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Structural Concrete
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ISISE HIGHLIGHTS

This third issue of the ISISE Newsletter comprises the activities developed mainly in the last 6 months of The Institute for Sustainability and Innovation in Structural Engineering. In this period, over 1.3 M€ of competitive funding was assured by several new national and European R&D projects, together with the successful completion of some ongoing projects,

demonstrating the high activity in this field. ISISE has also maintained strong outputs in the organization of national and international events, such as the 4th ISISE Day-out and Workshop, as well as concluded PhD theses. In this issue, special focus is given to the projects completed (two European R&D projects), as well as to the PhD theses completed.

European Steel Construction Day & Annual Meeting



Residual mechanical properties of ordinary concretes after fire

R&D PROJECTS COMPLETED (2012)

> **SBRI - Sustainable Steel and Composite Bridges in built environment**

Principal Investigator: Luís Simões da Silva

Budget: UC 279.019€ / Total 1.459.864€

ID: SBRI - RFSR-CT-2009-00036

Funding Entity: EU - RFCS

Participating Institutions: Univ. Stuttgart, Germany (coordinator); FCTUC; AG der Dillinger Hüttenwerke; ArcelorMittal, Luxembourg; LNPC - Laboratoire Nationale de Ponts

et Chaussées, France; Ramboll, Sweden; Brisa, Portugal; SETRA - Service d'Etudes Techniques des Routes et Autoroutes; BAST, Germany.

Date: 30/06/2012

Summary: In the SBRI research project, a holistic approach was applied to steel-composite bridges by combining analysis of Lifecycle Assessment, Lifecycle Cost and Lifecycle Performance. Under the perspective of sustainability, an entire lifespan, from the construction to the demolition of a bridge, is regarded. A valuable collection of data in view of existing bridges was obtained and a lifecycle scenario was described including maintenance strategies; measurements of optimization towards cost-effectiveness and low environmental impact were achieved. The new sustainable design process was evaluated on three types of representative highway steel-composite bridges with a complete design of realistic case studies throughout all aspects. In a second step, variations and optimization were applied. The long term behaviour of each component of bridges affected by degradation processes such as fatigue, corrosion and carbonation, was studied in detail.



> **COMPFIRE - Economical and safe design of steel joints under the natural fire**

Principal Investigator: Aldina Santiago

Budget: UC 297.380€ / Total 1.578.814€

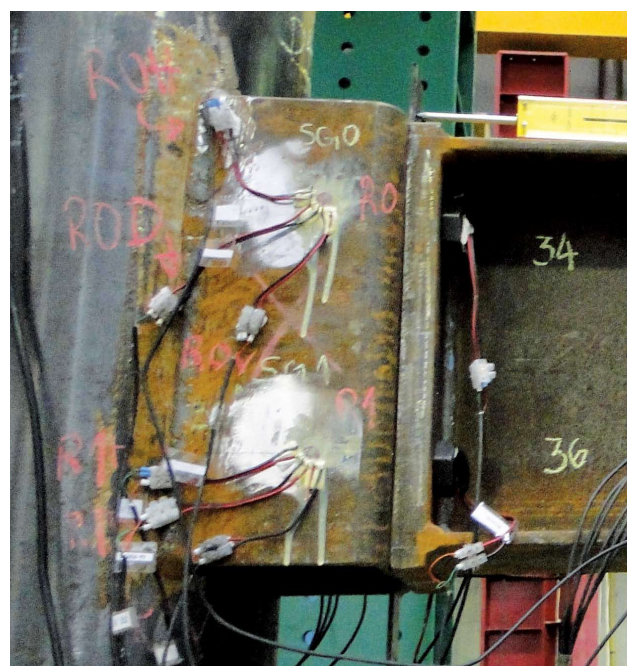
ID: COMPFIRE RFSR-CT-2009-00021

Funding Entity: EU - RFCS

Participating Institutions: FCTUC (coordinator); Univ. Manchester, UK; TU Lulea, Sweden; Univ. Sheffield, UK; TU Prague, Czech Republic; Desmo, Czech Republic; Corus Tubes, UK

Date: 30/06/2012

Summary: The main goal of the research framework is to allow prediction of the behaviour of a joint throughout any fire event in a manner consistent with the ambient-temperature design of joints, which is currently impossible. The detailed study of the behaviour of composite steel-concrete joints under natural fire conditions, especially during the cooling phase, is proposed. Fire testing is included on joint components, isolated joints, composite structural subassemblies and demonstration structures. The project investigation is focused on the joints between steel beam and concrete-filled tube columns using reverse channel sections. Numerical analyses of temperature development in protected and unprotected joint components in natural fires and coupled thermo-structural analyses will foster development of the integrated component-based model consistent with Eurocode procedures for composite steel-concrete joints.



R&D STARTED PROJECTS AFTER MARCH 2012

> **3DJOINTS – Three-dimensional behavior of steel joints**

Principal Investigator: Luís Simões da Silva
Budget: UC 138.420,00€ / Total 138.420,00€
ID: PTDC/ECM/116904/2010 - 3DJOINTS
Funding Entity: FCT
Participating Institutions: FCTUC

> **FIRE_COLDSTEEL – Experimental and Numerical Analysis of Cold Formed Steel Elements Subjected to Fire**

Principal Investigator: João Paulo Rodrigues
Budget: UC 126.639€ / Total 132.639€
ID: PTDC/ECM/116859/2010 - FIRE_COLDSTEEL
Funding Entity: FCT
Participating Institutions: FCTUC (Coordinator); PERFISA

> **HILONG – High Strength Long Span Structures**

Principal Investigator: Luís Simões da Silva
Budget: UC 271.145€ / Total 1.606.908€
ID: RFSR –CT-2012-00028 “ILONG”
Funding Entity: EU – RFCS
Participating Institutions: SCI, UK (Coordinator); UC, Portugal; LTU, Sweden; Imperial College London, UK; AUTH, Greece, V&M, Germany; S2, Australia

> **SustIMS – Sustainable Infrastructure management Systems**

Principal Investigator: Paulo Lourenço
Budget: UMINHO 393.440,86€ / Total 1.026.315,82€
ID: 23113

Funding Entity: ADI

Participating Institutions: Ascendi IGI, Inovação e Gestão de Infraestruturas, S.A. (Coordinator), UMINHO, FCT/UNL

> **S-Glass: Structural Performance and Design Rules of Glass Beams Externally Reinforced**

Principal Investigator: Paulo Cruz
Budget: UMINHO 76.738,00€ / Total 142.785,00€ / UC: 66.047,00€.

ID: PTDC/ECM/116609/2010

Funding Entity: FCT

Participating Institutions: UMINHO (Coordinator); FCTUC

> **Retroinf – Developing Innovative Solutions for Seismic Retrofitting of Masonry Infill Walls**

Principal Investigator: Graça Vasconcelos
Budget: UMINHO 100.155,00€ / Total 142.679,00€
ID: PTDC/ECM/122347/2010

Funding Entity: FCT

Participating Institutions: UMINHO (Coordinator); FEUP

> **CH-SECURE – Reducing the vulnerability of cultural heritage buildings to blast loading**

Principal Investigator: Paulo Lourenço
Budget: UMINHO 100.568,00€ / Total 157.188,00€
ID: PTDC/ECM/120118/2010

Funding Entity: FCT

Participating Institutions: UMINHO (Coordinator); Laboratório de Energética e Detónica; Associação de Apoio (LEDAP)

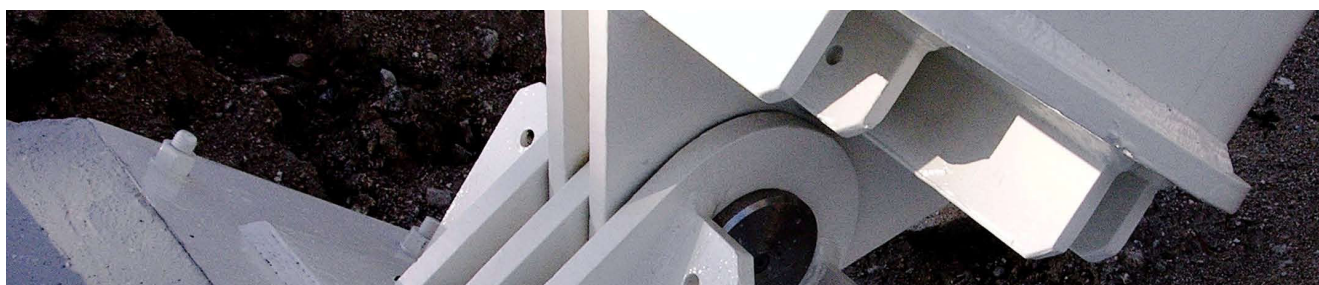
> **SlabSys-HFRC - Flat slabs for multi-storey buildings using hybrid reinforced self-compacting concrete: an innovative structural system**

Principal Investigator: Vítor Cunha
Budget: 100.568,00€

ID: PTDC/ECM/120394/2010

Funding Entity: FCT

Principal Contractor: UMINHO



PHD THESES COMPLETED

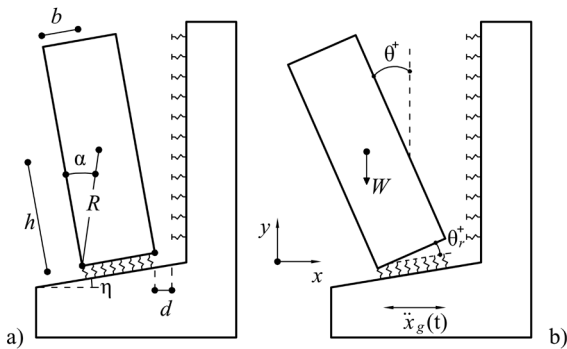
► Multiscale analysis of masonry structures using homogenization

Author: Alberto Mauro

Supervisors: Gianmarco de Felice (University Roma Tre, Italy) and Paulo B. Lourenço (UMINHO)

Date: April 17th, 2012

Summary: Masonry structures withstand seismic loads by developing both out-of-plane and in-plane mechanisms. The former are governed by the dynamics of rigid bodies while the latter by the mechanics of anisotropic media. The present thesis gives a contribution to the understanding and modelling of both these failure mechanisms.



Distinct element model of masonry specimen. a) Configuration before each test: initial out-of-plumb η and gap d related to mortar vertical joint. b) Kinematic descriptors of the motion: out-of-plane rotation of the facade wall measured with respect to the vertical (θ^*) and to the tilted foundation (η).

Concerning the behaviour of masonry walls under out-of-plane loads, the results of a shake-table laboratory campaign on a tuff masonry U-shaped assemblage are presented. The tests highlight the main factors affecting the dynamic response of the wall. A modelling strategy based on the Discrete Element Method is then presented, which is shown to reasonably reproduce the experimental tests. Aiming at simulating the in-plane behaviour of masonry, a multi-scale procedure based on first-order homogenization is formulated. The proposed scheme is implemented in Abaqus and adopted for studying the response of dry stack masonry panels. Eventually, the applicability of the proposed meth-

odology to practical engineering problems is discussed by means of an application to a case study.

CV: **Alberto Mauro** was born in Isernia, Italy in 1984. Graduated in Civil Engineering in 2008, he got his PhD in 2012 under a joint research collaboration between the University of Minho and Roma Tre University. His activities focus on the development of constitutive models for masonry through homogenization and on the study of out-of-plane seismic behaviour of monolithic-like and multi-leaf walls.

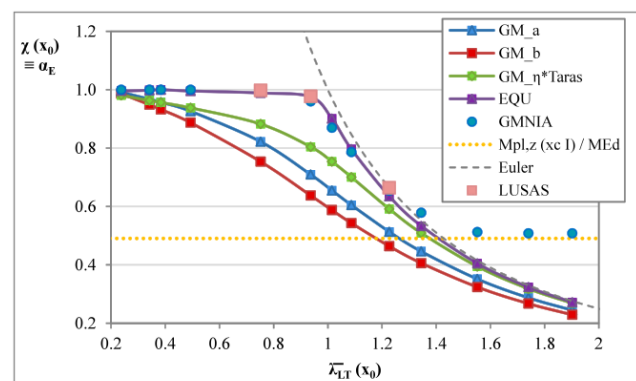
► Design of steel structures using advanced finite element methods

Author: Liliana Marques

Supervisors: Luís Simões da Silva (FCTUC) and Richard Greiner (TU Graz, Austria)

Date: June 25th, 2012

Summary: Tapered steel members are usually adopted in order to optimize the load capacity at each cross section. EC3-1-1 provides several methodologies for the stability verification of members and frames. However, regarding non-uniform members several difficulties are noted and there are yet no guidelines to overcome any of these issues. As a result, safety verification is conservative, not accounting for the advantages non-uniform members provide. This dissertation focuses on developing new stability rules for lateral and lateral-torsional buckling of web-tapered members in which the buckling phenomena is accounted for by a



Improvement of the proposed methodology in comparison to other possible methodologies and current approaches for tapered beams.

proper buckling coefficient related to realistic imperfections. The objective is to have a straightforward procedure, but with mechanical consistency. The outcomes of this research are consistent

with existing rules for prismatic members and aim to contribute to the harmonization of stability member verification procedures of EC3.

CV: **Liliana Marques** is a Post-Doctoral researcher at ISISE, University of Coimbra. She graduated in Civil Engineering by the University of Coimbra in 2007 and finished her PhD in June 2012, in the area of Steel and Mixed Construction. Her research interests are in the scope of stability of steel structures, namely non-uniform members and structural systems.

➤ **Residual mechanical properties of ordinary concretes after fire**

Author: Cristina Calmeiro dos Santos
Supervisors: João Paulo Correia Rodrigues (FCTUC)
Date: July 24th, 2012

Summary: The purpose of this work was to study the residual mechanical properties of ordinary concrete after fire. It was chosen for studying granite and calcareous aggregate concretes. The following parameters were tested: loading level (0.3 and 0.7fcd), cooling process (cooling in the air and cooling by water jet), and maximum temperature



level attained (20, 300, 500 and 700°C). The mechanical properties studied were the residual compression, direct and splitting tensile and flexural strengths, modulus of elasticity and Poisson's ratio. The high temperatures attained and the rapid cooling down process on the concrete showed a negative effect on its residual mechanical properties. The load level showed a positive effect on the residual compression strength of the concrete cooled slowly in the air, but the opposite was observed in the case of sudden cooling down by water jet.

CV: **Cristina Calmeiro**, graduated in Civil Engineering by the Faculty of Sciences and Technology of the University of

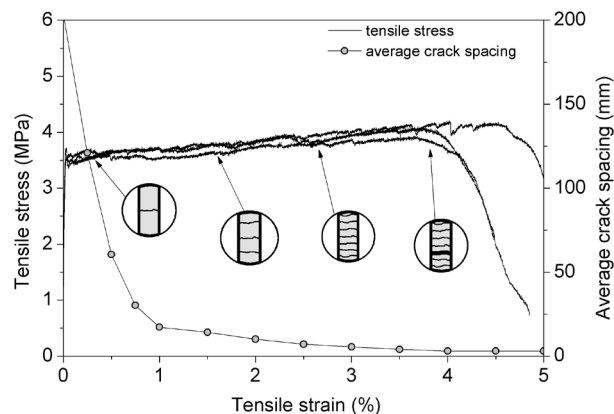
Coimbra in 1995, Master of Science in Civil Engineering in 2002 in FCTUC, a researcher at ISISE in FCTUC, and finished her PhD in July 2012 by the same University. Senior Member of Civil Engineering College. Professor at the Polytechnic Institute of Castelo Branco.

➤ **Processes of cracking in strain hardening in cementitious composites**

Author: Eduardo Nuno Borges Pereira
Supervisors: Joaquim Barros (UMINHO) and Gregor Fischer (DTU, Denmark)

Date: September 24th, 2012
Summary: This research was focused on the characterization of the cracking processes in Strain Hardening Cementitious Composites (SHCC). The strategy followed considered mostly the material meso-scale, although micro- and macro-scales were also approached. The objective was to contribute to the extension of knowledge about the nature of the fracture processes in these composites, as well as to contribute to the development of the numerical strategies dedicated to the simulation of the structural behaviour of SHCC members. To this purpose, alternative testing procedures were proposed to characterize fracture of SHCC. These included alternative specimen geometries, test setups, and the use of innovative techniques to analyse deformations with considerable resolution based on digital imaging. Classical elasto-plasticity was also explored to the simulation of the structural behaviour of SHCC under generic tri-axial states of stress.

CV: **Eduardo Pereira** obtained his 5-year Civil Engineering degree in 2001 at the University of Minho. Since then he has been teaching as an assistant at the School of Engineering, University of Minho. His PhD research was conducted at the University of Minho and at the Technical University of Denmark, focusing on the constitutive modelling and the micro-mechanical characterization of strain hardening cementitious composites.



EVENTS

2012 FOZTUA INTERNATIONAL CONFERENCE - RAILROADS IN HISTORICAL CONTEXT: CONSTRUCTION, COSTS AND CONSEQUENCES

Place: Foz Tua

Date: October 5th-7th, 2012

Organizing by (Institutions): University of Minho, Massachusetts Institute of Technology (USA) and MIT-Portugal

Summary: The conference brought together 50 scholars for a sustained, collective, and truly interdisciplinary meeting. These scholars were from a broad array of disciplines, from oral history to structural engineering, from economics to museum design, from digital geographic information systems to the history of public policy, corporate finance, firm management, engineering education and innovation.



ECCS 2012 - EUROPEAN STEEL CONSTRUCTION DAY & ANNUAL MEETING

Place: Lisbon

Date: September 19th-21st, 2012

Organizing by (Institutions): CMM – Portuguese Steelwork Association

Summary: The ECCS European Steel Construction Day & Annual Meeting is one of the most important events in the European steelwork context. This year's event took place in Lisbon, and brought to Portugal very relevant figures of the steelwork area. This event comprised several activities, including ECCS Steel Seminar, ECCS Awards Ceremony, I Steel Construction Job Fair, among others. This event was a huge success.



4th DAY-OUT AND WORKSHOP

Place: Ofir, Portugal

Date: July 5th-6th, 2012

Organizing by (Institutions): ISISE

Summary: The 2012 ISISE Day-Out and 4th PhD Workshop took place at the Axis Ofir Beach Resort Hotel on 5th and 6th July. It was, once again, a great opportunity for all ISISE members to interact and to also have some enjoyable time out. A dynamic group activity, sport activities and the personal testimony and life path of a former PhD student were some of the highlights.





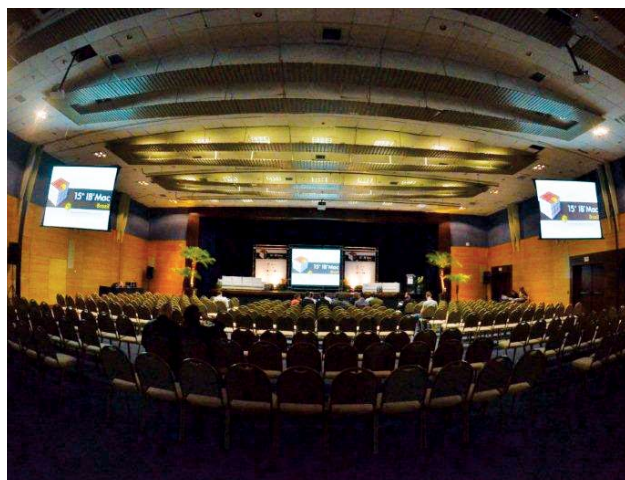
15th INTERNATIONAL BRICK AND BLOCK MASONRY CONFERENCE

Place: Florinópolis, Brazil

Date: June 3rd-6th, 2012

Organizing by (Institutions): Nine institutions from Brazil (main organizer), Australia, Canada and Portugal (University of Minho)

Summary: Over 100 papers were presented covering a wide range of areas on masonry research and applications, with more than 230 participants from 39 countries. A panel discussed the Development of the Engineered Masonry. Workshops were held on Slender Walls, Prestressed Masonry, FEM, Accidental Damage and Progressive Collapse. Keynotes addressed heritage masonry, earthquakes and masonry sustainability.



INTERNATIONAL CONFERENCE ON REHABILITATION OF ANCIENT MASONRY STRUCTURES

Place: Lisbon

Date: May 4th, 2012

Organizing by (Institutions): Six institutions from Portugal, including New University of Lisbon (main organizer) and University of Minho

Summary: There is a need for optimization of resources in construction, and the building rehabilitation is crucial for sustainability. This conference addressed Ancient Masonry Structures in 4 complementary subjects: mortar properties, masonry arch bridges, seismic actions, and rehabilitation processes. Over 200 participants, involved in the design and construction of structural rehabilitation, were present.



8th RILEM INTERNATIONAL SYMPOSIUM ON FIBRE REINFORCED CONCRETE: CHALLENGES AND OPPORTUNITIES (BEFIB 2012)

Place: Centro Cultural Vila Flor, Guimarães, Portugal

Date: September 19th-21th, 2012

Organizing by (Institutions): ISISE

Summary: 122 extended abstracts and full papers were selected and published, and participants from 36 countries in representation of 123 institutions attended BEFIB2012, leading to a total number of attendants of about 150. New emergent areas in fibre reinforced concrete (FRC), such is the case of "Nanofibers in FRC" and "Innovative structural systems", were promoted in order to extend to the forum new challenges and opportunities: the subtitle of the BEFIB2012.



UPCOMING EVENTS

> 11th International symposium on fiber reinforced polymers for reinforced concrete structures (FRPRCS11)

Website: www.frprcs11.uminho.pt

Place: Centro Cultural Vila Flor, Guimarães, Portugal

Date: 26th-28th June 2013

> IOMAC 2013 – International Operational Modal Analysis Conference

Website: www.iomac.dk

Place: University of Minho, Guimarães, Portugal

Date: 13th-15th May 2013

> 9th International Masonry Conference

Website: www.9imc.civil.uminho.pt

Place: University of Minho, Guimarães, Portugal

Date: 7th-9th July 2014

> 2nd CILASCI - Congresso Ibero-Latino-Americano em Segurança Contra Incêndios

Place: Coimbra, Portugal

Date: 29th May –1st June, 2013

MASTER COURSES

> **SAHC – www.msc-sahc.org**

> 1st Phase: until 20th January

> 2nd Phase: until 20th May

> 3rd Phase: until 20th August

> **Master Program SCS/Suscós
www.dec.uc.pt**

> 1st Phase: 1st until 12th March

> 2nd Phase: 1st until 12th July

> 3rd Phase: 1st until 12th September

PHD COURSES

> **Doctoral Program Civil Engineering
www.eng.uminho.pt and
www.dec.uc.pt**

> 1st Phase: 23rd May until 14th June

> 2nd Phase: 8th August until 6th September

> 3rd Phase: 3rd until 28th January

> **Doctoral Program Steel and Composite Structures – www.dec.uc.pt**

> 1st Phase: 1st until 12th March

> 2nd Phase: 1st until 12th July

> 3rd Phase: 1st until 12th September

