



For Research and Practice.
The Laboratories of the FEhS Institute

INSTITUT FÜR
BAUSTOFF
FORSCHUNG

FEhs

North America



Europe



South America



Asia

THE FEHS BUILDING MATERIALS INSTITUTE

The FEhS Institute has been researching, testing and advising on iron and steel slag and the building materials and fertilisers produced from them for more than 70 years. Thanks to its extensive experience and globally recognised expertise, the Duisburg-based institute is a sought-after partner for companies and industry, associations, authorities, quality associations, standardisation bodies and institutions from the fields of science and research.

The FEhS Institute has seven in-house laboratories for cement, concrete, chemistry, physics, melting metallurgy (mobile laboratory included), transport construction and fertilisers. They offer members and external clients intensive advice, comprehensive laboratory services and sound analyses at the highest level. Quickly, reliably and efficiently.

In addition to the interdisciplinary work of laboratory technicians, scientists and engineers, the FEhS Institute is characterised by its enormous practical experience and international networking. Its partners include national and international universities, federal ministries, the Federal Environment Agency, the European Committee for Standardisation (CEN) and the European Slag Organisation EUROSLAG.

In the following we present
an extract from the range of
services provided by our
laboratories. You can find
all offers at
[https://www.fehs.de/en/
our-service/downloads/](https://www.fehs.de/en/our-service/downloads/)



FROM THE PROFESSIONALS FOR THE PROFESSIONALS: THE FEHS LABORATORIES

We see ourselves as a sophisticated laboratory service provider, for whom individual support, best quality and a service-oriented handling of orders are standard practice.

Our extensive range of services includes mineralogical and geoscientific, metallurgical as well as chemical and chemical/physical work, and further specific investigations of cement and mortar, aggregates and building material mixtures, fresh and hardened concrete, structures, fertilisers, soils and plants. With our mobile equipment of the melting laboratory, we can also carry out operational tests directly at the customer's site.

The laboratories of the FEHS Institute are equipped with state-of-the-art technology. Procedures for routine tests are accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS). They have numerous national and European approvals. Many of the tests required in accordance with German and international standards for building materials and fertilisers can be carried out in-house.

PHYSICS LABORATORY

SERVICES

- X-ray diffraction analyses to determine the mineralogical composition, qualitatively, semi-quantitatively and quantitatively, using the Rietveld method
- Grain size distribution using a laser granulometer LA-300 Horiba and air jet sieving AS 200 Retsch with cyclone
- Heating microscopy to determine the melting behaviour of solids such as incineration ash
- Microscopic methods using Leica DM2500 P polarisation microscope and Leica DSM1000 stereo microscope such as determination of the glass content in granulated blast furnace slag and microscopic evaluation of thin sections and particle preparations including documentation and simple image analysis
- Investigation of the thermal conductivity and heat capacity of solids with TPS 1500 Hot Disk Instruments
- Other mineralogical/geoscientific investigations (petrography, hardness determination etc.)



APPARATUS

Malvern PANalytical
XRD Empyrean 3rd Generation
Multi-purpose diffractometer platform
with automated aperture system

LA-300 Horiba

AS 200 Retsch with cyclone

Leica DM2500 P polarisation microscope

Hg pressure porosimeter Pascal
440/140 series Thermo Scientific

TPS 1500 Hot Disk Instruments

VARIOLuxx gas analyser



CEMENT LABORATORY

PHYSICAL PROPERTIES

- Density (true density, raw density, bulk density)
- Angle of repose
- Grain size distribution (laser granulometer, sieve analyses)
- Fineness (Blaine fineness or BET fineness)
- Grindability according to Zeisel
- Micro-vickers hardness

CEMENT TESTS

- Standard characterisation
- Heat of hydration
- Mineralogical composition
- Chromate content
- C-value determination

MORTAR TESTS

- Production and storage of mortars at different temperatures and humidity levels
- Fresh mortar (flow spread, air content, setting time)
- Strength (compressive strength, flexural strength, tensile bond strength, bond strength)
- Dynamic and static modulus of elasticity
- Water absorption coefficient
- Volume stability

Tests in
accordance
with

**DIN EN
and ASTM**

TESTS ON THE DURABILITY OF MORTARS

Sulphate resistance of cements and
binder mixtures (SVA, Wittekind,
Koch/Steinegger methods)

Alkali-silica rapid test procedure

Acid resistance

Mercury intrusion porosimetry

CONSULTING

Quality and production testing of products

Product development and optimisation

EQUIPMENT

Compressive/flexural strength testing machine 300/15 kN

Climate chamber

Solution heat calorimeter Gamab Social

Isothermal heat flow calorimeter TAM Air

Resonance frequency tester Grindosonic MK5

BET surface and pore size analyser
Micromeritics Gemini V

Micro-vickers hardness tester
Buehler MicroMet 5104



TRANSPORT CONSTRUCTION LABORATORY

SAMPLING AND SAMPLE PREPARATION

- Crushing and grinding, sample division, water content

GENERAL MATERIAL PROPERTIES

- Petrographic and mineralogical testing
- Material constituents of recycled aggregates
- Particle density of aggregates
- Water absorption

GRANULOMETRIC PROPERTIES

- Grain size distribution and fine content
- Flakiness and shape index
- Percentage of crushed/broken surfaces and flow coefficient
- Bulk density and affinity

FLOATING IMPURITIES

- Acid-soluble sulphates and total sulphur content
- Chloride

COMPACTION AND BEARING CAPACITY

- Vibrating hammer test (DIN EN 13286-4)
- Proctor compaction and California bearing ratio test (CBR)
- Self-hardening of steel slag



**RAP
Stra**

Our transport construction laboratory is an "RAP Stra" test centre for aggregates and building material mixtures in road construction

RESISTANCE TO WEATHERING

Volume expansion of steel slag (DIN EN 1744-1) and Municipal Incinerator Bottom Ash Aggregate (MIBA)

Free lime content

Lime and iron decomposition

Boiling and magnesium sulphate test

Freeze-thaw and freeze-thaw in presence of salt test

Resistance to thermal shock

RESISTANCE TO MECHANICAL STRAIN

Resistance to fragmentation (DIN EN 1097-2)

Los Angeles and micro Deval test

Uniaxial compressive strength

Polished stone value (PSV)

OTHER TESTS

Skid resistance measurements

(SRT and outflow meter)

Water permeability

(TP Gestein-StB 8.3.1/8.3.2/8.3.4)

Dynamic and static plate load test



CHEMISTRY LABORATORY

GUIDELINES, OFFICIAL REQUIREMENTS AND ORDINANCES (EXCERPT)

- AP(89)1 Use of colorants in plastic materials
- Water, soil and gases aggressive to concrete, DIN 4030
- DIN CEN/TS 16637-2, 64-day test
- Landfill, substitute building materials and fertiliser ordinance
- Sand and gravel for human use, EN12904
- Toy guidelines , DIN EN 71-3
- Soil, household waste incineration ash and recycling/construction waste, LAGA
- LUA NRW, MB 7
- NRW and recycling decree
- RAL-GZ 510/RAL-GZ 511/RAL-RG 501/1
- REACH, Annex 1
- RoHS (2002/95/EC)
- Sachsen-Anhalt-Min. -Blatt (1998), Tab. 10
- German Technical Instructions on Municipal Waste (TASI) of 14.05. 1993, Annex B
- German Technical Conditions of Delivery for Aggregates in Road Construction/Armourstones/Grit
- Drinking water ordinance
- Waste stowing ordinance
- Additive water for concrete according to DIN EN 1008



CHEMICAL SAMPLE PREPARATION

All common digestion methods
(also total digestion with HF)

Separation of the oxidation stages of metals

All common elution and percolation methods

INSTRUMENTAL ANALYSIS

Fast full analysis with XRF

Trace and ultra-trace analysis ICP-MS/AES

Product control or identification by IR

ATR spectroscopy

Element analysis

Reference analysis – wet chemistry

Arbitration analysis



CONCRETE LABORATORY

AGGREGATES FOR CONCRETE

- For range of tests, see transport construction laboratory

FRESH CONCRETE TESTS

- Design and production of laboratory mixtures
- Sampling and testing of fresh concrete
- Determination of w/c value and steel fibre content

HARDENED CONCRETE TESTS

- Compressive strength
- Splitting tensile and flexural strength
- Hardened concrete density and water absorption
- Water penetration depth
- Freeze and freeze-thaw with de-icing salt tests
- Air void characteristic values (counting with a stereo microscope)
- Porosity (mercury intrusion porosimetry)
- Cement content, composition of hardened concrete (insoluble residues, CO_2 , H_2O , dry bulk density, grading curve)
- Penetration of a test liquid into non-cracked concrete according to DAfStb-Rili BUMwS
- Determination of the damage depth of substances aggressive to concrete according to DAfStb-Rili BUMwS

TESTING OF STRUCTURES AND STRUCTURE SAMPLES

Taking of structure samples
(drill cores, bore dust)

Preparation (sawing and grinding) and testing
of drill cores for compressive strength, including bulk density

Strength test with the rebound hammer

Surface tensile, tensile bond and tear strength

Carbonation depth

Concrete coverage (non-destructive) line and area scans

Potential field measurement

Crack detection, placing of plaster marks, shrinkage
measurements with the mechanical extensometer

Determination of surface roughness

Determination of moisture content using the
CM method for example

Layer thickness measurements using the
stereo microscope for example

Chemical analyses of structure samples,
e.g. sulphate and chloride content

Testing of concrete products,
masonry units and bricks

MELTING LABORATORY (SLAG METALLURGY)

LABORATORY SERVICES

- Melting of oxidic materials under reducing conditions in the graphite crucible up to 2,000°C in the nitrogen-flushed Tammann furnace
- Melting of oxidic materials under neutral and reducing conditions in the ceramic crucible up to 2,000°C in the nitrogen-flushed Tammann furnace
- Production of synthetic slag
- Metal content analysis by melting oxidic materials
- Defined cooling of refractory masses (water granulation, rotary plate, copper plate...)
- Measurement of the electrical conductivity of refractory materials up to 1,700°C
- Tempering in defined atmospheres up to 1,400°C

MODELLING

- Viscosity calculation of blast furnace slag
- Calculation of heat capacities based on the chemical composition
- Calculation of thermal conductivities based on the melting behaviour

OPERATIONAL TESTS AND CONSULTING

Concept development to avoid
disintegration of slag

Sampling of molten
materials during operation

Mobile equipment for different cooling
processes during operation (e.g. water granulation)

Recording and optimisation of material
flows of the secondary materials

Creation of novel oxidic products
from molten phase

Optimisation of physical and
environmental properties of slag

Optimisation for slag
handling during operation

FERTILISER LABORATORY

FERTILISER TESTING

- Validation and assessment of liming materials and mineral/organic commercial fertilisers, farm manure and recycled materials in accordance with the requirements of the German Fertiliser Ordinance (DüMV)

SOIL TESTING

- pH value determination and analysis of plant nutrients in accordance with the German Fertiliser Ordinance (DüMV)
- Analysis of contaminants

PLANT ANALYTICS

- Determination of main and trace nutrients, valuable constituents and contaminants

CHEMICAL AND CHEMICAL-PHYSICAL SAMPLE PREPARATION

- Various digestion and extraction processes (aqua regia, full digestion, microwave, CAL extraction, ammonium nitrate or water extraction) of fertilisers, soil and plant material

CHEMICAL AND
CHEMICAL-PHYSICAL ANALYTICS

Main and trace elements as well as contaminant
analytics using ICP-MS/AES, XRF, AAS,
IR/MIR/NIR spectroscopy

X-ray diffraction analyses to determine
the mineralogical composition of
liming materials, fertilisers and soils

Grain size distribution
(dry and wet screening)

Fast water analysis using infrared detection

CONSULTING

External quality and production
control of liming materials and fertilisers

Product development
and optimisation



A background image of laboratory glassware, including several test tubes in a rack and a beaker, with a circular white overlay in the center containing text.

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The FEhS Institute is
accredited for **71 tests** at
the Deutsche Akkreditierungsstelle
GmbH (DAKKS).

RECOGNISED COMPETENCE

Whether investigations, test orders, external monitoring or research projects, anyone using the services of the FEhS Institute can be certain that the high quality of the laboratories has been tested. Examples include:

- Accreditation by the DAkKS according to DIN EN ISO/IEC 17025:2018
- Building authority recognition as testing, monitoring and certification centre for the Deutsches Institut für Bautechnik
- Recognition under private law of the State of North Rhine-Westphalia as a test centre for building materials and building materials mixtures as well as water management characteristics in road construction (RAP Stra)
- Recognition as a concrete testing centre of the VMPA Verband der Materialprüfungsanstalten e.V.
- Membership in the Landesgütegemeinschaft Instandsetzung von Betonbauwerken Nordrhein-Westfalen e.V.

In addition, the laboratories of the FEhS Institute regularly work on the development or further development of test methods such as the steam test according to DIN EN 1744-1. Furthermore, the FEhS experts participate in the preparation and revision of codes and standards, including on behalf of the Federal Ministry for the Environment, and in international research projects, such as on heat recovery from blast furnace and steelworks slag.

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