

CENTRAL LABORATORY FOR STRUCTURES AND MATERIALS

Activity Report 2024

“We build bridges between the past and the future, exploring the traces of concrete and steel to make our structures more durable, resilient and sustainable, with science, innovation and commitment to the planet”

In 2024, the **Laboratorio Central de Estructuras y Materiales (LCEYM)** has carried out intense activities in the field of **Concrete and Steel Structure Pathologies**. As these materials are widely used in engineering, the studies conducted at **LCEYM** cover **Bridges, Ports, Dams, and Historical Buildings**. The different **areas of the laboratory** allow for complementary studies on these pathologies, covering the diagnosis and causes of the problem, structural safety analysis, and monitoring for control behaviour of the structure.

Other materials that have also been studied in the laboratory include **geomembranes used for waterproofing ponds for water storage**, as well as **materials used in road signals**. Many of these studies have a significant component of innovation and research, with notable projects such as **LIASON** (European) and **GPort** (National) currently underway. All these works will be detailed in the following sections.

More durable structures

In order to achieve **more durable structures**, work has been carried out for the **General Direction of Water** in the field of dam concrete pathologies. This work is clearly aligned with objective 6 of sustainable development (clean water and sanitation). Thus, the **Materials Science Area** has carried out the study of the concrete used in the **gallery of the Canales Dam**, in the province of **Granada**.

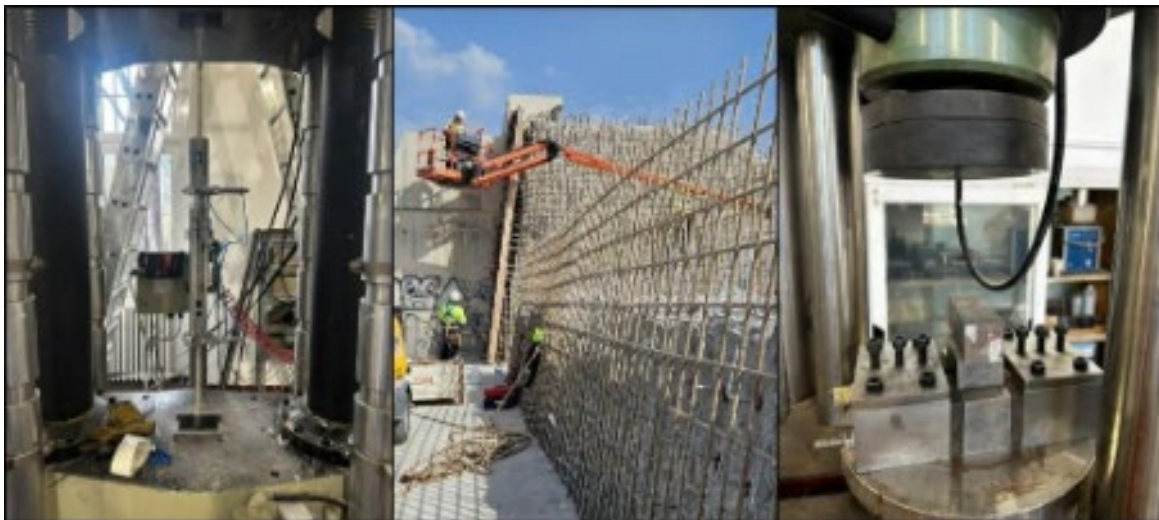
The **Studies and Assessment Structural Area** has continued providing technical assistance to **Puertos del Estado** in many projects, while also updating the Caisson Manual to the new Spanish Structural Code. For the **General Directorate of Roads (DGC)**, in addition to providing technical assistance in construction works, it has started a study on the effectiveness of non-destructive testing to assess **post-tensioned tendons**, starting with the state of art and conducting a quantitative analysis of the susceptibility of different bridges to develop issues related to potential flaws in these tendons.

LCEYM, through its **Construction Products Area**, has continued working on alternative reinforcements for concrete, primarily using fiberglass-reinforced polymers. Among practical projects, it is worth highlighting the completion of the technical consultancy for State Ports for the rehabilitation of the breakwater of the **North Entrance in the Port of Barcelona**, and the beginning of the characterization of the **GFRP reinforcements** being installed on the site.

Likewise, the **GFRP reinforcements** installed in the concrete walls of the new stations for the extension of **Line 11 of Madrid Metro** have been tested for the joint venture Metro Line 11. In the research of the properties of these new

alternative reinforcements, it is worth highlighting the studies developed during the first year of the **GFRPort R&D project** in collaboration with the **University of Girona** and the companies **Vialobra** and **Rover Maritime**.

The dissemination workshop "**Sustainable And Innovative Reinforced Concrete Structures. Fiber-reinforced polymer (FRP) reinforcements**" was organized at CEDEX facilities in collaboration with **Owens Corning**. The focus of this work is aligned with increasing the sustainability of materials and considering their full life cycle, pursuing several targets of SDGs 9, 11, 12, and 13.



GFRP reinforcement

More resilient, safe, and sustainable structures

The **Materials Science Area** has begun a study of expansive pathologies in bridges for the **General Direction of Roads**; a work aligned with **objective 9 of sustainable development**. The first report on the study of expansive alkali-silica reaction in post-tensioning concrete decks has been completed, a work in which it has been studied in depth which materials have caused this pathology, how the modulus of elasticity and strength of the concrete have been affected, and what differentiates the highly damaged deck from the piers of these same structures, also built with reactive aggregates, and which nevertheless present only slight damage.

With the same objective of sustainable development, the **Materials Science Area** has continued with the **study of corrosion processes of concrete in port structures**, at the request of **Ports of the State**. The aim objective of this work is to prevent corrosion problems through the design of a field test to control the quality of concrete placement, from the durability point of view. This work has been carried out on the **Ro-Ro and Duques de Alba ramp at the Port of Huelva**.

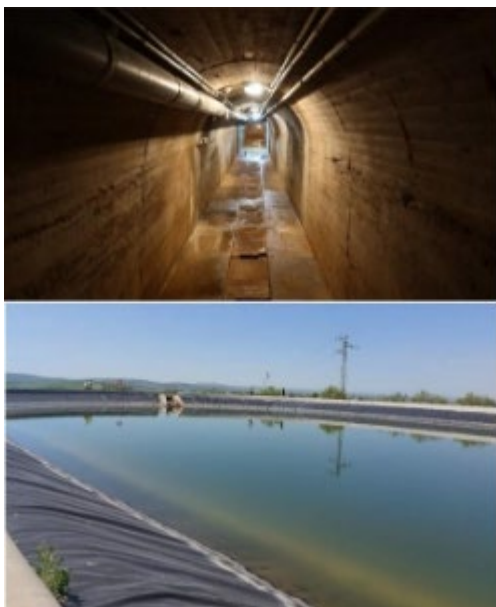
Moreover, a state-of-the-art report has been carried out, which will be published soon, on very high durability concretes for marine environment. Finally, a seawall made with the requirements of the **EHE-08 Instruction (Granadilla Port)** has been

studied in order to know if the increase in the concrete requirements implemented by this regulation with respect to the previous ones has influenced the improvement of the durability of port structures.

On the other hand, within the agreement signed between **Dirección General de Carreteras** and **CEDEX** for technical assistance, research, and technological development in areas of their expertise, aligned with **Sustainable Development Goal 9**, several dynamic tests have been conducted on bridges affected by chemical pathologies due to alkali-silica reaction in the concrete deck. Additionally, the tendering for instrumentation and continuous monitoring of two bridges has been carried out to study their behavior.

In line with the goal 12.2 (achieve the efficient use of natural resources) of sustainable development objective 12 (Responsible Production and Consumption), the **Central Laboratory for Structures and Materials** is coordinating and participating in the work being carried out by **CEDEX**, at the request of the D.G. for Environmental Quality and Evaluation, to update the **Catalog of Wastes Usable as Construction Products**. This work consists of updating the 19 existing product reports and creating two new ones. This document, available online (<https://www.cedexmateriales.es/>) and which will be completely updated in 2027, aims to promote the use of waste in construction, thus reducing the demand for non-renewable natural resources and the amount of waste that goes to landfill without being used.

The **Materials Area** has continued its work for the **General Directorate of Water**. The concrete study for the **Rosarito Dam (Ávila)** has been completed, and the study for the **Bárcena Dam (León)** has begun. In the field of waterproofing, a total of **14 reservoirs** belonging to the **Guadalquivir River Basin Authority** located in the provinces of **Jaén, Córdoba, and Seville** have been inspected to study the performance of the waterproofing geomembranes used in the reservoirs.



Bárcena Dam gallery (top) and Villanueva-Espeluy Sector III Reservoir (bottom)

With this same objective, **37 reservoirs** have been inspected as part of the collaboration agreement with **Balsas de Tenerife** and the **La Palma Island Water Council**, and **6 reservoirs** as part of the contract with **the Taibilla Canal Association**.

These studies will contribute to the improvement of our water resources, one of our most precious and scarce assets (SDGs 6.4, 6.5, and 5.A).

The laboratory has continued its activity as a steel **testing laboratory for construction**, mainly for product certification within the framework of various **Technical Committees of the AENOR Certification Commission**, and the laboratory maintains its **ENAC accreditation**. Within the line of activity related to more resilient and safe structures, the study, characterization, and analysis of pathologies in metal construction products continues, the structure of the **Crystal Palace in Madrid's Retiro Park**, begun in 2024, is the most significant. In this project, research has begun to evaluate the effectiveness of different non-destructive methods in order to assess the condition of cast structural components.

The study to quantify the degradation of track infrastructure under the influence of trains continues, as part of **ADIF's commission to CEDEX**. This work is part of a sector of great economic importance for the country, the steel industry, which is applicable to several aims of SDGs 8 and 9.



Crystal Palace materials

In the **area of Structural Technical assistance**, working alongside the **Laboratorio de Geotecnia**, it was launched a study to assess the condition of the floor slab and a retaining wall in the

Escuela Judicial del Consejo General del Poder Judicial.

The **Structural Dynamics** area is an active part of the **European Common Research and Innovation Project Europe's Rail Joint Undertaking (ERJU)**. As a key milestone in this regard, this year the complete installation of all the instrumentation on the **Huertas de Mateo Viaduct** was carried out as planned.

Additionally, participation took place in the international follow-up meeting held in **Monopoly (Italy)** to assess the progress of the project as it reaches its halfway point.



Instrumented Viaduct for the ERJU Project

Digitalization of Structures and Innovation

In addition to it, as part of the European R&D+i project **“Europe's Rail Joint Undertaking”** (EU-Rail JU), it is underway the work to create a point cloud of the **Mateo Huertas Viaduct** on the **Madrid-Valencia high-speed rail line**. Ground laser scanning and drone-based photogrammetry are merged in order to integrate it into a management tool. The Structures Area also continues coordinating the **CEDEX Drone Operator**.



Drone-based operations for obtaining the point cloud of the viaduct



Development of a first “point cloud” of the viaduct for the ERJU project

As an independent action in the task with the DGC, the **monitoring data of the Amposta Bridge from 2012** has been recovered for its incorporation into the DGC's CELOSIA platform.



Amposta bridge

The **Division of Structural Studies and Assessment** keenly participates in industry

committees and working groups, lending a hand in crafting technical and regulatory documents, whilst paving the way for the eventual adoption of the **next wave of structural Eurocodes**.

Regarding the use of the **seismic simulator** has been maintained in collaboration with the **National Geographic Institute (IGN)**, providing support for the **calibration of its accelerometer-type sensors, known as SILEX**. It is worth highlighting the maintenance work being carried out on the accumulators of the seismic simulator to prepare them as the initial phase of an upgrade to the installation.

In the field of road signage, work has continued verifying indicators related to the **retroreflection of road markings and vertical signage**, commissioned by the **General Directorate of Roads**. This work will have a clear impact on improving road safety, minimizing traffic accidents, and increasing the perception of well-being by facilitating driving (SDG 3.6).

As a new development, commissioned by **AENA**, the **chromatic coordinates and luminance factor have been measured** on different paintings and locations at **Adolfo Suárez Madrid-Barajas Airport**.




Chromatic Coordinate Measurement

In the field of innovation, the project with the **Spanish Institute of Cement and its Applications (IECA)** on the **study of recycled concrete fines as a constituent of Portland cement continues**. Initially, as a first step, in addition to studying the state of the art regarding its use as an addition to cement, tests have been carried out to chemically characterize the samples of fines studied.

At the **international level**, the **Horizon Europe LIAISON project** continues, which aims to develop methodology, support tools, and technological solutions to transform EU transport infrastructure into a more sustainable and low-carbon activity. Within the governance framework defined in the project, work is underway to incorporate sustainability and circularity indicators into public tendering processes.

The results of the **IECA and LIAISON projects** will contribute to the development of more sustainable infrastructure (SDGs 9.1, 9.4).

The **LCEYM** maintains its **quality management system as an ENAC-accredited laboratory, according to UNE-EN ISO/IEC 17025:2017**, to evaluate the physical, chemical and mechanical property tests of different steel products for construction: structural, active reinforcements and passive reinforcements for concrete. The planned activities have been carried out: updating of documentation, quality control of tests, equipment, skills and training of staff, audits and meetings.



The **LCEYM** is certified in the **CEDEX Multi-site UNE-EN ISO 14001 Environmental Management System**, to comply with the Sustainable Development Goals (SDG) and the Green Deal.

The planning on environmental objectives has been fulfilled, replacing diesel boilers with natural gas and addressing efficient improvements to the facilities, such as air conditioning equipment, lighting, etc. Staff awareness and sensitization on environmental matters and waste recycling continues.

The **LCEYM** has organised a visit to an electrical and electronic waste (WEEE) plant for the **CEDEX Environment Commission**, to raise awareness and sensitise them in its collection, transport, storage, recycling and recovery.