A-CITEEC

Agrupación estratéxica
Centro de Innovación Tecnolóxica
en Edificación e Enxeñería Civil

SERVICE CATALOGUE

XUNTA DE GALICIA

UNIVERSIDADE DA CORUÑA

Agrupación Extratéxica CITEEC

About us

The Strategic Research Group of the Centre for Technological Innovation in Building and Civil Engineering (A-CITEEC in Galician) is an initiative of aggregation of research groups from the University of A Coruña with the aim of improving and intensifying the research and knowledge transfer within the scope of the sustainable civil engineering and building, thus encouraging people's welfare, the economic development, and the optimization of ecosystem services.

Technological offering

Development of projects of both innovation and basic and applied research focused on solving complex or singular problems.

Technological and strategic advice within the scope of civil engineering and building according to companies and institutions' needs.

Ways of collaboration

- Collaborative concurrence as partners in projects and tenders.
- The hiring of activities under the protection of both the Article 83 of the Spanish Organic Law of Universities and the Statutes in force of the University of A Coruña.

Prioridades científicas

Preserving the environment by promoting the adaptation to both climate and global change.

Encouraging sustainable management of water resources, urban water systems and circular economy.

Promoting sustainable mobility through the integration of coastal infrastructures, such as ports and transport networks, into efficient systems.

Designing, developing and monitoring innovative, safe, durable and sustainable materials, processes and constructions.

Reliable structural design on civil, aeronautical and wind engineering.

Designing efficient buildings and infrastructures.

Numerical simulation of engineering problems related to the innovative and the sustainable management of natural resources, and to the promotion and improvement of industrial competitiveness, the knowledge economy and the quality of life.

Research groups

This catalogue presents the research areas and the technological offering of each of the groups that comprise A-CITEEC. These groups have their own organisational structure and are the natural interlocutors since they know their capabilities for the development of technological solutions and advice to companies and institutions.

Water and Environmental Engineering Group (GEAMA)

Group of Numerical Methods in Engineering (GMNI)

Construction Group (gCons)

Architectural Structures Research Group (GEA)

Structural Mechanics Group (GME)

Research Group of Roads, Geotechnics and Materials (CGM)

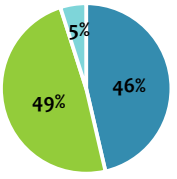
Group of Railways and Transportation Engineering (GFT)

Project Engineering and Management Group (GRIDP)

Advanced Visualization and Cartography Group (VAC)

The figures of the Strategic Research Group

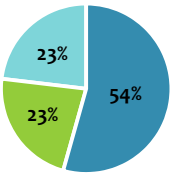
- Financing obtained by research projects, agreements and contracts with companies. Data: 2019



TOTAL: 5,0 million euros (M€)

- Agreements/contracts: 2,3 M€
- National projects: 2,4 M€
- European projects: 0,3 M€

- A-CITEEC staff:



TOTAL: 160 members

- Senior researchers: 87
- Junior researchers: 36
- Technical and administrative staff: 37

Water and Environmental Engineering Group. GEAMA

About us

The GEAMA research group focuses its activity on the dissemination of knowledge, the encouragement of research, and the advisory for companies and institutions on the study field of the natural and urban cycle of water. The group includes complementary disciplines and capacities in Water Engineering to address problems from a multidisciplinary perspective.

Research areas

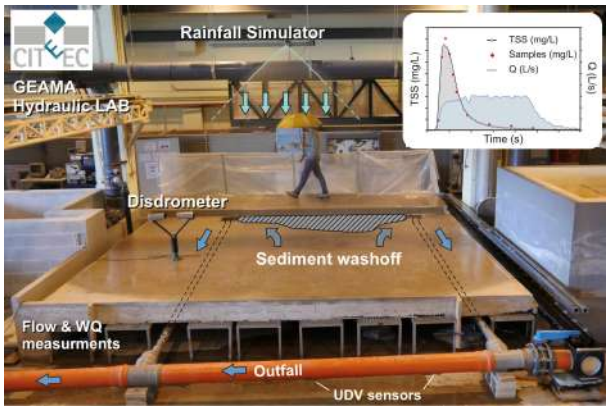
- HYDRAULIC ENGINEERING
- SANITARY AND ENVIRONMENTAL ENGINEERING
- MARINE AND PORT ENGINEERING
- HYDROGEOLOGY AND APPLIED GEOLOGY

Hydraulic engineering

The lines of work related to this hydraulic engineering area are mainly focused on the evaluation of water resources and the management of surface continental waters, both at a hydrographic basin scale and in the urban scope:

- **Evaluation and management of flood risk**
  - Development of methodologies to evaluate, forecast, and manage floods and the risk related to river floods.
  - Early warning systems against the flood risk.
  - Development of experimental and numerical, hydrologic and hydraulic models to evaluate flood zones (**www.iberaula.es**).

- **Integral management of water resources**
  - Development of methodologies to characterize droughts at a regional and hydrographic basin level.
  - Evaluation of the effects of climate change on floods and droughts.
  - Planning and integral management of water resources at a hydrographic basin level.
- **Urban hydrology**
  - Numerical and experimental analysis of hydrological and hydraulic processes in the urban environment.
  - Integrated urban water modelling, including adjustment of surface flows, the network and the receiving environment.
  - Nature-based solutions for urban water management.



Scientific platform for Urban Hydrology Tests of the CITEEC

Sanitary and environmental engineering

This area is focused on understanding and improving water urban systems and their relation to the territory, with a systemic, integrating and sustainable vision. It is an approach towards a multidisciplinary research referred to wholeness, in which techno-scientific issues are increased (physical, biological, social, cultural, and economic environment).

The research-innovation methodologies and procedures developed are highly conscious of the fact that several tools (pilot plants, laboratory tests, numerical modelling, working field with characterization and intensive instrumentation, etc.) are not goals themselves, but are subject to the ultimate goal: the knowledge and understanding of environmental phenomena to give actual solutions to the problems or challenges presented. This approach gives the works addressed a pragmatic character regarding the ultimate usefulness of the results obtained.

Six research lines are presented below, in which specific works or projects are developed:

- **Integral management of the pollution in sanitation and drainage systems in rainy weather**

The need for minimizing human pressures and impacts on water bodies forces to review and analyse the idea of new urban sanitation and drainage systems as well as the operation of the existing ones according to their role and behaviour both in dry and rainy weather. Combined systems overflows (CSO) in rainy weather and the consideration of polluted runoffs as wastewaters from rivers forces to develop new strategies and ways to plan, project and exploit water urban systems.

- **Water sensitive urban design (WSUD)**

The WSUD represents a new paradigm in the planning and design of the urban development to minimize the impacts on the natural water cycle. Resilience, sustainability and the application of solutions based on nature are pursued to improve citizens' life quality, the preservation and improvement of the natural environment, and the adaptation to climate change.

- **Sustainable urban drainage systems (SUDS)**

SUDS are a great ally of the WSUD. SUDS are constituted by a set of management techniques and strategies of rain waters and are based on the simulation of the natural hydrologic cycle in both urban environment and natural treatment processes. These systems are designed to maximize the possible opportunities and benefits obtained from the management of the rain water, such as leisure, health or biodiversity opportunities.

- **Urban wastewater treatment**

The area is specialized in the innovation and research on biofilm reactors, having a great expertise on the design, exploitation, and modelling of these reactors. Studies are also conducted to design, exploit, and control natural treatment systems based on artificial wetlands.

- **Analysis of pressures on continental water bodies due to discharges of wastewaters**

Knowing and understanding the response of physicochemical and faecal contamination quality indicators of a water body receiving a waste discharge requires the use of numerical simulation models of the water quality. These models should be complex according to the typology of the aquatic environment, the impacts to be studied, and the spatial and temporary scopes.

- **Water in the rural environment**

This area has collaborated, and still does, in the development of both Sanitation Guidelines in the Rural Environment in Galicia and Technical Instructions for Hydraulic works in Galicia (ITOHG in Spanish). The Technical Instructions for Hydraulic works in Galicia for Water Purification Plants (ITOHG-EDAR in Spanish), focused on the sanitation, particularly in the rural environment, are today being developed.

Marine and port engineering

The field of marine and port engineering of the GEAMA combines experience in applied research projects with advisory projects for companies and institutions. The fundamental work areas are the physical modelling, field campaigns, and the development of numerical modelling projects in coastal environments. The research lines are:

Design and optimization of coastal protection structures

Performance of works encompassing the analysis of structural stability and optimization of designs of mound breakwaters, breakwaters with vertical faces, and anti-reflective caissons. Floating structures are also analysed to ensure optimal operation conditions. In addition, submerged anti-wave diaphragm walls were designed by focusing on the relationship between porosity, transmitted waves, and the efforts in piles.

Basin of the Laboratory of Ports and Coasts of the CITEEC. Surface area: 1000 m²

Development of management systems and decision-makings in the port operation

Study of the performance of loading and unloading operations, such as the dynamic behaviour of the ship berthed. The essential tool for this study is the in-situ monitoring of the ship berthed, including the use of load cells. These measures are complemented by an integrated system which evaluates the six degrees of freedom of a ship. These works are not just focused on the "Ship-Mooring system" scope.

All this information is combined with climate forcing data to develop and calibrate transfer functions which can be used as a tool to predict the ship behaviour. This tool is very useful to create port management applications.

Modelling and field campaigns in port facilities

Application of 2D and 3D numerical models of coastal dynamics. The lines of work include wave propagation, the determination of related phenomena such as tidal streams and estuaries, and the application of port agitation models. Furthermore, the interaction "Wave-Structure" is studied with CFD fluid dynamic models (IHFOAM) and Lagrangian models of smoothed hydrodynamics SPH particles (DualSPHysics).

Loading and unloading operations in the Puerto Exterior in Punta Langosteira (A Coruña)

Hydrogeology and Applied Geology

The activity is developed in the field of natural waters and environment, as well as in various aspects of the applied geology and the geological engineering. The research lines are:

Hydrology and hydrogeology

Studies to estimate water balances by evaluating the various hydrologic components to be used in mining restoration, exploitations of natural stones and mine management.

Integral studies are also developed to use water resources in various areas, as well as studies related to the hydraulic of floods related to extreme hydrologic events.

- Use and exploitation of groundwaters
- Characterization and hydrogeological studies
- Salt-water intrusion
- Hydrologic planning
- Combined use of surface and ground waters
- Limnology of lakes and reservoirs

Quality of natural waters

Characterization of groundwaters from rubbish tips by using passive treatments, and studies of the hydrochemical quality of springs.

Mining restoration

Studies on the environmental impact and restoration plans of various open-air exploitations, and evaluations of possible hydrologic zones feasible for the deposition of the mining waste generated in slate exploitations.

Hydrothermalism and geothermal energy

Catchment, use of thermal, mineral and spa waters, and evaluation of the protection perimeters related to the respective catchments.

Applied geology

Petrophysical and mechanical characterization of rocks, and valuation of mining waste; evaluation of the thermal, water, mechanical and chemical behaviour of potential rocks for the geological storage of CO_2.

Remotely operated vehicle (ROV) to inspect infrastructures and deep-seabeds

Coordination: Luis Cea Gómez
luis.cea@udc.es
www.geama.org
Grupo de Ingeniería del Agua y del Medio Ambiente

Group of Numerical Methods in Engineering. GMNI

About us

GMNI is specialized in the large-scale and on-demand numerical simulation to solve multidisciplinary coupled problems related to engineering and applied science.

GMNI general research lines are part of what is called today Computational Engineering, i.e., the approach of problems to calculate, optimize or identify parameters in multidisciplinary engineering (Civil and Environmental, Mechanics, Electrical, Aeronautical, Biomedical, etc.) through formulations of Computational Mechanics, such as finite elements methods (FEM), boundary elements methods (BEM), finite volume methods (FVM), and more recently, the isogeometric analysis (IGA). The resulting models are solved by Numerical Methods, thus being necessary to implement them in conventional or high-performance computers, depending on the size of the problem.

For each specific problem, our action includes: the identification of physical phenomena and the processes involved; the formulation of the physical-mathematical model and its discretization; the programming of the resulting numerical formulation; the development or adaptation of modelling and visualisation tools; the calibration of parameters; the performance of simulation in our servers (or the delivery of the application, where appropriate); and the interpretation and assessment of results. In general, new-generation numerical methods and an own-developed software are used.

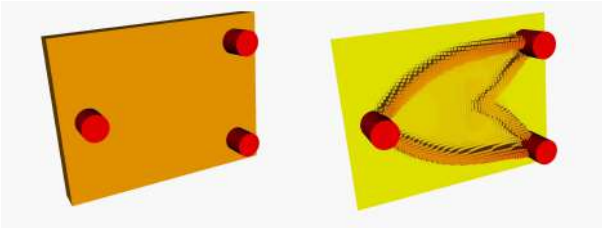
Research areas

- SOLID MECHANICS – STRUCTURE OPTIMIZATION
- FLUID MECHANICS (CFD) – TURBOMACHINERY DESIGN
- CONTROL OF SALINITY, TEMPERATURE, WASTE, AND SPECIES IN THE MARINE ENVIRONMENT
- ENERGY TRANSPORT AND GENERATION
- RATIONAL CALCULATION OF FLEXIBLE PAVEMENTS
- BIOMEDICAL ENGINEERING – SPECIFIC MODELS FOR THE PATIENT

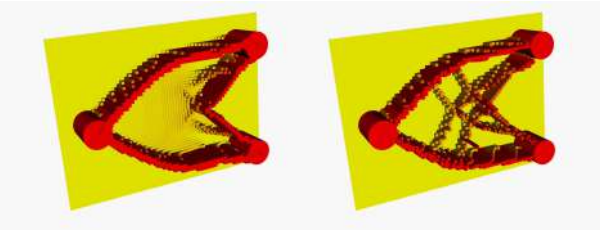
Solid mechanics - structure optimization

GMNI has general-purpose programmes for the numerical resolution of solid mechanics problems through matrix approaches for discrete structures, and FEM and IGA for continuous structures. As it is an own-developed software, it is possible to introduce the modifications required to adapt the calculations to the specifications of each case. Each calculation programme has a respective higher-order sensitivity analysis (analytically accurate), thus obtaining the variations of the results accurately by modifying data without recalculating the whole problem.

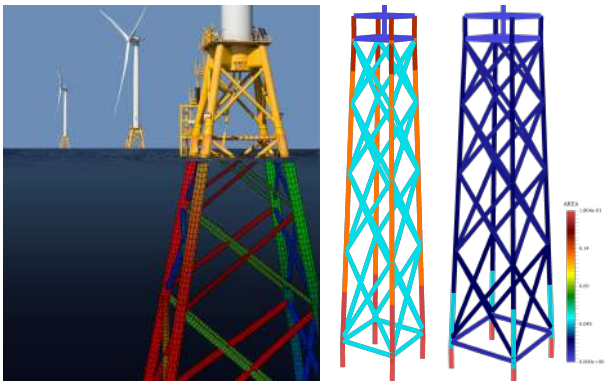
The group has also own-developed programmes for the numerical resolution of optimization problems with general limitations. The combination of the previous tools raises and solves problems related to the parameter estimation, the optimization of dimensions and forms, and the topological optimization of any kind of structures. The most recent research lines of this area are the optimization of jacket structures for offshore wind power farms and the topological optimization of mechanical pieces.



Topological optimization of a mechanical piece (1)



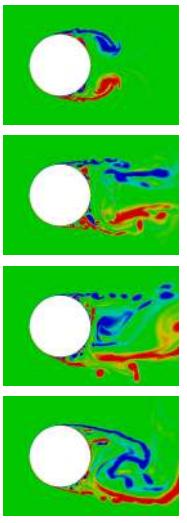
Topological optimization of a mechanical piece (2)

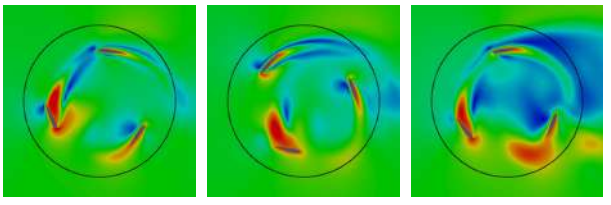


Optimization of jacket structures for offshore wind power farms

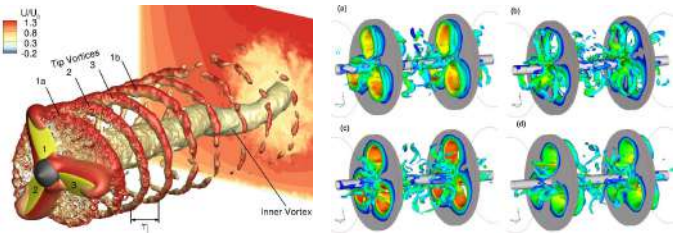
Fluid Mechanics (CFD) – turbomachinery design

GMNI has programmes for the numerical resolution of fluid mechanics (CFD) problems through FVM and FEM. As it is an own-developed software, it is possible to adapt the calculations to the specifications of each case. The most recent research lines in this area are, among others, the simulation of turbulent flows, the detection of shock waves in compressible flow, the analysis of the cavitation in aerodynamic and hydrodynamic profiles, the design and analysis of turbomachinery, the transonic flow, the optimization of aerodynamic and hydrodynamic profiles, and the approach of purely hyperbolic convection-diffusion problems (which allows wavefronts to be detected). The group has also developed methods without mesh which effectively deal with certain complex free surface problems, including the fluid mixture and filling of moulds.





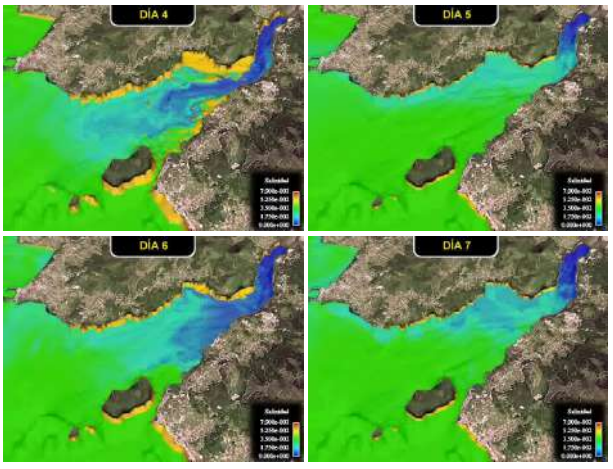
Turbulent flow around the blades of a vertical turbine



Horizontal marine turbine to generate energy and dynamics of an oscillatory bioreactor with three holes for biofuel production

Control of salinity, temperature, waste, and species in the marine environment

The approach of coupled problems in fluid mechanics allows to solve simultaneously the hydrodynamic flow and the propagation in the marine environment of salt, heat, pollutants, solids in suspension, and biological species. Models could be extraordinarily large. The images show the evolution of the salinity in the zone of Lombos del Ulla, in the Ria de Arousa. In this simulation, a model of the whole estuary was used as it considered the contribution of fresh water of the river, the tidal wave, wind, and the possible storm occurrence. Thanks to this study, the dredging of the zone, which would have cost tens of millions of euros and would have caused an environmental and economic disaster without precedent by drastically decreasing the salinity level (necessary for the proliferation of shellfish), was not considered. Nowadays, it is possible to model large coastal zones, thus monitoring the propagation of waste.

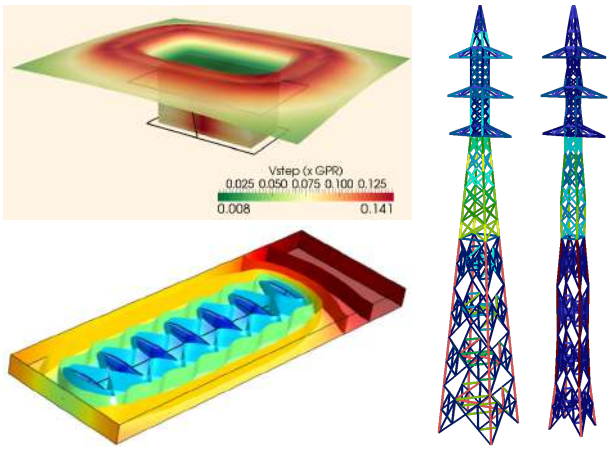


Hydrodynamics and evolution of the salinity in the Lombos del Ulla (Ria de Arousa)

Energy transport and generation

Among the applications developed by GMNI in this area, there are several software packages for the computer-aided design, the calculation and optimization of high-tension towers, as well as for the computer-aided design and the calculation of grounding networks for electrical substations (the TOTBEM programme, based on the BEM). This programme calculates the equivalent resistance of the earthing system, the distribution of surface potentials during a discharge, and the potential transferred to large distances through buried conductors.

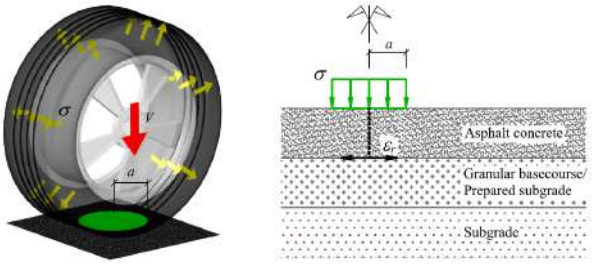
The most active lines today are the extraction of hydrocarbons through non-conventional methods and the exploitation of middle-deep geothermal energy.



Surface passing potential originated by the ground of a buried substation, pressure in a fracked shale gas well, and optimization of a high-tension tower

Rational calculation of flexible pavements

As occurs in most countries in the world, the procedure established for the fatigue analysis of flexible pavements in the Spanish standard 6.1-IC is mainly an adaptation of the original included in the North American standard AASHTO, by which the section of the pavement is fatigue designed. The number of cycles resisted by the material is determined by a fatigue law based on the horizontal deformation produced in the deepest asphalt layer when a standardized axis passes over. However, none of the actual standards considers the dynamic effects by the deterioration of the longitudinal roughness profile of the road. GMNI has programmes which calculate the structural behaviour of the pavement, simulate the degradation of the running surface, and quantify the reduction of the useful life of the section due to the increase of the dynamic loads exerted by vehicles as the time passes. The group has recently developed a simplified application (DMSA) commissioned by the European Investment Bank (EIB) both to measure the section of the pavement by considering these effects and to analyse the duration of its useful life according to the maintenance programme and the conservation operations performed.

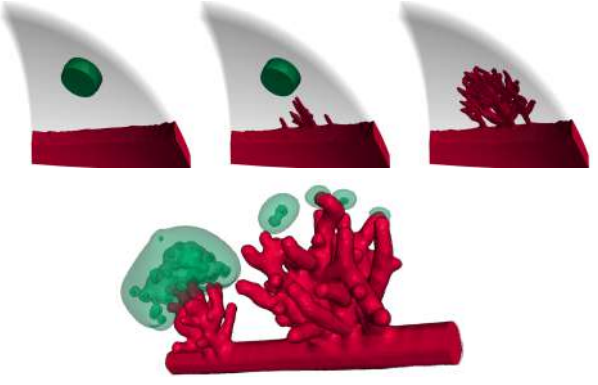


Fatigue analysis of flexible pavements by considering dynamic effects of raceway

Biomedical Engineering – specific models for the patient

The Biomedical Engineering is a new field based on the application of procedures from engineering, particularly the methods from the Computational Engineering, to solve the problems related to the treatment and curing of illnesses. The development of specific models for the patient is a recent paradigm which supports the study of each case by considering the characteristics of the patient and their diseases with the aim of designing always the best possible treatment, whether surgical, pharmacological, radiological or any other type of treatment. GMNI has Cardiovascular Engineering models which analyse the circulatory system function to identify the ideal place to perform a bypass or to predict the evolution of an aneurysm, among others.

More recently, models simulating the angiogenesis and considering its effect on the prediction of a tumour's growth have been developed.



Angiogenesis simulation and tumours' growth

Coordination: Fermín Luis Navarrina Martínez
fermin.navarrina@udc.es
http://caminos.udc.es/gmni

Construction Group. gCons

About us

The research group gCons researches, disseminates, and transfers knowledge about the broad field of the construction engineering. Its activities are significantly based on experimentation thanks to the laboratories at the School of Civil Engineers and the CITEEC.

Research areas

- TECHNOLOGY OF MATERIALS AND STRUCTURES
- USE AND MANAGEMENT OF WASTES AND THEIR RECYCLING AS CONSTRUCTION MATERIALS
- BOND AND ANCHORAGE
- STRUCTURE PATHOLOGY, REPAIR AND REINFORCEMENT
- DEVELOPMENT AND APPLICATION OF NEW MATERIALS
- LARGE-SCALE TESTS TO CHARACTERIZE THE PERFORMANCE OF STRUCTURES
- APPLICATION OF TECHNIQUES BASED ON ARTIFICIAL INTELLIGENCE IN ENGINEERING AND BUILDING
- TEST INSTRUMENTATION AND TECHNIQUES IN ENGINEERING AND BUILDING
- THERMAL AND ACOUSTIC CONDITIONING IN BUILDING

Technology of materials and structures

The research group gCons is specialized in the study of concrete, particularly its rheological behaviour in fresh state (Horreo and InHormes projects), the repercussion of adding natural or synthetic fibres, and the influence of the internal curing in concrete (Haccuracem project).

Characterization of fresh concrete

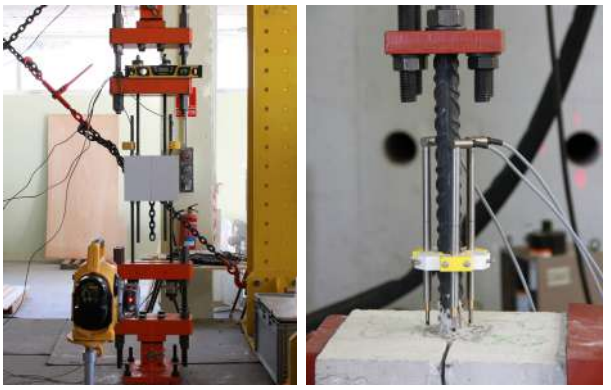
Use and management of wastes and their recycling as construction materials: Sustainable Construction

The research group gCons, together with many companies, has been leading several national and autonomous projects since 2000. These projects are focused on the study of recycled aggregates to produce concrete (Dihapo, Recnhor, Cleam, Gear, and Tecnoval projects, among others). Based on these works, the incorporation of other urban or industrial wastes is studied under the framework of Sustainable Construction. Among the cases addressed are the recycling of bivalve shells (Biovalvo project), ashes and slags (Cenicienta project), and fillers of several industries (Alfiller and Pantera projects, among others).

Biovalvo module built with recycled mussel shell

Bond and anchorage

This line was started when gCons was created (Zancla and Adhan projects) and is focused both on the development of tests and standards (e.g., tests of anchorage length of pretensioned reinforcement or tests to reproduce the splicing of passive reinforcement) and on the solution of problems in singular construction structures. This line includes the works for the underground in Quito and the concrete wind towers in Chile.



Reinforcement lap and bar anchorage tests

Structure pathology, repair and reinforcement

This line is addressed in a multidisciplinary way, including physical-chemical degradation processes, repair and reinforcement materials, and reinforcement techniques. Some of the cases studied are the pier of the Rande bridge, the biological deterioration of the EDAR Bens sewage plant, and the repair of Pedra de Abalar, in Muxía, with resins and carbon fibres. Today a design project of concrete structures with non-metal active and passive reinforcement is developed (Straduravius project).

Development and application of new materials

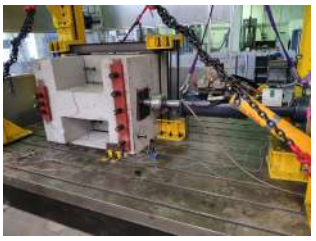
- **Application of composite materials in engineering and building structures**

The research group gCons is strongly specialised in this line, which is particularly focused on the repair of structures and the development of new building types. The project aimed to reduce cracks in potable water warehouses (Afidhavit project) and the project to develop new containment structures for docks, which was executed in a dock located in the port of Vilanova de Arousa (Pilam project) are here stressed.

Wharf executed with the sheet-piling technique® and tensile reinforcement test with a fibre glass sheet

- **Development of new materials and new structures**

The increasing competitiveness of the sector, together with the need for internationalizing the market, has allowed gCons to collaborate in the design and construction of new building solutions. Among these solutions are, for example, the reinforcement of structures with shape memory materials (Horvital project), the development of lightweight and big prefabricated building structures (Pretabico project), the study and construction of elements of concrete domestic and urban furniture (Decocem project), the design of elements of railway infrastructure (DF project), the development of concrete docks and floating pontoons (Floating Concrete project), and the research on foundations of wind towers in arctic climates (Artech project).




Design of new foundations


Furniture design with concrete, and prefabricated dwelling with lightweight concrete

Large-scale tests to characterize the performance of structures

Two well-equipped laboratories are available for gCons: the Construction Engineering Laboratory at the School of Civil Engineers which is very focused on the technology of materials, and the Construction Laboratory at the CITEEC in which large structures can be tested thanks to its reaction wall (10 m height) and its loading slab. Large-scale structures are tested: beams of 2 m height to study the effect of the size on the shear (Horvital project, a European record in its line), beams of 10 m prestressed to study the length of active prestressed reinforcement, utility tunnels of 2 x 2 x 2 m^3, graphite cylinders of 0.5 m diameter used as electrodes in the silicon sector, etc.


Tests of graphite electrodes and prestressed reinforcement anchorage

Shear test of a concrete beam of 2 m height (European Record)

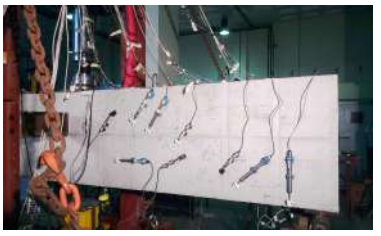

Fatigue tests of prestressed systems and tests of support devices of confined neoprene (High capacity press MTS-15MN)

Application of techniques based on artificial intelligence in engineering and building

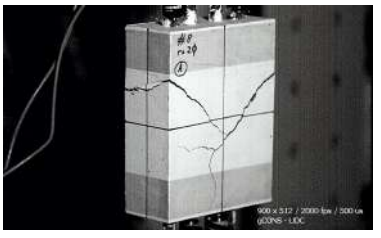
Excellent test databases are available in many fields in construction. Databases are a source of knowledge which increase year on year thanks to, among others, the tests developed by gCons. Artificial intelligence (AI) techniques (mainly neural networks and genetic programming) are successfully used to obtain new knowledge from such tests, even with the possibility of adjusting algebraic expressions capable of predicting the performance of materials and structures. Some of the cases studied with these techniques are the bond between concrete and steel (Adhan project), the shear in concrete beams with or without reinforcement, the resistance of concrete based on its composition (Metefores project), and the durability of dams (Gestdam project).

Test instrumentation and techniques in engineering and building

The work in two singular laboratories requires specific instrumentation techniques. The research group gCons is specialized in instrumentation and measure equipment, even developing their own systems patented, including those based on digital image correlation techniques (DIC, Vadema project), those used in long-term tests of expansive concrete (Dama project), and the rheometer designed and built to determine the rheological parameters of concrete (Horreo project).

Instrumentation in large laboratory or in-situ tests

Development of an own rheometer and instrumentation by using DIC techniques

Thermal and acoustic conditioning in building

Sustainable construction is also included in the construction of buildings with as less energy consumption as possible. The research group gCons develops studies to assess the insulating capacity of several materials and building solutions (*Caja-Caliente* Hot-Box project).

Hot-Box: Measurement of the thermal properties of materials and elements

Coordination: Fernando Martínez Abella
fernando.martinez.abella@udc.es
http://www.gcons.udc.es/

Architectural Structures Research Group. GEA

About us

The GEA research group focuses its activities on knowledge dissemination, research, and consultancy for companies, institutions, and professionals in the general scope of building structures, both in relation to the intervention in existing structures and in new building projects.

Research areas

- **SINGULAR STRUCTURES**
- **WOODEN STRUCTURES**
- **HISTORICAL STRUCTURES**
- **STRUCTURE PATHOLOGIES**

Singular structures

Generic scope focused on the development of slight modular and quick-mounting roof structures. The work developed in unfolded structures is particularly significant within this group.

- Analysis of different topologies.
- Geometric incompatibilities during folding/unfolding phases.
- Design of nodes.
- Numerical analysis of the structural behaviour.
- Experimental analysis.
- Building development.

Design of systems for unfolded structures

Unfolded and modular emergency constructions

Compact module of porticoed structures

Wooden structures

The research in the scope of wooden structures mainly includes three lines of work, in which all the aspects related to the design, the numerical and experimental analysis, and the development of building solutions have been addressed.

- Spatial meshes of stackable modules.
- Glued joints of wooden threaded rods.
- High-performance mixed slabs Glulam+CLT and Glulam+Concrete.

Spatial meshes constituted by hollow bars of laminated wood

Systems to improve the anchor of steel bars glued to wood

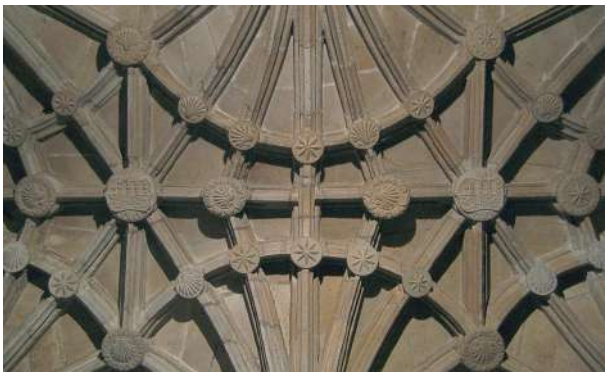
Connectors of composite section Glulam-Concrete and Glulam+CLT

High-performance wooden slabs

Historical structures

Within the historical structures, the research includes two important lines of work. On the one hand, an extensive study of the orientations of medieval churches. On the other hand, all the aspects related to the structural analysis and the pathology of this type of buildings, under the protection of agreements and collaborations with institutions.

Study of the orientations of medieval churches



Identification, measurement, and cataloguing of ribbed stone vaults

Analysis of the structural problems of historical buildings

Rehabilitation of structural systems in historical buildings

Structure pathologies

This scope includes the analysis of the structural pathology, rehabilitation and restoration of damaged structures and their reinforcement. Like historical structures, this working scope is linked to collaborations with companies, institutions, and professionals.

The Comprobar® software developed to check structures is also stressed within this scope.

Studies of applied structural pathology

Applied research on assessment and structural reinforcement protocols

Technological offer

According to the lines of work detailed, the group's technological offer includes:

- Building structure projects.
- Singular structure projects.
- Structural pathology reports.
- Structure rehabilitation and restoration.
- Structure calculation applications.
- Transfer of the many patents developed within the scope of singular structures and wooden structures.

Coordination: Javier Estévez Cimadevila
javier.estevez@udc.es
http://gea.udc.es

grupo estructuras arquitectónicas

Structural Mechanics Group. GME

About us

GME focuses its activity on the teaching, research, and the practical application of scientific advances within the field of structure engineering. It has a wide experience in aerodynamics and aeroelasticity studies, non-lineal structural analysis, seismic actions, structure pathologies, and optimal design in engineering.

Research areas

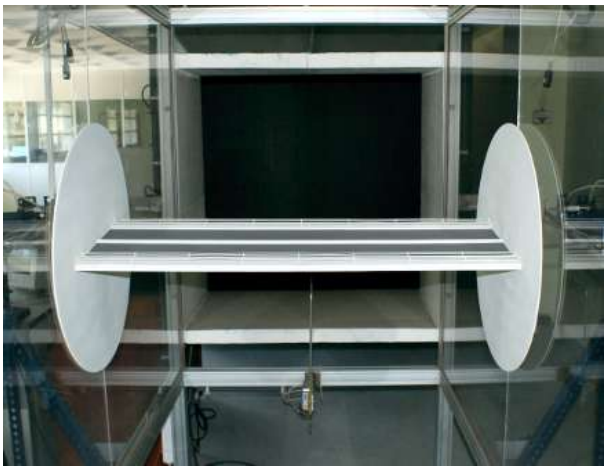
- AERODYNAMICS AND AEROELASTICITY
- SEISMIC ANALYSIS
- GEOMETRIC AND MATERIAL NON-LINEARITY
- STRUCTURE OPTIMIZATION

Aerodynamics and aeroelasticity

This area studies the movements and efforts in structures under the wind action. Among the most studied structures by GME are the long-span bridge decks and the fuselage of aircrafts.

Wind generates important efforts in the long-span bridge decks, such as suspended or suspension bridges in which the distance among bearings is wide enough to consider this action in the design phase. The goal of this discipline is the search for more effective and reliable designs, which implies the consideration of form variables in the section of the deck, which is one of the essential elements of the bridge. This affects its aerodynamics, as well as its mechanical properties, and in turn the aeroelastic response of the bridge.

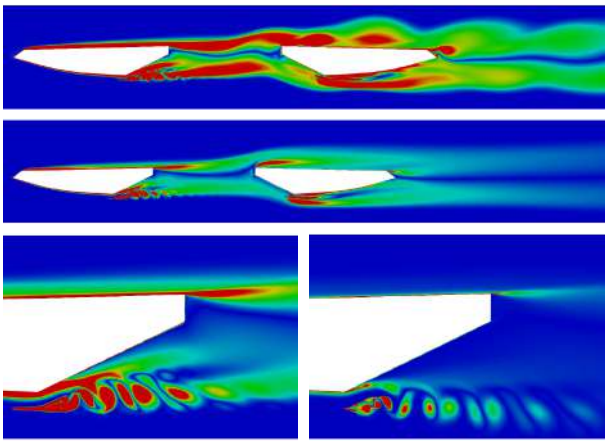
Over the last decades, the most usual practice to obtain the aerodynamic and aeroelastic response of a structure under the wind action is the performance of scale tests in a wind tunnel. To do this, GME has an aerodynamic wind tunnel and a boundary layer wind tunnel in the facilities of the CITEEC.



Aeroelastic test on a section of a bridge deck

Nonetheless, the recent advances in the capacity and power of computer resources allows the analysis through numerical applications. For this reason, what is today usual is the use of numerical procedures to optimize both long-span bridges and fuselage structures of aircrafts, considering variations in the structure and including design conditions related to structural and aeroelastic responses.

These models facilitate the visualisation of the aeroelastic and aerodynamic response, thus identifying structures in the flow and interpreting phenomena taking place around the geometries analysed.



Vorticity maps in sections of long-span multibox bridges simulated with CFD

Seismic analysis

This area studies the behaviour of engineered structures against seismic actions, particularly their optimization and reliability. The studies performed are:

- **The wind turbines' behaviour against seismic actions**

The study of the behaviour of prestressed concrete aerogenerator towers against seismic actions in pre-assembly and assembly stages.

- **Dam seismic analysis**

The aim of these studies is the structural security in dams against sliding or overturning. For this purpose, calculations of the dam-reservoir-foundation interaction are made by considering seismic and thermal loads as well as the hydrostatic thrust.

- **Seismic calculation in linear and non-linear theory in bridges**

Dynamic analysis of bridges against a set of accelerograms corresponding to the earthquake design required, considering non-linear effects in bearings.

Aerodynamic wind tunnel

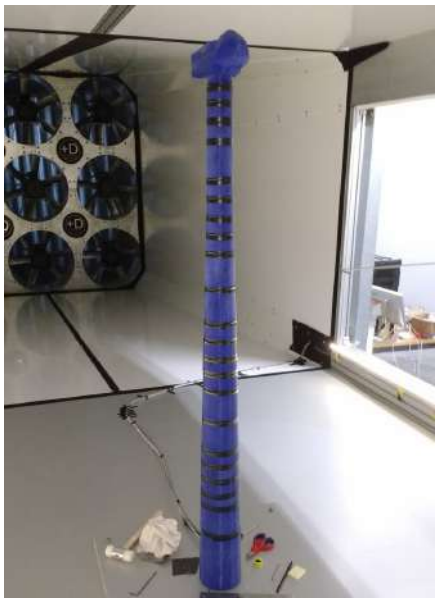
- Dimensions of the test chamber: 1×1 m²
- Maximum test velocity: 30 m/s
- Tests to obtain the following information:
  - Aerodynamic coefficients: C_L, C_D, C_M
  - Flutter functions: A^*_i, H^*_i, P^*_i
  - Vortex shedding behaviour

Geometric and material non-linearity

This area mainly studies the non-linear behaviour of structures. The most studied elements by GME are pillars and tubular and adhesive junctions.

The global model of pillars or bars in linear analysis are usually not enough to determine the tension state of junctions. For this purpose, a local model of these junctions is commonly developed, verifying, in plastic regime, their behaviour.

The procedures followed by these studies firstly considers the geometric definition of the full structure and preliminary data, such as the type of material, transversal sections or design load. Secondly, local models of the junctions are made, and boundary conditions from the global model of the structure are applied to obtain results in each nude analysed.



Test in a boundary layer wind tunnel with vertical junctions of prestressed concrete aerogenerator towers

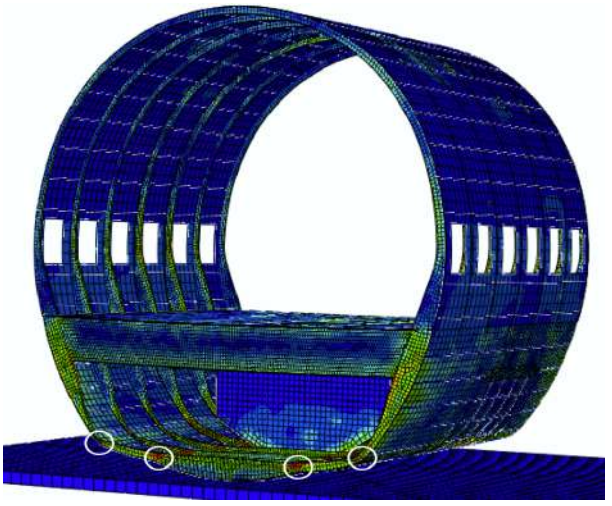
Boundary layer wind tunnel

- **Dimensions of the test chamber: 3×2 m² × 22 m**
- **Maximum test velocity: 25 m/s**
- **Tests to obtain the following information:**
  - Wind profile according to the atmospheric boundary layer
  - Aerodynamic coefficients: C_L, C_D, C_M
  - Movements, velocities and accelerations of models
  - Reactions in the base of models

Structure optimization

In this area, GME works in the improvement of aeronautical designs and the structural optimization for the protection against impacts. The works developed by the group aim to study and optimize numerically the response to various parts of the fuselage, such as the use of metallic tubes with different fillers as vertical supports in aircrafts. In this case, various configurations in honeycombs of composite materials and foam blocks are studied as reinforcement both to improve the energy absorption and to limit force picks which could damage occupants.

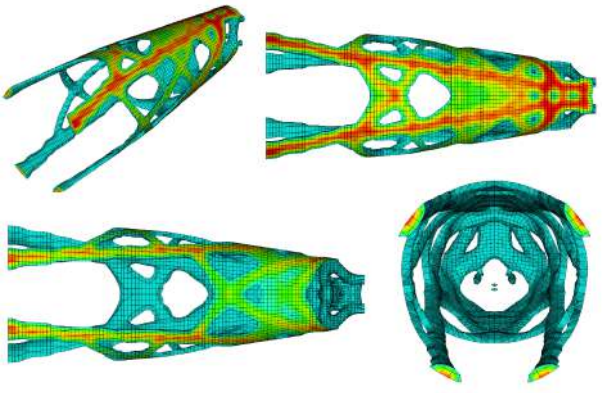
To determine the effects on the materials absorbing the impacts in an aircraft, a vertical impact simulation of a section of the fuselage is commonly developed and adjusted. After including these materials and optimizing their design, a better response of the fuselage is obtained, thus increasing the total energy dissipation and reducing the maximum accelerations and the damage level in passengers significantly.



Map of the deformations of the fuselage structure of a Boeing 737

These works also include the reliability analysis and the optimal design in uncertainty environments with the aim of solving practical aerospace structures problems.

In general, two types of problems are showed, each solved with a different approach. The first problem applies the topological optimization in uncertainty environments to aerospace structures like those usually found in an industrial context, whereas the second problem applies the optical design to aerospace components which require thorough and computationally expensive simulations to predict their behaviour correctly.



Models to optimize the fuselage rear section of a plane

Coordination: Santiago Hernández Ibáñez
santiago.hernandez@udc.es
www.gme.udc.es
MECÁNICA DE ESTRUCTURAS

Research Group of Roads, Geotechnics and Materials. CGM

About us

The CGM research group focuses its activity on the study of materials of road pavements, geotechnics, road safety, and traffic. The research works have been conducted based on experimental and numerical simulation models. To do this, CGM has equipped laboratories to research on materials for pavements and to perform tests with granular materials, bituminous mixes, soil-cement, etc. Also, the group has a wide experience in the use of numerical softwares to conduct geotechnical studies.

Research areas

- ROAD PAVEMENTS
- ROAD SAFETY AND TRAFFIC ENGINEERING
- GEOTECHNICS

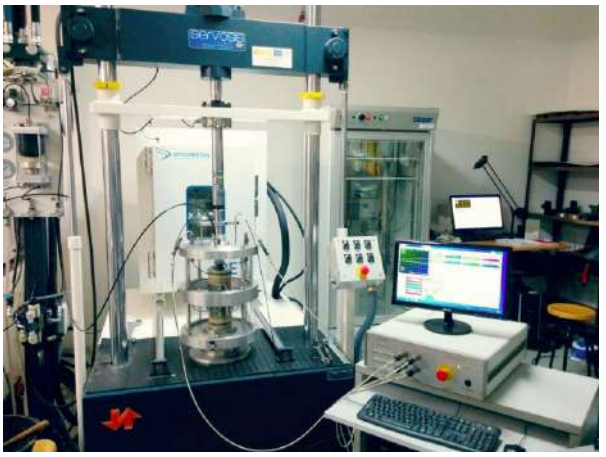
Road pavements

- **Cold bituminous mixes and in-situ recycling of road pavements**

The group studies this type of mixes both with natural aggregate (conventional quarry aggregate) and recycled aggregate from the road grinding (RAP). Particularly, the group is focused on solving the main disadvantages of these technologies, such as the shortening of their maturation period by going more deeply into the knowledge of their mechanical properties.

- **Mild and semi-hot mixes**

These mixes collaborate with the sustainable development by reducing the CO_2 emissions to the atmosphere and other gases responsible for global warming. The goal of this research line is to go more deeply into the knowledge of the dosing and properties of these mixes with high performances but also with lower manufacture temperature.



Dynamic test machine ME-401/10 (Servosis)

- **Reuse of various types of waste and by-products in linear structure works**

The goal of this line is the analysis of the possibility of using waste in the production of various asphalt materials (e.g., cold bituminous mixes, hot bituminous mixes, etc.) and the study of how they affect their behaviour. Some waste are construction and demolition waste, material from the road grinding, powder from used tyres, cork, etc. The goal is to avoid the natural resource depletion, as well as to prevent to take high value materials to rubbish tips, thus contributing to the circular economy and the sustainable development.

- **Bioasphalts**

This line consists in using modifiers or substitutes of asphaltic bitumen and their by-products obtained from biomass or vegetal industrial by-products (e.g., by-product rich in lignin, cellulose, etc.).

- **Use of nanomaterials in bituminous mixes**

To improve the mechanical properties of road pavements, this research line analyses the results of including nanomaterials, such as nanocellulose, nanoclays, nanosilica, etc., in bituminous mixes.

Universal pneumatic servo press NU14 (Cooper)

Gyratory compactors: Superpave Gyratory compactor (Gyrotronic) and Plate compactor. Heated Roller compactor

Static press (Ibertest) and wheel tracking (Hamburg Wheel tracker)

Colloidal mill to produce bituminous emulsions and rotary evaporators

Road safety and traffic engineering

This area comprises the analysis of traffic conditions and the elaboration of appropriate improvement proposals, the development of dynamic systems to manage traffic in motorways and/or the V2X cooperative driving, particularly platooning. In addition, the research is focused on optimising new ways of mobility, such as sharing and MaaS, as well as on several initiatives to improve road safety.

Traffic analysis

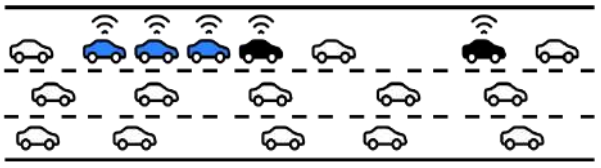
This line comprises the measurement of traffic variables by using sensors located in the infrastructure or vehicle, the processing of these variables to assess the prevailing conditions, the identification of controversial locations, bivariate relationships, capacity drop, etc., as well as the elaboration of the improvement proposals required.

Dynamic systems of traffic management in motorways

Design of techniques for real-time traffic management, operation and control. Approach of strategies both for the optimization of the available capacity (e.g., dynamic speed limits, dynamic lane allocation, and incident management) and for the access control (e.g., travel time information systems, ramp metering, and tolls).

Cooperative driving (V2X systems, platooning)

The research is focused on the design of strategies to manage traffic. These strategies are based on the co-operation among smart vehicles, the infrastructure, and other data sources (e.g., mobile phones). First, mixed driving environments, in which vehicles with a high autonomy degree share road with traditional vehicles, are considered. All strategies aim to optimize the total traffic flow and to reduce the probability of accidents. Also, work is proceeded on the implementation of eco-driving techniques contributing to sustainable mobility, thus reducing consumption and, where appropriate, emissions. This line is focused on platooning, whose huge possibilities have already been showed, such as the increase of the theoretical capacity in lanes. For all this, mathematical models, numeric techniques, and simulation programmes are used.



Platoon in a mixed lane of motorways (COOP project)

Mobility on-demand. Sharing, ride-hailing, and P2P. MaaS

All of them are different ways of emergent transport with huge future perspectives which are focused on encouraging the transformation of "owners" of vehicles into "users" of vehicles. For instance, sharing, ride-hailing, and P2P (peer-to-peer) are different shared vehicle systems which could belong to the fleet of a company or being private. More disruptive, the mobility on-demand and its maximum exponent, MaaS (Mobility as a Service), provide an integrated view of transport in which users, generally through a mobile phone application, indicate their origin and destination points and obtain a real-time and continuous combination of means of transport. This combination includes collective means of transport, taxis, shared vehicles, bicycles, etc., upon users' request. In MaaS, an operator is the only responsible for all managements, including charges, which could also be managed as a flat rate.

Studies on road safety

This line is focused on the detection of accident concentration points (in motorways and roads), the reasons of these accidents, and the definition of possible solutions. For the future, strategies of cooperative driving are studied in accordance with the Vision Zero Accidents. The role of the human factor and the systems to assist the drivers of the vehicles in an accident is analysed.

Geotechnics

Underground tunnels and works

Study of the problems both of tunnels dug through any procedure (e.g., the Belgian method, the Austrian method, a tunnelling machine, etc.) and of any type of underground excavation (enclosures between cut-off walls and underground stations).

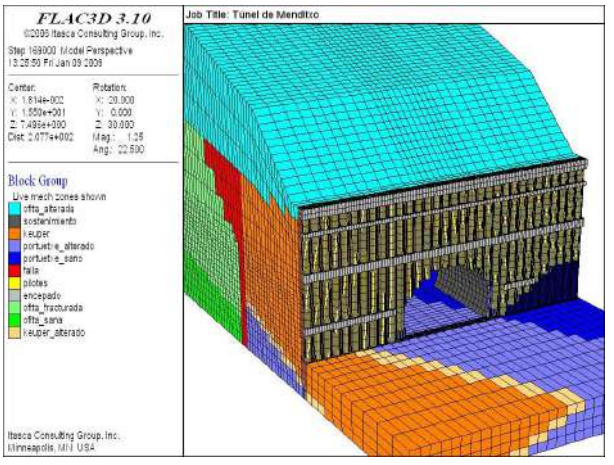
Soil rheological models

Study of the secondary consolidation in bog soils, very usual in port labours.

Numerical modelling of geotechnical problems

Study and analysis of all types of geotechnical works through numerical models: surface and deep foundations, geotextiles, ground treatments, dikes, slope stabilization, etc.

The programmes used are FLAC3D, PLAXIS 3D, GEOSTUDIO, PFC3D, 3DEC, and RIDO.



Modelling with FLAC3D

Dynamic behaviour of soils

- Study of the propagation of waves in the ground and their relation to the stress-strain behaviour of soils.
- Damping of soils.
- Study of vibrations in the ground caused by the railway traffic: surface and underground lines.
- Study of vibration mitigation measures based on the inclusions in the ground.
- Computational models formulated in the time/space domain to study the wave propagation in the ground.

Advanced constitutive models for soils

- Study of the ground behaviour according to the deformational state and its relation to constitutive models of the ground behaviour.
- Application of advanced constitutive models to various geotechnical problems: cut-off walls, railway vibrations, tunnels, foundations, etc.

Coordination: Ignacio Pérez Pérez
iperez@udc.es
sites.google.com/site/grupocgmetsiccpcoruna

Group of Railways and Transportation Engineering. GFT

About us

GFT focuses its activity on the dissemination of knowledge, the boost of research, and advisory for companies and institutions in all fields related to transport and mobility engineering, as well as in aspects related to railway engineering.

Research areas

- URBAN TRANSPORT AND SUSTAINABLE MOBILITY SYSTEMS
- TRANSPORT PLANNING AND MODELLING
- RAILWAY SUPERSTRUCTURE AND DYNAMICS
- GOODS LOGISTICS AND TRANSPORT

Urban transport and sustainable mobility systems

The activities within this area are focused on the following aspects:

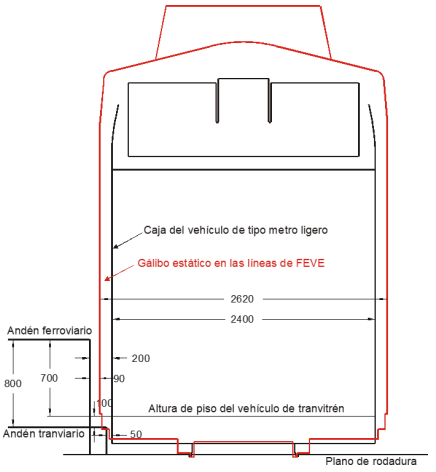
- Performances to achieve sustainable mobility.
- Integration of the metropolitan and interurban transport.
- Technological solutions and security.
- Integration of systems in the urban space.
- Urban transport system operations.

In relation to the previous aspects, the following transports are addressed:

- Conventional bus.
- High-level service bus.
- Slight underground and streetcar.
- Underground.
- Metropolitan railway.
- Tram-train and train-tram.
- Cableway transport.
- Cycle mobility.

Slight underground and tram-train in Alicante. Bogie systems

Slight underground track on grass in Alicante

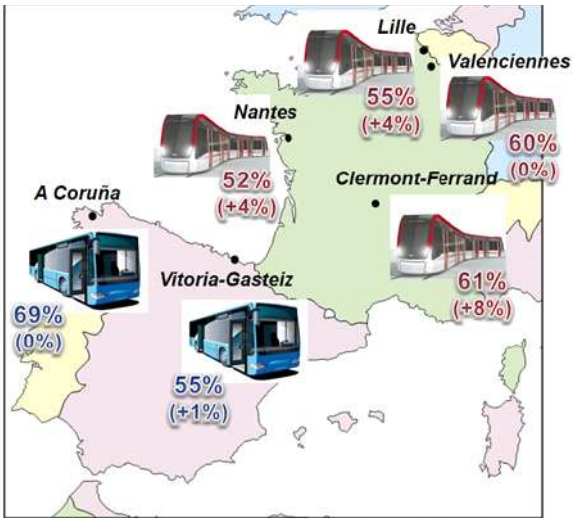


Comparison of a gauge train of FEVE (Spanish Narrow Gauge Railways) with slight underground

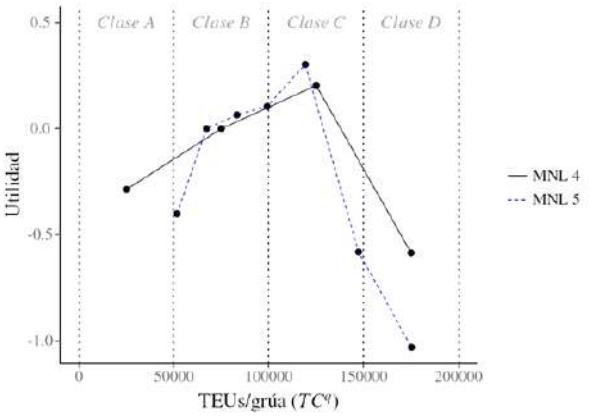
Transport planning and modelling

The main lines of work in this area are:

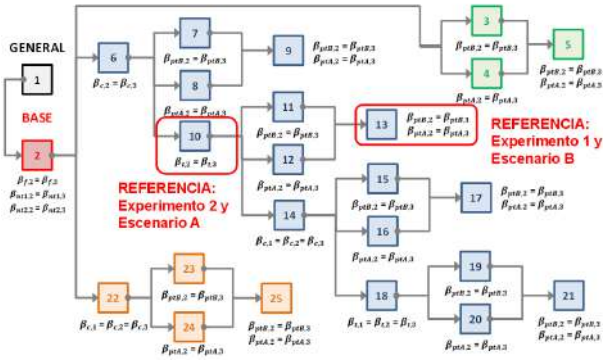
- Planning of metropolitan, interurban, and regional transport.
- Discrete-choice models in transport.
- Port choice.
- Classic transport model, route allocation models.
- Land Use Transport Interaction Models.
- Demand and operation integrated models.



Results of the transport preference (slight underground or high-level service bus) in various cities studied



Use degree of port facilities in contrast to the usefulness of ports under study. Four and seven types



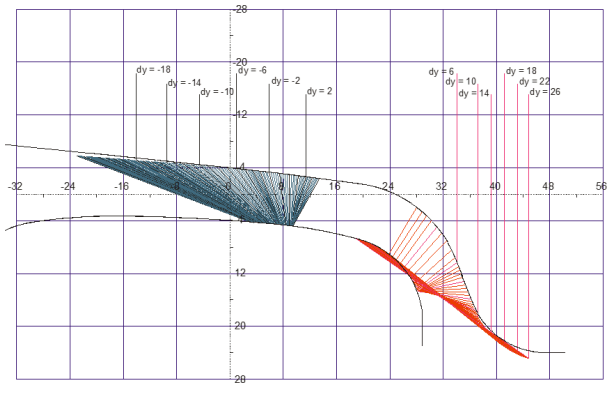
Scheme of the various models according to the usefulness specifications of the alternatives from the base specifications

Railway superstructure and dynamics

The main lines of work in this area are:

- Design, exploitation, and maintenance of railway deviations.
- Wear of railway tires.
- Superstructure of the line. Slab track.
- Simulation of railway dynamics.

In this scope, dynamic simulation programmes (SIMPACK and GENSYS) for the behaviour of railway vehicles are used. In addition, there is a laser profile meter which determines both the actual geometry of the rails of the track in the track itself and in deviations and the actual geometry of the tires of railway vehicles.



Simulation of wheel-rail contact points using GENSYS

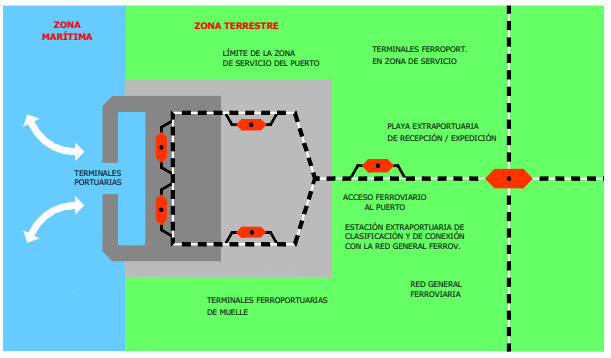
Prefabricated block for mounting the fastening of the rail in the slab track prototype

Change of a completely Spanish prototype of high-speed deviation

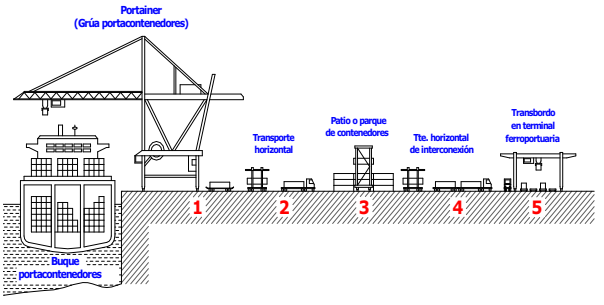
Goods logistics and transport

The main lines of work in this area are:

- Railway and port integration.
- Last kilometre.
- Modelling of goods traffic.



Possible locations of railway terminals with respect to port spaces



Integral processes of the modal interchange of load units between maritime and railway transports

Coordination: Miguel Rodríguez Bugarín
m.bugarin@udc.es
http://caminos.udc.es/grupos/ferroca/

Project Engineering and Management Group. GRIDP

About us

GRIDP members have professional experience in the private sector, engineering and project management, particularly in projects related to industrial plants, commercial buildings, office and corporate buildings, R&D&i centres, singular buildings, mini hydro power stations, gas networks, regasification facilities, and wind and solar parks, among others. Also, they have experience in the field of energy planning.

Two members have held engineering and management positions in companies. On the other hand, they have combined academic and R&D&i experience in these fields, in some cases for more than 30 years. They have also held managerial positions in the public sector.

They have experience in the software development to be used in the fields outlined here. In addition, they have worked on decision support methods applied to the assessment, optimization and management of sustainability, procurement decisions, management and response to project risks and opportunities, and investment prioritization.

According to this, the group has the capacity to:

- Help in the conception and management of projects such as those mentioned above.
- Understand the usual needs and circumstances of the engineering and management personnel of companies and public bodies in the pursuit of their objectives.
- Help in the development of R&D&i projects within the framework of these organisations.
- Help project teams to organize, synthesize and exploit their knowledge related to innovative aspects for building models to solve their problems.
- Conceive and develop a software related to the fields outlined here.
- Carry out training activities related to these subjects.

Research areas

- **SUSTAINABILITY ASSESSMENT, MANAGEMENT AND OPTIMISATION. SUSTAINABLE DESIGN IN CONSTRUCTION AND ENERGY ENGINEERING**
- **SUSTAINABLE ENERGY PLANNING. RENEWABLE ENERGIES.**
- **SUSTAINABLE ASSESSMENT FOR THE DECISION-MAKING**
- **PROJECT MANAGEMENT**

Regasification plant. Advanced stage of construction (Lara 2007; Mugardos, Galicia, Spain)

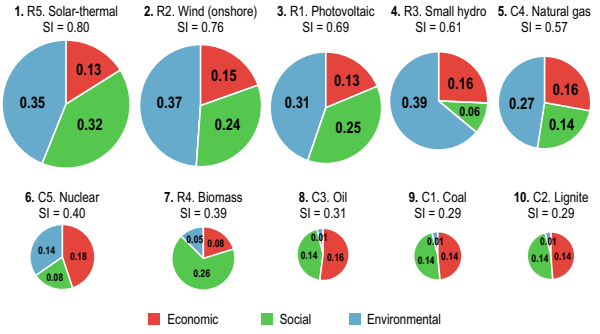
Sustainability assessment, management and optimisation. Sustainable design in construction and energy engineering

The group can provide services related to:

- The sustainability assessment of:
  - Construction systems: concretes, mortars, roofing and façade systems, structures, heating or air conditioning services, and urban engineering systems, among others.
  - Complete buildings.
  - Power plants.
- The optimisation of the sustainability of building components and energy subsystems.
- The project sustainability management.

For these works, we can use:

- Quantitative Life Cycle Analysis (LCA) models including the four pillars of sustainability (environmental, social, economic, and technical-functional), with data obtained from both the client and internal and external databases.
- Methods for integrating LCA results to obtain a sustainability index including all its pillars, using multi-criteria decision support techniques, such as the MIVES method (Integrated Value Model for Sustainable Assessment), among others.
- Methods to deal with uncertainty, variability, subjectivity and vagueness inherent to the estimation of sustainability indicators: Monte Carlo stochastic simulation or the use of fuzzy mathematics.
- Artificial Intelligence (AI) techniques for optimisation: genetic algorithms, particle swarm, and crow search algorithm, among others.
- Proprietary procedures for managing the sustainability objective in projects.



Comparative sustainability assessment of power plants with data from the main countries of the five continents (Cartelle et al. 2015; Energy 89:473-489)

Based on these methods, techniques and procedures, it is possible:

- To choose among various design alternatives and, on this basis, develop engineering designs according to sustainability criteria.
- Within the above alluded framework, for instance, to perform comparative analyses of conventional building materials (e.g., concretes or mortars) in relation to the corresponding materials employed as environmental sinks (e.g., concrete made with by-products generated from industrial waste).
- To perform automated design search processes to maximise the sustainability level of a building component (e.g., a structural element) or an energy sub-system (e.g., a heat exchanger).
- As for project sustainability management, to help the promoter in establishing quantitative sustainability objectives in the conception of sustainable buildings, the definition and implementation of appropriate management processes to meet these objectives, and the building sustainability certification.

Sustainable energy planning. Renewable energies

By employing the sustainability assessment methods and techniques mentioned above, various types of renewable and non-renewable power plants can be compared, as well as engineering systems using different types of energy.

This helps to devise an appropriate energy planning, either in the form of corporate energy strategies or public energy policies.

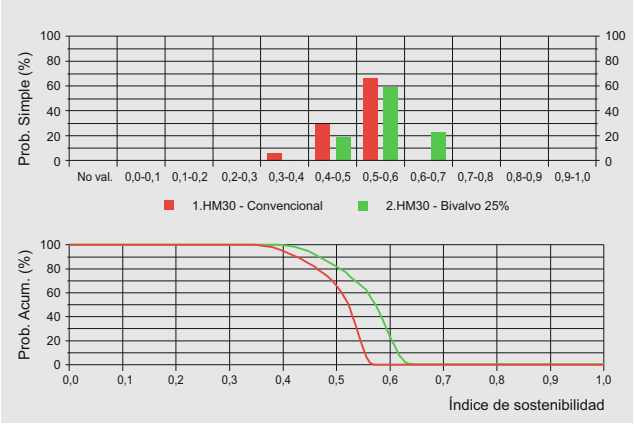
Public bodies and private organisations can also be supported by feasibility studies, resource assessment, as well as in the project conception, design and management of both wind and solar parks and mini hydro power plants.

Computer application to assess the sustainability of concrete structures; it was carried out for the Spanish Ministry of Public Works (Gómez et al. 2011)

Sustainable assessment for the decision-making

Considering the four pillars of sustainability and employing advanced multi-criteria decision support techniques, the client can be helped, among other aspects, to:

- Select suppliers.
- Select alternatives in feasibility studies of capital projects.
- Prioritize capital projects related to the infrastructure maintenance, the increase of safety and security against robberies in commercial premises, or the restoration of historical heritage, among many others.
- Estimate the risk level of crime impacts (e. g., robbery in commercial premises) or the intrinsic risk of infrastructures, and to obtain support in making preventive decisions.
- Prioritize business project portfolios.
- Prioritize research, development and innovation projects for the establishment of a company's R&D&i strategy.



Comparative probabilistic assessment of the sustainability of both conventional concrete and concrete with partial substitution of aggregate with by-products from industrial waste (Bordello et al. 2015; Proxecto Biovalvo)

Construction of pioneer wind farms (Lara 1997; Paxareiras, Galicia, Spain)

Project management

In the field of project management, the promoter can be helped in the management of the scope, time, cost, quality and sustainability objectives, as well as in the management of acquisitions, opportunities and risks, stakeholders, and integration (global vision of the project planning and control).

A problem in which the group has extensive experience is the management of uncertainty, subjectivity, vagueness, opportunities and risks affecting the achievement of the project or programme objectives, and the interrelations with the remaining managerial functions.

In this sense, the group can help the client in using innovative systems both to reduce uncertainty, subjectivity and vagueness and to assess and manage opportunities and risks in projects, especially in construction and energy projects due to their various management sub-processes: planning, opportunity and risk identification, qualitative and quantitative analysis, response planning, monitoring, and control.

Another possibility is to help the client both in the definition of its contracting strategies (contractual scope of each participant, organization of these participants, types of contractual price, and types of award procedures) and in the analysis of the interrelations with the other aspects of the project management, especially in terms of risk.

Finally, the client can be helped to create decision support systems for project management, especially for the purposes of time, cost, sustainability, procurement, and opportunities and risks. These support systems may be based on multi-criteria decision-making techniques or fuzzy logic.

Coordination: Alfredo del Caño Gochi
alfredo.cano@udc.es
https://www.udc.es/gridp/

Advanced Visualization and Cartography Group. VAC

About us

The Advanced Visualization and Cartography Group focuses its activities on the knowledge, research, and application of technologies of graphic representation to the territory, infrastructures, and construction from the geospatial analysis through Geographic Information Systems and the visualisation of the work built or projected, as well as from both the historical, landscape and cultural heritage and the human activities taking place in it.

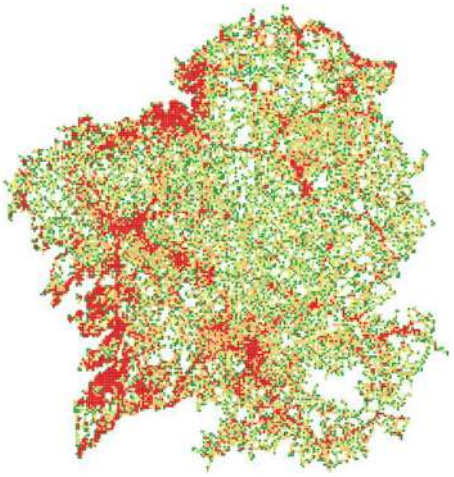
The technological scopes used for this purpose, cartography and GIS on the one hand, and 3D visualisation on the other hand, divide the group into two interrelated laboratories: the CartoLAB, where the works focused on the treatment and analysis of the geographic information are developed, and the VideaLAB, where the projects focused on the 3D visualisation in construction are carried out.

Research areas

- GEOSPATIAL ANALYSIS OF INFRASTRUCTURES
- CARTOGRAPHIC SYSTEMS FOR PUBLIC PARTICIPATION
- ADVANCED VISUALISATION IN THE CONSTRUCTION AND TERRITORY
- RECREATION OF THE HISTORICAL HERITAGE AND VIRTUAL ARCHAEOLOGY

Geospatial analysis of infrastructures

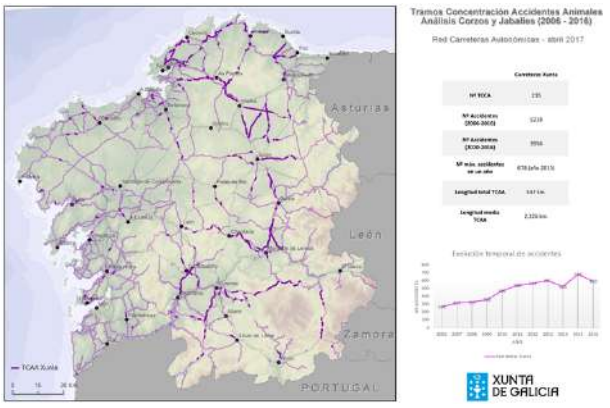
All the elements related to territorial infrastructures have a very important spatial component for their operation and their maintenance management. Our group develops methodologies of analysis and advanced treatment of the data of these infrastructures, particularly road infrastructures, by using cartographic applications both to analyse their functionality and to allow a more efficient management, taking advantage of various sources of information (LiDAR, satellite images, vector data, DEM, etc.).



Analysis of impacts of civil infrastructures on the Green Infrastructure in Galicia

Characterization of the quality of the sections of the French Way

Map viewer for slope management

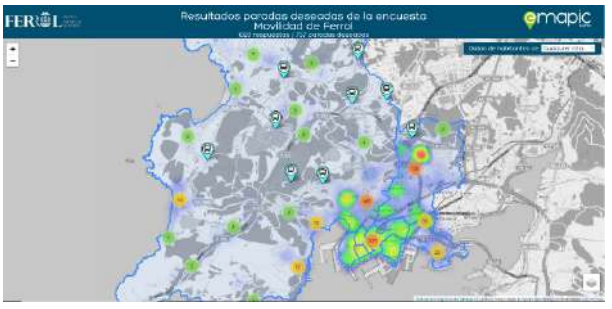


Identification of accident concentration sections due to the collision with wild boars or deers

Cartographic systems for public participation

The new technologies of geographic information design cartographic systems in which citizens can participate more directly and efficiently in the management public policies of their city, region or country. For this purpose, our group has developed a web service (https://emapic.es) to elaborate geolocated questionnaires or surveys and opinion and consultation maps, so that any person interested can interact with this type of technologies.

Example of the Empaic's functionalities for the compilation, analysis, and visualisation of geographic data through participatory processes



Example of using Emapic for the mobility survey in Ferrol (Spain)

Advanced visualisation in the construction and territory

From the construction detail to the large infrastructure, the visualisation through computer gives advantages in all the life stages of the object built, from the decision-makings in the preliminary design stages to the execution of the work, its public dissemination, and the posterior management and maintenance.

So, 3D visual models of the project are very useful for studies on environmental impact, the choice of materials, the lighting analysis, the analysis of alternatives, and process simulation, among others, also considering the importance of the public dissemination and promotion.

Overflow simulation of the Albarregas river (Mérida, Spain)

Study of the alternatives for the Tui – A Guarda main road (Pontevedra, Spain)

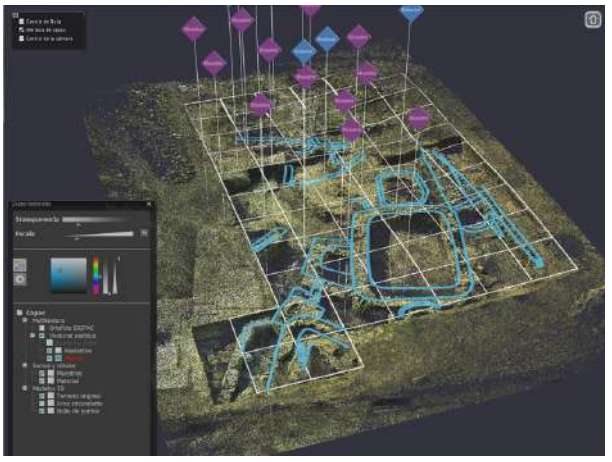
Recreation of the Historical Heritage and Virtual Archaeology

The research group has a wide experience in the recreation of heritage elements, from the making of realistic three-dimensional models of the possible appearance of non-existing objects to the design and making of systems and environments for the research and dissemination in museum facilities, paying special attention to their way of experimentation.

In this regard, it is worth stressing the experience of the group in the design and implementation of interactive solutions to natural interactive devices, such as those based on both the image and body-language analysis and on the incorporation of visualisation systems through mixed reality, virtual worlds, video game engines, etc.

Constructive study and interactive recreation of the Tholos of Delphi

3D Interactive Model of the Santiago de Compostela Cathedral



GIS-hybrid system with 3D display screen for the management of archaeological excavations. Castro de A Lanzada (Pontevedra, Spain)

Real-time reconstruction and simulation of the Villa Romana del Alcaparral (Seville, Spain)

Museum facilities: Casa de las Ciencias and Galicia Dixital

Coordination: Luis Hernández Ibáñez
luis.hernandez@udc.es
https://vac.udc.es

The CITEEC as a distinctive element of the Consortium

Located in the Campus of Elviña of the University of A Coruña (Spain), the Centre for Technological Innovation in Building and Civil Engineering (CITEEC in Galician) is a unique infraestructure at the international forefront of technology and experimentation in civil engineering and building. The CITEEC makes its facilities and equipment available to the Consortium, which are capable of carrying out large-scale tests at the level of the most advanced centres in EU.

Construction Laboratory

Laboratory of Hydraulics

Laboratory of Sanitary and Environmental Engineering

Laboratory of Ports and Coasts

Laboratory of Roads and Geotechnics

Aerodynamic and boundary layer wind tunnels

Laboratory of Railway Engineering and Transport

Laboratory of Numerical Methods in Engineering

Laboratory of Rock Mechanics

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Agrupación estratéxica
Centro de Innovación Tecnolóxica en Edificación e Enxeñería Civil

Campus de Elviña, s/n
15071, A Coruña
P: (+34) 881 015 178 - 881 015 179 | F: (+34) 981 167 179
E: agrupacion.citeec@udc.es

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