GEOTECHNICAL LABORATORY (LG)

2024 Activity Report

"Serving society facing soil and foundation challenges"

In 2024, the **Geotechnical Laboratory (LG)** developed an intense and varied activity, integrated within the challenges of the organisation's **Strategic Agenda**, in particular, those of **resilience in mobility** and the **natural environment, sustainable mobility and sustainability in the natural environment**, and fundamentally in thematic areas of competence of the **Ministry of Transport and Sustainable Mobility and the Ministry for Ecological Transition and the Demographic Challenge**. The activity of the **Geotechnical Laboratory (LG)** results in the correct maintenance and development of the country's infrastructures through the **technical analysis** of projects for new works or pathologies detected in existing ones and the proposal of technically and economically reasonable solutions.

Road Geotechnics

About the line of activity of **road geotechnics**, the **Geotechnical Laboratory** has carried out, within the framework of the assignment from the **Directorate General of Roads (DGC)** to **CEDEX** of '**Technical Assistance in geotechnical matters within the scope of the DGC', geotechnical consultancy work and instrumentation, monitoring and analysis** of the behaviour of different sections of the **State road network** which have presented problems related to the ground.

A total of **39 technical reports** were drawn up in 2024 relating to the study and resolution of pathologies of **embankments, walls, undercuts and cavities** under the roadway, **foundations of viaducts, tunnels, cuttings and natural slopes** affecting various sections of roads and motorways of the state network.

Among the sections studied, the following can be mentioned: **A-2** dual carriageway in Sant Vicenç dels Horts (Barcelona); **A-49** dual carriageway in Camas (Seville); **A-33** dual carriageway in Font de la Figuera (Valencia); Alcoy bypass of the **A-7** dual carriageway (Alicante); **N-420** road in Fuencaliente (Ciudad Real); **A-7** Mediterranean dual carriageway on the Polopos-Albuñol and Carchuna-Castell de Ferro sections (Granada) and in Málaga; **N-432** road (Córdoba); Escucha bypass on the **N-420** (Teruel); embankment on the **A-3** dual carriageway in Rivas Vaciamadrid (Madrid); slope on the **N-625** in Oseja Sajambre (León); wall on the **N-502** in Cuevas del Valle (Avila); rock falls on a section of the **N-536** at Puente de Domingo Flórez (León); rockfall on the **N-332** at Altea, (Alicante); **AP-4** motorway at Jerez de la Frontera (Cádiz); **A-44** dual carriageway, Las Gabias-Alhendín section (Granada); **A-67** dual carriageway (Cantabria), on the exit branch to Corrales de Buelna; clearing on the **N-320** at Sacedón (Guadalajara); **VA-30** dual carriageway (Valladolid); **A-44** dual carriageway at La Guardia de Jaén (Jaén);

N-211 road at Anquela del Ducado (Guadalajara); **A-8** at Reocín (Cantabria); **N-552** at Redondela (Pontevedra); and **N-320** at Horche (Guadalajara).

Finally, it should be noted that in the last months of the year, the **DGC** assisted in the **rockslide** that caused the closure to traffic of both carriageways of the **AP-66 (Huerna Motorway)** and at various points of the road network in the province of Valencia in the vicinity of the **Barranco del Poyo** due to the damage caused by the **DANA of 29 October.**

As part of the R**esearch & Development & Innovation (R+D+i)** programmes in the field of roads developed this year by the Geotechnical Laboratory, it should be noted that new methodologies are being implemented to monitor the evolution of geotechnical pathologies such as those described based on the latest technologies available, such as laser scanning, photogrammetry or interferometry.

Rockfall on the AP-66 motorway

Railway Geotechnics

In the field of **railway geotechnics,** in the **Technological Infrastructures Area**, the work related to the **European GEOLAB programme** stands out, where the testing of the **PEDLER project** has begun, committed to LECA as an external entity, and the management of the activities related to the '**Exchange between centers'** programme has been completed.

Likewise, the **Geotechnical Laboratory** has coordinated **ADIF's four-year assignment to CEDEX** for the provision of **advisory services, research and technological development** in the different techniques of the railway and building system, carried out

in September 2022, which includes eleven actions carried out by different CEDEX centers.

A large number of works included in the four actions that depend on LG of the ADIF assignment have been carried out: the instrumentation of two sections of the conventional railway network (on the Madrid-Irun and Madrid-Valencia lines), the critical speed of high-speed line sections running on soft ground was determined to analyse the influence of the improvement treatments applied, a methodology was developed to correctly interpret the results of the Panda equipment when they are made on ballast and a laboratory method is being analysed to determine when a ballast layer should be replaced.

Instrumentation calibration and facility maintenance work has also been done at **CEDEX Track Box.**

Geotechnical Engineering for Port and Coastal Works

In **geotechnical engineering for port and coastal** works 2024, continuous geotechnical advice was provided to **Puertos del Estado** within the framework of this organisation's assignment to **CEDEX**. We have participated in the assessment and improvement of preliminary projects and projects for various **port authorities** relating to ground treatment, increasing the depth of caissons, in situ tests, resolving pathologies in foundations using piles, foundations of ships, buildings and structures, extensions to docks, and conditioning of access roads.

In this field, the following actions can be highlighted: the increase of the depth of the caissons of the **South Quay of the Port of Barcelona** and the **underground/parking of Avda. De Hispanoamérica** next to the land of the **Port Authority of Huelva**; the alternatives for the refurbishment of the Muelle Armamento in the **Port of Seville**; the extension of the San Juan breakwater in the **Port of Gijón**; the increase in draught by jet grouting under the **Muelle Castilla, in the Port of Tarragona**; the creation of the '**Muelle Baleares'**, as a continuation of the **Muelle Cataluña**, in the same port.

Ongoing advice is also being provided to the **Port Authority of Alicante** on the deficiencies in the execution of the piling of a marine structure at the mouth of the inner harbour. Based on technical rigour, this work results in more excellent reliability, durability and a reduction, sometimes very significant, of costs, both in the construction and operation phases, as well as in the event of unforeseen events or deficient behavior of the infrastructures.

This line makes it possible to carry out unique tests not available in the private sector, aimed at assessing the reliability of port structures, promoting new techniques for the inspection, characterization and auscultation of the port environment and its infrastructures and contributing to the creation of technical documents (standards, guides and good practice manuals).

About port R+D+i, progress has been made on the **'Study for a proposed revision of**

R.O.M. 0.5-05, in line with Eurocode 7'. On the other hand, experimental studies are being carried out on sacrificial measuring devices in port structures and others on secondary consolidation in soils, as well as modelling a sheet pile quay recently commissioned with instrumentation.

In the coastal area, technical assistance continued to be provided to the **Directorate General for the Coast and Sea of the MITECO** on the question of the structural section to be adopted in the tunnel under construction on the Miraconcha—Easo section of the Donostia Metro, which runs under the maritime-terrestrial zone. There was a landslide on the tunnel section's left gable end and a surface collapse.

Geotechnical Engineering for Hydraulic Works

In **geotechnical engineering for hydraulic works**, technical assistance to the **Directorate General for Water (DGA)** and hydraulic confederations has had a notable activity in pathology and dam safety assessment.

The following work continued in 2024: evaluation of the stability of the decommissioned diversion tunnel and the left slope of the **Riaño dam** (CH Duero); detection using non-invasive techniques of the crest of the core of the **Canales dam** (CH Guadalquivir); fieldwork related to the safety of the **El Atance dam** (CH Tajo). Studies have begun on the seepage and possible erosion of the Argos Dam (CH Segura), the foundation of the **Rambla del Moro Dam** (CH Segura), and the geotechnical conditions of the spillway pool of the **Mediano Dam** (CH Ebro). In addition, the Geotechnical Laboratory is also participating in drafting a **dam inspection manual that the DGA is promoting.**

On the other hand, the commission from the **CH of the Guadalquivir** has been completed on the overflows through the western slope of **the Breña II dam** basin.

Likewise, the order from the Júcar CH for an in situ test to determine the resistance of the friction-concrete-growth contact at the foot of the **Amadorio Dam** was completed.

Setting up an in situ shear test for one of the cubes. Side view

All this activity improves and optimises projects, fundamentally rehabilitates and reinforces dams in service with technical rigour, and offers reliability, durability and cost reduction.

Environmental Geotechnics

Regarding **environmental geotechnics**, as part of the R&D&I activities for **Puertos del Estado**, a document is being drawn up on the use of dredging and alternative materials (civil works excavations, CDW, and steel aggregates), their regulatory limitations, and the alternatives for fixing or confinement, if appropriate.

Likewise, for **MITMS**, in coordination with other **CEDEX** centers, updating the C**atalogue of waste usable in construction has been taken up again.**

Laboratory Tests

Seventeen **laboratory tests** were completed for external clients, internal research work, and support for other areas.

Of particular note is the work for the mining company **Sandfire MATSA**, with a multitude of laboratory tests in general and dynamic tests in particular on samples with special characteristics that have made it necessary to fine-tune testing processes and methodologies that are out of the ordinary.

Also noteworthy is the **work on coarse granular samples** in the 30x30 cm and 1x1 m direct shear test equipment, tests in which this Laboratory is a benchmark. Several pieces of test equipment have been acquired, and the data acquisition and recording systems have been modernised (new triaxial equipment for soils, data acquisition system for edometers and soil cutting, pressure system for the rock triaxial, control and data acquisition system for the rock mechanics press).

Material extracted from one of the Shelby tubes received at the Geotechnical Laboratory for testing.

Computer equipment and software for the control and data processing of the IC, TGA-DSC and WD-XRF analysis systems have been renewed in the **chemistry section**. The implementation of the **ISO 9001 Quality System** for the laboratory tests of the GL is to be highlighted, and it is expected to be implemented in 2025.

Geophysics

About **geophysics**, it is worth highlighting the work carried out as part of the work commissioned by **ADIF** (auscultation of high-speed tracks when trains pass and surface wave tests to study the critical speed of railway sections), **Puertos del Estado** (Port of Avilés and the Port of Tarragona), as well as the programme with the **Directorate General for Water** (Canales Dam, Mediano Dam and the drafting of a guide to geophysical and geotechnical tests inside boreholes).

In addition, a **course on signal acquisition with LabVIEW** for field and laboratory tests was coordinated, and **CEDEX** continued to be represented at **meetings of the Spanish Geodesy and Geophysics Commission.**

In the in situ geotechnical testing and instrumentation field, the work on large-scale in situ shear tests to determine concrete friction - concrete at the Amadorio dam is particularly noteworthy.

In **standardisation**, work continues in **UNE CTN 103 Geotechnics committees**, of which the company is chairman, and **CTN 140-SC7, relating to Eurocode 7 (EC7)**, as well as in the corresponding European (CEN) and international (ISO) committees.

Likewise, the drafting committee's work for the update of the **Guide to Anchorages of the Directorate General for Roads** has been completed and is awaiting publication.

Work has begun on drafting the '**Guide for the Application of Eurocode 7 in port works**' for **Puertos del Estado**, and work has already started on drafting the Spanish National Annex to the future EC7. The drafting of the '**Technical Guide for the Use of Expanded Clay in Infrastructure Projects and Works**' is being finalised and will be published as a **CEDEX Monograph.**

Within the ISO 182 (Geotechnics) committee, the standardisation of laboratory tests in Rock Mechanics has been promoted. The Geotechnics Laboratory team has led, within the **CEN 396 (Earthworks) committee**, the promotion of chemical tests in the geotechnical field.

R&D&I

In the field of **R&D&I,** the Laboratory's activities have been reflected in the publication of **8 articles in international JCR journals** (and another four in the process of revision), **23 papers in international congresses, 1 in national congresses and conferences and a CEDEX monograph.** Several doctoral theses have continued to be partially carried out in the Laboratory, such as those related to the structural dimensioning of piles and the geotechnical characterisation of expanded clay as a lightweight aggregate.

Four pre-doctoral researchers from the **Universidad Nacional de la Patagonia San Juan Bosco (Argentina)** were present. They are working on their doctoral thesis on the geological storage of CO2, one of which was co-directed by technicians from LG.

In rock mechanics, the line of research focused on the tensile behaviour of rocky materials has continued. The article **'A New Insight into the Stability of Precariously Balanced Rocks'**, co-authored by LG researchers, was awarded in 2024 with the **Giovanni Barla Prize** for the best article published in the **journal Rock Mechanics and Rock Engineering (Springer)** during the year 2023.

Technology Transfer

Regarding **technology transfer** activities, in 2024, after a preselection of more than 70 candidates from various countries, the **42nd edition of the CEDEX/UNED Master's Degree in Soil Mechanics and Geotechnical Engineering** was successfully held with **23 students** (from Bolivia, Chile, Costa Rica, Spain, and Mexico). This edition was the fourth year of blended learning, with an online format during the academic period (February - June) and an in-person format during the internship period (October). **The Geotechnical Laboratory, together with the UIDI,** has also promoted ways to streamline and support the **processing of patents**.

Significant effort has been made to maintain CEDEX's presence and participation in national and international geotechnical forums, including Spanish geotechnical societies, national UNE, European (CEN), and international (ISO) standardisation committees, the ELGIP platform, and technical workshops and conferences.