Institute for Sustainability and
Innovation in Structural Engineering

ISISE Stats & Highlights 2020

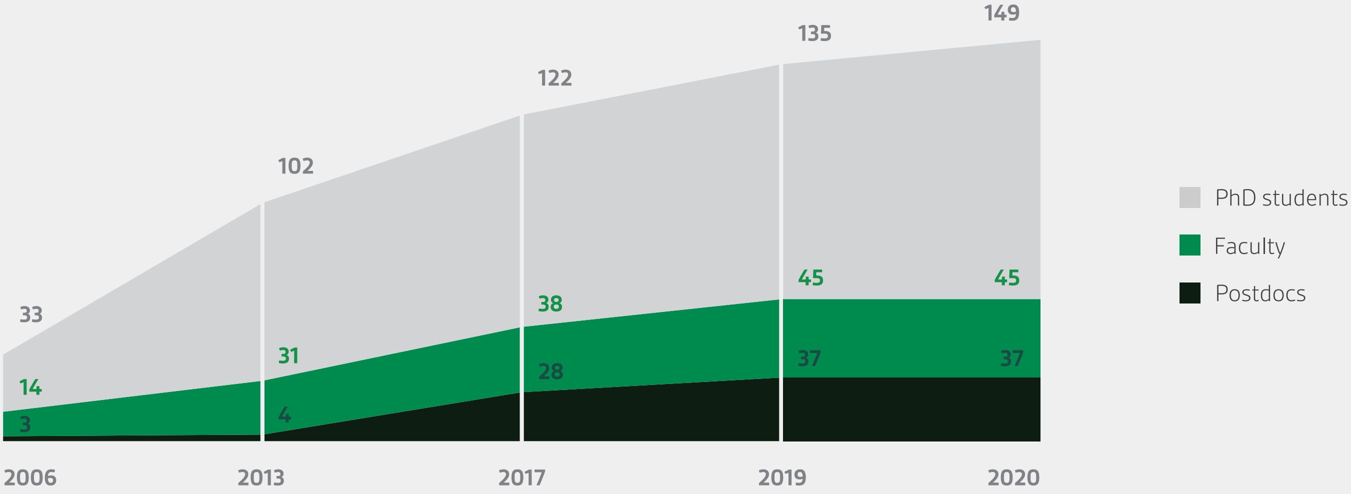
www.isise.net

FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE D COIMBRA

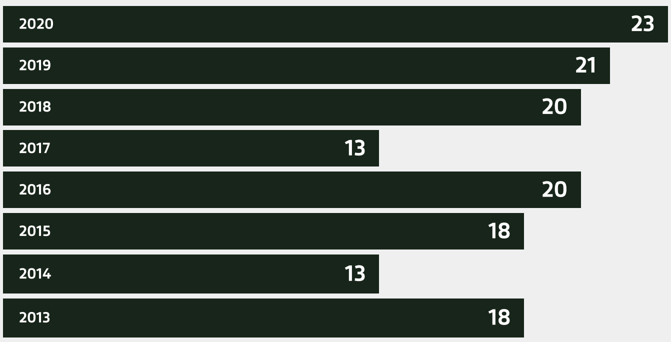
Universidade do Minho
Escola de Engenharia

ISISE in Numbers

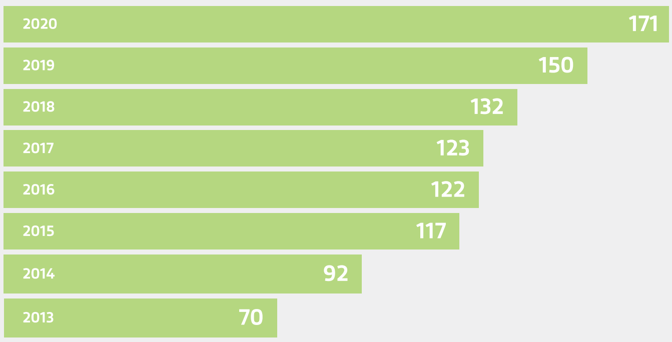
Members



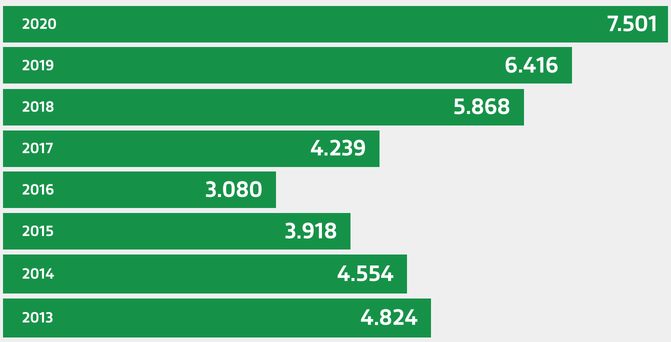
Concluded PhD Theses



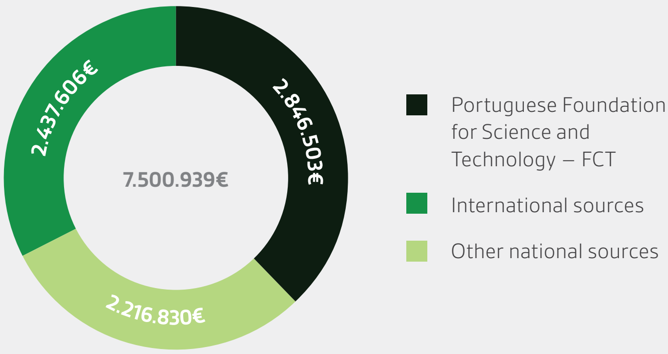
Articles Published in WoS Journals



Contracted Project Funding (M€)

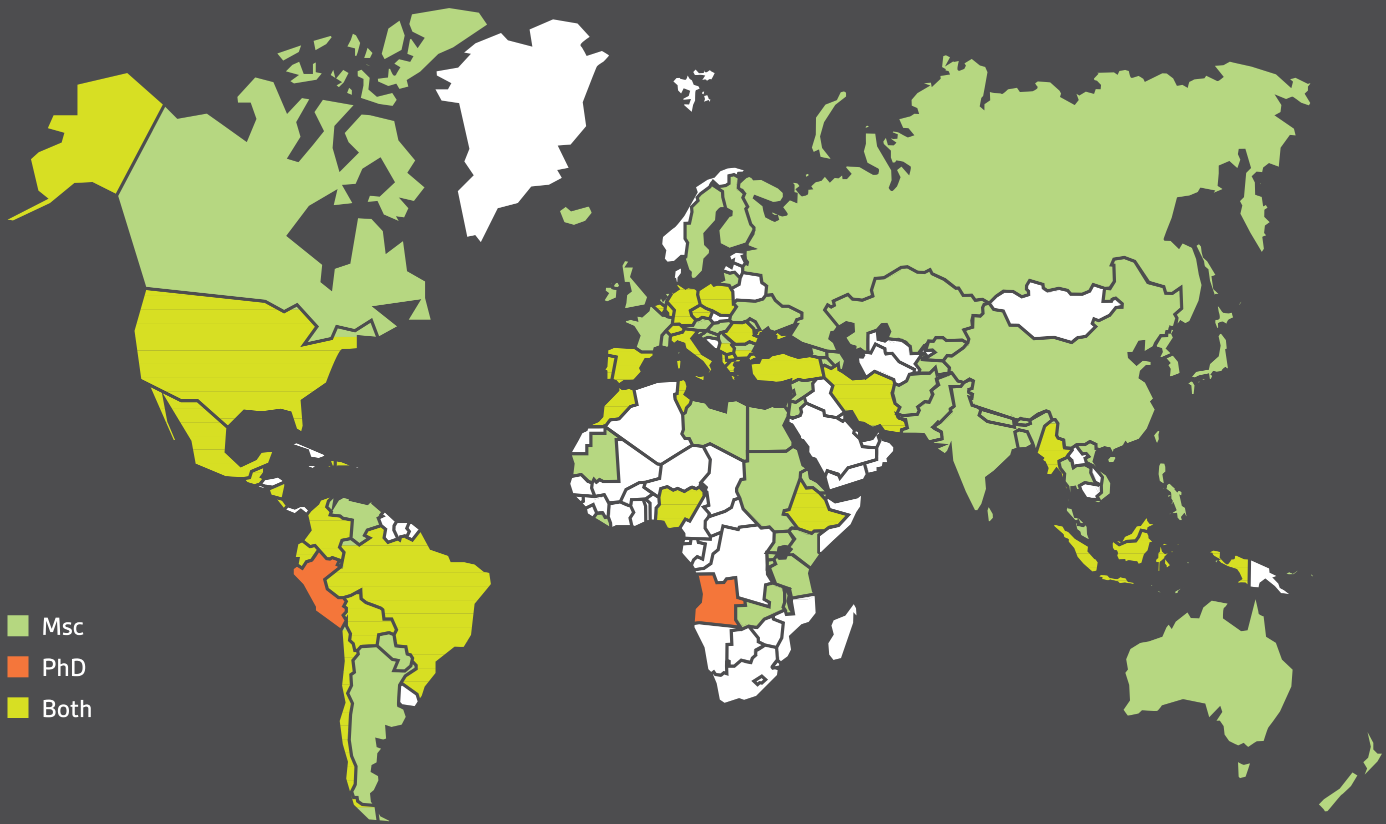


Funding Distribution in 2020



International Alumni

isise



MSc alumni: 89 countries (86% of the world population)

America
- Argentina
- Bolivia
- Brazil
- Canada
- Chile
- Colombia
- Costa Rica
- Dominican Republic
- Ecuador
- Guatemala
- Mexico
- Nicaragua
- Paraguay
- United States of America
- Venezuela

Africa
- Ethiopia
- Kenya
- Liberia
- Libya
- Mauritania
- Morocco
- Nigeria
- Sudan
- Tanzania
- Tunisia
- Zambia

Oceania
- Australia
- New Zealand

Asia
- Afghanistan
- Bangladesh
- Bhutan
- China
- Georgia
- India
- Iran
- Israel
- Japan
- Jordan
- Kazakhstan
- Kyrgyzstan
- Lebanon
- Malaysia
- Myanmar
- Nepal
- Pakistan
- Philippines
- Singapore
- South Korea
- Syria
- Thailand
- Vietnam

Intercontinental States
- Azerbaijan
- Cyprus
- Egypt
- Indonesia
- Turkey

Europe
- Albania
- Austria
- Belgium
- Bulgaria
- Croatia
- Czech Republic
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Lithuania
- Macedonia
- Moldavia
- Netherlands
- Poland
- Portugal
- Romania
- Serbia
- Slovakia
- Slovenia
- Spain
- Sweden
- Ukraine
- United Kingdom

PhD alumni: 33 countries (44% of the world population)

America
- Bolivia
- Brazil
- Chile
- Colombia
- Costa Rica
- Ecuador
- Guatemala
- Mexico
- Peru
- United States of America

Africa
- Angola
- Ethiopia
- Morocco
- Nigeria
- Tunisia

Intercontinental States
- Indonesia
- Turkey

Asia
- Iran
- Myanmar

Europe
- Albania
- Belgium
- Bulgaria
- Croatia
- Czech Republic
- Germany
- Hungary
- Italy
- Poland
- Portugal
- Romania
- Serbia
- Spain

SELECTED PROJECTS

INNO3DJOINTS

Reusable Steel Structures Made Easy

In recent years, modular construction has been used in low-to medium rise multi-story and even high-rise buildings. Pre-fabrication by off-site manufacture leads to faster and safer construction, improved quality, reduced resources, and waste.

The research activity carried out within the European project INNO3D-JOINTS aimed at developing innovative plug-and-play joints which enable modularity, faster construction, and deconstruction.

The developed modular construction system is hybrid, whereby tubular columns are combined with cold-formed lightweight steel profiles using plug-and-play connections to provide an efficient structural system.

Within the course of the project, the following was achieved:

- Development of design procedures in the framework of the component method for innovative plug-and-play joints and asymmetrical column splices for tubular RHS sections, where consistency was kept with the structural Eurocodes. This was accomplished by extensive experimental and numerical studies, which were carried out at the joint level and at the component level.
- Characterization of design aspects of joints involving cold-formed tubular sections, namely the influence of manufacturing procedures in the behaviour of the profile, the influence of the welded region on the plug-and-play connection and the effect of the level of cold working in the corner regions of the cross-section on the welding of the plug-and-play connection.
- Implementation of a general procedure for analysis of the 3D behaviour of the steel joints, essential for due consideration of structural robustness. A generalized finite element that includes all the studied components of the design model for joints with 3D behaviour is developed and further implemented in a software tool.

Finally, the project demonstrated the suitability of the hybrid system including the innovative joints for low to medium-rise buildings under normal and accidental actions (fire and seismic) through representative case studies, using the developed methodologies.

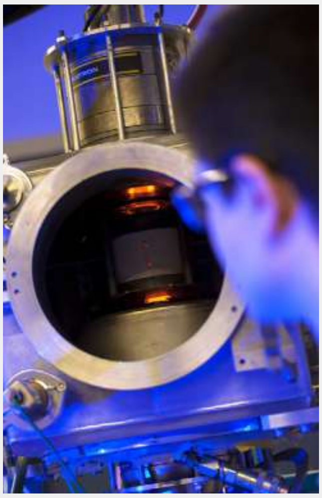
ATHOR

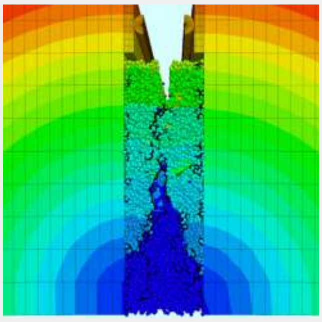
Advanced Thermomechanical Multiscale Modelling of Refractory Linings

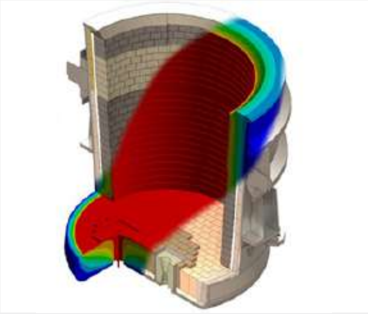
The ATHOR Consortium gathers 6 academic partners and 8 industrial partners across Europe, with the objective of training the next generation of industrial engineer industry leaders.

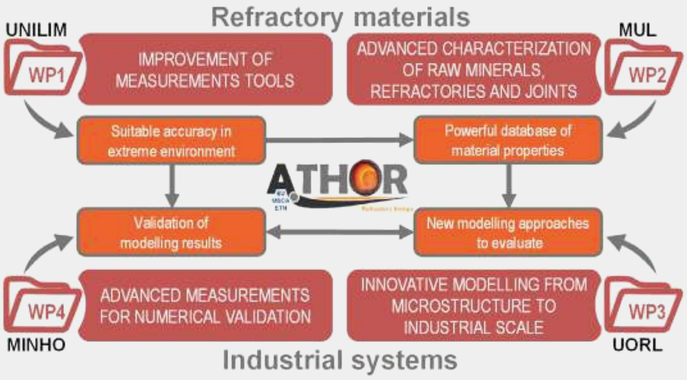
This Innovative Training Network addresses refractory (heat-resistant) materials used as inner linings of high temperature furnaces, reactors, and processing units. These are low-cost ceramic materials able to sustain operation conditions at temperatures typically above 1000°C, used to contain and process fluids in a harsh environment, such as molten metal and glass.

The total refractories consumed per year is over 50 million tonnes. Ceramics are also present in many technologically advanced fields such as the aerospace engineering for heat shielding, parts in combustion engines or many applications in electronics. But refractories are also essential for the competitiveness of European steel companies in which the lining operates at 1200-1600° C.









Constant engineering of refractories is needed to cope with new and more demanding requirements in the steel making process. The steel ladle forms the heart of the process and accounts for about ¼ of all refractory consumption.

Dependent on the purpose and position in the ladle, the refractory material requirements range from high thermal stability, to high erosion resistance, high corrosion resistance, penetration resistance, thermomechanical stability, impact resistance, flexibility and creep resistance.

ATHOR is targeting the development of high-end engineering technologies in the fields of material's science and numerical simulations to allow robust and reliable design of refractory linings. In addition to identifying and develop materials tailored to increase the longevity of linings, improvements to experimental and computational techniques will reduce refractory costs, increase the ladle availability and enhance process control.

This will help to maintain jobs, to energy savings and more sustainable linings in steel ladles. In fact, energy consumption represents from 20% to 40% of the steel production costs. Thus, many opportunities exist to achieve significant energy savings and reduce the environmental impact.

SELECTED PROJECTS

NEXT-SEA

Next-generation Monitoring and Management of Coastal Systems in a Scenario of Global Changes

NEXT-SEA was a structured project involving three research centres form the University of Minho: ISISE (Institute for Science and Innovation in Structural Engineering), CMEMS (Centre for Micro-electro-mechanical Systems), and CBMA (Centre for Molecular Biology and Environment).

The project was focused on developing cutting-edge strategies to monitor, anticipate and mitigate the unprecedented effects of global changes, with particular emphasis on climate and anthropogenic pressures on marine coastal ecosystems.

The multidisciplinary team of Biologists, Microelectronics and Civil Engineers, was jointly developing alternative strategies to enable the continuous and widespread monitoring of marine coastal ecosystems, based on novel and cost-effective autonomous sensors and biosensors, enabling the large scale monitoring of critical variables with high spatial resolution. Also the most recent environmental DNA based monitoring techniques were included, enabling precise identification of species and abundancies.

Alongside, novel strategies for global modelling and monitoring of marine coastal areas were developed, with a view on the identification of key indicators of coastal ecosystems health.

New strategies based on biomimetic and bioresponsive structures were also developed as part of novel ecosystems restoration techniques, resulting in the development of advanced fabrication techniques and smart materials for this particular purpose.

ISISE team was working on two concurring fields:

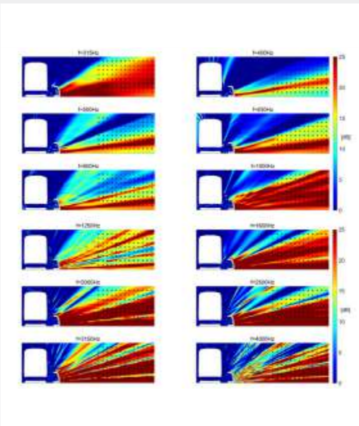
- the development of innovative structural systems and materials for biomimetic, autonomous, smart multifunctional constructed reefs;
- the development of multivariate multi-dimensional marine space models for monitoring and managing marine systems.

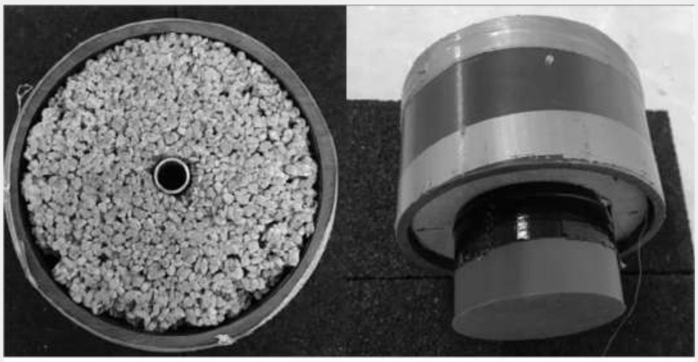
The main vision was to support the future sustainable use of coastal and ocean systems, considering its multiple environmental, social and economic dimensions.

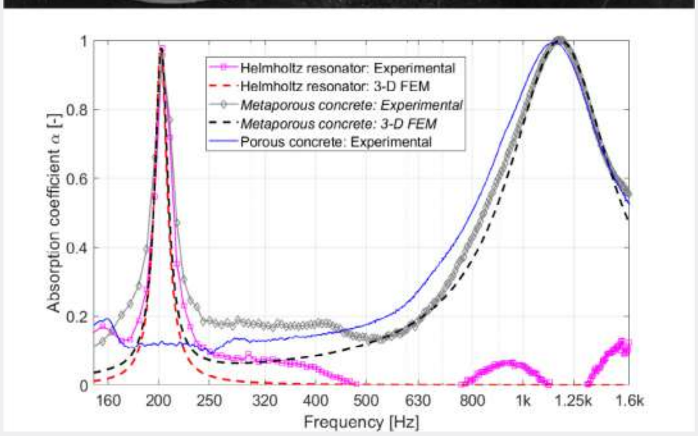
InBRAIL Innovative Noise Barriers for Railways

Challenges in the Mitigation of Railway Noise – New Paradigms for Noise Barriers

Railway transport is the most sustainable mode of transport, which has the lowest energy consumption, takes up the least space and leaves the smallest carbon footprint in comparison with any other mode of land or sea transport. In spite of this, the noise and vibration generated by this mode of transport poses a complex environmental challenge.







Therefore, and considering that the currently applied noise barriers are not ideal solutions to railway noise, the project "InBRAIL – Innovative noise barriers for railways" aims to develop an innovative noise barrier solution, specifically designed to minimise the effects of rail traffic noise.

This new solution will be of low-height, positioned very close to the railway, and specifically developed to overcome some of the difficulties found in traditional solutions, allowing a better integration in urban and suburban context.

Visual integration is of particular relevance, since it is usually an obstacle to implementation of this type of measures. The involved physics make use of both reflective and absorptive behaviour of different material to maximize acoustic performance.

The development of this project will be supported by a consortium established among three highly qualified entities: Mota-Engil Engenharia e Construção, University of Coimbra (ISISE), and Faculty of Engineering Porto University (CONSTRUCT).

The team from ISISE is mostly dedicated to the development of the acoustic engineering solution, simulating, testing and optimizing material solutions to allow maximization of the performance of the noise barrier for the specific case of railway noise. The project is also supported by two railway manager administrations (as partners), namely Metro do Porto and Infraestruturas de Portugal. The project entails a total investment of the order of 1 million euros.

Seismic Retrofitting

The Seismic Retrofitting Project (SRP) is an ongoing project of the Getty Conservation Institute, USA (GCI), with the objective of developing guidelines for efficient low-tech seismic retrofitting techniques and easy-to-implement maintenance programs for historical earthen buildings, in order to improve their seismic performance, while preserving their historical fabric.

The context is locations where advanced equipment, materials, and technical skills are not readily available. The SRP selected Peru due to its diverse and rich earthen architectural heritage, the current and historical knowledge and professional interest in the subject. Moreover, this heritage is at high risk due to its vulnerability and seismic hazard.

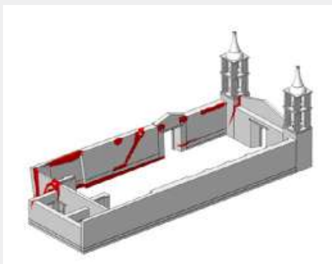
University of Minho has been involved since January 2015. In-situ inspection and non-destructive tests were performed to evaluate the structural damage, the interaction between structural parts and the elastic properties of masonry.

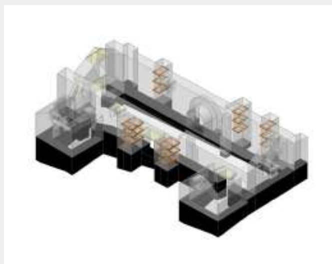
Subsequently, structural analyses were conducted to investigate the seismic load capacity and failure mechanisms. Then, as needed, strengthening was designed together with GCI and Pontifical Catholic University of Peru (PUCP), including additional stiffness elements, but also measures for consolidation and increased durability.

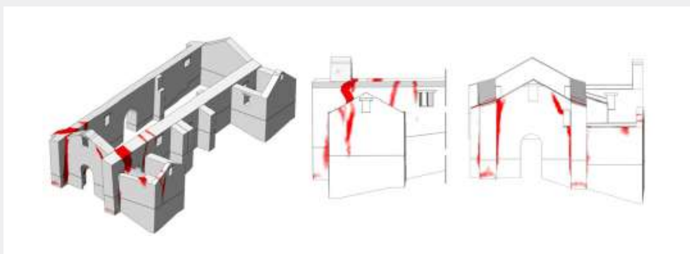
The SRP started the implementation of the seismic retrofitting plan in the Church of Kuño Tambo. The in-situ testing carried out after the intervention demonstrated that the same was successful in reaching the desired behavior.

The monitoring system being installed includes environmental parameters (temperature and humidity), accelerometers for recording ambient vibration and future earthquakes, crack monitoring activity and rotation of the walls.

Finally, the GCI organized a set of workshops for midcareer professionals of the Peruvian Ministry of Culture. Professionals were exposed to the theory of conservation and a value-based approach to develop retrofitting projects. Practical issues were addressed, such as buttress design, corner keys and roof structure, in situ testing, underpinning, mortar composition or earth-based grout injections.



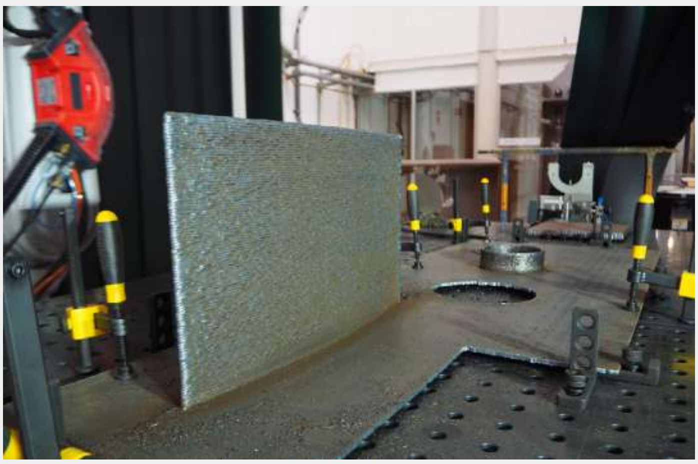




Additive Manufacturing Lab @ UC

The additive manufacturing lab at the University of Coimbra is focused on metals. It is a joint facility between two research centers ISISE@UC (Institute for Sustainability and Innovation in Structural Engineering) and CEMMPRE (Centre of Mechanical Engineering, Materials and Processess) in the scope of the project AMConstruction (Additive Manufacturing in Steel Construction).

The additive manufacturing lab currently covers Wire and Arc Additive Manufacturing (WAAM) process. The WAAM system is composed by ABB IRB 4600 60 2.55 robot with linear track IRBT 2005 5m and welding machine FRONIUS TPS 400i with Cold Metal Transfer (CMT) process.



The CMT welding process allows for welding at much lower temperatures and therefore reduce the possibility of distortions and imperfections in the final product. The system range covers an area of about 5 x 3 meters.

The system software is fully in-house developed and includes the control and optimization of the physical system as well as the implementation of a digital twin of the real system.

The digital twin enables most of the developments, including design, simulation and production preparation in a digital platform that is equivalent to the real one. It allows for visualization of fabrication process in advance, as well as for synchronized broadcast together with the functioning real system.

The first products of the Additive Manufacturing lab @ UC include steel tubes, plates and currently exploring more complicated shapes. Shortly, it will also be able to use new process Laser Metal Deposition (LMD).

University of Coimbra

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