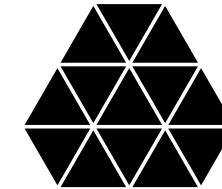
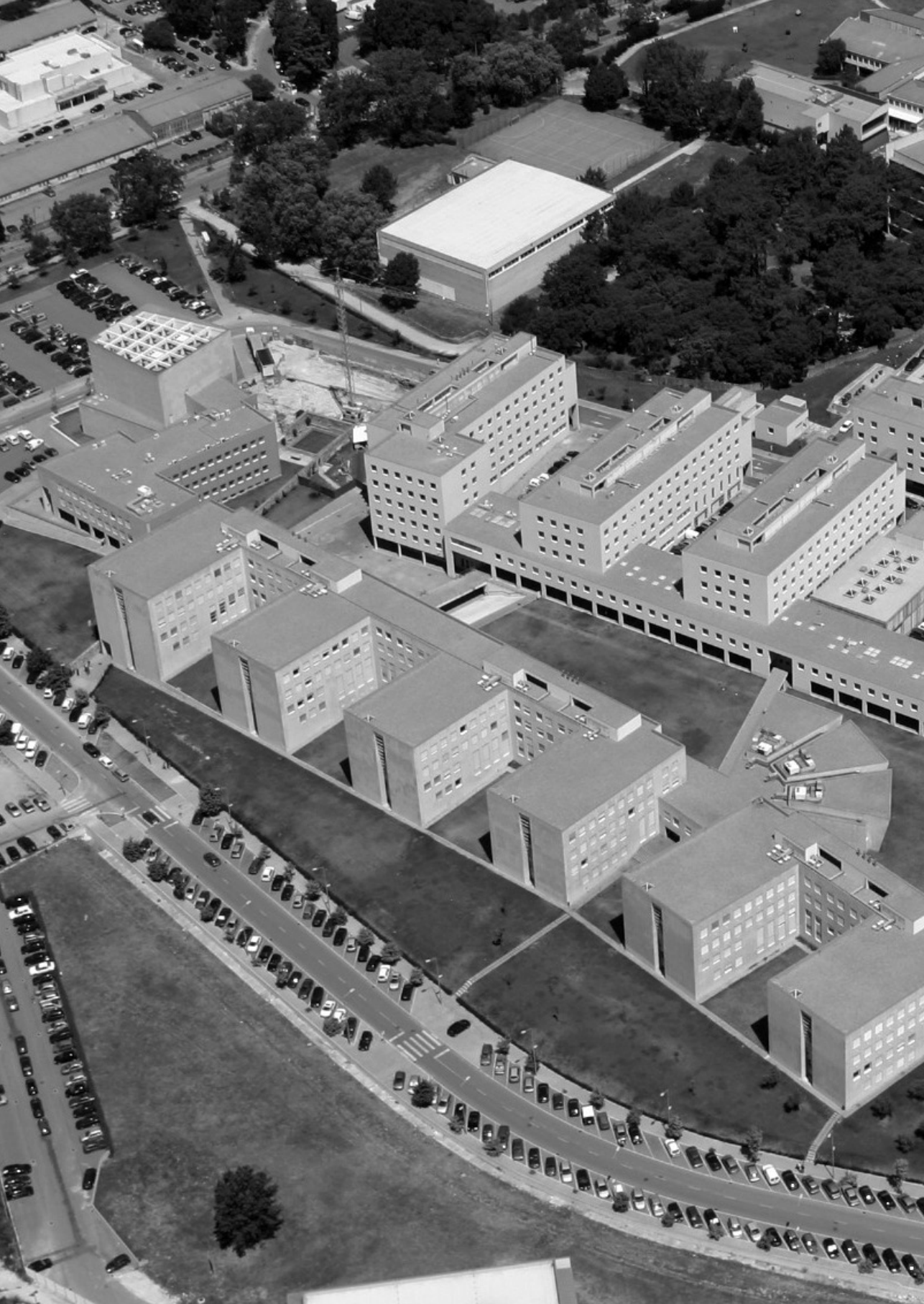


RESEARCH UNIT INSTITUTE OF R&D
IN STRUCTURES AND CONSTRUCTION



CONSTRUCT

U. PORTO
FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO



CONSTRUCT

Research Unit Institute of R&D
in Structures and Construction

The Institute of R&D in Structures and Construction (CONSTRUCT) is a R&D Unit, hosted by FEUP and funded by the Portuguese Foundation for Science and Technology (FCT), focused on the development of applied research on Safety, Serviceability, Durability, Economy and Sustainability of Civil Engineering constructions.

The activity of CONSTRUCT is presently framed by the following 6 Thematic Lines, corresponding to areas of high interest at national and international level:

- TL1 · New construction materials. Recycling and valorisation
- TL2 · Built historical heritage. Preservation, natural actions and climate change
- TL3 · Safety assessment and seismic engineering. Modelling and testing
- TL4 · Assessment and SHM of energy and transportation infrastructures
- TL5 · Railway infrastructures
- TL6 · Efficient and smart Construction

The team, scientific competences and laboratorial infrastructures of CONSTRUCT stem from the continuous effort developed, during the last 20 years, by its following 6 Research Groups:

- LABEST · Laboratory for the Concrete Technology and Structural Behaviour
- LESE · Laboratory of Seismic and Structural Engineering
- VIBEST · Laboratory of Vibrations and Structural Monitoring
- GEO · Geotechnics
- LFC · Laboratory of Physics of Constructions
- GEQUALTEC · Management and Technology of Building Construction

The research and consultancy activity of CONSTRUCT is carried out in the context of a matrix organisation, the involvement of the different Research Groups in the several Thematic Lines being characterised by the following table:

THEMATIC LINES RESEARCH GROUPS	LABEST	LESE	VIBEST	GEO	LFC	GEQUALTEC
TL1 · New construction materials. Recycling and valorisation	•			•		•
TL2 · Built historical heritage. Preservation, natural actions and climate change		•			•	
TL3 · Safety assessment and seismic engineering. Modelling and testing	•	•	•	•		
TL4 · Assessment and SHM of energy and transportation infrastructures	•	•	•			
TL5 · Railway infrastructures	•	•	•	•		
TL6 · Efficient and smart Construction		•			•	•

CONSTRUCT Team: formed by 51 PhD Integrated Members, supervising the scientific work of about 70 PhD students, 11 post-docs and a significant number of other doctorate and non-doctorate collaborators, inside and outside FEUP.

Means: Laboratorial infrastructures with a total area of about 3500 m² and scientific equipment with a value higher than 5 M€.

Scientific and Consultancy activity:

- Development of 72 R&D Projects obtained under competitive calls at European and National level and organisation of 44 international conferences in the period 2013-2018
- High number of Consultancy Services under contract with industry and public administration, in Portugal and abroad.
- Publication of about 180 papers in international journals in 2018.

Annual Budget (2013-2017):

- 2.2 M€/year (excluding permanent staff)
- 37 % supported by National R&D Projects (FCT, ANI)
- 13% supported by European Projects
- 13 % stemming from Consultancy Contracts with Industry and Public sources
- 28 % stemming from FCT PhD and Post-doc scholarships
- 9 % coming from the FCT Basic Funding

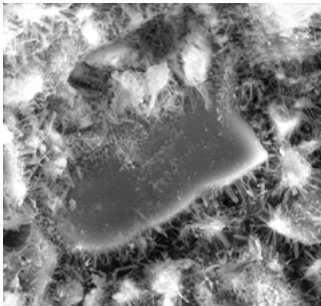
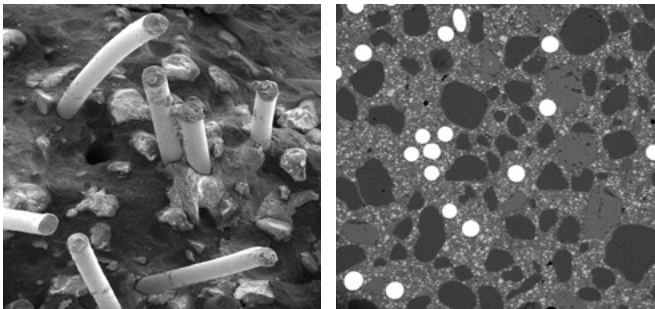


Contact:
Prof. Álvaro Cunha
(Scientific Coordinator of CONSTRUCT)

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4200-465 Porto

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TL1 · NEW CONSTRUCTION MATERIALS. RECYCLING AND VALORISATION



Research areas

- Development of eco-efficient construction materials
- Development of advanced cementitious materials
- Recycling of industrial and construction and demolition waste

Knowledge transfer and industry support services

- Characterisation of geosynthetic materials for construction
- Quality control and application of geosynthetics in landfills, canals and reservoirs, road and maritime works
- Characterisation of short and long term behavior of structures reinforced with polymeric materials
- Development of new coastal protection materials - geocontainers
- Development of concrete tailored to performance requirements
- Development and characterisation of new cementitious materials
- Support in the implementation of production processes for new cementitious materials

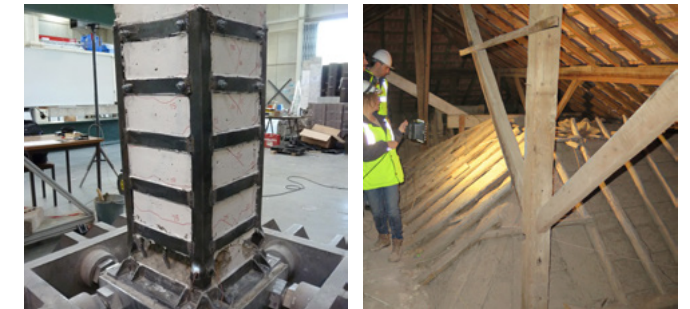
Team

Researchers of four groups of CONSTRUCT: LABEST, LESE, GEO, GEQUALTEC

Coordinator

Prof. Lurdes Costa
(lcosta@fe.up.pt)

TL2 · BUILT HERITAGE: PRESERVATION, NATURAL ACTIONS AND CLIMATE CHANGES



Research areas

- Experimental mechanical characterisation of masonry walls, namely brick infills and wooden partitions, in traditional stone masonry and regular reinforced concrete buildings, including the study of low-cost strengthening systems
- Experimental and numerical characterisation of the structural behaviour of stone masonry bridges
- Inventory and characterisation of damages, losses and risks in built historical heritage assets due to several types of disasters (natural or not), mainly with structural and building physics emphasis.

Knowledge transfer and industry support services

- Geometric, physical and mechanical characterisation of different materials, constructive typologies and existing structural/non-structural components (masonries, wooden partitions, floors...)
- Use of numerical and analytical techniques to study the structural and non-structural behaviour of traditional and heritage constructions
- Development, validation and implementation of strengthening techniques in different types of structural components of existing constructions
- Application of low-cost monitoring techniques in heritage structures, processing and management of collected information
- Assessment and management of vulnerability and risks in built heritage
- Definition, improvement and implementation of maintenance plans and management methodologies for buildings in service

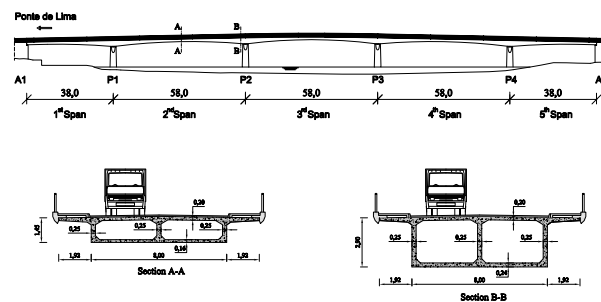
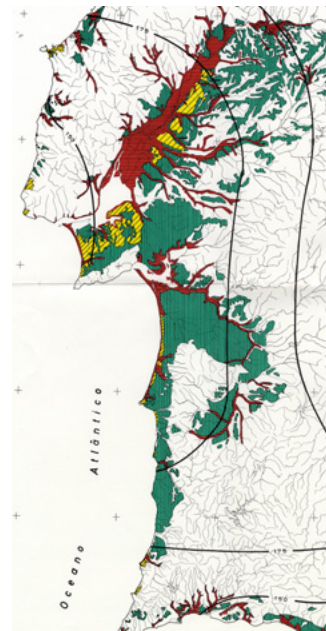
Team

Researchers of three groups of CONSTRUCT: LESE, LFC, GEQUALTEC

Coordinator

Prof. António Arêde
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TL3 · SAFETY ASSESSMENT AND SEISMIC ENGINEERING. MODELLING AND TESTING



Research areas

- Safety of existing building structures under seismic loading, retrofitting techniques and risk mitigation
- Seismic isolation in RC structures and infrastructures protection against soil liquefaction induced by earthquakes.
- Thermo-mechanical modelling of concrete structures due to early-age cement hydration heat release and assessment of structural condition using non-destructive testing techniques

Knowledge transfer and industry support services

- Safety of existing building structures under seismic loading
- Seismic strengthening solutions for RC members and heritage constructions
- Risk mitigation of new and existing infrastructures
- Life-cycle performance and safety assessment of existing bridges
- Infrastructures protection against soil liquefaction induced by earthquakes
- Numerical modelling and performance observation studies of geotechnical structures
- Thermo-hygral-mechanical simulations of RC structures to minimize cracking risk
- Assessment of structural condition using non-destructive testing techniques
- Safety assessment of existing structures for code integration

Team

Researchers of four groups of CONSTRUCT: LESE, LABEST, VIBEST and GEO

Coordinator

Prof. Abel Henriques (aarh@fe.up.pt)

TL4 · ASSESSMENT AND STRUCTURAL HEALTH MONITORING OF ENERGY AND TRANSPORTATION INFRASTRUCTURES



Research areas

- Experimental and numerical characterisation of the static and dynamic behavior of buildings and of energy and transportation infrastructures
- Structural health monitoring and control supporting infrastructures management systems
- Development and integration of sensors and innovative technologies for the extraction of relevant information from permanent monitoring systems

Knowledge transfer and industry support services

- Experimental characterisation of vibratory phenomena and implementation of vibration control systems
- Characterisation of cable forces in cable structures (cable-stayed bridges, cable roofs, external prestress)
- Characterisation of the static and dynamic behavior of buildings and of energy and transportation infrastructures (load tests, temporary and permanent monitoring)
- Installation of SHM systems in wind turbines, dams, high-voltage transmission lines, railway, roadway and pedestrian bridges
- Characterisation of the aerodynamic behaviour of slender structures on the basis of in-situ measurements
- Evaluation of traffic loads and their dynamic effects for fatigue assessment of metallic bridges
- Track monitoring in railway lines

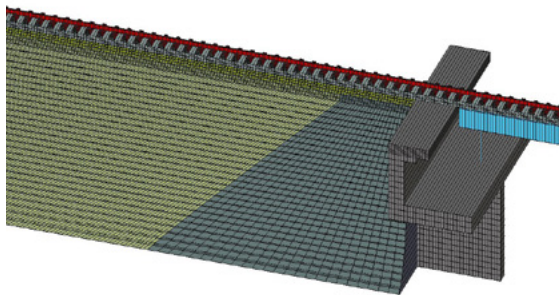
Team

Researchers of three groups of CONSTRUCT: VIBEST, LABEST and LESE

Coordinator

Prof. Elsa Caetano (ecaetano@fe.up.pt)

TL5 · RAILWAY INFRASTRUCTURES



Research areas

- Advanced dynamic models for analysis of the train-infrastructure interaction
- Advanced methods of assessment, rehabilitation and reinforcement of railway infrastructure (bridges, track and transition zones)
- Advanced models for analysis of the propagation of vibrations and noise in the vicinity of railways (surface and underground traffic)

Knowledge transfer and industry support services

- Development of innovative solutions for railway bridges (new or for rehabilitation/reinforcement of existing bridges)
- Development of innovative solutions (structural systems, new eco-sustainable materials, new resilient elements and advanced production systems) to improve the performance of railway tracks (ballasted and non-ballasted tracks)
- Development of new solutions to mitigate vibrations and noise in the vicinity of railways
- Advanced algorithms for analysis of the condition of the railway infrastructure, to support decision-making in intelligent asset management systems
- New monitoring technologies and maintenance strategies based on the condition of the railway system (wayside and on-board systems)

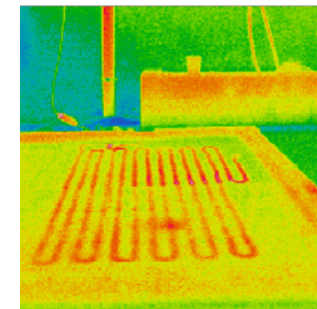
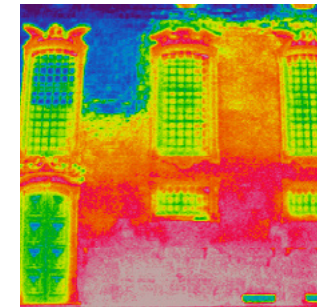
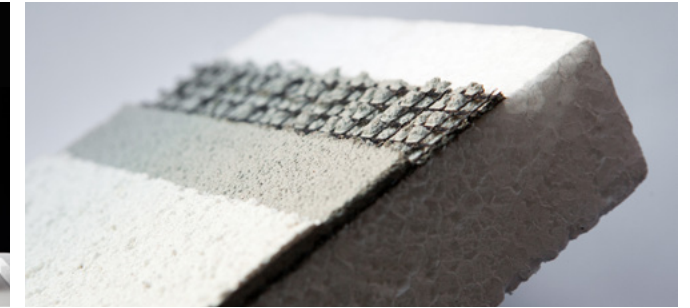
Team

Researchers of four groups of CONSTRUCT: LESE, LABEST, GEO, VIBEST

Coordinator

Prof. Rui Calçada
(ruiabc@fe.up.pt)

TL6 · EFFICIENT AND SMART CONSTRUCTION



Research areas

- Sustainable energetic and constructive rehabilitation
- In-situ monitoring and simulation of energy consumption, comfort, indoor air quality of residential and service buildings
- Development of sustainable green-roofs (building scale and urban effect)
- Hygroscopic inertia as a passive way to control the interior relative humidity fluctuation
- Innovative smart masonry and façades system (modelling and testing)
- Improvement of the productivity and efficiency of the building industry, mainly through building information systems and innovative procurement methods
- Development of BIM and VR models and software tools
- Building use, maintenance and facility management, oriented to active ageing

Knowledge transfer and industry support services

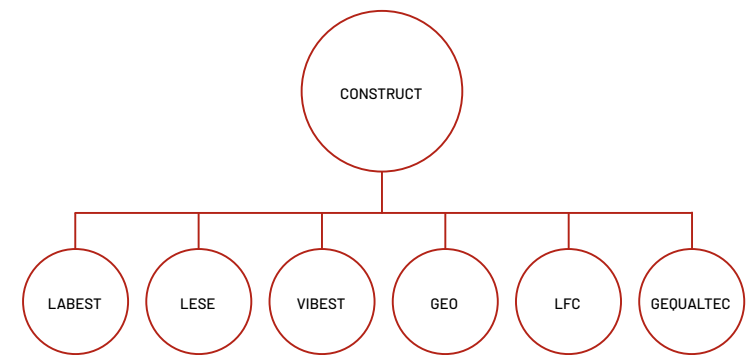
- Development of nZEB technologies
- Advanced in-situ characterisation of building envelopes with the combination of infrared thermography, airtightness tests and 3D scanning
- Thermal characterisation of building elements using thermography
- Green Roof Performance Evaluation
- Performance Evaluation of Thermal Mortars
- New methodologies for rising damp treatment
- Integrated experimental/numerical evaluation of materials and components of buildings
- Development of high-performance masonry systems
- Development of models and information management systems in the Building industry
- Linking BIM methodologies to sustainability and virtual models
- Acoustics - Test and Development of building solutions, Noise Maps
- Building Maintenance - Assessment, Diagnosis and Maintenance Manuals

Team

Researchers of two groups of CONSTRUCT: LFC, GEQUALTEC

Coordinator

Prof. Nuno Ramos
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Prof. Rui Calejo
(calejo@fe.up.pt)



RESEARCH GROUPS

LABEST

Laboratory for the Concrete Technology and Structural Behaviour

LESE

Laboratory of Earthquake and Structural Engineering

VIBEST

Laboratory of Vibrations and Structural Monitoring

GEO

Geotechnics

LFC

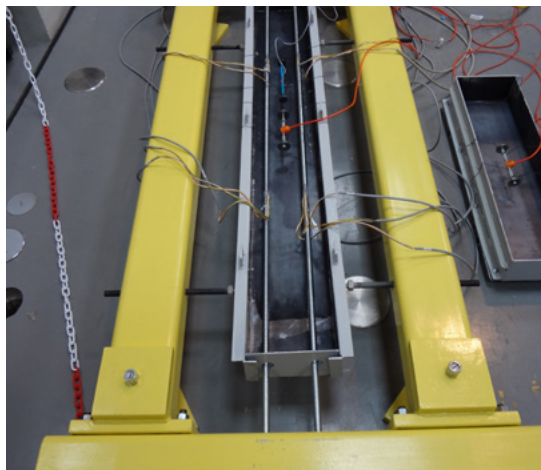
Laboratory of Physics of Constructions

GEQUALTEC

Management and Technology of Building Construction



CONSTRUCT



LABEST

LABORATORY FOR THE CONCRETE TECHNOLOGY AND STRUCTURAL BEHAVIOUR

Areas of Activity

- Design and performance of advanced construction and repair materials, including Self Compacting Concrete (SCC), Fibre Reinforced Concrete (FRC) and Ultra High Performance Fibre Reinforced Concrete (UHPC)
- Valorisation of industrial by-products and recycled aggregates in concrete
- Structural Health Monitoring (SHM)
- Advanced numerical modeling of reinforced concrete (RC) structures
- Structural safety and service life assessment of RC structures
- Simulation of RC structures since the onset of cement hydration, including the prediction of cracking due to restraints to the free deformations of concrete

Relevant Consultancy Services

- Permanent monitoring of the Luiz I Bridge (Metro do Porto, S.A.)
- Optical based monitoring of the new Alto Ceira Arch Dam (EDP)
- Load test of the Corgo Viaduct (CAET XXI Construções ACE)
- Permanent monitoring of the Pinhão Steel Bridge (IP Infraestruturas de Portugal, S.A.)
- Monitoring of the Agueira Bridges during rehabilitation (IP Infraestruturas de Portugal, S.A.)
- Assessment of the conservation status of the Levada Tunnel (LGC Linha de Gondomar Construtores, ACE)
- Laboratory characterisation of several structural components (composite slabs, GRC panels, corbels, prefabricated elements)

Resources

- Servo-controlled hydraulic actuators, universal load testing machines, weathering and aging chambers, equipment for characterizing concrete constituents, rheometer, mortar and concrete mixers, devices for characterizing various concrete durability indicators, creep and shrinkage racks
- Non-destructive testing for in-situ characterisation of UHPC
- Optical and electrical acquisition systems for structural monitoring, transducers of various types
- Nonlinear structural analysis programs, algorithms for analysis of structural monitoring data

Principal Investigator

Prof. Rui Faria
(rfaria@fe.up.pt)



LESE

LABORATORY OF EARTHQUAKE AND STRUCTURAL ENGINEERING

Areas of Activity

- Experimental and numerical studies of structures, structural components and constructive systems to characterize their behaviour under actions of dynamic nature, seismic in particular, and static
- Studies for characterization, assessment and mitigation of seismic risk in buildings and in transport and energy infrastructures
- Survey, diagnostics and field tests, including monitoring of existing structures, particularly built historical heritage structures, to support possible interventions of rehabilitation and conservation
- Experimental and numerical studies for characterizing the short and long term dynamic behaviour of the railway infrastructure (bridges, track, transition zones)
- Dynamic studies of railway bridges in high speed lines (HSL Madrid/Extremadura, Spain-Coba; HSL Poceirão/Caia-Mota-Engil; Third Tagus crossing-J.L. Cândia Martins; HSL Bretagne/Pays de la Loire, France-Mota-Engil; Railway crossing of the Volga River, Russia-OJSC Giprostroy most Institute)
- Studies of dynamic stability of the track foundation in high speed lines (HSL Poceirão/Caia-Coba, Mota-Engil; HS2 London/Birmingham - Mott MacDonald)
- Studies of long-term dynamic behaviour Transitional zones (HSL Poceirão/Caia - Soares da Costa; New variant of Alcácer-REFER)
- Studies of vibration mitigation solutions in the vicinity of railway lines (Lisbon Metro, Porto Metro)

Resources

- Several systems of mechanical actuation and response monitoring for quasi-static cyclic tests of full scale structural components, highlighting a test system of piers in biaxial bending with constant or variable axial force
- Testing system for walls, stone masonry or infills, under out-of-plane actions, concentrated or distributed, using hydraulic actuators and/or airbags with pneumatic actuation, for use in laboratory or field tests
- Several non-destructive and/or semi-destructive testing systems for material and structural characterisation in the field, with special emphasis on old constructions
- Several systems for monitoring the dynamic response of railway infrastructure (bridges, tracks, transition zones) and dynamic forces (vertical and lateral) imposed by railway vehicles

Relevant Consultancy Services

- Design, monitoring and implementation of the structural monitoring system of the new stone masonry road bridge, built in Vila-Fria, Vizela, (CM-Felgueiras, 2003-2005)
- In-situ cyclic tests of stone masonry walls of damaged constructions, to characterize their structural behaviour and validate seismic reinforcement techniques (Faial, Azores, 2007-2013)
- Medium to long term monitoring of the structural behaviour of historical constructions: Lapa churches in Porto (2009), Misericórdia and Santo António, Viana do Castelo (2014), Foz Côa and Torre de Moncorvo (2015 >), Guimarães Castle (2009-11), Ruins of Vila-Velha de Vilariça (2011-13), Mercado do Bolhão, Porto (2010-12), Portuguese Center of Photography, Porto (2016 >)
- Study, design and validation of pre-cast solutions of decks and piers of railway bridges in seismically active areas (Mota-Engil, 2009-2013)

Principal Investigator

Prof. Rui Calçada
(ruiabc@fe.up.pt)



VIBEST

LABORATORY OF VIBRATIONS AND STRUCTURAL MONITORING

Areas of Activity

- Experimental and numerical characterisation of the static and dynamic behaviour of buildings and of energy and transportation infrastructures
- Structural health monitoring and control supporting infrastructures management systems
- Development and integration of sensors and innovative technologies for the extraction of relevant information from permanent monitoring systems

Resources

- Systems for excitation of civil structures and measurement of the response
- Systems for indirect measurement of loads (wind, railway and roadway traffic)
- Algorithms/software for data analysis, automated modal identification and continuous monitoring
- Continuous dynamic monitoring systems for large Civil infrastructures

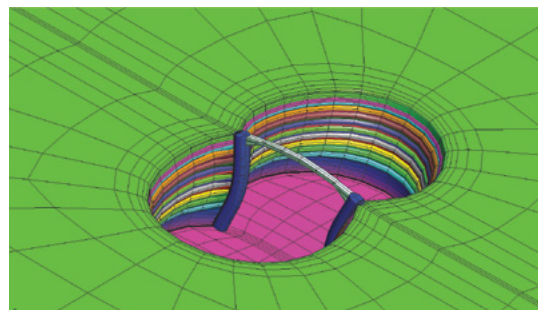
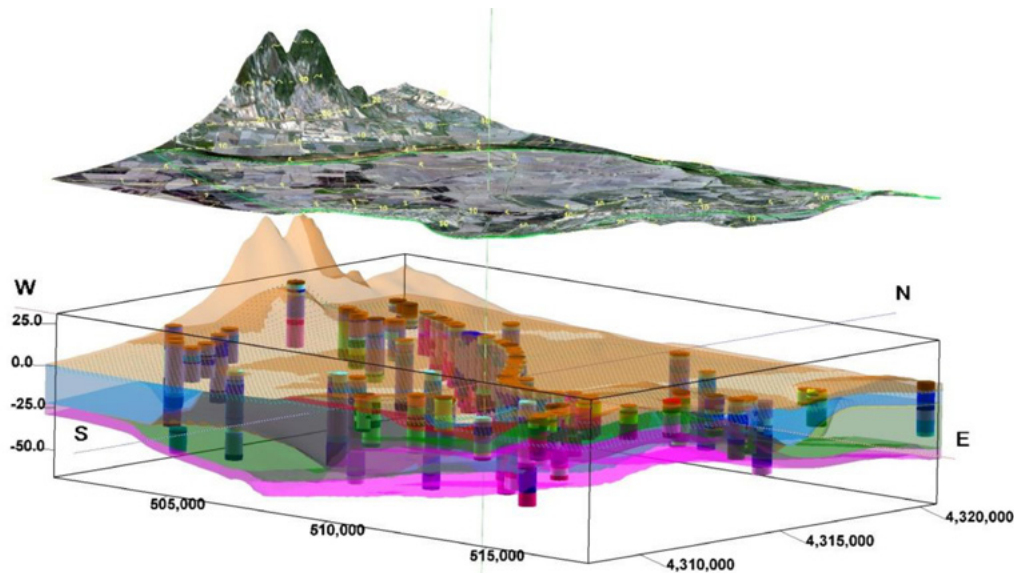
Relevant Consultancy Services

- Dynamic tests of Vasco da Gama Bridge at the commissioning stage, 1998 (Lusoponte)
- Dynamic tests of Millau Viaduct at the commissioning stage, 2004 (CSTB Nantes)
- Aerodynamic studies of Catumbela and Barra do Quanza Bridges, 2004, 2007 (Armando Rito Engenharia)
- Measurement of cable forces of 2012 London Olympic Stadium cable roof, 2010 (Bureau Happold and Team Stadium)
- Permanent dynamic monitoring of railway and roadway Foz-Tua Bridges, 2011-2017 (EDP Produção)
- Characterisation of the dynamic behaviour of Baixo Sabor and Foz-Tua Dams based on continuous dynamic monitoring, 2016-2019 (EDP Produção)
- Dynamic tests of Cardinals Stadium retractable pitch, Arizona, USA, 2016 (Tottenham Hotspur)

Principal Investigator

Prof. Elsa Caetano
(ecaetano@fe.up.pt)

GEO GEOTECHNICS



Areas of Activity

- Advanced laboratory and in situ testing for characterisation of natural soils (residual soils, unsaturated and sensitive soils with emphasis to liquefiable soils), stabilized and cemented soil mixtures.
- Wastes (urban, industrial, including ash, sediments and mine tailings).
- Experimental and numerical characterisation of short and long-term behaviour of geosynthetic-reinforced structures under static and dynamic loading.
- Soil dynamics and Earthquake Engineering.
- Geomechanics and numerical modelling of geotechnical structures (foundations, tailings dams and sediment deposits, deep excavations, underground works, embankments on soft soils, landfills, highways and railways).

Relevant Consultancy Services

- In situ and laboratory geotechnical tests for characterisation of bridge foundations: Vasco da Gama and 25 de Abril bridges, Lisbon; Salgueiro Maia, Santarém; Infante D. Henrique, Porto; Mosqueiros, Benavente; new Douro Bridges at Entre-os-Rios between 1994 and 2003 (Teixeira Duarte, SA; Tecnasol, SA; ICOR - Institute for Road Construction).
- Geotechnical (mechanical and hydraulic) testing of soils and rocks involved in large dams projects: Pinhosão, Alvão, Enxoé, Luz, Olgas, Álamos, Sambade, Santa Justa, Pisão, Rio Seco, Paradela, Lapa, Padroselos, Canto Cagarra - Cabo Verde, Almeidas 1994-2019 (COBA Consultores, SA; Hidrorumo, SA; Geoma, SA; Tetraplano, SA; Mota-Engil, SA, EDP Gestão de Produção de Energia, SA; Geoqual, Lda; SEG, SA; Monte Adriano, SA; Elsamex Portugal, SA, TPF- CENOR).
- In situ and laboratory geomechanical tests for soil characterisation and rocks within the scope of the

- first phase of the Metro do Porto project, between 2000 and 2004 (Transmetro, ACE) and the new phase of the Metro do Porto project (2018-present)
- Soil testing and geotechnical characterisation of tailings: oedometer tests, monotonic and cyclic triaxial and simple shear tests, permeability and retention curves tests (Somincor and Cerro do Lobo; Coper Mine - Spain; Heap Leach Pad 4A - Sociedad Minera Cerro Verde, La Coipa, Chile, between 2013 and 2016 (Golder Associates Portugal, Lda; URS Corp., USA; Knight Piésold and Co., USA); Casa de Pedra (CSM, Brasil) and diverse dams in Brazil (VALE).
- Characterisation of the geocontainers behaviour at the Restinga of Ofir, 2016 (Polis Litoral Norte). Quality control of the liners of Valença and Vila Real landfills, 2013-2014 (Valorminho), 2016 (Resinorte). Behaviour analysis of a geosynthetic-reinforced wall at EN 353, Isna de Oleiros, 2017 (Grupo Lena).

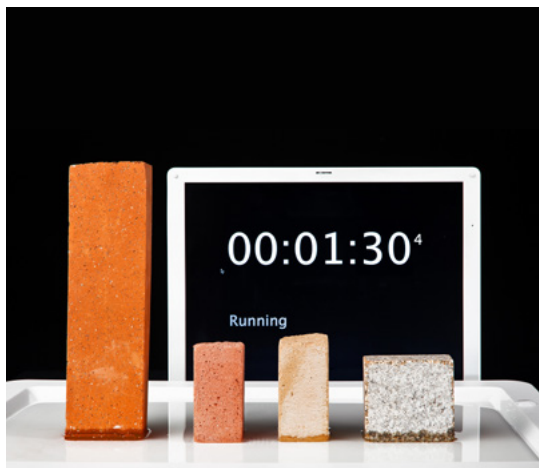
Resources

Wide range of geotechnical laboratory equipment for soils and rocks, including automated triaxial and direct/simple shear systems for static, stress-path, cyclic and dynamic testing, double triaxial chamber for unsaturated soils, true triaxial cube, precision internal instrumentation (hall-effects, bender elements) and large triaxial systems for ballast testing. In situ testing equipment: CPT/CPTU/SCPT, Seismic CH and U/DH; PLT; PMT; Guelph permeameter

Laboratory equipment for characterisation of short and long-term behaviour of geosynthetics, including durability, and software for numerical analysis of the behaviour of geosynthetic-reinforced structures.

Principal Investigator

Prof. António Viana da Fonseca
(viana@fe.up.pt)



LFC

LABORATORY OF PHYSICS OF CONSTRUCTIONS

Areas of Activity

- Building materials hygrothermal properties measurement;
- Comfort and energy efficiency – in-situ monitoring and simulation;
- Hygrothermal performance of green roofs;
- Assessment of moisture migration through materials interface;
- Study of materials drying process;
- Building degradation by salt attack;
- Treatment of rising damp (hygro-regulated wall base ventilation system);
- Building assessment with infrared thermography for building diagnosis;
- Predicted Human Life Quality;
- In-situ assessment of buildings airtightness and ventilation rates;
- Study of overheating problems in buildings;
- Characterisation of museums hygroscopic inertia;
- Establishment of a benchmark for School Buildings;
- Study of hygrothermal pathologies and use of ICT for the dissemination of knowledge;
- Moisture in cultural heritage.

Relevant Consultancy Services

- Hygrothermal behavior in service evaluation – social housing, schools, old buildings and monumental heritage;
- Thermographic Studies;
- Green roofs performance assessment;
- Thermal mortars performance evaluation;
- Rising damp control and flood drying – wall base hygro-ventilation system;
- Pathologies studies associated with hygrothermal problems;
- Facades and roofs systems and components development.

Resources

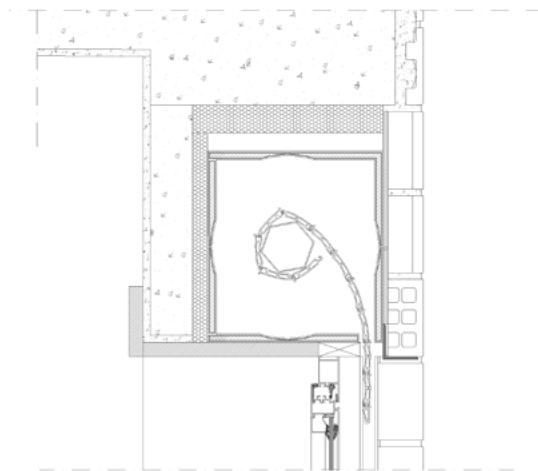
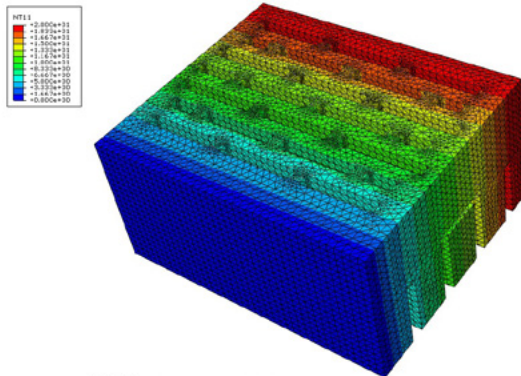
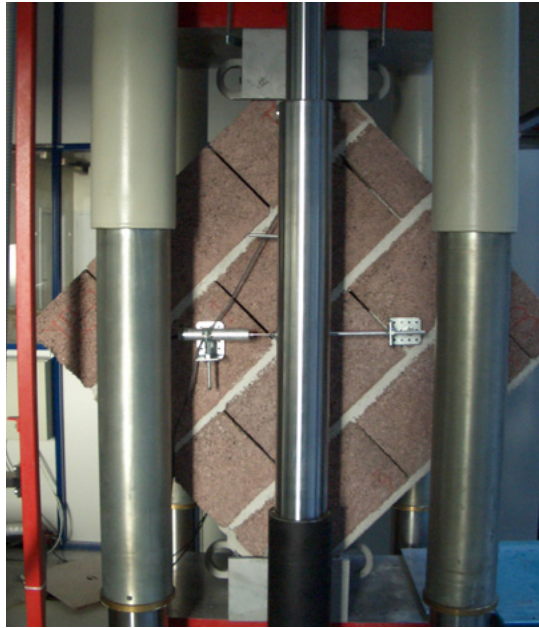
- Laboratory resources that allow measuring: moisture content (gamma ray and TDR); water absorption; water vapor permeability; liquid water permeability; hygroscopic curves; dimensional variation with relative humidity; thermal conductivity; durability; pull-off and mechanical testing on façade coatings; ventilation flow; temperature, relative humidity and CO₂.
- Hygrothermal software use and development.

Principal Investigator

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(anasofia@fe.up.pt)

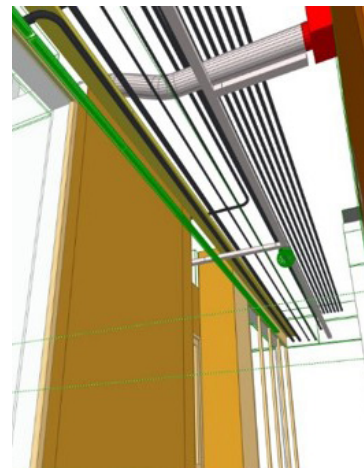
GEQUALTEC

MANAGEMENT AND TECHNOLOGY OF BUILDING CONSTRUCTION



Real transfer
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Step: Input transfer; Real transfer
 Simulation: 11/19/15 Time = 1.200
 Primary Var: UZ1
 Deformed (var not set) Deformation Scale Factor not set



Areas of Activity

- Efficient management – processes, use, maintenance & facility management, information systems & BIM
- Building smart technologies - Innovative and smart materials & systems, Non-structural fire risk assessment, Life cycle and sustainable assessment

Relevant Consultancy Services

- Development of energy efficient and sustainable wall system (Project Efficient wall plus Saint Gobain-Weber, 2016/2019)
- Implementation of ProNIC methodology to Parque Escolar's investment program (Parque escolar Protocol, 2008/2019)
- Strategic plan for rehabilitation and maintenance Interventions of the municipal housing park (MatosinhosHabit Protocol , 2018/2019)
- TransSMART - Programa de Transferência de Tecnologia para um "Smart Building Environment"

Resources

- Standard test system for the experimental assessment of water-tightness, air permeability and wind resistance of facade systems
- Universal press machine with 3000 kN of capacity to perform several mechanical testing of masonry samples
- Testing Infrastructure to determine sound absorption "alfa Sabine", airborne sound insulation (Rw) and percussion sound insulation (Lntw) of construction materials/systems
- Urban noise monitoring system and software for the production of noise maps - Cadna A

Principal Investigator
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UNIVERSIDADE DO PORTO

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 **REPÚBLICA
PORTUGUESA**

