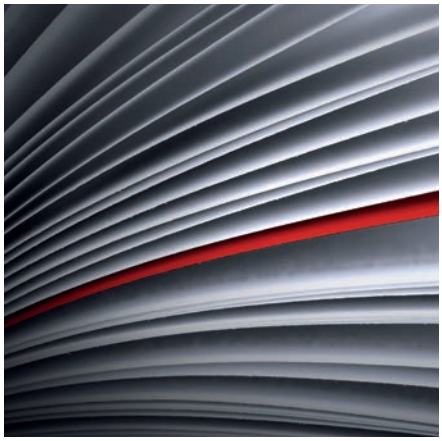
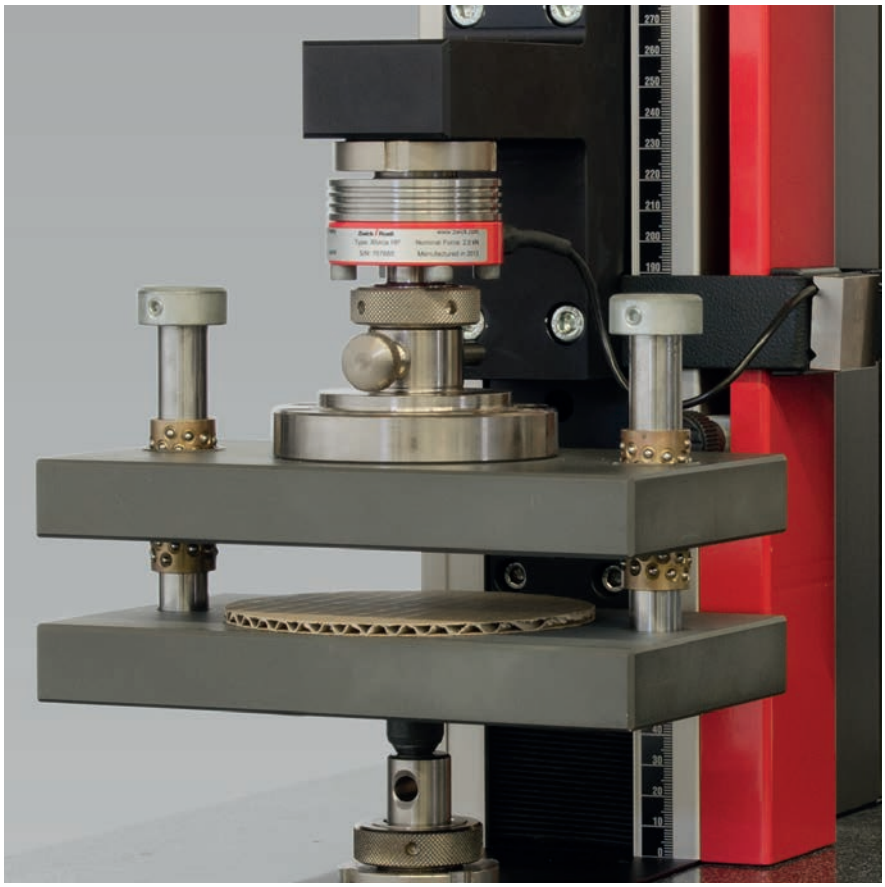
Zwick / Roell

Testing Machines and Testing Systems for Paper, Board and Tissue Products





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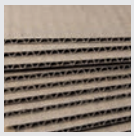
Intelligent Testing

Zwick / Roell






1 The ZwickRoell Group

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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

1.2 The basis of a successful partnership: innovative employees, innovative products!

Always at your service

Over 1,100 people 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 customization to a fully automated testing system or a test bench for special purposes.

1.3 Reliable test results

Reliable test results are a fundamental and hot topic in materials testing. With each materials and components test we ask the same questions:

Is the value obtained accurate? Are the results repeatable? Are these results comparable to other measurements? Is it possible to trace who did what, when and how? Does the test equipment used satisfy all the necessary specifications and standards?
ZwickRoell's machine and software solutions provide accuracy, repeatability and reproducibility, as well as complete traceability of test results.

Fig.1. Reliable test results with machine and software solutions from ZwickRoell

2 Paper Applications

2.1 Tests on paper

2.1.1 Two-point flexure test on paper

Bending stiffness is of critical importance in the onward processing of paper and board. To enable reliable and easy operation of packaging and filling machines, the paper or board must be flexible within defined limits. At paper feed changeover, uniform stiffness properties are also essential for smooth operation of the packaging machine. ZwickRoell's two-point flexure test kit covers two applications: measurement of bending stiffness as per DIN 53121 and ISO 5628 and determination of creasing characteristics as per DIN 55437-3 up to a bending angle of 120°. Accurate, high-resolution measuring technology eliminates the need for a change of load cell.

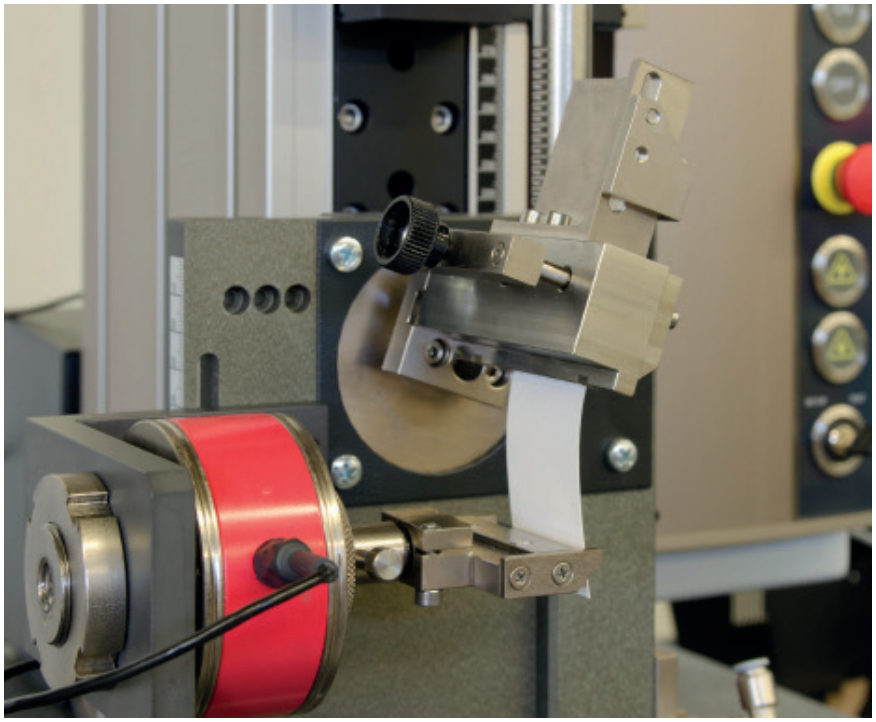

Fig.1. 2-point flexure test

2.1.2 Internal bond test / Z-direction tensile test

In the internal bond test (Z-direction tensile test) the internal bond strength between layers is determined in accordance with TAPPI T 541 (or ISO 15754).
The bond strength between the layers of multi-layer materials (duplex or coated papers) is measured. This determines processability during printing or after coating. Loading is in the form of a force applied perpendicular to the specimen surface. To avoid the testing equipment influencing the separation of the layers, the force must also remain perpendicular to the specimen at failure, making high transverse stiffness and absolute parallelity of the specimen grips a primary essential.

2.1.3 Measuring coefficient of friction

Friction in paper and paper compounds (coefficient of friction) is

important for their onward processing in automatic systems. The coefficient of friction can be measured as "paper against paper" or "paper against other material". During measurement of the coefficient of friction, properties such as static and kinetic friction are determined in accordance with TAPPI T 549.

2.1.4 Zero-span tensile test

The zero-span test is performed to TAPPI T 231 and provides information on the fiber strength of paper. A tensile load is applied to a test strip with a grip-to-grip separation approaching zero.
This causes most of the load to be applied to the cellulose fibers and less to the total fabric of the paper.

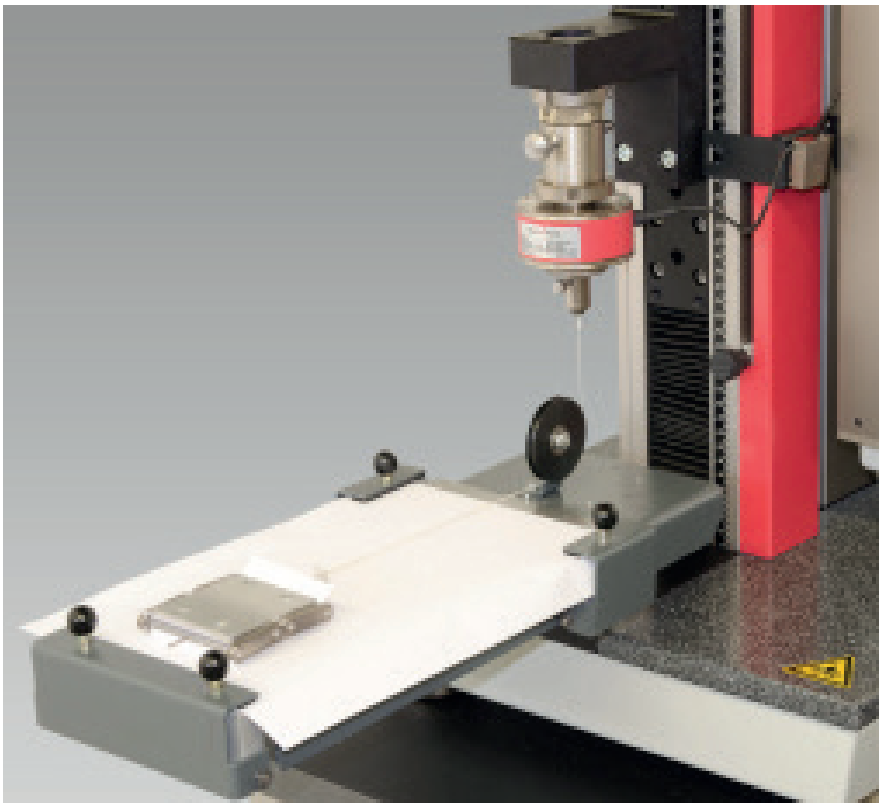

Fig.2. Measuring coefficient of friction

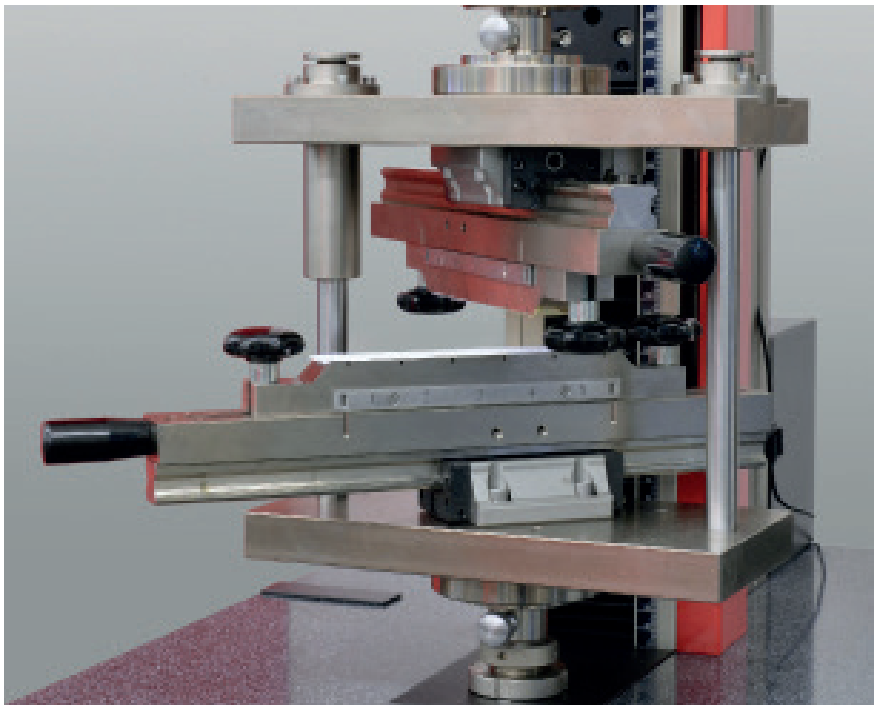

Fig.1. Internal bond test (Z-direction tensile test)

Fig.1. Zero-span tensile test

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2.1.5 Short-span compression test (SCT)

In the short-span compression test (SCT) the compressive strength of paper is determined to ISO 9895, DIN 54518 or TAPPI T 826.

In the short-span compression test the strength of the paper in compression mode is determined. Because only a very short length of paper (0.7 mm) is used in the test, greater account is taken of the load-bearing fiber portion of the material than with the traditional test methods (ring crush test, corrugated crush test or linear crush test). Determination of the compressive resistance has now become established as an alternative to the ring crush test .

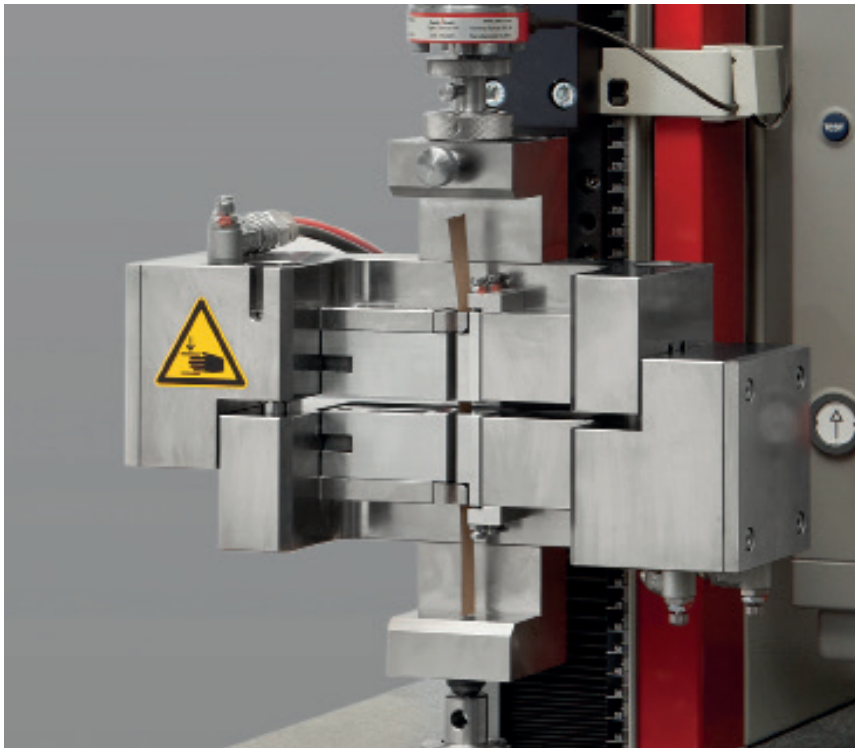

Fig. 1. Short-span compression test (SCT)

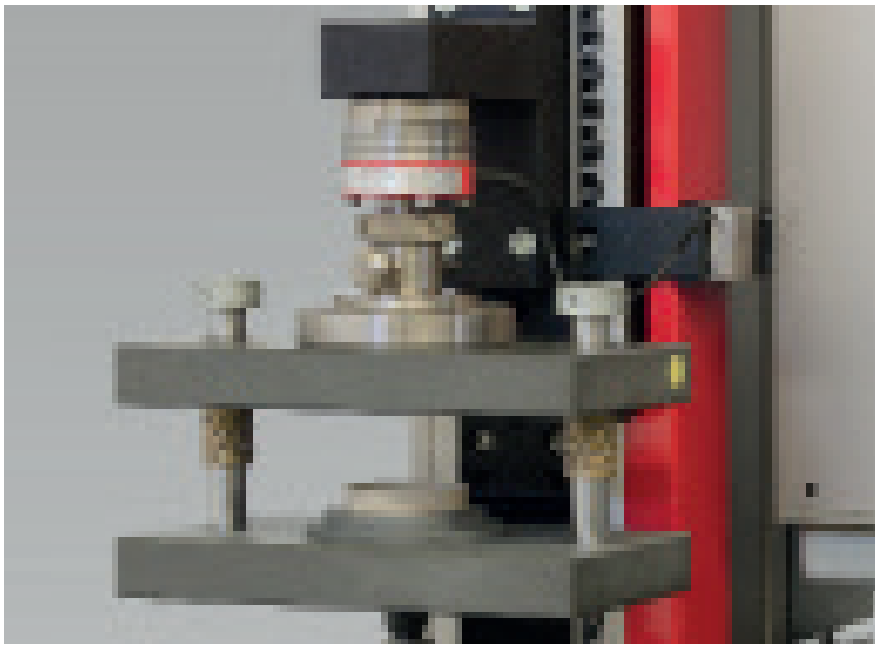

Fig.2. Ring crush test (RCT)

2.1.6 Ring crush test (RCT)

The ring crush test (RCT) is used to determine the ring crush resistance of a paper strip formed into a ring with a standardized length and width. This test is performed to ISO 12192 and TAPPI T 822.

The ring crush test is similar to the short-span compression test in that the strength of the liner or fluting is measured both in the machine direction and perpendicular to it. It is important that force application to the specimen is exactly perpendicular during these tests.
The results of this test are highly dependent on proper specimen preparation. Specimen and guides must be exactly parallel to ensure accurate determination of ring crush strength. As the ring crush test provides information about specimen buckling behavior rather than crush behavior, it is increasingly being replaced by the short-span compression test.

2.1.7 Corrugating medium test (CMT)

One side of the formed medium is adhered to a backing strip and subjected to compressive loading. The maximum load characterizes the behavior of multi-wall corrugated board during subsequent processing operations (punching, printing). It is important that force application to the specimen is exactly perpendicular during these tests. A disadvantage of this method is that only the A and B flutes are tested. The behavior of other types of fluting must therefore be determined mathematically in order to obtain their crush resistance.

2.1. Burst test

The burst test determines the maximum resistance (in kPa) of a specimen to an increasing pressure. ZwickRoell burst testers determine the bursting strength of paper in accordance with ISO 2758. The bursting strength of board and paper as per ISO 2759 can also be determined with ZwickRoell, thereby covering the entire range from paper to heavy corrugated board.
To measure bursting strength, the specimen is held firmly between two clamping rings. Once a corrugated board specimen is clamped it is essential to maintain the gripping force to ensure reproducible test results.

Particular attention must be paid to the dynamics of the testing equipment. As a burst test is performed within a few seconds and the maximum pressure must be determined with absolute precision, the measurement speed of the testing instruments must be correspondingly high. If results are to be compared between different laboratories, the measurement speeds of the instruments must be identical. A constant volume-flow must also be maintained during the test with a high degree of accuracy.

2.1.9 Dry tensile test on paper

Tensile tests provide information on a range of properties: stiffness, modulus, tensile strength, tear length and energy absorption.

Dry tensile tests on paper are performed to EN ISO 1924-2/3 or TAPPI T 494.

In addition to paper, tissue products can be tested.

Fig. 1. Corrugating medium test (CMT)

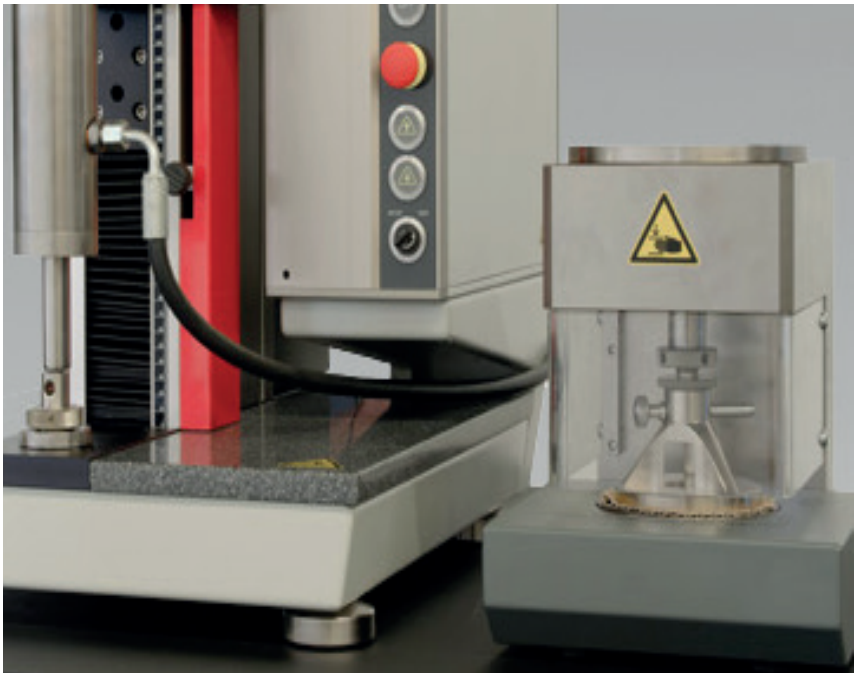

Fig. 2. Burst test

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2.1.10 Wet tensile test on paper

In the wet tensile test the strength of the paper (or tissue) in a wet state is determined. Wet tensile tests on paper are performed to EN ISO 3781 or TAPPI T 456.

If paper is used or processed in a wet condition, wet strength is one of the key material properties.

2.1.11 Compressibility properties

In the development of high-quality offset printing paper the force-deformation ratio in the compression test is crucial for clean print results. Missing
half-tone dots are just as undesirable as an unclear print image.

The compressibility test provides information regarding the behavior of paper during offset printing.
The paper is loaded up to nominal load in the printing device;
force and strain are measured during this process. The deformations are of a magnitude of 10 µm, necessitating a high-resolution extensometer.

Fig.1. Dry tensile test on paper

Fig. 2. Wet tensile test on paper

2.2 Tests on corrugated board and solid board

2.2.1 Buckling resistance

This three-point flexure test is performed to determine the buckling resistance of corrugated board to DIN 54608. The test is used for advanced characterization of multi-wall corrugated products.

Performing the determination is simple and requires only relatively small specimen sizes.

The value depends on various basic parameters:

- SCT of the initial papers
- Flute geometry
- Quality of the corrugated board adhesion
- development of material flaws, such as plastic deformation during the manufacturing/molding processes, development of vacuum lines etc.

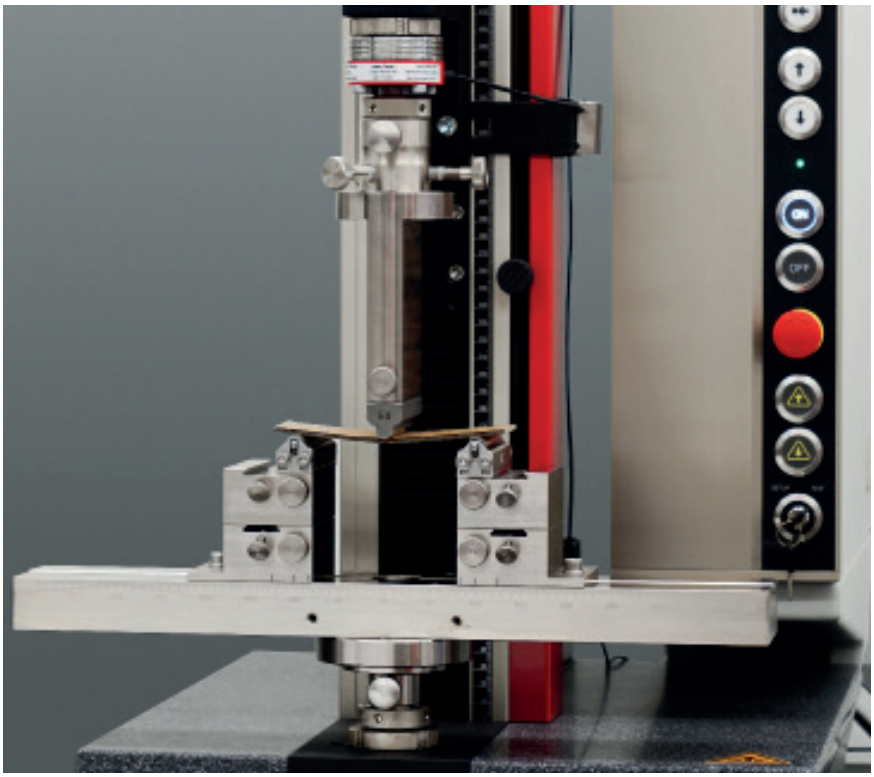

Fig.1. Buckling resistance of corrugated board, DIN 54608

2.2.4 Four-point flexure test

In the four-point flexure test the bending stiffness of corrugated board is determined in accordance with DIN 53121 or ISO 5628. The four-point flexure test delivers reliable stiffness values in the machine and transverse directions. This is particularly important for mini-flute corrugated board, where the stiffness of the board plays a significantly greater role than with standard flute heights.

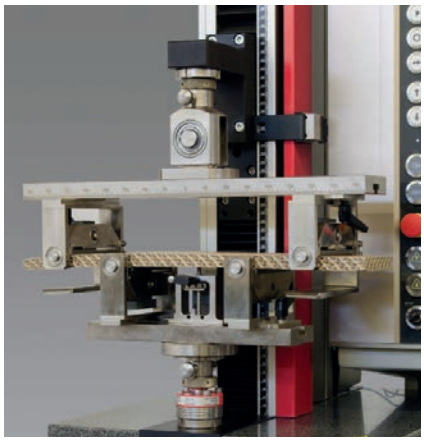

Fig. 2. Four-point flexure test

2.2.3 Box crush and stacking tests

In the box crush and stacking crush tests the strength or stackability of corrugated board boxes or folding boxes is determined.

In the box crush test the package is loaded up to nominal load or to failure; in the stacking crush test a stipulated force is maintained at a constant level for a specified duration or until the box fails.

2.2.4 Edge crush test (ECT)

The edge crush test (ECT), to EN ISO 3037 or TAPPI T 811, provides information on the strength of corrugated board with flutes positioned vertically. It is important that forces are applied exactly perpendicular to the specimen during these tests.

The edge crush resistance is included in the McKee formula and is therefore of particular importance for quality control in corrugated board factories. An essential requirement of this test is that the specimen has clean, parallel and perpendicular edges and the material must be free of existing damage. Knives are not ideal for cutting specimens and lever shears are not suitable at all. Good results are achieved with a twin-blade circular saw.

Fig.1. Box crush test and stacking crush test

2.2.5 Flat crush test (FCT)

Flat crush tests (FCT) are performed to EN ISO 3035 or TAPPI T 825. In the flat crush test, a single-flute corrugated board specimen is loaded perpendicular to its surface. The resistance this corrugated board presents to the force provides an indication of its behavior during processing and in use.

It is important that forces are applied exactly perpendicular to the specimen during these tests.

Characteristic curve

- Depending on individual flute heights, the highest flutes collapse first, then the middle ones, followed by the remaining flutes at the end of the test.
- The crush energy and curve provide indications of the level of any pre-damage which may be present as the curve is fundamentally different in the event of pre-damage to the board.

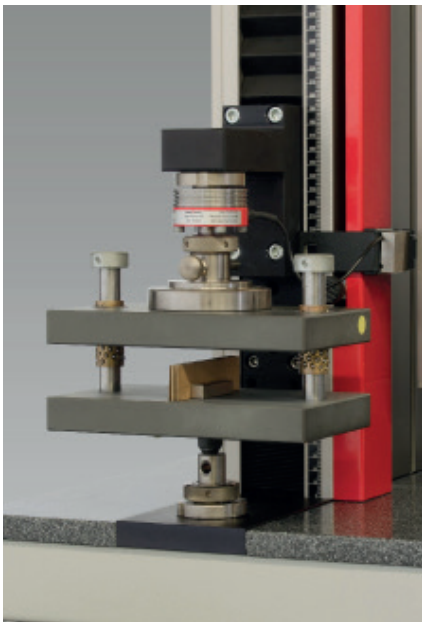

Fig. 2. Edge crush test (ECT)

- If the corrugated board has been pre-damaged, the curve is fundamentally different. The crush energy and curve provide indications of the level of any pre-damage.

2.2.6 Puncture test

The puncture test measures the energy required to puncture corrugated board. In the puncture test to DIN 53142-2 the use of a pyramid puncture head causes the material to be loaded in all spatial directions. During this process, combined tensile, compression, flexural and shear forces occur. The result obtained in this test is the energy absorbed in puncturing the material.

A materials testing machine is used for this test.

2.2.7 Test creasing

Using a materials testing machine it is possible to determine accurate setting parameters as per DIN 55437-1 for creasing units (test creasing).

A specimen can be creased with predefined creasing-knife width, creasing-groove width and defined creasing depth. The high creasing-speed as compared with that of manual creasing presses, together with positioning accuracy in the µm range, greatly facilitates evaluation of creasing.

The creasing channel and creasing knife can be changed quickly and easily.

2.2. Burst test

The burst test determines the maximum resistance (in kPa) of a specimen to an increasing pressure. ZwickRoell burst testers determine the bursting strength of paper in accordance with ISO 2758. The bursting strength of board and paper as per ISO 2759 can also be determined with ZwickRoell, thereby covering the entire range from paper to heavy corrugated board.

To measure bursting strength the specimen is held firmly between two clamping rings. Once a corrugated board specimen is clamped it is essential to maintain the gripping force to ensure reproducible test results.

Particular attention must be paid to the dynamics of the testing equipment.

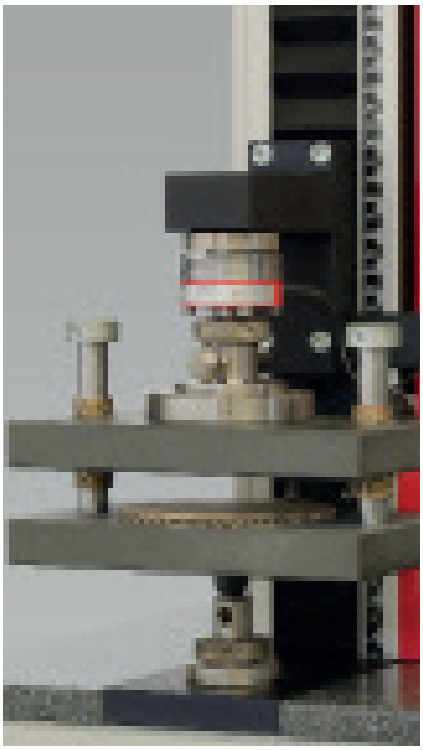

Fig.1. Flat crush test (FCT)

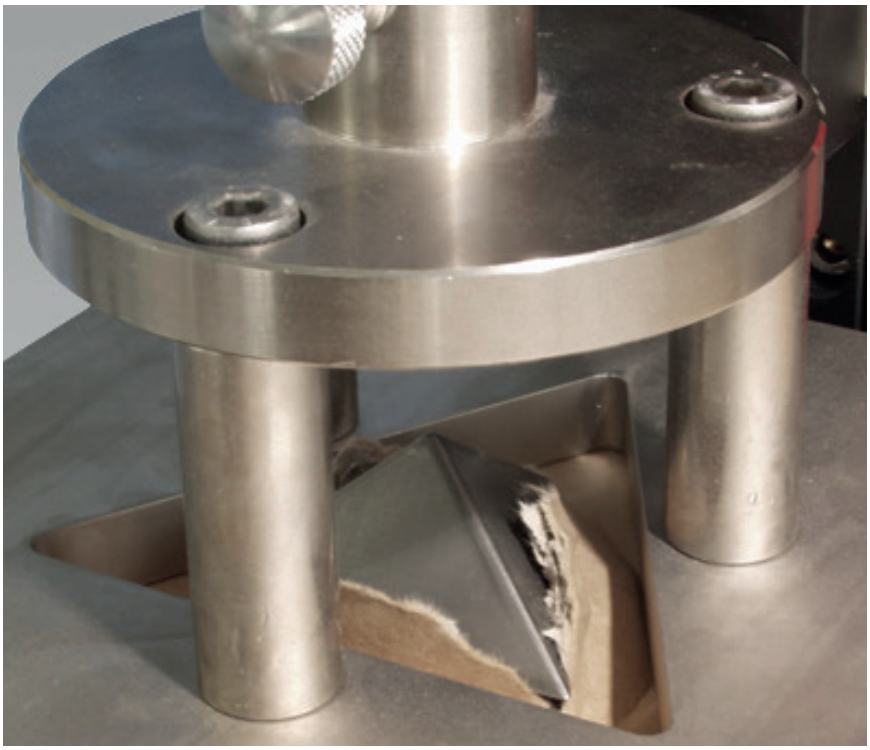

Fig. 2. Puncture test

As a burst test is performed within a few seconds and the maximum pressure must be determined with absolute precision, the measurement speed of the testing instruments must be correspondingly high. If results are to be compared between different laboratories, the measurement speeds of the instruments must be identical.

A constant volume flow must also be maintained during the test with a high degree of accuracy.

2.3.4 Compressive strength of a specimen clamped in an S-shape (S-test)

Determination of the compressive strength of corrugating medium to DIN 5014 (draft).

The specimen is secured between two clamps, with a 1 mm offset from the sheet plane.

A compressive load is then applied parallel to the paper plane. This results in a double flexure load on a test length of 4 mm. At maximum load failure of the structure occurs in the form of buckling.

2.3.5 Pin adhesion test

In the pin adhesion test as per Tappi T 821 the upper We can also assist in the event of capacity bottlenecks or perform cross-validation tests and lower layers of a glued strip of corrugated board are separated from the fluting by means of steel pins.

The test result is the maximum force occurring in relation to the overall length of the glue line.

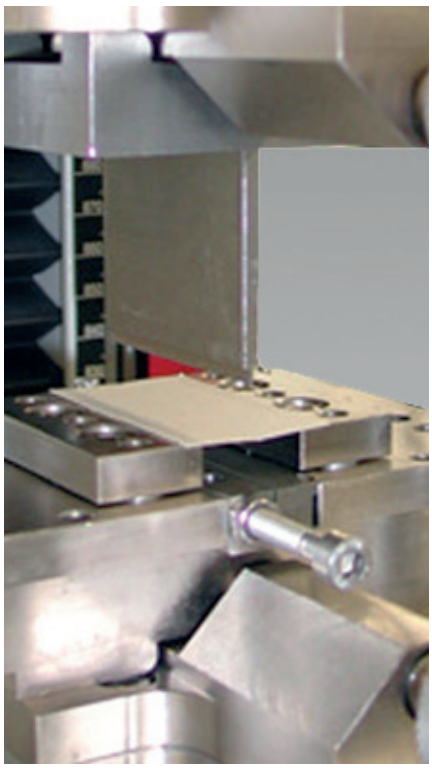

Fig.1. Test creasing

Fig. 2. Burst test

Fig.2. Pin adhesion test

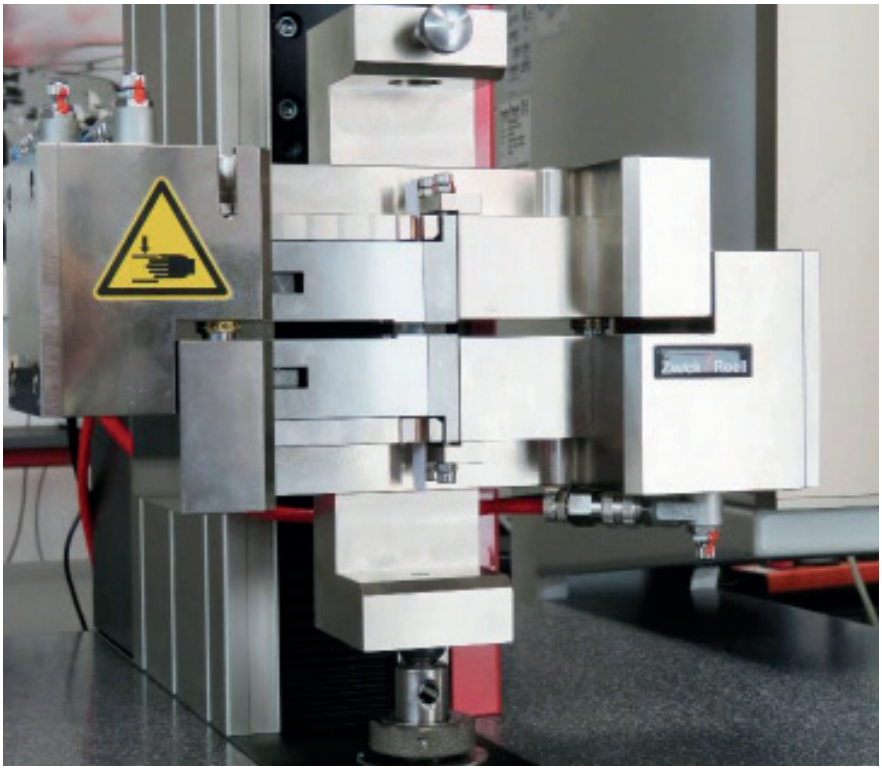

Fig.1. Compressive strength of a specimen clamped in an S-shape (S-test)

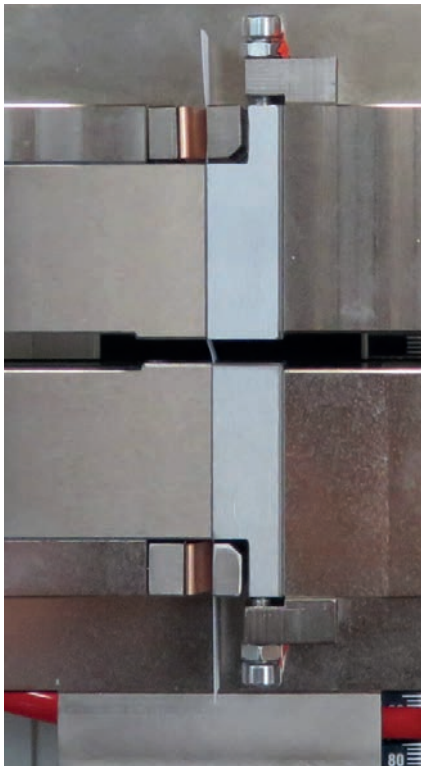

Fig. 3. Short-span compression test

2.3 Tests on tissue products

2.3.1 Ball burst test on tissue paper

In the ball burst test on tissue paper and products the bursting strength is determined to EN ISO 12625-9.

This test simulates the mechanical penetration of a sheet of tissue paper by a solid object.

2.3.2 Dry tensile test on tissue paper

Tensile tests on tissue papers and products provide information on a range of properties: stiffness, modulus, tensile strength, tear length and energy absorption.

Dry tensile tests on tissue paper and products are performed in accordance with EN ISO 12625-4

Paper can be tested as well as tissue products.

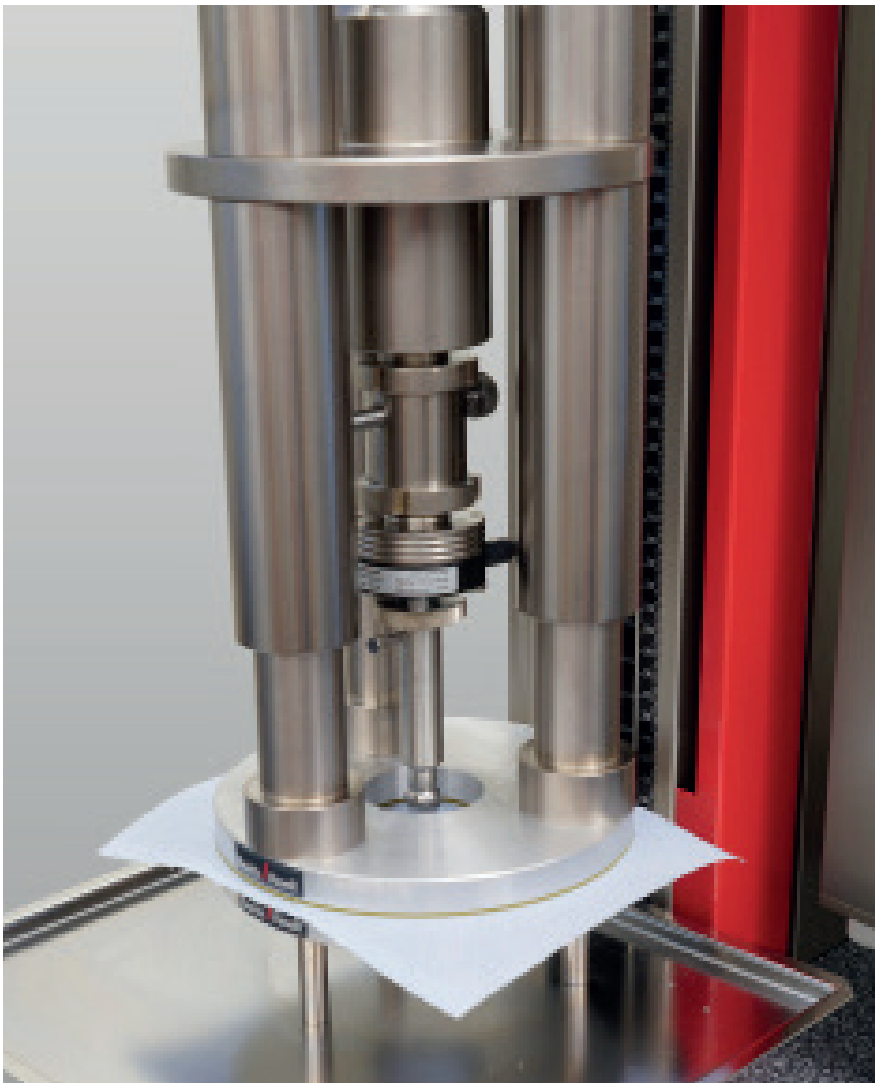

Fig.1. Ball burst test - bursting strength

2.3.3 Wet tensile test on tissue paper and products

In the wet tensile test the strength of the tissue (or paper) in a wet state is determined. Wet tensile tests on tissue papers and products are performed in accordance with EN ISO 12625-5. If tissue paper is used or processed in a wet condition, wet strength is one of the key material properties.

The advantages of ZwickRoell testing technology include an easy-to-operate Finch clamp plus rapid changing between wet tensile and other tests.

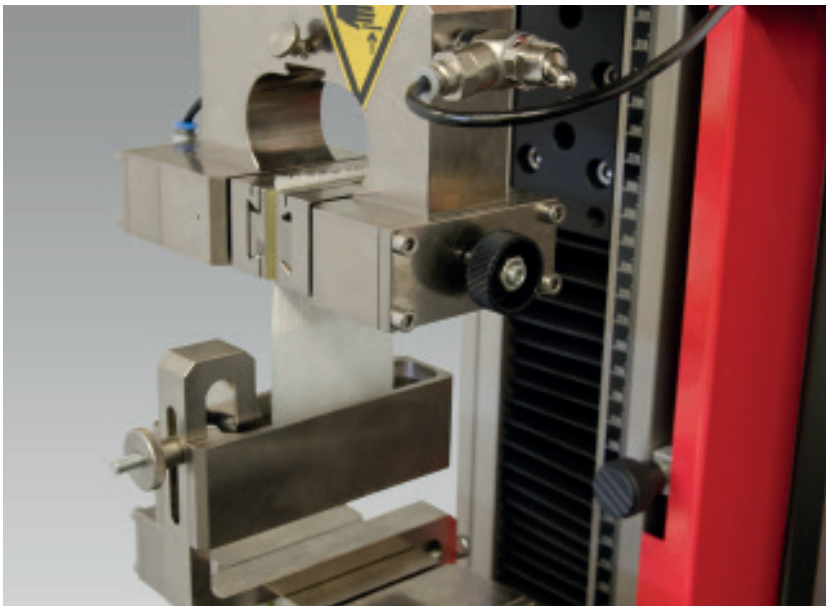

Fig. 2. Wet tensile test on tissue paper using the simple Finch device

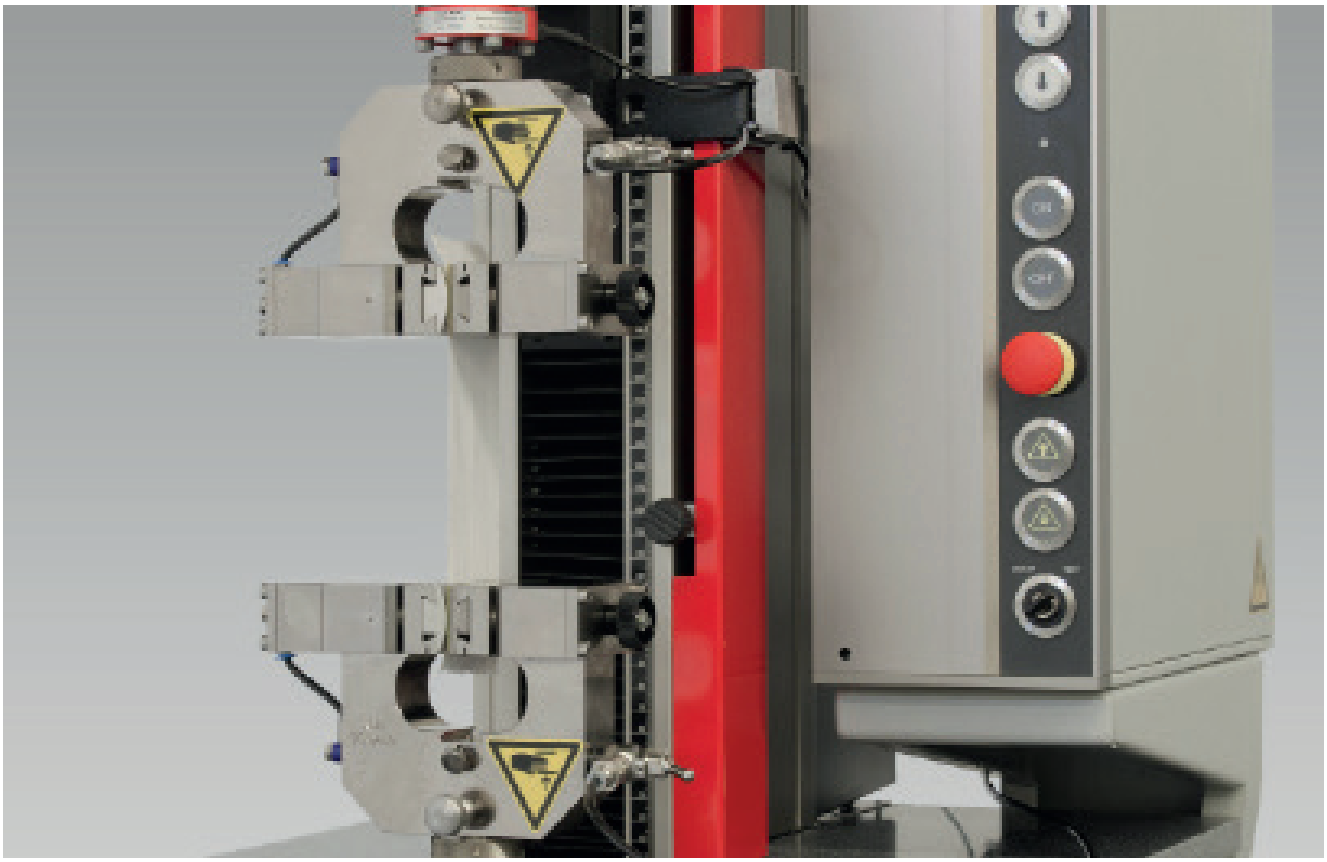

Fig.1. Dry tensile test on tissue papers and products

3 Products and Services

3.1 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 numerous 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 five 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 systems feature simple, flexible integration of load cells, specimen grips and extensometers. The static testing machine is the classic testing solution for reliable validation of characteristic values of materials and components.

zwickiLine
Included in our testing machines rated up to 5 kN is the single-column zwickiLine, which offers a powerful, flexible testing solution for a wide range of materials and components. This materials testing machine is equally ideal for research and development and for routine quality assurance testing. A wide range of equipment options enables zwickiLine to be used for tests on plastics, rubber, metals, composites, paper, board, textiles, foams and components.

ProLine
Our ProLine materials testing machines were primarily developed for performing standardized tests

zwickiLine testing machines

ProLine testing machine

on materials and components in a force range of up to 100 kN. When combined with our intuitive testXpert III testing software, cLine materials testing machines offer fast, easy operation.

AllroundLine
The new AllroundLine can be used for applications from all fields and is equally ideal for quality control testing as for demanding research projects. These materials testing machines are available from a force range of 5 kN. Depending on requirements and force-range, there is a choice between profile-framed and column-type machines.

High-capacity testing machines
High-capacity machines were developed for materials and component tests for which high test loads are required. Test fixtures for lower test forces expand the range of use and are easily attached.
Our standard product range covers several load frame versions in a force range from 330 kN to 2,500 kN Force application can be electromechanical or hydraulic. For higher force ranges, customized solutions featuring hydraulic high-capacity testing machines are available. Our high-capacity testing machines offer high levels of stiffness, robustness, flexibility and reliability.

oundLine testing machine

AllroundLine testing machine

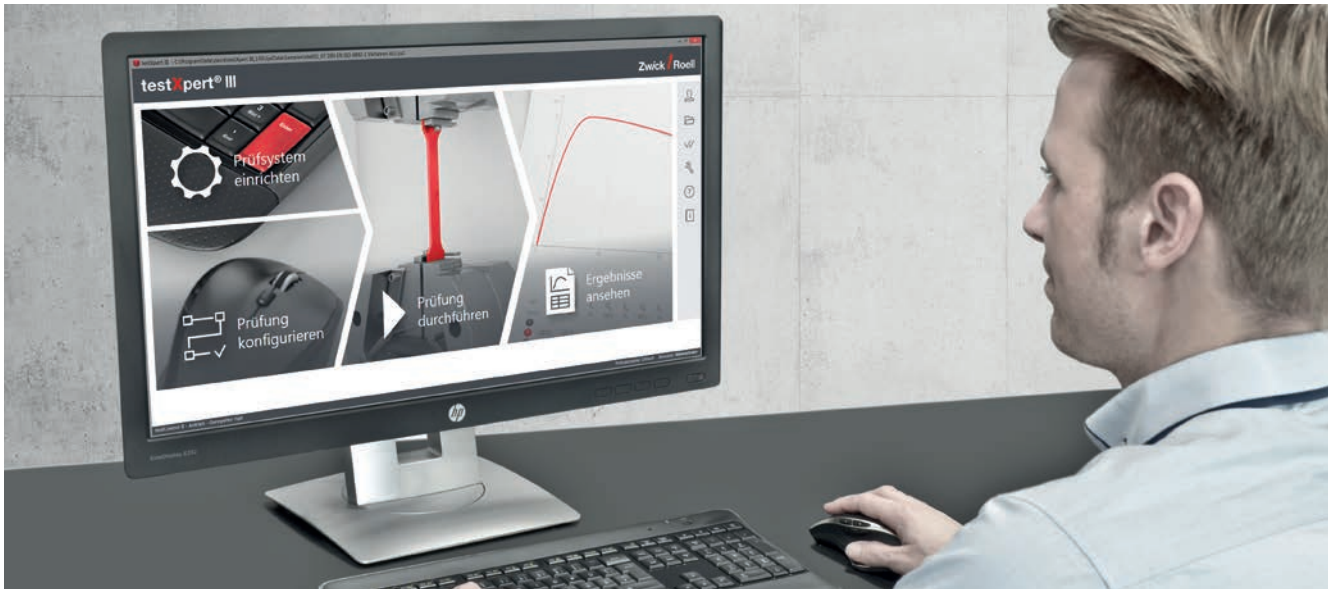

Fig. 1. Workflow based on working processes: administrator's view, with full functionality - www.testXpert.de

3.2 testXpert® III testing software

Intuitive and workflow-based from the very start!
testXpert III is the result of close collaboration with users in materials testing and the experience gained from over 30,000 successful testXpert installations. With its intuitive, structured operation, testXpert III is easy to use right from the start. Informative icons and clear visual linking of related items assist the user, while reducing mouse movement and clicks.

A workflow based on your lab processes

- 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 allows you to define user roles or import user roles direct from Windows accounts via LDAP. The user can focus on the task at hand right from the start and avoid input errors. testXpert III is workflow-based throughout, keeping training time to a minimum and enabling efficient, reliable testing.

System Configuration Builder—a unique software concept
System Configuration Builder allows you to preset and save all relevant

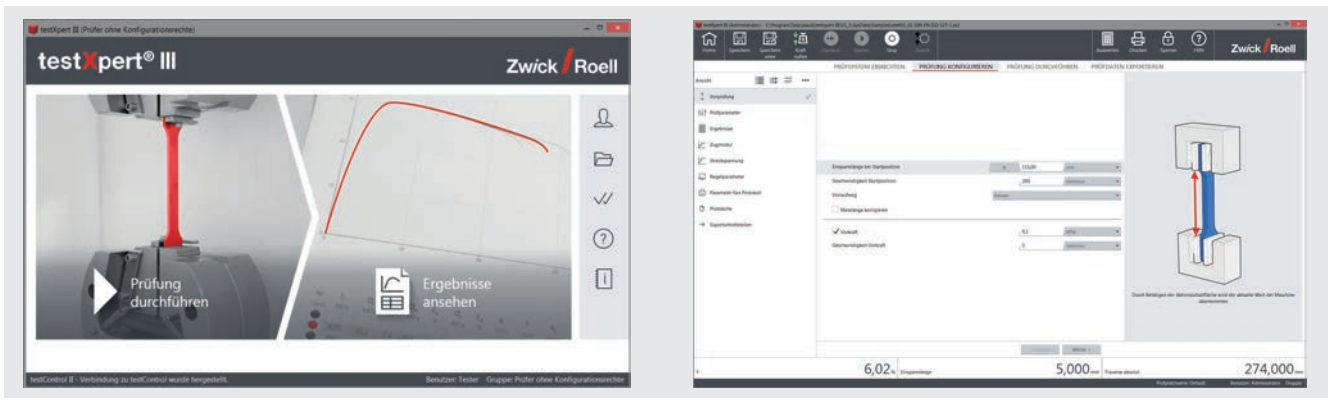

Fig.2. View optimized for the tester (left); intelligent wizard for test configuration (right)

testing system and safety settings such as crosshead position, fixture separation or sensor configuration in a freely definable system configuration. The saved system configuration checks the connected sensors. The test can only be started when the parameters match the preset requirements. This ensures exactly reproducible test conditions.

Tamper-proof test results
testXpert III logs all testing system and system settings, ensuring traceable results. The traceability offered by testXpert III means you always have answers to the question: "When does who do what, 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-related data is imported quickly and directly from ERP systems, databases or
external devices. Data can easily be exported to all your usual evaluation/analysis platforms.

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

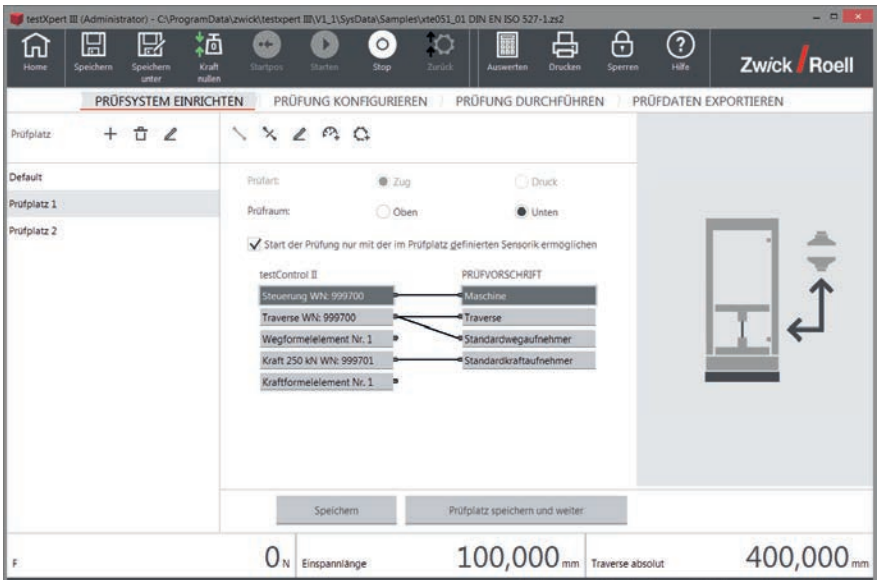

Fig.1. Saved test arrangements can be recreated following a change of test arrangement, allowing tests to be performed using identical settings.

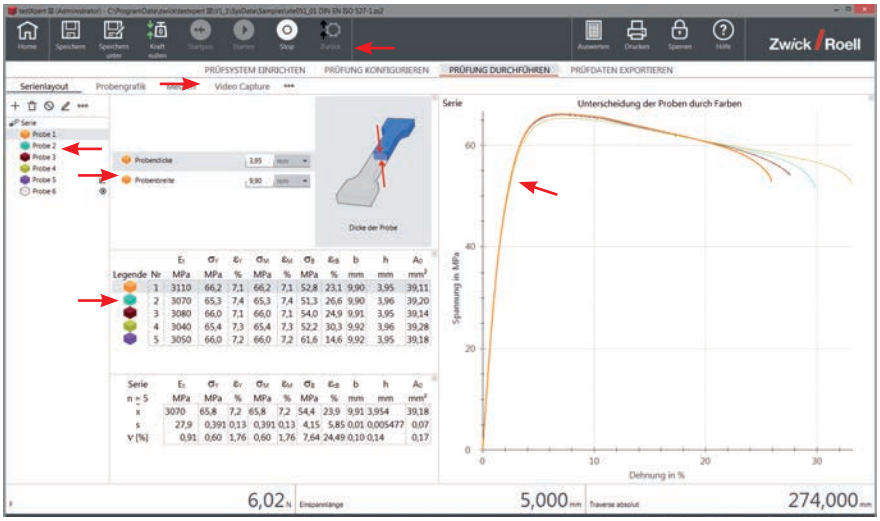

Fig. 2. Structured workflow with clear visual association of related content

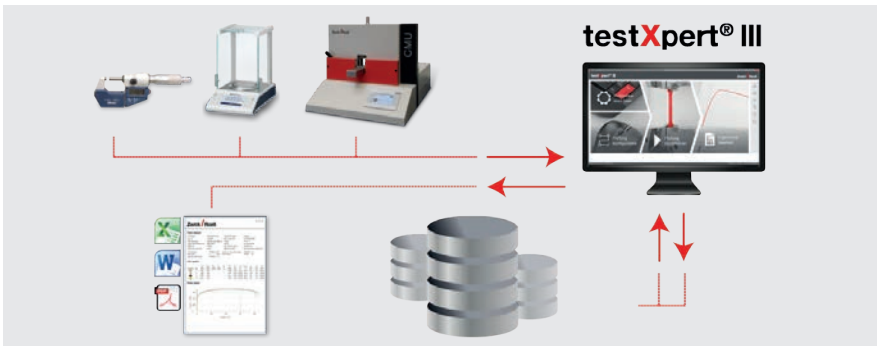

Fig. 3. Simple, reliable interfaces for sharing test results

3.3 Specimen grips

With a wide range of specimen grips featuring varied designs, test-load ranges and test temperatures, ZwickRoell provides cutting-edge solutions for testing paper, board and tissue products.

ZwickRoell has grips to suit all specimen materials and specimen shapes. The range covers the full spectrum of established operating principles for non-positive-clamping grips and positive-clamping grips.

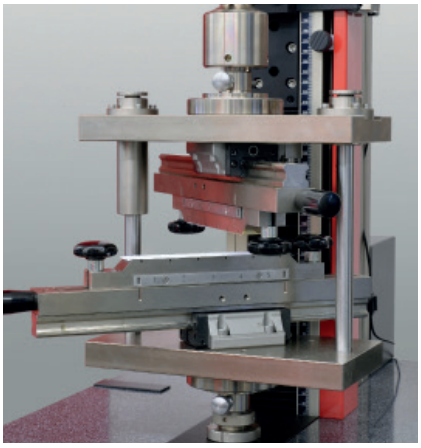

Fig.1. Grips, Z-direction tensile test

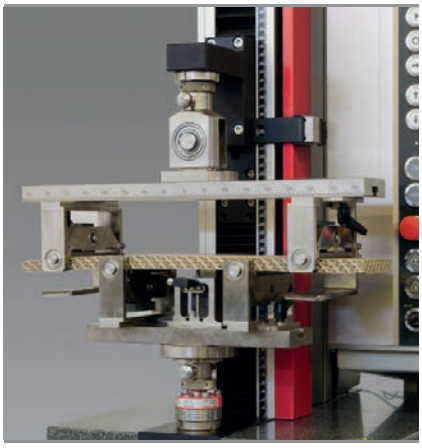

Fig. 4. Specimen grips, 4-point flexure test

3.3 Extensometers

ZwickRoell has the widest range of different extensometers for tests on paper, board and tissue paper and products.

videoXtens
videoXtens uses image processing, allowing high-accuracy non-contact determination of transverse and longitudinal strain.

lightXtens long-travel extensometer
The mechanical long-travel extensometer is used when tensile modulus is not required.

Optical version lightXtens is ideal for specimens prone to whipping and for measurements in temperature chambers.

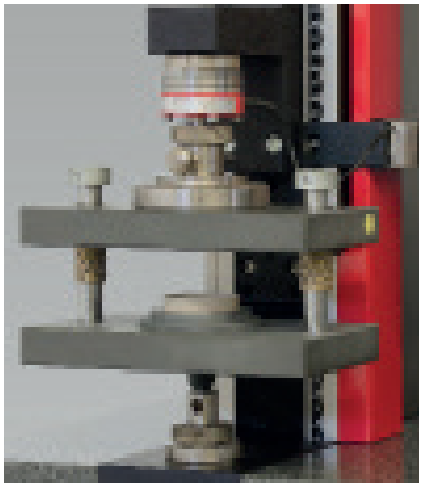

Fig. 2. Specimen grips, ring crush test

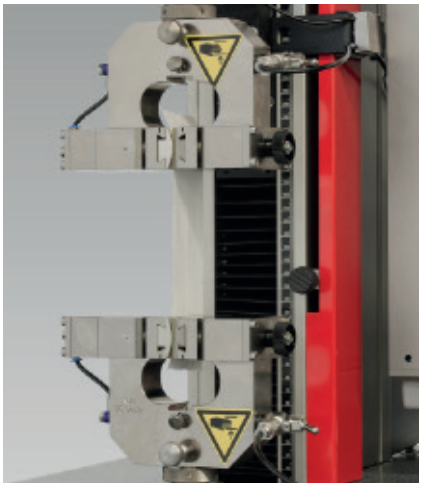

Fig.5. Pneumatic grips, tensile test

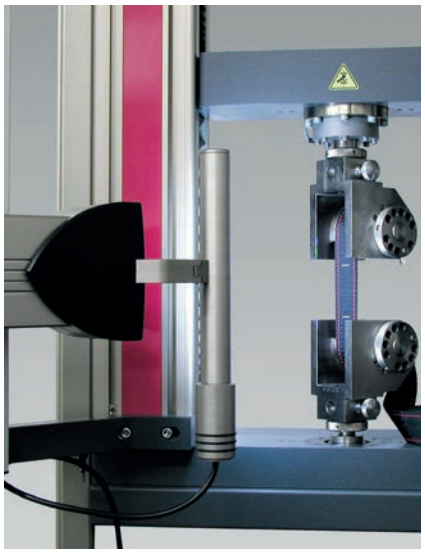

Fig. 3. Extensometers: videoXtens II (left) and lightXtens (right)

3.5 Modernization and retrofitting for testing machines

RetroLine modernization packages for all makes of materials testing machines

ZwickRoell has already transformed several thousand materials testing machines from over 40 different manufacturers into state-of-the-art equipment using proven modernization components such as measurement and control electronics, drive technology and testing software. Modernization packages are available for both electromechanical and servohydraulic testing machines, as well as for resonance testing machines and hardness testers.

Modernization takes place either on-site at the customer's premises or, if required, at ZwickRoell's site in Ulm. In the latter case, a complete overhaul, painting, and CE marking may be performed.

Benefits offered by modernizations include:

- Spare part availability for a minimum of 10 years
- Use of improved safety components
- Option to retrofit the latest sensors and test fixtures for a wide range of testing requirements
- Compatibility with current Windows operating systems

Retrofits

Every year over 3,500 customers upgrade their testing machines using proven ZwickRoell products:

- Load cells—sensitive and robust with the highest accuracy class
- Specimen grips and test fixtures Modular design enables easy and flexible retrofitting
- Extensometers—maximum measuring precision Standard-compliant measurement to ISO 9513
- Safety for operator and machine, with retrofitting of safety technology (e.g. safety doors) to existing testing systems
- testXpert III—stay up to date at all times; testing software updates and upgrades ensure you always have the latest functions
- Temperature chambers and furnaces—retrofitting of temperature chambers and high-temperature furnaces up to 1,600°C

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

Fig. 2. Xforce load cells

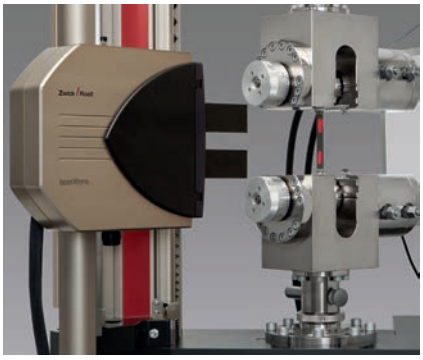

Fig. 3. Specimen grips and extensometers can be retrofitted whenever required

Fig. 4. Temperature chambers can also be retrofitted

4 ZwickRoell Services

4.1 Laboratory for materials and components testing

For companies with a testing requirement but no suitable testing option, ZwickRoell's laboratory for materials and components testing is ready to provide expert assistance.

We can also assist in the event of capacity bottlenecks or perform cross-validation tests. It makes no difference whether 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 laboratories for materials and components testing perform testing services of all kinds, on all static and dynamic materials testing machines.

Fig. 2. Static testing machines and instruments in the ZwickRoell testing laboratory

Fig. 3. The ZwickRoell Academy offers an interesting and wide-ranging training program for new students and advanced learners alike.

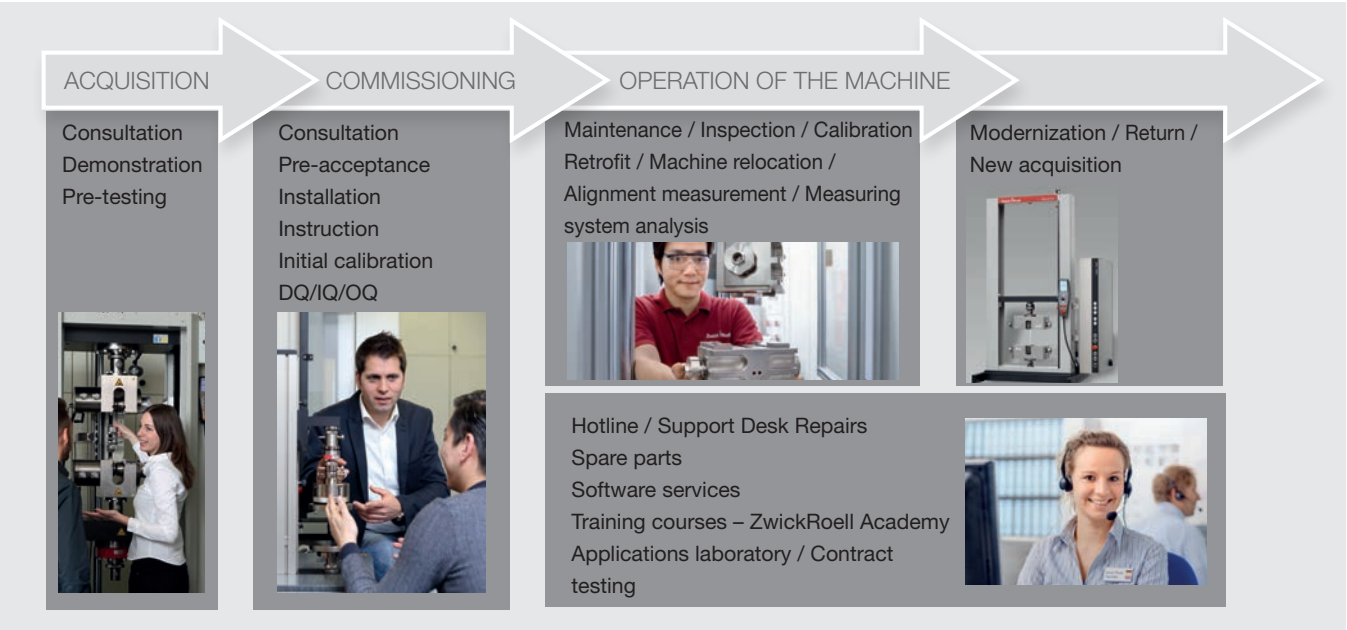

Fig. 1. ZwickRoell provides continuous support throughout the entire life-cycle of materials testing systems.

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5 Test Standards and Test Devices

Type of test	Standard
• Burst test	EN ISO 2758, Tappi T 403
• Burst test	EN ISO 2759, Tappi T 807, Tappi T 810
• Determination of grammage	EN ISO 536, ISO 5638, Tappi T 410, FEFCO No. 2
• Flexure test (2-point method)	DIN 53121, ISO 5628, ISO 2493-1
• Flexure test (3-point method)	DIN 53121, ISO 11093-6
• Flexure test (4-point method)	DIN 53121, ISO 5628
• Corrugating medium test (CMT)	EN ISO 7263-1/2, Tappi T 809
• Thickness measurement	EN ISO 7263, Tappi T 809, ISO 3034
• Puncture test (LPET)	DIN 53142-2
• Puncture test(tissue)	EN ISO 12625-9
• Determination of buckling resistance	DIN 54608
• Determination of crease resistance	DIN 55437-3
• Flat crush test (FCT)	EN ISO 3035, Tappi T 825
• Internal bond test (Z-direction)	Tappi T 541, ISO 15754
• Edge crush test (ECT)	EN ISO 3037, Tappi T 811
• Compressibility	no standard
• Pin adhesion test (PAT)	Tappi T 821
• Test creasings	DIN 55437-1
• Friction test	ISO 15359, Tappi T 549
• Ring crush test (RCT)	ISO 12192, Tappi T 822
• Box crush test (BCT)	EN ISO 12048, Tappi T 804
• Plybond resistance	DIN 54516
• Stacking test	EN ISO 12048, EN ISO 2234
• Compressive strength of a specimen clamped in an S-shape (S-test)	DIN 5014 (currently at draft stage)
• Short-span compression test (SCT)	DIN 54518, ISO 9895, Tappi T 826
• Cobb water absorption test	EN 20535, ISO 535, Tappi T 441
• Tear growth test	EN ISO 11897
• Tensile test on paper (wet initially)	DIN 54514
• Tensile test on paper (wet)	ISO 3781, Tappi T 456
• Tensile test on paper (dry)	EN ISO 1924-2/3, Tappi T 494
• Tensile test on paper (zero span)	Tappi T 231
• Tensile test on tissue (wet)	EN ISO 12625-5
• Tensile test on tissue (dry)	EN ISO 12625-4

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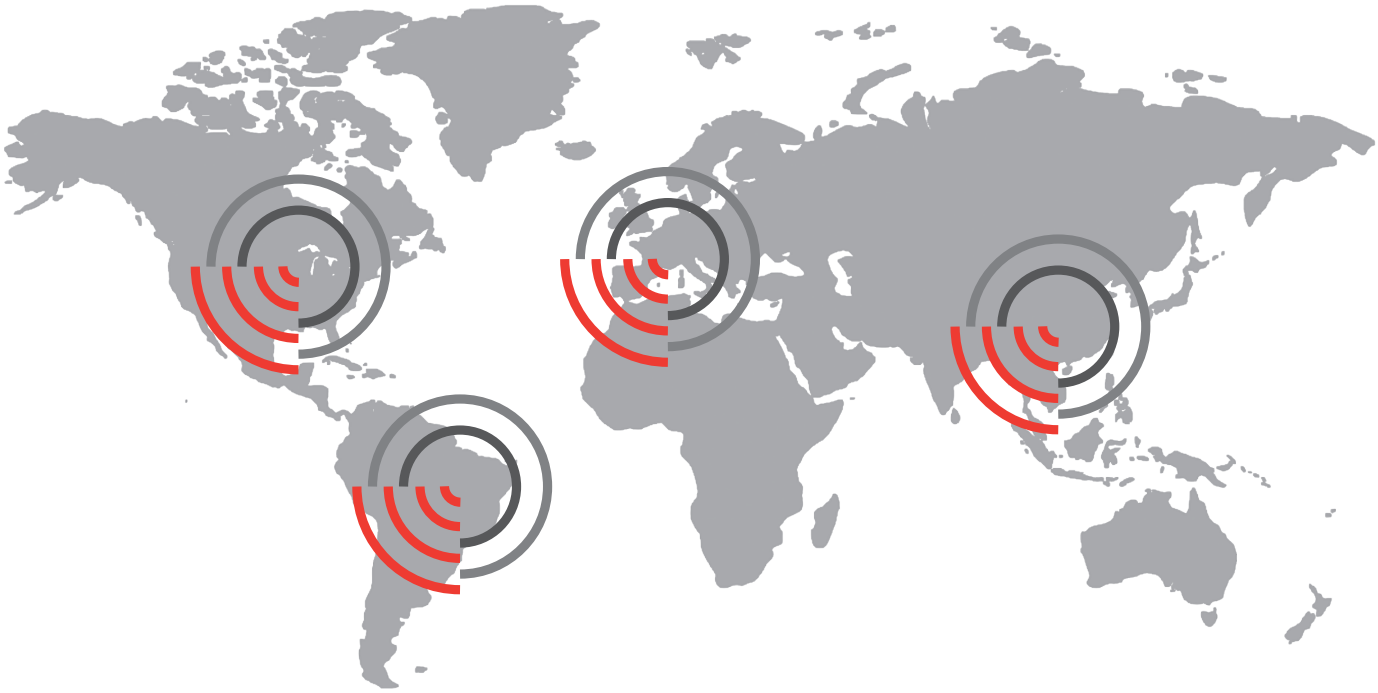

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