



Science meets industry

# Shaping Innovation

For more than 25 years, the IAB – Institut für Angewandte Bauforschung Weimar GmbH (Weimar Institute of Applied Construction Research – a non-profit organisation) – has been demonstrating its high-profile expertise and strong ability to innovate. With more than 100 employees, we support our customers and partners by conducting research and development and providing services that cater to practical requirements in the industry. To retain your competitive edge in the long term, we can join forces with you to develop new products, technologies and processes. Get first-hand information about our range of services and our interdisciplinary approach – and benefit from our scientific expertise and hands-on experience. We look forward to engaging in a professional dialogue with you.



Weimar Institute of Applied  
Construction Research

# Ready for the Future

Our research addresses current challenges and brings tangible benefits. The IAB testing and laboratory buildings are complex test facilities in their own right. All our activities focus on verifying our own R&D results under realistic conditions.

Our findings form the basis for the transfer of insights to similar projects and are reflected in further research activities with respect to energy efficiency, cost effectiveness and sustainability.



# Construction Research for Practice

The performance and competitiveness of businesses essentially relies on their research and development activities. Technology leadership becomes the key success driver as globalisation progresses. “Made by IAB” is all about identifying trends and pushing developments forward. We are your partner for application-oriented construction research, and our aim is to align our creative approach with the requirements of the underlying economic framework. Our work is centred around the needs of our clients. Together we design efficient, sustainable solutions both at the detail and systems level.

IAB Weimar draws on its scientific expertise in several divisions, which include Building Materials and Process Engineering, Construction Systems and Components, Civil Engineering and Pipeline Construction as well as Energy and Building Services. The profile of our Institute includes not only an exceedingly wide array of forward-thinking research and development activities, but also a comprehensive range of services.

We build upon the close collaboration between science and industry to strengthen our position as an important partner in the regional and national research community as well as on the inter-

national market. Small- and medium-sized enterprises particularly benefit from our strong ability to innovate. It is thus one of our most important tasks to provide them with access to practical solutions and to jointly transfer those into market-ready products.

Targeted education and training activities result in knowledge and skills that enable us to master future challenges. We thus offer a continuing training platform that builds upon thorough scientific expertise whilst responding to specific market needs and demand patterns, such as our annual IAB Science Days. This is where industry and science meet to share experience and expertise and to interlink their activities more effectively. We also organise seminars and workshops on relevant topics and areas.

Being able to think out of the box makes us your dynamic partner. Diversity is firmly rooted in our understanding as a state-of-the-art research institution. The wide range of R&D activities provides ample proof of how we implement this mission in our day-to-day work. We are open to any new research request that we receive. Many years of experience have taught us that a collaborative approach is the best way to shape innovation.

# IAB

Institut für Angewandte Bauforschung Weimar gGmbH  
Weimar Institute of Applied Construction Research

Building  
Materials  
and Process  
Engineering

Construction  
Systems and  
Components

Civil Engineering  
and Pipeline  
Construction

Energy  
and Building  
Services

Services

**IAB – Institut für Angewandte  
Bauforschung Weimar gGmbH**

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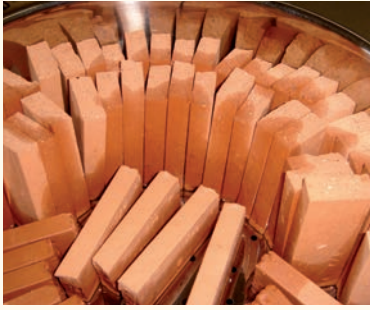
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Measurement of the porosity values of ceramic products



Solidification of subsoil with a low load-bearing capacity using polymer-bound stone columns



The rotary kiln installed at the IAB enables production and testing of a wide variety of granular materials

The building materials of tomorrow will perform better whilst consuming less energy.



Foam concrete blocks ensure heat insulation, sound absorption and a healthy indoor climate

## Materials, Processes and Machines

The Building Materials and Process Engineering research field investigates and develops the scientific and technical bases for the extraction of raw materials and the production and processing of building materials. Its tasks and responsibilities essentially result from the close interaction between materials, processes and equipment. The only way to implement effective new solutions or improve existing processes is thus to adopt a holistic view and to engage in close collaboration between the fields of materials science, process engineering and mechanical engineering.

In a multitude of projects, an exceedingly wide range of **concrete and other mixes** are being developed and improved with respect to their material characteristics and workability parameters. Materials include conventional ready-mixed and cast-in-place concrete, self-compacting and ultra-high-performance concrete (SCC and UHPC), fibre-reinforced concrete as well as textile, lightweight, aerated and foam concretes, mineral foams, compounds for dry mortar products, soil mortar and plastic-bound polymer concrete.

As the oldest man-made building material, brick must respond to steadily increasing requirements regarding its physical properties. We are working on innovations related to raw materials and the production process so as to keep brick competitive both in terms of its physical properties and its commercial viability.

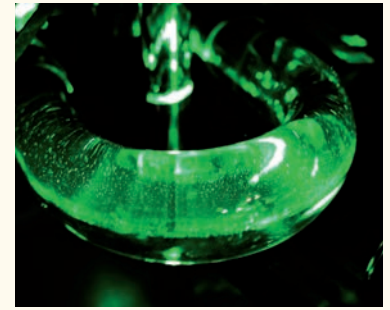
This research is also inextricably linked to reducing energy consumption and lowering CO<sub>2</sub> emissions in production and processing. We conceive sustainability strategies, investigate potentials and develop approaches to the efficient use of resources and waste materials.

Furthermore, increasing efforts are being made to conserve primary resources and to promote building with **regenerative raw materials**. Related research activities pertain not only to wood, but also to the use of hemp, miscanthus and various types of grain.

 [www.iab-weimar.de/materials](http://www.iab-weimar.de/materials)



Structural examination under the scanning electron microscope to evaluate the morphology of the microstructure



Flow measurement in a pipe geometry that reduces the growth of algae



Combination of pneumatic measurement and control systems on a filter test rig

## It's the Process that Matters Most

Most road pavements are still built with **asphalt**, even though the significance of concrete in road construction has continuously increased in the past few decades. Requirements for road infrastructure become more and more demanding due to constantly increasing payloads in truck traffic.

This situation opens up a huge potential for an additional field of research. Conventional asphalt grades are continuously being improved and optimised to reflect the ever-changing specifications and conditions for their use.

For all material systems mentioned above, the IAB applies state-of-the-art methods of **material analysis** and standardised construction material tests. Machine measurements are conducted simultaneously to analyse and evaluate sequences of existing process steps.

Methods and processes studied at the IAB can generally be grouped into a selection of basic operations in the fields of mechanical and thermal process engineering:

- Extraction and storage
- Conveying and batching
- Crushing and grinding
- Mixing and classifying
- Firing and calcining
- Agglomerating and moulding
- Reprocessing and recycling

The above list is non-exhaustive because the IAB's resources enable research into almost all material-related processes. Furthermore, these processes determine the related **equipment**, which comprises a large number of devices, systems and control components.

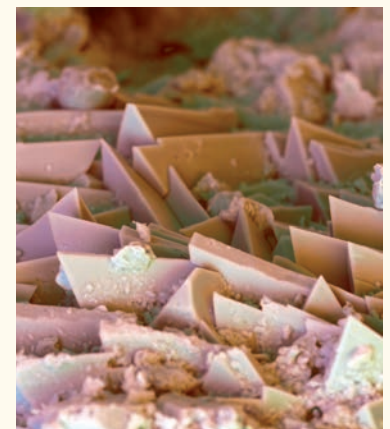
Our work primarily deals with **processing machinery** for granular and pasty materials. Crushing, mixing and compaction units must increasingly cope with highly complex material systems. The range of materials under study includes fluids, suspensions, foams and granular materials as well as complex, multi-phase systems that combine the characteristics of several individual phases.

 [www.iab-weimar.de/bmpe](http://www.iab-weimar.de/bmpe)

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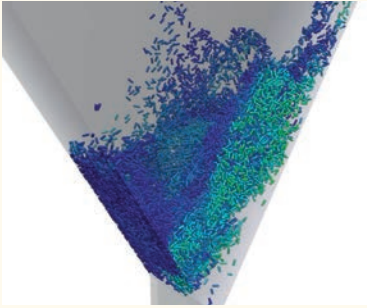
The quality of the outcome often results from the design of the entire process.

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Scanning electron microscopy of a clay mineral





Simulation of a fluidised bed



Filter cartridge in the bubble test



Test rig for enabling automated quality control of the position and dimensional accuracy of the reinforcement in railway sleepers

## Control Accuracy Exactly to Specifications

A consistently high quality standard and workmanship essentially relies on utmost precision.



One of the main areas of activity of the IAB is the development of sophisticated **quality control systems**. This work concentrates on measurement and analytical systems used for quantifying material behaviour. Data gathered by these systems is subsequently passed on to instrumentation and control components and thus contributes to improving quality in production.

**Optical measuring methods** used in process monitoring are of particular interest to IAB researchers. This is where image processing systems come into play because they are easy to use in quality control. They visualise important characteristics of the material, such as its texture and colour stability. This approach is complemented by methods based on fibre optics that enable high-resolution temperature and strain measurements along the entire length of a light conductor.

Devices or systems required for this purpose are developed from the ground up if existing equipment does not meet the agreed specifications. Prior to this development activity, the method best


suited to the relevant basic operation is selected and dimensioned in process engineering terms. In the next step, the required machines are developed, designed and **engineered**, and various prototypes are tested.

A range of numerical methods is applied in parallel with conventional development and design work in order to **optimise** existing systems and equipment under development. Numerical models of the overall system are derived from the analysed material characteristics and machine geometry. These models reflect both the material system to be processed and the dynamics of the machine.

Following reliable model validation, **numerical simulations** are applied to calculate various scenarios that create the basis on which to improve relevant components even further whilst also significantly enhancing process understanding.

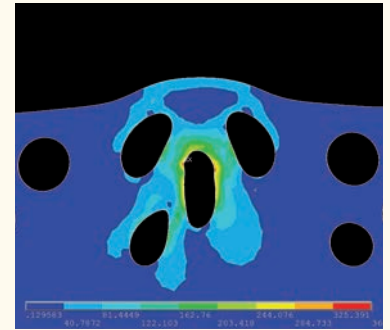


Computing cluster at the data centre used for simulations

 [www.iab-weimar.de/process](http://www.iab-weimar.de/process)



3-point flexural bending test of a lightweight concrete element



Simulation of a GFRP sleeve anchor



GFRP sleeve anchor

## Sustainability in Precast Construction

The building of tomorrow is essentially determined by **material and energy efficiency**. Application-oriented research needs to provide sustainable solutions, **modular building systems and high-performance structural components**. The effort is geared towards automating design, production, delivery and assembly processes.

The scientific and engineering studies conducted in our Construction Systems and Components field of research focus on the development of prefabricated systems and components as well as construction methods, with the aim to implement **environmentally friendly and recyclable solutions**. Research and development activities are centred on structural and process solutions for precast elements, concrete products and construction methods. Structural components and buildings are developed and optimised with high energy efficiency in mind.

Making buildings more **sustainable** requires flexible and reversible building systems to respond to ever-changing living needs and shorter use cycles in production and commercial activities. This is

why we aim to consistently separate the load-bearing structure from its envelope, which also applies to interior finishing versus building services. In so doing, we develop energy-efficient solutions for the construction industry.

Cost-effective systems that provide maximum functional and structural flexibility, a high degree of prefabrication and simple connectors ensure sustainable residential and commercial construction. This research is focused on **developing and optimising structural components** by applying innovative moulding processes, substituting conventional reinforcement and using new materials or composites. Structural simulations and pilot tests enable tapping into previously unused load reserves. The requirements for **connection and assembly techniques** become more demanding in line with the increase in the building's conversion and extension potential. Activities focus on developing connectors that enable efficient production and detachment at the end of the component's service life.

 [www.iab-weimar.de/prefab](http://www.iab-weimar.de/prefab)

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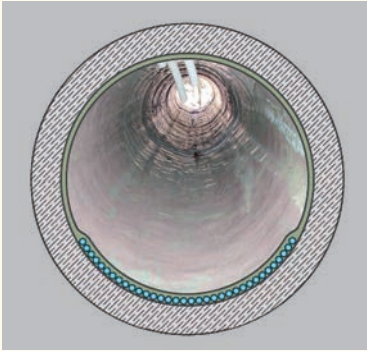
The shift of processes from the construction site to the prefabrication stage contributes to improving product quality, reducing costs and enhancing safety at work.

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Tightness test of vacuum-insulated panels (VIPs)





Heatliner – generating energy from wastewater heat



Infill of sophisticated manholes: WBM-Weimarer Bodenmörtel® (Weimar soil mortar)



The fully automatic pipe-laying machine enables secure fixing and laying of pipes without people in the trench, thus eliminating the need for complex manual work steps

## Utility Networks are Lifelines

Fully functional utility networks are one of the backbones of urban infrastructure.



Civil engineering and pipeline construction are crucial for a functioning urban infrastructure. This includes water supply and disposal, gas supply and district heating, but also the installation of new power grids and communications networks. Besides installing new infrastructure, existing networks must be upgraded and adapted to demographic, technical and economic needs.

IAB researchers are developing new and improved solutions in the fields of civil engineering and pipeline construction to increase the effectiveness of network expansion and gap closure and to extend the remaining life of pipelines by rehabilitating them.

About 20 percent of sewer systems are in need of short- to medium-term **rehabilitation**. The situation is similar for other utilities and transport infrastructure. The IAB is thus working on various related topics and primarily develops solutions for pipeline rehabilitation, including textured liners or ready-to-use manhole liners for sewer networks as well as liners for gas and water supply lines.

Furthermore, natural fibres and mineral materials are used to make rehabilitation more sustainable. In another area of activity, the IAB is conducting research on self-compacting backfill materials. Earth-moving operations incur significant costs; their quality standard essentially determines the service life of the pipelines. Research previously conducted on the **WBM-Weimarer Bodenmörtel®** (Weimar soil mortar) continues to result in significant savings in the construction phase and also enables a high quality standard in pipe-laying and the long-term stability of the paved surface.

**Quality control in civil engineering** is crucial to ensure long service lives of networks. Joining techniques and new compaction methods are being investigated. Self-regulating and self-learning fittings and control systems are needed for the expansion of existing pipelines and the installation of new networks in order to achieve the required performance and degree of flexibility.



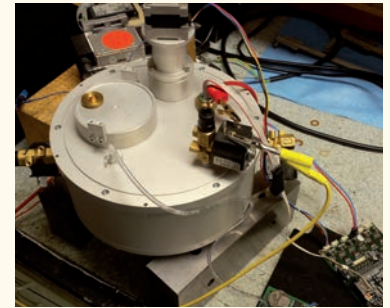
Pressure tests of a reinforced-concrete pipe

 [www.iab-weimar.de/infrastructure](http://www.iab-weimar.de/infrastructure)

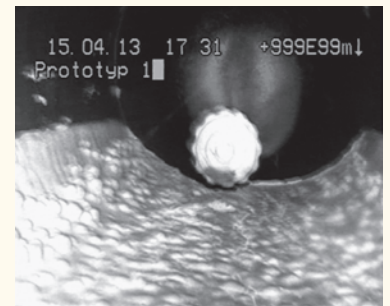




For several years, the recovery of wastewater heat has been one of the main research and development tasks at the IAB



Monitoring of small wastewater treatment systems



Flushing head to remove sinter in tunnel structures

## Innovations for our Infrastructure

Future research activities will be dedicated to replacing, **rehabilitating** and complementing infrastructural networks. These activities aim to

- increase network efficiency and flexibility
- increase economic efficiency to achieve resource savings

Projects are thus being implemented in the field of liner technology that involve the use of domestic regenerative raw materials and subsequent upgrades, such as cathodic corrosion protection using a plastic liner.

Further research activities are facing a huge challenge due to the continuous reduction in water consumption in Germany and the associated increase in the concentration of pollutants in the wastewater. In future, greater emphasis should be put on assessing and limiting the amount of certain materials or substances contained in wastewater. Research activities thus focus on automated systems to continuously measure BOD<sub>5</sub> values in wastewater that has been purified in small treatment systems and subsequent remote

transfer of the gathered data to plant operators, maintenance providers or the relevant authorities. Furthermore, test methods are being developed to monitor the disintegration capability of nonwoven materials in wastewater.

Another key area of interest relates to the **recovery of heat from wastewater**, which particularly applies to pipelines inaccessible to people. This research concentrates on systems that derive the heat potential directly from the wastewater or the soil/sewer system. Buried systems and solutions for utilising wastewater heat in buildings are currently being developed.

Our long-term experience in wastewater heat recovery using heat pumps has also driven research and development with respect to **control systems** that use the physical characteristics of the heat carrier fluid to influence the heat output of individual collectors or probes.

 [www.iab-weimar.de/pipelines](http://www.iab-weimar.de/pipelines)

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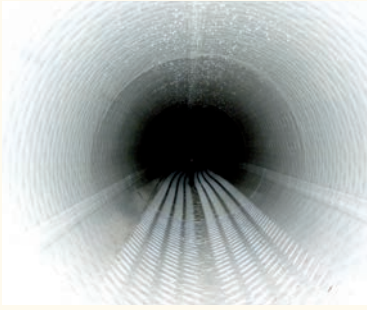
Utilising heat from wastewater can make a major contribution towards increasing the energy efficiency of buildings.

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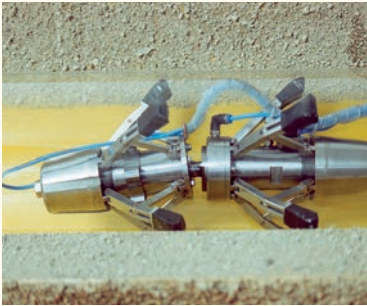


Self-regulating flow control valve assembly





Pipeline rehabilitation with a self-cleaning effect: TROLINING SelfCleaning system



Analysis of pipelines that are difficult to access: pipe crawler equipped with sensors



An example from nature: the sandfish provided the blueprint for developing surfaces with minimised friction

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Nature teaches us many ways to come up with solutions to a large number of challenges in construction research.  
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Utilisation of the Fin Ray Effect® for a pipe-laying gripper attachment

## Bionics-Based Research

The field of bionics systematically investigates structures, processes and evolutionary principles of biological systems and develops engineered solutions to enable their transfer to commercial use. Related research aims to replicate principles tried and tested in nature rather than just trying to copy a shape or form.

Starting from research into the wing veins of insects, we develop **structural concepts** for the inside walling of pipes to prevent sedimentation and to specifically influence the transport of solids and liquids within pipelines. For this purpose, solutions are being conceived to create artificial eddy currents in zones close to the pipe wall with the aim of removing solids or preventing re-sedimentation.

Another area of IAB research relates to the analysis and performance assessment of structures created by nature to optimise and put into practice technical systems such as **flow monitors** or **transport and inspection equipment** in an exceedingly efficient, cost-effective manner.

Research activities also cover the following topics:

- Utilisation of innovation potentials provided by nature to optimise pipelines and pipeline systems
- Reduction in losses due to diversion and friction in pipe components
- Optimisation of the functioning of closure elements
- Development of sensors to register the condition of pipe materials
- Optimisation of load-bearing and surface structures
- Increase in the pollutant disintegration potential
- Self-cleaning of surfaces
- Use of regenerative energy sources
- Regulation of the indoor climate in buildings

Particular emphasis is placed on **energy minimisation**, which is one of the most fundamental evolutionary strategies. Implementation of this principle opens up a huge research and development potential for ground-breaking sustainable solutions.

🏠 [www.iab-weimar.de/bionics](http://www.iab-weimar.de/bionics)





Long-term test in a rig installed at the IAB premises: cold/heat storage system for utilising regenerative energy sources



Solar-thermal collectors generate heat and fulfil a wide variety of tasks



Generating energy via the façade using a hot-air collector

## Using Regenerative Energy Efficiently

Besides increasing the share of renewables, efficient energy and building control systems are key to implementing the energy revolution.

The energy policy concept published by the German federal government stipulates that primary energy consumption should be reduced by 50 percent of the 2008 value by 2050. Effective 1 January 2016, the permissible primary energy consumption of new buildings must be 25 percent lower. At the same time, the primary energy factor for electricity was lowered from 2.4 to 1.8. In this context, innovative building control systems enable energy-efficient, environmentally friendly heating and cooling of buildings.

Our research and development activities focus on the following topics:

- Systems to improve the efficiency and environmental safety of **geothermal energy** using geothermal probes and heat pumps
- Systems and processes to utilise the wastewater heat potential in sewers to supply energy-efficient buildings

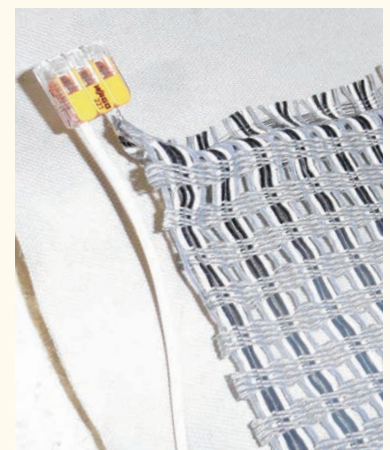
- Methods for the large-scale integration of solar collectors into the building envelope
- **Cold/heat storage systems** for renewable energy sources to supply energy-efficient buildings, including systems integration
- **Dynamic simulation of buildings and systems** integrating physical performance, use patterns, climate data and building control systems
- **Integrated concepts** for building services with simulation-based operation including user behaviour and weather forecasts
- **Innovative district cooling/heating systems** as a prerequisite for the use of efficient combined heat and power systems, geothermal energy, low-cost solar heat and waste heat from industrial processes
- **Multi-functional supply components** for generating and storing energy, providing sunshading, glare protection and privacy, sound and heat insulation, daylight use and ventilation

 [www.iab-weimar.de/energy](http://www.iab-weimar.de/energy)

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Building services and envelope can truly become the No. 1 energy saver.

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Heating fabric design for internally insulated wall structures to prevent condensation in the interfacial layer



Certified to  
DIN EN ISO  
9001:2015



Testing Body  
No.  
VMPA-B-2157



The IAB performs compression tests for a wide range of building materials

## Testing Services for the Construction Sector

Our vast array of test methods complies with demanding requirements as specified by the DAkks and VMPA.

For experimental tests, we operate a **test laboratory accredited** by the Deutsche Akkreditierungsstelle GmbH (DAkks) in accordance with DIN EN ISO/IEC 17025:2005 (Accreditation No. D-PL-19544-01).

Tests are conducted in the following areas:

- Technical/physical, mechanical and thermal tests of mortar, concrete and masonry blocks as well as ceramic materials
- Structural physics performance tests
- Acoustic tests
- Vibration tests

The **concrete testing facility** (No. VMPA-B-2157) operated by the Institute has been accredited by the Verband der Materialprüfungsanstalten e. V. (German Association of Materials Testing Facilities) and meets the requirements specified for a “permanent concrete testing facility” and for an integrated testing institution for in-process quality control. We perform the following tests:

- Tests of fresh concrete, including self-compacting concrete
- Tests of hardened concrete
- On-site tests of structures

The **IAB pipe laboratory** can provide assessments of the condition of pipe specimens for the purpose of maintaining and rehabilitating utility networks consisting of pipelines made from metallic materials.

Stage 1: Determination of basic parameters including a forecast with respect to the future behaviour of the pipe material

Stage 2: Investigation of potential causes of corrosion resulting from ground conditions, groundwater, laying methods and the effectiveness of applied corrosion protection

Stage 3: Determination of types of corrosion and of the size of affected areas (inside and outside) as well as of the resulting residual wall thickness and remaining service life of the pipeline.

Test results make it possible to identify the optimal point in time for pipeline rehabilitation. The quality of supply is thus significantly enhanced, and operating and maintenance costs are reduced.

[www.iab-weimar.de/services](http://www.iab-weimar.de/services)

[dienstleistung@iab-weimar.de](mailto:dienstleistung@iab-weimar.de)





Production of melting tablets for X-ray fluorescence analyses: A melting salt is used to melt the powdered sample at temperatures between 800 and 900°C to produce a transparent glass disc



Sample changer of the X-ray multi-diffractometer



Test set-up to determine the pozzolanic properties of meta-clays

## Down to the Tiniest Detail

The development of new materials essentially relies on knowledge of the chemical and mineralogical composition of starting materials and finished products. This information permits conclusions regarding triggered reactions and resulting material formation processes. The IAB uses the following methods for **material analyses**:

- X-ray fluorescence analysis (XRF)
- Thermogravimetry (TG)
- Differential scanning calorimetry (DSC)
- FT-IR spectroscopy
- Laser-induced plasma spectroscopy
- X-ray diffractometry (XRD)

Structural analyses are performed by means of:

- Microscopy (digital and scanning electron microscopy)
- Mercury porosimetry
- Particle size analysis using laser granulometry or the sedigraph instrument


Material development aims to create defined chemical and physical characteristics to ensure the required functionality and **durability** of the finished product.


Analyses and **tests** adopt a holistic view of building material systems, including classification of raw materials, consideration of the material formation process and the **functionality** of the finished product in use.

### Selected services

Measurement of

- Strength values (compressive, tensile, flexural tensile and adhesive strength)
- Acoustic characteristics (sound absorption and damping)
- Thermal insulation parameters (thermal conductivity, temperature-induced strain, water vapour diffusion and sorption)
- Chemical characteristics (chemical stability, reactivity and durability)
- Matrix characteristics (apparent, real and bulk density; pore content and distribution of pore radii; particle shape and particle size distribution)

 [www.iab-weimar.de/analytics](http://www.iab-weimar.de/analytics) and  
[www.iab-weimar.de/testing](http://www.iab-weimar.de/testing)

 [labor@iab-weimar.de](mailto:labor@iab-weimar.de)

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**Materials are multi-faceted. Their analysis and testing is at the very heart of sophisticated research programmes.**

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Analysis of the mineralogical composition of powdered samples using an X-ray diffractometer





Vibration measurements for machine diagnostics

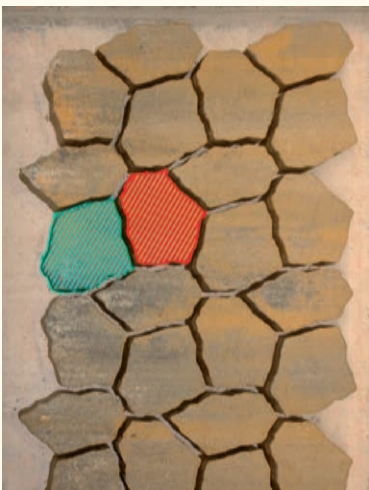


Programming of analysis software



Quality control in the manufacture of concrete products using a block height measuring system to which a module can be added to determine the bulk density

Quality control standards are constantly evolving in line with the continuous improvement of production processes.



Contour recognition enabled by image processing to replace defective concrete products

## Controlling Processes – Improving Quality



The Process Analysis and Control department provides services to the mechanical engineering, construction, transportation, environmental and occupational health sectors. It aims to **collect, process and use** information gathered from production and environmental processes, particularly for quality control purposes. We propose client-centred solutions to resolve industry-specific problems. Our range of services includes current condition assessments as well as commissioning, maintenance and customer support. Processing of customer requests usually involves the following steps:

- Analysis and design of process workflows
- Definition of in-service conditions
- Design of equipment configurations
- Preliminary tests if and when required
- Production support
- On-site assembly and cabling
- Commissioning, documentation, induction

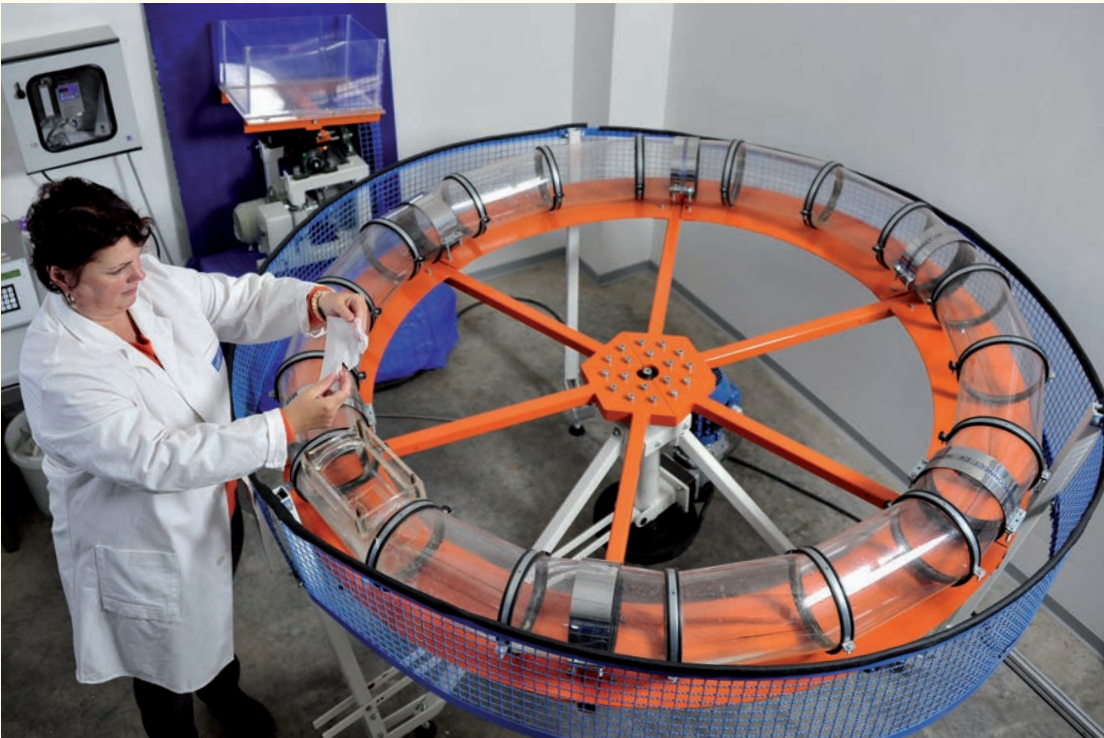
The IAB pilot facility comprises a large number of **test rigs** that make it possible to replicate development process steps under realistic conditions without disrupting actual production processes.

### Selected services

- Vibration and strain measurements of machines, buildings and foundations
- Assessment of dynamic processes for machines and structures
- Image processing to determine dimensions and to recognise patterns, contours and textures
- Optical process analyses using particle image velocimetry (PIV)
- Visualisation of highly dynamic processes using a high-speed camera
- Localisation of sound sources using an acoustic camera
- Measurement of noise levels at the workplace and in its surroundings
- Measurement of noise levels generated by plant and machinery
- Development of automated quality control systems
- Programming of analysis software, micro-controllers and control systems

 [www.iab-weimar.de/automation](http://www.iab-weimar.de/automation)  
 [automation@iab-weimar.de](mailto:automation@iab-weimar.de)





Development of innovative test rigs for specific investigations: endless sewer to study the disintegration kinetics of nonwoven materials



Inspection of inaccessible district heating lines using the "Crawler Eye" device



Corroded pipe specimen

## Tests Inside and Outside the Pipe



Our scientists provide a wide range of services related to civil engineering and pipeline construction. For instance, our **pipe laboratory** makes it possible to determine the remaining service life of pipes made from metallic materials and reinforced concrete. Important parameters include the type, area and depth of corrosion that has formed over time under in-service conditions. The residual wall thickness is measured and fed into an algorithm to calculate the remaining service life of the pipe.

Another example is our unique **inspection technology**, which primarily includes inspection devices designed for district heating lines that cannot be accessed. These devices move on the surface of the insulation of the pipes to survey the condition inside the duct as well as the pipe insulation and bedding.

Additional test rigs are used for **hydraulic** and **burst tests**. An **endless sewer** was installed to replicate the hydraulic and biochemical conditions in an actual sewer in order to assess the disintegration kinetics of wet wipes.

### Selected services

- Assessment of the material condition in pipelines
- Testing of the disintegration kinetics of materials and substances contained in wastewater
- Testing of pipe sinter formation in a test rig
- Hydraulic tests of pressure pipelines and gravity sewers
- Pressure loss measurements
- Tests of textured pipes and channels
- Burst pressure tests
- Fatigue tests
- Inspection of district heating lines inaccessible to people
- Inspection of pipelines and cavities
- Pipeline localisation
- Investigation of heat potentials using a mobile measuring and heat pump container
- WBM-Weimarer Bodenmörtel® (Weimar soil mortar): mix design as well as internal and third-party quality control
- Measurement of material characteristics

 [www.iab-weimar.de/pipelab](http://www.iab-weimar.de/pipelab)  
 [rohranalyse@iab-weimar.de](mailto:rohranalyse@iab-weimar.de)

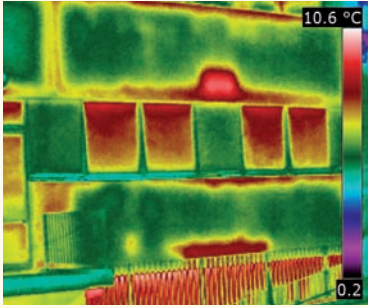
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 In contrast to humans, the ‘life expectancy’ of a pipe can be predicted very accurately.

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Test rig to measure pressure loss





Thermography localises weak spots that adversely affect the energy efficiency of buildings



Pressure monitoring of ground/air heat exchangers



Geothermal installation with seven probes at the IAB laboratory building to supply heat and to collect data for a long-term study

**The building envelope and the building services both make a major contribution to improving the building's energy efficiency.**



Floor slab activation for heating and cooling an office building


## Reducing Consumption, Storing Surpluses

To ensure energy and resource efficiency in the utilisation of renewable sources, the related supply, conversion, storage and transport systems must have an exceedingly compact design whilst consuming a minimum amount of raw materials. The life cycles of construction products used for this purpose should be extended significantly. It is imperative to minimise consumption of primary resources across the entire system whilst gradually increasing the ratio of recycled materials. Furthermore, energy and resource efficiency enable significant reductions in production costs.

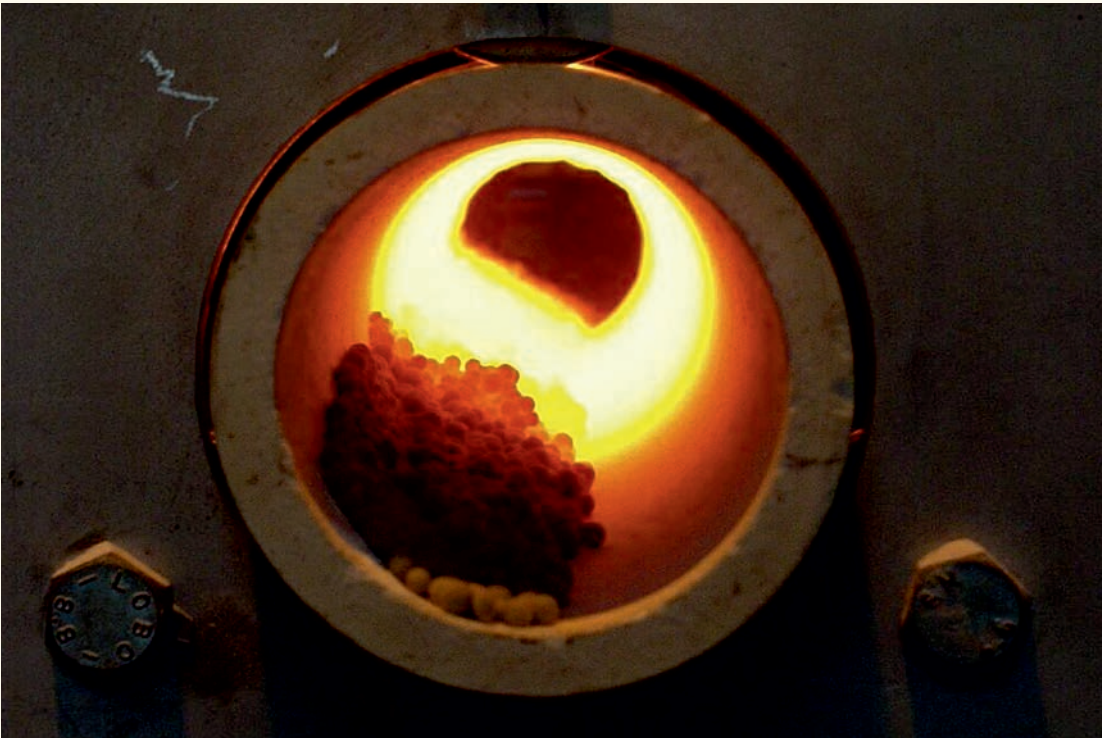
### Selected services

- **Scientific evaluation** of construction projects, including the detailed design stage
- Development of concepts for drafting **municipal heat supply schemes** to integrate renewable energy sources, including geothermal and combined heat and power in urban neighbourhoods or local heating networks
- Field tests and evaluation of new technologies and supply structures involving all renewable energy sources

- Development of methods to determine the most favourable renewable energy mix in both environmental and economic terms, including **utilisation of waste heat** from various processes
- Optimisation of design processes with respect to living comfort and energy efficiency, as well as forecasts of energy consumption during the use phase
- Forecast of annual energy generation and consumption, including annual energy profiles
- **Cost reduction scenarios** by continuous standardisation of equipment and systems and their integration into the building with the aim of developing a minimalist, simple and highly efficient design of building services
- Development of concepts for the integration of all renewable energy systems
- Drafting of **climate change mitigation concepts** for municipalities and local communities

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Expanded lightweight aggregates produced from recycled material



The separation of composite materials poses a huge challenge



Recycled aggregates in concrete

## Far-Sighted Recycling Expertise



Owing to the large amount of raw materials consumed in the construction industry and the limited availability of non-renewable resources, used products and materials should be fed back into the material cycle. This requires development of concepts and technologies for closed material cycles that focus on the recovery and reuse of raw materials.

Improving resource efficiency both at the product and process level requires substitution of specific raw materials and use of resource-saving recycled materials as well as industrial residues and by-products. To achieve this goal, it is necessary to accurately determine material flows as well as the physical and chemical characteristics of materials to identify potentials for reuse in common products or to develop new products and processes. The ultimate aim is to arrive at a consistent recycling scheme based on a functioning system of managing waste and recyclable materials. Related activities reduce the consumption of mineral resources whilst removing some of the burden from landfill sites and our environment in general.

The opportunities generated by the life cycle approach of extraction, use and reuse require a broad service profile. Of particular interest are processes that enable upcycling and thus keep used raw materials and secondary resources in the economic cycle.

### Selected services

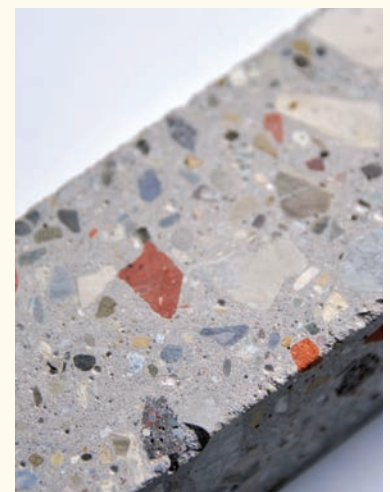
- Drafting of **recovery and reuse concepts**
- Sustainable product design and return of components into the utilisation process
- Development of **recycling methods**
- Simulation of recycling processes to optimise related plant and machinery
- Analysis of **recycled materials and industrial residues and by-products**
- Studies for the substitution of mineral raw materials
- Development of products based on recycled materials as well as industrial residues and by-products

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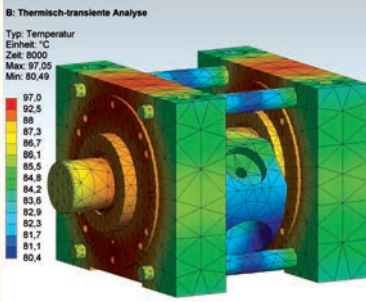
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Within the life cycle, each finished product becomes an input product again.

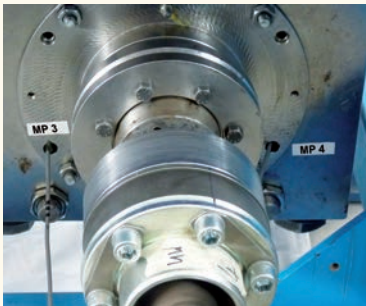
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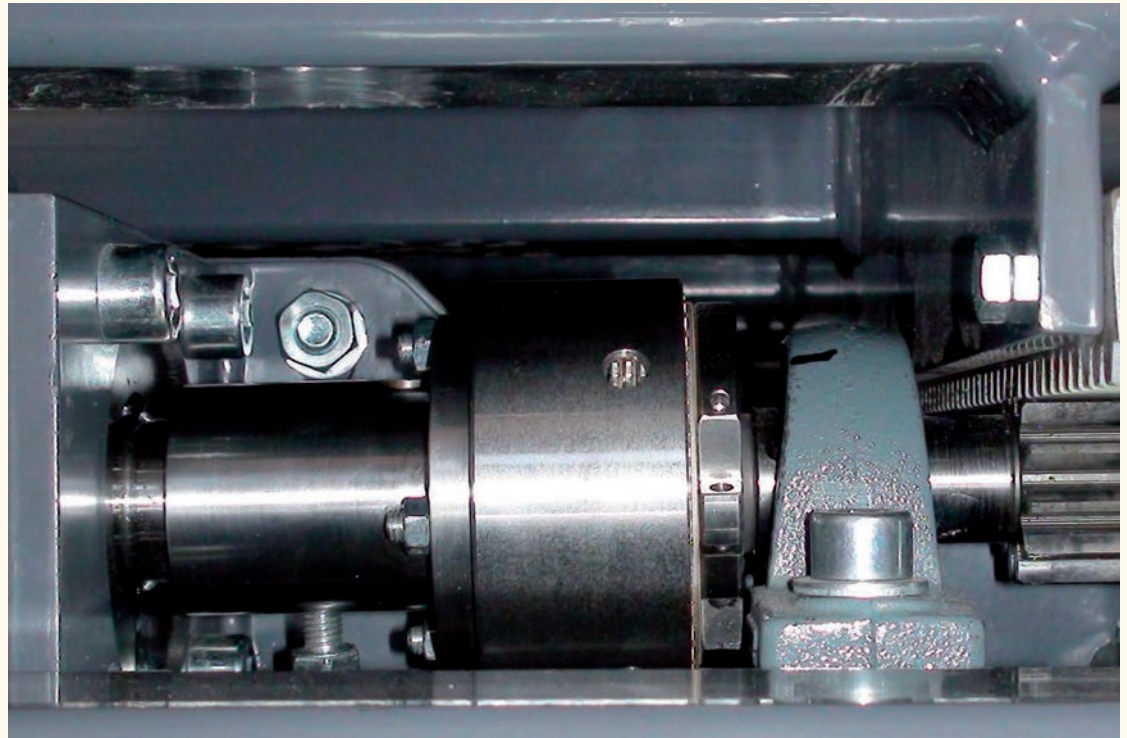
Concrete mix design using recycled materials



Calculation of the temperature distribution in an unbalanced component



Rig for dynamic testing of machines



Drive component of a test rig

## Machines and Components

Simulations of the actions of external forces on structural components enable assessment of their stress/strain behaviour.

Our Design and Calculation department deals with tasks related to mechanical, process and production engineering. These activities primarily involve the development of processes and products for the building materials industry as well as for mechanical engineering and special machinery. Our success is based on our extensive technical knowledge and many years of experience in the areas of machine dynamics, modelling and simulation.

**Machine design and engineering** includes the development, design and dimensioning of components, assemblies, machines and entire production lines in accordance with functional specifications and load profiles. We use state-of-the-art 3D CAD software for this purpose.

The finite-element method (FEM) and multi-body dynamics (MBD) are applied to **calculate, model and simulate** process workflows under static and dynamic loading. The respective software suites enable 3D modelling as well as material stress and displacement analyses.

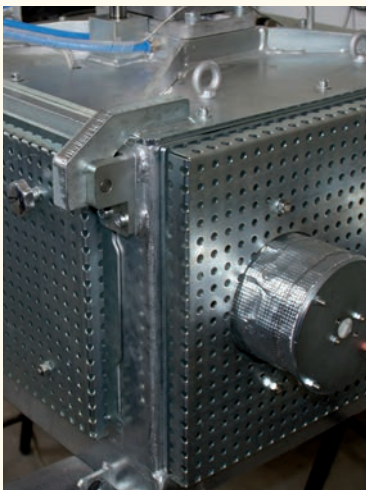
**Modal analyses** are used to investigate the dynamic behaviour of machines to efficiently identify weak spots in order to optimise their overall design.

### Selected services

- Development of new processes and products
- Increasing the reliability and efficiency of production lines
- Development of innovative test facilities and quality control systems
- Design, user-centred engineering and dimensioning of equipment (operating components, machines, apparatus) for the processing of mixes and for drive systems
- Development of measures to prevent noise, shock and vibration and to design foundations for dynamic loading

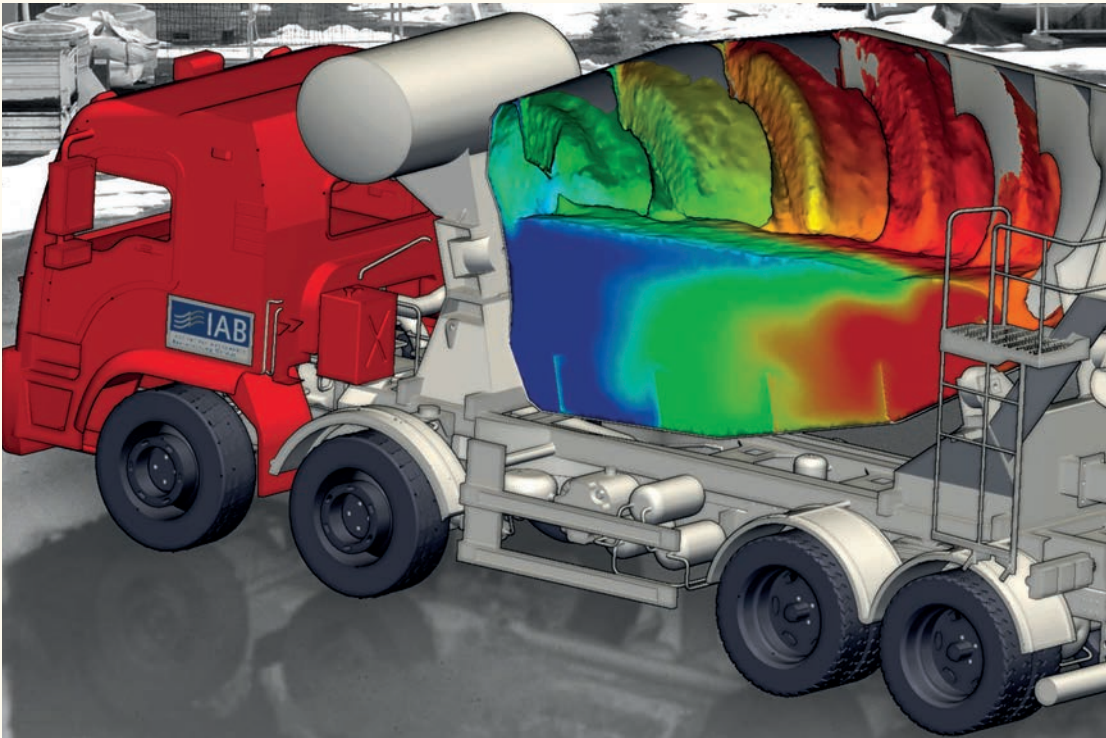
We also provide a wide range of engineering services, including literature and patent search, drafting of project applications and assessment of technical systems.

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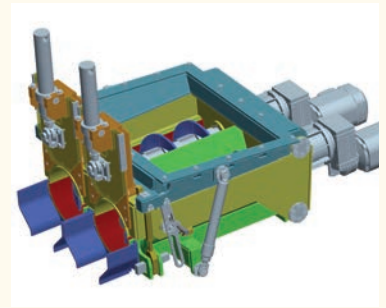


Development of a test rig to investigate the service life of bladders

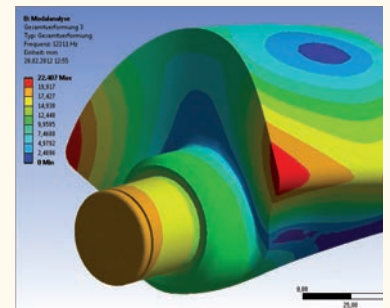




Numerical simulations using Computational Fluid Dynamics (CFD) replicate the motion patterns of fluids and suspensions, such as inside the drum of a truck mixer



Design of a batching system using a 3D model (CAD)



Calculation of an unbalance using the Finite-Element Method (FEM)

## Virtual Engineering Enables Optimisation

Virtual environments are increasingly used to design and optimise machines, processes and structures. Related activities include the digital design and configuration of components and machines and the simulation of motion patterns, actions on materials, modes of operation and interactions with processing media – always with the aim of knowledge gain and performance optimisation. In this respect, virtual engineering is essential due to its high degree of precision and reliability when it comes to ensuring sustainability and resource efficiency, thus dramatically shortening development cycles and mitigating risk.

Irrespective of the specific application, expert knowledge in the individual areas of virtual engineering is crucial for successful, reliable and efficient modelling. IAB researchers began to pursue activities in this field as early as the 1990s and have joined forces with our partners to develop innovative, customer-centric solutions. The wealth of experience gained during these many years of work also enables us to find solutions to exceedingly complex tasks.

### Selected services

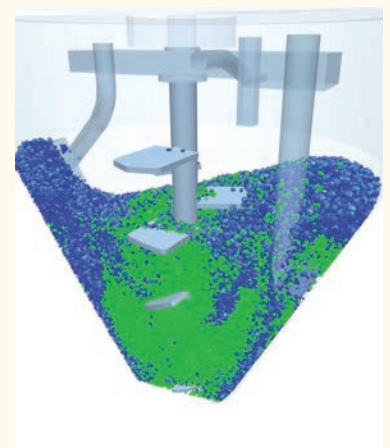
- Static and dynamic calculation of displacements, loads and material stresses in machines and structures **(FEM)**
- Simulation of the dynamic behaviour of mechanical multi-body systems **(MBD)**
- Simulation of the motion behaviour of bulk products **(DEM)**
- Flow simulation of liquid and gaseous materials **(CFD)**
- Simulation of **interaction effects** in multi-phase material systems
- Object digitisation using **3D scanning**
- Rapid prototyping using **3D printing**
- Parametrised **optimisation** using statistics-based test design and analysis
- Computer-aided machine design **(CAD)**

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In many cases, simulations deliver more accurate results more quickly and economically compared to using a test rig.

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Particle simulation of a cone mixer using the Discrete-Element Method (DEM)





The transfer of knowledge and expertise, during the IAB Science Days for example, creates synergies between industry and academia

Processing and passing on knowledge is a catalyst for many innovations.



## Education and Consultancy

Commensurate with the ever-faster transformation of the world, the volume of research findings is also constantly increasing, and established knowledge is broadening to include peripheral areas of interest. In this context, we organise a large number of events to support the transfer of knowledge and expertise. One of these is the annual IAB Science Days that host two events in one: the International IFF Conference and the Pipeline Construction Congress. It has become common practice for participants to present their own research findings and to discuss them with a broad audience. This is where industry and science meet to develop their ideas further, to gain new momentum and to lay the foundation for innovative products and technologies. For continuous technology transfer is the only way to ensure the ability to innovate of small and medium-sized enterprises.



The ongoing training programme offered by the IAB is tailored to the specific interests of participants and includes a wide range of topics, up-to-date information and a high quality standard.

We regularly hold **seminars and workshops** in close collaboration with national and international associations. These events are dedicated to joint work on standards and guidelines and to the education and ongoing training of industry professionals.

Our academic activities also include **guest lectures** at universities and other institutions of higher education. We also supervise PhD candidates, Bachelor's and Master's theses as well as trainees.

Furthermore, IAB staff prepare **expert reports and opinions**, for which the Institute relies on the support of publicly appointed and sworn experts employed in-house.

Our activities in the working groups and bodies of various national and international organisations, associations and committees ensure that findings and innovations arising from our research are reflected in their work.

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