TU 1404
COST ACTION

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Institutional posters eBook

according to 1st WORKSHOP

with Focus on experimental testing of cement-based materials

held in Ljubljana, Slovenia, April, 16-17, 2015

ESF provides the COST Office through a European Commission contract

COST is supported by the EU Framework Programme

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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Layout COST Action TU1404

Cover COST Action TU1404

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COST (European Cooperation in Science and Technology) is a pan-European intergovernmental framework. Its mission is to enable break-through scientific and technological developments leading to new concepts and products and thereby contribute to strengthening Europe's research and innovation capacities.

It allows researchers, engineers and scholars to jointly develop their own ideas and take new initiatives across all fields of science and technology, while promoting multi- and interdisciplinary approaches. COST aims at fostering a better integration of less research intensive countries to the knowledge hubs of the European Research Area. The COST Association, an International not-for-profit Association under Belgian Law, integrates all management, governing and administrative functions necessary for the operation of the framework. The COST Association has currently 36 Member Countries. www.cost.eu

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INTRODUCTION

About COST ACTION TU1404

Cement-based materials (CBM) are the foremost construction materials worldwide. Therefore, there are widely accepted standards for their structural applications. However, for service life designs, current approaches largely depend on CBM strength class and restrictions on CBM constituents.

Consequently, the service life behaviour of CBM structures is still analyzed with insufficiently rigorous approaches that are based on outdated scientific knowledge, particularly regarding the cumulative behaviour since early ages. This results in partial client satisfaction at the completion stage, increased maintenance/repair costs from early ages, and reduced service life of structures, with consequential economic/sustainability impacts.

Despite significant research advances that have been achieved in the last decade in testing and simulation of CBM and thereby predicting their service life performance, there have been no generalized European-funded Actions to assure their incorporation in standards available to designers/contractors.

The main purpose of COST TU1404 Action is to bring together relevant stakeholders (experimental and numerical researchers, standardization offices, manufacturers, designers, contractors, owners and authorities) in order to accelerate knowledge transfer in the form of new guidelines/recommendations, introduce new products and technologies to the market, and promote international and inter-speciality exchange of new information, creating avenues for new developments.

About 1st Workshop of COST ACTION TU1404

The Workshop was focused on specific tasks related to an extended Round Robin Testing (RRT+) organized within Workgroup 1 of COST ACTION TU1404. The following main objectives were:

- to make a scientific discussion on the proposed plan of RRT+ procedure and to allow the participants to provide their own comments/suggestions;
- to define of all the activities together with a detailed time schedule necessary to adequately start with the RRT+ procedure (i.e. to define transportation logistics, amount of basic materials that need to be transported to specific laboratory, etc.);
- to present the leaders of Group Priorities of WG1 and to allow them to express their ideas, demands, strategies, and expectations related to their GP in the form of short presentations;
- to allow other RRT+ participants to present some contributions relevant for a specific GP (e.g. their experiences related to previous RRT programs, etc.);
- to present expectations of WG2 and WG3 members related to the results of RRT+;
- to invite relevant speakers not included in COST ACTION TU1404;
- to allow the participants (i.e. members of RRT+) to present themselves, their organizations, their scientific work and contributions;
- to get acquainted with other RRT+ participants and WG members, etc.

About 1st Workshop of COST ACTION TU1404











Objectives of the posters

Two types of posters were presented at the Workshop, namely

- Institutional posters (type 1) and
- research posters (type 2).

The objective of type 1 posters was to present each institution participated at the Workshop which is necessary to know each other a little bit better and thus to achieve quality collaboration between the institutions included in the Action. Authors of the posters were therefore asked to provide the following main information:

(1) basic data of the organization including gender balance, number of young scientists and researchers, etc.,

(2) main research equipment and testing techniques used to evaluate properties of cement based materials and concrete structures,

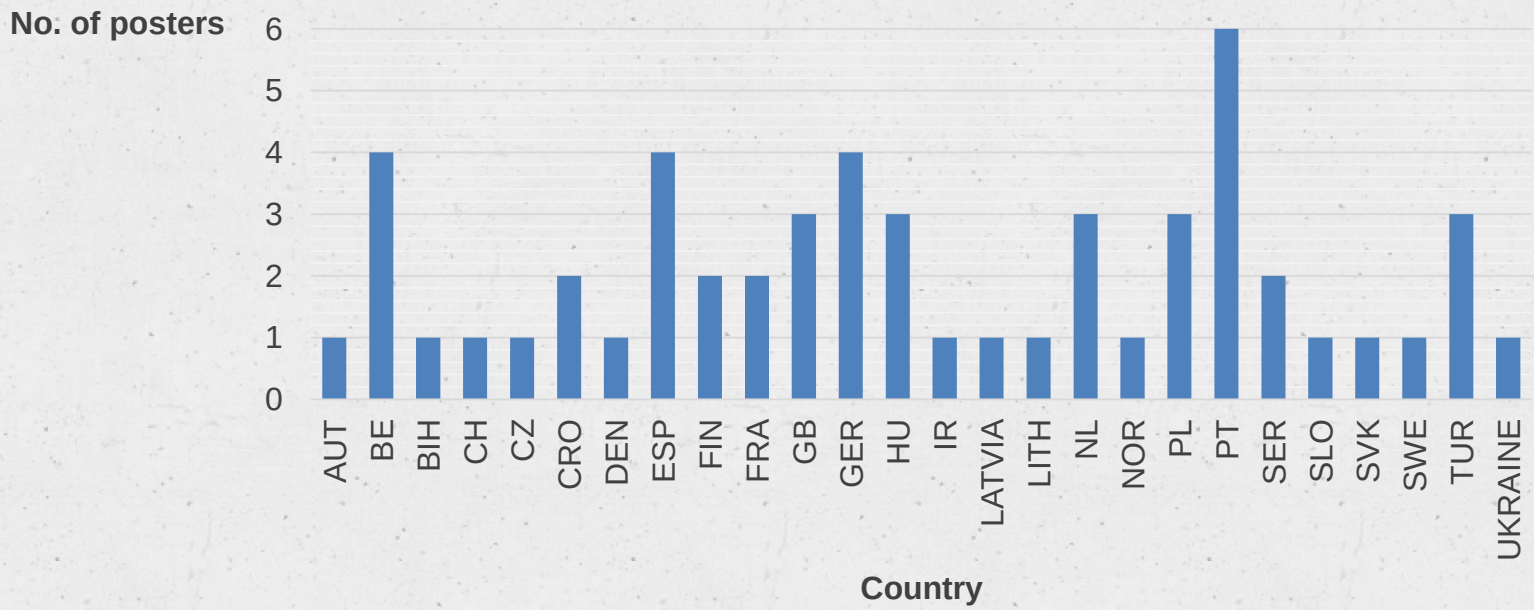
(3) a list and (if possible) very brief presentation of potential self developed advanced testing techniques used to evaluate properties of cement based materials and concrete structures,

(4) a role of the institution in this COST Action,

(5) other information they consider important .

Some statistics…

- 63 institutions from 27 European countries were presented at the Workshop,
- 54 Institutional posters (type 1) were presented.
- Distribution of type 1 posters with respect to the participating countries is presented in the figure below:



INSTITUTIONAL POSTERS

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Serbia	Faculty of Technical Sciences, University of Novi Sda	52
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TU Graz
Graz University of Technology



Graduates

Data Source: Intellectual Capital Report, as of 31.12.2014

2011/12[2]	2012/13[2]	2013/14[2]	
477	549	759	Master's Degrees
22,4%	27,7%	26,0%	of whom are women (%)
11,1%	7,3%	12,3%	of whom are international students (%)
187	155	176	Doctoral Degrees
21,4%	27,1%	22,7%	of whom are women (%)
33,2%	21,3%	23,9%	of whom are international students (%)

Staff in Full-Time Equivalents 2014

Data Source: Personnel Data, TUGRAZonline, as of 31.12.2014

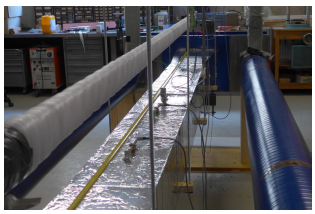
♀	♂	Total	
206,50	1.009,39	1.215,89	*Academic Staff*
8,21	102,90	111,11	of whom are professors
6,50	97,97	104,47	of whom are associate professors
6,70	26,08	32,78	of whom are assistant professors
94,48	290,00	384,48	of whom are assistants[1]
90,61	492,44	583,05	of whom are project staff

Institute of Structural Concrete / Research group "Crack width control in restrained concrete members"

Experimental testing

Simulation of the whole stress history of concrete





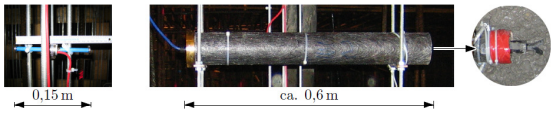
Restraint frames for reinforced concrete

- stress monitoring during hardening phase
- simulation of service life with additional deformation impacts applied with hydraulic cylinders
- crack width development during service life

In-situ measurements

Measuring restraint stresses in the hardening phase

- redundant measuring system allowing compatibility check
- vibrating wires combined with stressmeters (MPA Braunschweig)



Crack width monitoring in jointless structures



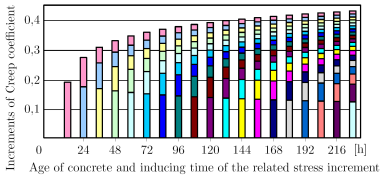
Measurements

Modelling

Reinforcement design

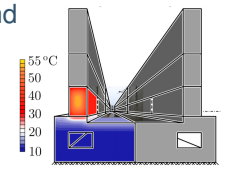
Material models

Deformation based approach for consideration of viscoelasticity on base of pure creep curves



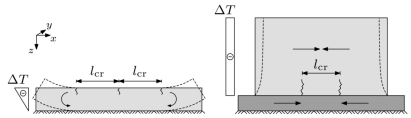
3D-FEM simulations

Quantification of temperature and restraint due to hardening with transient time-discrete multi-physical 3D-FEM models (verified by measurements)

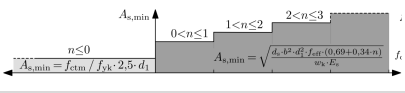


Minimum reinforcement

Mechanical based crack width control considering the real member behavior



Reinforcement on basis of number n of secondary cracks needed for deformation compatibility

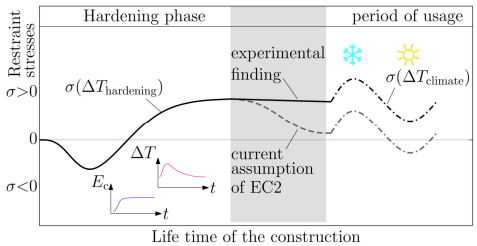


Unreinforced concrete

Mass concrete structures with minor stressing due to loading but intense temperature increase during hydration

Stress history

Superposition of hardening induced restraint with restraint during service life



Relevant publications

[1] Schlicke, D. and Tue, N.V.: Minimum reinforcement for crack width control in restrained concrete members considering the deformation compatibility. in: Structural Concrete, June 2015, DOI: 10.1002/suco.201400058

[2] Turner, K.; Schlicke, D. and Tue, N.V.: Restraint and crack width development during service life regarding hardening caused stresses, in: Proceedings of *fib* 2015 symposium in Copenhagen.

[3] Schlicke, D. and Tue, N.V.: Consideration of Viscoelasticity in Time Step FEM-Based Restraint Analyses of Hardening Concrete, in: Journal of modern physics, October 2013. DOI: 10.4236/jmp.2013.410A2002

[4] Heinrich, P.J. and Schlicke, D.: Serviceability and Stability of Unreinforced Mass Concrete Structures. in: Proceedings of CONCREEP-10 conference 2015 in Vienna

Scientific Participation:
WG2 + WG3 + STSM

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ECOLE POLYTECHNIQUE DE BRUXELLES

BATir

BATir department : BUILDING, ARCHITECTURE AND TOWN PLANNING

- LGC Civil Engineering
- SMC Computational Mechanics
- LGM Geomechanics
- AIA Architectural Engineering
- UAT Town Planning

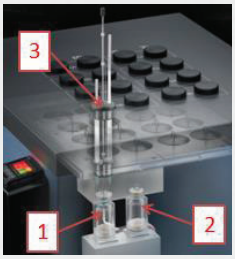
11 full time professors
27 part time professors
25 PhD students
5 post docs
3 secretaries
5 technicians

more information at batir.ulb.ac.be

LGC Laboratory of Civil Engineering – TU 1404 cost action WG1 and WG2

contact: sstaquet@ulb.ac.be

Calorimetry measurements (cement paste, mortar or concrete)



TAM Air Isothermal Calorimeter


Semi-Adiabatic Calorimeter


Adiabatic Calorimeter

- Heat flow, cumulated heat release
- Degree of hydration
- Adiabatic temperature rise
- Comparison paste-mortar-concrete

Ultrasonic transmission measurements (cement paste, mortar or concrete)


FreshCon setup for the simultaneous measurement of P-wave and S-wave transmission


Smart Aggregates : embedded piezoelectric transducers (P-wave)
left : piezoelectric patch; center : waterproof coating; right : smart aggregate

- P+S wave transmission information (energy, frequency, amplitude, velocity)
- Setting time determination
- Dynamic elastic properties
- Development of damage index with embedded sensors

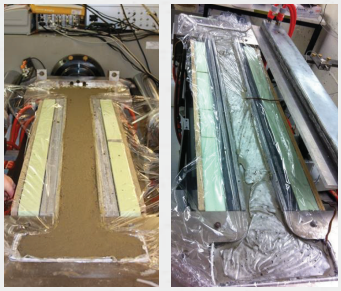
Autogenous deformations (cement paste, mortar or concrete)

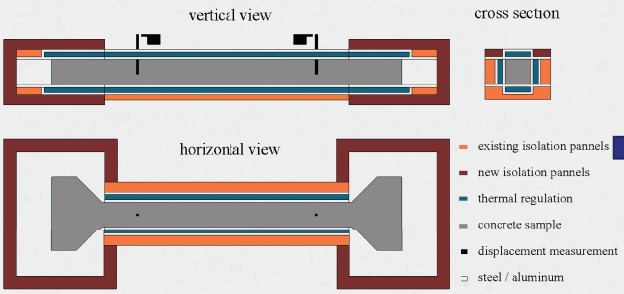


Left : vertical linear measurement, middle: volumetric measurement, right : horizontal linear measurement

- Autogenous deformations
  - isothermal conditions
  - specific temperature history
  - since before the setting time
- Coefficient of thermal expansion
  - since the setting time
  - cyclic methodology

Temperature Stress Testing Machine (mortar or concrete)





- Isothermal / realistic temperatures (5-50° C)
  Sealed / unsealed conditions (50%-100% RH)
- Elastic modulus
  - tension/compression
  - since the setting time
  - cyclic methodology
- Creep / Relaxation (dummy mould)
- Free / Restrained deformations tests

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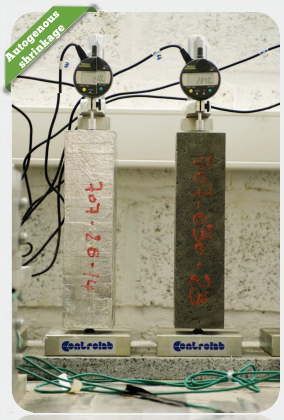
The Belgian Building Research Institute (BBRI) is a private research centre at the service of the construction sector with a view to improving quality and productivity

Research & Innovation ⬟ Information ⬟ Development & Valorisation

- **Total BBRI Workforce :** 240 people
- **Lab's Concrete & Structures :** 20 engineers & tech's
  65% young scientists
  42/58 male/female %

Laboratory CONCRETE TECHNOLOGY (BE)
COST TU 1404 potential role in : WG1 / GP1.a|e





- Measurements of fresh concrete properties (slump, flow, V-Funnel, L-Box, J-Ring, Kajima box, …)
- Concrete rheometer
- Autogenous shrinkage
- CO_2 room for durability tests
- Chloride diffusion
- Freeze-Thaw cycles
- ASR Testing equipment
- Setting time & heat of hydration
- Long experience with recycled aggregates concrete

Laboratory STRUCTURES (SC)
COST TU 1404 potential role in : WG1 / GP1.d|f





- Large Testing Hall
- Hydraulic jacks [25-4000 kN]
- Multi-channel (8x20) acquisition systems
- Displacement sensors (LVDT's, laser, optical fibre, …)
- Load cells
- Crackmeters
- Permeability of cracked concrete
- Restrained shrinkage (ring, dog-bone)
- Creep (compression, bending)
- Long experience with fibre reinforced concrete (FRC)

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University of Leuven, Civil Engineering Department
Building Materials and Building Technology Section
Leuven, Belgium



Situated in Belgium, **University of Leuven (KU Leuven)** has been a centre of learning for nearly six centuries. Today, it is Belgium's largest university and, founded in 1425, one of the oldest and most renowned universities in Europe. As a leading European research university and co-founder of the League of European Research Universities (LERU), KU Leuven offers a wide variety of international master's programmes, all supported by high-quality, innovative, interdisciplinary research.

	March 2014
Administrative and Technical Staff (ATP/IK/CBED)	3,601
Junior Academic Staff (AAP/OP)	1,173
Senior Academic Staff (ZAP)	1,595
Teaching Staff (OP3)	344
Other Academic Staff (BAP/COZ)	4,978
Total (in persons)	11,534*

	Male	Female
Administrative and Technical Staff (ATP/IK/CBED)	37.2	62.8
Junior Academic Staff (AAP/OP)	49.2	50.8
Senior Academic Staff (ZAP)	73.8	26.2
Teaching Staff (OP)	69.8	30.2
Other Academic Staff (BAP/COZ)	55.9	44.1
Total	52.3	47.7

	Belgian/EU	Non-Belgian
Administrative and Technical Staff (ATP/IK/CBED)	96.7	3.3
Junior Academic Staff (AAP/OP)	95.6	4.4
Senior Academic Staff (ZAP)	89.9	10.1
Teaching Staff (OP)	96.8	3.2
Other Academic Staff (BAP/COZ)	63.3	36.7



In rankings from all over the world, the **Faculty of Engineering Science** of KU Leuven features among the best technical universities (n° 1 in Belgium, n° 6 among continental European universities – top 100 worldwide). In total there are ± 5.200 students of which ± 1.000 PhD researchers. With over a hundred different nationalities the student population is a very international community: 25% of the students come from all over the world. Almost 150 graduating PhD researchers a year.



Department of Civil Engineering performs excellent fundamental and applied research in an international context on building physics, buildings materials and building technology, structural mechanics, and hydraulics. Research is based on experiments and numerical modeling on the material, component, structural and environmental level.

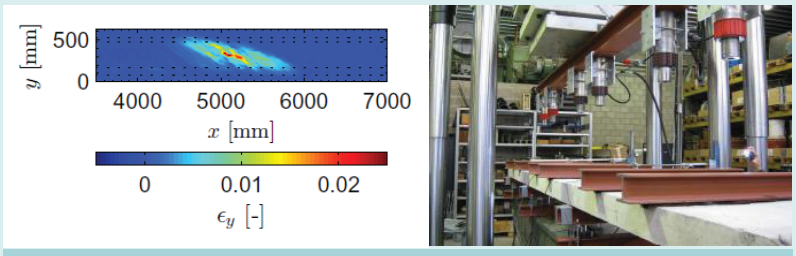
Professors	18
Postdoctoral researchers	12
Doctoral researchers	55
Female	29%
Foreigner	33%

The **Reyntjens Laboratory** of the **Building Materials and Building Technology** division conducts innovative, fundamental and applied research on the properties and behaviour of building materials and components such as binders, mortars, concrete, steel, timber, masonry, soil and polymers such as FRP. Research is supported by advanced numerical design techniques and experiments performed in fully equipped Reyntjens Laboratory of:

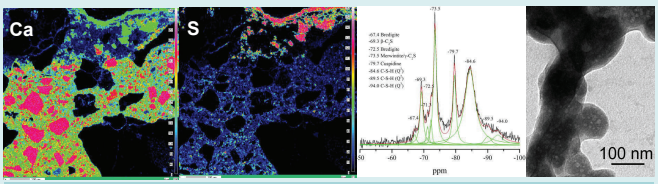
- **Cement and concrete laboratory**: Mixing, curing and testing of cement, mortar and concrete; durability tests
- **Chemistry laboratory**: Chemical analyses on binders, mortar, concrete, soil and other building materials
- **Main testing hall**: Equipped for large-scale mechanical tests on building materials and components
- **Laboratory for soil experiments**: Tests on soil samples (shear tests, compression tests, tri-axial tests, etc.)



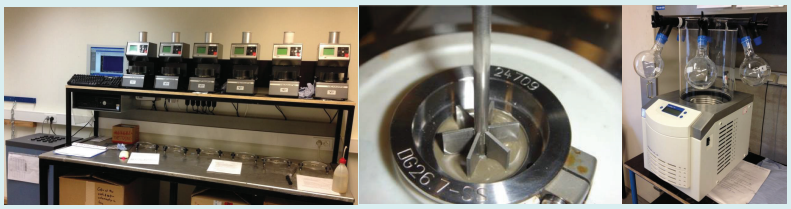
Advanced optical measurement techniques to assess the displacements and deformations during the loading of prestressed concrete beam



Testing equipment to investigate mechanical properties of construction materials and structural components such as concrete elements and steel profiles (compression test up to 5000kN, tension, bending bench)



Research collaborations with other departments for XRD, TGA, electron microscopes, small angle X-ray scattering , ICP-MS, Si/Al MAS-NMR, nano-CT, XRF, AAS, ATR-FTIR



Cement laboratory equipped with isothermal calorimetry, automatic vicat, autogeneous shrinkage dilatometer, viscometer, rheometer and freeze dryer

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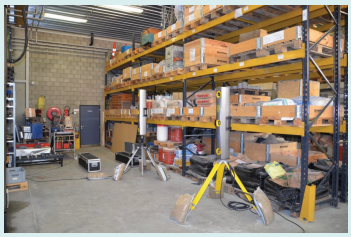
KU LEUVEN

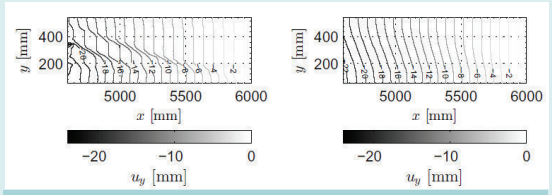
University of Leuven, Civil Engineering Department
Building Materials and Building Technology Section
Leuven, Belgium

PhD research: Shear capacity of prestressed and reinforced concrete members: Modeling and experimental validation, Kristof De Wilder (COST member), KU Leuven

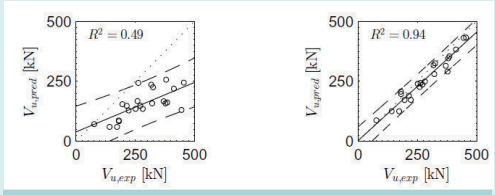




Current codes of practice tend to propose highly conservative design procedures for shear in prestressed concrete elements. To optimize and economize the overall structural design, a study assessing the structural behavior of shear-critical structural concrete elements was conducted. During the experimental work, specific attention was given to the use of advanced optical measurement techniques to assess the displacements and deformations during the loading procedure. The obtained experimental results were used to validate numerical models and to gain knowledge of the structural response of the test specimens.

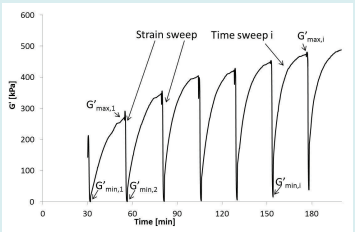


Comparison between experimentally observed (left) and numerically predicted (right) vertical displacement field in the shear span at 95 % of the experimental failure load



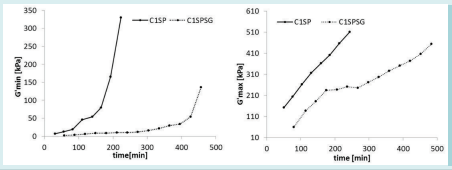
Correlation between experimental results obtained from EC2 (left) and model predictions (right)

PhD research: Interactions between cement and combined concrete admixtures: The influence on cement paste rheology, Karel Lesage, KU Leuven

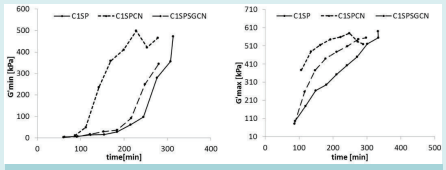


Monitored storage modulus for cement paste. After each cycle, the time sweep is alternated with the strain sweep

The objective of this work is to investigate the rheological mechanism in cement paste for the combined use of superplasticizer, retarder and accelerator. In particular, an effect on the particle agglomeration is aimed for in order to contribute to a more fundamental understanding of the concrete's flow behavior.



Evolution of G'_{min} and G'_{max} shows retader effect on the plasticized cement paste



Evolution of G'_{min} and G'_{max} shows accelerator effect on the retarded plasticized cement paste

Research projects related to the COST Action TU1404

1. Valorisation of AMORAS sludge as SCM in concrete, in partnership with Flemish Government, VITO, FLSmidth, KU Leuven, 2014-2017.

Annually half a million tonnes of dry matter base of sediments need to be dredged from the port of Antwerp. This projects investigates sustainable valorization routes for the recycling and reuse of this maintenance dredging material as SCM in concrete.



2. Valorisation of ArcelorMittal's BOF slag into low-carbon CRH building materials with enhanced properties, IWT O&O project, 2015-2017
3. Modeling early age properties of sustainable binders, PhD research, 2014-2018
4. Mineralogical study of the pozzolanic properties of calcined clays, PhD research, 2013-2017
5. Structural evolution in novel calcium silicate binders consolidated with calcined clays and alkalis, FWO research project, 2015-2018
6. Innovative modeling methods for the shear design of cement based steel fibre reinforced composite beams, Postdoc research, Kristof De Wilder

Publications related to the COST Action TU1404

- De Wilder, K., Lava, P., Debruyne, D., Wang, Y., De Roeck, G., Vandewalle, L. (2015). Stress field based truss model for shear-critical prestressed concrete beams. Structures.
- De Wilder, K., Lava, P., Debruyne, D., Wang, Y., De Roeck, G., Vandewalle, L. (2015). Experimental investigation on the shear capacity of prestressed concrete beams using digital image correlation. Engineering Structures, 82 (1), 82-92.
- Knapen, E., Van Gemert, D. (2015). Polymer film formation in mortars modified with water-soluble polymers. Cement & Concrete Composites, 58 (1), 23-28.
- Lesage, K., Cizer, Ö., Desmet, B., Vantomme, J., De Schutter, G., Vandewalle, L. (2014). Plasticizing Mechanism of Sodium Gluconate Combined with PCE. Advances in Cement Research, art.nr. DOI : 10.1680/adcr.13.00087
- Desmet, B., Atitung, K., Sanchez, M., Vantomme, J., Feys, D., Robeyst, N., Audenaert, K., De Schutter, G., Boel, V., Heirman, G., Cizer, Ö., Vandewalle, L., Van Gemert, D. (2011). Monitoring the early-age hydration of self-compacting concrete using ultrasonic p-wave transmission and isothermal calorimetry. Materials and Structures, 44 (8), 1537-1558.
- Craeye, B., De Schutter, G., Desmet, B., Vantomme, J., Heirman, G., Vandewalle, L., Cizer, Ö., Aggoun, S., Kadri, E. (2010). Effect of mineral filler type on autogenous shrinkage of self-compacting concrete. Cement and Concrete Research, 40 (6), 908-913.
- Knapen, E., Cizer, Ö., Van Balen, K., Van Gemert, D. (2009). Effect of free water removal from early-age hydrated cement pastes on thermal analysis. Construction & building materials, 23 (11), 3431-3438.

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Vrije Universiteit Brussel

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VRIJE UNIVERSITEIT BRUSSEL
MeMC
MECHANICS OF MATERIALS AND CONSTRUCTIONS

Department of Materials and Construction, Vrije Universiteit Brussel

Vrije' means 'Free' (in English) and MEMC has incorporated VUB's core values, which are:

•Research and thought without dogma
•Open atmosphere of tolerance and diversity
•Active pluralism, respect and open-mindedness

Our Mission

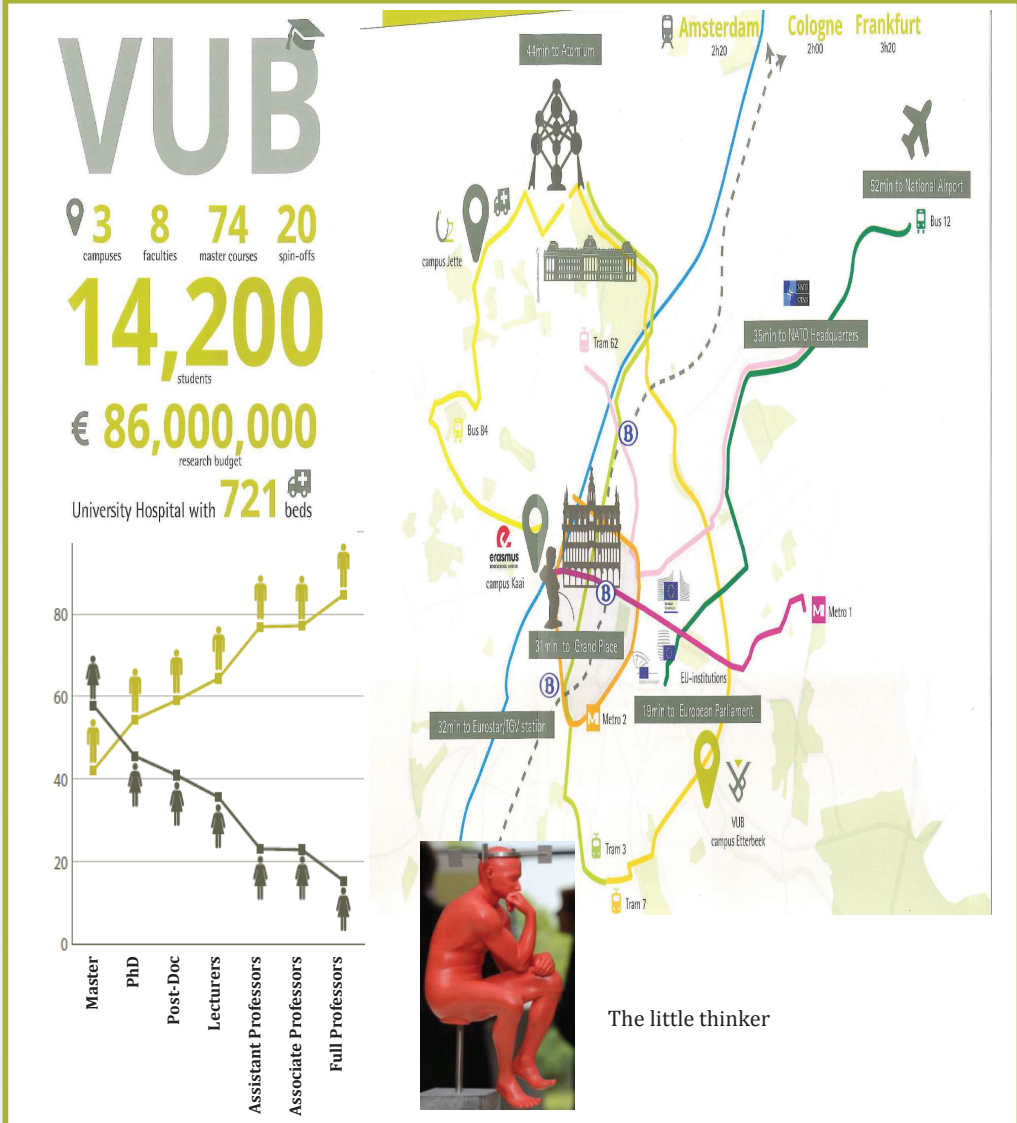
"To study the mechanical behavior of innovative material systems and lightweight constructions under complex loading conditions by means of (combined) experimental testing and advanced numerical modeling, in close collaboration with our national and international academic and industrial partners."

Fundamental and applied research is developed on the following themes:

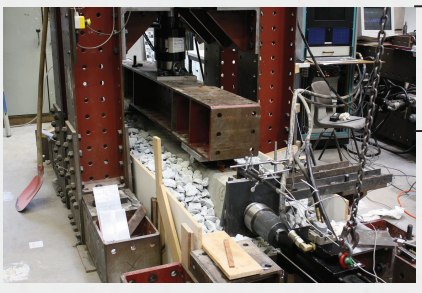
1. Durability - Reliability of polymer based composite systems
2. Mixed numerical-experimental techniques or inverse methods
3. Mineral polymers and their composites
4. Damage mechanics on material and structural levels
5. Non-destructive testing and experimental mechanics
6. Design and analysis of constructions
7. Renovation of buildings and civil engineering constructions.

2. Basic equipment

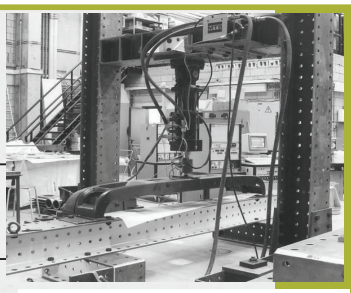
•Two Acoustic Emission systems (12 channels)
•Pattern Recognition Software
•Ultrasonic workstation
•Digital Image Correlation systems
•Standard concrete laboratory
•Several mechanical test-benches
•Bi-axial dynamic test bench
•Strong floor of 180 m^2, with 7x11 fix points



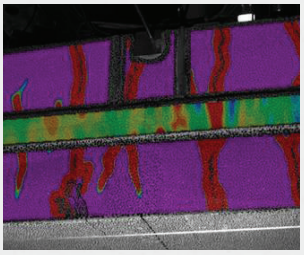
The little thinker



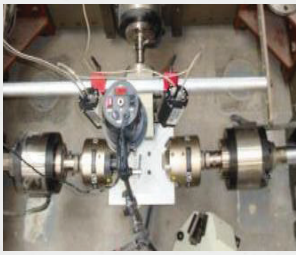
Testing of railway sleeper on ballast



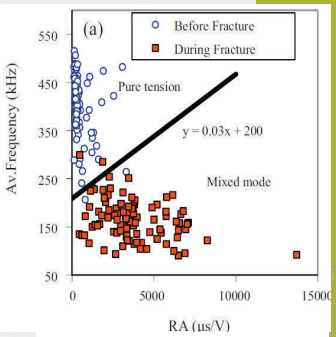
Testing of vehicle bumper



Strain field of a concrete beam including a CFRP reinforcing patch under bending



Unique bi-axial test bench for static and dynamic loading



Classification of AE data according to fracture mode

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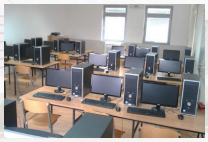
UNIVERSITY “DŽEMAL BIJEDIĆ” IN MOSTAR
FACULTY OF CIVIL ENGINEERING




Universtiy “Džemal Bijedić” in Mostar was funded in 1977. Faculty of Civil Engineering was established in 1978. Within the Faculty acts Institute for the design and testing of materials and structures with well equipped laboratory.

There are over 600 students in one undergraduate and two postgraduate study programmes. After completing undergraduate study programme, students may choose postraduate stuy programmes in two departments: Department of construction and Depatment of hydrotecnic. After education and research work, graduates are equipped with good basic knowledge to enable them to develop their academic career or work on teams selected.

The flexibility of curriculum allows that studies reflect the rapid development of technology and to adjust to the needs of the economy through the knowledge and experience in the use of modern computer applications in the construction industry.

The quality of these studies has been recognized at the international and national level. Compatibility of curricula with those of the EU enables the exchange of students from EU Universities.

Faculty employs 30 higher education teachers and researchers: 3 professors, 5 associate professors, 9 assistant professors, 12 assistants (3 young scientists) and 5 laboratory assistants.

Practical part of lectures and scientific research takes place in the Institute with modern equipment for different types of laboratory and field tests: soil testing, testing of concrete and components, testing of steel, construction testing, surveying, testing of asphalt, etc. Institute has successful cooperation with industry in the design, testing and monitoring of various types of materials and structures.

The Institute is engaged in projects in the field of preservation of historical heritage buildings, roads, hydraulic structures, etc.

laboratory is equipped for testing cement based materials and concrete structures. Basic equipment is:

- Mixer for cements
- Vicat apparatus with Le Chatelier's rings
- Blaine apparatus
- Devices for testing cement strength
- Press for testing of concrete strength
- Chest for testing concrete to frost and frost/salt
- The device HILTI for testing the early strength of shotcrete
- Equipment for testing water permeability of concrete
- Equipment for concrete sampling
- Equipment for sieve analysis of aggregates
- Hydrostatic digital scale with plinth
- Apparatus for consistency of fresh concrete
- Penetrometer for concrete

Within testing of cement based materials, following tests can be carried out :

- Fineness of cement
- Soundness cf cement
- Consistency of cement
- Initial and final setting time of cement
- Strength of cemenet
- Workability of fresh concrete
- Strength of concrete
- Water permeability of concrete
- Concrete testing to frost and frost/salt

All tests are performed in accordance with EN.

SIGNIFICANT PROJECTS OF THE INSTITUTE		
External quality control on highway Vc, section Vlakovo-Tarčin	2014.	
The revision of the Main project highway Vc, section Počitelj-Bijača	2014.	
Geophysical surveys, stability report and cause of the crack inspection in the "C" gallery of Jablanica dam	2012.	
The revision of the Main project highway Vc, section Tarčin-Konjic	2012.	
Rehabilitation project of "Bišćevića home" in Mostar	2010.	
Rehabilitation project of Kapetan's Tower in Bihać	2009.	


Mixer for cements


Vicat apparatus with Le Chatelier's rings


Blaine aparatus


Devices for testing cement strength


Press for testing of concrete strength


Apparatus for consistency of fresh concrete


Penetrometer for concrete


Equipment for sieve analysis of aggregates


The device HILTI for testing the early strength of shotcrete


Chest for testing concrete to frost and frost/salt


Equipment for testing water permeability of concrete


Equipment for concrete sampling


Hydrostatic digital scale with plinth

UNIVERSTIY “DŽEMAL BIJEDIĆ” IN MOSTAR
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www.gf.unmo.ba

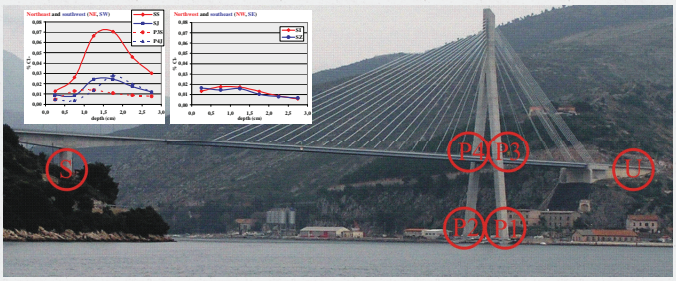
Institut IGH d.d.
J.Rakuše 1, Zagreb, Croatia
www.igh.hr

INSTITUT IGH - Laboratory for materials - Laboratory for concrete - Split

- Part of Laboratory for materials located in Croatia, in Split, city on the Adriatic coast
- Laboratory for materials in Split consists of Laboratory for binders and Laboratory for concrete
- Laboratory for concrete in Split - main testing areas:: testing of fresh and hardened concrete and concrete composites, concrete in structures, precast concrete elements by performing of more then 60 test methods
- Accredited according to HRN EN ISO/IEC 17025 for 33 test methods

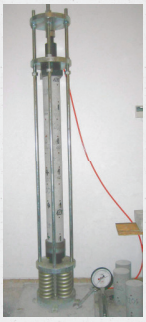
MAIN RESEARCH AREAS

- Testing of deformational properties of concrete: modulus of elasticity, shrinkage, creep
- Testing of durability properties of concrete, especially in maritime environment





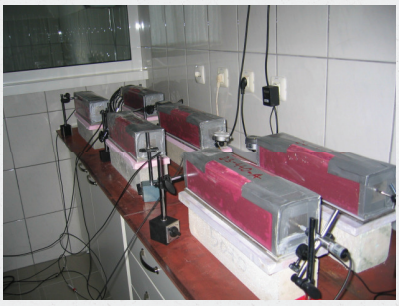




MAIN RESEARCH PROJECTS

TESTING OF DEFORMATIONAL PROPERTIES OF CONCRETE:

- Shrinkage and autogenous shrinkage
- PhD project which resulted in dissertation
- An extensive research in order to determine the dependence of shrinkage of high and normal strength concrete on the compressive strength and concrete composition



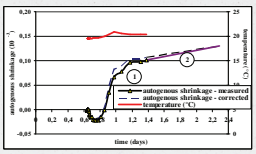


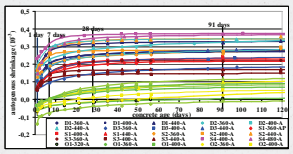
Project resulted in:

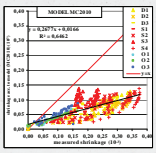
- Self developed modification of method for measuring autogenous shrinkage
- Two models for predicting concrete shrinkage values after initial curing, autogenous shrinkage and total shrinkage values
- The dependence of shrinkage on concrete composition
- The analyse of the influence of initial curing on shrinkage and autogenous shrinkage of concrete
- The comparison between theoretical models and experimental data

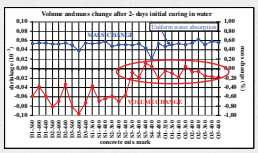
Objectives for future work:

- Measuring of long term shrinkage
- Performing the same programme with changed type of constituents







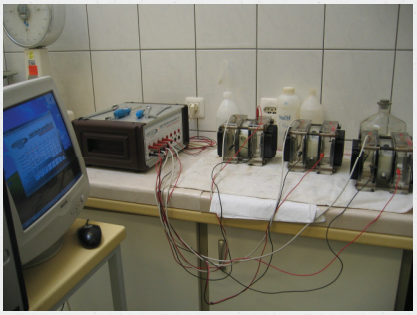


TESTING OF DURABILITY PROPERTIES OF CONCRETE IN MARITIME ENVIROMENT:

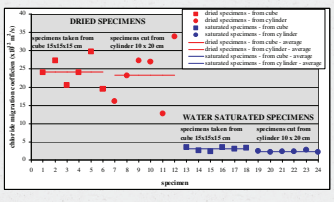
- Water and gas permeability of concrete
- Chloride penetration in concrete
- Two projects are planned
- First project: Samples for an extensive research in order to determine the dependence of chloride migration coefficient measured using NT BUILD 492 method on concrete composition are prepared and ready for testing
- Second project: Taking specimens during the construction of Čiovo bridge, determination of initial values of durability properties in order to enable comparison with concrete properties of construction in service
- Monitoring of chloride ingress during exploitation

Objectives for future work :

- Determination of criterions for concrete exposure classes in maritime environment
- Comparison of projected and real performances of concrete









Contact: elica.marusic@igh.hr

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Department of Materials

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Contact: **banjadi@grad.hr**

EDUCATIONAL ACTIVITIES

- Materials Science
- Theory and Technology of Concrete
- Building Physics
- Destructive and Non-destructive Testing
- Durability of Structural Materials
- Technology of Repair and Strengthening
- Fire Protection
- Special Types of Concrete and Technologies
- Precast Systems
- Numerical Modelling in Material Engineering
- Quality Management

PROFESSIONAL ACTIVITIES

- Assessment of materials in structures
- Laboratory testing and on-site testing
- Design of repair and rehabilitation of structures
- Corrosion monitoring of structures
- Infrared testing of structures and materials
- Energy audit of buildings
- Supervising of construction process
- Properties of cementitious materials on high temperatures

SCIENTIFIC ACTIVITIES

National scientific projects financed by Croatian Science Foundation.

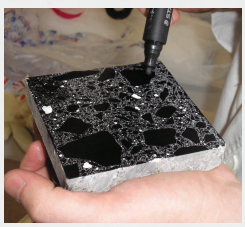
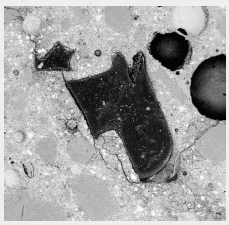
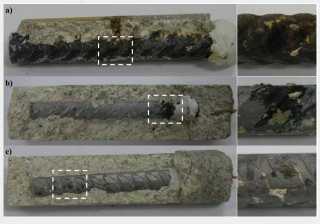
Current international research and development projects financed by the European Commission:

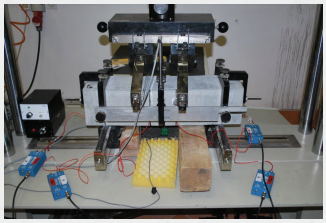
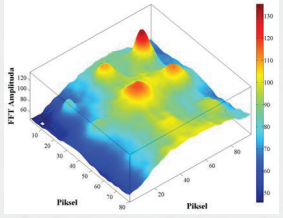
- FP7 2014 - Innovative Reuse of All Tyre Components in Concrete – ANAGENNISI
- CIP Intelligent Energy Europe 2014 - CROSKILLS II BUILD UP Skills Croatia
- CIP Eco-innovation 2012 - ECO-SANDWICH Energy efficient, recycled concrete sandwich facade panel
- COST TU1404, FP1404

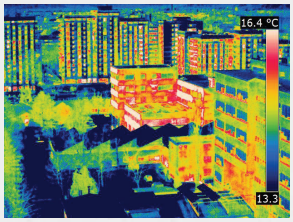
Past international research and development projects financed by the European Commission:

- CIP Intelligent Energy Europe 2012 - CROSKILLS BUILD UP Skills Croatia
- CIP Eco-innovation 2010 - RUCONBAR Rubberised concrete noise barriers
- FP6 STREP - Assessment and Rehabilitation of Central European Highway Structure - ARCHES
- EUREKA E!4166 FIRECON, E!2823 FIRE-TUNNEL, E!2345 "Industrial floor"
- LIFE05 TCY/CRO/000114 CONWAS
- COST TU0904, COST 530, COST 534



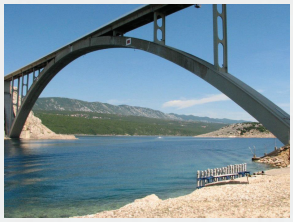













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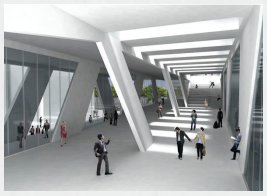




Faculty of Civil Engineering Osijek– teaching, research & professional projects

Specific experiences

- concrete behavior,
- metal, timber, masonry and composite structures exposed to permanent, variable and accidental actions,
- innovation in brick manufacturing industry,
- seismic and fire resistance of engineering structures,
- utilization of waste materials in construction,
- geotechnical engineering,
- road construction,
- application of geosynthetics in geotechnical works and road construction
- building renovation and reinforcement technologies,
- safety at work,
- productivity of construction workers,
- quality assurance in the engineering projects and economic impact of investment projects on the environment
- reinforced concrete structures design in seismic active regions at desired behavior level,
- seismic resistance assessment technics of existing engineering structures and their strengthening,
- infilled frames seismic analysis,
- seismic stability of historic buildings,
- water management and environmental protection,
- architectural heritage protection,
- rural architecture,
- energy efficiency in architecture (solar architecture),
- industrial architecture,
- landscape in spatial planning.



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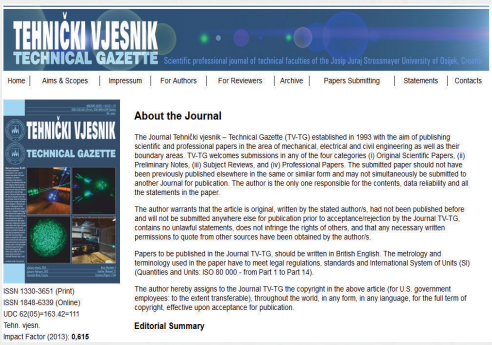
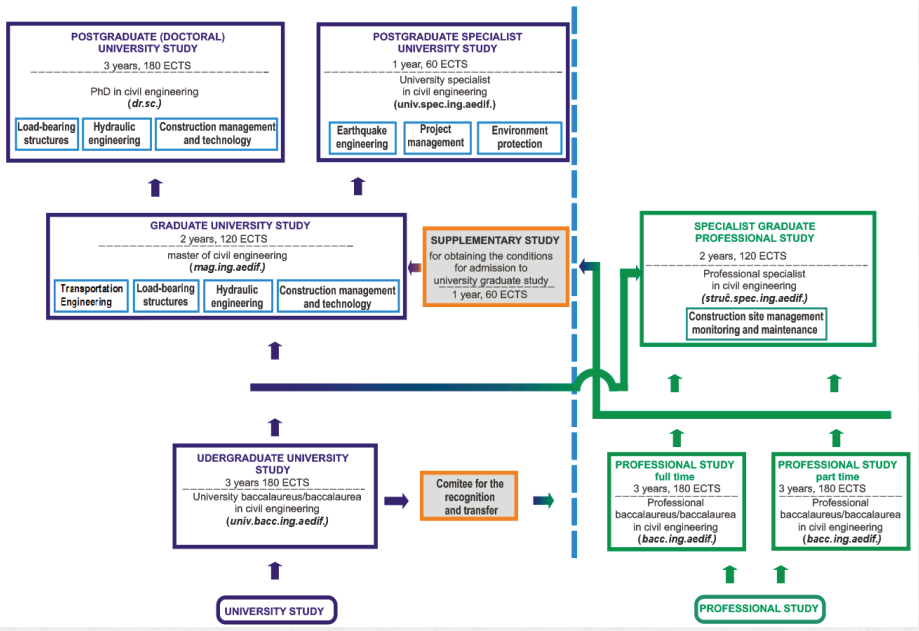


The Faculty is one of the co-publishers of scientific and professional journal of technical faculties of the J. J. Strossmayer University of Osijek, Technical Gazette.

Schematic display of study program structure



Relevant research topics

- **Civil engineering materials**
- **Waste materials in civil engineering**
- **Alternative aggregates and binders for structural concrete**
- **Alternative aggregates and binders in road pavement structure**
- **Testing on material characteristic level**
- **Testing on structural element level**

TU1404 MEMBERS:

Ph.D. Ivanka Netinger Grubeša, nivanka@gfos.hr
Ph.D. Ivana Barišić, ivana@gfos.hr
Ph.D. Ivana Miličević, ivana.milicevic@gfos.hr
Ph.D. Hrvoje Krstić, hrvojek@gfos.hr

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Czech Technical University in Prague, Faculty of Civil Engineering

represented by Vít Šmilauer, Radoslav Sovják and Karolína Hájková

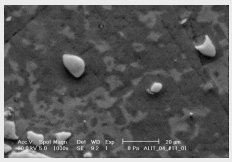
Czech Technical University in Prague was founded in 1707 as the oldest non-military technical university in Europe and became the leading technical university in the Czech Republic. Nowadays it consists of seven Faculties with 23 000+ students. The university covers 114 study programs with 450 fields of study. Faculty of Civil Engineering is the largest one. According to QS World University Rankings, the university holds 411 rank in World University Rankings 2014/15 and 151 in University Subject Rankings.



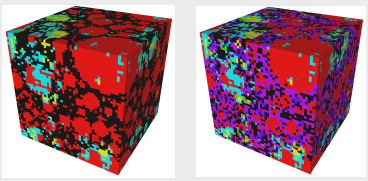
The Department of Mechanics is a part of the Faculty of Civil Engineering. The research is focused on computational mechanics, material models, experimental and numerical investigation of quasi-brittle and composite materials on micro-macro scales, geomechanics, optimization, and biomechanics. The department is formed by 7 full professors, 11 associate professors, 19 assistant professors and 41 PhD students. The department has numerous contacts with universities across the world and is involved in ~25 projects and contacts funded nationally and internationally, e.g. FP7 projects, collaborative projects with NSF, Skanska, Metrostav.

Experimental Centre (EC) is a part of the Faculty of Civil Engineering. EC deals with development and testing of Ultra-High Performance Fibre-Reinforced Concretes. UHPFRC is becoming very popular so its utilization in the modern and also protective structures is nowadays highly promoted. EC is focused on the assessment of the mechanical and dynamical properties, and also on the accelerated aging tests of the CBM. The department is formed by 1 full professor, 3 associate professors, 3 assistant professors and 6 PhD students.

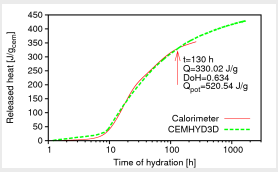
Multiscale modeling of cement-based materials



Statistical descriptors from BSE image



Hydrating cement microstructure



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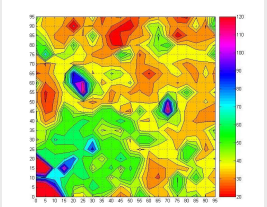
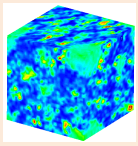
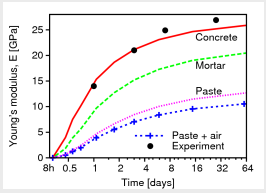


Nanoindentation map for elastic modulus – intrinsic property

Multiscale homogenization
Evolving 3D microstructure of cement paste, mortar and concrete





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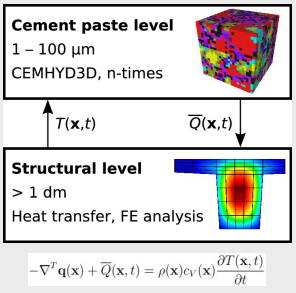
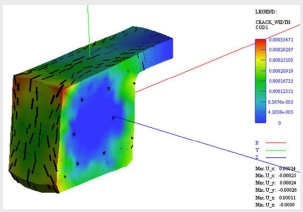


$$-\nabla^T \mathbf{q}(\mathbf{x}) + \overline{Q}(\mathbf{x},t) = \rho(\mathbf{x}) c_V(\mathbf{x}) \frac{\partial T(\mathbf{x},t)}{\partial t}$$



Crack development in the arch of Oparno bridge, Czech Republic

Experimental testing of cement-based materials

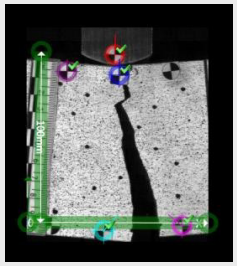




Extracting the core sample and adjusting it to the standard size for further expertise



Assessment of mechanical properties including compressive strength, tensile strength, modulus of elasticity, Poisson's ratio, modulus of rupture and fracture energy



Testing the resistance of CBM to high strain rates such as impact loading



Assessment of dynamical properties such as dynamic modulus of elasticity using modal analysis or ultrasonic pulse method

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AALBORG UNIVERSITY
DENMARK

DEPARTMENT OF CIVIL ENGINEERING

ABOUT US

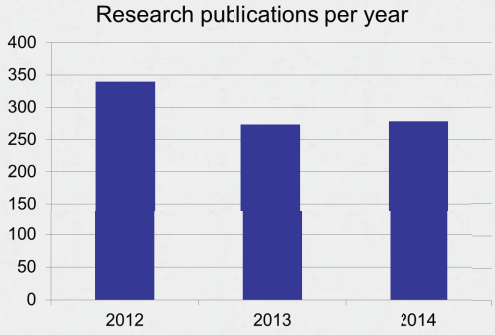
The Department of Civil Engineering focuses on research concentrated on developing and impacting the building sector in the future. Research and teaching are conducted in areas which centre on understanding environmental causality and planning people's physical environment. We undertake contractual research projects for government institutions as well as private companies.

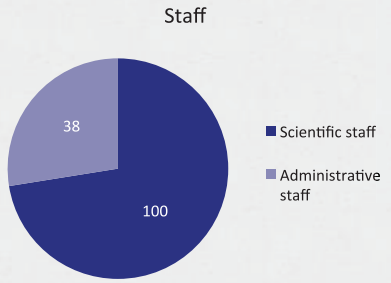
Regarding both student and research projects, we are widely experienced in collaborating with external partners. We mainly collaborate with companies within the building and construction sector, and we have a profound knowledge of the demands and legislation within this area.

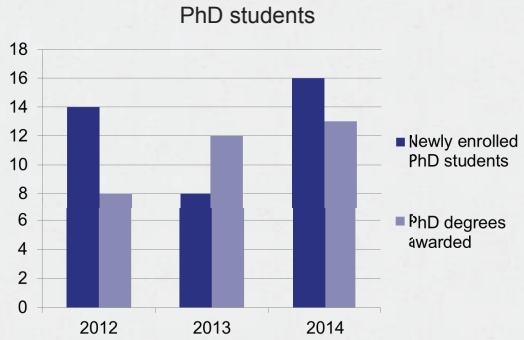
New projects and co-operations are always welcome as new thoughts and ideas are best developed through dialogue.

RESEARCH

The research is conducted in both international and national research environments. The Department undertakes contractual research projects for governmental institutions as well as for private firms. These projects comprise theoretical research as well as site measurements and experimental tests in the laboratories.







DIVISIONS

ARCHITECTURAL ENGINEERING

"We work with research and education in analysis, design, construction and operation of engineering systems for commercial, industrial and institutional facilities. Our main research areas are energy-efficient building design, indoor environment and building informatics."

Keywords:
user systems for buildings, indoor environment, acoustics, ventilation

TRANSPORTATION ENGINEERING

"We research in safety, planning and management within the traffic area, public transport in cities and urban areas and also research in different aspects of physical planning."

Keywords:
traffic safety, traffic planning, traffic management, intelligent transport systems, transport development

STRUCTURES, MATERIALS AND GEOTECHNICS

"Our research field revolves around both theoretical and numerical modelling and experimental verification within the field of structural mechanics, structural materials and geotechnics."

Keywords:
construction stability, fracture mechanics, geotechnics, material modelling, vibrations, foundations

WATER AND ENVIRONMENT

"We research in the hydraulic and hydrological problems in relation to environmental plants and projects and in the physical geography mainly aimed at environmental and resource issues."

Keywords:
hydraulics, physical geography, rain and waste water run off

RELIABILITY, DYNAMICS AND MARINE ENGINEERING

"Our research and study activities are centred around challenges related to civil engineering structures like harbour structures, offshore structures, wind turbines and wave energy devices."

Keywords:
harbour structures, offshore constructions, wind turbines, wave energy

CIVIL.AAU.DK

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TAMPERE UNIVERSITY OF TECHNOLOGY

Department of Civil Engineering
Unit of Structural Engineering

Employs approx. 50 people in 7 different research groups:
- The building acoustics
- The building physics
- The fire engineering of structures
- The mechanics of structures
- The metal construction
- **The service life engineering of structures**
- The structures and their behaviour





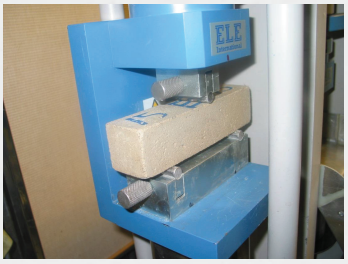

The service life engineering of structures

The main research areas

- Renovation
- Energy efficiency
- **Adaptation to climate change**
- **Product development** with industry
- **Condition assessments of structures**
- Assessments of structural and renovation plans
- **Quality assurance and testing of building materials**
- Developing and publishing design guidelines
- **Life-cycle analyses**

Research team:

- Professor Matti Pentti
- Adjunct professor, leader of the group, Jukka Lahdensivu
- 4 PhD students:
  - Petri Annila: *Model for early detection of moisture and mould damage*
  - Kimmo Hilliaho: *Energy saving potential and indoor climate of glazed spaces*
  - **Arto Köliö: *Service life of existing concrete buildings***
  - **Toni Pakkala: *Adaptation to climate change of existing concrete structures***
- 3 Project researchers & 1 research assistant






Testing facilities

"Truly unique in Scandinavia and would be placed among the top 10-15 in the USA"
Birgisson, B., Fournier, C., Haugen, T., Wang, M.L., de Vries, B. 2011. TUT Research assessment exercise. Panel II: Faculty of Built Environment. Assessment Report. 17 p.

- Freeze-thaw testing equipment for small test specimens (e.g. mortar prisms)
- Two accelerated weathering test equipment for large structures (e.g. ETICS test walls, 2 x 3 m²)
- Rapid carbonating equipment for mortars and concrete
- Equipment for testing both small and large scale tensile and compression strength and tensile strength in bending
- Abilities and 30 year's of experience in preparing experimental and advanced testing facilities

For more information visit: *www.tut.fi/servicelife*

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AALTO UNIVERSITY SCHOOL OF ENGINEERING, FINLAND

Department of Civil and Structural Engineering
Fahim Al-Neshawy; Esko Sistonen; Olli-Pekka Kari; Mari Eik; Jari Puttonen
(firstname.surname@aalto.fi)

BASIC DATA OF THE ORGANIZATION

School of Engineering: Expertise in technology and the built environments

Key figures 2013: Students: 4 001; Doctoral degrees: 26; Masters' degrees: 317; Bachelors' degrees: 345; Personnel: 769; Professors: 57

Departments: (1) Applied Mechanics; (2) Civil and Environmental Engineering; **(3) Civil and Structural Engineering;** (4) Energy Technology; (5) Engineering Design and Production; (6) Real Estate, Planning and Geoinformatics

Department of Civil and Structural Engineering

Educational Studies: Structural Engineering and Structural Mechanics; Building Materials Technology and Construction Technology; Building Physics and Service Life Management of Structures; Construction Economics and Management; Building Services Technology; Building Information Modelling

Research Areas: Building Information Modelling and Construction Management; Building Physics, Building Services Technology and Environmental Microbiology; Computational Structural Engineering and Building Materials

RESEARCH ACTIVITIES

- **Performance of concrete structures:** Condition surveys; Behaviour of building materials; Prediction of deterioration of structures; Behaviour of rehabilitated structure
- **Monitoring of the hygrothermal behaviour of concrete structures:** Prediction of deterioration based on the monitored data and the properties of building materials
- **Simulations of the complex physiochemical processes in concrete**; estimating the long-term (over 100s of years) ageing phenomena in concrete
- **ICT applications for the construction sector:** Condition assessment databases; Environmental condition monitoring applications; Historical mortars database "von Konow – database"; Deterioration prediction software
- **Research on items related to nuclear safety:** Assessing the condition of NPP safety related concrete structures
- **Service life prediction**
- **Mechanical design of special structures:** Numerical analysis in engineering
- **Steel fibre reinforced concrete (SFRC):** DC-conductivity testing by a robot; X-ray micro-tomography scanning

POTENTIAL SELF DEVELOPED ADVANCED TESTING TECHNIQUES

- 3D-printer for concrete
- Laser scanning of concrete structures
- Hygrothermal monitoring platforms

OUR ROLE IN THIS COST ACTION

Our research team is seeking co-operation and support in the following fields:

- Durability modelling and service life prediction of concrete structures
- The use of ICT platforms for buildings
- Steel fibre reinforced concrete

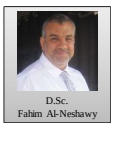
Aalto University
School of Engineering


Prof. Jari Puttonen


D.Sc. Wei Lu


Lic.Sc. Mika Reivinen


D.Sc. Esko Sistonen


D.Sc. Fahim Al-Neshawy


D.Sc. Marika Eik


D.Sc. Olli-Pekka Kari

Research team

LMDC - Toulouse University*

Experimental devices for THCM behaviour of concrete

42 faculty members		≈55 PhD or postdoctoral students	8 administrative and technical staff
36% Women	30% Early Career Investigators		

* Université de Toulouse; UPS, INSA; LMDC (Laboratoire Matériaux et Durabilité des Constructions)
135, avenue de Rangueil; F-31 077 Toulouse Cedex 04, France

Thermo-hygro characterisation

- Thermal conductivity and capacity devices
- Sorption isotherms (coupling with T)
- Permeameters, diffusion cells

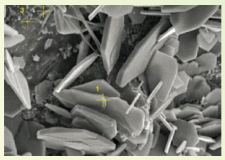
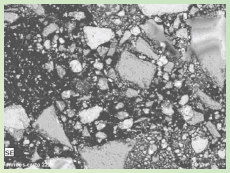





Chemical characterisation

- Calorimeters (isothermal and semi-adiabatic)
- Degradation devices
- SEM, EDS
- XRD
- TGA, DSC




Understanding of the behaviour of concrete structures under THCM loadings

Mechanical characterisation

- Loading devices for structures
- Video-correlation for cracking characterisation
- Fresh-properties devices (rheometers)





Characterisation under THM loadings

- Creep under scalable TH conditions
- Large climatic chambers





Data for model design and fitting

Implication in COST TU1404		WP1	WP2
MC Substitute for France	Coordinator of WP2-e	THCM behaviour of concrete and reinforced concrete at early age	Macroscopic and multiscale modelling of early age behaviour

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LAFARGE Research Center
Institution description

Lafarge is a world leader in building materials. It's a major player in the cement, aggregates and concrete businesses, operating in 62 countries with 64000 employees. Lafarge contributes to the construction of cities throughout the world with innovative solutions, providing cities with more housing, and ensuring that they are more compact, more durable, more beautiful and better connected.

Location of the Research Center



Description

- **The Research Center**
  - 240 researchers
  - 60% of our managers have PhDs
  - 10 nationalities represented
- **A unique patent portfolio**
  - More than 150 granted patents
  - Over 1000 patents in global portfolio
- **Unique pilot-scale facility devoted to concrete innovation**
  - Real-time and industrial-scale conditions
  - Rapid market launches of new innovative concretes
- **"CDL Euromed": a laboratory devoted to the development of new construction systems**



Main missions for the Research Center

- Create value in our market segments with innovative construction solutions
- Remain one step ahead, anticipating trends and highlighting new technologies
- Be a reactive partner in business, providing expertise in addition to local resources

Collaboration policy

- Close partnerships with the world's best teams of researchers to accelerate progress made in materials science
- Founder member of the European network "Nanocem", based at the "Ecole Polytechnique" in Lausanne, Switzerland
- Member of the Concrete Sustainability Hub, partnership with MIT

Contact: arnaud.delaplace@lafarge.com

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TU Braunschweig iBMB/MPA

Facts and organisation

- Location: Braunschweig, Germany
- Staff: approx. 200 employees
- Gender balance: approx. 20% women
- Young scientist / phD students: approx. 30
- Organisation: two institutions – one entity

MPA
Material testing

iBMB
Research (university)

Exchange:
- Know-how
- Technical competence
- Experience from research
- Development of tests methods
- New research needs from industry

Jointly used:
- Buildings
- Experimental facilities
- Library



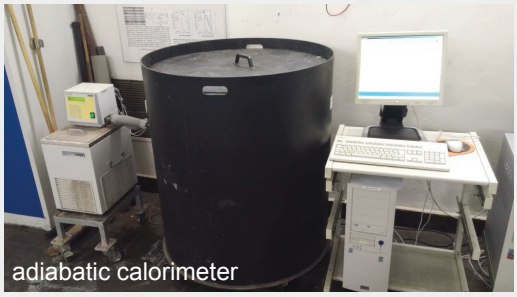
Participation in COST Action

- Wibke Hermerschmidt (WG1+2)
  w.hermerschmidt@ibmb.tu-bs.de
- Alex-W. Gutsch (WG1+3)
  a.gutsch@mpa.tu-bs.de
- Hans-W. Krauss (WG1)
  h.krauss@ibmb.tu-bs.de

Research and testing equipment for cement based materials and concrete structures

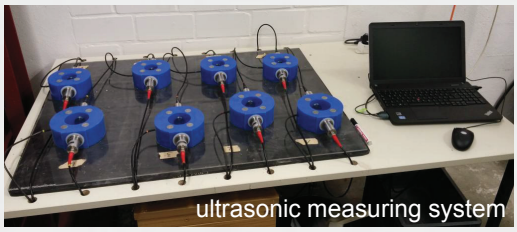
Hydration process

- Calorimetry
  - isothermal (paste, mortar)
  - semi-adiabatic (mortar, concrete)
  - adiabatic (mortar, concrete)
- Ultrasonic measuring system for measurement of setting processes


adiabatic calorimeter

Mechanical properties

- Test machines
  - compression
  - tension
  - bending
- Temperature stress testing machines (TSTMs) for measurement of viscoelastic properties of early age concrete
- Mechanical creep rigs for tension and compression
- Optical 3D deformation analysis (digital image correlation)


ultrasonic measuring system

Microstructural characterisation

- Micro-CT
- Digital microscope
- MIP, SEM/EDX


temperature stress testing machines

General equipment

- Concrete mixers with different volumes
- Standard mortar laboratory
- Climatic chambers


test machines


creep rig


digital microscope


micro-CT

www.ibmb.tu-braunschweig.de www.mpa.tu-braunschweig.de

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BAM Federal Institute for Materials Research and Testing, Berlin, Germany

Department 7: Safety of Structures
Contact: andreas.rogge@bam.de







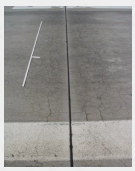


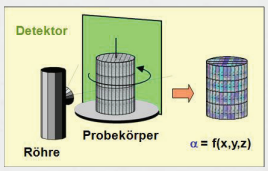
Expertises and technical departments

Dept. 1: Analytical Chemistry; Reference Materials
Dept. 2: Chemical Safety Engineering
Dept. 3: Containment Systems for Dangerous Goods
Dept. 4: Materials and Environment
Dept. 5: Materials Engineering
Dept. 6: Materials Protection and Surface Technologies
Dept. 7: Safety of Structures
Dept. 8: Non-destructive Testing
Dept. 9: Component Safety
Dept. S: Quality Infrastructure

Divison 7.1 Building Materials:

- Cementitious and bituminous materials
- Damage mechanisms and protective measures
- Microstructural and X-ray methods

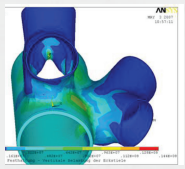


Division 7.2 Buildings and Structures:

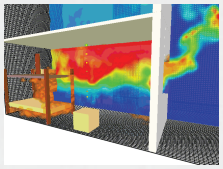
- Experimental Structural Safety Assessment
- Structural health monitoring and condition analysis
- Wind energy structures

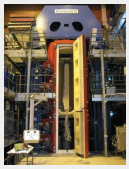





Division 7.3 Fire Engineering:

- Fire effects on materials and structures
- Industrial fires and fire scenarios
- Large component fire testing



Divison 7.4 Technology of Construction Materials:

- Cementitious and mineral materials
- Saving resources by recycling
- Admixtures and rheology



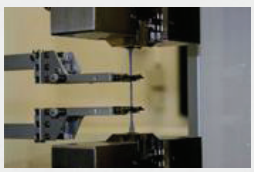




Division 7.5 Technical Properties of Polymeric Materials:

- Elastomer and Reference Materials
- Fire Retardancy and Weathering Resistance of Polymers





TU 1404 COST ACTION
ESF provides the COST Office through a European Commission contract
COST is supported by the EU Framework Programme
cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Chair of Non-destructive Testing

LEHRSTUHL FÜR ZERSTÖRUNGSFREIE PRÜFUNG

Prof. Dr.-Ing. Christian Große

FOCUS OF RESEARCH

The chair is as working group 6 (AG6) part of the center for building materials in Munich-Pasing and member of both the faculty of civil geo and environmental engineering and the faculty of mechanical engineering. Field of activities are further developments and applications of non-destructive testing methods for the investigation of materials, components, structures and buildings as well as the education of students in non-destructive testing techniques.

Topics

- Quality assurance before, during and after the construction
- Inspection of parts and facilities
- Continuous surveillance/monitoring
- Assisting with component design and material selection

Applications/Materials

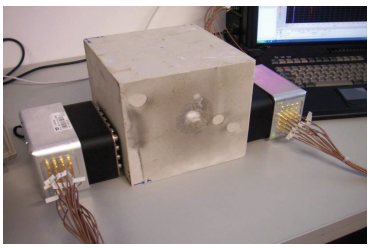
- Inspection of Constructions (concrete, steel, timber technology, natural stone)
- Quality Control of Fresh Concrete
- Mechanical Engineering (wind turbines, aeronautical and automotive structures)
- Buildings of the Cultural Heritage (preservation)
- Materials:
  Concrete, reinforced concrete, steel, composite materials (CFRP, GFRP), wood, natural stone, ceramics, polymer materials



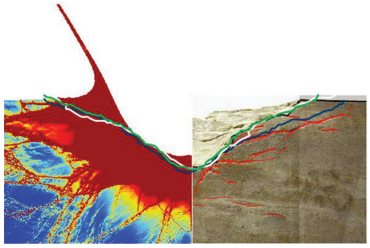
GEOSCIENCES / IMPACT RESEARCH

Impact processes are among the most important processes in the solar system. In laboratory experiments, these processes can be studied under controlled conditions. Ultrasound is used to determine the extend of the damage zone.

TU München – Civil Engineering and Surveying, Chair of Non-destructive Testing, Manuel Raith (M.Sc.)



Ultrasound-Tomography recording carried out on an impacted sandstone. The front view shows features of an impact crater.



The validity of a simulated meteorite impact (left picture) can be tested by juxtaposing results of the simulation with real test objects (right picture) impacted in a laboratorial environment.

CONTINUOUS MONITORING OF BULDINGS AND STRUCTURS

The aging of structures and components is a growing problem. Monitoring systems (structural health monitoring) can help in terms of a life prognosis (e.g. expansion joints).

TU München – Civil Engineering and Surveying, Chair of Non-destructive Testing, Dipl.-Geophys. Robin Groschup



Bridges are typical objects examined by structural health monitoring systems.



Using wireless sensor nodes for monitoring historical buildings.

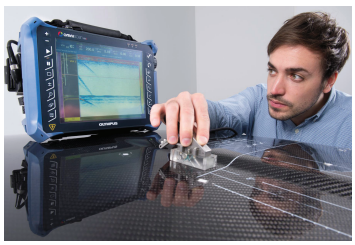
FIBRE REINFORCED COMPOSITES: AERONAUTICS & AUTOMOTIVE

Finding defects (e.g. delamination) in composite materials (here: Satellite Panel) using lock-in thermography and BondMaster. In the automotive sector lightweight constructions are increasingly important. In particular more and more CFRP is used. New testing methods need to be developed in order to maintain a reliable detection and assessment of damages and defects.

TU München – Faculty of Mechanical Engineering, Chair of Non-destructive Testing, Dipl.-Ing. Philip Jatzlau



Quality assurance of a satellite panel using non-destructive means of Lock-in thermography and ultrasound measurements.



The application of new materials, like CFRP, requires a development of new non-destructive testing techniques to maintain safety standards, quality controll and repair measures.

RANGE OF SERVICES AND METHODS

Ultrasound
- Ultrasound in through-transmission, e.g. for the determination of elastic properties (elastic moduli, porosity, crack density, etc.)
- Ultrasound reflection and phased array
- Location of faults (cracks, voids, etc.)

Acoustic Emission Analysis
- Detection of damage (microcracks)
- Representation of spatiotemporal damage development
- Localization (1D, 2D, 3D)
- Analysis of damage parameters (size, surface and type of a fracture)

Modal and Vibration Analysis
- Determination of modal parameters
- Determination of elastic properties
- Detection of damages

Infrared-Thermography (active / passive / Lock-In)
- Detection of subsurface damage
- Detection of moisture and areas with increased heat flow (energy analysis, thermal bridges)

RADAR (Georadar)
- Detection and localization of reinforcements (reinforcements, ducts and pre-stressed elements)
- Locating defects or moisture
- Analysis of layered components

Further NDT methods:

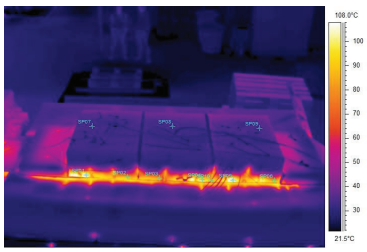
Laser vibrometry
Impact-Echo
Monitoring using wireless sensor techniques
Delamination testing (BondMaster)
Endoscopy
Moisture measurements
Eddy current
Radiographic testing

IMPROVEMENT OF CEMENTITIOUS MATERIALS (CONCRETE)

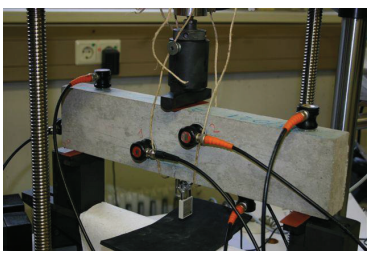
By exposure to fire mechanical properties of concrete can change (cracking). In high-strength concrete, explosive spalling can occur. Acoustic emission analysis and infrared thermography monitor deteriorations and thus aid a development of concrete mixes, which will prevent spalling in the future.

Self-healing of concrete by adding healing agents minimizes crack induced corrosion by creating a barrier against fluids. Investigated healing mechanisms include the application of micro-tubes filled with a healing agent and microorganisms precipitating calcium carbonate.

TU München – Faculty of Civil Engineering and Surveying, Chair of Non-destructive Testing, Fabian Malm (M.Sc.) and Prof. Dr.-Ing. Christian Große



Thermographic image of conrecte test bodies under fire exposure. Attached sensors record acoustic emissions during thie experiment.



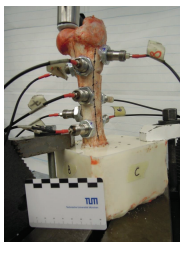
Non-destructive testing and monitoring techniques will help to characterize effects of different self-healing mechanisms in small and full-size specimens.

BIOMECHANICS

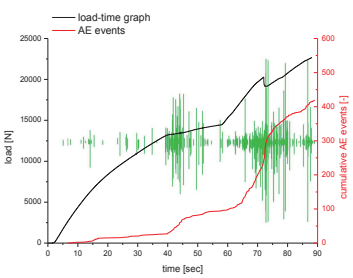
Examination of the fracture process in femoral neck fractures. Whereas the monitoring and evaluation of dynamic fracture events is nearly impossible with imaging methods, the acoustic emission analysis is able to record such breaking processes load dependently.

TU München – Civil Engineering and Surveying, Chair of Non-destructive Testing, Fabian Malm (M.Sc.)

Klinikum rechts der Isar der TU München; Klinik für Orthopädie und Sportorthopädie; Abteilung für Biomechanik; Dipl.-Ing. Peter Föhr



A porcine femur, embedded in a casting resin ,clamped in a universal testing machine. Attached sensors record the acoustic emissions during the load depended experiment.



A typical diagram of a load dependent acoustic emission experiment, where the load time curve (black) is shown together with the cumulated acoustic emission events (red). The green curve reflects the incoming signals of a single transducer.

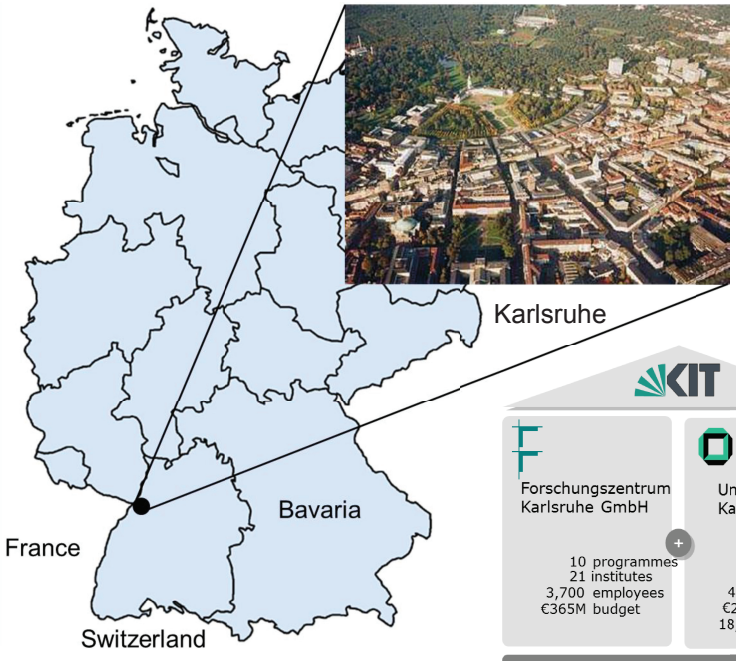
FURTHER COLLABORATIONS WITH OUR INDUSTRY PARTNERS

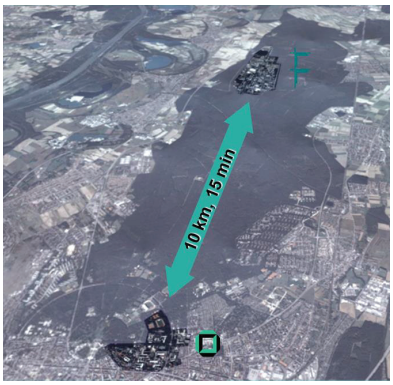
Examples for current investigations are:

- Failure mechanisms of Carbon-Fiber-Reinforced-Polymer materials characterized by acoustic emission techniques
  BMW AG, Dipl.-Phys. Martin Radlmeier
- Holistic Monitoring and Inspection of Structures at Large Wind Turbines
  IABG mbH, Dipl.-Ing. Christian T. Geiss & Dipl.-Ing. Bernhard Wondra
- Quantitative Structure and Defect Characterization of Carbon Fiber Reinforced Polymer Materials with Micro-Computed Tomography
  Airbus Group Innovation, Dipl.-Ing. (FH) Denis Kiefel
- Performance Assessment of various NDT-Methods to be applied for the one-sided Inspection of CFRP-Honeycomb Structures
  Airbus Helicopters Deutschland, Dipl.-Inf. Michael Mosch

Institutional and industrial partners of the Chair of Non-destructive Testing

Institute of Nanotechnology







Institute of Nanotechnology (INT)

KIT

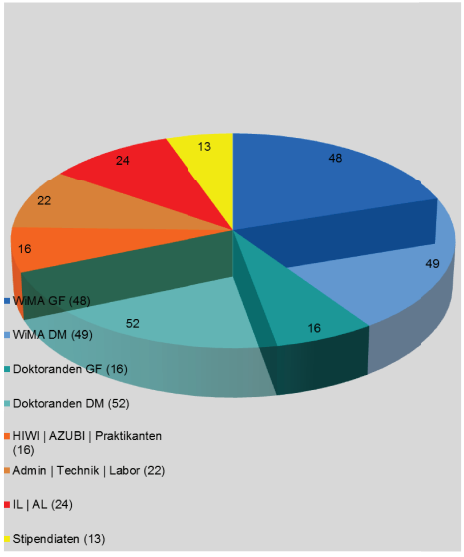
Forschungszentrum Karlsruhe GmbH
10 programmes
21 institutes
3,700 employees
€365M budget

Universität Karlsruhe (TH)
11 faculties
118 institutes
4,000 employees
€272M budget
18,500 students

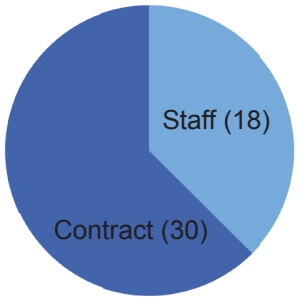
Natural sciences and technical engineering

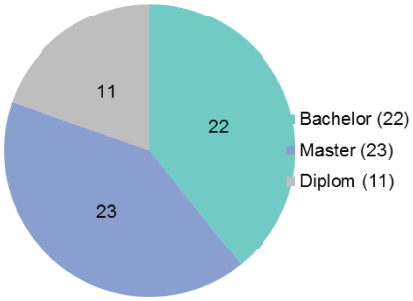
INT Personnel 2013

Total number of personnel = 240 (56 female)



Total number of Research Scientists 48





Total number of Students = 56 (11 female)

Equipment & Facilities

The Institute of Nanotechnology (INT) is a world-class facility with equipment and technologies ranging from imaging and diffraction to cryophysics. And for those requiring custom-made glass apparatus or unique, manufactured devices, we have an in-house glassblowing workshop and mechanical and electrical workshops.

Open-access Facilities (KNMF)

The INT also collaborates with the Karlsruhe Nano Micro Facility (KNMF), a large-scale facility providing public users from industry and academia free access to state-of-the-art micro and nanotechnologies. Part of this facility is coordinated in-house as the Electron Microscopy and Spectroscopy Laboratory.

MŰEGYETEM 1782

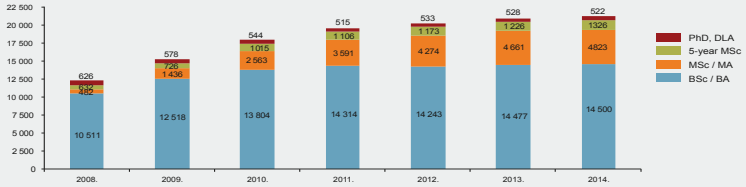
BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS

Leader in technical higher education

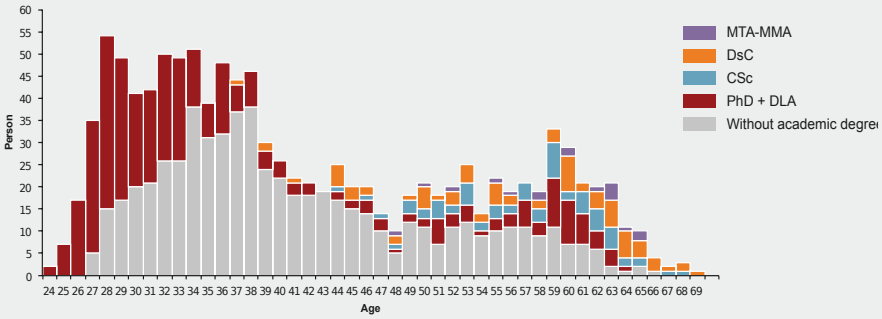
Applicants in recent years
2010-2014

Year	Applicants countrywide	Applicants at BME	BME / countrywide
2010.	160 033	13 625	8.5%
2011.	161 731	13 752	8.5%
2012.	126 544	13 955	11.0%
2013.	109 269	11 966	11.0%
2014.	121 509	13 017	10.7%

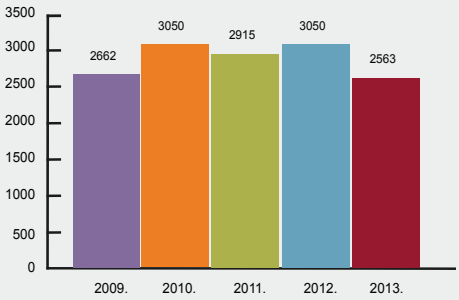
Number of BME students by level of qualification
2008-2013



Full-time professors and researchers of BME
2014, N=1133



Scientific publications of BME
2009-2013



Faculties

- Architecture
- Mechanical Engineering
- Natural Sciences
- Economics and Social Sciences
- Chemical Technology and Biotechnology
- Transportation Engineering and Vehicle Engineering
- Electrical Engineering and Informatics

MŰEGYETEM 1782

Civil Engineering

Departments:

- **Construction Materials and Technologies**
- **Engineering Geology and Geotechnics**
- Geodesy and Surveying
- Photogrammetry and Geoinformatics
- Structural Engineering
- Structural Mechanics
- Highway and Railway Engineering
- Hydraulic and Water Resources Engineering
- Sanitary and Environmental Engineering

Material Testing Laboratory

Cement paste:

- microstructural analyses by XRD and TG/DTG/DTA

Mortar and concrete:

- testing early age properties (for normal and SCC),
- testing mechanical properties (strengths, NDTs, modulus of elasticity, etc.)
- testing shrinkage cracking development,
- durability characteristics (freeze-thaw, salt scaling)
- rapid chloride migration (by NT Build 492)
- resistance in elevated temperature.

Our role in the COST Action: taking part in the Round-Robin testing.

TU 1404 COST ACTION

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COST is supported by the EU Framework Programme

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UNIVERSITY of MISKOLC - HUNGARY
FACULTY of EARTH SCIENCE & ENGINEERING

Contact: Gábor Mucsi, Deputy Dean, e-mail: ejtmucsi@uni-miskolc.hu

Introduction

The University of Miskolc is the leading higher education institution and academic center in the North Hungarian region, a state university with long traditions and with great development potentials. The history of the university can be traced back to 1735, when the world's first technical higher education institution, the Selmecbánya School of Mining and Metallurgy was established. Naturally, the institution, which in the meantime had to move from Selmecbánya to Sopron and then to Miskolc,



Figure 1. City of Selmecbánya



Figure 2. Academy in Sopron



Figure 3. University of Miskolc

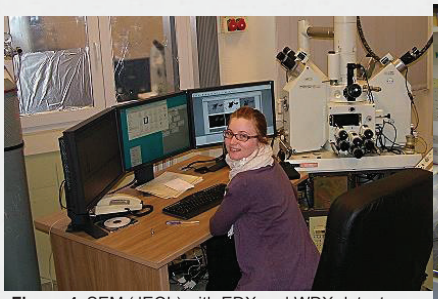

Figure 4. SEM (JEOL) with EDX and WDX detector

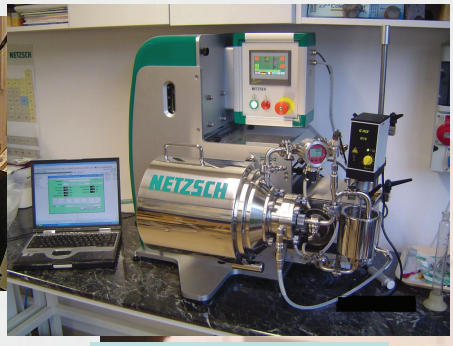

Figure 5. Netzsch MiniCer nano-mill, x_{90} = 100…200 nm



Figure 6. Netzsch ultrafine classifier, x_{90} = 2…5 µm



Figure 7. JASCO 4200 FT-IR spectrometer

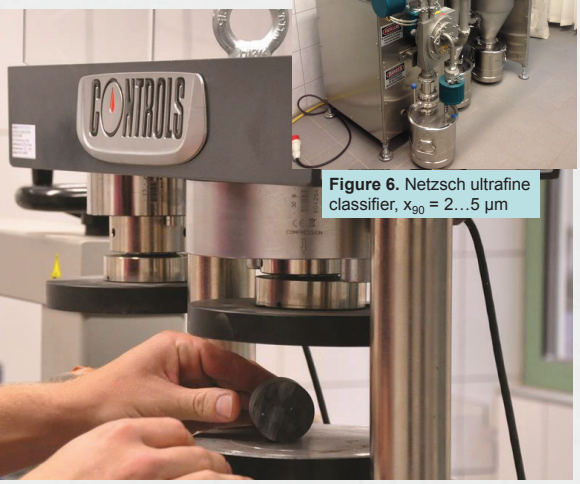

Figure 8. CONTROLS strength testing machine



Figure 9. Field trip with students (Cement plant)



Figure 10. BRUKER D8 Advance 2 Powder diffractometer

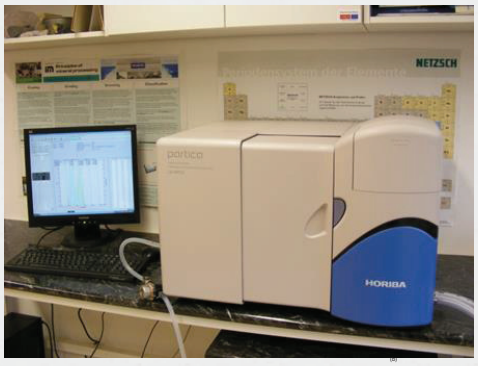

Figure 11. HORIBA laser particle size analyser (10 nm – 3 mm)

The Faculty of Earth Science and Engineering - the former Faculty of Mining - has been conducting research and training engineers involved in locating, exploiting and processing natural resources, preserving our natural environment as well as managing and decreasing damage caused to the environment by civilization. The objective of the courses offered by the department is to train engineers who know the laws of nature, earth science and environmental sciences well, are able to apply them and are well-qualified. The engineers graduated from our faculty design, manage, exploit, prepare and assist with locating raw materials, energy resources and water supplies as well as exploit, prepare, plan and carry out geological research for non-mining purposes.

The academic and research work going on at the Faculty is conducted on a high level and has gained national and international recognition. This is ensured by well-prepared academics and researchers as well as by wide international co-operative activities. The conditions for education and research activities are also provided: technical books, journals, and collections of technical literature, state-of-the art experimental systems, modernized laboratories, devices and equipment and the informatics infrastructure.

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Dublin Institute of Technology
Research & Enterprise



Overview

Research in DIT is consolidated into four overarching themes including:

- Information, Communications & Media Technologies;
- New Materials & Devices;
- Environment, Energy & Health and
- Society, Culture & Enterprise

Sustainability

DIT is committed to sustainability in all aspects of its teaching, research, operations and community engagement.

Research Groups

DIT's research activities are carried out through its Research Institutes and designated R&D Centres and Groups.

Technology Transfer

DIT Hothouse is an award-winning Innovation and Technology Transfer Office and is responsible for the commercialisation of intellectual property arising from DIT research. Through their New Frontiers Programme, an incubation centre is available for innovative and promising start-up companies.



Directorate of Research and Enterprise

- Research policy, implementation, development & management
- Administration of Graduate Research & PhD programmes
- Maintenance and provision of research information
- Engagement with industry, professional services and commercialisation of research.

Contact

Dr. Brian O'Neill
Director of Research, &
Dean of the Graduate Research School
Phone: +353 1 402 3481
Email: brian.oneill@dit.ie

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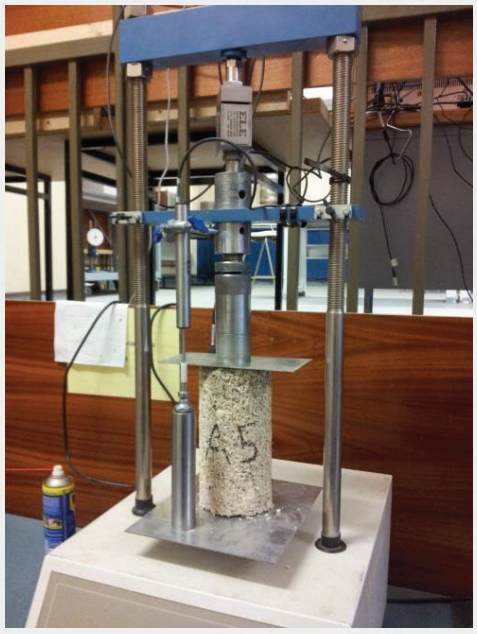
Dublin Institute of Technology

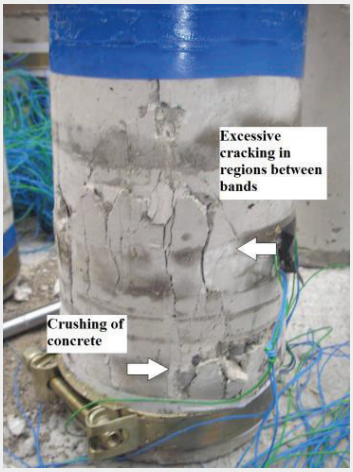
Civil Engineering Research Group

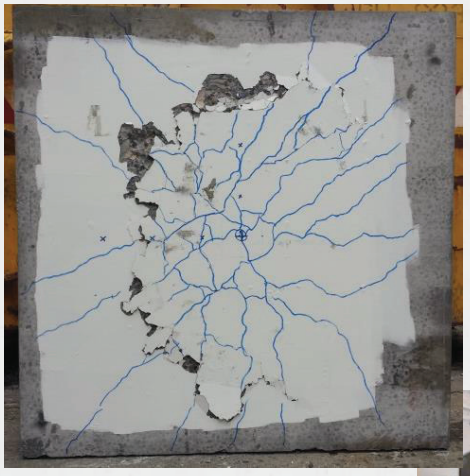
CERG is involved in a wide range of construction materials research projects, many with industry collaboration. Example of ongoing research projects include:

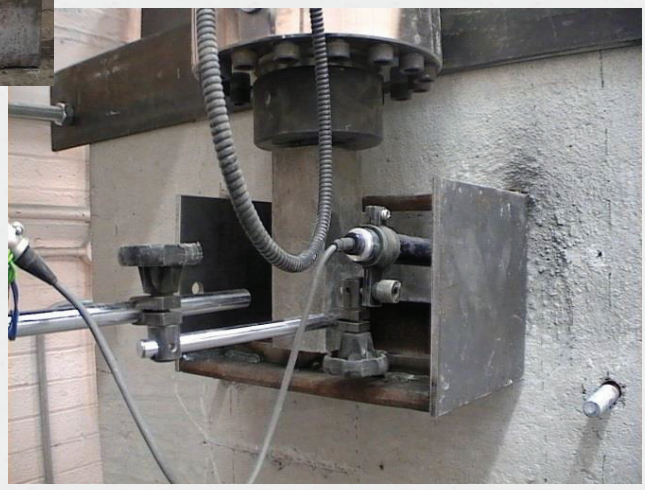
- Mechanics of stone staircases
- Concrete acoustic improvements using waste materials
- Assessment of new cementitious materials
- Determining structural and mechanical properties of a new soil stabilisation product
- Structural assessment of innovative portal frames and connection details
- Active confinement of concrete columns











The group is led by Dr. Niall Holmes, Lecturer, School of Civil & Structural Engineering
Email: niall.holmes@dit.ie
Ph: (+353) 1 402 2914

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RIGA TECHNICAL UNIVERSITY
FACULTY OF CIVIL ENGINEERING

INSTITUTE OF MATERIALS AND STRUCTURES

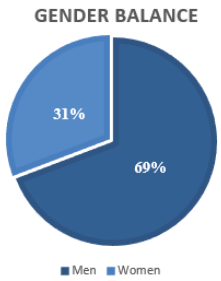
D.Bajare*, A. Korjakins*, G. Shakhmenko*
* Faculty of Civil Engineering, Riga Technical University, Kalku st. 1, Riga, Latvia

IMS RIGA TECHNICAL UNIVERSITY INSTITUTE OF MATERIALS AND STRUCTURES

COST action TU 1404

The Institute of Materials and Structures (IMS) has been accumulating experience in the field of advanced composite materials and structures. IMS participates in various local and international scientific projects, funded by the Latvian Council of Sciences, Ministry of Education and Science, as well as European Commision.
IMS consists of 2 units: Department of Building Materials and Products and Department of Composite Materials and Structures.

IMS personnel	
Doctoral students	10
Researchers	10
Leading researchers	7
Academic personnel	
Professors	4
Ass.professors, docents	5
Lecturers	1
Technical personnel	
Technicians	4



IMS partnership includes leading composites businesses, research institutes and universities in composites research such as German Aerospace Center, AIRBUS, Israel Aircraft Industries, MEYER WERFT in projects under EC Framework 7 programme:

- New Robust Design Guideline for Imperfection Sensitive Composite Launcher Structures – DESICOS (Collaborative Project, 2012-2015);
- Cooperation of Space NCPs as a Means to Optimise Services – COSMOS (Coordination and Support Action, 2008-2011);
- Development of an Innovative Manufacturing Process for the in-Line Coating of pultruded composites – COALINE (Collaborative Project, 2013-2016).

Participated in:
• COST Action TU0701, "Improving the Quality of Suburban Building Stock";
• COST Action TU0802, "Next generation cost effective phase change materials for increased energy efficiency in renewable energy systems in buildings (NeCoE-PCM)";
• COST Action TU1301, "NORM for building materials";
• COST Action MP0902 „Composites of Inorganic Nanotubes and Polymers";
• COST Action TU1104 „Smart Energy Regions"

Main research directions:

- Concrete structures, design, preformance
- Recycling of industral and agricultural waste
- Nanoconcrete
- Ecological materials
- Building materials and technologies
- Smart building materials
- Finite element analysis of sandwich and laminated composite structures
- Optimal design of composite materials, structures and technological processes
- Damping analysis of composite materials and structures
- Identification of material properties and damage in advanced composites
- Interlaminar fracture analysis of laminated composites
- Finite element modelling and analysis of active control for metal and composite structures by piezoelectric patches and layers
- Dynamics

Contact information:

Head of the Institute: Prof. Andris Čate, e-mail: and_cate@latnet.lv

Address: Kalku 1, Riga, LV – 1658, Latvia
Tel.: +371 6708 9254, e-mail: ims@rtu.lv
Webpage: www.ims.rtu.lv

Equipment:

- **Equipment to measure hydration temperature inside of concrete mixes**





- **Controls impermeability apparatus C245**



- **Planetary ball mill Retch PM 400**
- **Twin shaft batch mixer BHS Sonthofen**
- **Cavitation apparatus**
- **Autoclave**
- **Compression tester CONTROLS 30000 kN**
- **AACS climate chamber, Angelantoni Industries**
- **INSTRON 8802 and INSTRON 8872, multifunctional servohydraulic system** for static, dynamic and fatigue testing of materials and structures.
- **Zwick Z100 system**, which is used for quasi-static loading of materials using constant, increasing or changing forces, as a pulsing loading for compression, tension and bending.
- **INSTRON 925HV**, multifunctional impact system for impact testing of materials and structures, with possibility to investigate material's energy absorption and damage propagation characteristics.
- **USP 3010 Ultrasonic Imaging System**, which measures up to 20000 amplitudes and up to 10000 time-of-flight values per second.
- **Polytec OFV-5000**, which modular design allows the frequency, velocity and displacement capabilities to be tailored to specific or multiple applications, and ISI-SYS Vibrograph system for non-destructive testing in combination with dynamic, thermal heating and static loads (vacuum and internal pressure).

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ktu institute of architecture and construction 1922

The Accredited Laboratory of Composite and Finish Materials

EDITA SMETONAITĖ AND MILDA JUCIENĖ

Main Trends of Activities of Institute

•Investigation of history and heritage of Lithuanian architecture and urbanistics.

•Research in land management and territorial planning and its scientific foundation.

•Scientific research in the fields of the methods of energy saving in buildings; of the properties of building structures and building materials as well as the processing of technogenic raw materials into building materials.

The institute has 36 employees (18 male and 18 female), of which 1 chief researcher, 6 senior researchers, 15 researches, 7 junior researchers , 5 doctoral students.

Main Trends of Activities of Accredited Laboratory of Composite and Finish Materials

Scientific research in the fields of the properties of building structures and building materials as well as the processing of industrial raw materials into building materials.

Testing Techniques:

- QUV Spray Tester for accelerated testing of durability of building finish materials ;
- Q-FOG Tester for corrosion resistance testing of metal roofing materials and profiled steel sheets;
- Water permeability tester for cement bases mixtures;
- Dual Scope Microscope;
- Hydraulic press ALFA 3-3000H;
- Cooling incubator 3004.











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NTNU Norwegian University of Science and Technology

NTNU – Trondheim
Norwegian University of Science and Technology
Terje Kanstad: terje.kanstad@ntnu.no
Anja Klausen: anja.klausen@ntnu.no

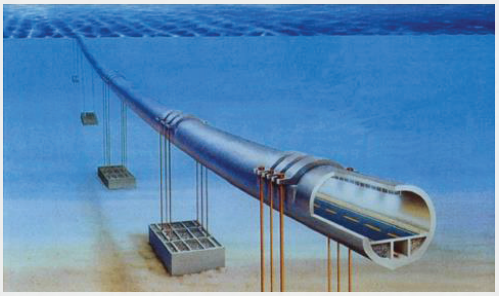


Situated: In Trondheim in the middle of Norway
Covers Medicine, history and languages in additional to technical sciences and has about **22 000** registered students and 3200 employed in education and research

Strong cooperation with SINTEF – One of Europe's largest independent research organisations

Department of structural engineering:

Computational mechanics, , Impact and energy absorption, Wind loading, Concrete technology, Concrete Structures, Steel and lightweight metals (SimLab), Timber structures, Fracture mechanics and fatigue, Nanomechanics, Biomechanics



Concrete Group

Permanent staff (2 females)
Svein I Sørensen
Terje Kanstad
Stefan Jacobsen
Jan Arve Øverli
Mette Geiker
Max Hendriks (30%)
Klaartje de Weerdt

Temporary staff (PhD-candidates and Postdocs (>50% females)
Egil Møen, Giedrius Zirgulis, Mahdi Kioumarsi , Karla Hornbostel, Elena Vidal Sarmiento, Anja Klausen, Rolands Cepuritus, Alessia Colombo, Morten Engen, Guzel Shamsutdinova, Alisa Lydia Machner, Andres Revert, Gilles Plusquellec,
+ 5 positions where employment is in progress

Research related to the COST action

Relevant projects
Ferry-free E39 along the Norwegian west coast (2015-)
Durable advanced concrete solutions (DaCS) (2015-)
Concrete Innovation - COIN (2007-2015)



Relevant equipment:
TSTM, free deformation rigs, & creep rigs: See Poster 2
Rigs for mechanical testing
Special forms for mechanical strength testing of specimens exposed to realistic temperature histories
Equipment for fresh concrete testing
Equipment/lab for durability research
Chemistry lab
Ice abrasion laboratory/ Cold climate equipment
X-ray computed tomography (CT-scanner)



Role in the COST action:

Experimental investigation related to property development at early ages (see poster 2) in WG1

Materials modelling and structural thermo-mechanical analysis with CrackTestCOIN and Diana in WG2

Contribution to pre-normative and standardization work in WG3

1st Workshop TU14040
Ljubljana, April 16th – 17th, 2015

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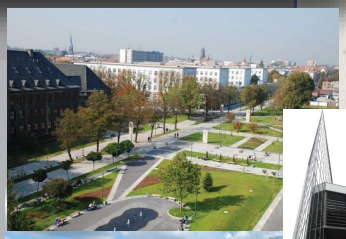
SILESIAN UNIVERSITY OF TECHNOLOGY

Faculty of Civil Engineering

Department of Building Materials and Processes Engineering

Akademicka 5 Str., 44-100 Gliwice, Poland































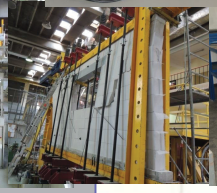
























The Silesian University of Technology (SUT) is one of the biggest universities of technology in Poland, with 70-years successful tradition in education, research and development as well as cooperation with industry. Nowadays the University consists of 15 Faculties including Faculty of Civil Engineering. University staff consisting of over 1700 academic teachers including 300 professors and DSc degree holders.

The faculty of Civil Engineering was one of the four faculties which gave rinse to the Silesian University of Technology. There are 22 professors and associate professors, and 86 Philosophy Doctors (PhDs) employed at the Faculty. The employers of the Faculty carry out research into all the fields of construction design, building materials, building technologies, transport services engineering and infrastructure. The main research fields are: theory of reinforced-concrete, prestressed-concrete, steel and timber structures, testing of soils and foundations performance, rheology and other properties of fresh concrete and cement based materials, durability of materials, products and structures (mainly concrete based), new techniques in bridge construction and others

Research activities of Department of Building Materials Engineering are mainly connected with concrete technology including: rheology of fresh cement mixtures and building suspensions, durability of concrete especially exposed on freeze – thaw conditions, usage of raw materials in cement and concrete, technology of special concretes as self-compacting or high performance concrete

	Faculty of Civil Engineering	Department of Building materials and Processes Engineering	Involved into GP1 activities
Research staff	100	9 (4 female)	6 (3 female)
Technical staff	17	2	2
PhD students	48	9 (4 female)	9 (4 female)

Role of the institution in this COST Action

WG1: TESTING OF CBMS

(1) to recommend new advanced techniques which have been developed during the last years to become standard in the (near) future,

(2) to test the ability of using different waste, recycled, and by-products as raw materials to design sustainable concrete mixture,

(3) to prepare a database of concrete mixtures which could serve designers and engineers to better predict lifespan, durability, and serviceability of concrete mixtures and structures,

(4) to provide input data needed for modelling phase of the Action (WG2).

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Wrocław University of Technology
Faculty of Civil Engineering
Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, POLAND

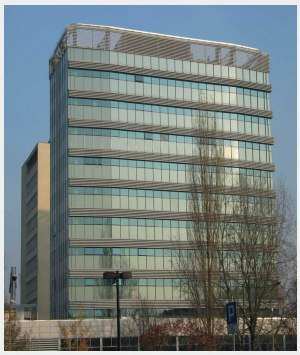
INSTITUTION DESCRIPTION

Krzysztof SCHABOWICZ

Wrocław University of Technology is an autonomous technical university and an academic research institution. Its mission is to shape the creative critical and tolerant personalities of students and post-graduate students and to define the directions of development in science and technology. The education offered at our institution is strongly linked with scientific research and the needs of economy, and is consistent with standards of the European Higher Education Area. The degrees awarded by Wrocław University of Technology are a symbol of high quality of education, confirmed by the National Accreditation Committee and the Accreditation Committee of Universities of Technology. The university executes its mission through the following: inventiveness and innovations, the highest standards in scientific research, knowledge transfer, and high quality of education and freedom of criticism with respect of law.







Since the very beginning of its existence, it has been an important centre of technical education. It rates high in the annual rankings of Polish universities. Recently, it has been announced the best Polish technical university in Webometrics Ranking of World's Universities.

Figures about the Wrocław University of Technology:

- 34 100 students
- 15 Faculties in Wroclaw, Jelenia Góra, Legnica and Wałbrzych
- over 4 000 employees, including about 2 000 research and teaching staff
- over 223 buildings with modern laboratories, libraries, Internet access, multimedia-fitted lecture rooms
- over 780 international agreements
- 5 240 registered inventions, including utility models
- 8 languages taught in the School of Foreign Languages (English, Czech, French, Spanish, Japanese, German, Russian, Italian)
- 162 student science groups
- 25 student organizations
- 27 student culture agencies

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Wrocław University of Technology
Faculty of Civil Engineering
Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, POLAND

INSTITUTION DESCRIPTION

Krzysztof SCHABOWICZ



Faculty of Civil Engineering

- over 3200 students
- 230 employees (180 researcher) – about 50 young scientists
- 3 part: Building Engineering, Geotechnics and Hydrotechnics, and Civil Engineering.

Main research activities: theory of structures (static and dynamic analysis, strength of materials), building materials, construction management, geo- and hydro-technical engineering, transportation (roads, bridges, railways).

Exchange programmes: ERASMUS, T.I.M.E., COST, CH.ESS. Member of the AECEF and EUCEET.

Certified Research Laboratory of the Faculty of Civil Engineering

- standard PN-EN ISO/1 EC 17025:2005
- accreditation by the Polish Accreditation Centre, no AB 455.
- two accreditation laboratiories: Laboratory for Building Constructions and Laboratory for Concrete Technologies. The scope of accreditation is available at: www.pca.gov.pl.
- active member of the Polish Research Laboratories Club POLLAB, associated in the European Organisation for Research EUROLAB and an active member of the Polish Forum Club ISO 9000

Scope of activity:

- Tests of elements and building constructions in order to assess their technical condition and loading of various construction objects,
- Heat energy consumption analysis for residential, public and industrial buildings, research in energy consumption optimisation, and also thermal and humidity diagnostics of partition walls,
- Preservation and reinforcing of historical constructions made of wood, bricks and stones – research, expertise, design,
- Research in mechanical and physicochemical construction materials.

Research offer:

optimal modification of concrete material with chemical admixtures and additives, and research in the composition of ordinary, high-value and self-consolidating concrete used for different classes of exposure, given by the standard PN-EN 206-1:2003.
The tests of ready-mix, special and pre-fabricated concrete, tests of the technical features of natural stones, mixing ordinary and special mortars and testing their physical and durability features, and also tests of the quality of concrete.

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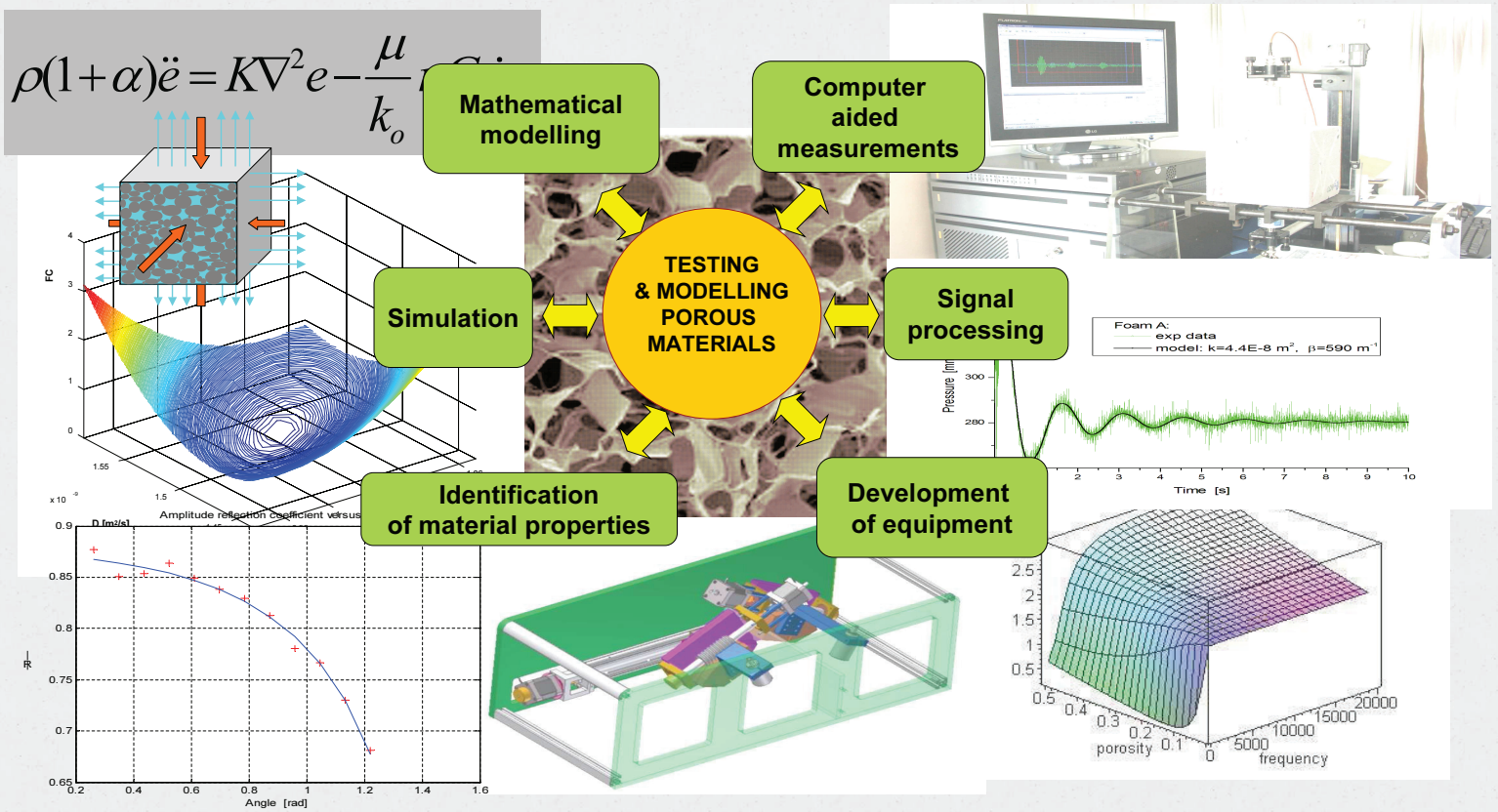
Kazimierz Wielki University
in Bydgoszcz, Poland
Institute of Mechanics and Applied Computer Science (IMACS)
imis@ukw.edu.pl

$$\rho(1+\alpha)\ddot{e} = K\nabla^2 e - \frac{\mu}{k_o}$$



MAIN ACTIVITIES:

- ❑ Modelling and simulation of coupled processes of deformation, flow and transport,
- ❑ Modelling internal structure, constitutive description, micro – macro upscaling,
- ❑ Development of methods of identification of material properties, model based approach,
- ❑ Application of optimization techniques for model calibration,
- ❑ Development of image processing techniques,
- ❑ Experimental investigations of porous and inhomogeneous media using US non-contact techniques,
- ❑ Porosimetry, studies of permeability, tortuosity, mass diffusion and sorption,
- ❑ Studies of evolution of wave properties due to maturing and aging.

SELF DEVELOPED TECHNIQUES FOR STUDIES OF CBM:

- ❑ Ultrasonic non-contact (air coupled) methods with different modalities:
  - echo,
  - transmission,
  - surface wave,
  - plate wave and,
  - reflectometry;
- ❑ Air and water permeability testing:
  - stationary and
  - non-stationary methods.

IMACS in numbers:

Research staff	Technical staff	PhD students	TOTAL
27	10	14	51 (F 12)

Contact: prof. Mariusz Kaczmarek
Institute of Mechanics and Applied Computer Science
Kopernika 1, 85-074 Bydgoszcz, Poland
tel: +48 52 3257613/650
e-mail: mkk@ukw.edu.pl or imis@ukw.edu.pl

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Universidade do Minho
Escola de Engenharia

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA

GOVERNO DA REPÚBLICA PORTUGUESA

European Union
European Social Fund
investing in jobs and skills

isise Institute for Sustainability and Innovation in Structural Engineering

University of Minho, PORTUGAL
Institute for Sustainability and Innovation in Structural Engineering

THE UNIVERSITY OF MINHO – SCHOOL OF ENGINEERING

- A "new" university founded in 1974
  - 18000 students, 1200 academic staff
  - 600 technical and administrative staff
  - www.uminho.pt
- Two campuses
  - Braga - The 3rd largest Portuguese city
  - Guimarães - The cradle of the nation



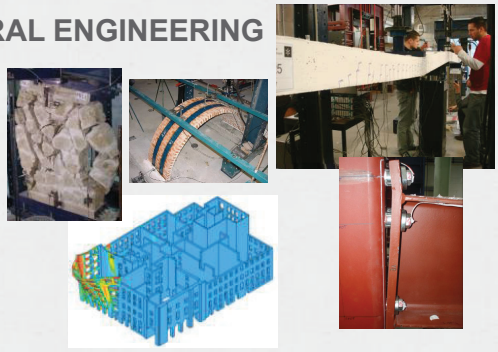




- School of Engineering (Guimarães)
  - 6000 students
  - 9 departments
- Department of Civil Engineering
  - 900 5-year students in Civil Engineering
  - 100 professional MSc students / year
  - Two R&D Units: ISISE and C-TAC

ISISE – INSTITUTE FOR SUSTAINABILITY AND INNOVATION IN STRUCTURAL ENGINEERING

- ISISE is a Research, Development & Innovation Unit formed in 2007 and involving the Structural Groups from the Civil Engineering Departments of the Universities of Coimbra and Minho. -> www.isise.net
- In the last Research Assessment Exercise (2008-2014), ISISE was rated as Excelent.
- 30 PhD members; 80 PhD students; 8.5 M€ of competitive funding granted; 2 European Master Courses; International leadership.





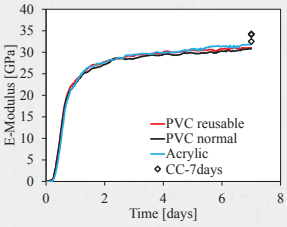
LEST
LABORATÓRIO DE ESTRUTURAS
U.MINHO

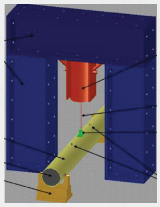
Our laboratory premises
- LEST – Structural laboratory of UMinho
- Full list of equipment in www.lest.uminho.pt



KNOW-HOW AND POTENTIAL FOR CONTRIBUTION FOR TU1404

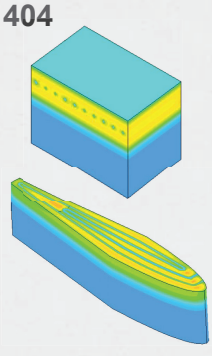
EMM-ARM
Elasticity Modulus Measurement through Ambient Response Method

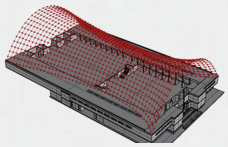




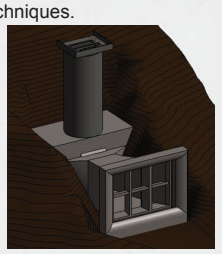
VisCoDyn
Continuous monitoring of concrete viscoelastic properties since early ages

Multi-physics simulation approaches
Evaluation of mass concrete with thermo-mechanical frameworks; Evaluation of shrinkage stresses with thermo-higro-mechancial simulation frameworks. All simulations based on experiments performed at UMinho.





Building Information Modelling
Focus on connections between BIM and structural concrete: interoperability and complex geometry modelling, together with the support of advanced simulation techniques.



Contact us: miguel.azenha@civil.uminho.pt ; We are willing to host STSM's!

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FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA
GOVERNO DA REPÚBLICA PORTUGUESA
European Union
European Social Fund
investing in jobs and skills

CONSTRUCT

Faculty of Engineering of the University of Porto (FEUP), PORTUGAL
CONSTRUCT - Institute of R&D in Structures and Construction

ABOUT THE "FACULTY OF ENGINEERING OF THE UNIVERSITY OF PORTO"

- The Faculty of Engineering of the University of Porto is a public institution of higher education.
- Founded in 1837, FEUP is the largest faculty of the University of Porto.
- FEUP has more than 8000 students and 500 professors across 9 departments.
- www.fe.up.pt



ABOUT "CONSTRUCT - INSTITUTE OF R&D IN STRUCTURES AND CONSTRUCTION"

- CONSTRUCT is a Research Unit, rated as Exceptional by an International Evaluation Panel in 2014. It is devoted to development of science and high consultancy in the domains of Materials, Geotechnics, Structures and Constructions.
- The Evaluation Panel stated 'the achievements of the Unit are very impressive, which come from basic and applicable research'.
- www.fe.up.pt/construct
- 46 PhD members; 65 PhD students.
- Laboratories with an overall area larger than 3500m^2, with equipment evaluated in more than 5M€.



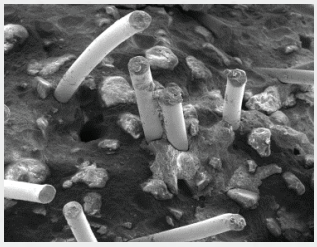




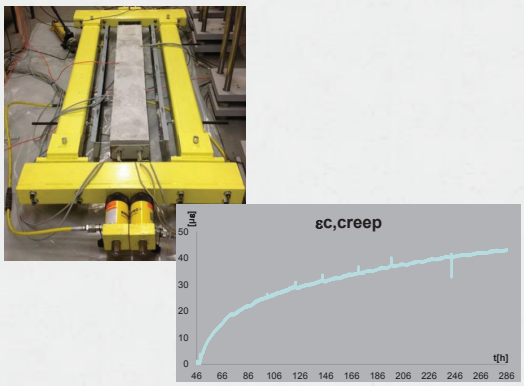
KNOW-HOW AND POTENTIAL FOR CONTRIBUTION FOR TU1404

Development of Eco-Efficient Materials. Use of by-products and waste in concrete.

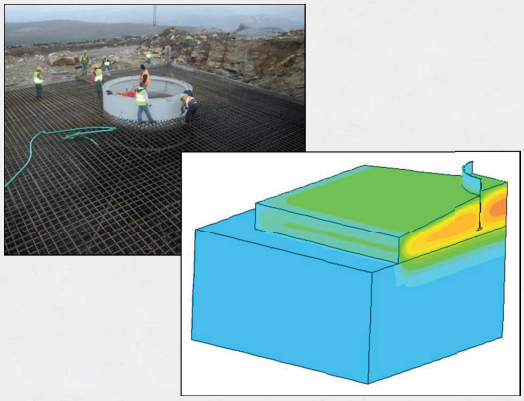




Characterization of tensile creep and shrinkage induced stresses.



Thermo-higro-mechanical numerical simulations, supported by experimental characterization.
Ex: temperatures on a wind tower foundation.



Contact: rfaria@fe.up.pt

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> Welcome to LNEC

The National Laboratory for Civil Engineering, LNEC, is a Portuguese public research and development (R&D) institution founded in 1946.

It works in the various domains of civil engineering, giving it a unique multidisciplinary perspective in this field.

The Laboratory has, at present, 468 staff, of which 49% hold a university degree and 31% are researchers with a PhD or equivalent qualification. It also has about 110 science research fellows holding different types of grants awarded by LNEC or other bodies.



LNEC is located in Lisbon, in a 22 ha campus, close to Lisbon's Portela Airport.

> Organization

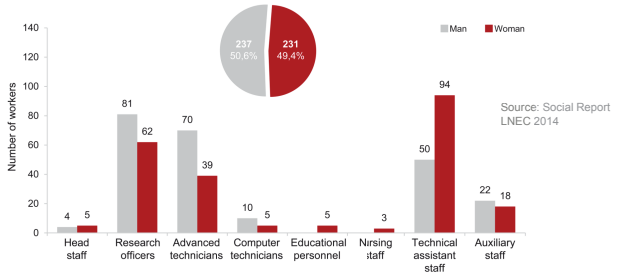
The organization structure of LNEC comprises 8 operative services, broken down into 32 units, which correspond to its major activity lines.

> Laboratories

At LNEC, there are 20 Test and Metrological Laboratories whose activity complies with the rules of LNEC's Quality System. This system is based on the Portuguese Standard NP EN ISO 17025. Nine of those laboratories are accredited by the Portuguese Institute for Accreditation (IPAC).



> Gender Balance



Distribution of workers by gender and position

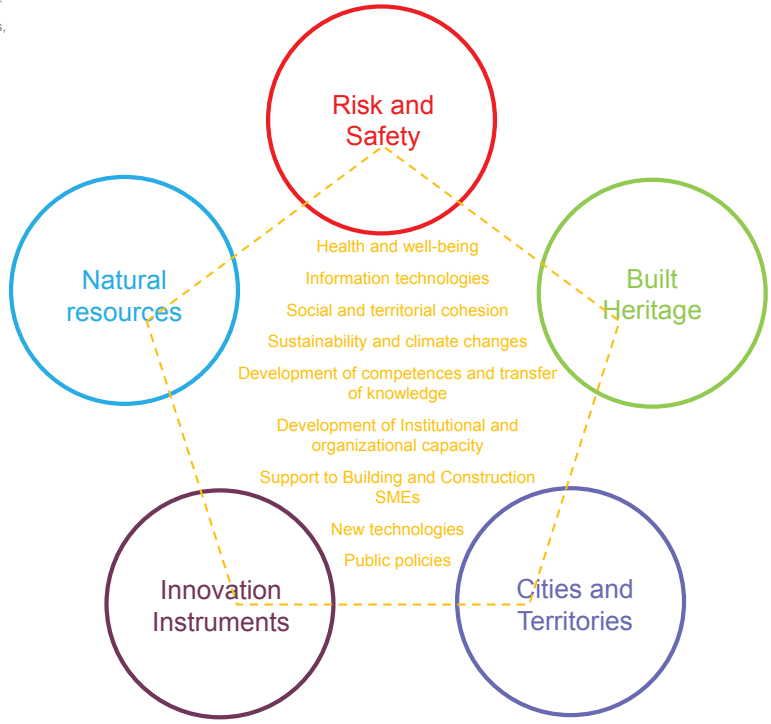
> Activity

LNEC carries out activities in the fields as follows: public works, housing, town planning, environment, water resources, estuaries, coastal areas, transportation and communication networks, materials industry, building components and other products.

Those activities include planned research in strategic thematic areas for the country, studies and expert reports under contract, promotion of quality in construction, co-operation with other bodies.

Short Term Scientific Missions (STSM), as well as dissemination of knowledge and technical and scientific training are amongst those activities.

> Strategic Research Areas



> Role of LNEC in Cost Action TU1404

LNEC is represented in the Management Committee (MC) of the action, as an MC Substitute of the Portuguese Delegate.

LNEC intends to participate actively in the following Group Priorities of WG1 and WG3:

GP1a: setting time
GP1b: porosity
GP1c: density, permeability, carbonation diffusion
GP1d:compressive, bending and tensile strength, Young's modulus
GP1e: drying shrinkage

GP3.c: development of recommendations and pre-standard methods
GP3.d: recommendations, pre-standard documents and associated coordination

Researchers intending to carry out STSM will be welcome.

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

Maria Sofia Sousa Ribeiro
Research Officer
sribeiro@lnec.pt
www.lnec.pt

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UAlg ISE
UNIVERSIDADE DO ALGARVE
INSTITUTO SUPERIOR DE ENGENHARIA



The University of Algarve is a young state university, located in the southern part of Portugal, one of the most touristic regions of Portugal. The University has witnessed a significant growth in terms of student population, modern facilities and the quality and diversity of programmes on offer.

The University student population is today close to 10,000 and employs over 700 academics. It has three faculties and four schools, offering a range of quality undergraduate and postgraduate courses in beautiful academic settings.

Recently, there has been a significant increase of foreign students from more than 60 countries due to the internationalization strategy of the University of Algarve.





The Institute of Engineering (Instituto Superior de Engenharia - ISE) has as its main goal education and research in engineering and technology, covering the areas of Food, Civil, Electrical and Electronics, Mechanical and Survey Engineering. The ISE is a centre of creation, transmission and dissemination of culture and scientific and technological knowledge.

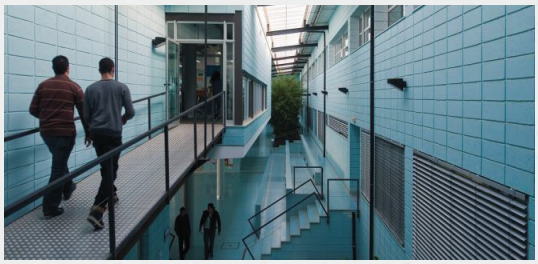
The Laboratory of Building Materials (LBM) , integrated into the Department of Civil Engineering of Instituto Superior de Engenharia / Universidade do Algarve, develops scientific and technological activities in the fields of Construction Materials.

Performs activities to promote interaction with the University and Industry.

Is an important tool for monitoring the quality of construction in the region.

Endowed with significant technical and human resources, the LBM performs, on a continuing basis, test to control the quality of the following materials:

- aggregates
- cement
- mortars
- concrete









Laboratory area: 340 m2

Most important equipment:

Core drilling machines;

Los angeles machine

Apparatus fortesting fresh self compacting concrete

Vebe consistometer

Mixers for concrete

Automatic computerized tropicalized vicat recording apparatus

Cement compression and flexural machine

Concrete flexural and compression testing machines

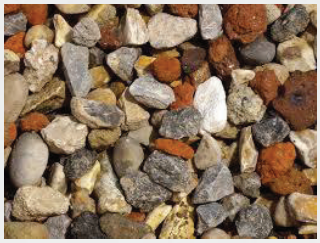
Universal multipurpose compression/flexural and tensile frame for compression / flexural tests

Heated room with wind tunnel

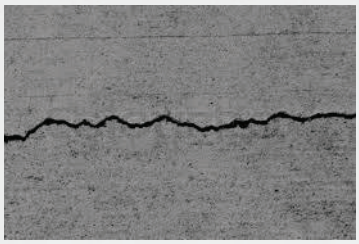
Grinding machines

NDT evaluation apparatus for concrete

WG1: TESTING OF CBMS







Our contribution may focus on:
Recycled aggregate concrete - Self compacting concrete - Volume stability and cracking

Contacts:
Laboratory of Building Materials
School of Engineering, University of Algarve
Campus da Penha , 8005-139 Faro
Tel : +351289800100 ext : 6415
Tel : +351289888415
Fax : +351289800183
email : mjolivei@ualg.pt
www.ualg.pt

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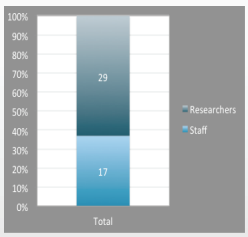
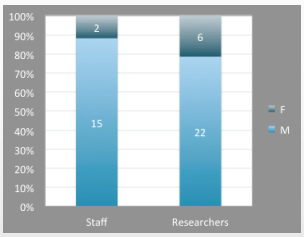
universidade de aveiro
theoria poiesis praxis

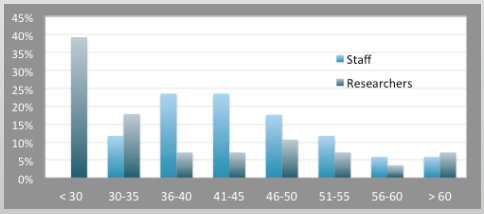
Civil Engineering Department

BASIC DATA OF INSTITUTION





Motivated and dynamic team
International environment
Integrated in international networks



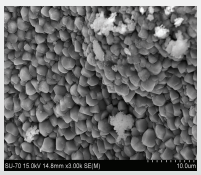
University:
www.ua.pt

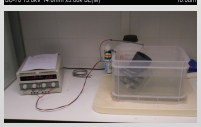
Department:
www.ua.pt/decivil

Contact:
Paulo Cachim
pcachim@ua.pt

Materials engineering









Expertise in evaluation and analysis of building materials
Mechanical and physical parameters
Microstructural characterization
Evaluation of binary/ternary compositions
Durability of building materials
Chloride ingress

EQUIPMENT

Scanning Electron Microscopy (SEM)
Thermogravimetric Analysis (TGA)
X-Ray Diffraction (XRD)
X-Ray Fluorescence (XRF)
Piezoresistivity
Artificial ageing


Aerial view of Aveiro lagoon


Old town


Old town

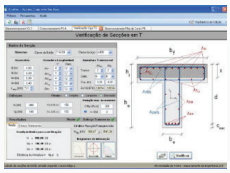

Costa Nova beach

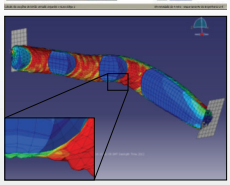

Campus view

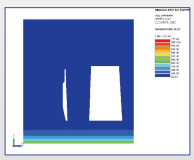

Civil Engineering building

Structural engineering

Evaluation of fire resistance of construction elements
Evaluation of the mechanical behaviour of structures and materials
Evaluation of cracking and retrofitting strategies
Innovative structural solutions
In-situ testing of structures















Software development
Numerical modeling and analysis

EQUIPMENT

Vertical furnace – 3x3 m^2
Reaction wall and steel frames
Actuators
Measurement equipment

RISCO@DECivil

RISCO is the research unit of DECivil. It is a small unit, focused on three thematic lines:

- Risks in the built environment
- Construction sustainability
- Built heritage conservation and restoration

Study programs

- Doctoral program in Civil Engineering
- Specialization course in Risks and sustainable restoration
- Integrated Master in Civil Engineering



Participation in several European and Portuguese research projects

Publications

- Average 2.8 ISI articles/year/member (members have PhD degree)
- Average 5 concluded PhD/year

www.ua.pt/risco

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HIGH INSTITUTE OF ENGINEERING OF LISBON (ISEL)

ISEL
INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA

DEPARTMENT OF CIVIL ENGINEERING
LISBON, PORTUGAL
https://www.isel.pt/

Member of COST ACTION TU1404:
CARLA M. COSTA
carlacosta@dec.isel.pt
http://gwp.net.ipl.pt/dec.isel/carlacosta/

HISTORY AND MISSION



The Industrial Institute of Lisbon (IIL) was established in 1852, by a Decree of D. Maria II of Portugal. In 1974 IIL changes its name to Institute Superior of Engineering of Lisbon (ISEL). This Institution has a history of more than 150 years.

The mission of ISEL is teaching technical and scientific subjects by creating a stimulating multidisciplinary learning environment. Involvement in business projects directed to the labor market and training of high quality professionals with specific skills in engineering are emphasized.

ISEL has attained a leading role in scientific research and technical training in Portugal. The institution is involved in a number of research projects, creating development opportunities, providing qualified human resources, and promoting excellence in research and education.

FACTS & FIGURES AT A GLANCE

# Programs		%
Undergraduate	8	42
Graduate	11	58
Total	19	100

# Students		%
Undergrad.	3352	79
Graduate	900	21
Total	4252	100

# Staff		%
Faculty	414	75
Admin.	136	25
Total	550	100

# Faculty		%
Female	104	25
Male	310	75
Total	414	100

# Struture		%
Departments	7	28
R&D Centers	18	72
Total	25	100

# Civil Engineering Dep.		%
Faculty	78	9
Students	779	91
Total	857	100

DEPARTMENT OF CIVIL ENGINEERING :
CEMENT-BASED MATERIALS: MAIN RESEARCH EQUIPMENT AND TESTING TECHNIQUES

CEMENT AND MORTAR

- Flow table apparatus (EN 1015-3)
- Air Entrainment Meter (EN 1015-7)
- Setting times: Vicat apparatus (EN 196-3)
- Flexural and compression tester (EN 196-1 & EN 1015-11)
- Blaine air permeability apparatus & Le Chatelier flask (EN 196-6)
- Length comparators (analogic & digital) (EN 12617-4, EN 12808-4)
- Plunger penetration apparatus (EN 1015-4, EN 459-2, EN 413-2)
- Cement water retention apparatus (ASTM C110 & ASTM C91)
- Water absorption due to capillary action (EN 1015-18)
- Pull-off, bond strength tester (EN 1015-2)
- Water penetration - Dr Carstens method (EN 1323)

Other test methods we are willing to use:

- X-ray diffraction (XRD)
- Fourier transform infrared spectroscopy (FTIR)
- Thermogravimetric analysis (TGA)

CONCRETE

- Abrams cone (EN 12350-2) &Vebè consistometer (EN 12350-3) & Concrete flow table (EN 12350-5)
- Unit weight measures (EN 12350-6)
- Air entrainment meters (EN 12350-7)
- SCC testing apparatus (SCC slump cone; V-Funnel apparatus, L- Box apparatus, Sieve segreation test set, J-Ring apparatus) (EN 206-9)
- Concrete compression tester (EN 12390-1 & EN 12390-2 & EN 12390-3)
- Tensile splitting strength of test specimens (EN 12390-6)
- Specific gravity frame and baskets (EN 12390-7)
- Digital rebound hammer (EN 12504-2)
- Hydraulic shrinkage moulds with measurement apparatus (UNI 11307)
- Pull-off, bond strength tester (EN 12504-3)
- Ultrasonic pulse velocity tester coupled to an oscilloscope (EN 12504-4)
- Electrical migration tests to evaluate resistance to chloride penetration (NT BUILD 492)
- Electrical resistivity test

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UNIVERSITY OF NOVI SAD - **SERBIA** - FACULTY OF TECHNICAL SCIENCES
DEPARTMENT OF CIVIL ENGINEERING AND GEODESY
Prof. dr Vlastimir Radonjanin, Prof. dr Mirjana Malešev
Ivan Lukić, Vesna Bulatović

INSTITUTION DESCRIPTION - FACULTY OF TECHNICAL SCIENCES



The largest Faculty within the University of Novi Sad.

Has more than 12.000 students and over 1.300 professors and other teaching and administrative staff.

Was founded on 18th May 1960 as the Faculty of Mechanical Engineering.

Faculty is accredited for conducting educational activities on 87 study programes, from that study programes are accredited to teach in English.

Faculty comprises 13 departments, 10 administrative units, 80 laboratories and 32 research centers. The Faculty is the founder of more than 70 companies.

SCIENTIFIC AND RESEARCH ACTIVITIES

Current research activities encompass 90 international projects (FP7, TEMPUS, IPA CBC, COST, WUS, CEEPUS, ERASMUS MUNDUS) and 120 national scientific projects. The Faculty publishes three international journals and organizes 16 scientific and professional conferences on various aspects of engineering.



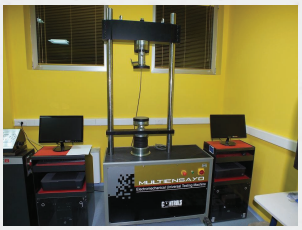
DEPARTMENT OF CIVIL ENGINEERING AND GEODESY

Department has more than 1.000 students and 57 professors, assistants and young researchers. Among them 19 are womens and 10 young researchers.

Department is accredited for conducting study programes in Civil Engineering, Geodesy and Risk Management and Fire Protection (bachelor, master and doctoral studies).

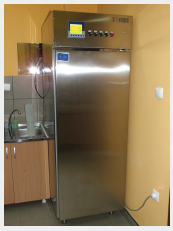
Department of Civil Engineering and Geodesy comprises 5 cathedras, 6 laboratories and 2 research centers.

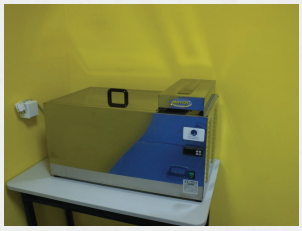
LABORATORY FOR TESTING BUILDING MATERIALS

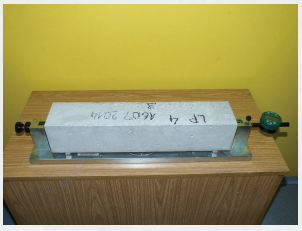



Equipment for testing of mechanical properties

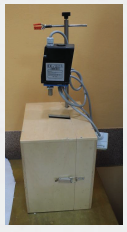
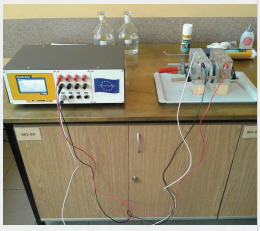



Equipment for curing and conditioning





NDT equipment






Water impermeability apparatus and scales for mass measuring

Laboratories for testing building materials are predominantly supplied with equipment for testing of cement based materials. Laboratories occupy an area of approximately 300m². Equipment in the laboratories is used for education and research (projects and doctorates).

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The Institute for Testing of Materials – IMS, Belgrade, SERBIA

IMS Institute

Founded in 1929, the Institute for Testing of Materials is the oldest scientific research institution in Serbia. The basic idea at the time of foundation was the need for a unique institution that would, in addition to research and development, also work on regular control of raw materials, semi-finished products, and products of the industry of chemicals, construction and metals. The IMS Institute acquired international reputation owing to the development and application of building technology and prestressing systems, as well as a result of extensive research pertaining to the protection of facilities from water, acoustic and thermal insulation, protection from fire, development, research and rehabilitation of constructions, and numerous completed projects in the field of architecture, civil engineering and mechanical structures, technology, geotechnics and road infrastructure.

Activities of the IMS Institute encompass laboratory investigations of building materials, certification of products, preparation of design documentation, scientific research work in all fields of construction industry, development and application of prestressing technologies, on-site supervision, testing of various types of structures, and the control of mechanical equipment.

The management of the IMS Institute has opted for a quality management system based on management of processes, according to SRPS ISO 9001 standards, for which the IMS Institute has been certified. The IMS Institute has confirmed its competence by the highest level of accreditation with the Accreditation Body of Serbia (ATS), by accreditation of testing and metrology laboratories and the Certification Body.

Intensive activity on the innovation of regulatives in the field of construction industry and harmonization with European Union directives, based on contemporary scientific achievements and their introduction into engineering practice. The goal of the IMS Institute is to maintain the leading role in innovations, research and development, and the experimental field in the process of transition, namely the adaptation of construction and energy industry of Serbia to the requirements and standards of European countries.

Laboratory testing of materials and products Certification of products and processes Preparation and control of all phases of design documentation and the preparation of tenders Scientific research and development in all fields of construction industry Development and application of building technologies and prestressing systems Consulting services and on-site supervision Testing and investigation of civil engineering and mechanical structures Control of mechanical equipment

IMS Institute has around 270 employees (1/3 are women), of which almost one half are engineers: civil engineers, engineers of technology, mechanical engineers, etc.

IMS Institute has 26 scientific researchers, of which 6 scientific advisors and 7 junior research assistants. Of the total of 16 expert researchers, 4 are with the highest title (advisor).

This gives a total of 42 researchers, or almost one third of all engineers.

Main research equipment and testing techniques

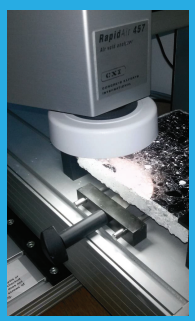
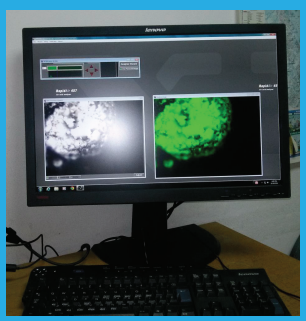
Fresh concrete according to SRPS EN 12350
Hardened concrete according to SRPS EN 12390
Setting time of concrete according to SRPS U.M1.019
Creep according to SRPS U.M1.027
Modulus of elasticity according to SRPS ISO 6784
Nondestructive testing: SRPS EN 12504, RapidAir 457 EN 4 ASTM 457
Precast paving units: SRPS EN 1338, 1339, 1340

COST Action TU 1404

WG1: GP1a, GP1d







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SERBIA

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www.institutims.rs

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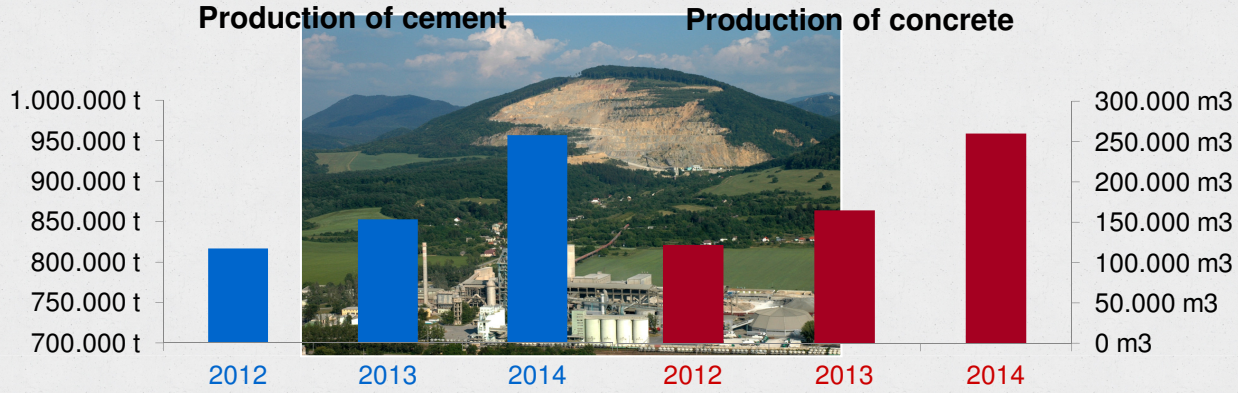
Považská cementáreň, a. s., Ladce

---------- since 1889 ----------

Považská cementáreň, a. s., Ladce (PCLA) is independent private joint stock company located in western Slovakia 150 km northly of capital Bratislava.

Employees: 350 of that female 58

Applied R&D: 2 senior researchers for cement&concrete involved in quality&strategy department



CEMENTS PRODUCED ACCORDING EN 197-1

CEM I	CEM II	CEM III
42,5N, 42,5R, 52,5 R	32,5 R, 42,5 N, 42,5 R	32,5 N

Cement, mortar and concrete testing equipment XRF, XRD, optical microscopy, calorimetry, spectral photometry, IR spectrometry, laser granulometry, UV/VIS spectrophotometry, elementar CNHS, automatic Vicat, consistency, mortar and concrete rheology, compressive and flexural strength, density, slump, air content etc.
Nonstandard concrete testing is in development like shrinkage of concrete cylinder etc.

LATEST INDUSTRIAL INNOVATIONS BASED ON OUR OWN APPLIED R&D

CHROMATMIN	BIOLINOVA	H-CEMENT	NONRIVAL	CHAMPION	Trade marks
Chromatless cement	Antifungal additive	Shrinkage reducing cement	Sulphateresisting cement	Ultrahighperformance cement	

Patents

SK 286379 Method of reducing CO_2 in cement production
SK 288177 Portland cement
SK 287203 Method of mineralogical control of portland clinker
EP 1092690 Method of reducing Cr6+ in cement
PP 50026-2010 Antimicrobial cements, binder, patent in pending
PP50024-2012 Hybrid binder based on wastes, patent in pending
and more

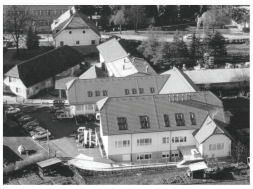
Awards

2010 Innovation award of Slovak ministry of economy
First prize of Slovak patent office
SLOVAK GOLD award
2011 Innovation award of Slovak ministry of economy

QMS ISO: 9001, 14001, 18001

Role PCLA in COST Action: industrial approach with practical innovative outcomes

Contact: Dipl. Ing. Pavel Martauz, director quality&strategy
E-mail: martauz.p@pcla.sk
Tel.: +421/42/4603103
www.pcla.sk



igmat d.d.

Building Materials Institute

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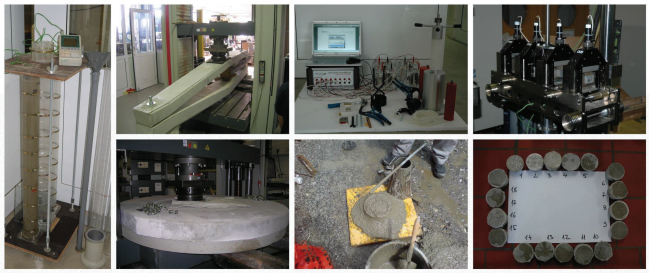
tel.: +386 1 586 26 00
fax.: +386 1 586 26 01
info@igmat.eu

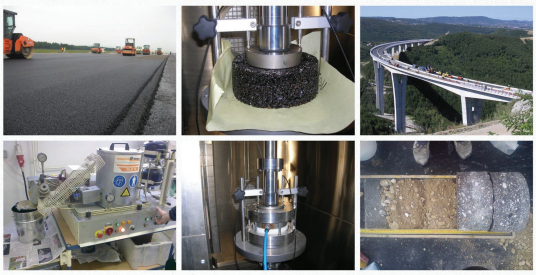
CONCRETE DEPARTMENT:

1 Quality control and quality assurance
2 Laboratory testing
3 Planning and design of fresh concrete mixtures and concrete projects
4 Waterproofing testing of sewerage system
5 Detail inspection of various concrete structures
6 Monitoring of different objects during construction
7 Consultancy and training in concrete technology, research and education



ASPHALT DEPARTMENT

1 Design of hot and cold asphalt mixtures
2 Laboratory testing of asphalt mixtures and constituent materials
3 Factory production control on asphalt plants - QA & QC
4 Quality assurance and quality control of asphalt laydown
5 Monitoring of recycling with foamed bitumen
6 Providing expertise and expert opinion
7 Training in asphalt technology and laboratory testing
8 Pavement structural design
9 Asphalt research and development



DEPARTMENT FOR INDUSTRY OF BUILDING MATERIALS

1 Laboratory investigation and research
2 Field work monitoring
3 Providing expertise and expert opinions
4 Research and development



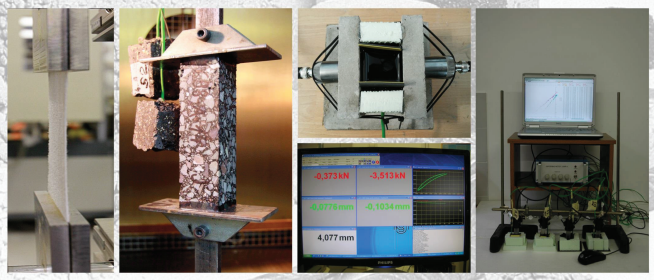
DEPARTMENT OF GEOMECHANICS

1 Quality control and quality assurance
2 Laboratory analysis and field measurements
3 Production of recipies for stabilisation and technological consultation
4 Geological and geomechanical surveillance and consultation
5 State and condition of highways, major and local roads, airfields
6 Consulting and research activities
7 Hydrological investigations



RESEARCH DEPARTMENT

1 Performance of complex andvanced techniques for determination of dif ferent propterties of various construction materials
2 Introduction, analyzing and developing of new advanced techniques for determination of various properties of civil engineering materials
3 Computing and modeling
4 Equipment handling and maintaining
5 Research-scientific work and training of all employees



INFORMATION TECHNOLOGY DEPARTMENT

IT department coordinates and manages IT projects at the Institute. We are developing web applications, advice in the field of IT and looking for right IT solutions. We take special care for continuous availability of our systems (24/7/365).

CERTIFICATION

Notified body for Construction Products Regulation (305/2011/EU).
Notified body number: 1373
Certification activities on many Construction products and different Certification systems.
Notified body for awarding Slovenian Technical Approvals - STA.



marec 2015

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G- CARMA: Group of Characterization of materials by Nondestructive Evaluation

J. J. Anaya, M. G. Hernández, S. Aparicio, J. Olivera, M. Molero, J. Ranz and D. Lluveras

The Spanish National Research Council (CSIC) is the largest public institution dedicated to research in Spain and the third largest in Europe

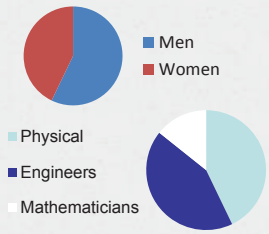


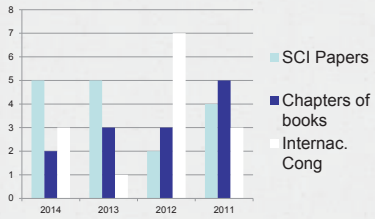


http://www.itefi.csic.es/en

http://sitios.csic.es/web/gcarma

The Group of Characterization of Materials by Nondestructive Evaluation, G-CARMA is a multidisciplinary group with a scientific, technological, educational and industrial transfer history since 1997. The main line of research is the characterization of materials using nondestructive evaluation technique. The group is formed by two senior researchers, four early stage researchers and one pre-doctoral fellow.



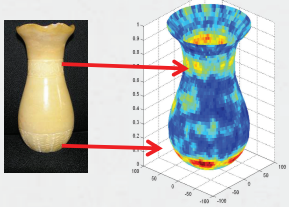


The objective of G-CARMA *is to characterize the cementitious material in both the manufacturing process and during its life when put into service. The group conducts research and technological developments in the following fields:*

Non Destructive Evaluation using Ultrasounds



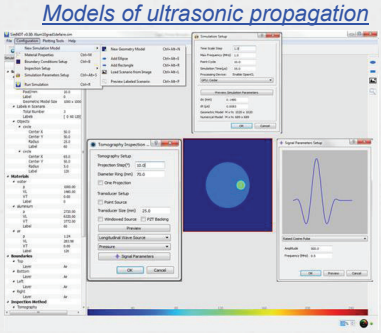
IMAUSHOR
Radial Inspection System



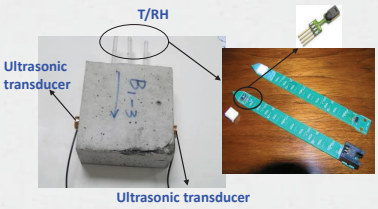
C-scan image

Imaging processing
+
Ultrasonic signal processing

Models of ultrasonic propagation



Design of self-sensing materials and embedded sensors

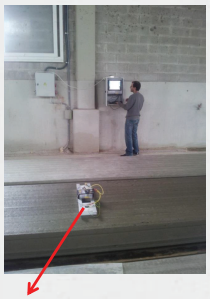


Concrete sample with encapsulated T/RH sensors and ultrasonic transducers

Applications

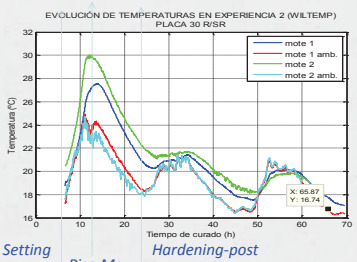
Monitoring of Precast Concrete

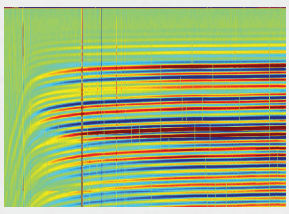




WilTempUS System

Monitoring parameters:
Temperature, Relative humidity and Ultrasonic velocity



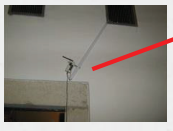


Monitoring Cultural Heritage







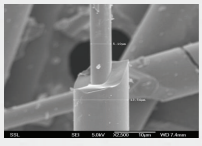


WilTemp System

Wireless monitoring
+
Embedded sensors

Monitoring parameters:
Temperature, Relative humidity, Gas, Vibrations, Air flow, etc.

Development of cementitious material intrinsically sensor for structural evaluation based on ferromagnetic microwires



Micrograph of the glass-coated microwire by SEM.



MMCC sensor embedded in concrete sample

Acknowledgements
The Spanish Economy and Competitiveness Ministry supported this research under grants numbers BIA2011-29575-C03 and TEC2012-38402-C04-03.

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M.G. Hdez. 2015

Monitoring water penetration in hardened concrete by means of nondestructive techniques: INFRARED THERMOGRAPHY AND GROUND-PENETRATING RADAR

Rodríguez-Abad I., Martínez-Sala R., Mené-Aparicio J.
Escuela Técnica Superior de Ingeniería de Edificación. Universitat Politècnica de València.
E-mail: isrodab@upvnet.upv.es. Camino de Vera s/n 46022, Valencia, Spain

POSTER 1

Universtat Politècnica de València



Schools / Faculties	14	Undergraduate programs	57
Undergraduate students	37,093	Master's programs	54
Faculty and research personnel	2,866	PhD programs	30
Non-teaching staff	2,272	PhD students	2,616
Departments	44	UPV diplomas (master's and "University Expert")	57
Research instituions	43	Lifelong learning courses	1,724

School of Building Engineering

Laboratories:

- **Construction materials**
- Installations and building services
- Construction technology
- Chemistry and Physics









Construction materials lab equipment
Hydraulic compression testing machine IBERTEST Mod. MEH 1500 SW (A)
Flexural test machine IBERTEST Mod. PEF-150-MDA (B)
Tensile, compression testing machine IBERTEST Mod. UIB 600 D.AU (D)
Water penetration under pressure machine IBERTEST Mod. 20407 (C)
Climatic cabinet CLIMACELL mod. 222 (E)
Curing chamber HR: 50-100%, 20ºC-100ºC (F)
Oven and vent oven 200ºC
Air content in fresh concrete (8l) TESTING Mod. 20334
Precision balances METTER Mod. Pm 4000
Concrete mixer machine vertical axis (70 l)
Planetary mortar mixer
Disc cutter, polishing machine, etc





Infrared thermography equipment

Thermal imaging camera FLIR mod. i5 (G)
Thermal imaging camera TESTO mod. 875 (H)
Multifunction meter TESTO mod. 435-2 (I)







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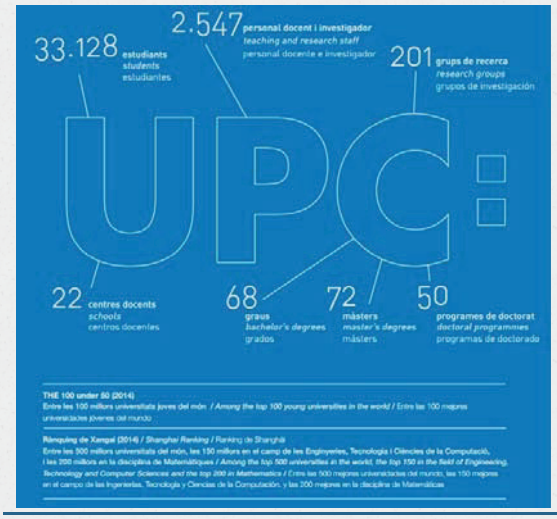
UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Department of Construction Engineering

http://dec.upc.edu/

BIA2012-36848

Engineering, architecture and science



Departmental Sections

- Structural Technology
- Construction Materials
- Industrial Constructions

Overview in numbers (year 2014):

- 77 Professors & Researchers
- 6 Researchers
- 45 PhD students
- 78 papers in indexed journals
- 60 papers in conferences
- 1 book, 5 book chapters
- 43 projects (competitive calls)
- 23 projects (non competitive)

Research Group of Structural Technology

The group develops both theoretical and applied research in the field of civil engineering and building structures. The focus is on structural analysis, design, construction and assessment. The main research areas are:

- Analysis and design of concrete, steel and masonry structures.
- Structural technology and materials
- Design of large scale concrete and steel structures

Technology Transfer: Government funded projects, Private and public agreements & Services

Construction Materials Laboratory

Lab focussed in material studies ; staff: 5 employees

Research areas:
Construction materials
Materials chemistry
Concrete structure
Use of residues as construction materials
Environmental impact of materials



Facilities & Equipment:
- Penetration of water under pressure
- Percolation column test (leaching tests)
- High-performance liquid chromatography
- Diffusion test
- Chemical lab : analysis, viscometer, muffles, pH-meter, conductivity, potentiometry
- Small equipment





Recent and ongoing most relevant works
- Study and use of residues in construction materials
  - aggregate from demolition
  - out of use tyre powder
  - mud from the incineration of RSU, etc...
- Residues from the construction of tunnels
- Residues from paper companies
- Slags from steel manufacturing
- Durability studies
- Studies of hydration of cement



Structure Technology Laboratory Luis Agulló

Lab focussed in applied research; staff: 8 employees

Research areas:
Concrete characterization (fresh & hardened)
Tests of structural elements
Large scale testing
Structural monitoring





Facilities & Equipment:
- Strong floor
- Biaxial reaction walls
- 2 Load frames and actuators
- Dynamic axial test machines
- Compression test machine
- Creep frames
- Concrete batching plant
- Climate chambers
- Aggresive environment chambers



Recent and ongoing most relevant works
- Concrete's Poisson module under cyclic pressure
- Structural elements under cyclic multiaxial loading
- Fresh & hardened characterization of SCC with light aggregates & HS-FRC
- Characterization of FRC against pulling
- Use of dredging sand in concrete
- Response of contact materials in precast tunnel sections
- Cracking and strain measurement with DIC techniques
- Early age shrinkage characterization
- Structural effects of corrosion
- Rehabilitation of D regions with initial damage
- Tests on partially prestressed concrete elements
- Monitoring tunnels of new Metro line L9
- Analysis of Historical constructions





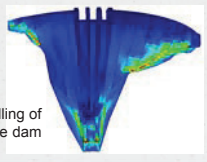
UPC in COST TU1404

Research sub-group of Concrete Technology

- Characterization & modeling of FRC
- Set accelerators & characterization of shotcrete
- Whitetopping & modeling of concrete pavements
- Durability of concrete structures
- Pervious concrete, enhanced bioreceptivity concrete
- Pathology diagnosis & multiscale modeling of concrete dams
- Optimization of FRC concrete elements (pavements, tunnels linnings, suspended flat slabs)
- Sustainability & value analysis



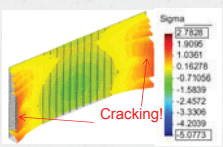
Barcelona test & Inductive method for fiber content and orientation

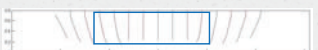


3-D modling of concrete dam

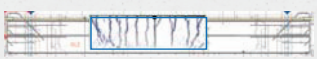
Research sub-group of Concrete Structures

- Experimental research at the stuctural level
- Development of nonlinear numerical models
- Analytical formulations
- Analysis since early ages
- Assessment & repair / retrofit
- Cracking
- Multiaxial force interaction
- Performance-based design
- Software development





RL1 ConCrack Numerical



Experimental Ceos.fr

Contribution in WG3

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UNIVERSIDADE DA CORUÑA (Spain)

Grupo de Construcción: Isabel Martínez-Lage, Miriam Velay-Lizancos et al

	PhD Professors			Young researchers		
	Total	Male	Female	Total	Male	Female
University	984	604	380	1437	754	683
School of Civil Engineering	61	54	7	67	53	14
Group of Construction	9	5	4	5	3	2

Laboratory of construction - School of Civil Engineering

- Compressive machine 3000 kN
- Loading frame 300 kN
- Non-destructive testing
- Temperature & humidity chamber
- Heaters and refrigerators
- Water digital curing bath for concrete specimens
- Concrete mixer
- Equipment for characterizing aggregates
- Testing equipment for fresh concrete



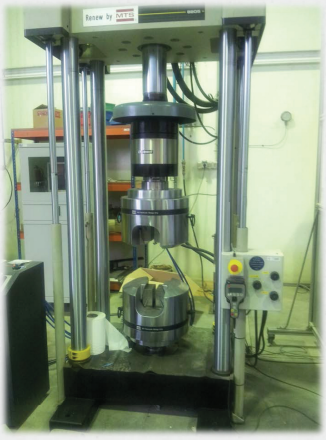





Center for Technological Innovation in Construction and Civil Engineering

- Loading slab of 23 m x 14 m with anchor point
- Reaction wall of 8 m x 10 m
- Concrete plant 250 l
- Climatic chamber 70ºC
- Dynamic Tensile/Compressive machine 1000 kN
- Tensile/Compressive machine 15000 kN
- Compressive machine 5000 kN with triaxial cell 80 MPa
- Actuators: 2 dynamic 500 kN, 1 pseudodynamic 2700 kN and 5 static
- 3 Loading frames 500, 750 and 1000 kN
- Data acquisition systems: static and dynamic






Contact: Isabel Martínez-Lage
isabel.martinez@udc.es
Miriam Velay-Lizancos
m.velay@udc.es

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CHALMERS

Department of Civil and Environmental Engineering



Division of Building Technology

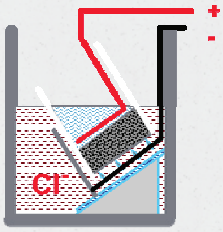
The Division of Building Technology brings together knowledge from Building Physics, Building Materials and Sustainable Building. The building industry represents one of the largest and most important enterprises in the world. Costs associated with housing are the largest expenditure of an average family. One third of the Swedish energy consumption is used in residential and commercial buildings.

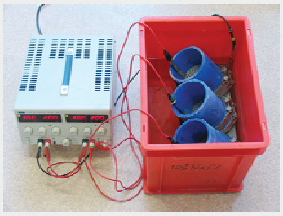


Facts and Figures

- **Professors: 4**
- **Associate professors/lecturers: 3**
- **Adjunct Professors: 1**
- **Assistant Professors: 6**
- **Doctoral student positions: 12**
- **Female: 38%**

Development of Rapid Chloride Migration (RCM) Test







$$D = \frac{RTL}{zF\Delta E} \cdot \frac{x_d - \alpha\sqrt{x_d}}{t} \qquad \alpha = 2\sqrt{\frac{RTL}{zFU}} \cdot \mathrm{erf}^{-1}\left(1 - \frac{2c_d}{c_0}\right)$$

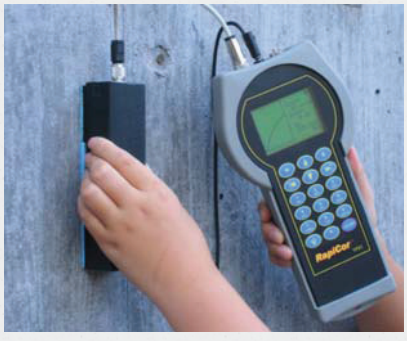
nordtest method NT BUILD 492 Approved 1999-11

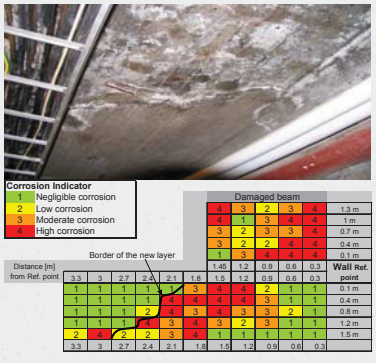
- 1st proposal (Tang & Nilsson, 1992)
- 1st complete method (Tang, 1996)
- EU DuraCrete recommendation (1998)
- Nordic standard NT BUILD 492 (1999)
- Swiss standard SIA 262/1 (2003)
- German BAW code (2004)
- American AASHTO TP 64 (2004)
- *fib* recommendation (Bulletin 34, 2006)
- Netherlandish translation (2008)
- Chinese standard GB/T 50082 (2009)

Chlorideindringwiderstand von Beton
(BAW Merkblatt "Chlorideindringwiderstand")



Rapid Corrosion Test (RapiCor)





Role in this COST Action

- **Contribute our expertise and previous experience to the main objective of the Action in development of a new generation of guidelines to predict or evaluate the service life of cement based materials and structures in Europe**
- **Participate in eventual Round-Robin Tests**
- **Participate in modelling mass transport and boundary conditions**
- **Disseminate outcome of the Action to Swedish stakeholders**

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cost European Cooperation in Science and Technology

Concrete / Construction Chemistry Laboratory

EMPA
Materials Science & Technology

Authors: Pietro Lura, Andreas Leemann, Frank Winnefeld, Barbara Lothenbach, Mateusz Wyrzykowski and Walter Trindler
Contact: pietro.lura@empa.ch, mateusz.wyrzykowski@empa.ch

Introduction

We perform both fundamental research and application-oriented research (R&D) on cement-based building materials. With our work we aim at improving the sustainability of building materials. By studying alternative binder systems and concrete of improved durability, we aim at reducing their energy consumption and CO_2-emission.

At the Concrete / Construction Chemistry Laboratory, we use our competence in the fields of concrete technology (e.g., self-compacting concrete, recycled aggregate concrete) and construction chemistry in national and international research project.

We act as consultants in all our scientific and technical fields and we offer investigations and measurements on a service basis. Four our partners, we research and bring to being sound solutions in demanding areas. In all our activities, we remain independent and impartial.

Cement hydration and microstructure

A main research focus is modelling of cement hydration. The composition of the solid and liquid phases during hydration is examined with a series of experimental methods and compared to the results of thermodynamic modelling (Figure 1).

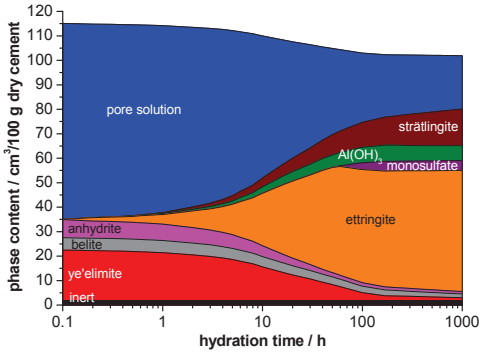


Figure 1: Thermodynamic modeling of hydration of a calcium sulfoaluminate cement

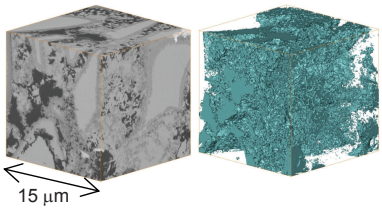


Figure 2: Focussed-ion beam nanotomography of a blast-furnace slag cement paste (left) and its pore structure (right)

Cement pastes and mortars are multiple phase composites which undergo a complex structural and chemical metamorphosis during their hardening process. In particular the porosity and the pore network are paramount for material properties like strength, permeability and durability. Quantitative morphological and topological characterization of pore structures is fundamental for the physical modeling of such properties.

Durability and sustainability

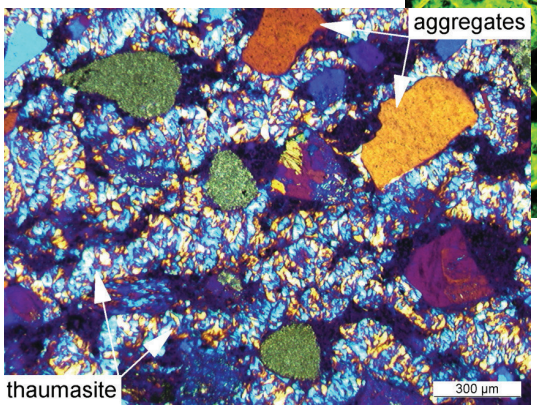
One of our main activities deals with the interaction between cement-based materials and the environment leading to concrete damages. The ingress or loss of ions critically influences the stability and the durability of concrete. The mechanisms are examined based on the microstructure and on the transport processes. Solutions for the development of more resistant concrete are investigated.

Additionally, we investigate the causes of shrinkage-induced cracks in concrete, which may lead to a reduction of the durability. The goal is to develop concrete mixtures with reduced shrinkage-induced cracking and improved durability.



Figure 3: Ganter bridge, Switzerland

Figure 4: Sulfate attack on concrete with formation of thaumasite. Thin section, transmitted light (Belchen tunnel, Switzerland)



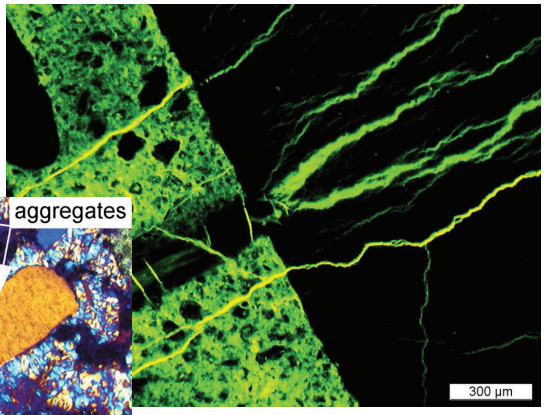


Figure 5: AAR induced cracks in aggregate with gel formation in paste. Thin section, fluorescent light (motorway bridge, Mels, Switzerland)

Our laboratory

Qualified staff and an outstanding infrastructure support the scientists in research and development projects as well as in challenging services.

Our laboratory offers a large range of tests on fresh and hardened concrete, cement, admixtures, additives, and aggregates. Tests for water conductivity, freeze-thaw, chloride resistance, shrinkage, creep, etc.

We perform both standard and non-standard tests and provide different types of measurements and analyses.

Our test laboratory meets the highest quality standards and is accredited in a number of STS scopes.



Figure 6: Creep stands for loads up to 600 kN

Our services

Thanks to our world-class laboratory infrastructure and the expertise of our researchers, we provide advice and information about different aspects of cement and concrete:

- research into the relationship between raw materials, methods of production and utilization in view of the practical application of new cementitious materials;
- transfer of knowledge by publications, courses organization and talks in national and international conferences;
- in our large laboratory we can perform both standard tests and specially tailored ones;
- the most modern chemical analysis methods and efficient microscopy investigations;
- acces to X-ray microtomography, state-of-the art image analysis techniques
- consulting about problems with concrete, mortar, cement and admixtures;
- cooperation in the elaboration of norms and guidelines within national and international professional organizations and standards committees.

Section Materials & Environment

TU Delft Microlab

Mission

The mission of the section M&E is to accumulate and transmit knowledge relating to the chemical, physical and mechanical properties of materials that may be used for architectural and civil engineering applications. Special attention is devoted to the sustainability and environmental aspects.

Resources & Recycling



Resources & Recycling is realising resource value in a safe and sustainable way

Concrete Modelling & Materials Behaviour



Concrete Modelling and Materials Behaviour focuses on modelling and design of cement-based materials
- mixing and casting of the concrete
- the hydration process and materials properties
- hydration-induced volume changes, early-age cracking
- degradation processes, transport properties, time-dependent behaviour, and service life predictions

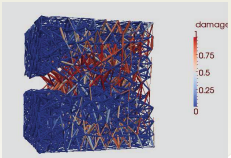
Sustainability



The chair Sustainability focuses on
- the development of sustainable performance in civil engineering
- interactions between the living and built environment, e.g. by integrating free ecosystem functions in the built environment
- studying detrimental effects of (micro) organisms on construction materials

M&E

Experimental Mechanics



The chair of Experimental Mechanics focuses on
- fracture processes to measure (mechanical) properties of materials
- self-healing materials

Durability



The focus of the chair of durability is
- finding solutions to stop or slow down the degradation
- develop strategies to prevent degradation in the future
- the control of durability-related challenges within the service life of civil structures

Contact
E:microlab-citg@tudelft.nl
W:http://www.me.citg.tudelft.nl

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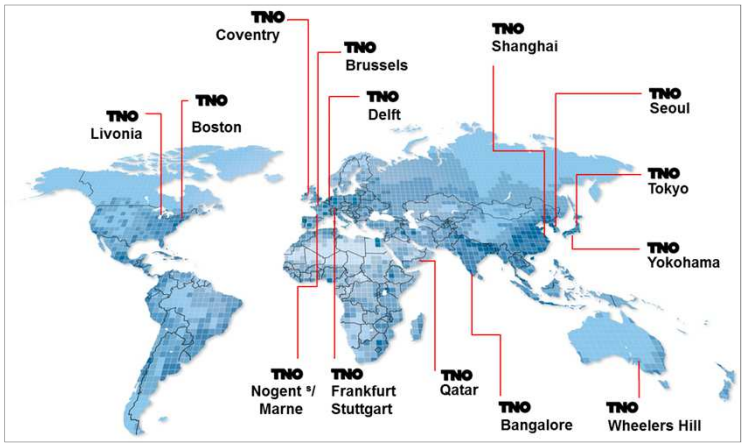
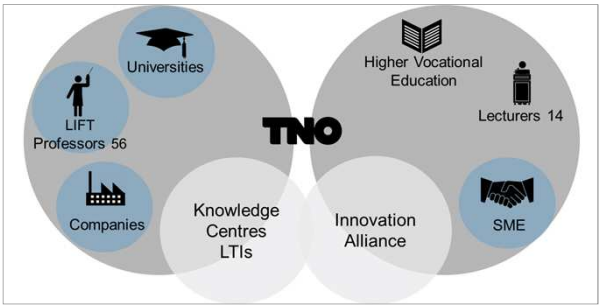
TNO innovation for life

TNO MISSION

TNO connects people and knowledge to create innovations that boost the sustainable competitiveness of industry and well-being of society.





TNO has 3215 employees and 953 are women !

***Target for women employees in 2018*:**

30% in top, subtop and principal scientists and 40% at LD

Structural Reliability Department-Materials for Built Environment



TNO Materials, Energy and Construction laboratory

- **Building materials**
- **Degradation Analysis**
- **Road Construction**
- **Energy Conversion and Storage**
- **Comfortable and healthy living environment**

Laboratories

- **Mechanical, Chemical, Thermal and Analytical tests**
- **Accelerated degradation and aging**
- **Non standard performance tests**
- **Optical and SEM microscopy**













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TNO DIANA

A TNO Company

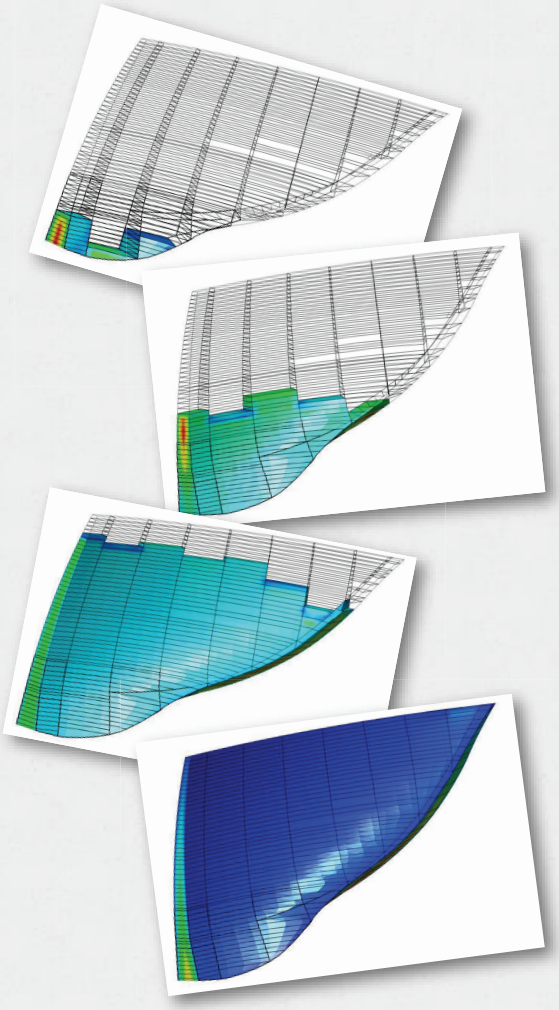
TNO DIANA BV became an independent company in 2003 following decades of research and development at the TNO Building and Construction Research Institute in Delft, The Netherlands.

TNO DIANA BV remains a small company with a diverse group of highly qualified staff including civil and geotechnical engineers, scientists and software developers, who together continue to develop and market the DIANA Finite Element Analysis software package.

With ever changing socio-economic and environmental climates affecting the design and construction of concrete, it is imperative that the optimum knowledge of material at all stages of life is understood in such a way as to maximise productivity and plan the lifecycle of construction projects using the material. Numerical analysis, coupled with a strong and compatible real life model, is key to this future scenario in avoiding built in problems that can manifest themselves during the life of the structure.

DIANA is, and continues to be, used worldwide in the analysis of many concrete structures such dams, bridges and buildings. This analysis often takes place during the design phase, but can also take place at all stages throughout the lifespan of the structure.

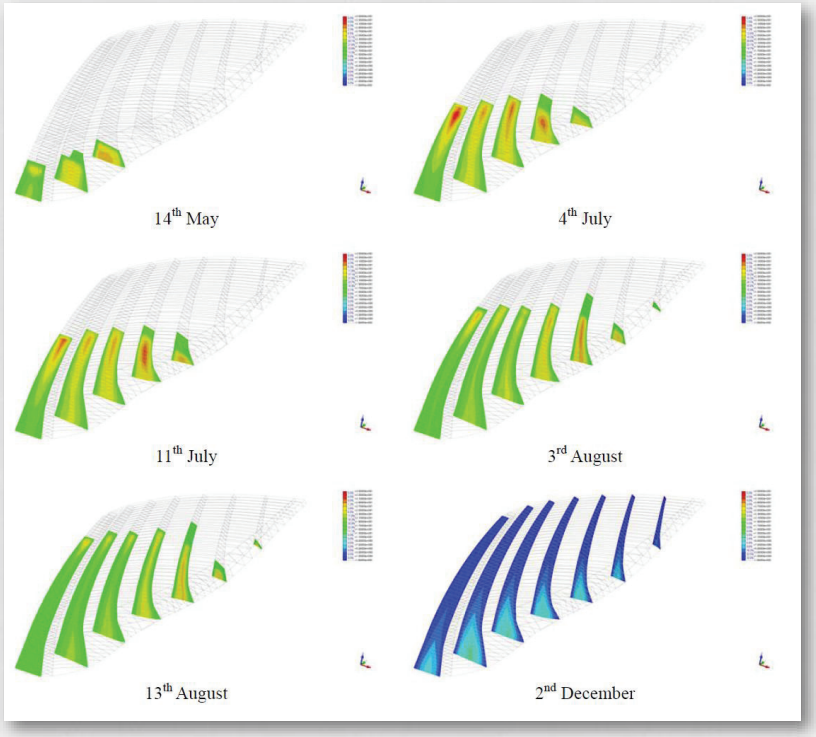
DIANA has an extensive library of material models and its ability to carry out multiple, and coupled, analyses in one command has pushed it to the top of its field.



Construction Stage Analysis of a Concrete Arch Dam & Temperature distribution throughout construction

DIANA offers a wide range of young hardening concrete models and is capable of predicting cracks with both linear, and more detailed nonlinear analysis. This, together with temperature dependent analysis which can predict and highlight thermal degradation of mechanical properties means that DIANA is an all in one solution for the finite element analysis of concrete structures.

This COST action provides further opportunity to retain forefront technologies in the material definitions for construction, housed within the software. This in turn will ensure the software remains relevant and up to date with industry techniques allowing researchers to develop computer models that facilitate simulation tests that further develop the essence of the project. Researchers and Industry alike should then benefit from the advanced technology. This knowledge transfer should directly benefit the use of cement based products in the construction industry.



For more information visit www.tnodiana.com or contact us via info@tnodiana.com

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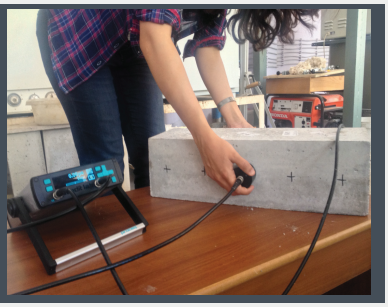
FIRAT UNIVERSITY

1404 COST ACTION

CONCRETE LABORATORY FACILITIES





Fırat University Civil Engineering Department was found in 1967 as Engineering and Architecture Academy by Middle East Technical University and Istanbul Technical University. In almost 50 years, undergraduate and graduate courses have been given by department own teaching staff. In this process, technical facilities and machines and devices in laboratories were

Lessons have been given in an individual building of Civil Engineering Department. The total residential area of the building is 3276 m^2. Building has 5 classes, 2 laboratories and 1 computer laboratory with 50 computers. The total residential area of the laboratories is 508 m^2. In addition, an additional service building built in 1998 has 3400 m^2 residential

Facilities of concrete laboratories which are still improving for academic researches are listed below.

Cement Tests
- Consistency test of cement with Vicat apparatus
- Setting time test of cement with Vicat apparatus

Aggregate Tests
- Sieve analysis for Gradation
- Los Angeles abrasion test
- Unit weight and specific gravity tests

Production Stage
- Mortar Mixer
- Drum type concrete mixer with 10 dm^3 maximum capacity
- Pan type concrete mixer with 50 dm^3
- Drum type concrete mixer with 80 dm^3 maximum capacity
- Drum type concrete mixer with 200 dm^3 maximum capacity
- Cube, cylinder, beam molds for mortar and concrete
- Water curing tanks

Fresh Concrete Testing Stage
- Slump testing equipment (for mortar and concrete)
- Ve-Be testing equipment
- V-funnel testing equipment (for mortar and concrete)
- L-box testing equipment
- B type concrete airmeter (determining air content)

Hardened Concrete Testing Stage
- Ultrasonic pulse velocity (UPV) test device (PUNDIT)
- Compressive strength test with 2000 kN maximum capacity (load controlled)
- Splitting tensile strength test with 2000 kN maximum capacity (load controlled)
- Flexural strength test with 100 kN maximum capacity (load controlled)
- Concrete test press with 2500 kN maximum capacity (closed loop deformation controlled) with compressive and flexural strength apparatus
- Mortar test press (load controlled) with compressive and flexural strength apparatus
- Steel tensile strength machine with 600 kN maximum capacity

Others
- Böhme abrasion test
- Freeze-thaw resistance test
- Concrete and marble cutting machine
- Cement dosage detection device
- Ovens
- Stone crusher



ISTANBUL TECHNICAL UNIVERSITY
Marmaray Laboratory





Established as a project dedicated laboratory at ITU in 2005, Marmaray laboratory serves for major infrastructure construction projects in which service life and durability considerations are taken into account.

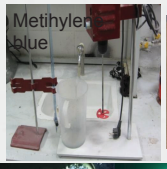
Aggregates





Alkali reactivity





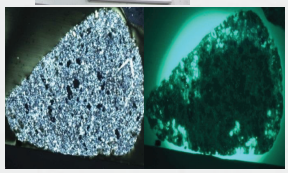
Metihylen blue



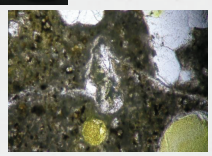
Alkalis



Chlorides

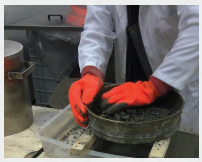


Reactive components



Fresh Concrete

SCC, bleeding, setting time, rheology







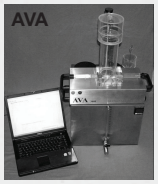


Setting time





Rheology



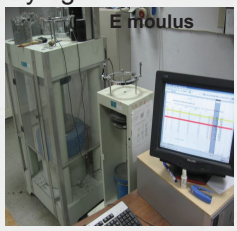
AVA

Hardening Concrete

Thermal, shrinkage and creep deformations, mechanical properties for early age crack control



Thermal expansion



E moulus



Shrinkage



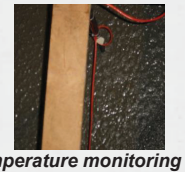
Creep



Adiabatic heat



1 m³



Temperature monitoring

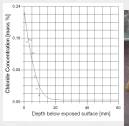


Activation energy

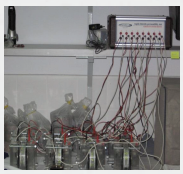
Testing for Durability

Freeze and thaw resistance, water permeability under pressure, electrical indication of chloride penetration, chloride ponding and migration, DEF





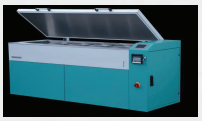




Durability testing on cores





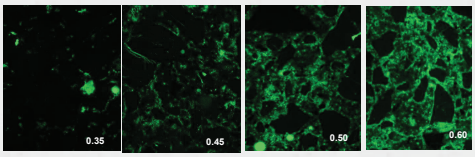




Microstructure

W/C ratio and homogeinty on thin sections

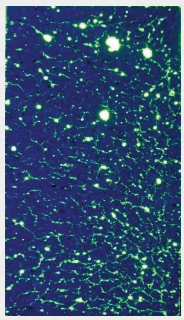




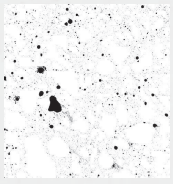
0.35 0.45 0.50 0.60

Microcracks, porosity, entrapped air voids, aggregate dispersion and internal stability on plane sections

Air void dispersion







Quality of Repairs

Testing for materials, workmanship and methods





Pull off strength

Interface & surface quality

Injection depth

Equipped for early age and durability testing

Microstructural homogeinty and internal stability

Testing for chloride permeability and alkali silica

Educational Activities
Research and Development
Industrial Collaborations

İ.T.Ü. Civil Engineering Faculty
Construction Materials Laboratory,
Maslak, İstanbul, 34469

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By Assist. Prof. Zeynep Basaran Bundur

About OzU

- Ozyegin University (**OzU**) was officially founded on May 18, 2007. The University currently has 225 full time faculty members and instructors within 5 Faculties; 3 Graduate Schools and 3 Schools.
- Faculty members are distinguishing researchers that 60% of them came from top 100 universities around the world.

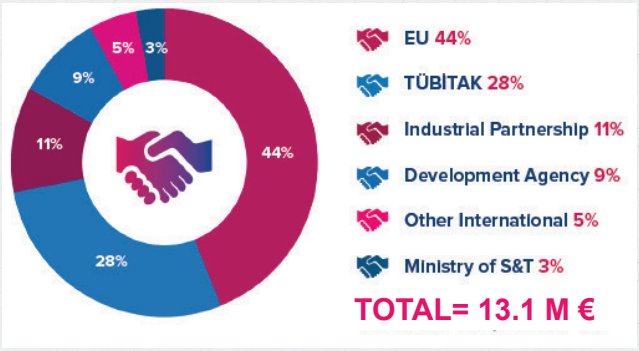


Laboratory Infrastructure @ OzU

- With 26 laboratories and 6 research centers with in its LEED certified campus, OzU offers sufficient lab infrastructure relevant to developing and analyzing novel techniques in cement-based materials.

Research @ OzU

- As of September 2014, OzU hosted 17 FP7 Marie Curie Programme Projects (CIG and IIF), 3 FP7 projects. Apart from FP7, OzU takes part in other EU funding opportunities such as COST, CIP, etc.
- These EC grants' budget constitutes about 40% of the total grants budget of the University.



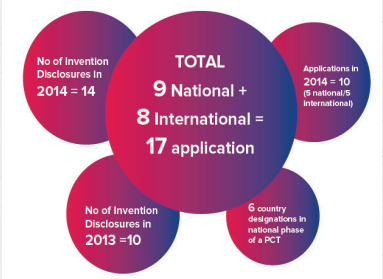
- The number of the on-going TUBITAK projects is exceeding 40 and most of them are research projects.
- OzU has recently been active in approximately 50 projects collaborated with world-known industries such as AirTies, DHL, Ericsson, etc. and leading national industrial institutions.

Technology Transfer Office @ OzU

- TTO works cordially with faculty members to carry out planning, development and management of research projects, development of industrial relations, innovation, technology transfer, and IP management.
- The main objective of the TTO at OZU is to assist research activities and innovation initiatives that aim to turn scientific and technological developments into social and economic benefits.

Patents @ OzU

- Total number of 10 new patent applications were filed in 2014.



- OzU encourages interdisciplinary research activities. Its entrepreneurial environment allows faculty members to access complementary skills and experience.

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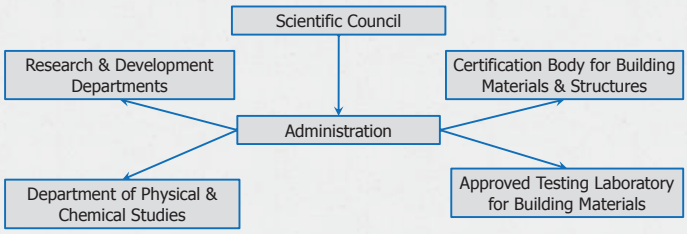
Kiev National University of Civil Engineering and Architecture

V.D. Glukhovsky Scientific Research Institute for Binders and Materials (SRIBM)

www.knuba.edu.ua

Structure of SRIBM



- staff members – 41, including: DSc(Eng) – 3, PhD – 10, young scientists and researchers – 10.
- gender balance: female/male – 17/24.

Main research equipment and testing techniques:

- physico-mechanical testing of building materials;
- physico-chemical examination: X-ray diffractomer, electron microscope, IR-spectroscope, calorimeter, differential thermal analyser, microprobe analyser, etc.;
- testing techniques in accordance with national standards of Ukraine and self developed techniques for a numerical modeling of cracking as a result of hydration heat and applied mechanical loads (the second - in collaboration with Lviv Polytechnic National University, Ukraine).

Some facts:

- Year of foundation of scientific research institute and scientific school on alkali activated materials (AAM) by professor V.D. Glukhovsky: 1958. Since those times a leading scientific school in the USSR for AAM.
- More than 140 PhD and 10 DSc thesises on alkali activated materials (AAM).
- More than 3000 scientific publications (the first publication on AAM: 1957).
- More than 500 USSR patents (author's certificates) and 20 international patents on AAM.
- A full set of all mandatory normative documentation (national standards) for a large- scale application of the AAMs and structures in the USSR and Ukraine.
- Four international conferences on AAM: Kiev, Ukraine (1994 and 1999), Prague, Czech Republic (2007), Chongqing, PR China (2014).
- Participation in *rilem*: TC 224-AAM "Alkali-Activated Materials" (2010- 3013) and 247-DTA "Durability Testing of Alkali Activated Materials" (2013- currently).

Role in this Action:

- participation in knowledge exchange and re-development and updating of existing standards for prediction of service life through STSM, training courses, seminars, etc.;
- bringing the collected knowledge and experience in the work on harmonization of the Ukrainian standards for cement-based materials, including the alkali-activated cement-based materials, with the European ones;
- application of the collected knowledge and experience for drafting a national Construction Product Directive, re-development of national building codes and approach to updating of national standards and technical approvals similar to those developed under EOTA (a first-priority task of the new Ukraine's government with regard to standardization activities).

The above activities will remove trade and other barriers, to attract foreign investments, to form a competitive environment in Ukraine as a newly admitted associated state member to the EU and to provide a possibility of equal partnership.

Some partners:

- Brno University of Technology, Brno, Czech Republic
- Chongqing Research Institute of Building Science, Chongqing, P.R. China
- Shenzhen Academy of Aerospace Technology, Shenzhen, PR China
- Association Eduardo Torroja Institute for Construction Science, Madrid, Spain
- "Partek", Finland
- "Holderbank (Holcim)", Switzerland
- "Chemcomex", Czech Republic
- Bauhaus University, Weimar, Germany
- "NUKEM", Germany
- Consortium "SGN (France)- Belgatom (Belgium)- Ansaldo (Italy), Chernobyl, Ukraine
- "Metchel, Chelyabinsk, Russian Federation
- "Illyich Mariupol Metallurgical Works", Mariupol, Ukraine
- Consortium "NOVARKA", Slavutich, Ukraine
- "Chernobyl NPP", Slavutich, Ukraine
- "УКРСКС Ltd.," Kiev, Ukraine

Participation in national and international grants:

- INTAS "Development of energy- and resources saving technology for making heat insulating materials using local raw materials and industrial wastes" (2005 – 2008)
- Grant of the President of Ukraine for Young Talents (2007 – 2008)
- EBRD ("Chernobyl New Safe Confinement" (Consortium "NOVARKA" (VINCI Construction Grands Projets/Bouygues Travaux Publics, France), Slavutich, Ukraine) (2008 – 2013)
- EBRD: "To Define the Recipes for the LRTP Final Product" (Chernobyl, Ukraine), 2011 – 2014)
- SUPMAT for the Czech Republic "Promotion of further education of research workers from advanced building material centers" (2011 – 2014)

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Nano & Advanced Cement-based Materials & Structures Research Group at Brunel

Group Leader: Dr Xiangming Zhou, Brunel University London

The **Nano & Advanced Cement-based Materials & Structures Research Group** at Brunel University London aims at researching high-performance, low-carbon and high energy efficient cement-based materials enhanced by nanotechnology and their structure performance including fracture, dynamic and impact behaviour to contribute sustainable development of infrastructure therefore human society.

The research of the Group has been sponsored by Engineering & Physical Science Research Council UK, Technology Strategy Board (now Innovate UK), European Commission 7th Framework Programme, European Commission Lift+, European Regional Development Fund, Horizon2020 MSCA-RISE, Royal Academy of Engineering UK etc.

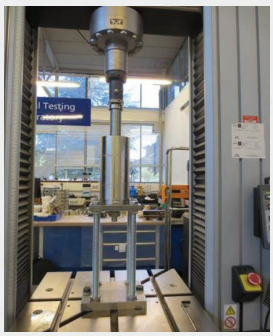
Funded Projects

- *A Novel Method for Assessing Cracking Tendency of Concrete at Early Ages*, EPSRC UK
- FIBCEM - *Nanotechnology Enhanced Extruded Fiber Reinforced Foam Cement Based Environmental Friendly Sandwich Material for Building Applications* , European Commission FP7
- WOODRUB - *Utilisation of Recovered Wood and Rubber for Alternative Composite Products*, European Commission Life+
- REMINE - *Reuse of Mining Waste into Innovative Geopolymeric-based Structural Panels, Precast, Ready Mixes and Insitu Applications*, Horizon2020, MSCA-RISE
- *Monitoring and Interpretation of Hydration Process and Strength Development of Low Carbon Geoement/Geopolymer Materials at Early Ages using Non-Contacting Resistivity Measurement*, EPSRC UK
- *Graphene-based Smart Skin Materials/Sensors for Structure Health Monitoring,* Royal Academy of Engineering UK
- Grow2Build - *Local Cultivated Hemp and Flax as Resource for Biobased Building Materials,* European Commission ERDF
- VIP4ALL - *Highly sustainable and effective production of innovative low cost vacuum insulation panels for zero carbon building construction*, European Commission FP7
- ICECLAY - *Highly efficient production of ultra-lightweight clay-aerogel materials and their integrated composites for building insulation*, European Commission FP7
- *Modelling Localized Fracture in Composite Floors at Elevated Temperatures*, EPSRC UK
- *Etc*.

MAIN & UNIQUE TESTING TECHNIQUES & RESEARCH EQUIPMENT

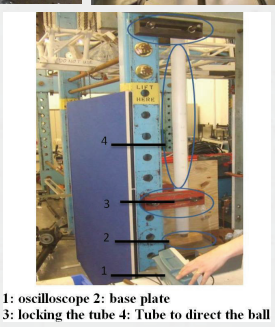
- *A series of Instron covering a broad range mechanical & structural tests*
- *A range of cement/concrete mixer for blending SCC to semi-solid CBM for extrusion*
- *A pilot –scale screw extruder for CBM*
- *A series of in-house apparatus for calibrating rheological (elastic, plastic and viscous) properties of semi-solid, dough-like fibre-reinforced CBM for extrusion*
- *A series of circular & elliptical ring test apparatus for assessment of shrinkage cracking of CBM*
- *A set of non-contact electrical resistivity measurement device for fresh CBM*
- *A set of in-house impact test apparatus for CBM*
- *A set of thermal conductivity test apparatus*
- *A set of thermal efficiency test rig for CBM panels*
- *SEM, FEG-SEM, TEM, EDXA, XRF, XRD, FTIR, WDXA, XPS, SPM, AFM, DSC, TGA etc.*











1: oscilloscope 2: base plate
3: locking the tube 4: Tube to direct the ball





Brunel University London

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AECOM



100,000
Employees Globally
150
Countries

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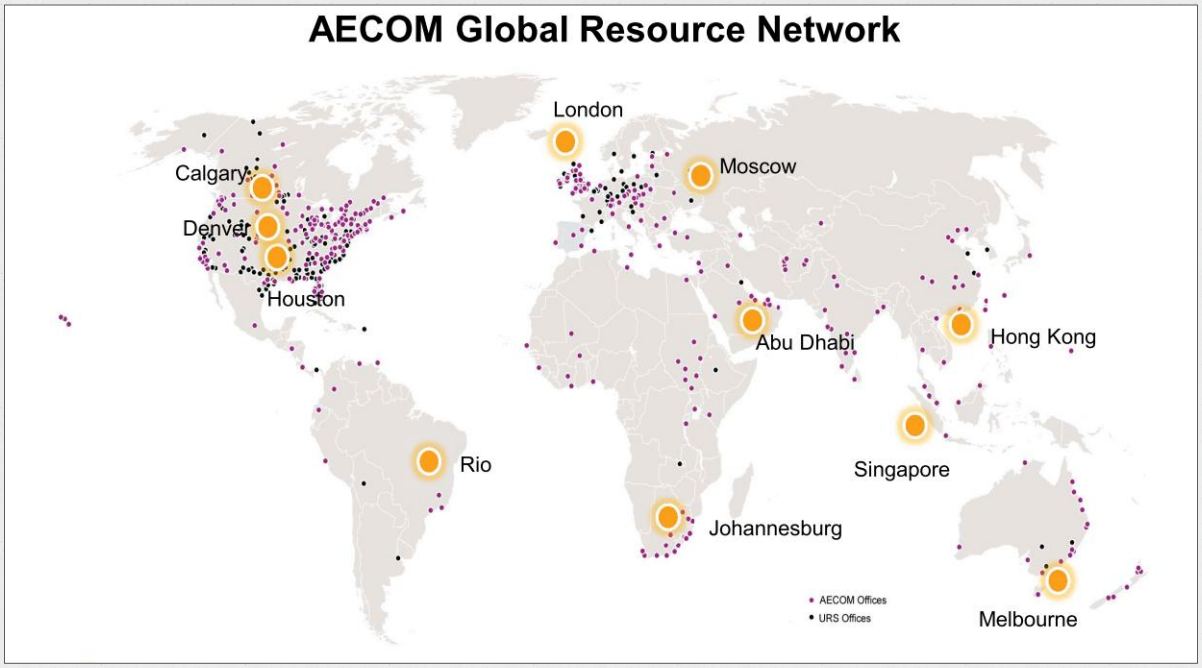


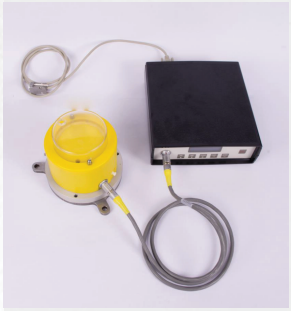
amphora NDT

Experts in Non-Destructive Test Methods, Durability Sensors & Structural Health Assessment

Future Testing Technology Implemented Today

Amphora NDT manufacturers a range of non destructive testing instruments for the concrete industry. Our products focus on testing and monitoring the near surface material properties of concrete to pick up deterioration and corrosion issues at the earliest possible opportunity.

Autoclam



The **Autoclam** Permeability System is an on-site or lab testing device, measuring:

- Air permeability
- Water Permeability
- Water Absorption

Simple set up and data interpretation
15 minute test time

Permit



The **Permit** Ion Migration Test is an in situ measurement of ionic transport properties. It allows:

- Determination of chloride diffusion coefficient
- Assessment of coatings/surface to chloride ingress
- Predication of chloride induced corrosion of reinforcement bar

Limpet



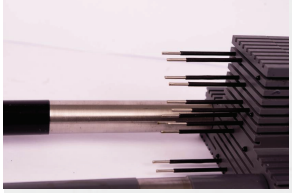
The **Limpet** Pull off Test

- On site testing of patch repair bonding
- Assessment of concrete strength via the pull off method

Lightweight and rugged for site or lab use

Septopod





Septopod Durability Monitoring System is a smart multi sensor device within one housing. Sensor allows:

- Real time water/chloride ingress via electrical resistance measurement at 10mm steps
- Freeze/thaw and temperature monitoring
- Corrosion monitoring of steel

Interested in:

- New instrument development and commercialisation
- Industrial and academic partnerships
- Contact **neil@amphorandt.com**

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