



TEST AND DEVELOPMENT CENTER FOR THE WIND ENERGY INDUSTRY

THE NUMBER ONE ADDRESS FOR COMPONENT AND MATERIAL TESTING FOR WIND ENERGY PLANTS

A strong wind energy industry requires a performance-capable and reliable partner who they can rely on in development processes - all the way from the initial idea to series production.





IMA Materialforschung und Anwendungstechnik GmbH, in short IMA Dresden, is the development and test centre for manufacturers and the entire supplier's industry to bring innovative products to market more quickly.

The IMA engineers hereby inspect and calculate every structural unit of a wind energy plant from the basic materials up to the overall structure. We always provide solutions which reliably support developers and designers in terms of product safety and operational safety, service life as well as quality assurance, irrespective of whether this relates to metallic materials or plastics. Our core competencies focus on the conception, implementation and evaluation of certification and development tests and inspections, as well as on the verification of component properties.

You can always rely on us: our laboratories are certified according to DIN EN 9100 and accredited according to ISO/IEC 17025. This ensures that we can always provide tailor-made solutions for a wide range of structures and test requirements.

IMA DRESDEN – AND IT WORKS:

- Full-scale testing of rotor blades
- Structure and component testing
- Material testing
- Non-destructive testing
- Electrical testing
- Materialography and damage analysis
- Simulation and strength verification
- Structural health monitoring

We also offer you further development accompanying services:

- Engineering solutions from a single source - from concept to prototype testing
- Development of test concepts
- Finite element analysis and multi-body system simulation
- Fatigue life analyses
- Software systems for test and laboratory data

IN FOCUS: FULL-SCALE ROTOR BLADE TESTING

Our test portfolio covers the entire test spectrum, from testing the raw materials for fibre-plastic composites up to the full-scale test of rotor blades.



For the overall assessment of complex blade designs and, in particular, for experimental verification within the framework of approvals for rotor blades, full-scale structural testing of wind turbine blades is explicitly demanded. A test basis is embodied by e.g. DIN EN/IEC 61400-23.

ROTOR BLADE FATIGUE TEST

A special feature of our test bench is a specially developed resonance excitation system. The hydraulic actuator is decoupled from the rotor blade by a spring assembly. The excitation principle only introduces a negligible mass into the blade. Additional masses can therefore be freely selected and positioned.

An electric motor-driven unbalance exciter system using a rotating mass is additionally available. It can be mounted at any position on the rotor blade. The rotational speed of the drive unit will be selected via a frequency converter in such a way that the rotor blade including the drive unit oscillates with the desired amplitude.

QUASI-STATIC TESTING

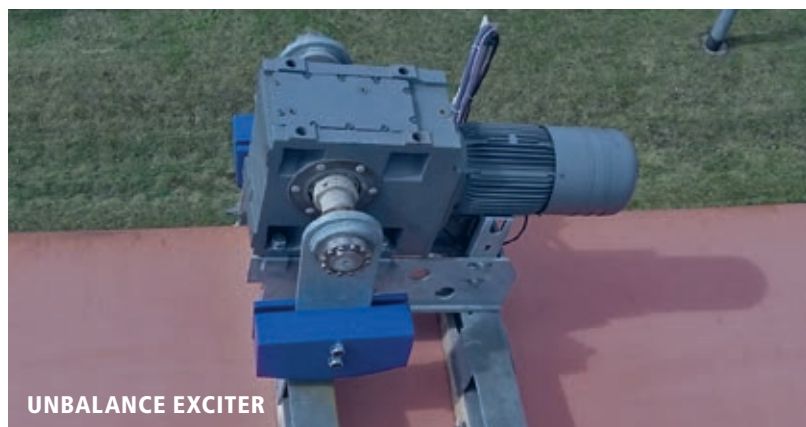
We can provide measurements of load, deflection, elongation and strain at discrete positions as an integral part of the rotor blade design verification. Besides failure static tests this includes calibration tests for the full-scale fatigue test as well.

MODAL ANALYSIS

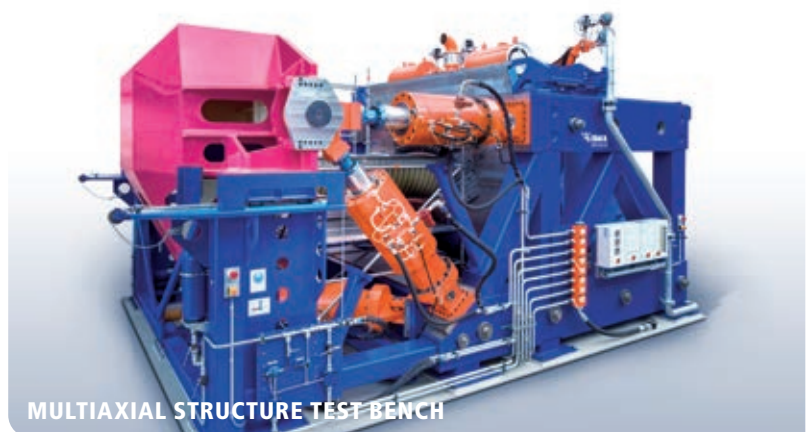
We experimentally determine dynamic properties such as resonances, stiffness characteristics and damping variables.

TEST SPECTRUM

- Max. moment - static loading: 6.6 MNm
- Max. moment - cyclic loading: 3.5 MNm
- Max. blade connection diameter: 2.3 m
- Max. blade length: 40 m



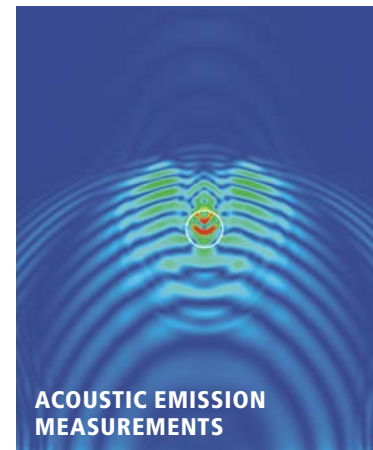
UNBALANCE EXCITER



MULTIAXIAL STRUCTURE TEST BENCH

IN FOCUS: OPERATIONAL MEASUREMENTS

Irrespective of the location, whether Helsinki or Melbourne, Düsseldorf and Dresden – no distance is too far for us. Our on-site measurements under real operating conditions enable us to obtain data for you so that you are capable to evaluate the service life or operational stability.



MOBILE MEASUREMENT

We execute measurements of mechanical, thermal and electrical values under various loading and operating conditions and install complete measurement chains including the process adaptation. We take over the development and manufacture of task-specific sensors for you: for example to measure strain, force, displacement, pressure or temperature.

ON-SITE

Our on-site measuring service can provide numerous possibilities: with high channel numbers and sampling rates, under harsh environmental conditions, autonomous measuring in the regular utilisation or under test conditions – we can provide you with as much measurement data as you require.

In addition to executing on-site measuring, we can also provide you with customised solutions: Designing measuring concepts, FE analysis, application of sensor technology, measurement data evaluation and derivation as well as implementation of appropriate test procedures. Benefit from our interdisciplinary know-how.

STRUCTURAL AND CONDITION MONITORING

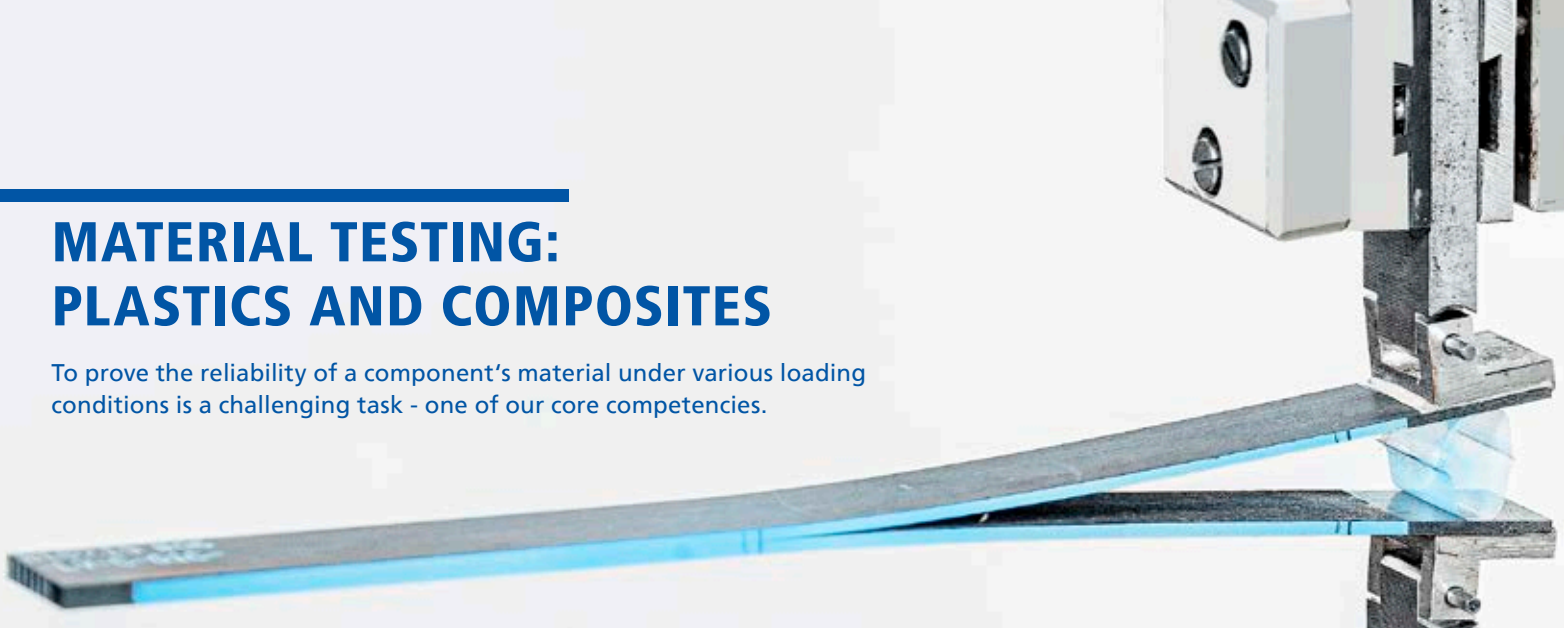
We can provide a wide range of possibilities for monitoring the systems on your wind energy plants and detect failures at an early stage. The focus is on availability and reliability. We hereby utilise energy-autonomous systems and sensors with innovative and proven sensor technology. We also ensure that the measured data can be transferred by versatile transmission technologies and then be utilised in the customer's own system.

Development and operation for customer-specific structure and condition monitoring systems regarding early detection of damage:

- Customised for every application case from the individual solution up to the serial product
- Measuring/monitoring of forces, elongations and strains, displacements, damage propagation, temperatures, positions (GPS)
- Automated data transfer (cable based, WiFi, mobile data networks, UMTS, LTE)
- Hardware and software for data acquisition
- Evaluation and customer-specific visualisation including integration into customer-specific systems (ERP, FEM) by providing corresponding interfaces

MATERIAL TESTING: PLASTICS AND COMPOSITES

To prove the reliability of a component's material under various loading conditions is a challenging task - one of our core competencies.



CYCLIC TESTING/
STRAIN MEASUREMENT



IMA-RAIL SHEAR



FRACTURE TOUGHNESS

TEST SPECTRUM

In the case of fibre-reinforced plastics, we prepare laminates as well as specimens and test materials for you.

Benefit from our comprehensive knowledge on preparing and executing material tests, including quasi-static, cyclic and dynamic testing as well as creep testing. Furthermore, we are at your service to answer any questions you may have about choosing and planning a test method and, of course, evaluating the results.

With our flexible accreditation, we cover a wide range of test standards (ISO, ASTM, customised).

- Polymer characterisation - DSC, DMA, TMA and many others
- Tension tests, compression tests, bending tests
- Shear tests - interlaminar, in-plane
- G_{1C} , G_{2C} and mixed mode testing for determination of the energy release rate
- Determination of fatigue properties under cyclic loading conditions
- Analysis of resistance against aggressive fluids (coolants, fuels etc.) and/or temperatures
- Conditioning

MANUFACTURING SPECTRUM

Our laboratory provides a wide range of various possibilities for producing high-quality test laminates and specimens. We manufacture according to national and international standards as well as customer specifications.

- Laminate manufacturing
 - Vacuum infusion
 - Resin transfer moulding (RTM)
 - 5-axis portal winding machine
 - Prepreg
 - Thermoplastics
- Test specimen manufacturing
 - CNC milling and sawing
 - Waterjet cutting
 - Composite drilling
 - Adhesive bonding
- Instrumentation and quality assurance
 - 3D coordinate measuring
 - Strain gauge application



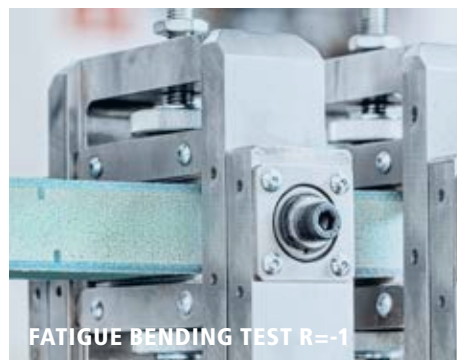
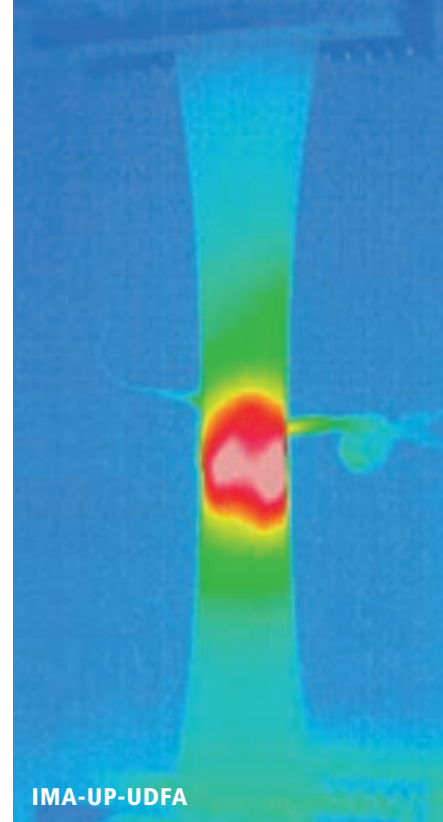
LAMINATE PRODUCTION

SPECIAL TESTING FIXTURES

We critically evaluate testing methods for their suitability and develop them continuously for future applications. The focus is thereby increasingly placed on new solutions for quality assurance and material testing.

Determining the compression properties of fibre composites is a special challenge. In the meantime, a family of patented IMA-Compression Fixtures has been developed for this purpose. With our IMA-Compression Fixture DPV 1000 extreme testing forces of up to 1,000kN are possible under the highest alignment requirements.

The IMA-Rail Shear Fixture was developed and patented especially for the determination of the in-plane shear properties of composite materials. The fixture is characterised by hydraulic specimen clamping as well as a linear guiding system.



FATIGUE TESTING – SPECIMEN DESIGN AND METHODS

The cyclic testing of fiber-reinforced composites requires a high degree of expertise, as the versatile characteristics of this material group must always be considered during the test. There is still a lack of recognised standards in this testing field.

Our engineers have therefore developed test methods for fatigue tests on unidirectional (UD) fibre-reinforced com-

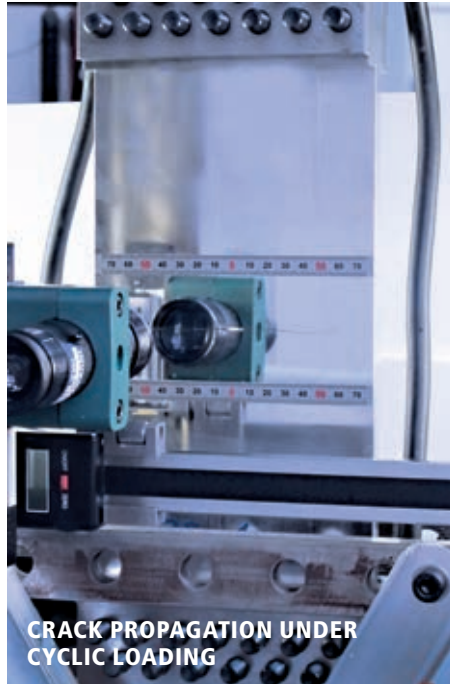
posites with a special specimen geometry which is tapered in thickness and width: IMA-UDFA and IMA-up-UDFA. UD fibre-reinforced composites with a thickness of up to 5mm can therefore be tested under all load ratios. Both test methods are accepted by DNV GL for characterising the fatigue behaviour have been accepted by DNV GL.

MATERIAL TESTING: METALLIC MATERIALS AND JOINTS

As a manufacturer or processor of materials, we will provide you with comprehensive engineering expertise regarding resistance, strength and reliability studies on standardised samples up to, and including, complex components.



CORROSION TEST



CRACK PROPAGATION UNDER
CYCLIC LOADING



TENSION TEST

TEST SPECTRUM

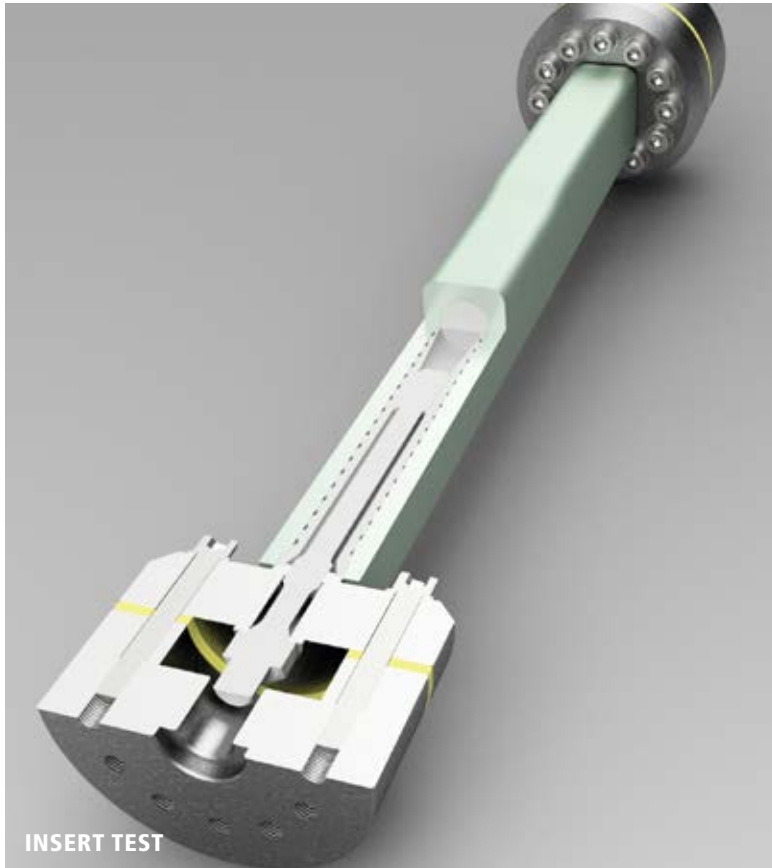
We identify material parameters comprehensively and determine the loading capacity of metallic materials, joined connections or hybrid material combinations for you.

Depending on your requirements or conditions, these tests can be executed at lower and higher temperatures as well as under media influence. We have extensive standard testing technology resources and experience in the design, construction and operation of special test benches for material and component testing.

- Determination of fracture mechanical parameters
- Investigations of crash and deformation behaviour
- Strength tests at high and low temperatures and under the media influence
- Strength tests of mechanical joints, welded and bonded connections (also under medium and/or temperature)
- Determination of the cyclical crack formation and crack propagation behaviour
- Damage analysis
- Materialography
- Tribological tests
- Determination of chemical composition
- Development and manufacturing of customised test rigs
- Function and service-life testing
- Part and component tests
- Corrosion tests
- Junker test (testing screw connections)

IN FOCUS: SUBSTRUCTURES AND COMPONENTS

Irrespective of whether for rotor blade connections, spar caps, blade segments or structural connections - tests on substructures always decisively help to reduce the development risk.



ROTOR BLADE CONNECTIONS

In all variants – we have been concentrating on testing blade connections for our worldwide customers since 2005. Our flexible DAkkS accreditation helps us to implement tailor-made tests. We possess comprehensive technology resources for standardised tests and experience in the design and operation of customer-specific test rigs.

- Electromechanical testing machines from 100N to 500kN
- Servo-hydraulic testing machines from 0.5kN to 4MN
- Individual test rigs by utilising modular systems
- Versatile measurement and conditioning technology available on all machines and test rigs
- Testing under media conditions
- Fatigue testing with various cyclic load ratios e.g. $R = 0.1$ or $R = -1$

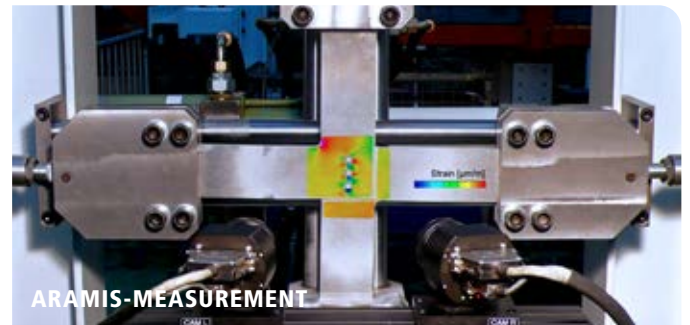
TEMPERATURE CONTROL AND CONDITIONING

The question of short-term or long-term temperature influences almost always arises in case of testing fibre-reinforced plastics. We can therefore provide a range of possibilities for defined temperature control and conditioning to achieve best test conditions for your specimens and components.

- Local cooling of temperature hot spots
- Global temperature conditioning from -55°C to $+90^{\circ}\text{C}$ by utilising conditioning units with external insulation chambers
- Short-term testing from -55°C to colder conditions by means of controlled liquid nitrogen cooling
- Temperature-depending control of test frequency

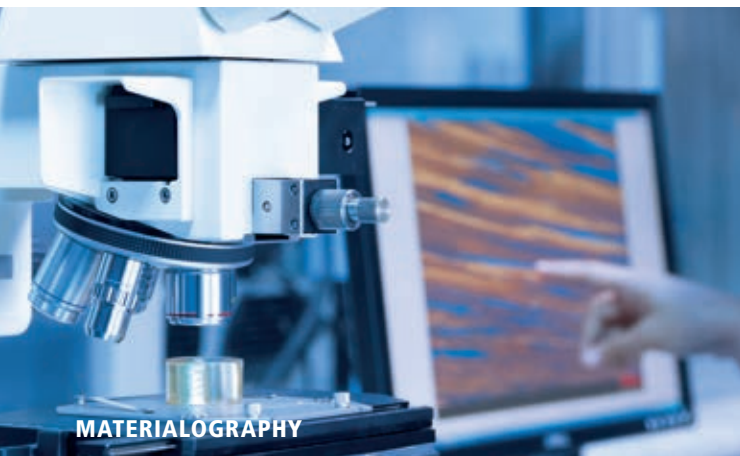
ADDITIONAL SERVICE PERFORMANCE

Irrespective of whether for quality assurance, damage-case analysis or research and development – if you require additional information about your component, we can provide numerous additional monitoring and diagnostic options for you during and after testing.



- Temperature measurement
 - Thermography (e.g. Lock-in)
 - Thermocouples
- Damage analysis
 - Microscopy (light, scanning electron, AFM)
 - Spectrometer
 - Acoustic emission
- Optical 3D deformation and strain measurement
 - PONTOS
 - ARAMIS
- Bolted joints
 - Defined and reproducible pre-tensioning of bolted joints
 - Hydraulic bolt tensioning cylinders with high pressure hydraulic pumps up to 1,500 bar – bolts can be pre-tensioned friction and torsion-free
 - Measuring and monitoring the pre-tensioning or clamping force
 - Elongation and strain measurement

THE FULL SERVICE TEST CENTER



MATERIALOGRAPHY

Countless new products are based on new materials and innovative manufacturing processes, whose success would not have been possible without materialography, i.e. the visual representation and evaluation of inner microstructures, the associated improvement of material properties, optimisation of processes and quality assurance in production. Whether the objective is quality assurance, damage analysis or research and development, in our accredited materialography laboratories we examine both metallic and non-metallic materials of different compositions using the appropriate qualitative and quantitative characterisation procedures. This includes the test preparation process and the use of all microscopic methods from light to electron microscopy for the analysis, evaluation and documentation of the results. The investigations can be supported and supplemented by further materials analysis, technological and physical procedures on request.

ELECTRICAL TESTING IN LOW-VOLTAGE RANGE

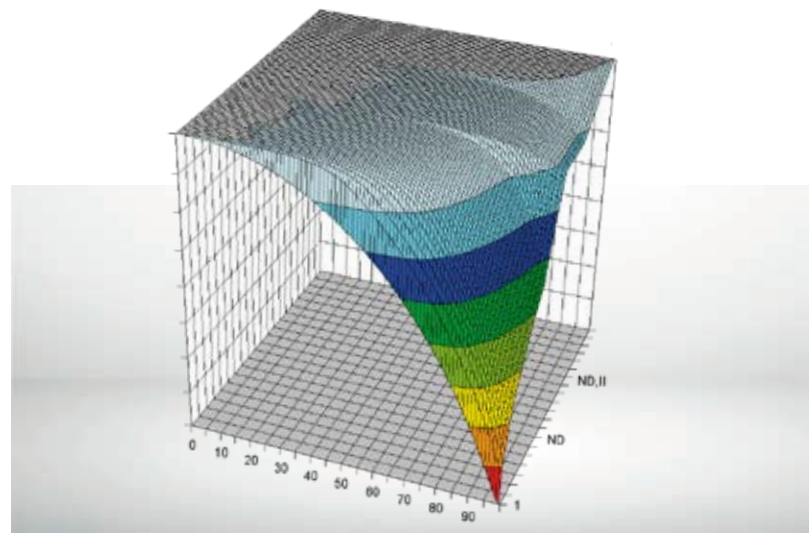
Whether you need short-circuit, short-time withstand current capacity, switching capacity or continuous current testing, with its in-house transformers IMA Dresden can offer testing services with test currents of up to 25,000 A, alternating current at 1,000 V and 20,000 A, and direct current at 1,100 V. In spacious modern testing facilities, test currents are SPS-controlled and data such as the current-voltage curves and temperatures are recorded. The modern high-performance test bay offers versatile test applications up to 25,000 A, such as switching capacity, performance, electrical endurance and short-circuit testing.

FE ANALYSIS

Experienced calculation engineers from the fields of statics, operational strength and dynamics are on hand to optimise your product by scaling its mass and shape on the basis of FE analysis. We determine stresses and deformations, examine the stability behaviour, obtain static, operational and permanent strength verifications, evaluate natural modes and resonances, and analyse and assess damage.

DAMAGE ANALYSIS

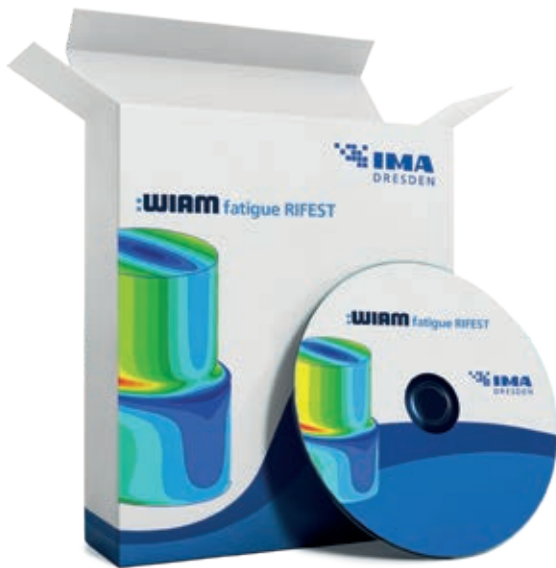
Is it because of an unfavourable distribution of forces? Lacking characteristics of the material or technology? Improper heat treatment, overstressing, friction or wear? Our experienced engineers can assist you to explore undesirable damage phenomena down to the last detail – for example by means of materialography and acoustic damage detection.



NON-DESTRUCTIVE TESTING

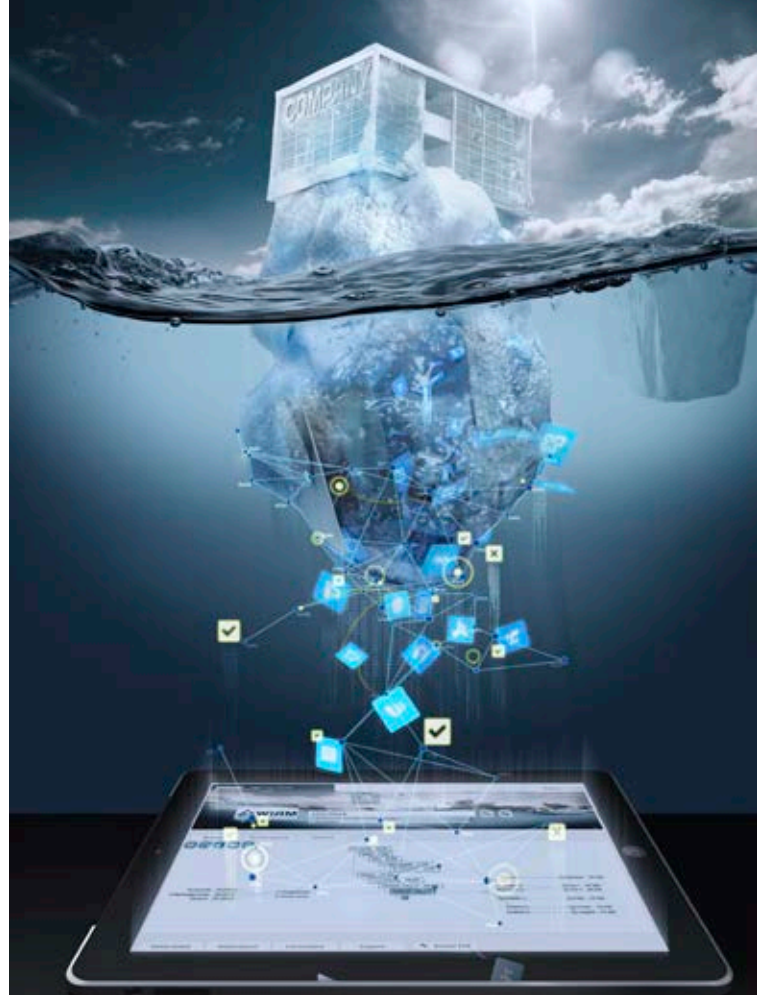
The interdisciplinary area of non-destructive testing at IMA Dresden examines structures and components in the test phase and in real use in cases of damage. Moreover, it examines when and where damage occurs, how it develops and how a structure reacts to cyclic loads after an impact. Delaminations, material deviations, tears or foreign material that has entered are made visible, allowing conclusions to be drawn about materials, technology, processes, operation and optimisation. Our qualified inspectors offer extensive experience in planning, coordinating and implementing large-scale testing and inspection activities, from coupon testing to across-the-board permanent monitoring of technical equipment.

In our own laboratories, but also at your premises, we can make statements regarding the quality of your test item. Our test personnel are qualified according to the ISO 9712 and EN 4179 standards and offer many procedures that allow non-destructive testing. We work according to German and international standards and guidelines (DIN, ASTM, ISO, etc.), or in accordance with factory settings.



WIAM® FATIGUE RIFEST

WIAM® fatigue RIFEST is software for the design process and component stress analysis, and displays the guideline-compliant strength test results at verification points for non-welded and welded components according to FKM Guideline, 2012 edition. The guideline applies to machine components and was first developed in 1994 under the management of IMA Materialforschung und Anwendungstechnik GmbH.



FIND INFORMATION, MANAGE DATA, NETWORKING KNOWLEDGE: WIAM® ICE

The structuring, processing and management of information helps to ensure expert technological know-how in the long term, streamline processes and thus increase quality and efficiency. The standard WIAM® ICE product promotes the flow of knowledge, simplifies areas of complexity and ensures added value and innovative strength. Having originated in the field of Material Sciences, the generic WIAM data model can now manage all kinds of knowledge and information. With WIAM® ICE, you can record, research, link, visualise, compare and evaluate diverse data easily and clearly.

BENEFIT FROM THE COMPETENCE OF IMA DRESDEN

As an independent test provider we guarantee reliable results and strict confidentiality. Our credo of thinking and acting like our customers was not carelessly formulated. It contains an earnest pursuit of engineering perfection, which merges intelligent solutions with sustainable usable result at fair prices. This, of course, also includes the flexibility to respond to all kinds of request and, in doing so, to provide peak performances which are not possible elsewhere. Each of our employees bears a portion of this responsibility.

Please do not hesitate to contact us for any questions or inquiries at sales@ima-dresden.de



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