
ECOREL UPM

Environment, Coast and Ocean Research Laboratory
Universidad Politécnica de Madrid

ECOREL UPM

ECOREL-UPM is a teaching and research facility in the field of maritime, coastal and port engineering whose mission is to generate new knowledge in these areas, to promote the achievement of the Sustainable Development Goals (SDGs) marked by the United Nations Assembly (UNGA) within its 2030 Agenda

ECOREL-UPM's vision is to become a benchmark that offers innovative solutions with a high level of commitment and excellence, following a long tradition of researchers of recognized relevance both nationally and internationally, such as Professor Ramón Iribarren or Professor Pedro Suárez Bores

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TEACHING

As part of the largest technical university in Spain and one of the best Civil Engineering schools in the world, we believe in and support the talent and education of students and future professionals.

RESEARCH

We have a very strong commitment to society, driven by our desire to serve. We bring new knowledge to life so we can improve the quality of life of people.

SOLUTIONS

Given our research profile, we add value by solving challenges and problems that require the generation of ideas and solutions of great ingenuity and technical experience.

ECOREL UPM

The Team

VICENTE NEGRO VALDECANTOS
Full Professor – Director

JOSÉ SANTOS LÓPEZ GUTIÉRREZ
Professor

JAIME GARCÍA PALACIOS
Professor

JOSÉ Mª DEL CAMPO YAGÜE
Professor

PEDRO FERNÁNDEZ CARRASCO
Professor

LUIS MORENO BLASCO
Associate professor

Mª DOLORES ESTEBAN PÉREZ
Associate professor

JOSÉ Mª VALDÉS FDEZ. DE ALARCÓN
Associate professor

ANTONIO CELIS CUBERO
Associate professor

MARIO MARTÍN ANTÓN
Researcher

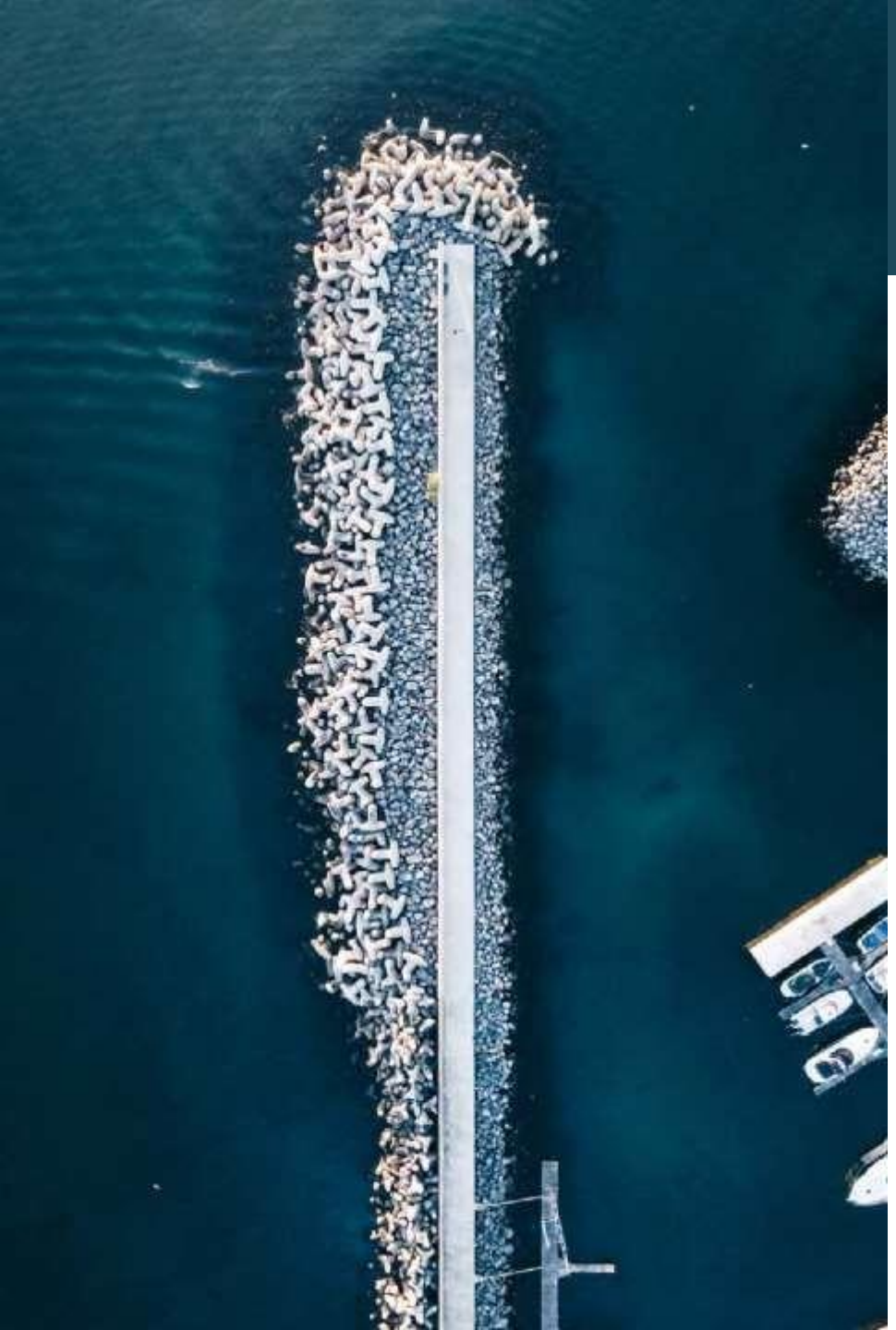
JORGE LUENGO FRADES
Researcher

CESAR SASTRE GIL
Software Engineer

JOSÉ LUIS ORTS EGÍO
SRE

ALEXANDER ARRUNATEGUI LÓPEZ
Technician

MARTÍN EZEQUIEL COLLADO
SRE



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Development Areas

Offshore

It is one of the solutions to the emerging energy problem and a booming area in which we focus much of our efforts.

Port infrastructure

With a long history in this area, we develop all our activities with new approaches, designs, and materials.

Coasts

It is one of the most changing and fragile environments in nature, so we feel the duty to constantly work for its proper conservation and exploitation.

Environment and Climate Change

We firmly believe in the transforming power of human beings, and we develop new technologies to minimize, control and monitor its impact on the environment, in order to preserve it for future generations.

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Technology Transfer

More than 50 articles indexed within the last 10 years:

- Offshore Wind Farms vs. Coastal Erosion. ICE´s 7th Conference on Coastal Management
- Design of Scour Protections in Offshore Wind Farms. ICE
- Design of Scour Protections in Offshore Wind Farms. ICE
- Scour Prediction and Scour Protections in Offshore Wind Farms. Renewable Energy. ELSEVIER
- The Effect of Scour Protections in Offshore Wind Farms. Journal of Coastal Research. CERF
- Design of Scour Protection Systems in Offshore Wind Farms. Journal of Energy ResourcesTechnology. ASME
- Methodology for the Design of Offshore Wind Farms. Journal of Coastal Research, CERF.
- Climate Change and Urban Coastal Flooding. Journal of Coastal Research, CERF.
- Influence of Bathymetry in Numerical Models for the Estimation of Loads for the Design of MaritimeStructures. Journal of Coastal Research, CERF.
- Why Offshore Wind Energy?, Renewable Energy Journal. Elsevier
- Integral Management Applied to Offshore Wind Farms. Journal of Coastal Research, CERF
- Coastal Barrier Cancun-Nizuc, Journal of Coastal Research. CERF
- Improvement of theoretical storm characterization for different climate conditions. CoastalEngineering. Elsevier
- Hydrodynamic Regimes in Offshore Wind Farms. Journal of Coastal Research, CERF
- New Coastal Regulation in Spain. A roadmap to a better approach to the coastal environment.Journal of Coastal Research, CERF.
- Review of coastal Land Reclamation situation in the World. Journal of Coastal Research, CERF.
- Software for Predicting Hydrodynamic Pressures on Offshore Pile Foundations: The Next Step inOcean Energy Development. Journal of Coastal Research, CERF.
- Overtopping of harbor breakwaters: a comparison of semiempirical equations, neural networks,and physical model tests. Journal of Hydraulic Research
- Offshore Wind Foundation Design: Some Key Issues. Journal of Energy Resources Technology. ASME
- Gravity-based support structures for offshore wind turbine generators: Review of the installationprocess. Ocean Engineering. Elsevier
- Review of the Influence of Oceanographic and Geometric Parameters on Oscillating Water Columns
- A New Climate Change Analysis Parameter: A Global or a National Approach Dilemma
- Review of the application of Artificial Neural Networks in Ocean Engineering

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Technology Transfer

- Field campaign on pressure on all the crown-wall at Outer port of Punta Langosteira Breakwater
- Comparison of Existing Equations for the Design of Crown Walls: Application to the Case Study of Ericeira Breakwater
- Optimizing Wave Overtopping Energy Converters by ANN Modelling: Evaluating the Overtopping Rate Forecasting as the First Step
- Nanomaterials in Protection of Buildings and Infrastructure Elements in Highly Aggressive Marine Environments
- The port of Valencia maritime network: an analysis of centralities and tree-optimization
- A simulation model of container terminals. The Port of Valencia case study
- Scale Tests to Estimate Penetration Force and Stress. State Of the Silica Sand in Wind farm Foundations
- Land Use and Port-city Integration in Reclamation Areas: A Comparison between Spain and Japan
- Blue economy: Compatibility between the Increasing Offshore Wind Technology and the Achievement of the SDG
- An Engineering Method for the Preliminary Functional Design of Perched Beaches: Design Guidelines
- Impact of offshore Wind Farms on Marine Ecosystems. Pelagic Species and Fishing
- Coastal Morphological Response to the Effects of Protection Structures against Erosion
- Evolution of Extreme Waves in Cadiz (SW Spain)
- Evaluation and Optimization of the Life Cycle in Maritime Works
- Feasibility Study of the Installation of Wave Energy Converters in Existing Breakwaters in the North of Spain
- Assessment of the influence of the acceleration field on scour phenomenon in offshore wind farms
- Preliminary Design for Wave Run-Up in Offshore Wind Farms: Comparison between Theoretical Models and Physical Model Tests
- New detected uncertainties in the design of foundations for offshore wind turbines
- From Julius Caesar to Sustainable Composite Materials: A Passage through Port
- Caisson Technology
- An Engineering Method for The Preliminary Functional Design of Perched Beaches. Theoretical Approach
- Action Strategy for studying Marine and Coastal Works with climate change on the horizon
- Wave Energy Potential Assessment and Feasibility Analysis of Wave Energy Converters. Case Study: Spanish Coast
- A modified method for assessing hydrodynamic loads in the design of Gravity Based Structures for Offshore Wind Energy
- A new classification of Wave Energy Converters used for selection of Devices
- Surveys applied to the improvement of beaches. Case studies: Las Canteras, Hoyo
- Parametric guidelines of tombolo formations behind detached breakwater systems in Spanish Mediterranean Coast
- The Gigantism of Public Works in China in the Twenty-First Century
- Monopiles in Offshore Wind: Preliminary Estimate of Main Dimensions
- The Impact of Public Works in Spain: Natural, Constructed and Destroyed Landscape
- Evaluation of Wave Loads on a New Type of Perforated Caisson

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Technology Transfer

More than 30 communications in National and International Congresses within the last 10 years:

- Change in teaching methodology during the pandemic of a marine renewable energy subject (INTED 2021)
- Implementation of laboratory activities in maritime engineering subjects (INTED 2021)
- Impact of offshore Wind Farms on Marine Ecosystems. Pelagic Species and Fishing (ICS 2020)
- Coastal Morphological Response to the Effects of Protection Structures against Erosion (ICS 2020)
- Evolution of Extreme Waves in Cadiz (SW Spain) (ICS 2020)
- Evaluation and Optimization of the Life Cycle in Maritime Works (ICS 2020)
- An Engineering Method for The Preliminary Functional Design of Perched Beaches. Theoretical Approach (PUSAN 2018)
- Action Strategy for studying Marine and Coastal Works with climate change on the horizon (PUSAN 2018)
- Wave Energy Potential Assessment and Feasibility Analysis of Wave Energy Converters. Case Study: Spanish Coast (PUSAN 2018)
- A modified method for assessing hydrodynamic loads in the design of Gravity Based Structures for Offshore Wind Energy (PUSAN 2018)
- A new classification of Wave Energy Converters used for selection of Devices (PUSAN 2018)
- Crown walls. mass or reinforced concrete? The way to aesthetics in maritime works. Case study: Spain (ICE 2017)
- 11th International Conference on Coasts, Marine Structures and Breakwaters ICE Liverpool (UK) 2017
- EGU 2017 European Geoscience Union. General Assembly 2017
- 1sr International Conference on Next Generation Wind energy 2014
- 8th International Conference on Coasts, Marine Structures and Breakwaters, ICE, Edinburgh, UK, 2013
- European Geoscience Union. General Assembly 2013, Viena, 2013
- The 2nd European Conference on Flood risk Management. Science, Policy and Practice: Closing the Gap, Amsterdam, 2012
- 7th International Conference on Coasts, Marine Structures and Breakwaters, ICE, Belfast, UK,2011

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Technology Transfer

More than 18 Doctoral Theses in the last 10 years

- Methodology Proposal for the Design of Offshore Wind Farms
- Detached Breakwaters Functional and Environmental Behavior and their Importance in Coastal Engineering
- Scour Phenomenon Protection in Offshore Wind Monopiles Supports
- Crown Walls Design in Rubble Mound Breakwater
- Use of Scrapped Ship as a Floating Breakwaters in Shallow Waters
- Storm Characterization for Analyzing Stone Armor Damage Progression
- Overtopping discharge in maritime structures
- Run up in coastal structures
- Natural and constructed landscape
- Detached breakwaters Systems. Behavior and shoreline response
- Soil-structure interaction in a wind farm foundations
- Hydrodynamic response of the wave action in caissons
- Life cycle of new materials in monolithic structures
- Refraction-diffraction model. Ray- wave front in the design of monolithic structures

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Technology Transfer

More than 30 research projects and contracts in the last 10 years:

- CENIT- E AZIMUT: Offshore Wind Energy 2020 (2010 - 2013, Gamesa)
- CENIT-E OCEAN LIDER: Marine Renewable Energies (2009 - 2012, Iberdrola Ingeniería y Construcción)
- Gravity DILAPE: Wave Converters in Vertical Breakwater (2009 - 2010, Dragados)
- Based Structures. Acciona Project (2012 - 2013)
- Offshore Wind Platforms, resources exploitation and actions on offshore structures and deep structures. (2010 – 2017, Intecsa – Inarsa)
- FP7-EC SMARTeST: Smart Resilience Technology, Systems and Tools (2010-2012, Building Research Establishment)
- MADAME: Development and validation of highly durable materials for application in maritime structures and crown walls vulnerable to Climate Change (RETOS 2017)
- Project LOE83: Experimental campaign with a multi-platform catamaran. (TechnoPro Hispania 2018 – 2019)
- TRIWIND. 3D Hydraulic model test of a hybrid wind farm platform, GBS and floating structure (2019 – 2020, Rover Maritime)
- ARCHIME3. Behavior test and design of an offshore wind floating platform European Union EIC Accelerator Program (2019-2021, Beridi)
- Life Urbanklima 2050: Current state analysis and reinforcement project of the port of Ondarroa breakwater (2021, TYPSA, Gobierno Vasco)
- 2D Hydraulic model test on the behavior of a rubble mound breakwater in Club Nautic S'Estanyol (2022)
- 3D Hydraulic model test on structural and functional stability in the rubble mound breakwater in Ondarroa, Vizcaya Spain (2021)
- 3D Hydraulic model tests of a hybrid wind farm platform, GBS and floating structure (2019 – 2020)
- Optimization of a floating structure type TRIWIND ARCHIMEDES (2021)
- RETOS(2018 – 2022)Development and validation of highly durable materials for application in maritime structures and crown walls vulnerable to Climate Change.
- Technical Assistance for carrying out the Tests of the Study Project in a Physical Model on the Evolution of Failures in Slope Breakwaters in theLaboratory of Harbors and Coasts (2022 CEDEX)

IBERDROLA · GrupoTYPSA · SIEMENS Gamesa RENEWABLE ENERGY · intecsa | inarsa · DRAGADOS · beridi · rover MARITIME · bre · acciona · ESTEYCO · GOBIERNO DE ESPAÑA · MINISTERIO DE FOMENTO · MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA · CEDEX · Puertos del Estado

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Facilities

A total of 2.100m^2 in:

- 1.000 m^2 Tests facilities
- 450 m^2 Classrooms, offices and museum
- 400 m^2 Workshops
- 250 m^2 Water deposit and service galleries

Facilities for physical experimentation:

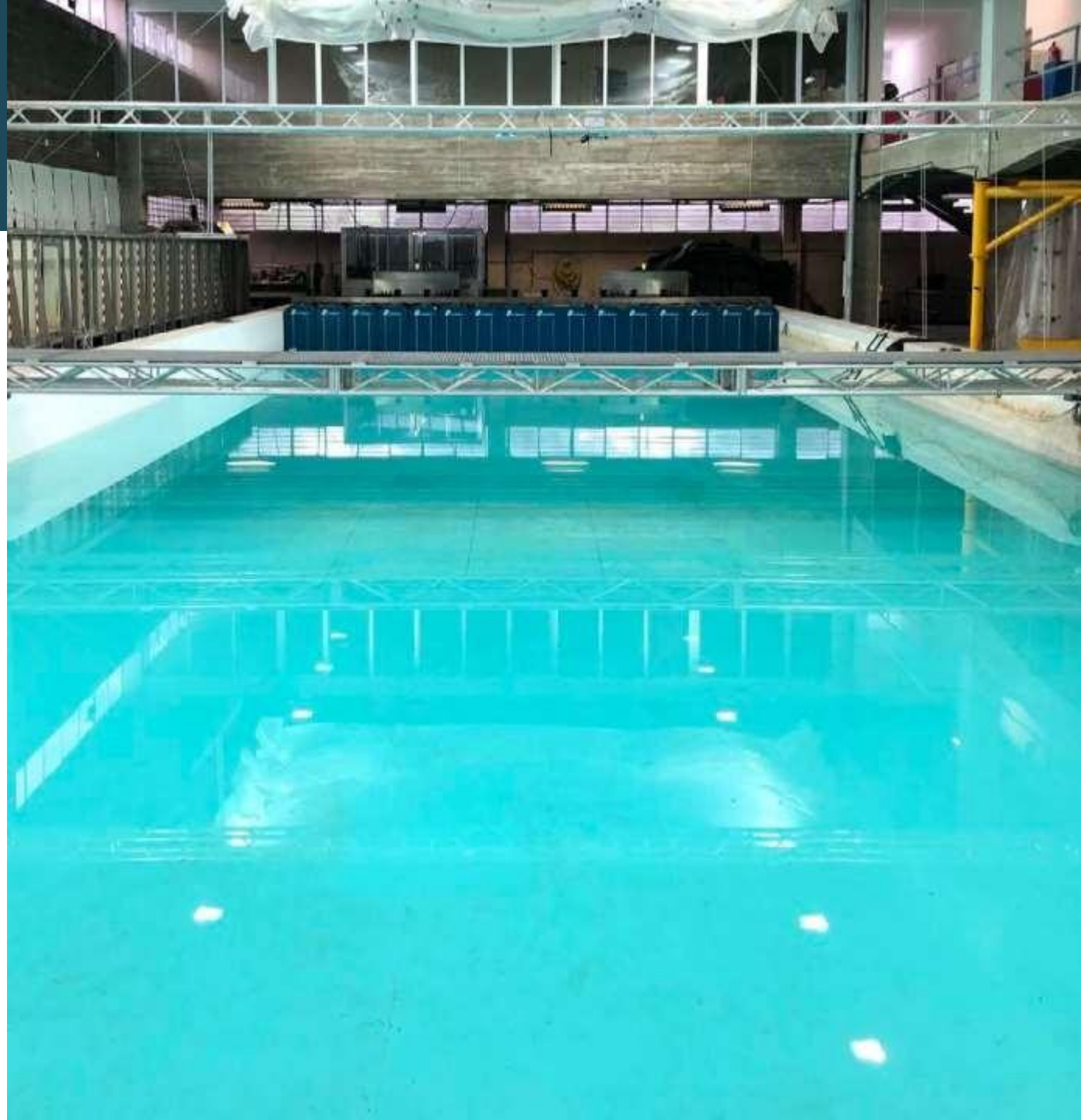
- Multidirectional wave tank 33 m x 11 m x 1,36 m
- Wave flume 52 m x 1 m x 1,5 m

Service facilities:

- Clean room
- CNC room
- Workshop
- Warehouse
- Loading bay

Staff and teaching facilities

- Meeting room
- Classroom
- Offices



Physical Experimentation Facilities

Multidirectional Wave Tank

The wave tank is our main facility. It carries out small-scale tests of different infrastructures, both coastal and offshore, in either anchored or floating configurations

Thanks to its great versatility and leading generation and acquisition equipment, it is possible to simulate numerous sea states.

Features
Dimensions: 33m x 11m x 1,36m
Maximum height: 1m
Passive energy absorption of 10 ppi
Mobile instrumentation gateway
Aluminum truss

Multidirectional generation
The generation of multidirectional waves is carried out by 16 piston-type paddles with active absorption of reflected waves manufactured by HR Wallingford. The system is capable of generating up to 0.30 m of wave height with 4 s period

Physical Experimentation Facilities

Wave flume

In the wave flume, we carry out tests of reduced-scale maritime infrastructure, such as cross-sections of breakwaters in all their typologies, beach profiles andcoastal protection structures.

From those, we obtain relevant phenomena to be taken into account in real-scale design and calculation.

Features

Dimensions: 52 m x 1 m x 1,5 m

Maximum height: 1 m

Omnidirectional lighting gantry

Easy access doors to the interior of the flume

Fully glass wall

Wave generation

Wave generation in the Flume is carried out using a single piston paddle designed and manufactured by HR Wallingford.

It is equipped with a control and absorption of reflected wave system.

Service Facilities

For a correct lab operation, it is necessary to have certain facilities dedicated to carrying out work that requires both specific instruments and specific safety measures.

Workshop

The workshop is equipped with machinery and tools for the construction and arrangements of all those elements that cohabit in the installation, be they wood, aluminum, PVC, steel, polymers or other materials.

It also has 3 3D printers and a laser cutter for prototyping and manufacturing parts.

CNC

Equipped with a high precision, large-size milling machine by ALARSIS, which allows the creation of elements with a high level of detail and customization, even with demanding geometries and large sizes, in different materials.

Clean room

It has a positive pressure system and tools dedicated to the design and manufacture of electronics, which allows for fully customize sensors required for testing and monitoring the facility.

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Instrumentation

The laboratory has modern instruments and systems, that are in constant renewal, which ensures quality and excellence in carrying out the tests.

Some of them are:

- Real-time tracking and positioning system using infrared light reflection (Optitrack)
- Level sensors (Capacitive, resistive and acoustic)
- Pressure sensors (Monoaxial and multiaxial)
- Video-image cameras
- Speed sensors
- Accelerometers and Inertial Systems (IMUs)
- Wireless communication and synchronization systems
- Topographic tools
- Photogrammetric tools
- Slowmo-Camera
- Submersible cameras
- Acquisition system for level probes up to 400 Hz
- High-resolution photo cameras
- High-performance drones for fieldwork

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Testing

The adaptation of our facilities to be able to carry out complex projects of different kinds, requires precise knowledge of all stages of the process.

Wave Generation

The generation is carried out using HRWallingford's own equipment with HR WaveMaker software that has capabilities for compensation of speed losses in the lateral walls and separation of t h e incident and reflected waves. In our own developments we have added new wave generation capabilities not contemplated by this software, such as the Chirp signal, which allow us to assess the conditions of our tank and model more clearly.

Data Acquisition

Data acquisition can be done thanks to the equipment developed by HR Wallingford, even so, we have developed improvements to control all the measurement channels of the different sensors in synchronized time, with more complete, automated information and with better data management, in such a way that possible human error is reduced. Acquisition in real time enables the ability to eliminate reflected waves.

Post-processing

Processing is continually under development, leveraging acquisition control for full report generation. Being our tools, it allows us to adapt to the different projects and customer requirements that are needed in the laboratory.

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Wave Generation

In addition to the capabilities of the current generation equipment (HR Merlin), we have developed our own software to generate directional and multidirectional waves taking into account the characteristics of the tank, the paddles and the waves. This allows us to:

- Generate multiple decompositions of a spectrum and analyze them to see how they fit the project requirements.
- Increase the number of bands of spectral decomposition to avoid aliasing phenomena.
- Use waves other than those provided by HR Wallingford's software, such as Chirp signals, which reveal resonance phenomena.
- Make an analysis prior to and in addition to that provided by HR Wallingford on the movement of blades in an empty tank to improve the safety and manageability of our facilities

Tank

- Length: 33 m
- Width: 11 m
- Max level: 1,00 m
- Hmax: 0,30 m
- Periods: 0,33 a 4,00 s

Flume

- Length: 52 m
- Width: 1,00 m
- Max level: 1,00 m
- Hmax: 0,50 m
- Periods: 0,33 a 5,00 s

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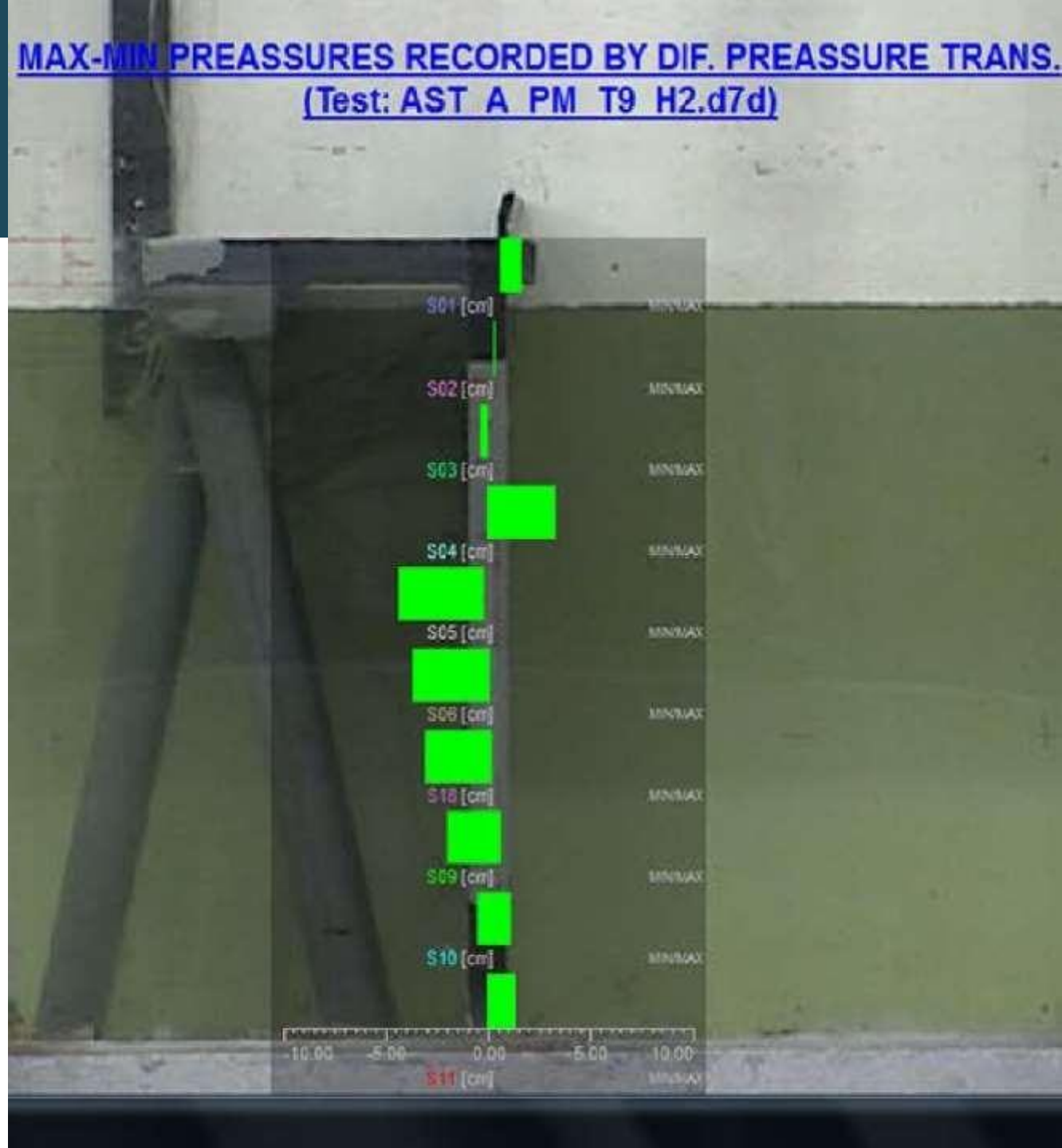
Data Acquisition

Data acquisition is a complex task since it requires synchronizing the input of the different equipment involved in measurement such as level, temperature, salinity probes, accelerometers, gauges, visible and infrared spectrum cameras, etc.

In addition to being able to use the software designed by HR Wallingford (HRDaq), we integrate its acquisition hardware in our programming environment, allowing us to analyze the signal in real-time and synchronized the different acquisition equipment.

The improvement in this field is constant, since we add new utilities arising in the different projects and experiences carried out.

Our multidisciplinary team is constantly evolving to improve the quality of the measurement, working from the sensor, its quality and the calibration process, to the final result of the analysis, without forgetting the acquisition equipment, its capabilities, limitations and possible improvements.



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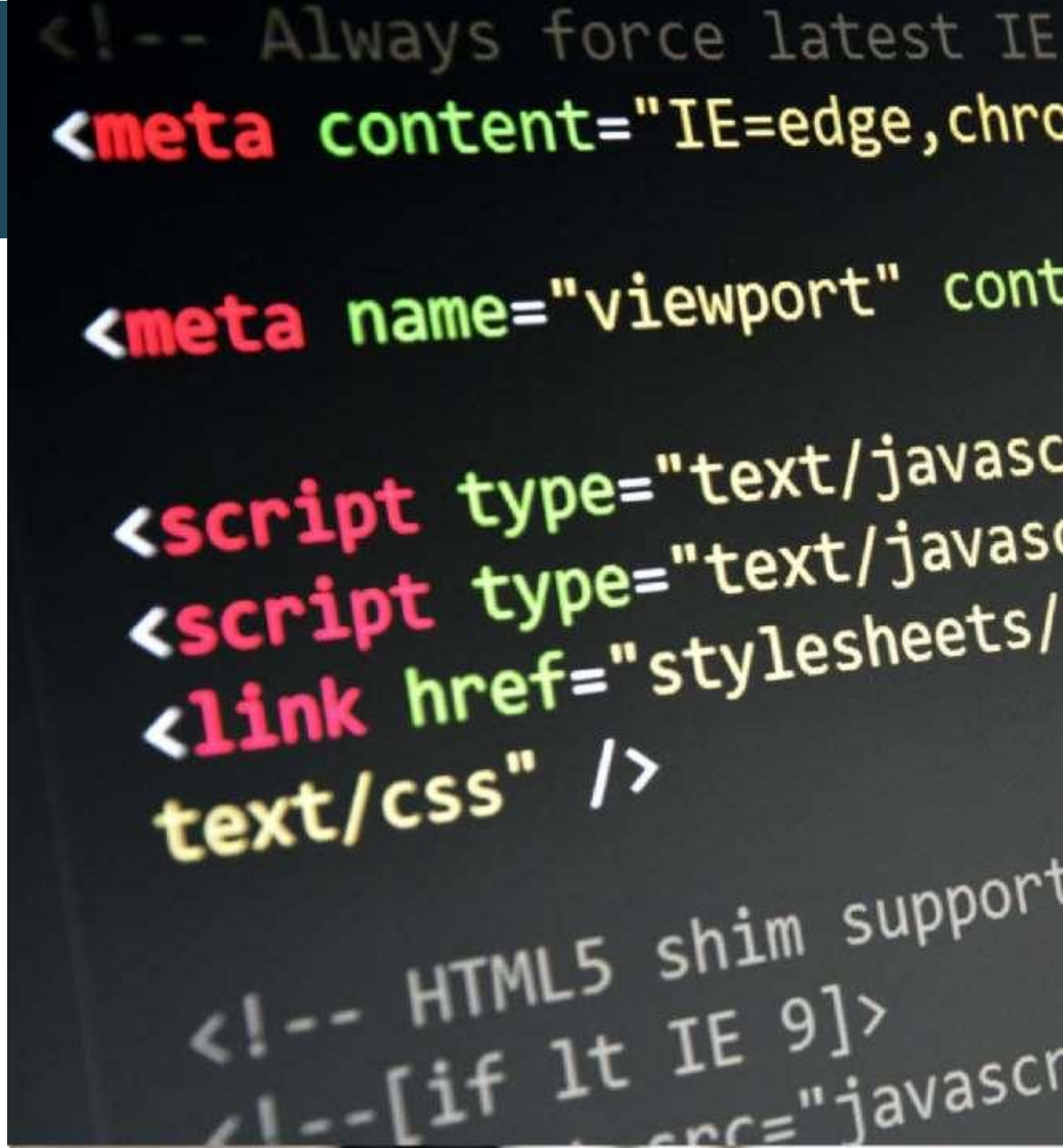
Post-Processing

Customer satisfaction is our goal and excellence is our way. For this we have invested in:

- Signal treatment techniques to improve results, understanding the implications of each of the processes, both in the time domain and in the frequency domain.
- Automation of processes with error analysis, validation of results and correlations between generation and results at the measurement points.
- Proven experience of the research team to analyze and expand the results according to the latest advances in maritime and coastal research.
- Experience in programming and analysis of results.
- Automated generation of reports that avoid the introduction of intermediate errors.
- Customized generation of reports adaptable to the requirements of our clients.



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Some of our Work

Project LOU83: “Experimental campaign with a TechnoPro Hispania multi-platform catamaran.”

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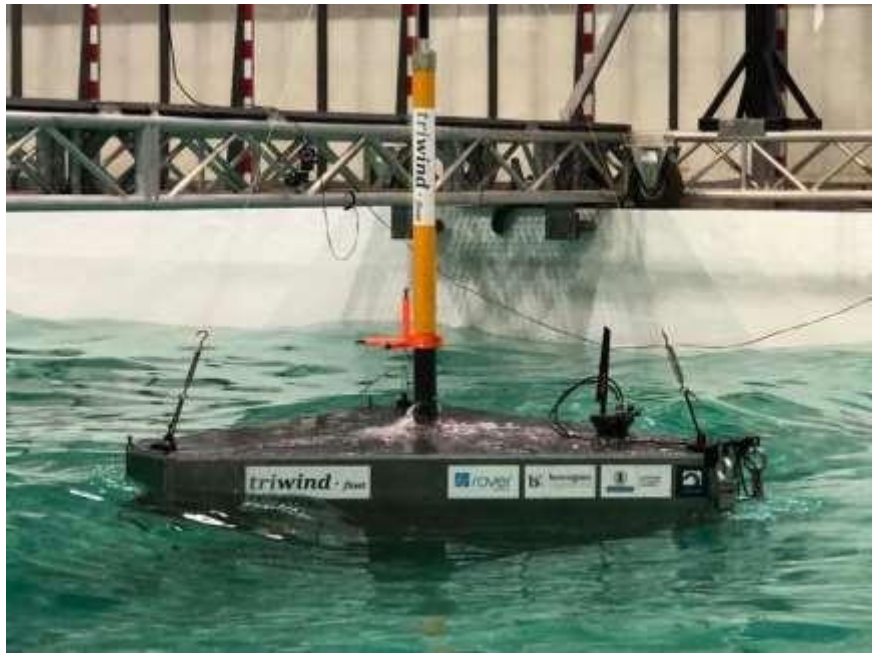
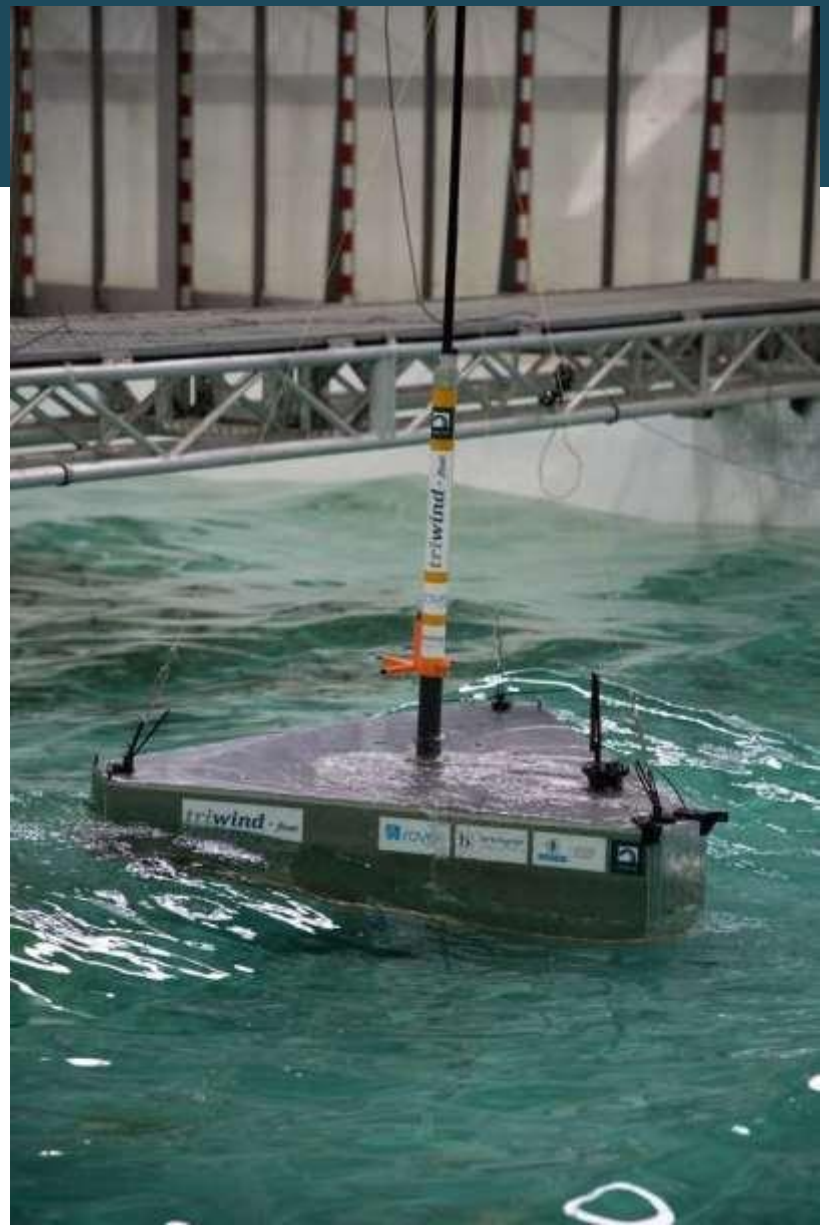
Some of our Work

Project: “Three-dimensional 3D physical model test of a TRIWIND gravity-flotation hybrid wind turbine”





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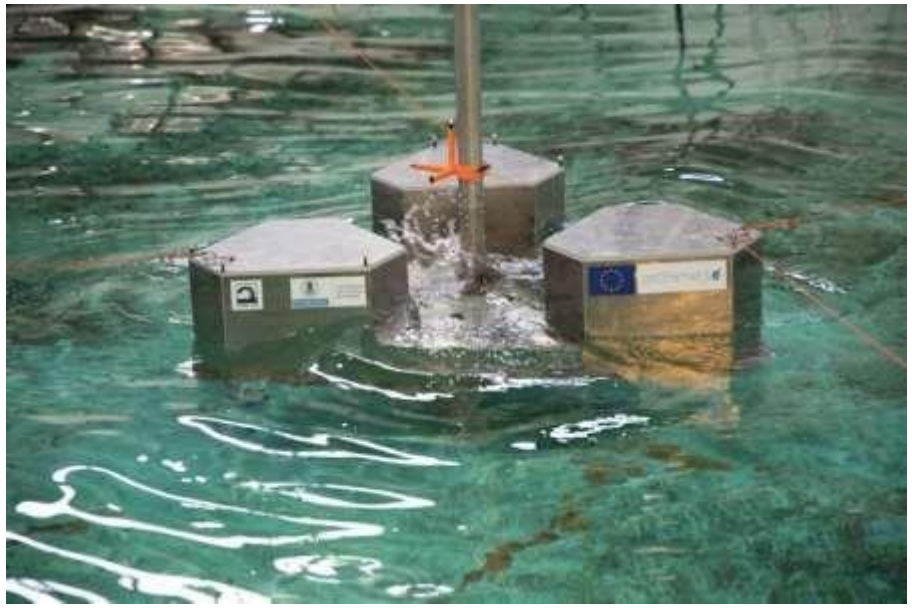
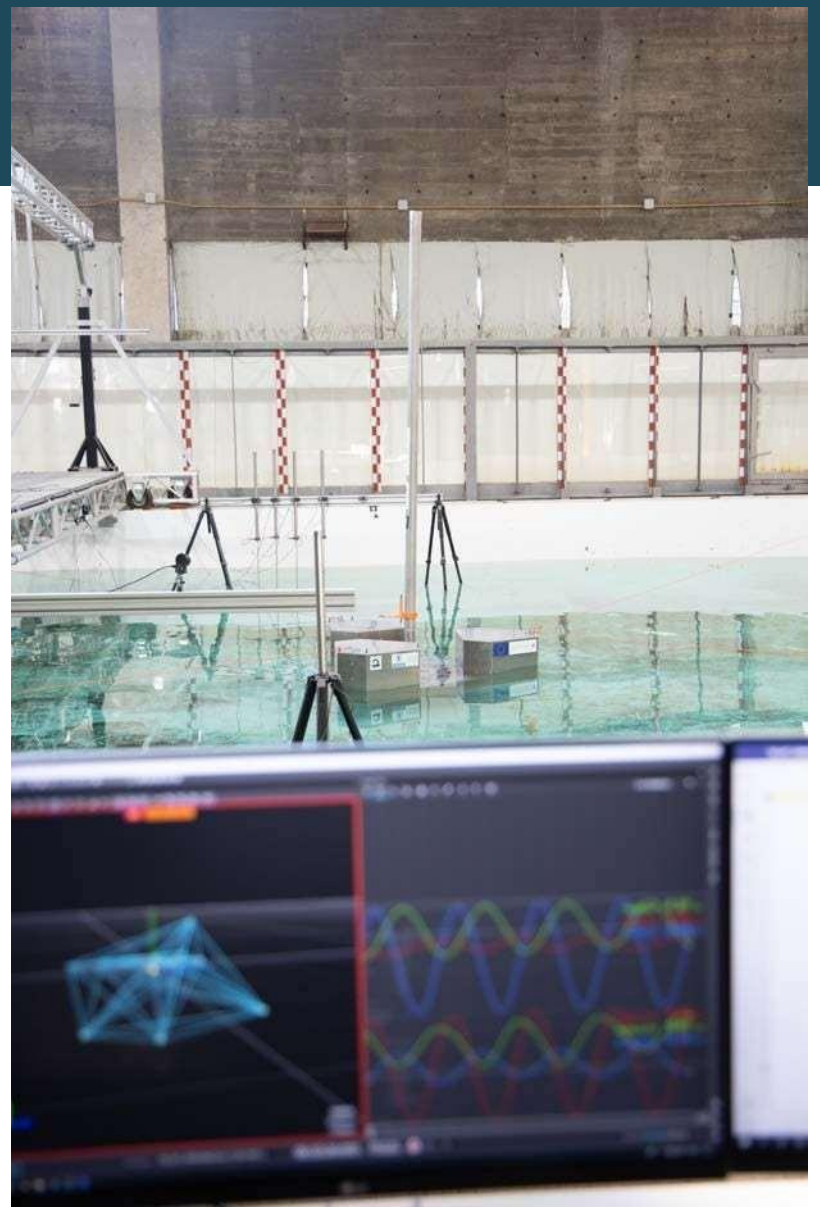
Some of our Work

ARCHIME3 project for the functional and design study of the floating offshore wind platform ARCHIME3 - European Union EIC Accelerator Program.





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Some of our Work

Project “Life Urbanklima 2050: Analysis of the current state and project for the reinforcement of the Ondarroa harbor breakwater.”

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Fundación Agustín de Betancourt

The Agustín de Betancourt Foundation (FAB) is a private cultural foundation of permanent character and Spanish nationality, non-profit and with general interest purposes, with its own legal personality and full legal capacity to act.

Research

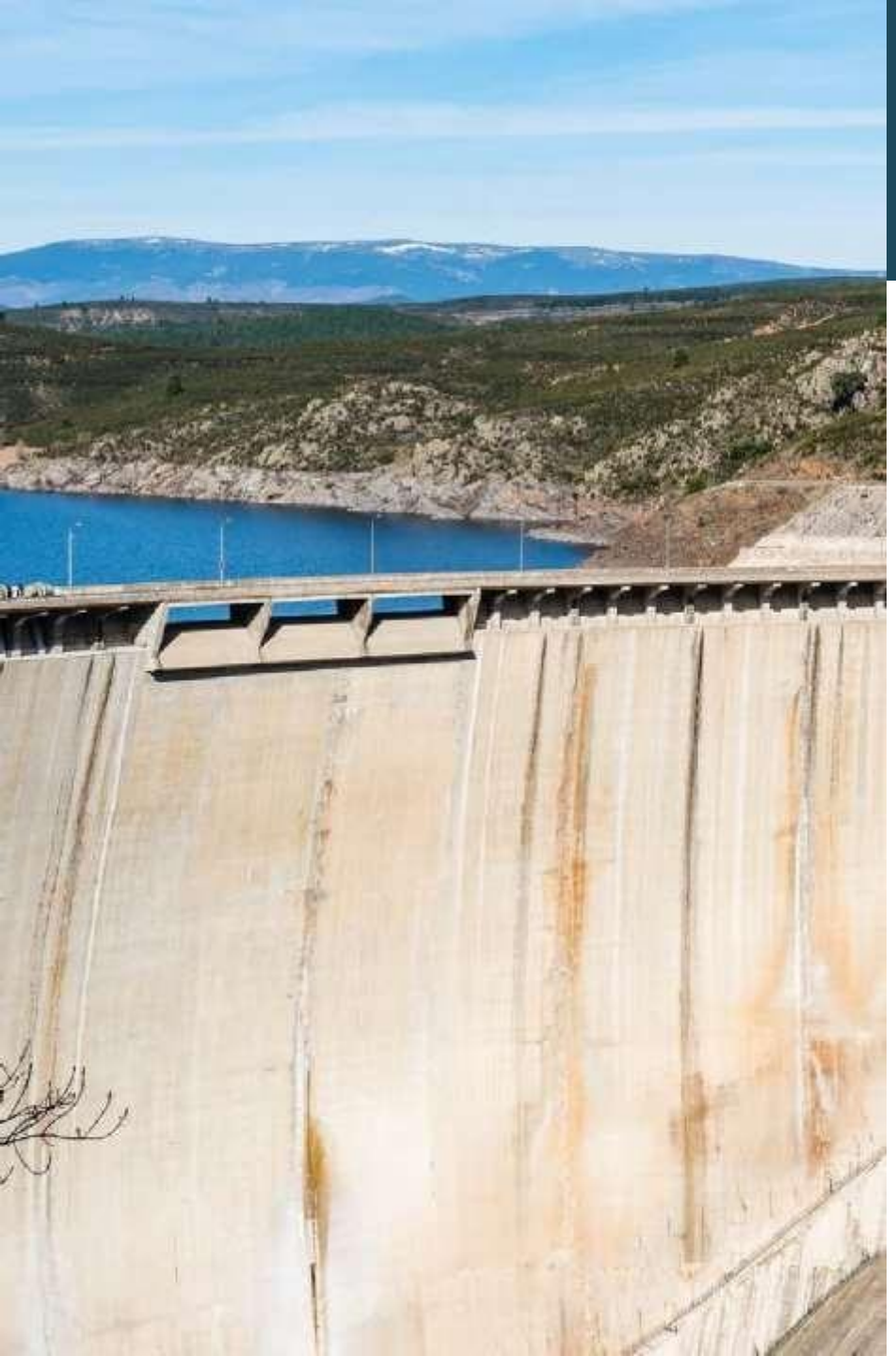
The Foundation carries out, subsidies and manages research projects, always directed bya professor of the E.T.S. de Ingenieros de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid who, with the degree of Doctor, has full research capacity.

Training

The Foundation collaborates in the training of students and professionals through the organization of Specialization, Postgraduate and Continuing Education Courses, also awarding different scholarships and grants.

University – Society – Civil engineering

The Foundation acts as a point of connection between Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid with Society and the Civil Engineering Sector, through the development of its activities and the dissemination of research, development and innovation in the sector.



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Fundación Agustín de Betancourt

After more than forty years of existence, the Foundation represents a prestigious technological reference that promotes the presence of the E.T.S. de Ingenieros de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid in the world of scientific and technical research, being a safe "partner" in the field of R+D+i. In this aspect, the Foundation collaborates with the most important companies in the construction and civil engineering sector and participates as a partner in important European projects of the Horizon 2020 Program and in other projects of national calls.

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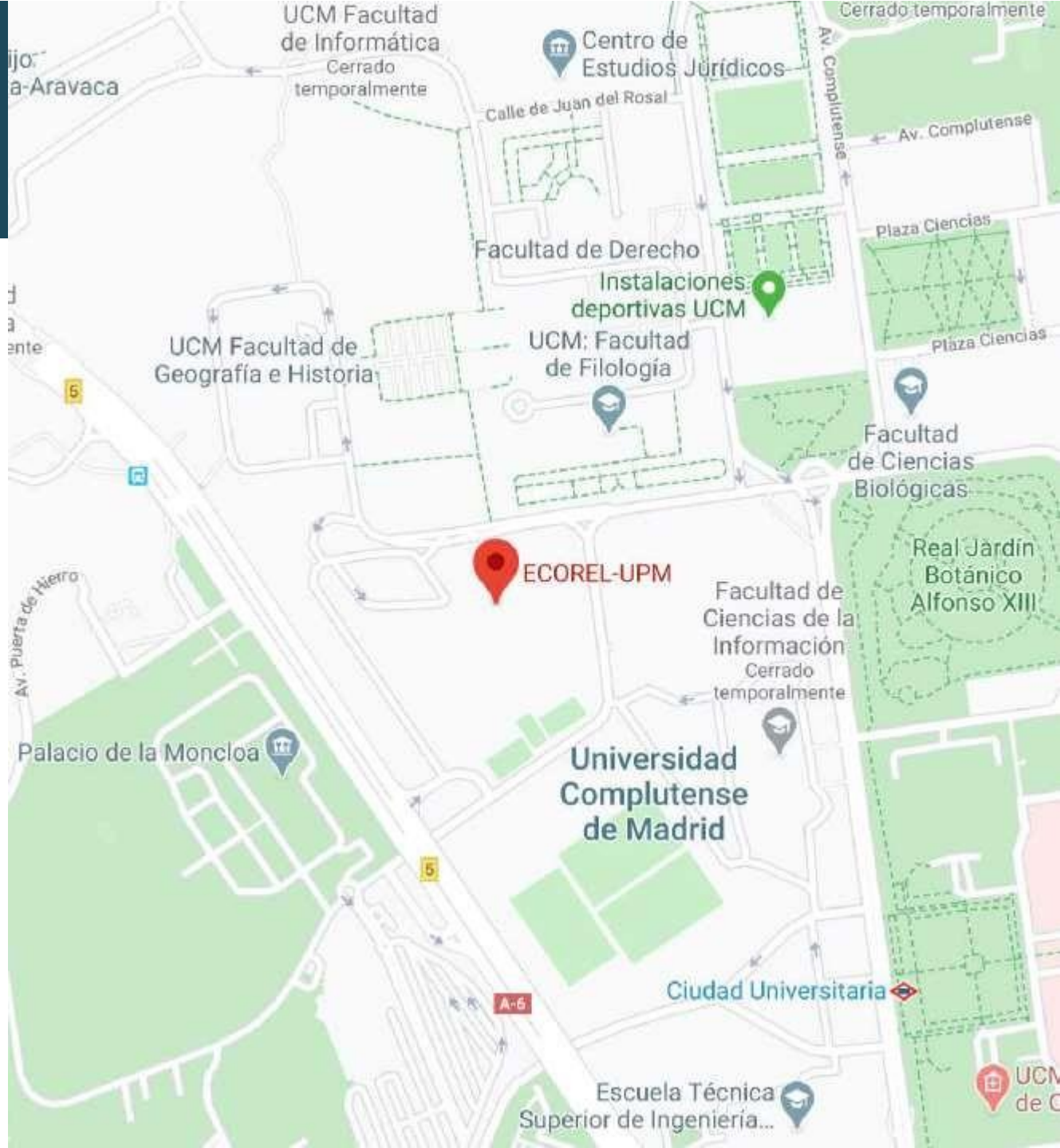


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