Mechanics of Materials and Constructions

MEMC
Mechanics of Materials and Constructions - MEMC - is a department of Vrije Universiteit Brussel (VUB), located in the centre of Brussels, in Campus Etterbeek, literally in the heart of Europe.

The Vrije Universiteit Brussel is the only Flemish university that has incorporated the principle of ‘free inquiry’ in its statutes. It is a competitive, high-quality, socially committed and internationally-oriented university located in Brussels.

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

in its mission, function, education and research strategy in order to realize them in the most concrete way.

Our Mission

To study the mechanical behavior of innovative material systems and light-weight 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.
Research / Expertise

In the Department of ‘Mechanics of Materials and Constructions’ (MEMC) fundamental and applied research is developed related to the following topics:

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.

MEMC has ‘state-of-the-art’ test facilities for mechanical characterization of advanced material systems and structural components under static, biaxial, cyclic and extreme loading conditions. The department has gained a unique expertise in the use of full field optical measurement techniques for monitoring displacement and strain fields, such as Digital Image Correlation (DIC), shearography and Electronic Speckle Pattern Interferometry (ESPI). A large number of experimental techniques like ultrasonic testing (UT), acoustic emission (AE), infrared thermography, stereo-microscopy, strain gages, liquid penetrants etc. can be applied to monitor the mechanical/damage performance. Beside these experimental techniques, analytical, numerical and mixed numerical-experimental techniques/tools may be applied to gain a more in-depth understanding of the observed mechanical behaviour of materials under complex loading including environmental effects.

Software and hardware is available for the research on these themes. In the applications, international relations and interactions with industry are a permanent incentive for future developments.

Basic equipment in brief:

- Two Acoustic Emission systems, 12 acquisition channels with sampling rate of up to 10 MHz are available and a variety of sensors for different frequency bands (R15, R6, miniature, wideband). Three dimensional (3D) source location can be used to examine the dimensions of the fracture zone in relation to the type and amount of loading.
- Advanced pattern recognition can be conducted by NOESIS software for clustering of the signals in relation to the different damage mechanisms.
- Ultrasonic measurements for stiffness determination and degradation can also be conducted with the available pulse generators that can excite different types of tone bursts, low, high frequency, sine sweep) to examine the dispersive behaviour of the material due to its heterogeneous structure.
- Two Digital Image Correlation systems for strain field measurements in real time with VIC3D software.
- Mechanical tests with different load cells are available, including a two bi-axial test benches for static and dynamic loading. Recently a Bose ElectroForce 3510 was purchased in order to perform delamination tests under fatigue loading.
- Strong floor of 180 m2 with 7x11 anchorage points.

Our department has a long-standing international recognized reputation in the development and mechanical characterization of fibre reinforced composite material systems with both inorganic and organic matrix, and in the design and analysis of structures. Concerning the development of new material systems most attention is devoted to the development of multifunctional high performance fibre reinforced cementitious composites (HPFRCC) mainly for application in civil engineering. An innovative glass fibre reinforced mineral matrix material was made available on the world market under the brand name of “vubonite” (EP 0 861 216 B1, “Inorganic Resin Compositions, Their Preparation And Use Thereof”). This chemically bonded phosphate matrix is totally pH-neutral after hardening at room temperature and has the suitable rheology in fresh state to penetrate fully fibre reinforcements which are common to polymer composites.
Areas of application towards the industry

- Composite industry
- New cementitious materials and cement-matrix composites
- Textile industry
- Construction industry and prefabrication industry
- Monitoring and damage assessment of structures
- Steel structures

Lightweight textile reinforced structures under bi-axial dynamic loading

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

Mechanical testing on human femur bone

Inorganic phosphate cement (IPC) Curved plate

Testing of railway sleeper on ballast

Classification of AE data according to fracture mode

Displacement field of metal plate after impact loading
Services for the industry

We have extensive and flexible lab equipment to investigate the mechanical performance of a large variety of structures/materials. A large array of measuring techniques (Acoustic Emission, Digital Image Correlation, ESPI) is available. Test set-ups are tailored to the needs of the industrial partner.

Our recent activity

Department MEMC actively participated in the maintenance-renovation project of the VUB swimming pool conducting a series of non-destructive tests for integrity of the sub-base structures supporting the main tank.

Specifically, ultrasonic tests with the portable equipment owned by the department and surface hardness measurements by the rebound hammer kindly borrowed by the Royal Military Academy helped to assess the stiffness and deterioration condition of the supporting columns and the floor.

Scientific Publications

The high quality and innovative scientific contribution of MEMC is seen by the increasing number of publications in peer reviewed journals and international conferences as shown in the curve below (source Web of Science).

Scientific Projects

MEMC is participating or coordinating several projects on a national and international level. On the National level different projects were funded by FWO, IWT, Innoviris and SIM. The department has also strong presence in the newly launched H2020 calls while it is already participating in the COST action TU 1404. MEMC contributes to teaching and supervising activities in a structured way outside European borders (Kenya, Malaysia, Japan).
Education

Our programs

1| **BACHELOR of Science in Engineering** (180 ECTS)
   offered in dutch language.

2| **MASTER of Science in Civil Engineering** (120 ECTS – 2 years)
   offered in English language.
   The program is organised in cooperation with Université Libre de Bruxelles: Brussels Faculty of Engineering (in short Bruface) and offers three (3) specializations to our master students:
   - Structures
   - Construction and Geomaterials
   - Water Resources
   "The overall objective of the program is to form academic engineers that can deliver services to society in many areas and are able to carry out and manage projects as skilled engineers. The academic program has a close relationship with the scientific research in the related fields and forms the basis for lifelong learning".

For more information, you are welcome to visit our website pages:

Lifelong Learning Program (LLP) / Erasmus
VUB students are given the opportunity to spend a period of time at a foreign university within the Erasmus framework of the Lifelong Learning Program of the European Union.

Social Engagement

Academia, as part of the society, should act towards social benefit. MEMC’s students take initiatives that promote these principles and raise awareness of their role as civil engineers to the society.

MeMC’s students show their solidarity with the local people by working build structures that are urgently needed in countries of the South. This is fulfilled through Edukado organization ([www.edukado.be](http://www.edukado.be)), which has already realized three projects (two times in Bangladesh, one time in Nepal).
Govinda Panthy started in 1998 a primary school on the demand of a few parents who wanted to give their kids a proper education. By 2013, the SAV-school in Bageshworí, Nepal, was in high need of an expansion since the number of students enrolled was becoming too much for what the school could handle. Edukado, an organization that supports and supervises a group of students for the realization of humanitarian projects, was charmed by the initiative of Govinda and decided to help with the expansion of the SAV school.

A group of VUB-students started in October 2013 with the preparations for building two additional class rooms and a library during the summer of 2014. The students would follow up the project from start to finish themselves. This means that the students had to raise the funds, draw the construction plans and even finally build the school themselves. In order to raise enough funds, approximately €15.000, the students had to organize different activities such as a benefit dinner, selling valentine chocolates, Christmas market.

Almost two months before the students would leave for Nepal, they received some bad news. The existence of the SAV-school at the original location could not be ensured. Govinda then proposed to move the SAV-school to a more rural town, Narayanpur, where there was also need for the construction of a school for the lower caste. At the beginning of July, after nine months of hard work, the students finally left for Nepal.

During two months, the students constructed the school themselves with the aid of local laborers. At the end of August, the school was almost finished and the students, after a short trip throughout Nepal, came back home. In the meanwhile the school has been completely finished and the first courses will start in April.

By Sander Fonteyn - current MEMC-VUB PhD student

"For the year 2015-2016, the project consists of building a kindergarten with three or four classrooms in Malawi. During this period, they have to perform a whole series of tasks in order to achieve their goal. They have to contact the local partner in Malawi to know what the needs are and then, promote the project and organize sensitization activities around the project.

Meanwhile, they obviously need to work out the building plans of their project, by taking into account local requirements and in collaboration with our partner organization. Furthermore, it is important to gather the necessary money by organizing fundraising activities and by looking for subventions, grants and sponsorships.

In the summer, when all this is over, the students will finally leave for six weeks to Malawi to actually implement the project."

By Aushim Koumar – current MEMC-VUB PhD student – founding member of Edukado
International Dynamic Presence

Conference Participation
MEMC participates in international conferences by presenting its recent scientific work and achievements, disseminating the multidisciplinary research conducted within the department and making impact in the global scene.

Indicative examples of recent conferences
- 19th International Conference on Composite Materials, Montreal, Canada, 2013.
- 7th International Conference on FRP Composites in Civil Engineering, Vancouver, Canada, August 2014.
- International Conference on Construction Materials and Structures (ICCMATS), Johannesburg, Republic of South Africa, 24-26 November 2014.
- KIFA 6, The 6th Kumamoto International Workshop on Fracture, Acoustic Emission and NDE in Concrete, Japan, Kumamoto, 17-18 September 2013
- IAES22, International Acoustic Emission Symposium, November 11-14, 2014, Sendai Japan
- 16th International Conference on Experimental Mechanics, Cambridge, 7-11 July 2014
- Structural Faults and Repair-2014, London 8-10 July 2014
- Concrete Solutions 2014, Belfast 1-3 September 2014

Conference organization
MEMC successfully organizes and manages international conferences contributing to the strengthening of VUB’s global presence.
- DURACOSYS 2012 – 10TH International Conference On Durability Of Composite Systems

Small description of previous ETNDT Conferences if necessary

ET-NDT6

- ICEM18 – 18TH International Conference on Experimental Mechanics Brussels, Belgium
  (date to be announced within 2018).
Our TEAM
“Together Everyone Achieves More”

MEMC’s team promotes group dynamics and sound cooperation in order to achieve high quality performance and research excellence.

Teaching staff
Sigrid ADRIAENSSENS
Dimitrios G. AGGELIS
Christophe BAUDUIN
Willy Patrick DE WILDE (Emeritus)
Sven DUMORTIER
Clement HIEL
Wim HOECKMAN
Lincy PYL
Hugo SOL
Tine TYSMANS
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