isise

Institute for Sustainability and
Innovation in Structural Engineering

ISISE Stats & Highlights
2021

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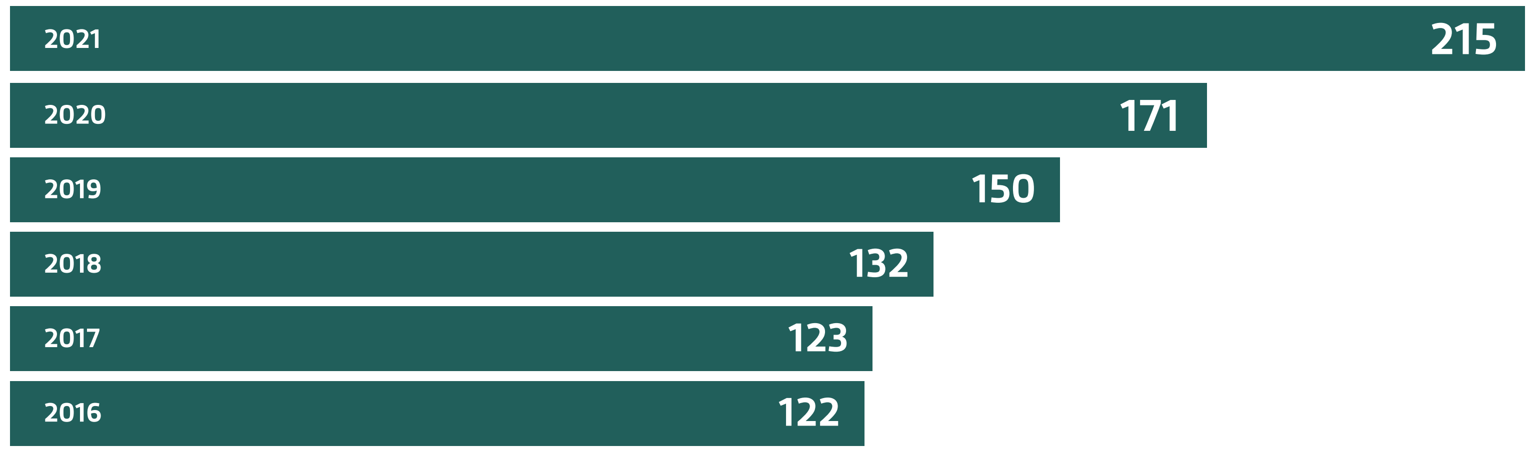
FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE D COIMBRA

Universidade do Minho
Escola de Engenharia

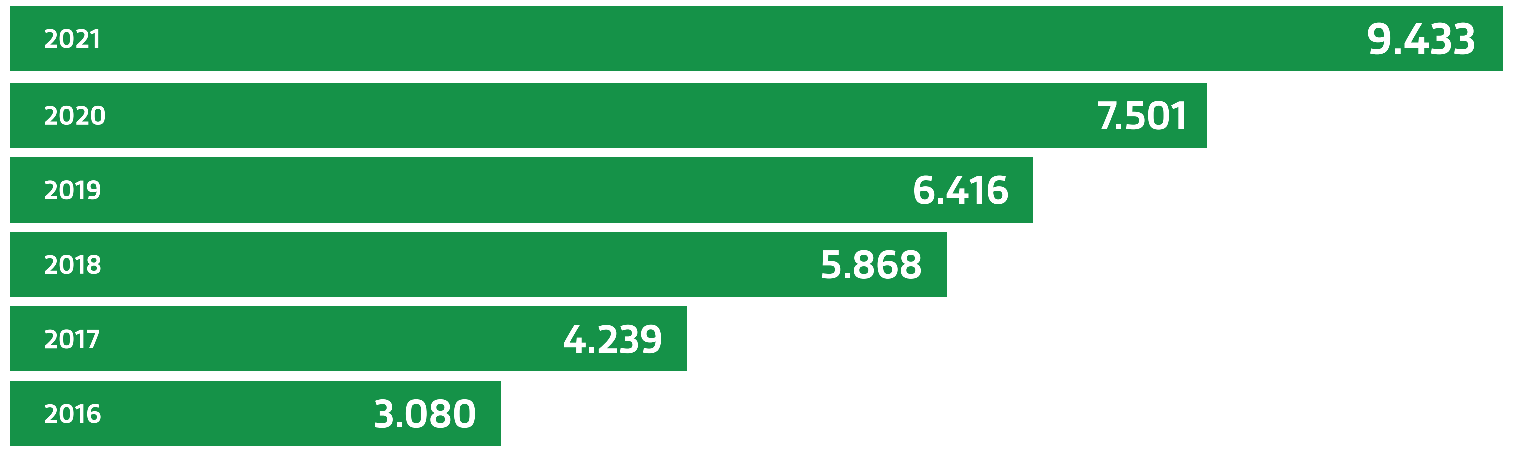
ISISE in Numbers

Concluded PhD Theses

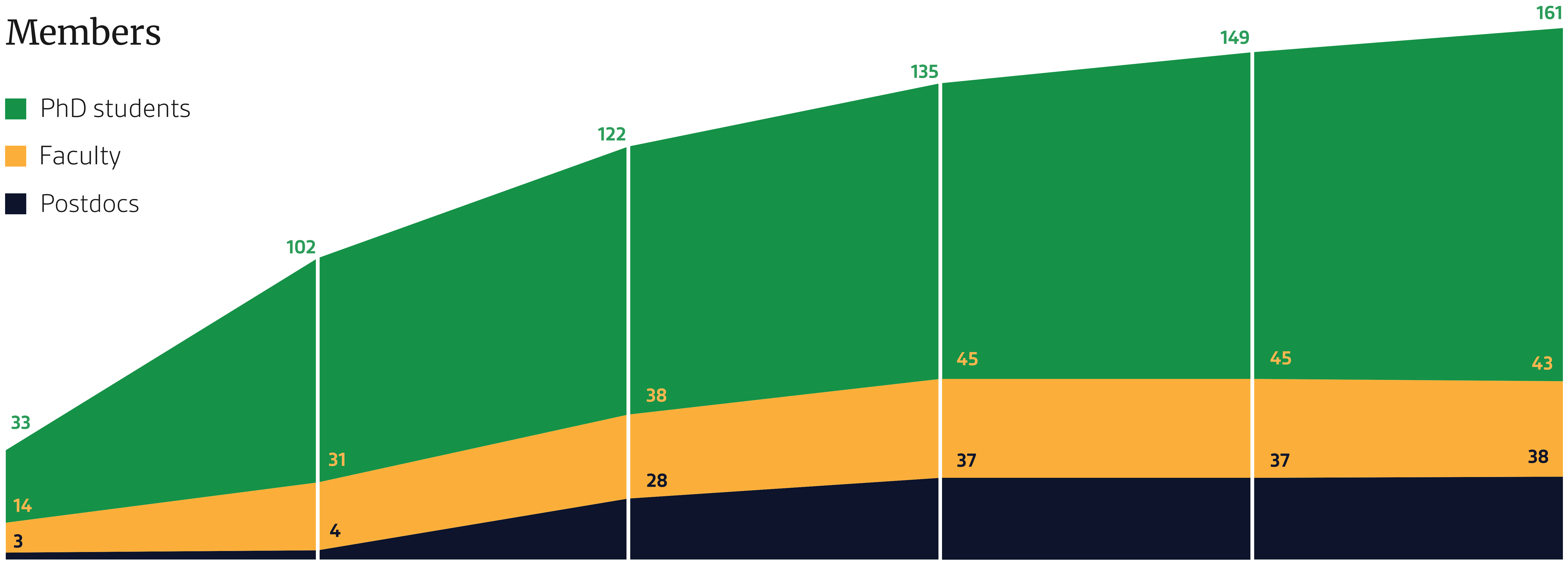
Articles Published in WoS Journals



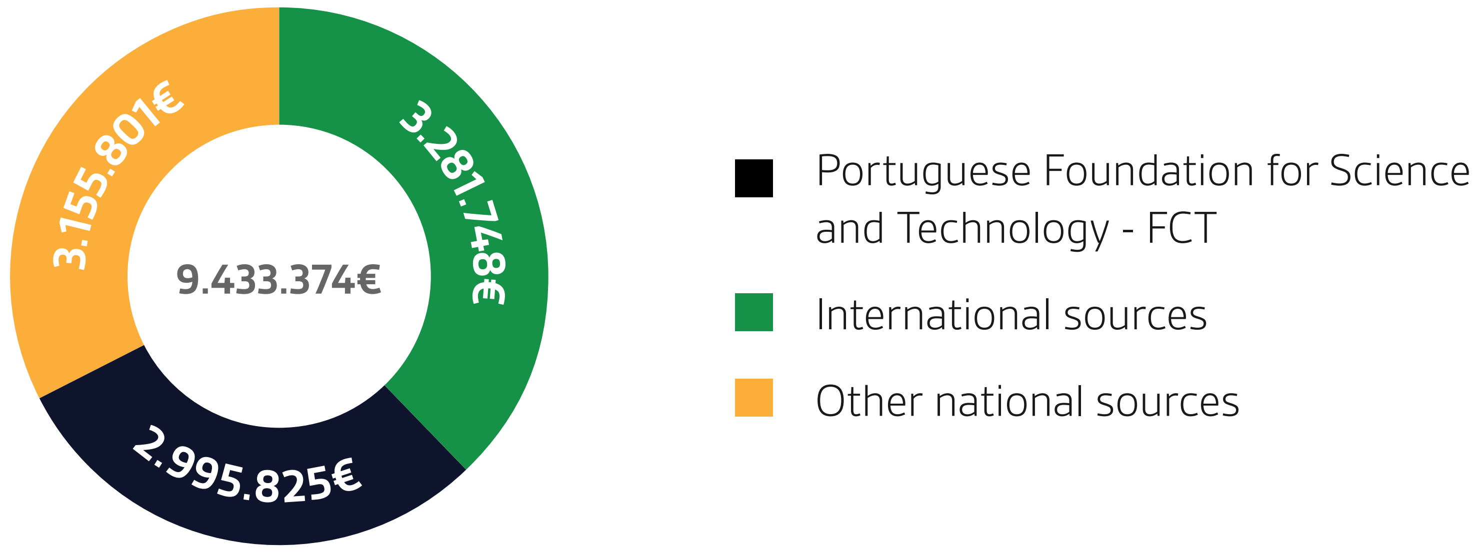
Contracted Project Funding (M€)



Members



Funding Distribution in 2021



International Alumni

MSc Alumni: 96 Countries
(88% 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

Oceania
- Australia
- New Zealand

Africa
- Algeria
- Angola
- Cameroon
- Ethiopia
- Ghana
- Kenya
- Liberia
- Libya
- Mauritania
- Morocco
- Nigeria
- Sudan
- Tanzania
- Tunisia
- Zambia
- Zimbabwe

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

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

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: 48 Countries
(68% of the world population)

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

Africa
- Angola
- Cape Verde
- Ethiopia
- Morocco
- Mozambique
- Nigeria
- Sudan
- Tunisia
- Rwanda

Asia
- Afghanistan
- China
- Iran
- Jordan
- Lebanon
- Myanmar
- Pakistan
- Syria
- Yemen

Europe
- Albania
- Belgium
- Bulgaria
- Croatia
- Czech Republic
- France
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- Portugal
- Romania
- Serbia
- Spain
- Ukraine

Intercontinental States
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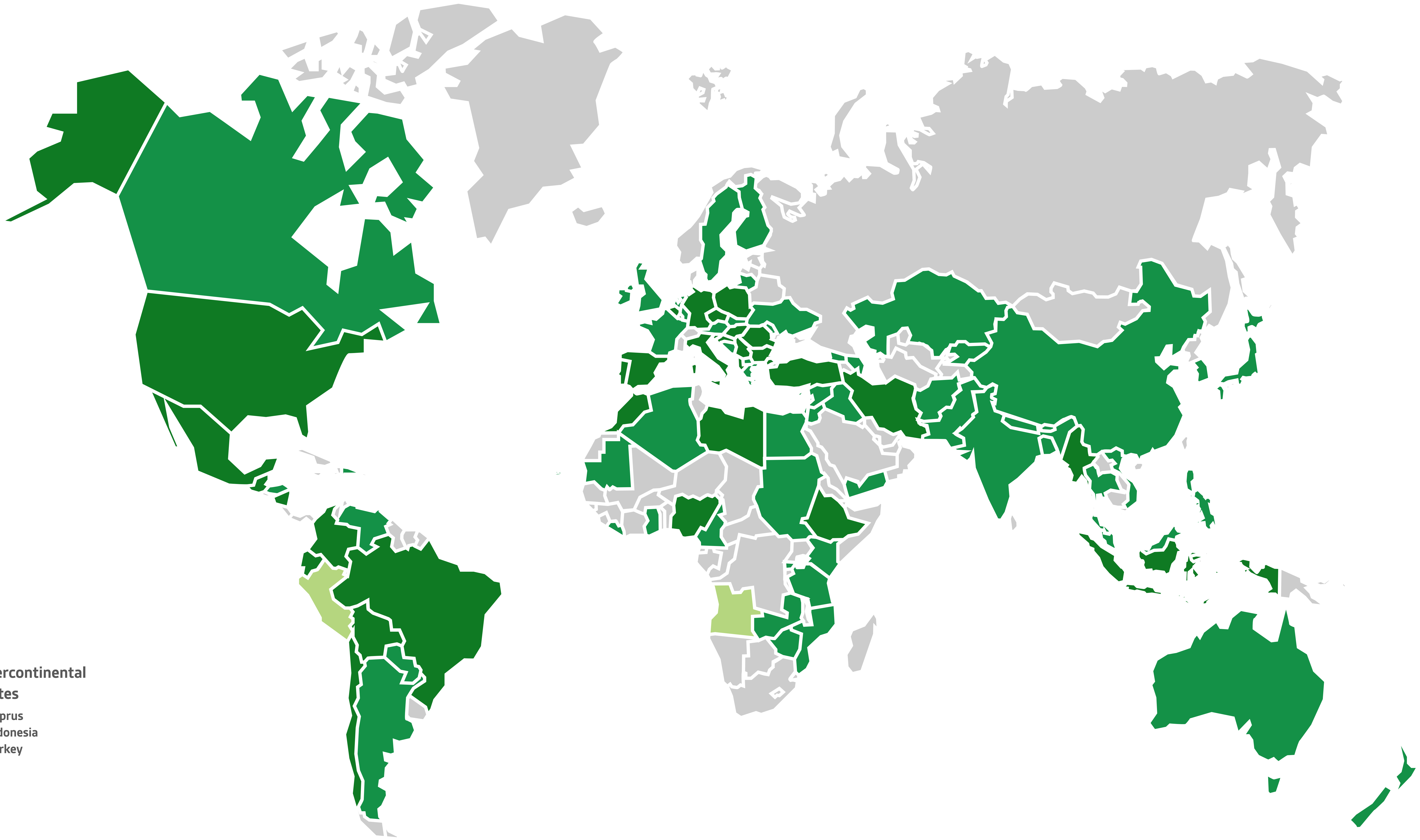


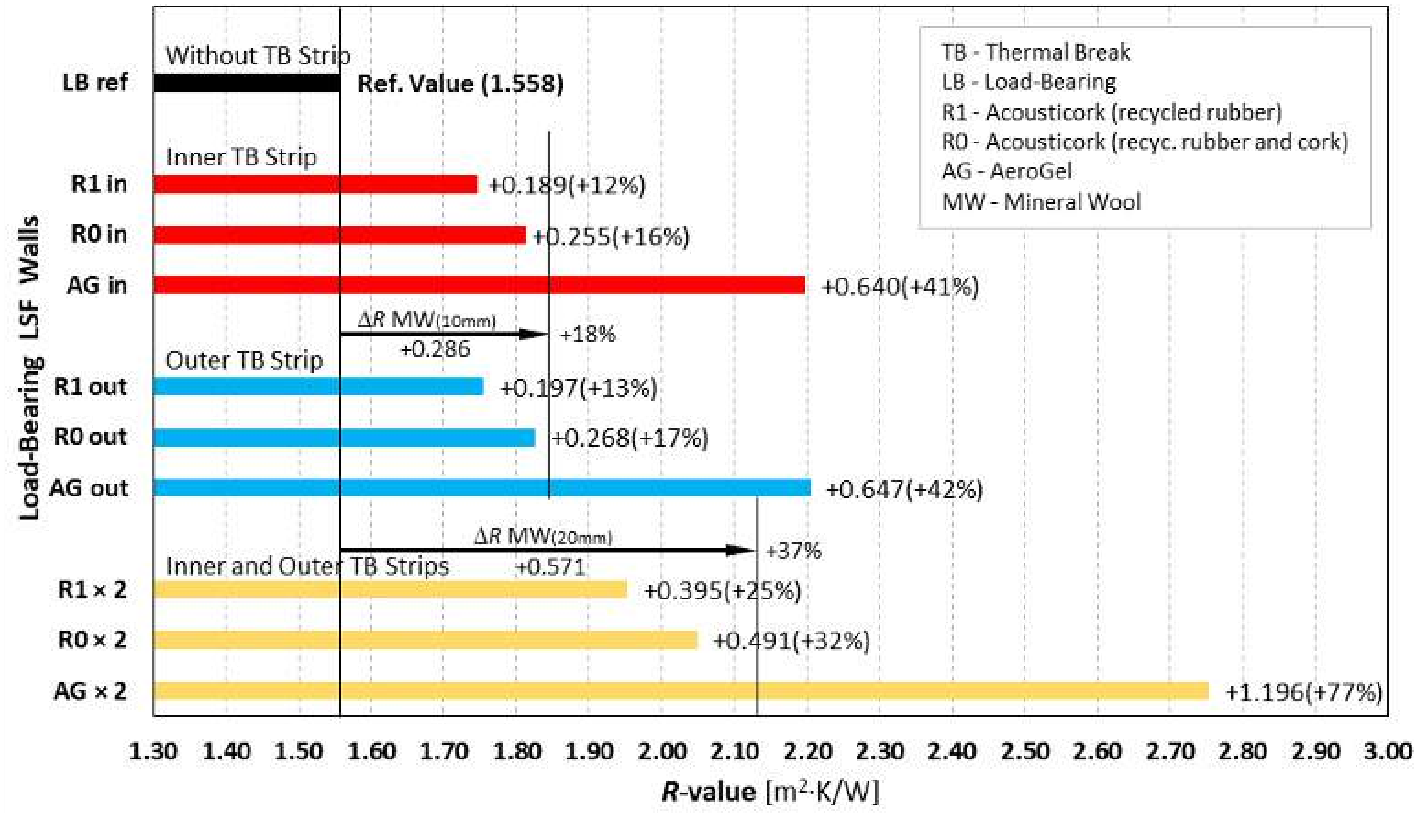
SELECTED PROJECTS

Tyre4BuildIns

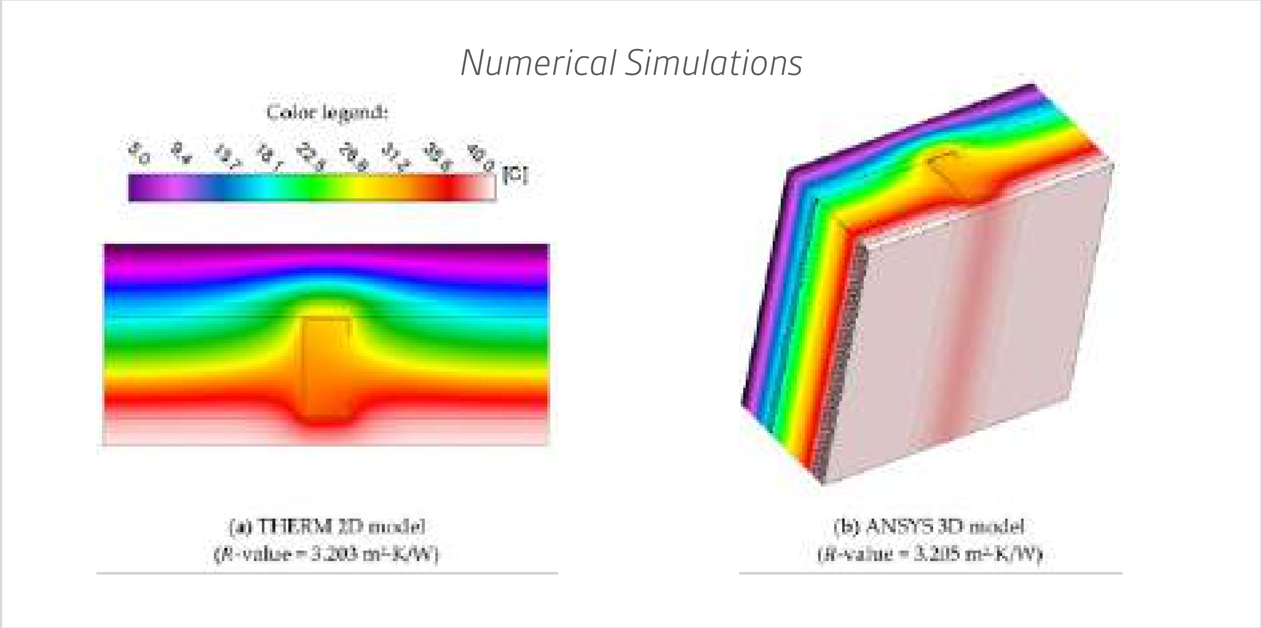
Recycled tyre rubber resin-bonded for building insulation systems towards energy efficiency

> Currently, waste management and energy consumption are two of the major concerns of humankind. In Europe, 355 million tyres are produced per year and buildings account for 40% of the total primary energy consumption. Thermal bridges may be responsible for up to 30% of heat losses in buildings.

Measured thermal resistances



New super-insulation material



Numerical Simulations

The main contractor of this project is the University of Coimbra, involving two research centres: ISISE and CIEPQPF (Chemical Process Engineering and Forest Products Research Centre).

The new super-insulation composite, having a thermal conductivity of about 16 mW/m/K, was developed in the Chemical Engineering Department and an international patent was already registered.

The research team from ISISE is focused in the development and performance evaluation of innovative Lightweight Steel Framed(LSF) elements, regarding mainly thermal behaviour, but also acoustic performance.

This project is being very successful regarding the achieved outputs, having already 13 scientific publications, 10 communications in international and national scientific meetings, 7 Master and PhD thesis, 1 computational application, 3 laboratorial prototypes, 2 new products and 2 patents.

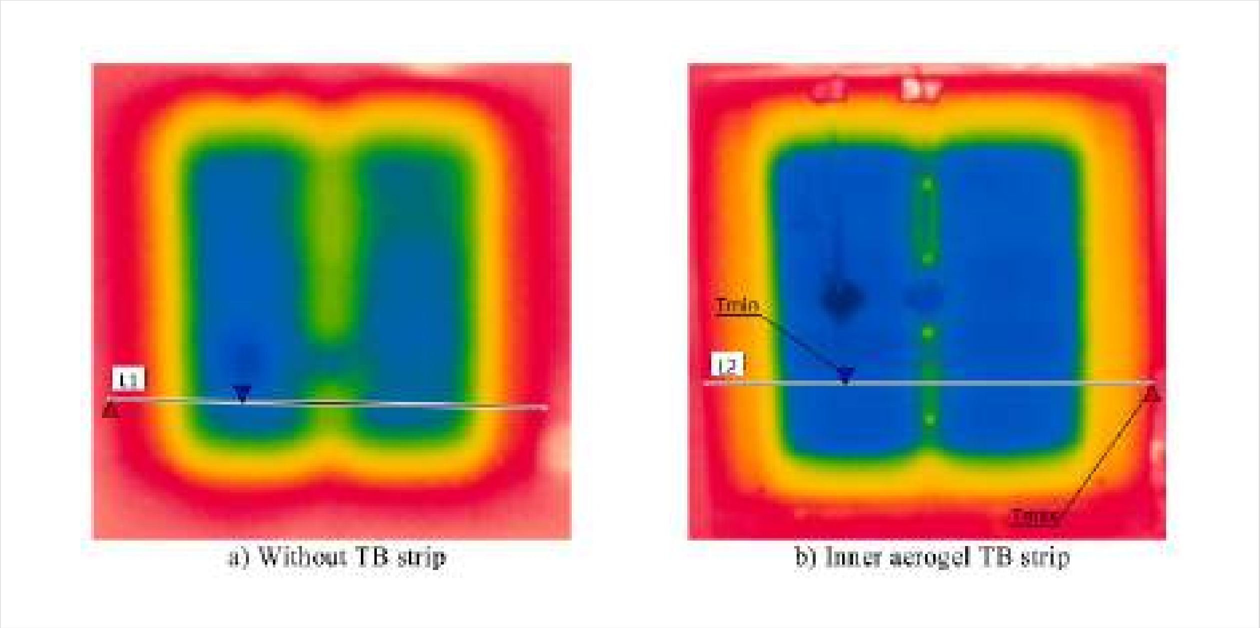
The main goals of this research project are:

(1) Develop a new eco-friendly and cost-effective insulation composite material based on recycled tyre rubber and aerogel insulation materials;

(2) Evaluate and optimize the performance of this new composite insulation material by characterizing its properties (hygrothermal, acoustic, fire reaction, mechanical resistance and durability);

(3) Optimize the use of the new insulation material in building elements (e.g. walls) in order take maximum advantage of it regarding thermal and acoustic performance, and;

(4) Assess the environmental impacts and cost of this new insulation material from a life cycle perspective.



Infrared images of LSF test-samples (TB – Thermal Break)

Experimental apparatus for thermal tests

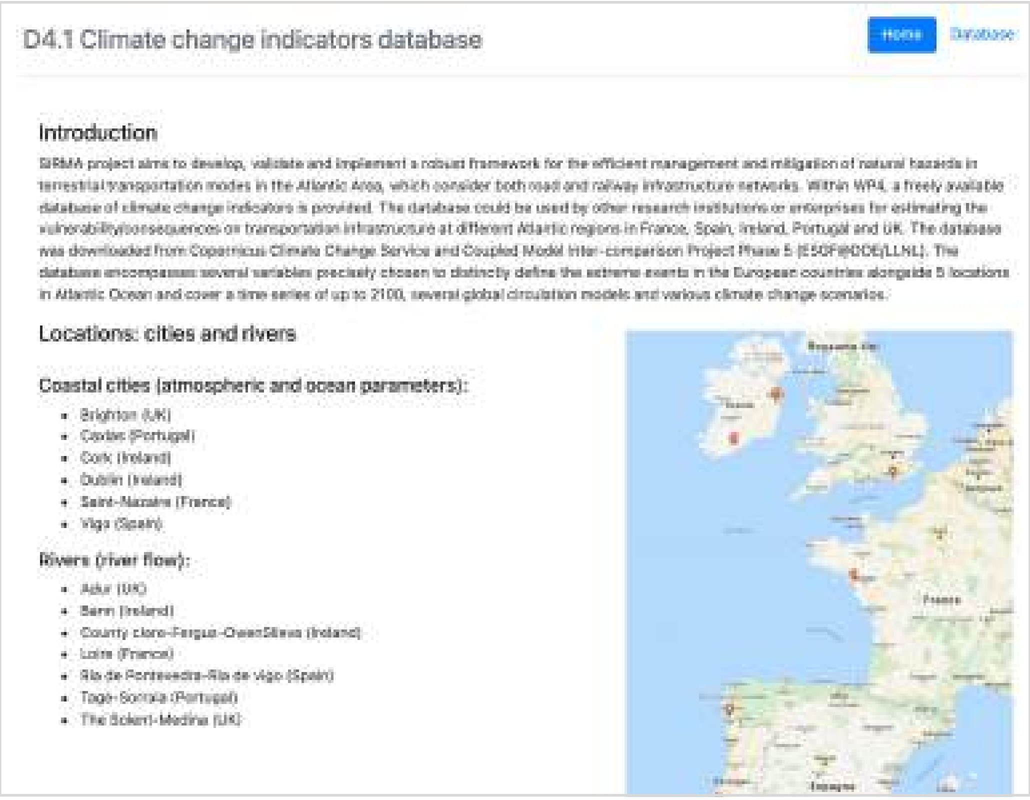
SELECTED PROJECTS

SIRMA

Strengthening Infrastructure Risk Management in the Atlantic Area

> SIRMA aims to develop, validate, and implement a robust framework for the efficient management and mitigation of natural hazards in terrestrial transportation modes in the atlantic area, which consider both road and railway infrastructure networks.

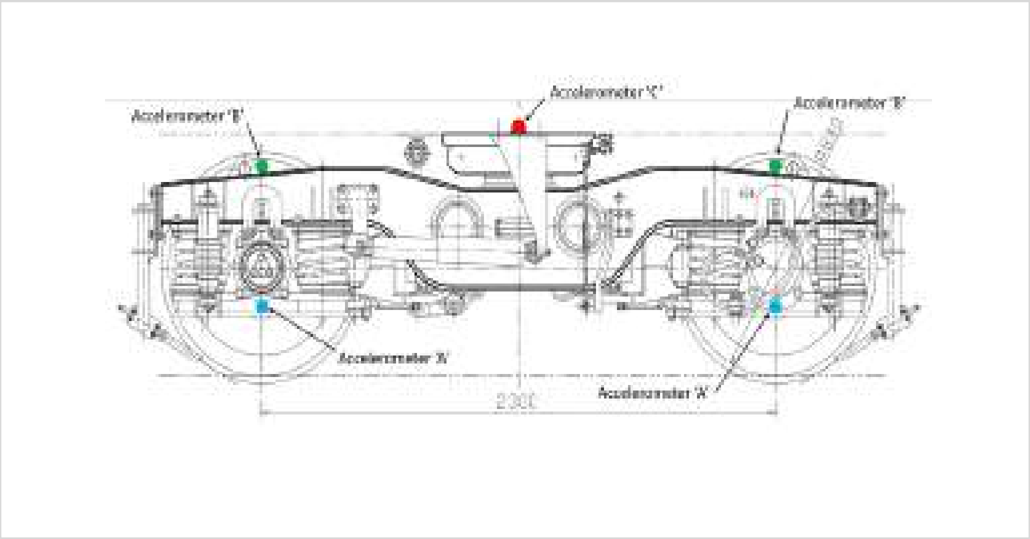
Most of the transportation of people and goods in the Atlantic Area is made through rail and road. The performance of these infrastructures is directly affected by extreme natural events and by the strong corrosion processes that result from proximity to the Atlantic Ocean. SIRMA is an Interreg Atlantic project designed to address this aspect. The consortium, leaded by UMinho, includes other 9 partners, from Spain, France, UK and Ireland.



Climate Change Indicator Database

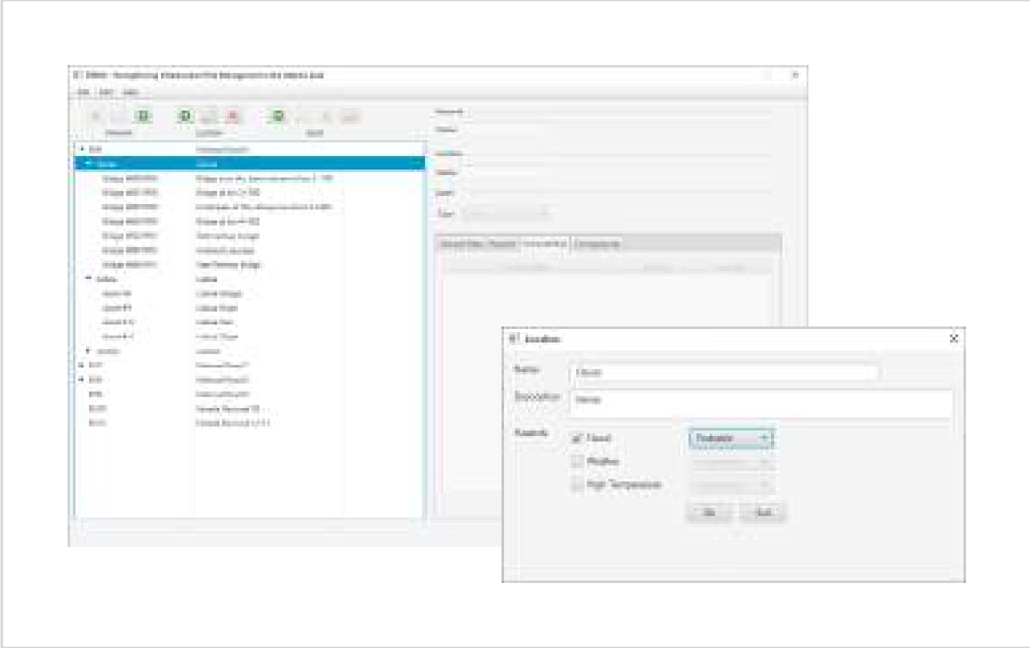
Free climate change indicators database including climate change indicators that can be used in the future by anyone for estimating the vulnerability and/or consequences on transportation infrastructure at different Atlantic regions.

Available at sirma-project.eu



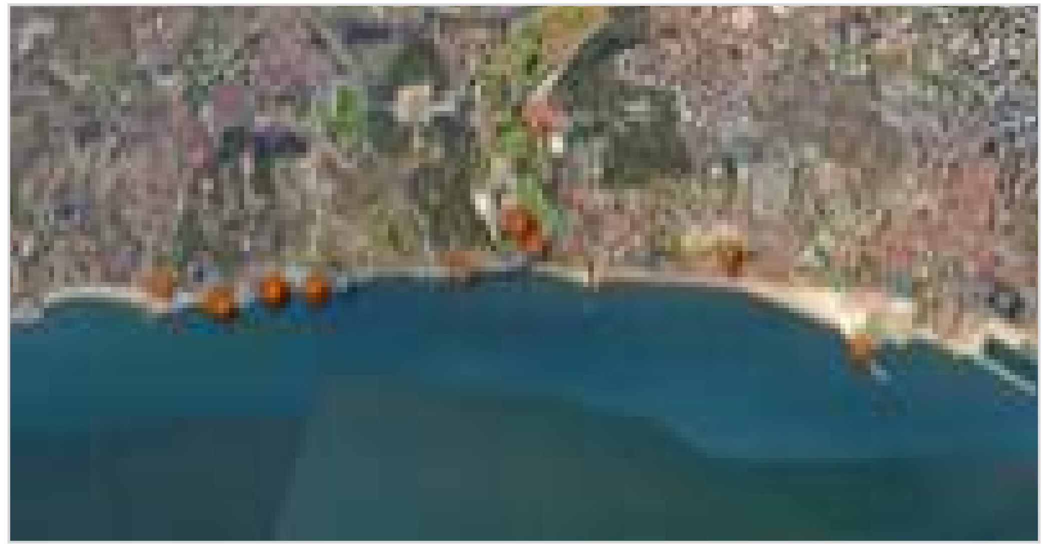
Analyzing the Evolution of Risk in Rail and Road Transport Networks

Tool that allows analyzing the evolution of risk in rail and road transport networks simultaneously. This tool integrates predictive models developed in the project and data resulting from the monitoring systems also developed in the project.



Enhanced Monitoring Transportation Assets' Risk

Tools and algorithms for enhanced monitoring transportation assets' risk in face of relevant hazards in the Atlantic region including the use of satellite data and data collected in-situ (the figure exemplifies the use of trains instrumented with accelerometers to assess scour vulnerability in the bridges it crosses).



Test & Validate

Two pilots will be implemented to test and validate the methodologies, tools and algorithms developed during SIRMA project (in the figure an example of coastal area between Lisbon and Cascais, one of the project's case studies).

SELECTED PROJECTS

FRPLongDur

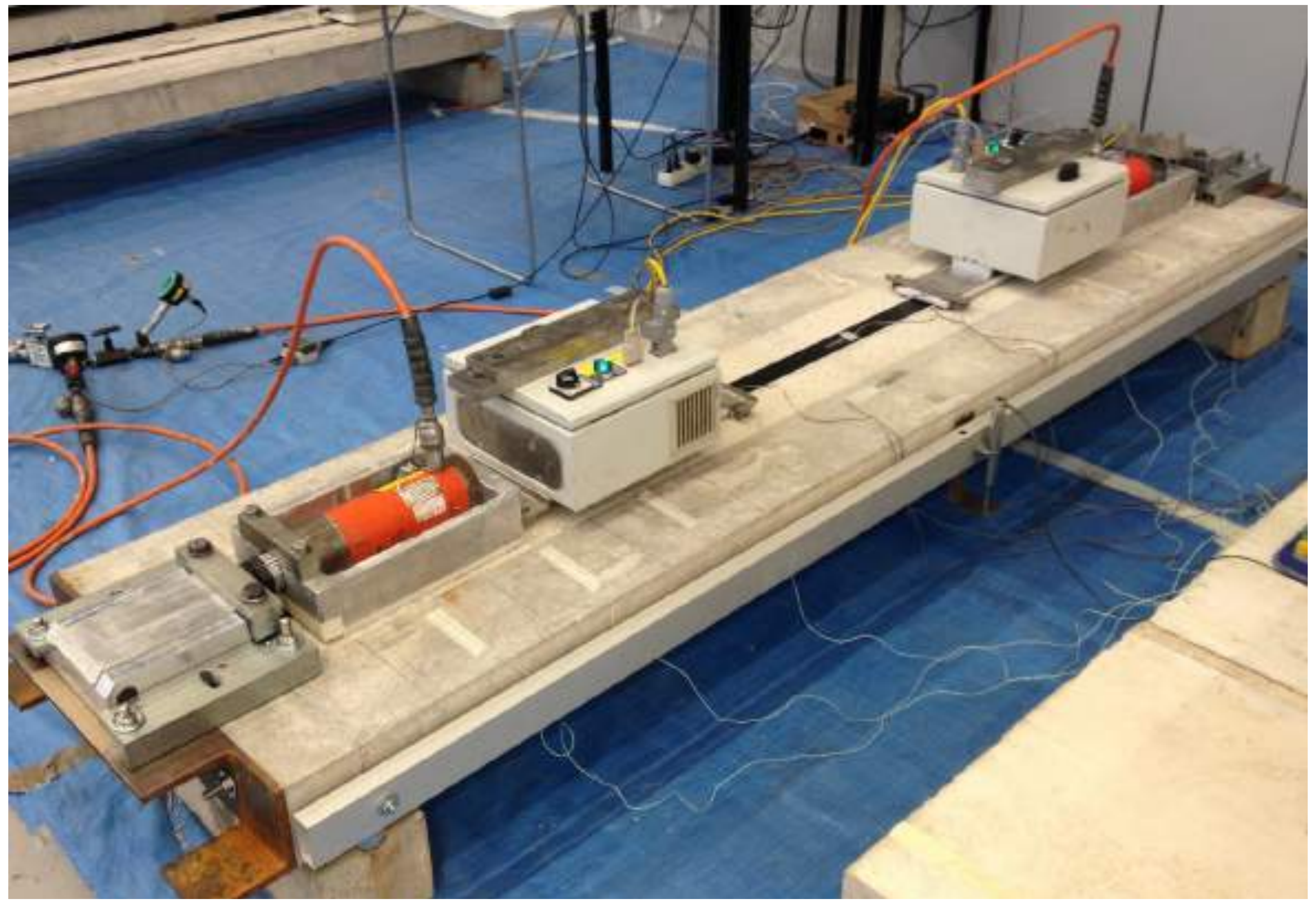
Long-term structural and durability performances of reinforced concrete elements strengthened in flexure with CFRP

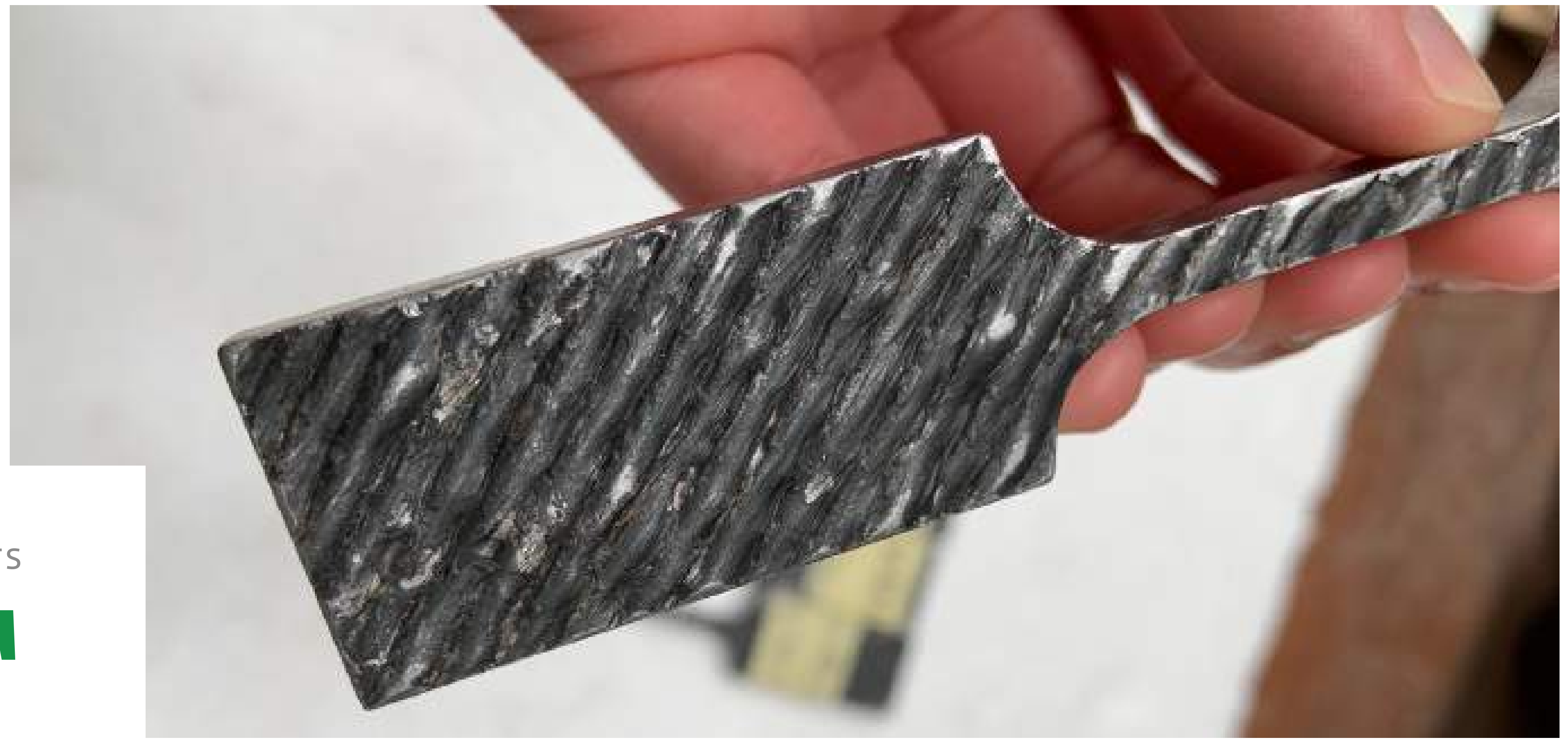
> The FRPLongDur is a research project involving the University of Minho, the National Laboratory of Civil Engineering (LNEC) and the Swiss Federal Laboratories for Materials Science and Technology (EMPA) aimed at contributing to the knowledge on the long-term behaviour and durability of RC elements strengthened with CFRP systems.

Nowadays, strengthening of existing reinforced concrete (RC) structures with fibre-reinforced polymer (FRP) systems is considered a state-of-the-art solution. Despite that, long-term behaviour and durability are still open issues. The FRPLongDur project focuses on the long-term behaviour and durability of RC elements strengthened with CFRP (Carbon FRP) laminates according to the EBR (Externally Bonded Reinforcement) and NSM (Near Surface Mounted) reinforcement techniques, under the effects of aging by natural and accelerated environments.

The work has involved: (i) an extensive experimental program, with the establishment of five experimental stations distributed throughout Portugal (Elvas, Guimarães, Lisbon, Serra da Estrela, and Viana do Castelo), where test specimens at three scales (material, bond and structural) were installed to evaluate their performance during the time; (ii) the development of numerical simulations, based on the results obtained in the monitoring carried out; and, (iii) the development of design recommendations by proposing new values for environmental conversation factors for the materials and bond strength for EBR and NSM strengthening techniques.

After four years of ongoing research (the project will last 10 years), several outputs have been already produced, including preliminary environmental conversation factors and comparisons between natural and accelerated aging. Part of these outputs was also used in the development of provisions included in the prCEN/TS 19101: 2020 Design of fibre-polymer composite structures (future Eurocode).



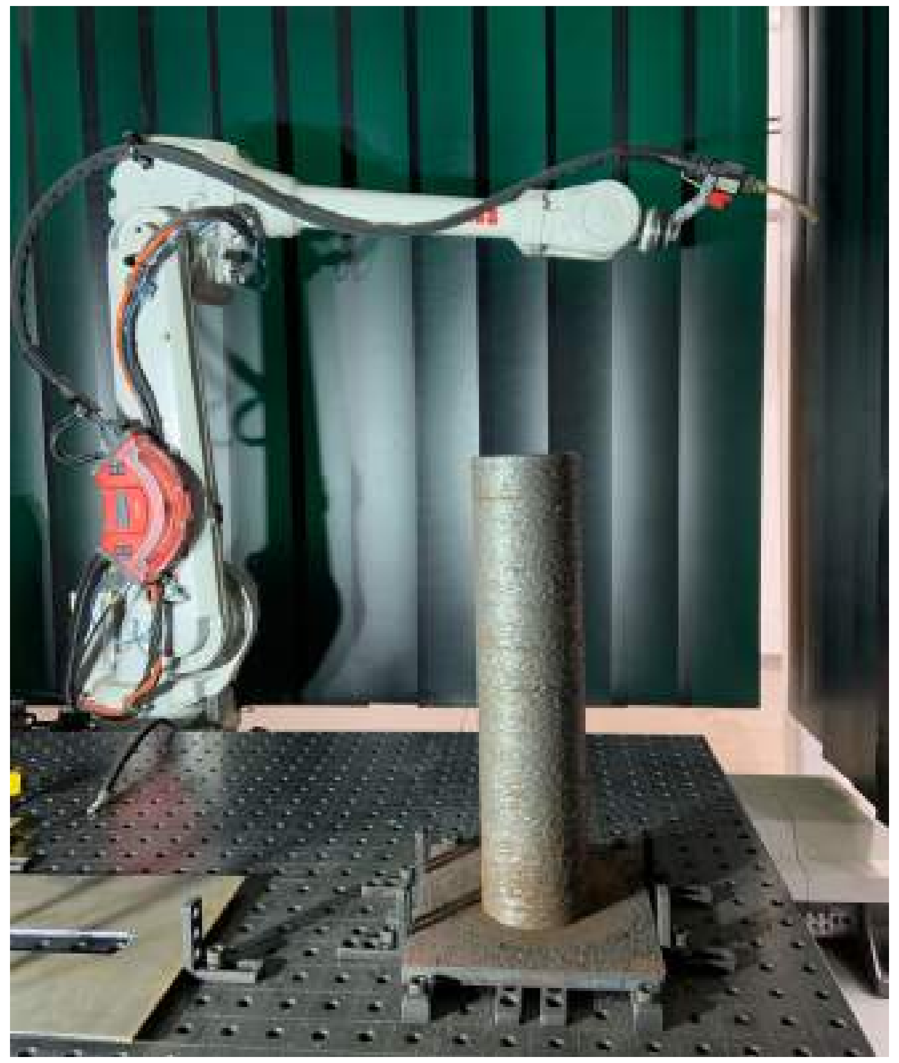


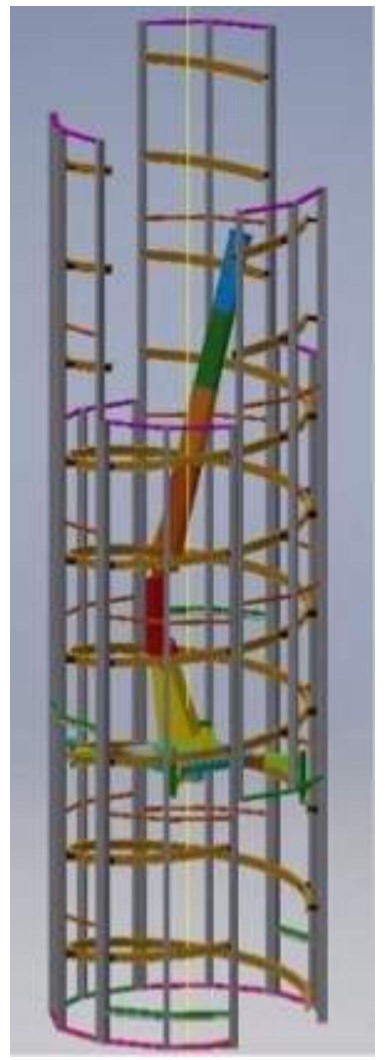
SELECTED PROJECTS

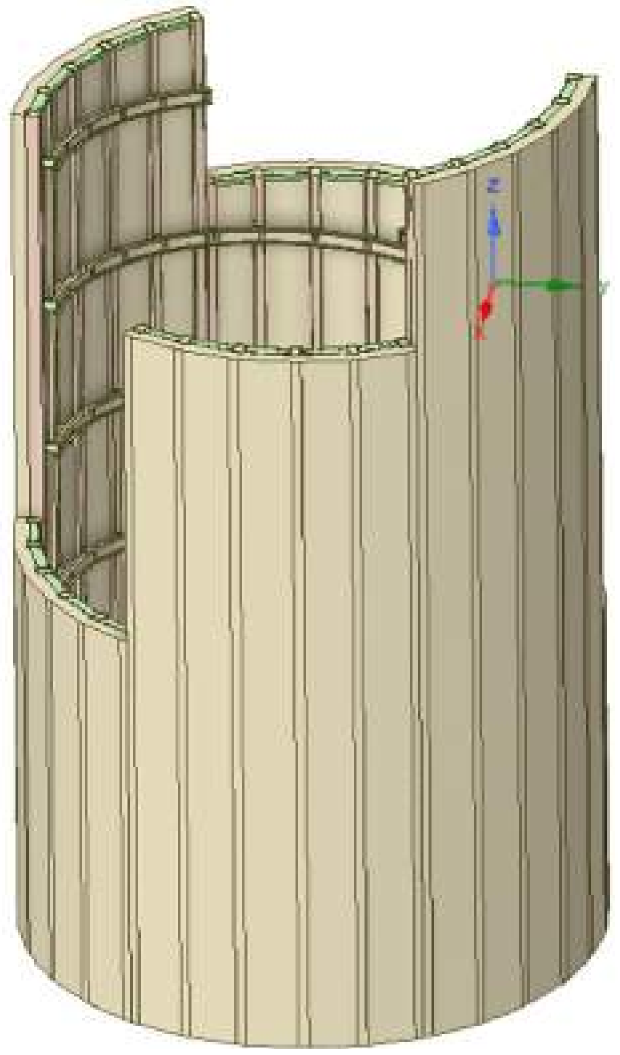
SeT

Self-erecting Tower

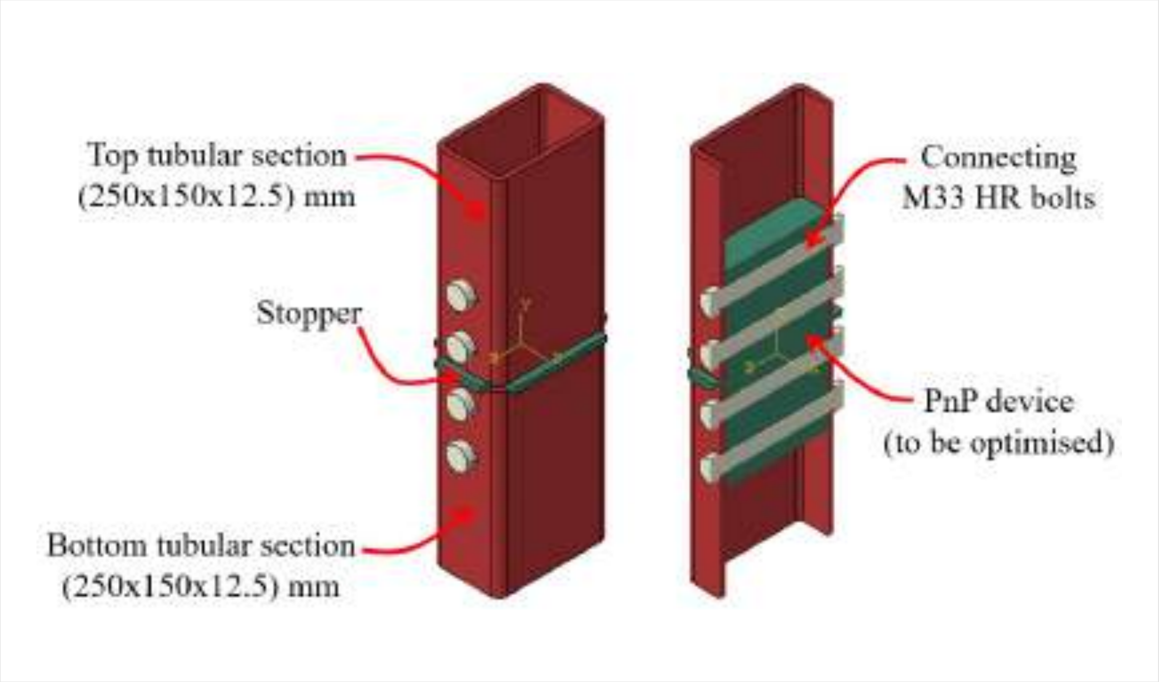
> Steel tubular towers and monopiles have been the predominant solution in the market of wind energy generation for the last decades, both onshore and offshore.







However, the need for new sites to allocate wind farms and the urgency of decreasing installation and maintenance costs are directing the market towards modular systems. Ideally, these systems would be pre-fabricated, easy to transport and simple to assemble.

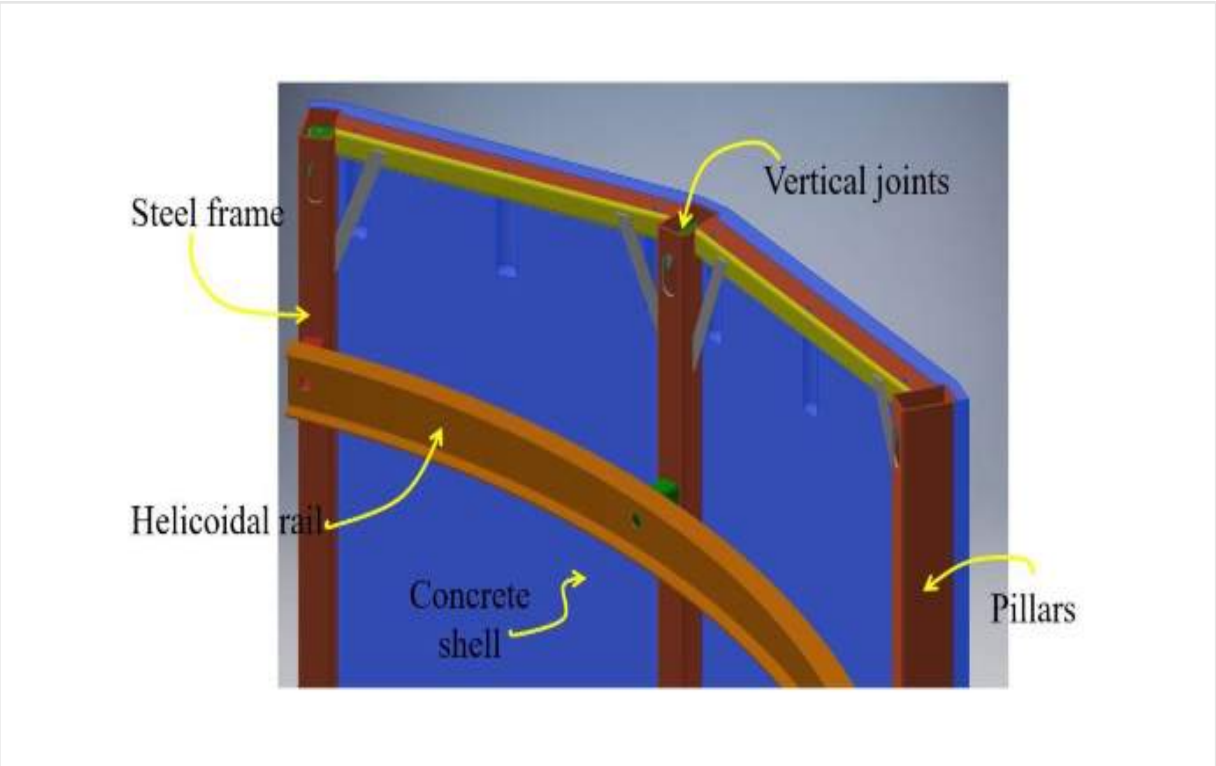


Schematic view of the tower structure and construction process

Within the course of the project state-of-the-art components for structural applications are under development using additive manufacturing (AM), or 3D printing, showing promising results with significant material savings.

Thus, a new type of connection is under development for the splice of the tubular elements that compose the structure in the self-erecting tower.

The concept is to optimise an internal 'plug and play' (PnP) device that allows joining the tubular elements only through bolts.

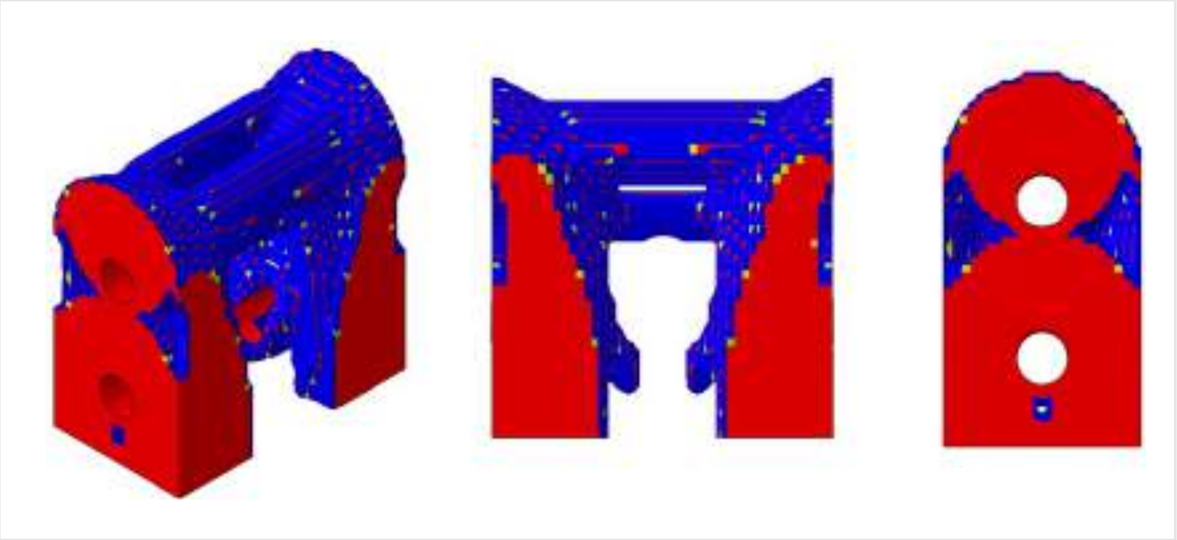


The **Self-erecting Tower (SeT)** project proposes a wind turbine tower formed segments using one single geometry to enable automatization in the manufacture and to eliminate incidents during assembly.

These segments are mechanically joined to guarantee the structural rigidity necessary for the good dynamic performance of the tower.

The interior of the segments supports a continuous helical rail that allows the internal mounting platform to rise through the interior of the tower during the assembly of the panels.

In this way, the modularity of construction and the virtual absence of height limitations are guaranteed. The platform includes an articulated crane of small dimensions.



Tubular connection and optimisation down to 50% of the volume for additive manufacturing

Offshore Steel Connections for ETERMAR

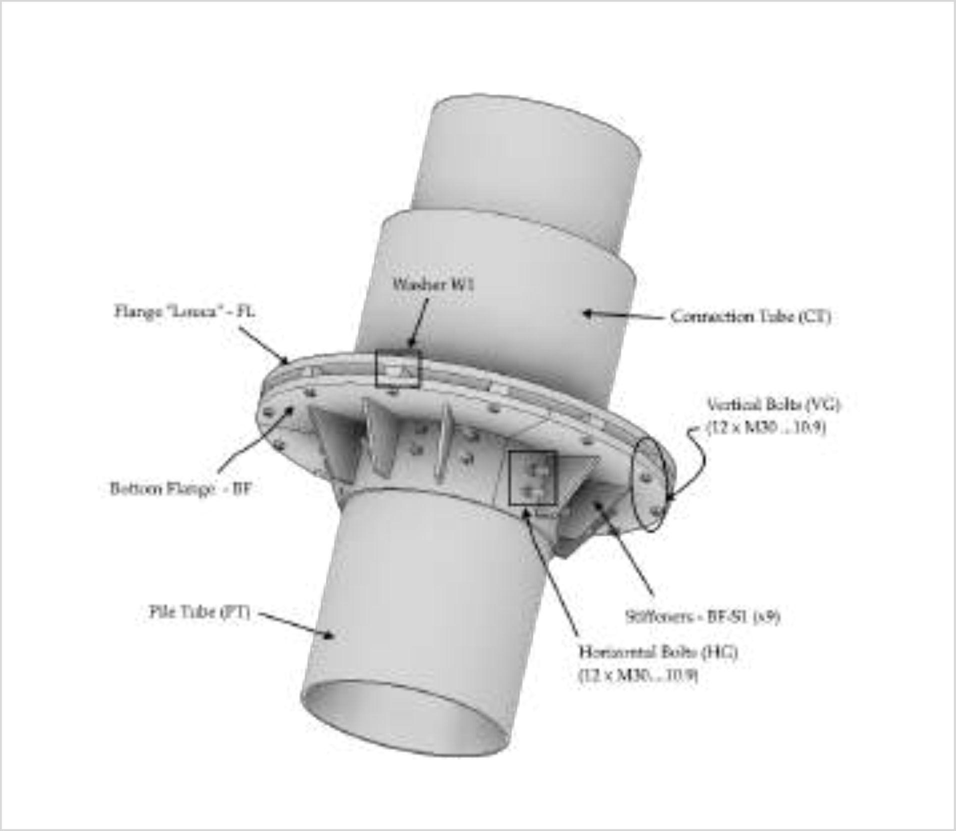
This consultancy was assigned by Senegal Minergy Port (SMP) to Design and Build the Dakar Liquid Bulk Materials Terminal (LBMT), in Bargny, Senegal.

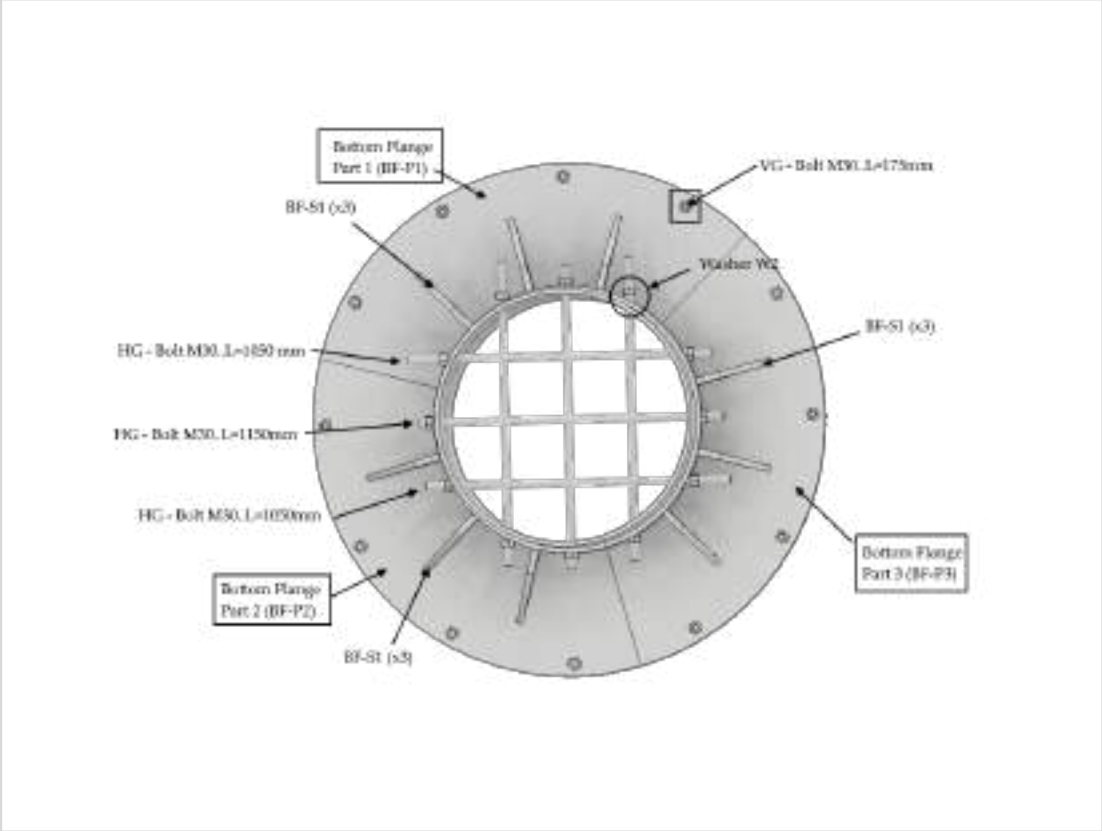
The LBMT comprises two berths in a system of breasting and mooring dolphins, platform and walkways for a range of 13000 DWT to 95000 DWT vessels. The LBM is to be built at approximately 2300 m distance from the shore, at 12 m deep, comprising two breasting and four mooring dolphins to receive the vessels.

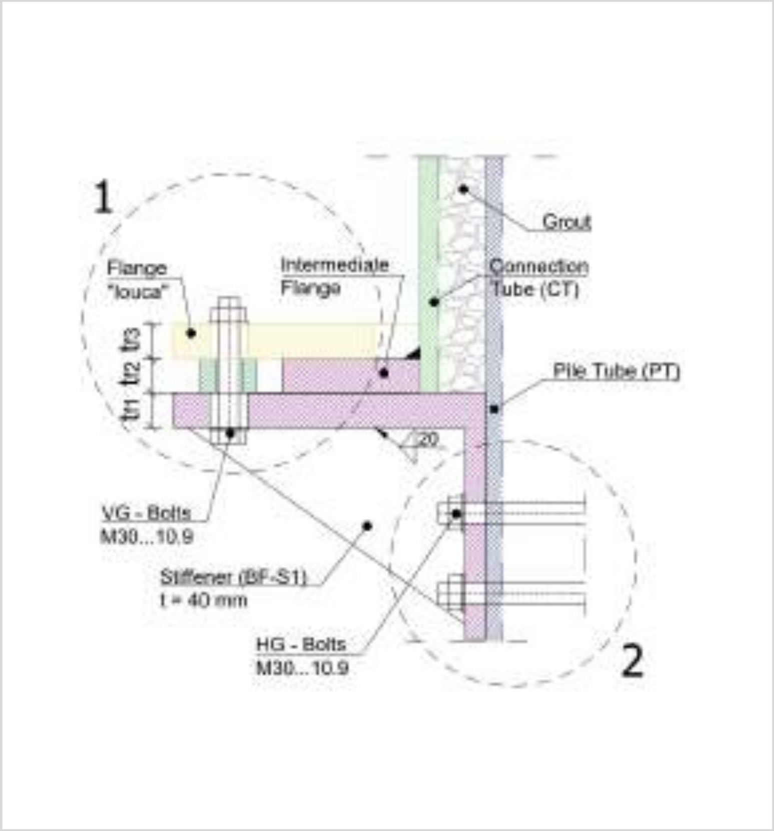
The dolphins have their soffit level at +5.50 m, corresponding to the top of the steel piles. Each dolphin has six steel battered piles, with 1016 mm outside diameter and the thickness of 23 mm and 20 mm for breasting and mooring dolphin, respectively. The superstructure, which starts at level +1.50 m, is connected to the steel piles by means of circular tubular elements with 1207 mm outside diameter and 26.8 mm thickness that fit around the battered piles.

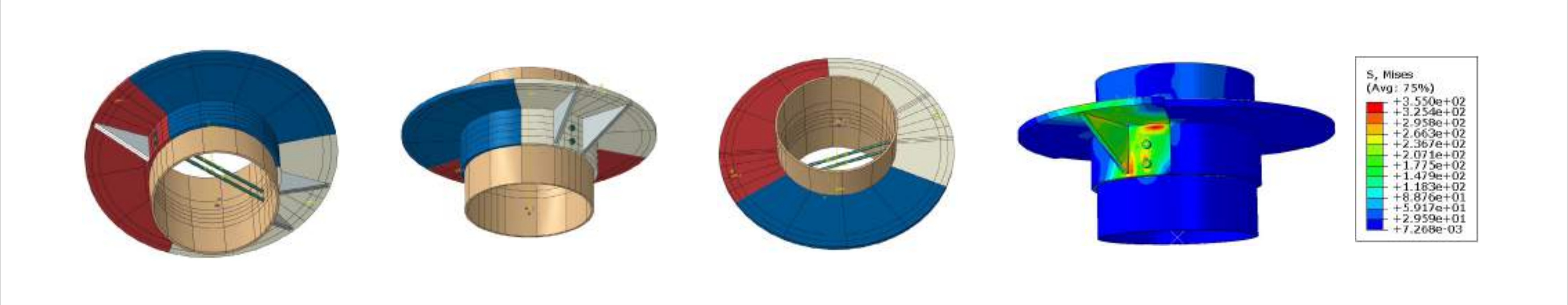
Since the connections between the circular tube (CT) and the pile tube (PT) are close to the sea surface, the conditions do not allow for the welding between the two. Therefore, an alternative circular bolted connection was designed by the University of Coimbra.

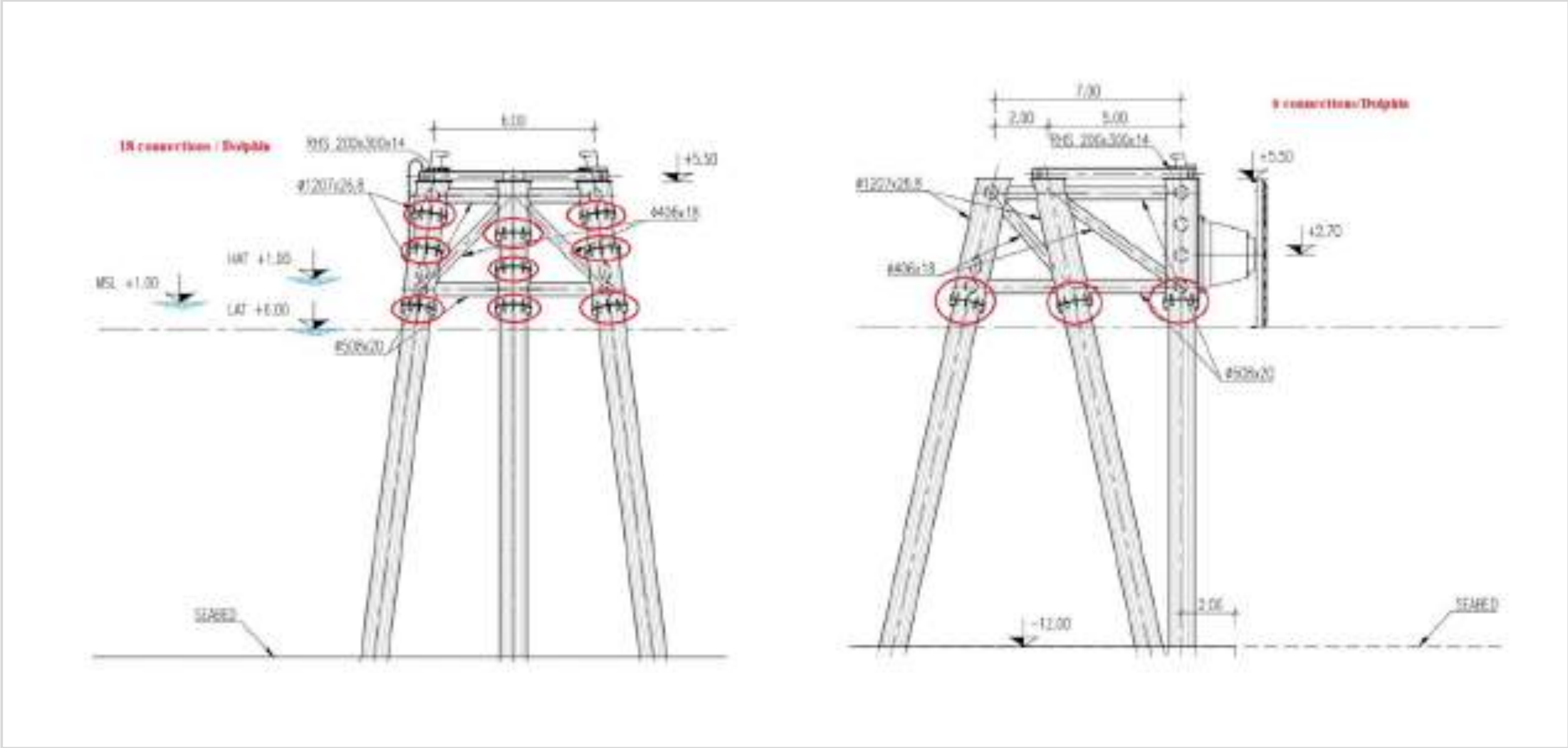
The structural design is carried out according to the relevant structural Eurocodes: EN 1993-1-1 and EN 1993-1-8, and verified by advanced numerical analyses using the finite elements method.

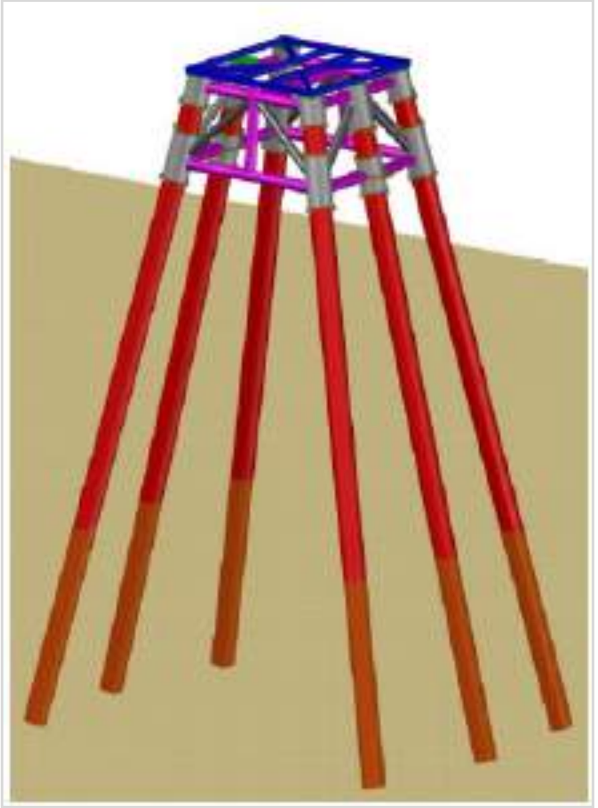


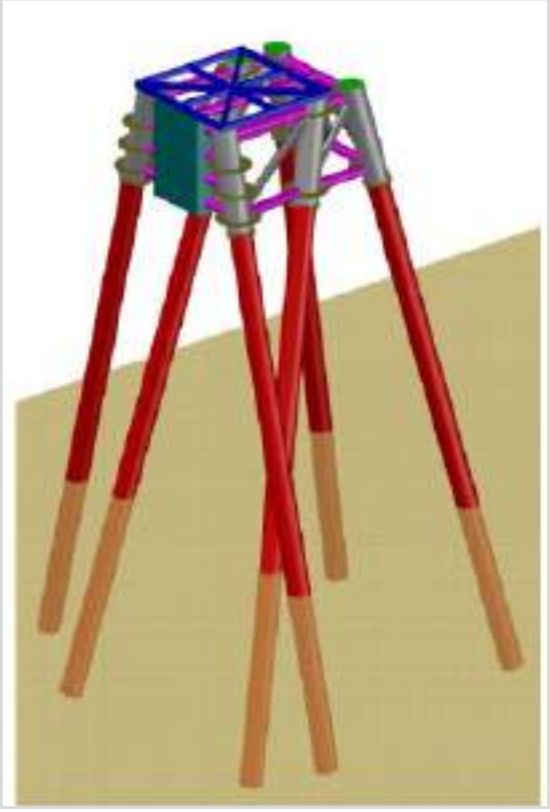










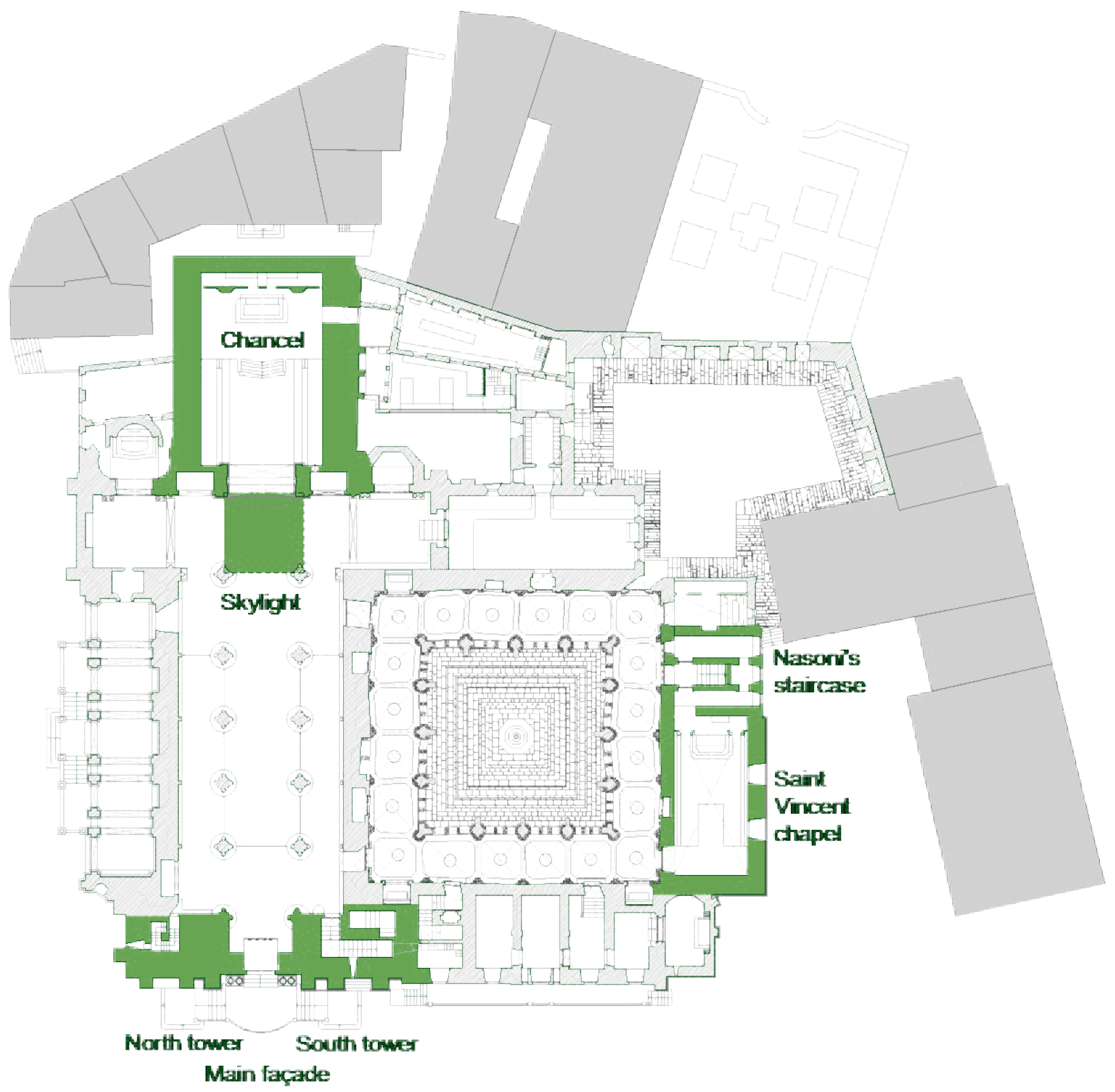


Porto Cathedral

Completing 20 Years of Structural Conservation

Porto Cathedral was founded in the 12th century and combines the Romanesque, Gothic and Baroque architectural styles. The Cathedral is located in the historical centre of Porto city (World Heritage by UNESCO) and it is classified as National Monument of Portugal.

University of Minho was involved in several works on the inspection, diagnosis, numerical modelling, monitoring and interventions in the Cathedral, namely at the Saint Vincent Chapel, towers, main façade, the skylight of the transept, Nasoni's staircase and chancel.



The diagnosis and structural analysis of the Saint Vincent Chapel allowed to conclude the chapel presented out-of-plane deformations in the South wall and a significant overload due to the rubble infill of the vault, and lead to an intervention that included the removal of the infill of the vault and the roof conservation.

The façade presented severe stone deterioration and iron corrosion. The intervention involved several remedial works for the stone conservation, such as removal of biological activity, dry cleaning and low pressure water cleaning, application of water repellents, reconstitution of voids and crack closure.

The towers presented severe global damage, namely cracking, crushing and separation of the wall leaves, and local damage to the domes, spires and balustrades.

To improve the structural behaviour, a rigid stainless steel frame, a set of inclined anchors and long ties were applied to provide a confinement ring. Additionally, a monitoring system was implemented. The skylight presented cracking and separation between the walls and vaults, and a rigid steel frame and a new timber roof were added.

The intervention carried out in the staircase designed by Nicolau Nasoni involved the injection of cracks, and the application of steel ties and anchors, improving the connection between walls.

More recently, the inspection, diagnosis and numerical modelling of the chancel lead to an intervention that included: removal of the infill of the vault and application of new steel structure and roof; application of steel ties at the rear façade; injection of cracks and application of anchors at the ribs of the vault; consolidation of the vault at the connection with the rear façade and remedial works at the external walls.

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