASTM E8	12.5	50		60	
	8.75	35		45	
JIS Z 2201 No 4	14	50		60	

Specimen grinding machine Zwick 7120
for grinding specimens to shape and size. Exact grinding dimensions of the parallel specimen length through vertical adjustment of the entire grinding unit (max. power consumption 0.75 kVA)

Specimen blanking press

Specimen grinding machine



Specimen types

Zwick / Roell

Materials Testing Machines

Field of application

Materials testing machines are predominantly used for the determination of the strength and deformation behaviour of specimens and components. For this purpose, tensile, compression, flexure or shear tests and with special devices even torsion tests are carried out. These testing machines have large test areas, test travels, speed ranges, exchangeable test tools and test data transducers etc. to enable tests to be carried out both on specimens and components of different shapes and dimensions made of most different materials and material combinations and of different properties.

Basic concept

The Zwick program includes testing machines in table-top and floor standing design with different measurement and control systems, load frames, drives and versatile function and supplementary units.

However in order to be able to offer the best machine for each requirement, Zwick has developed a user-related concept. The user can choose among three machine lines, each of them being completely different as to equipment, performance features and also as to the capability of expansion:

- BasicLine
- Standard Line
- Allround Line

The decisive testing machine component is the measurement and control system. Its conception and its scope of performance decide which drive can be controlled, which measurement sytem can be connected to it and which functions can be controlled with it – and they thus determine the range of application and the testing machine's capability for future expansion.

The advantages to the user of the three different testing machine versions are as follows:

- The BasicLine is particularly suitable for function tests on component parts and for the simple materials test.
- The Standard Line is ideal to solve simple test jobs reliably. It is a low-cost, sturdy solution which covers many testing needs.
- The Allround Line is the basis for a large spectrum of demanding test jobs and can easily be expanded with the requirements becoming more demanding. It is thus a solution that can be relied on for future requirements.

Measurement and control system BasicLine

The electronics taken from existing Zwick machine types guarantees a very high availability and reliability of the test system. The measurement and control electronics is compactly packed in a housing. BasicLine testing machines can be operated in the Stand Alone mode without PC and can be operated directly via function keys on the testing machine. As standard it is additionally possible to operate the BasicLine with the test software *testXpert*®, thus profiting from all advantages of standardized test programs and from the many years of experience on the development sector.

Measurement and control system *testControl*

(for the standard and allround version)

By using most state-of-the-art technologies and by granting highest quality standards, *testControl* offers a maximum of technical performance and a long-term investment guarantee. These are the particular features of *testControl*:

- Time-synchronous test data acquisition with high resolution and measuring frequency
- Real-time processing of the test data in a 500 Hz cycle for the monitoring and event-related test sequence control (e.g. speed change when reaching the yield or proof stress) and for safety limit values
- Adaptive control for exactly reproducible speeds and positions
- The measurement and control electronics and the power electronics for the drive system in question are compactly integrated in a housing. Thus, the usual cabling can be dispensed with.

Materials testing machine BasicLine Z020

The measurement and control system *testControl* is available in 2 variants:

Stand Alone Variant

Easy and reliable operation via coloured display, 10-key keyboard and a few function keys – without PC. A printer may be connected directly for the printout of test results.

PC-Variant

The system may be configured and expanded to cope with the most different applications. PC and user software *testXpert*® make applications very comfortable and extremely flexible.

Load frames

Different load frame versions for test loads up to 2.000 kN are available as standard. For special applications, special versions can be developed and manufactured, e.g. load frames in horizontal position suitable for the testing of long steel ropes.

Single-column load frame for table-top testing machines (zwicki)

These load frames are designed with very rigid aluminium high-precision extruded profiles. The working area is freely accessible from 3 sides. Thus, it is ideal for various tests on small parts and for Zwick hardness testing machines. It only requires a small floor space. Due to its light weight, it is easy to transport.

Two-column load frames for table-top testing machines

The load frames of the BasicLine are designed with 2 round steel columns. The load frames of the Standard and Allround Line are designed with patented aluminium high-precision extruded profiles. They are light, very rigid and serve simultaneously as lead-screw guide and protection. T-shaped grooves on the outer sides allow a simple fitting of accessories as e.g. safety devices without being impeded by the crosshead.
All load frames with two profiles – except for the BasicLine – can be equipped with legs. Advantages are:

- Positioning of the working area to an optimum height for the user
- Comfortable seated operation with absolute freedom for leg movement (making it also suitable for wheelchair users)

Load frame for floor standing models

The two supporting and guide columns of load frames for test loads up to 150 kN are also patented aluminium high-precision extruded profiles. When using load frames for higher test loads, 2 or 4 hard-chrome plated round steel columns are used. For testing machines with a hybrid drive system the stationary piston rods are at the same time used as supporting and guide columns. All load frames with an electro-mechanical drive system may optionally be equipped with a second working area allowing e.g. a rapid change of the test mode without having to change the equipment.

Materials testing machine Z2.5 (zwicki) with *testControl* Stand Alone variant

Materials testing machine Z050 with legs *and testControl* PC variant

Materials testing machine Z100 with *testControl* PC variant

Zwick / Roell

Features of the BasicLine, Standard and Allround Line

Machine component or function	BasicLine	Standard Line	Allround Line
Load frame			
• Type of set-up			
* Table-top machine (nominal load)	500 N to 20 kN	1 kN to 150 kN	1 kN to 150 kN
* Floor stand. machine (nominal load)	-	50 to 2.000 kN	50 kN to 2.000 kN
• Support and guide columns			
* No. of columns	2	2 or 4	2 or 4
* No. of aluminium profiles	1 (Z0.5)	1 or 2	1 or 2
• No. of working areas	1	1 or 2	1 or 2
• Expanded design (higher and/or larger)	-	✓	✓
Drive system			
• Electro-mechanical			
* No. of ball screws	1 or 2	1 or 2	1 or 2
* DC-Motor	✓	only zwicki	only zwicki
* AC-Motor	-	up to 600 kN[1)]	up to 600 kN[1)]
• Servohydraulic	-	from 400 kN[2)]	from 400 kN
• Hybrid	-	-	from 400 kN
Measurement and control system			
• BasicLine (also usable without PC)	✓	-	-
• *testControl* PC-variant (Standard)	-	✓	✓
testControl Stand Alone variant (Option)	-	optional	optional
Software			
• test software *testXpert*® (with PC)	optional	optional	optional
Transducer			
• Strain gauge load cell	1 (interchangeable)	1 (optional up to 2)	1 (optional up to 3)
• Digital crosshead travel monitor	integrated	integrated	integrated
• Digital extensometer	-	optional 1	yes (optional up to 3)
• Analog extensometer	-	optional 1	yes (optional up to 3)
Connection and control of external measurement systems			
• Digital extensometer	-	✓	✓
• Analog extensometer	-	✓	✓
• Analog reduction-in-width monitor	-	✓	✓
• Video Capturing	-	✓	✓
• Switch Contact	-	✓	✓
• Switch Control	-	✓	✓
• Further measurement systems	-	✓	✓
Control of external systems			
• Specimen grips (mot., pneum., hydr.)	-	-	✓
• Extensometer systems	-	semi-automatic	fully automatic
Supplementary units for special applications (optional)			
• Torsion drive	-	-	✓
• Torque transducer	-	-	✓
• Multi-channel force measuring system	-	-	✓
• High-temperature testing equipment	-	(✓)	✓
• Low-temperature testing equipment	-	(✓)	✓

[1)] Without zwicki

[2)] Only SP-matarials testing machine

Zwick / Roell

Drives

Electro-mechanical drive systems

The basis of all electro-mechanical drive systems are backlash-free and low-friction ball screws and digitally controlled drive systems. They are used with load frames for test loads up to 600 kN. Together with the digital measurement and control system they offer the following advantages:

- Extremely high, stepless speed range
- Very low speeds adjustable (from about 0.5 µm/min on)
- High-precision and exactly reproducible positions and speeds

The testing machines designed with single-column load frames (zwicki and BasicLine) are equipped with low-cost d.c. drives, all the others with particularly low-inertia, brushless three-phase drives.

Hydraulic drive systems

This drive unit is located centrally on the upper fixed crosshead. Thus, the test area lying beneath is easily accessible. A servo- or proportional valve regulates the oil flow between hydraulic unit and differential cylinder. The oil cushion in the upper pressure area avoids the „piston jump“ the rams are known for after the specimen break. The resolution of the piston travel transducer is 1.25 µm (less than 1/400.000 of the max. test travel). The hydraulic drive unit is the most economic solution particularly for high test loads.

Hybrid drive systems

In this patented drive unit, the advantages of the electro-mechanical drive (high precision) are combined with those of the hydraulic drive (high force density). The result is that even cylinders with high forces and long travels can be driven and positioned with an utmost accuracy. According to this principle 2 parallel synchronous cylinders coupled with the moving crosshead can regardless of the applied load be displaced exactly synchronously by following precisely and practically instantaneously the preselected position of an electronic pilot drive unit. The special features of this drive are the following:

- Large test stroke (no adjustment of the fixed crosshead required).
- Comparatively low height of the load frame.

Materials testing machine Z400E

Materials testing machine Z1200H

Load frames and drive systems of the BasicLine

Series	Z0.5	Z005	Z010	Z020
• Type	table top	table top	table top	table top
• Max. load, kN	0.5	5	10	20
• Working area, max.				
* Height, mm	596	561/1.061	1,041	1.041
* Width, mm	no limit	420	420	420
* Depth, mm	99.5	no limit	no limit	no limit
• Max. crosshead speed, mm/min	1.500	500	1.000	500
• Crosshead travel resolution, µm	0.226	0.05	0.09	0.045
• Max. power consumption, kVA	0.4	0.6	0.6	0.6

Zwick / Roell

Load frames and drive systems of the Standard and Allround Line (with electro-mechanical drive system)

Series	Z1.0	Z2.5	Z005	Z010	Z020	Z030	Z050
• Type	table top	table top	table top	table top	table top	table top	table top
• Max. test load, kN	1	2.5	5	10	20	30	50
• Working area							
* Height, short, mm	-	573	-	-	-	-	-
normal, mm	-	1073	1058	1058	1058	-	-
higher, mm	1373	1373	1458	1458	1458	1380	1380
higher + larger, mm	-	-	-	1787	1787	-	-
* Width, normal, mm	no limit	no limit	440	440	440	440	440
larger, mm	-	-	-	640	640	-	-
* Depth, mm	99.5	99.5	no limit	no limit	no limit	no limit	no limit
• Crosshead speed							
* max., mm/min	1800	800	3000	2000	1000/2000[2)]	1000	600
• Crossh. trav. resolution, µm	0.0002	0.0001	0.041	0.027	0.014/0.054	0.027	0.016
• Max. power consum., kVA	0.4	0.4	2/1.9	1.9	2.1/2.6	2.3	2.3

Series	Z050	Z100	Z100	Z150	Z250	Z400	Z600
• Type	floor stand.	table top	floor stand.	floor stand.	floor stand.	floor stand.	floor stand.
• Max. test load, kN	50	100	100	150	250	400	600
• Working area							
* Height, short, mm	-	-	-	-	-	-	-
normal, mm	1824	-	1824	1715	1715	1800	1940
higher, mm	-	-	-	-	-	-	-
higher + larger, mm	1765	1360	1765	1660	1660	-	-
* Width, normal, mm	630	640	630	630	630	630	740
larger, mm	1030	-	1030	1030	1030	-	-
* Depth, mm	no limit	no limit	no limit	no limit	no limit	no limit	no limit
• Crosshead speed							
* max., mm/min	400/2000[1)]	200/1500[1)]	200/1000[1)]	900	600	250	200
• Crossh. trav. resolution, µm	0.027	0.026	0.0136	0.0123	0.0082	0.031	0.025
• Max. power consum., kVA	5	6	5	5,5	6	7/13[2)]	20/26[2)]

[1)] depending on the selected drive system and its power [2)] with hydraulic grips

Load frames and drive systems for high forces (standard types with hydraulic or hybrid drive)

Series	Z400H	Z600H	Z1200H	Z2000H	Z600Y	Z1200Y	Z2000Y
• Max. test load, kN	400	600	1200	2000	600	1200	2,000
• Dimensions of load frame							
* Heigth, mm	2900	3000	3500	4200	2750	3147	4200
* Width, mm	1020	1080	1300	1400	1530	1614	1870
* Depth, mm	480	500	880	905	788	790	1100
• Working area							
* max. height, mm	500	500	600	600	1895	2300	2,400
* with adjustable crosshead, mm	900	900	1000	1000			
* Width, mm	670	670	850	870	790	860	950
* Max. travel , mm	500	500	600	600	850	1000	1,000
• Travel resolution, µm	1.25	1.25	1.25	1.25	0.05	0.05	0.05
• Max. test speed, mm/min	200	200	200	200	250	250	250
• No. of columns	2	2	4	4	2	2	2
• Max. power consum., kVA	8.5	8.5	15	23	8.5	15	23

Zwick / Roell

Special Metals Testing Machine SP

This testing machine was specially designed for the testing of flat, round and profile specimens made of steel. In addition to tensile tests, it is also possible to carry out compression, flexure and folding tests. It has a particularly rigid load frame with a hydraulic central drive mounted on the upper optionally fixed or adjustable crosshead. It is equipped with hydraulically-operated wedge grips as standard. For the test load measurement, electrical load cells are used. The grip separation is measured contactfree with a displacement transducer with a resolution of 0.5 µm. In spite of its size, the SP machine does not need a special foundation. It is placed on rubber mats directly onto the concrete floor.

Special Metals Testing Machine SP

SP-testing machines with hydraulic drive system for nominal loads from 400 to 2000 kN

Series	SP400.xx	SP600.xx	SP1000.xx	SP1200.xx	SP1500.xx	SP2000.xx
• Max. load, kN	400	600	1000	1200	1500	2000
• Working area						
* Height, mm (.00)[1]	100-600	100-600	120-720	120-720	120-720	120-720
* Height, mm (.01)[2]	0-800	0-800	0-900	0-1000	0-1000	0-1000
* Width, mm	670	670	700	850	850	850
• Max. travel, mm	500	500	600	600	600	600
• Travel resolution, µm	5	5	5	5	5	5
• Max. test speed, mm/min	250	200	200	200	200	200
• No. of columns	2	2	4	4	4	4
• Max. power consumption, kVA	10	10	18	18	18	30

[1] with fixed crosshead [2] with adjustable crosshead

Compression testing devices for SP testing machines for max. test loads from 400 to 2000 kN

Series/type	X070220 -194	X070220 -210	X070220 -226	X070220 -240	X070220 -254	X070220 -268
• Max. test load, kN	400	600	1000	1200	1500	2000
• Diameter, mm	230	230	300	300	300	300

Flexure test devices for SP testing machines for maximum test loads from 400 to 2000 kN

Example: support radius 25 mm, support separation 30 to 600 mm, support height 100 mm, flexure fin height 200 mm

Series/type	X070220 -196	X070220 -212	X070220 -228	X070220 -242	X070220 -256	X070220 -270
• Max. test load, kN	400	600	1000	1200	1500	2000
• Flexure fin-Ø, mm[1]	30,40,50	30,40,50	50	50	50	50

[1] Separate order items

Zwick / Roell

Test software *testXpert*®

Range of application

testXpert® is the universal Zwick test software for materials, component, and functional testing. Its application range goes from Zwick materials testing machines (for tensile, compression, flexure and functional testing) to hardness testers, pendulum impact testers, extrusion plastometers, automated test systems, etc. right up to the refurbishment of testing machines of a variety of makes and models.

Tasks and functions

The essential fields of use of *testXpert*® are:

- Verification and re-equipping of the test machine
- Preparation of the test or test series
- Performance of the test
- Evaluation and documentation
- Data management
- Quality management and
- Data exchange between *testXpert*® and other applications (Word, Excel etc.)

testXpert® supports the user for all tasks with software wizards and editors, explanatory pictures and video sequences, situation-specific user tips, warnings, error messages and online help.

Future-oriented concept

The *testXpert*® test software uses the special properties of the object-oriented programming with respect to a clear grouping in tasks and functions. Structure and contents are determined by the Zwick application and software know-how. The *testXpert*® concept is therefore a guarantee for highest flexibility, functional safety as well as simple usability.
The essential characteristic features are:

- Uniform basic software for all applications
- Modular system for test programs
- User support through software tools

Modular system

The test programs are compiled by Zwick from a selection of several hundred software modules. The modules are subdivided into classes such as test parameters, test sequence phases, screen views etc. They are continuously updated and expanded with respect to new states of knowledge and necessary supplements. This makes *testXpert*® an intelligent software, and thus enables the realization of test programs strictly to test standards and test programs related to practical applications. Thanks to the numerous possibilities of this system, *testXpert*® can be put to universal use for a wide applicational spectrum and for a variety of testing machines.

Test programs

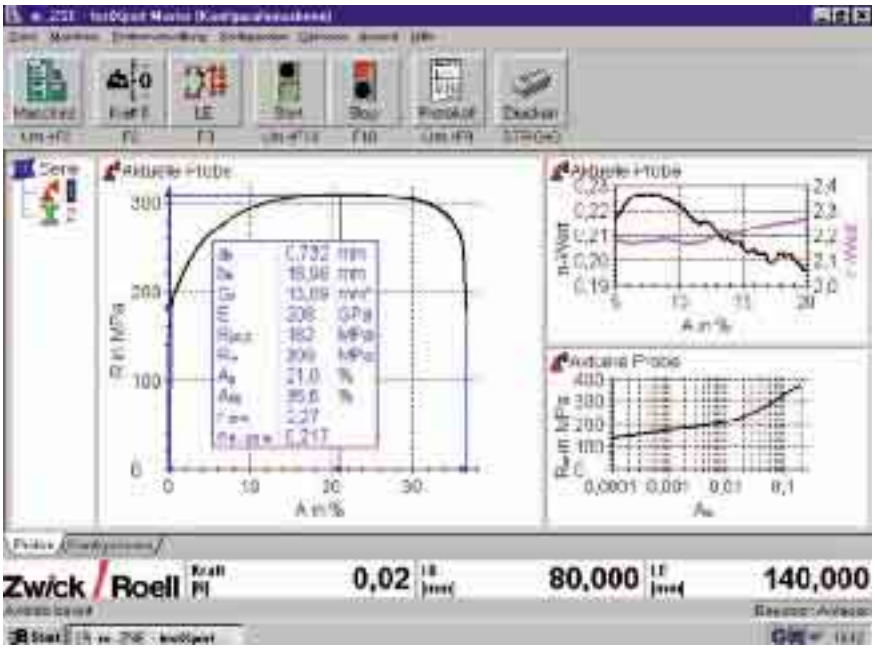
The test programs compiled by Zwick stipulate how tests are to be run. Their basis are selected software modules that are linked to one another and are pre-configured through fixed parameters depending upon the functions required. Thus the user only has to enter variable parameters in the „test template“.

There are three variants available for a wide range of requirements:

- Master test programs
- Standard test programs, and
- Customized test programs

International quality standards

A software product only complies with international quality standards if each and every version is transparent, documented and archived for 10 years. The *testXpert*®



testXpert-Screenshot: Tensile test on sheet steel with r- and n value determination

test software fully meets these requirements and even the particularly strict guidelines of the Good Manufacturing Practices (GMP).

The entire software development process and its components are diligently documented and archived from the source code through to the software tools used, for each and every version. This is valid for each phase from analysis via specification, design and implementation up to the test. Conformity to the standard ISO 9000-3 for development of *testXpert*® has been confirmed via audit report no. QM-F-96/1016.

Safety in detail

Windows software is normally used in offices. However, *testXpert*® takes over an additional and especially critical task: the monitoring and controlling of machines. Machine damage and potential danger to persons must be ruled out. That's why *testXpert*® doesn't use any overlapping windows in the test mode to avoid hiding important displays or key fields.

Automatic acceptance of system data

Different test jobs require different test machines with different and usually interchangeable components. Their specific properties are characterised by the system data (nominal force, travel, speed range, mounting height, calibration factors, etc.). Organisational data also belong to the above, e.g. the series number or the date of the last calibration.

testXpert® accepts these data automatically directly after the program start

- for the necessary settings
- for the determination of safety limit values
- for the correct measurement signal evaluation

Furthermore *testXpert*® checks whether or not

- the test can be carried out with this configuration
- all settings have been made
- the data have changed for the current test

Simplest operation

The operator's effort is reduced to a one-button operation, i.e. activating the start button, for standard applications. This is possible because *testXpert*® automatically records the test data, and dependent upon this, controls and monitors the test sequence and determines and documents the test results.

Preparation of a test series requires only two steps:

- Call-up the test program foreseen for the required application
- Input or selection of variable parameters

Optimum user information

All displays necessary for the performance of a test and a test series, can be grouped together in a clear
and concise manner in one single screen setting.

- Input fields for specimen-specific test parameters
- Curve diagram (single or multiple curves)
- Tables for test results
- Tables for result statistics

Data backup for further use

Depending upon the preselection in the test program, not only all data but also selected result data from a test or test series can be saved. The saving of all data offers the possibility of tracing the origin of the result data up to configuration and settings for the test machine. The standardized measurement data, i.e. the data converted to its basic units can be repeatedly displayed in the simulation mode and can also be evaluated according to other criteria.

Video Capturing

The test software *testXpert*® does not only support the user by means of „Help" videos. It is also possible to carry out multimedia tests by using a video camera and a video-capture card with the video pictures being recorded time-synchronously with the test data.

- With the cursor keys, a „video reticle" can be moved over the test curve and the corresponding picture can be displayed
- The pictures can be captured at a preselected distance of the measuring points or in dependence on the event
- The video can also be played alone, irrespective of the testing machine
- Distances between two points and angles between three points, radii, diameters and areas can be measured from the specimen in pictorial representation
- Optionally, the pictures can also be output with dimension lines and test data

Zwick / Roell

Force transducer
(load cells)

Strain gauge load cells are available for nominal load capacities from 5 N up to 2000 kN. Together with the digital measurement electronics they have the following advantages:

- Automatic identification and acquisition of all load cell settings, calibration parameters via sensor plug.Therefore the change of load cells is very easy and neither requires an input of setting data, nor calibration
- Automatic zero and sensitivity alignment
- Compensation of temperature fluctuations
- High measuring frequency
- High test data resolution
- Measuring accuracies: Class 1 (1 % of the measured value) from 0.2 to 120 % of the nominal load (1 % to 100 % for load cells with nominal load = 500 N) and class 0.5 (0.5 % of the measured value) from 1 to 100 % of the nominal load
- Overload protection
- Manufacturer's test certificate to give proof of the works calibration

Load cells with one or two-sided mounting studs and self-identifying sensor plugs are available for nominal load capacities from 10 N on.

Specimen grips for tensile tests

Zwick offers a large spectrum of specimen grips in different versions and test load levels to cover the large range of application of metal testing. The following grips are available:

- Wedge grips
- Wedge screw grips
- Pneumatic grips
- Hydraulic grips

Wedge grips

- Simple design, self-tightening
- Adaptable to different specimen dimensions by using different jaw faces
- For large forces with pneumatic actuation

Wedge screw grips

- Adjustable initial gripping force
- Large gripping range suitable for different specimen dimensions

Pneumatic and hydraulic specimen grips

- Increased user comfort for high specimen throughputs
- For tensile, compression and alternating load and safe holding of the specimen also after specimen break
- Large gripping area without having to change the jaws
- Integrated system connection by means of a T-slot change system
- Force control when closing the clamping jaws
- Optionally available with automatic gripping force adjustment and gentle closing force control

Force transducer with sensor plug

Wedge grips 8405 (50 kN)

Wedge screw grips 8506 (100 kN)

Zwick / Roell

Wedge grips for max. testing forces from 2.5 to 600 kN

Series/type	8201	8302	8303	8402	8403	8502	8509	8520
• Max. testing force, kN	2.5	10	10	50	50	100	250	600
• Max. spec. thickn., mm	10	20	4,5	18	10	6 - 30	16 - 48	16 -48
• Max. spec. diam., mm	-	12-20	-	10 - 18	-	10 - 30	16 - 52	18 - 62
• Max. clamping surface								
*Width, mm	32	60	30	60	30	60	80	100
*Height, mm	40	50	45	40	77	48	85	100
• Operation (open/clos.)	manual	manual	manual	manual	manual	manual	man./pneum.	pneum.
• Construction height, mm	145	165/175	110	165	196	210	320	400
• Individual weight, kg	1.9	6.5	3	13.5	5	27	70/100	300

Wedge screw grips for testing forces from 0.5 to 250 kN

Series/type	8106	8206	8306	8406	8406	8506	8506	8507
• Max. testing force, kN	0.5	2.5	10	30	50	100	150	250
• Max. spec. thickn., mm	5	10	30	30	30	30	30	64
• Max. spec. diam., mm	30	30	30	30	30	30	30	80
• Max. clamping surface								
* Width, mm	15	30	60	60	60	60	60	80
* Height, mm	30	60	60/80	60/80	80	80	80	100/120
• Operation (opening/closing)	manual	manual	manual	manual	manual/ motorized	manual/ motorized	manual/ motorized	manual/ motorized
• Construction height, mm	64	110	125	137	146/147	176/177	176/177	252
• Individual weight, kg	0.2	3	15	16	37/50	44/50	42/46	112

Pneumatic grips for testing forces from 1 to 30 kN
(single sided closing)

Series/type	8197	8297	8397	8497	8388[1)]
• Max. testing force, kN	1	2.5	5/10	30	5
• Clamp. force at 6 bar, kN	1.7	3. 6	9/18	35	5/13
• Max. opening, mm	20	20	24	24	5
• Max. clamping surface					
* Width, mm	60	60	60	60	60
* Height, mm	30/50	30/50	50	50	80
• Construction height, mm	95	95	162	175	182
• Individual weight, kg	1.7	2.4	8.2/10	15	6.6/7.5

[1)]with load reduction curve

Pneumatic grips for testing forces from 10 to 100 kN
(double sided closing)

Series/type	8397	8497.03	8497.50	8597
• Max. testing force, kN	10	20	50	100
• Gripp. force at 6 bar, kN	27	27	60	120
• Max. opening, mm	25	25	50	30
• Max. clamping surface				
* Width, mm	60	60	110	74
* Height, mm	50	50	110	74
• Construction height, mm	208	225	306	341
• Individual weight, kg	14	14	15/53	53

Pneumatic grips 8597 (100 kN)

Zwick / Roell

Hydraulic grips for testing forces from 50 to 2.000 kN

Series/type	8801	8494	8802	8592	8803	8594
• Max. testing force, kN	50	50	100	100	250	250
• Max. clamping force, kN	100	100	255	250	410	410
• Max. hydr. pressure, bar	300	300	300	300	300	480
• Max. spec. thickn., mm	40/59	59	59	59	59	59
• Max. spec. diam., mm	Ø15	Ø15	15/59	15/59	15/59	15/59
• Clamp. surface, width, mm	80/Ø50	Ø50	Ø74	Ø74	Ø74	Ø74
height, mm	70		-	-	-	-
• Type of clamping	single-sided	double-sided	single-sided	double-sided	single-sided	double-sided
• Construction height, mm	205	205	303	303	303	303
• Individual weight, kg	37	37	70	70	70	70

Series/type	8595.03	8595.02	8597.01	8597.02	8598.00	8599.00
• Max. testing force, kN	400	400	600	600	1,200	2,000
• Max. clamping force, kN	590	590	950	950	1,500	3,000
• Max. hydr. pressure, bar	480	480	480	480	480	480
• Max. spec. thickn., mm	80	80	100	100	60	100
• Max. spec. diam., mm	65	65	100	100	60	100
• Clamp. surface, width, mm	65	65	60	60	Ø150	Ø220
height, mm	40	40	80	80	-	-
• Min. gauge length, mm	170	170	220	220	350	500
• Type of clamping	single-sided	double-sided	single-sided	single-sided	double-sided	double-sided
• Construction height, mm	260	260	270	270	470	650
• Individual weight, kg	130	150	300	330	680	900

Hydraulic grips with dual clamping system

These specimen grips have been developed particularly for the tensile test on high-strength prestressing strands and concrete steel. The tensile force is transmitted from the specimen onto the specimen grips through 2 clamping systems arranged in tandem. So the gripping force is distributed over a longer specimen section and the tensile force is reduced in the specimen grips in two steps. The frequent specimen breaks within the gripping range can thus be avoided.

Another advantage: The retrofitting of the specimen grips from concrete steel to prestressing strands or vice versa becomes easier and can be realized within a short time

Hydraulic grips with dual clamping system (for strands e.c.)

Hydraulic grips 8594 (250 kN)

Zwick / Roell

Test tools for compression and flexure tests

For the performance of compression and flexure tests a multitude of test tools in different versions and dimensions as well as for different test load ranges are available.

The flexure supports and dies for the different flexure and folding tests are usually exchangeable. The adjustability of the support distance and the free height of the flexure supports and dies allow 90° flexure tests and flexure-folding tests with angles of up to 180°.

Deformation transducers

Extensometers

For the extension measurement, measurement systems with different gauge lengths, test travels and resolutions are available:

- Extensometers with contact measurement for the manual attachment to the specimen
- Extensometers with contact measurement for the manual or automatic attachment of the feelers to the specimen
- Extensometers with non-contact, optical measurement with specimen marks attached on the specimen

The manually attachable, incremental measurement systems can already be used with the testing machines of the standard line.

Motor-driven measurement systems are controlled automatically or by means of a manual control unit. The macroextensometer is particularly suitable for the determination of the proof stress as well as for the uniform elongation and for the strain at break. For the determination of the Young's modulus of elasticity a small test travel and a high resolution should be selected. The long-stroke and the contactfree extensometers are due to their low resolution only used for larger gauge lengths.

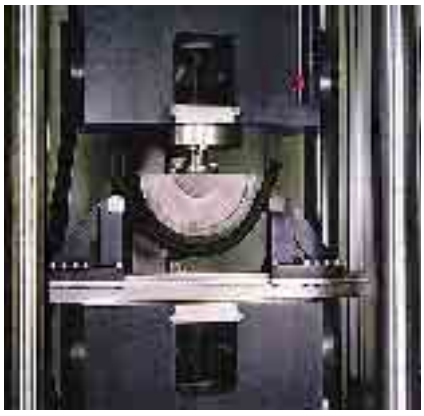
Reduction in width monitor

For the measurement of the change in width, particularly for the determination of the vertical anisotropy r (r-value) an extension module for the macroextensometer is used. With this module the change in width is measured with a high precision in 2 or 4 resp. on 1 or 4 cross-section levels.

Analog clip-on extensometer
(for manual operation)

Series/type	TC-EXACLEL .001	TC-EXACLEL .002/.003/.004	TC-EXACLEL .005
• Gauge length, mm	25/50	20/10	20/10
• Spec. thickn./diam., mm	28	25	40
• Measurem. travel, mm	25	+2/-1	± 2
• Travel transducer	inductive	strain gauge	strain gauge

[1] DMS = Strain gange



Zwick / Roell

Incremental extensometers

Series/type	TC-EXMACRO	TC-EXLONGS
• Description	Macro	Long stroke
• Gauge length, mm	10 bis 100/205	10 bis 1,000
• Gauge length adjustment	manual or automatic	manual
• Method of attachment	manual or automatic	automatic
• Measurem. travel, mm	80/120/160/75/112,5/150	1,000 – L_0
• Resolution, µm	0.12/0.18/0.24/0.3/0.45/0.6	5

Incremental reduction in width monitor

Series/type	TC-EXMACWD	TC-EXMACWD
• Application with	Macro and long stroke	Macro and long stroke
• Specimen width, mm	10 to 15/20 to 25 (2 steps)	10 to 25 (1 step)
• No. of measurem. levels	2/4	1/4
• Gauge length adjustment	manual	manual
• Method of attachment	manual or automatic	manual or automatic
• Measurem. travel, mm	5	>6
• Resolution, µm	0.02/0.1	0.02/0.1

Incremental clip-on extensometer
(for manual operation)

Series/type	TC-EXICLEL.001	TC-EXICLEL.002
• Description	Incremental clip-on extensometer	Incremental clip-on extensometer
• Gauge length, mm	20/25/30 (optional 50/80)	50/55/65/70 (optional 80/85/100/105)
• Spec. thickn./diam., mm	20x30 or Ø 20	20x30 or Ø 20
• Measurem. travel, mm	+13.5/-0.2	+40/-0.2
• Resolution, µm	0.1	0.1

Series/type	TC-EXICLWD .001	TC-EXICLBI .001	TC-EXACLWD .001
• Description	Incremental reduction in width monitor	Biaxial incremental clip-on extens.	Strain gauge reduction in width monitor
• Spec. thickness, mm	10 to 20	10 to 20	10/12.5/20/25
• No. of measurem. levels	1	1	2
• Measurem. travel, mm	1.5 to 11.5	1.5 to 11.5	4
• Resolution, µm	0.1	0.1	0.04

Macro extensometer with reduction in width monitor

Incremental clip-on extensometer

Contactfree extensometers

Series/type	TC-EXOPTIC	TC-EXLASER	TC-EXVIDEO
• Description	Optical extensometer.	Laser extensometer.	Video extensometer
• Gauge length (L_0), mm	10 to 900	10 to 500	5 to 1,000
• Measurem. travel, mm	900 minus L_0	max. 1,000 % to L_0 = 20 mm dep. on resolution	50/100/200/500/1,000,
• Resolution, µm	5	12	0.5/1/2/5/10
• Travel transducer	incremental	laser scanner	video, analog

Zwick / Roell

Specimen feed systems

Application

Automatic specimen feed systems are used for the efficient testing of large series with specimens of the same type.

Specimen feed systems can be supplied in 5 task-specific designs:
- Clip-on system
- X-linear system
- Polar system
- Light portal system
- Portal system

Common features:
- Integrated system designed to conform to CE regulations
- Data exchange with each Zwick universal testing machine via serial interface
- Use with conventional PC's

Advantages for the user

- Automatic operation
- High reproducibility of the test conditions and test results
- High data integrity and statistical long-term monitoring
- Manually controlled tests are also possible
- Simple adaptation and expansion to specific requirements through modular system

Construction and function of the individual systems

The clip-on system

is used for tensile tests. It consists of a movable unit with two chains, arranged above one another, and running in an oval, with spring clips or magnets for the horizontal holding of the specimens.

Various holding devices for different specimens can be used in combination also. Depending on the design of the holding device and the nature of the specimen, the broken specimen can also be brought back to the magazine place.

The X-linear system

enables tensile, flexure and compression tests to be performed. It consists of a movable substructure with the electronic units, a linear feed axis, a pincer gripper and – optionally – a movable magazine table. The whole system is controlled by a stored-program control system. The cross-section can be measured automatically at up to three places.

The polar system

is used for tensile tests. The system consists of a 5 or 6-axis industrial robot with pneumatic gripper. The modular design of the system allows to integrate in addition to a barcode reader and a cross-section measuring device also hardness, roughness and other measuring devices.

The light portal system

is used for tensile, hardness, roughness or coating thickness tests. It is considerably larger and its design makes it suitable for the use of several testing machines in one system. The system consists of 3 axes and a rotating gripper unit. It is controlled via stored-program control system. A protection device for the entire system is absolutely required to get the CE-sign and can be offered on request.

Clip-on system

X-Linear system

Polar system

Zwick / Roell

The portal system

The portal system is based on the same principle as the light portal system, but is designed for a considerably greater specimen weight. The portal system is supplied with shelf or belt magazine:

Data technology

With all systems, specimen data and test results are printed out and stored or transmitted via an interface or local PC network to a higher-order computer system for the production of certificates and for production control. A data transfer to MS-Office programs via ODBC is also possible.

Automated hardness testing

Application

For automatic hardness tests, a hardness testing device for Rockwell HR15T, HR30T, HR45T, HRF, HRB, HRC is coupled with automatic specimen feeding of the X-linear system

Specimen feed systems

Characteristic, feature	Clip-on system	X-Linear-System	Polar-System	Light-System	Portal-System
No. of magazine places (Standard)	50 – 100	60 – 120	100 – 400	200 – 400	140 – 240
Specimen types/ properties	round and flat specimen, wires, foils	inherently rigid round and flat specimen from appr. 0.2 mm thick	round and flat specimen weight to 20 kg	round and flat specimen weight to 1 kg	round and flat spec. weight to 10 kg
Specimen dimensions					
• Shoulder or strip width	up to 50 mm	up to 35 mm	up to 70 mm	up to 40 mm	up to 70 mm
• Shoulder or wire diameter	up to 16 mm	up to 22 mm	up to 60 mm	up to 18 mm	up to 40 mm
• Thickness (standard)	up to 5 mm	up to 6/12 mm	up to 60 mm	up to 10 mm	up to 60 mm
• Total length	up to 350 mm (variable)[1)2)]	up to 260 mm (variable [2)] via magazine inserts)	up to 500 mm (variable via magazine inserts)	up to 260 mm (variable via magazine inserts)	up to 500 mm (variable via mag. limit stops)
Cross section measurement					
• Thickness or diameter	thickn. o. inq.	✓	✓	✓	✓
• Width	-	✓	✓	✓	with centering[5)]
• No. of meas. levels/spec.	1	1/3	1/3	1/3	1/3
Specimen disposal	back to the magazine place[3)]	back to the magazine place[4)] (hardness testing)	to various bins[4)]	to various bins[4)]	to various bins[4)]
Specimen identification (with barcode)	✓	✓	✓	✓	✓
Optional tests					
• Roughness	-	-	✓	✓	✓
• Hardness[6)]	-	-	✓	✓	✓
• Coating thickness	-	-	✓	✓	✓

[1)] Through variation of the grip to grip separation L
[2)] Drive-in height fixed through fixed grip, i. e. axial alignment in the magazine
[3)] Not suitable for foils (not rigid). For specimens with large deformations, only one part of the broken specimen is replaced in the magazine
[4)] Requires additional time. Alternative: additional disposal grippers and e. g. good/bad switch points
[5)] In parallel length or to total length
[6)] HR15T, HR30T, HR45T, HRB with automatic range changing, e. g. dependent on the specimen thickness previously measured

Zwick / Roell

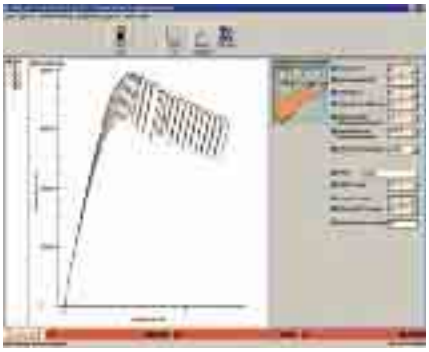
Fracture mechanics – Accessories / Software

Application

Mechanical fracturing tests for the rating of safety risks describe the propagation of an already existing crack by recognizing faults in the material.

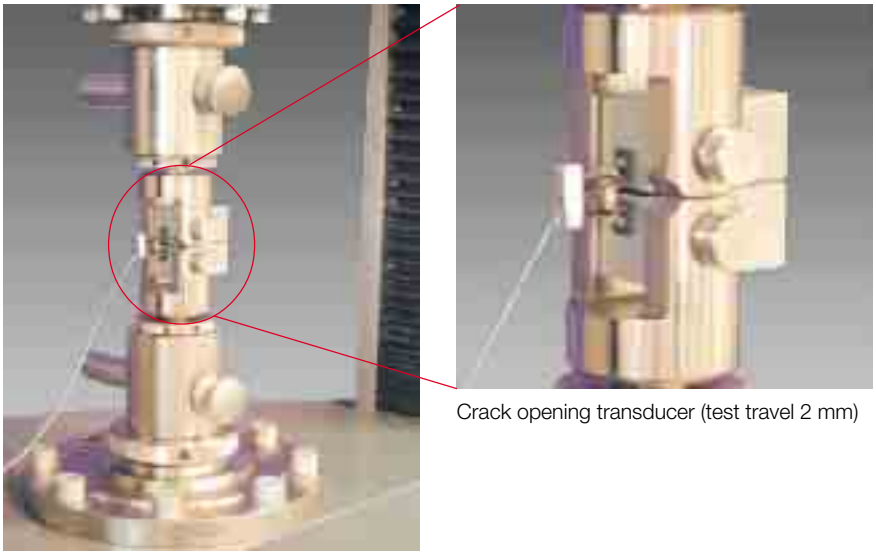
Standard testing machines, equipped with the corresponding accessories (specimen grips, crack opening transducers, software) are used for the determination of different characteristic data of fracture mechanics.

Zwick Z100 Testing machine for the determination of the K_{IC}-value



Screenshot of the *testXpert*® fracture mechanics software

Standard	Characteristic value	Specimen grips	Specimen shape	Transducer	Software
ISO 12135 6.2	K_{IC}	Zug B 8596.01XX	CT_{normal}	BX 066251-006	BX 069900.00.X0-21
ISO 12135 6.2	K_{IC}	Biege BP 70284.00.XX .50.XX .51.XX	SEB_{Biege}		BX 069900.00.X0-21
ISO 12135 7	J 0.2 BL	Zug B8596.01.XX	$CT_{abgestuft}$	BX 066251-032	BX069900.00.X0-20
ISO 12135 7	CTOD 0.2 BL	Zug B8596.01.XX	$CT_{abgestuft}$	BXC-EXACLEL005-001	BX069900.00.X0-20
ASTM E 399-90	K_{IC}	Zug B8596.01.XX	CT_{normal}	BX 066251-006	BX069900.00.X0-01
ASTM E 399-90	K_{IC}	Biege BP 70284.00.XX .50.XX .51.XX	SEB_{Biege}	BX 066251-006	BX069900.00.X0-01



Crack opening transducer (test travel 2 mm)

Zwick / Roell

Fatigue Testing Machines

Servohydraulic testing machines

Application

These testing machines are predominantly used to perform tensile, compression and flexure tests with complex, dynamic stress sequences.

Special features

- Extremely rigid, practically resonance-free load frame with manually or hydraulically adjustable crosshead.
- Continuous rated working cylinder with highly accurate guide mechanisms thus ensuring maximum rigidity on all testing levels
- Precision strain gauge load cells for continuous operation at maximum dynamic loading
- LVDT-extensometer (installed centrically in the piston rod) with high resolution, linearity and long service life.
- Freely positionable hydraulic unit
- Low noise level through internal geared wheel feed pump
- Optionally water or air cooling

Technical data

See table servohydraulic testing machines (STM)

Measurement and control electronics

The digital measurement and control electronics Amsler HydroWin® 9600 offers connections for external transducers and extensive applications software.

Servo-hydraulic testing machine
Amsler HB126/80

High-frequency testing machine
Amsler HFP 400

High-frequency testing machines (Vibrophores)

(with electro-magnetic resonance drive)

Application

Force or strain-controlled tests for determining the oscillation stability in the time and fatigue strength range.

- Fatigue tests according to DIN 50100 (Wöhler curve) in the tensile, compression, pulsating and alternate load range
- Mechanical fracturing tests on CT and COD specimens
- Stimulation of oscillations of the flexure specimens
- Time and fatigue-strength investigations on components such as springs, bolts, crankshafts, connecting rods, steering knuckles etc.
- Production and quality control of components which are exposed to dynamic stressing during their service life.
- Tests under various environmental conditions (temperature, aggressive media).

Special features

- Low energy consumption
- High test frequencies, short test times
- No adjustment of excitation air gap

High-frequency testing machine
Amsler HFP 5

Zwick / Roell

Technical data

See table high-frequency testing machines (HFP)

Measurement and control system

Measurement and control of these testing machines is taken over by the measurement and control electronics VibroWin®.

The data selected by the operator as well as the set values and actual values are digitally displayed on the screen.

Rotary bending testing machines

Application

With the rotary bending test, the fatigue strength of round specimens under reversed bending stresses is determined.

Technical data

See table rotary bending testing machines (UBM)

Rotary bending testing machine
Amsler UBM 200

Servo-hydraulic testing machines (STM)

Standard design[1)]

Series/type[2)]	HC	HB	HA
• Construction type	table top	floor stand.	floor stand.
• Load frame nominal force, kN	5 - 25	50 - 1,000	50 - 500
• Test stroke, mm	100	100/250/400	100/250
• Specimen length, mm	100 - 700	100 - 1,100	250 - 1,500
• Hydraulic unit			
* System pressure, bar	210/280	210/280	210/280
* Flow, l/min	4 – 23	9 – 600	9 - 600
• Max. power consum., kVA	2.2 – 11	2.2 – 74	2.2 - 74

[1)] Load frames and actuators for higher nominal forces on request
[2)] In the HC and HB serie the actuators are situated in the upper crosshead, in the HA serie in the lower crosshead

High-Frequency testing machines (HFP)

Series/type	Amsler HFP 1 - 5	Amsler HFP 20 - 550
• Construction type	table top	floor standing
• Load frame nominal force, kN	1 - 5	20 - 550
• Max. force amplitude, kN	2.5	275
• Max. elast. spec. deform., mm	± 3	± 2
• Frequency range, Hz	35 - 300	35 - 300
• Frequency levels	5	16/5
• Working area width, mm	350	530/600
• Max. power consum., kVA	2	5

Rotary bending testing machines (UBM)

Series/type	AmslerUBM 200	Amsler UBM 2000
• Max. bending moment, Nm	200	2,000
• Load reversal frequency, min-1	50 - 5000	600 – 3000
• Max. specimen diameter, mm	25	50
• Max. power consum., kVA	1.6	5.5

Zwick / Roell

Impact testing machines

High-speed testing machines

Application

High-speed testing machines are used for high test speeds, particulary for rapid-tearing and impact penetration tests.

With the corresponding equipment tensile, compression and flexure tests according to DIN 51220, DIN 51221, DIN 51223 and DIN 51228 under continous, dynamic and alternate load for static, quasi-static and dynamic load applications are possible.

Measurement and control electronics

The control electronics SpeedWin® with the user software *testXpert*® allows an extensive evaluation of test results as well as the creation of test reports and data administration.

Technical data

See table high-speed testing machines (HTM)

High-speed testing machine
Amsler HTM 5020

High-frequency testing machines (HTM) standard design

Series/type	Amsler HTM 2012	Amsler HTM 2020	Amsler HTM 5004	Amsler HTM 5008	Amsler HTM 5020
• Nominal force, kN	20	20	50	50	5
• Test speed, m/s	12	20	4	8	20

Pendulum impact testers (RKP)

Series/type	Zwick 5113	Amsler RKP 450	Amsler PSW 750
• Max. impact energy, J	50	150/300/450	300/450/600/750
• Angle of fall, degrees	160/124.4	150	161
• Impact velocity, m/s	3.46 / 3.85	5.23	5.42
• Pendulum shape	disk (C)	box (U)	disk (C)
• Instrumentation	optional	optional	optional

Zwick / Roell

Pendulum impact tester

Application

With pendulum impact testers Charpy and IZOD impact tests as well as tensile impact tests are carried out.

Features

- Rigid, distortion-free frame with low-friction pendulum bearing.
- Electromagnetic safety brake and auto-lifting device for the pendulum (from 50 J on)
- Analog dial display for the reading of the absorbed impact energy and angle and intelligent digital display for the direct reading of the absorbed impact energy
- User-friendly test software *testXpert*® - as option
- Accessories easy to change

Technical data

See table pendulum impact testers

Pendulum impact tester Zwick 5113

Pendulum impact tester Amsler RKP 450

Ductility testing machines

Application

- Testing of the formability of sheet metal
- Testing of the influences of surface treatments, coatings and lubricants for typical types of deformation (deep drawing, stretching and forming)
- Test tools for Erichsen- and Olsen cupping tests, cupping draw test, Fukui test, Bulge test etc

Special features

- Simple and fast exchangeability of the test tools as e.g. shaping ram, deep drawing die, sheet metal holder, blanking punch, die ring and sheet metal scraper.

Ductility testing machine Amsler BUP 200

- Test tools from previous models to be used without restriction or modification.
- Quiet, clean operation and easy to transport for the use in laboratories, offices or seminar rooms.
- Low piston-to-cylinder friction for precise measurements and reproducible test data records.

Technical data

See table ductility testing machines (BUP)

Ductility testing machines

Series/type	Amsler BUP 100	Amsler BUP 200	Amsler BUP 400	Amsler BUP 600
• Max. cupping force, kN	100	200	400	600
• Max. sheet met. clamp. force, kN	25	25	30	50
• Punching force, kN	-	150	250	600
• Max. test stroke, mm	80	80	120	120
• Max. test speed, mm/min	235	750	750	750
• Circular blank diameter, mm	80	170	210	260
• Max. sheet met. strip width, mm	120	120	160	260
• Max. sheet met. strip thickn., mm	2	4.5	4.5	10
• Circ. blank punch diameter, mm	-	120	160	220
• Test punch diameter, mm	60	75	90-105	100
• Max. power consumption, kVA	7.5	7.5	15	20

Zwick / Roell

Hardness Testers and Testing Machines

Webster pliers

Portable, easy to operate testing pliers with display of penetration depth which can be converted into Rockwell or Brinell hardness.

PZ 3

Unique portable device for the performance of standardized, static ball penetration tests according to Brinell up to a max. load of 29420 N. It is possible to carry out hardness tests on materials and workpieces that cannot be tested in the laboratory, e.g. steel stocks, finished constructions, machines, larger metal components. The results correspond to the results obtained with stationary hardness testers.

Webster pliers

Sclerograph

Portable hardness testing device for steel and non-ferrous materials. Optionally available:

- Testing anvil for the testing of small test pieces (mass < 1 kg).
- Device for hardness testing on rollers (diameters 100 - 800 mm)

Hardness Tester Zwick 3106

For the testing of the indentation hardness on plastics, Rockwell hardness on metals, plastics and carbon materials as well as the hardness of building plaster and asphalt.

It is equipped with a digital dial gauge and can be expanded for the data output on a printer.

Rockwell Hardness Testers Zwick/ZHR

The different devices of this product family are designed for

- the classical Rockwell methods (loading : 60 - 150 kg),
- the Super-Rockwell method (loading: 15 - 45 kg) and the
- combination of these methods (loading: 15 - 150 kg).

These devices are distinguished by an indentor mounting support for hardness testing at hardly accessible measuring positions and guarantee a simple and easy operation by

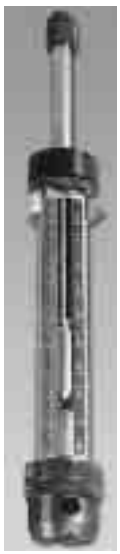
- automatic test mode
- selection of loading weights by rotary type push-button resp. by touchscreen
- automatic loading and unloading
- automatic evaluation including conversion

Additional features:

- preselection of tolerances
- robust construction with backlash-free, ball-bearing mounted spindle
- working area up to a height of 292 mm for the testing of large specimens
- RS 232 interface as standard
- manifold standard accessories (indentors, anvils, hardness comparison plates).
- low-cost version with elastic force load application

Sclerograph

PZ 3



Hardness tester Zwick 3106

Rockwell hardness tester Zwick/ZHR

Zwick / Roell

Hardness Testers Zwick/ZHV

These Vickers hardness testers cover many different load ranges and have equipments of various comfort levels. Thus, for each case of application customer-specific and suitable devices are available.

Hardness Tester Zwick/ZHV 10

This device is especially approved for the determination of the
- Vickers hardness,
- Knoop hardness,
- Brinell hardness,
- depth of hardness, hardness penetration and nitriding depth as well as
- the scratch hardness (3212001).

Loading weights from 0.2 kg to 10 kg (or to 30 kg) and exchangeable objectives for different magnifications and image ranges are available for both variants:
- With the analog tester (3212001) the hardness value is evaluated by means of hardness tables.
- The PC version (3212003) works with the user software *testXpert*® which is easy to use and which can be flexibly adapted to changing test conditions.The indentation is measured at the monitor and is evaluated automatically. A Master test program for Vickers, Knoop and Brinell hardness tests is available for series measurements which can be extended for hardness gradient tests and automatic indentation measurement. In addition to manually movable or motorized compound tables, a variety of further accessories as e.g. clamping devices are available.

Vickers Hardness Testers Zwick/ZHV 30 and Zwick/ZHV 50

These devices working in a test load range from 9.8 N to 490 N are used for testing the
- Vickers hardness and the
- Brinell hardness (optional).

They are equipped with dead load weights and an indentor mounting support making them suitable for hardness testing at most flexible test positions and they are supplied with LCD line display or with a touchscreen.

The measuring microscope is provided with moveable curtains for the simple acquisition of the indentation diagonal. This value is transferred to the software by pressing a button and the value of hardness is displayed automatically. In addition to the input of tolerance limits, standard-conforming conversions and statistical evaluations are also possible. Available as standard are RS 232 interface(s) and a large variety of accessories (indentors, anvils, hardness comparison plates).

Universal Hardness Tester Zwick ZHU/187.5

These devices are designed for hardness tests according to Vickers, Brinell and Rockwell and for different load level combinations. They are easy to operate. The test sequence is carried out automatically. A measuring microscope and a

Vickers Hardness Tester Zwick/ZHV10


Vickers Hardness Tester Zwick/ZHV50


Vickers Hardness Tester ZHV20/Z2.5

multiline LCD-display are integrated. The conversion of hardness is also possible. Indentors, hardness comparison plates and specimen tables round off the standard accessories.

Vickers Hardness Testing Machines Zwick ZHV20/Z2.5 and Zwick ZHV30/Z2.5

The hardness testing device for optical measurements is integrated in a zwicki testing machine. The built-in load cell measures electro-mechanically applied test loads between 2 and 200 N resp. 3 and 300 N.
A CCD-camera is fitted on a microscope at an angle of 90°. Objective lenses and indentor holding device(s) are integrated in the revolver head so that the change of positions between the setting and the measurement of the indentation is carried out by turning the revolver. A Master test program includes series tests according to the methods of Vickers, Knoop and Brinell. Optionally available are extensions for automatic indentation measurements and focusing as well as hardness gradient measurements with manual or motorized compound tables

Universal Hardness Testing Machines ZHU2.5/Z2.5

They can be selected with the installation of the hardness measurement head to a materials testing machine. The hardness measurement head covers all hardness test methods with indentation measurement as e.g.:
- Martens hardness HM (macro-range),
- Rockwell hardness, scales A to K, N, T as well as HMR5/250,
- Ball indentation hardness H,
- Vickers depth measurement HVT and
- Brinell depth measurement HBT.

Integrated in the measurement head are a digital travel measurement system (resolution 0,04 µm), a load cell (ranges: 2 N to 200 N resp. 5 N to 2500 N) and an exchangeable indentor.
The particular features are:
- Simple „1-button“-operation
- Fast and automatic run-up even with different specimen heights
- High accuracy and reproducibility of the test data by high test data resolution and constant test conditions
- Determination of additional characteristic material data from the force-penetration progression
- Suitable for product-accompanying tests

A supplementary unit „Optics“ has been developed for the hardness measurement head. This supplementary unit consists of a measuring microscope with up to 4 objective lenses and a linear slide unit to ensure that the component to be tested is not displaced.

The universal hardness testing machine of this combination is – in addition to the above-mentioned test methods – able to carry out standard-conforming hardness tests according to Vickers, Knoop and Brinell. The combination of the supplementary unit Optics and the hardness measurement head leads to extraordinary properties via the *testXpert*® intelligence. In addition to the known advantages such as automated test sequences and simple adaptation to changing test conditions e.g. the recording of the force-indentation depth sequence is also possible with optical hardness test methods.

The Master test program developed for the hardness measurement head allows to carry out hardness tests according to Martens, Rockwell and ball indentation hardness as well as Vickers and Brinell hardness according to the method HVT and HBT (indentation depth measurement). It is expandable for Vickers, Knoop and Brinell hardness tests. In addition hardness gradient tests with automatic indentation measurement and focusing are also possible.

Universal Hardness Tester Zwick/ZHU187.5

Universal Hardness Testing Machine Zwick ZHU2.5/Z2.5

Zwick / Roell

ZMART – Zwick Modernization and Retrofit Technology

Modernization packages

With the modernization packages *ZMART.KIT® and ZMART.PRO®* both electro-mechanical and hydraulic materials testing machines of different manufacturers can be upgraded and brought to the most recent state-of-the-art. After a modernization the guaranteed spare parts supply for modernized components, the entire accessory program including extensometers or specimen grips and in particular also the most recent version of the test software *testXpert®* are available.

The decision regarding the purchase of a new machine and a modernization primarily depends on the value and technical condition of the machine components to be taken over. Due to the fact that in addition to the load frame other components can be used furthermore, as e.g.: load cell and extensometer, the costs for a modernization remain relatively low compared to the costs incurring for the purchase of a new machine.

The modernization packages are composed of the following components:
- Digital measurement and control electronics
- Test software *testXpert®*
- Maintenance-free AC-drives
- Proportional valves or servo valves and hydraulic units for hydraulic testing machines

Special features or services	***ZMART.PRO®***				
	testControl		**Allround (DUPS)**		
	M[1)]	**H[2)]**	**M[1)]**	**H[2)]**	**I[3)]**
Connection to					
• Electro-mechanical testing machines	✓	-	✓	-	-
• Quasi-static hydraulic testing machines	-	✓	-	✓	✓
• Can also be used without Personal Computer (PC)	✓	✓	-	-	-
• Can be used with up to 3 hydraulic testing machines	-	-	-	✓	-
Test data acquisition and display					
• Test force and crosshead or piston travel resp.	✓	✓	✓	✓	✓
Connection of:					
• Analog extensometers (inductive)	✓	✓	✓	✓	✓
• Analog extensometers (strain gauge system)	✓	✓	✓	✓	✓
• Incremental extensometers	✓	✓	✓	✓	✓
• Several load cells (changeover via *testXpert®*)	✓	✓	✓	✓	✓
Test data storage and processing					
• Display of maximum force and travel when reaching the test end criterion (without PC)	✓	✓	-	-	-
• Optional display of test force or stress, travel and/or deformation or strain (only with PC)	✓	✓	✓	✓	✓
• Output of XY-curves with the coordinates force/stress, travel and/or deformation/strain or test time (only with PC)	✓	✓	✓	✓	✓
• Automatic determination and documentation of materials characteristic data and statistical data (only with PC)	✓	✓	✓	✓	✓
Test sequence and test speed control					
• Automatic recognition of the test end (specimen break, force-travel or time limit value or number of test cycles reached)	✓	✓	✓	✓	-
• Automatic stop at test end or return to start position	✓	✓	✓	✓	-
• Automatic speed changes according to the test program (only with PC)	✓	✓	✓	✓	-
• Test speed control in dependence on the measured force or deformation („closed-loop“-control), only with PC and optional program)	✓	✓	✓	✓	-
Monitoring of safety limit values					
• Test force	✓	✓	✓	✓	-
• Crosshead- resp. piston travel	✓	✓	✓	✓	-

[1)] For electro-mechanical testing machines [2)] For hydraulic testing machines, [3)] Only data aquisition and display

Zwick / Roell

Services

Customer satisfaction is given top priority to at Zwick/Roell. Therefore, nearly one third of the employees are active in the service field. Extensive services guarantee the best use possible and a high availability of the supplied testing machines and systems.

Advice and support

Our technically competent and experienced service personnel support the user directly at site, by phone, fax or e-mail. Detailed information may also be looked up in the internet or may be downloaded in case of need.

Maintenance and repair

A service contract with individually agreed service intervals for a careful and thorough maintenance and calibration guarantees the correct and trouble-free operation of the supplied testing machines and systems. Whereby it is not important which manufacturer supplied the testing machine. In case of a malfunction, a service-engineer or – technician is quickly available at site. Modern auxiliary means such as a telediagnostic service via modem allow a quick and exact fault localization at an early stage. Different reaction models guarantee the availability of a technician within the shortest period of time possible.

Calibration service according to ISO 9000

The Zwick/Roell maintenance and calibration service is accredited as DKD[1)]-, UKAS[2)] or COFRAC[3)] calibration laboratory resp. Thus, it is authorized to check the testing machines and systems at the place of installation and to issue DKD or UKAS calibration certificates for the measured quantities force, extension, energy and hardness. These calibration certificates are not only recognized within the European Union, but also in almost every country of the world.

Particular advantage:
The technicians of the calibration service can, on the occasion of their service visit, not only service, adjust and calibrate the Zwick/Roell testing machines and systems, but also the machines and systems of other manufactures. This saves time and costs.

The regular maintenance and calibration of the testing machines is also a prerequisite for a quality management system according to QS-9000 and VDA 6.1.

Hotline – Quick assistance in case of malfunctions

For Zwick/Roell, the perfect functioning of the testing machine is very important. Should, in spite of the high quality standard, any malfunctions occur on the machine or within the software, then competent specialists are available on the free hotline.

Creation and adaptation of test programs

With the test software of the Zwick/Roell Group already many different test programs can be acquired. The test requirements are however not always standardized. Experts will adapt your existing test programs individually or will create a new test program which is tailor-made to comply with your requirements.

Seminars

Studies have shown that more than half of the problems with technical systems are not caused by the technology itself, but rather by the user. A good training of the users helps to avoid troubles and, as a result, to reduce the costs.

The Zwick/Roell seminars inform about theory and practice of the materials and component part testing, the evaluation and the valuation of the test data, test results and the operation and maintenance of the testing devices. These seminars either take place directly at the user's place or at the locations of Zwick/Roell companies or representations.

Support line – Assistance for operation and application

Alternatively to the visit of a seminar or to the service visit of a technician at site, you can talk to our experts on the support line – against charge – whenever you have any questions. They will assist you with the adaptation of the test software, with the creation of test programs, when having questions regarding the operation of the software or the machine and they will give you an application-specific support.

Spare parts

Standard components are mostly available on stock and will be sent to you by courier service on the day of order. Special components, not being carried on stock, will be manufactured „just in time“ by means of the latest production technology.

[1)] DKD: Deutscher Kalibrier-Dienst (German Calibration Service)
[2)] UKAS: United Kingdom Accreditation Service
[3)] COFRAC: Comité Francais d´Accreditation