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AUG | NOV 19

HIGH SPEED
The AVE conquers Granada

+ ARTICLES

Airport planning in Colombia
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The EU promotes the safe use of drones
Valencia launches its new TACC
Brand Spain: The Alhambra

EDITORIAL

Ingenuity and talent serving society

We dedicate the cover of this issue to the arrival of high speed to Granada with a full report in which we wanted to give a voice to the Ineco technicians who worked with Adif Alta Velocidad on the execution of the final 114-kilometre section. In so doing, we not only celebrate the fact that the historic city of Granada now enjoys connections similar to those of other large cities such as Barcelona and Madrid, but also highlight the technical knowledge and expertise of our professionals in the execution of this kind of infrastructure; ingenuity and talent serving society. This new line is undoubtedly another step in the firm commitment to structuring and uniting the country socially, culturally and geographically, representing another breakthrough in Spanish engineering, and all framed by the comprehensive vision of our transport model, part of the Ministry of Public Works' Safe, Sustainable and Connected Mobility strategy.

On the subject of railways, this issue features a report on the work that Ineco has been carrying out for more than 15 years to guarantee the quality and supply of railway materials used for track assembly.

In the field of airports, the conducting of studies and projects under the premise of efficient, sustainable and safe work, in the case of the projects recently carried out for Aeronáutica Civil de Colombia, has a special attraction: the satisfaction of participating in the development of airports located in remote regions with enormous agricultural, commercial and tourist potential. On this same subject, we are particularly pleased to hear the comments of the CEO of Aerocivil, engineer Juan Carlos Salazar.

This issue also highlights Ineco's participation in the design and development of four projects aimed at effectively and sustainably improving mobility, two in the international arena –the construction of Line 12 of the Mexico City Metro and the new Paseo del Bajo road corridor, which crosses Buenos Aires from north to south– and two in Spain –ENAIRE's new terminal area control centre (TACC) in Valencia and the San José de Valderas commuter rail station in Madrid–.

In the space dedicated to corporate social responsibility, we highight Ineco's initiatives to promote equality. Moving towards real gender equality involves commitment and concrete actions. In this regard, we want to showcase and share with you the 'IN' Women's' Programme that we recently launched. ■

"We celebrate the arrival of high-speed rail to Granada, a new milestone in Spanish engineering's commitment to structuring and uniting the country socially, culturally and geographically"

CARMEN LIBRERO
President of Ineco

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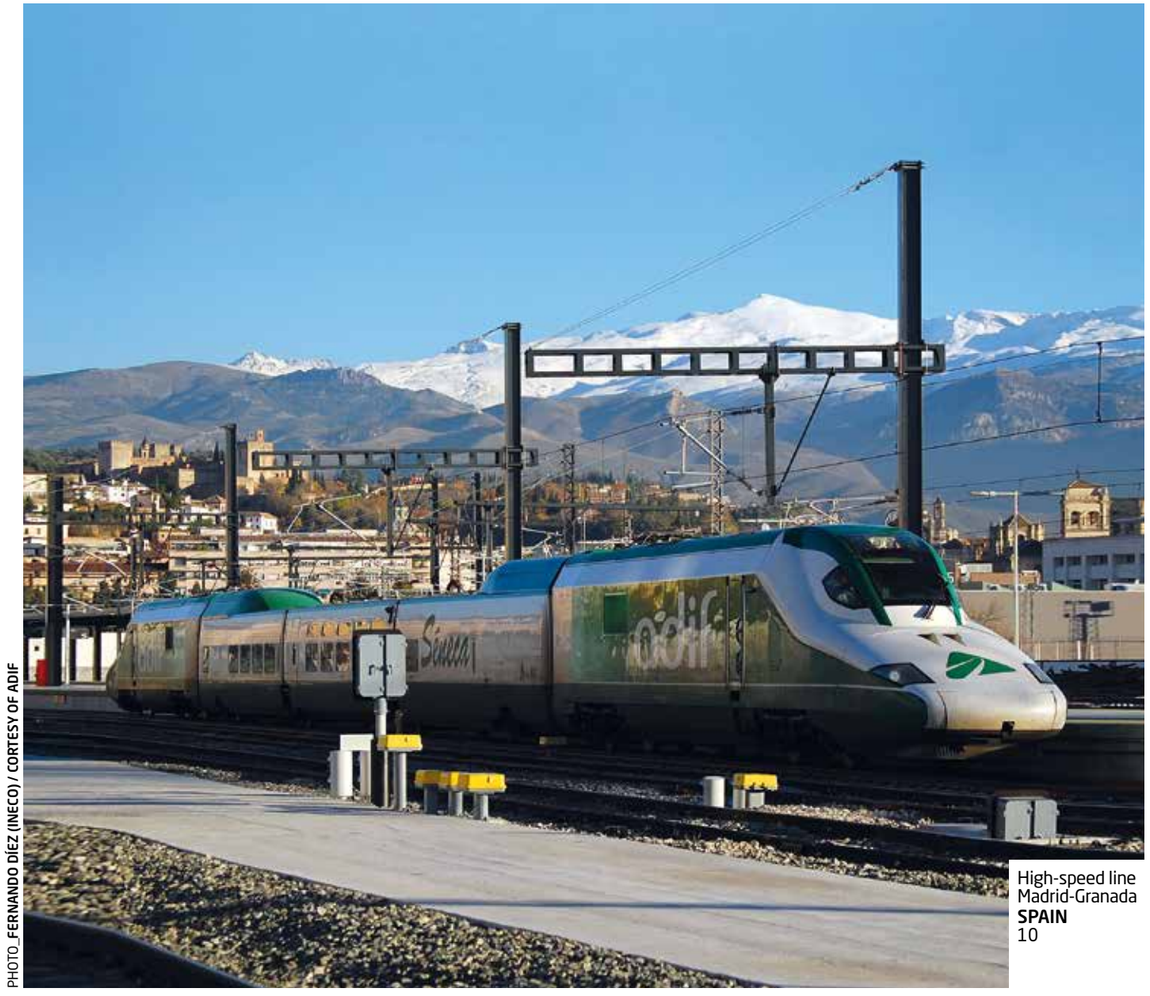

PHOTO_FERNANDO DÍEZ (INECO) / CORTESY OF ADIF

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ONE OF ADIF'S LABORATORY TRAINS DURING THE TRAVEL TESTING OF THE ACCESS TO GRANADA. PHOTO_FERNANDO DÍEZ (INECO) / CORTESY OF ADIF.

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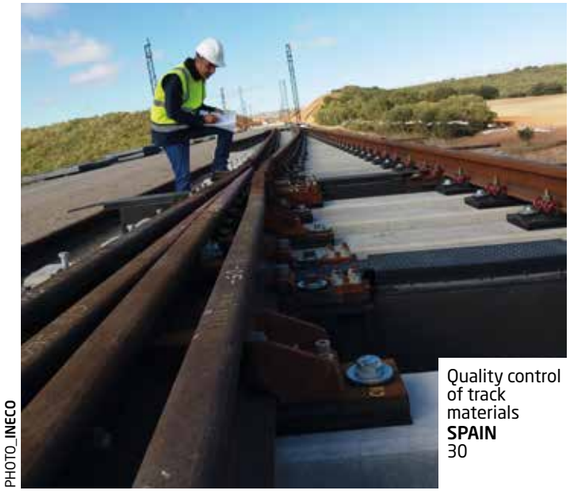

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RAIL BALTICA: DESIGN OF A HIGH-SPEED LINE

The joint venture that is executing the Rail Baltica project –a rail network for passengers and freight that will connect Estonia, Latvia and Lithuania with Finland and Poland and the rest of Europe– has awarded the Spanish engineering firms IDOM and Ineco the technical design contract for a 56-kilometre high-speed section in the city of Riga, consisting of three subsections: Upeslejas central station-Riga (in the image); Tonsakalns-Imanta and Riga International Airport-Misa River. The project, which was awarded in May, has a 24-month deadline.

Ineco is already working on two other contracts for Rail Baltica, in this case in consortium with the Spanish company Ardanuy: the implementation of energy systems and definition of maintenance facilities on the entire 870-kilometre line.

EUROPE

NEW ERTMS STUDY FOR THE EUROPEAN COMMISSION

The European Commission has awarded Ineco the contract to undertake a study entitled *Support to the European Commission on the deployment of ERTMS on Core and Comprehensive Networks: On-Board and Infrastructure deployment strategies.* Ineco is heading up this job in conjunction with the consulting firm PWC with the aim of facilitating the deployment of the ERTMS system in different European fleets. To carry it out, three specific networks will be identified and described from an operator's perspective, and this will enable a commercial decision to be made with regard to investing in ERTMS trains, taking into account all of the technical aspects that this entails.

INDIA

ERTMS FOR THE EASTERN RAIL FREIGHT CORRIDOR

Ineco will be providing assistance to the state-owned company Dedicated Freight Corridor Corporation of India Limited, part of India's Ministry of Railways, for the acquisition of ETCS/ERTMS level 1 signalling systems for the Eastern Dedicated Freight Corridor, one of the two that are being built, totalling 3,358 kilometres. The 1,300-kilometre Eastern corridor is divided into two sections: Dadri-Khurja-Bhaupur-Allahabad-Mughalsarai-Sonnagar (896 km) and Sahnewal-Pilkhani-Khurja (404 km). The project is being financed by the World Bank.

AENA INTERNACIONAL TO MANAGE SIX AIRPORTS IN BRAZIL

Aena Internacional has been announced by the Brazilian National Civil Aviation Agency (ANAC) as the winning bidder of the 30-year concession tender for the Northeast Brazil airport group, consisting of six airports (Recife, Maceió, Joao Pessoa-Bayeux, Aracajú, Juazeiro do Norte and Campina Grande). Ineco collaborated with Aena on the preparation of the bid.

The Northeast airport group recorded passenger traffic of more than 13 million in 2018, 6.5% of the total traffic in Brazil.

From left to right: The presidents of Adif and Ineco, Isabel Pardo and Carmen Librero, with Pedro Ruiz, Moisés Gilaberte and Laura López, from Ineco.

SPAIN

OPENING OF THE AVE HIGH-SPEED LINE TO GRANADA

On 25 June, the new AVE high-speed line between Madrid and Granada officially opened with an inaugural journey attended by the acting prime minister, Pedro Sánchez (in the centre of the image), the acting minister of Public Works, José Luis Ábalos, the president of Adif, Isabel Pardo de Vera (right), the president of Renfe, Isaías Taboas, and the secretary of state for Infrastructure, Transport and Housing, Pedro Saura, (left), among other guests and dignitaries.

Commercial operation began the following day, on 26 June, with three services in each direction between Granada and Madrid, a distance of 568 km and with a maximum travelling time of 3 hours 19 minutes. A daily service has also been established between Granada and Barcelona with a travelling time of 6 hours 25 minutes. All services stop in Cordoba.

The new high-speed line has three stations, in Antequera, Loja and Granada, and is equipped with ERTMS level 2 and GSM-R mobile communications (see report on page 10).

SAUDI ARABIA

ENVIRONMENTAL PLAN FOR DAMMAM AIRPORT

Ineco has drafted the Sustainability Management Plan of Dammam King Fahd International Airport in Saudi Arabia for the Dammam Airports Company (DACO). The work consisted of preparing an environmental assessment, identifying the objectives and proposing the actions and measures to achieve them, in addition to monitoring implementation and supervising the actions. This is Ineco's second job for Dammam Airport, the largest in the world in terms of area, after drafting its Master Plan, completed at the end of 2018.

The company has worked for more than 15 years on the environmental management of airports both in Spain and abroad, including Kuwait International Airport (2013), among others.

SWEDEN

INECO TO ASSIST SWEDAVIA IN THE CREATION OF A SPECIALISED ORAT DEPARTMENT

Swedavia, a Swedish public operator that manages 10 airports, managing approximately 42 million passengers per year, has signed a framework agreement with Ineco as a specialised ORAT consultant to assist it in the process of creating its own ORAT department with the aim of strengthening its management capacity.

Due to the growth of Sweden's air traffic over the last decade, the operator needs to undertake various expansions at its airports. To carry out the operational readiness and transfer of these new infrastructures, Ineco will provide Swedavia with its consulting services in order to identify resources and define the methodology to optimise these tasks.

Ineco's study will be carried out in several phases. Using the current situation as a starting point, the work will focus on determining the structure and dimensions of the new department, and the method of adapting it to Swedavia's organisational environment. The proposed solution will then be tested as a pilot project on the Göteborg Landvetter Airport expansion. The last stage will be the final implementation of the ORAT methodology, a process in which Ineco has 20 years of experience in Spanish airports across the Aena network and internationally, in airports such as Newark in the US, and Abu Dhabi, where the company has been carrying out an ORAT project since 2014.

On the left, section B of Paseo del Bajo on which Ineco and AC&A worked. In the foreground, the Eje Histórico de la Ciudad, and, in the centre, the Parque del Bajo and Casa Rosada, the official residence and office of the President of Argentina.

PHOTO_COURTESY OF AUSA, AUTOPISTAS URBANAS SA

Interior of the trench reserved exclusively for lorries weighing 12 tonnes or more and coaches, during construction (March 2019). The section has only three exits: Sur, Retiro and Norte.

An aerial view of the works in July 2018. In the centre, the trench of the semi-depressed four-lane highway reserved for heavy vehicles. In some sections, it runs on the surface or above ground level. On both sides, lanes for private vehicles and city buses.

Ineco's works inspection team, which was responsible for section B, from left to right: Luis Miguel Sesé, Óscar Heredia, Katherine Baez, Nora Vadino, Cecilia Biafore, Norberto Ripetta, Juan Pablo Morla and Sergio Leguizamón.

The elevated Section A South, linking the Paseo del Bajo trench with the La Plata and 25 de Mayo highways. In the background, the skyscrapers of Puerto Madero.

ARGENTINA

BUENOS AIRES OPENS THE NEW PASEO DEL BAJO AMID MUCH FANFARE

On 27 May, the Argentine capital opened a new 7.1-kilometre route that crosses the city from north to south, saving drivers up to 40 minutes of travel time. Ineco, with its local partner AC&A, was responsible for the inspection of one of the three sections of this complex construction, one of the largest civil works project ever in the country.

By **José Luis Pancorbo**, civil engineer and head of works inspection

According to the municipal government, more than 134,000 residents of Buenos Aires benefit directly from the Paseo del Bajo, a new 7.1 kilometre road corridor that opened in May and crosses the city from north to south, connecting the Buenos Aires-La Plata and Illia highways. It has a total of 12 lanes, four of which run in the semi-depressed central road section (trench) that is exclusively for heavy vehicles and operates as a highway: according to the Buenos Aires Department of Urban Development and Transport, every day more than 15,300 lorries weighing 12 tonnes or more and more than 800 coaches travel this section.

The rest of the traffic -which consists of approximately 76,000 private vehicles per day and public transport- uses the eight surface lanes located on both sides of the trench, four on each side (two in each direction), on Avenidas Alicia Moureau and Huergo. The left-hand lanes are designed for through traffic and cars are not allowed to stop. The project also included the construction of nine bridges along the Paseo to connect both sides of the road and 60,000 m² of green areas, bicycle lanes and a large pedestrian stairway by the Puente de la Mujer bridge, which connects Plaza de Mayo to the Puerto Madero district of the city.

> IT IS ONE OF THE MOST IMPORTANT CIVIL WORKS PROJECTS IN THE COUNTRY AND, THANKS TO IT, TRAVEL TIME HAS BEEN REDUCED FROM 50 TO 10 MINUTES

INECO'S PARTICIPATION

Beginning in 2017, Ineco, together with its local partner AC&A, carried out inspection work for AUSA (Autopistas Urbanas SA) on the new infrastructure's section B, the 'southern semi-covered trench,' which was opened to traffic on 27 May after several days of events and in an atmosphere of celebration: it was a project that was long-awaited by the three million inhabitants of the Argentine capital, which, together with its metropolitan area, has a population of around 12 million people.

It is one of the most important civil works projects in the country and, thanks to it, travel time has been reduced from 50 minutes to 10 minutes. The new road enables cargo traffic to travel from the Buenos Aires-La Plata highway, cross the city centre without having to stop for traffic lights and directly access the port and Retiro bus terminal.

On 27 May, the Paseo del Bajo opened to traffic in front of a large audience. Speakers at the ceremony included the Argentine president, Mauricio Macri (in the centre of the image with microphone), the head of government of the Autonomous City of Buenos Aires, Horacio Rodríguez Larreta, and the governor of the province, María Eugenia Vidal.

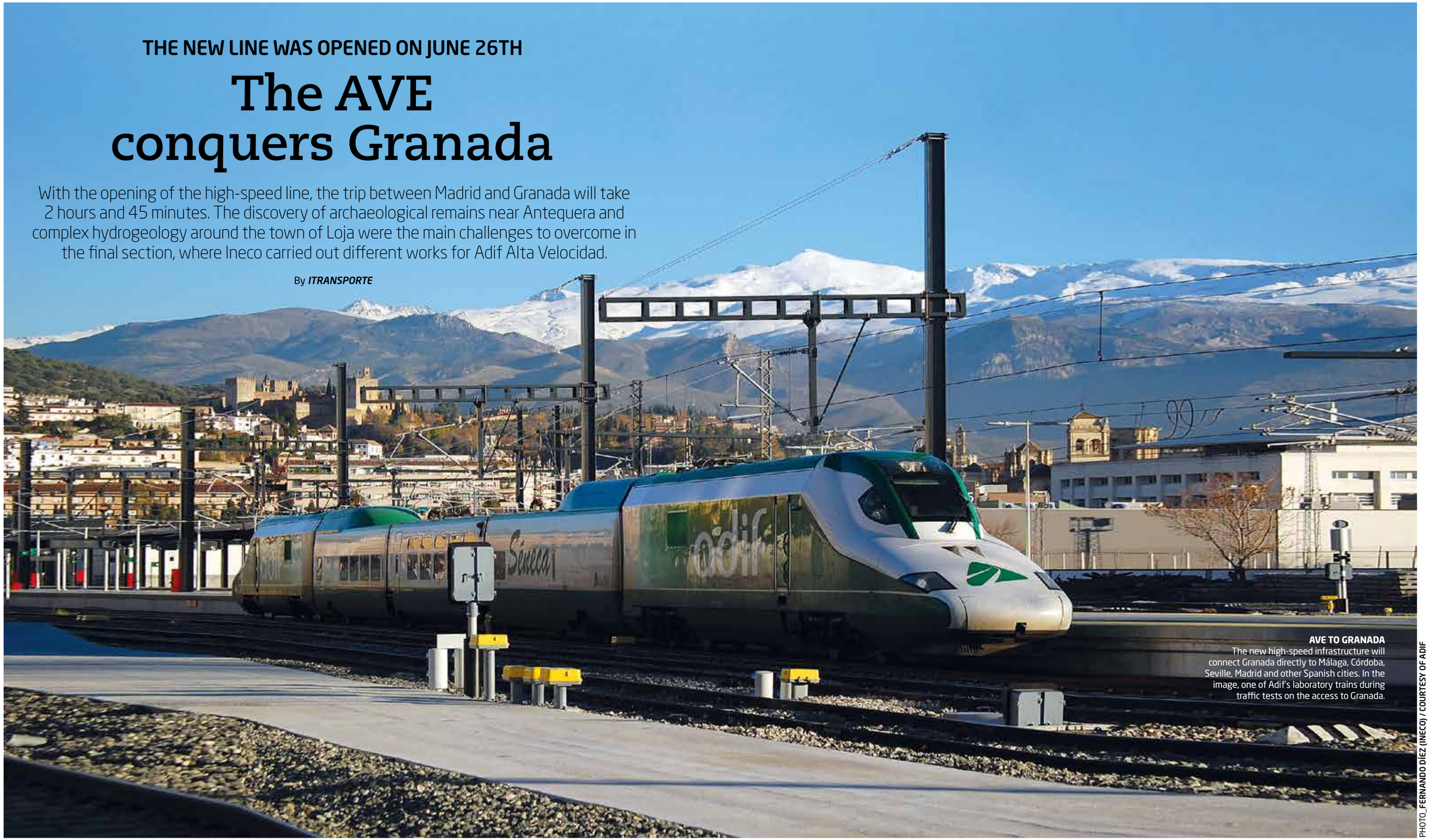
PHOTOS_INECO

THE NEW LINE WAS OPENED ON JUNE 26TH

The AVE conquers Granada

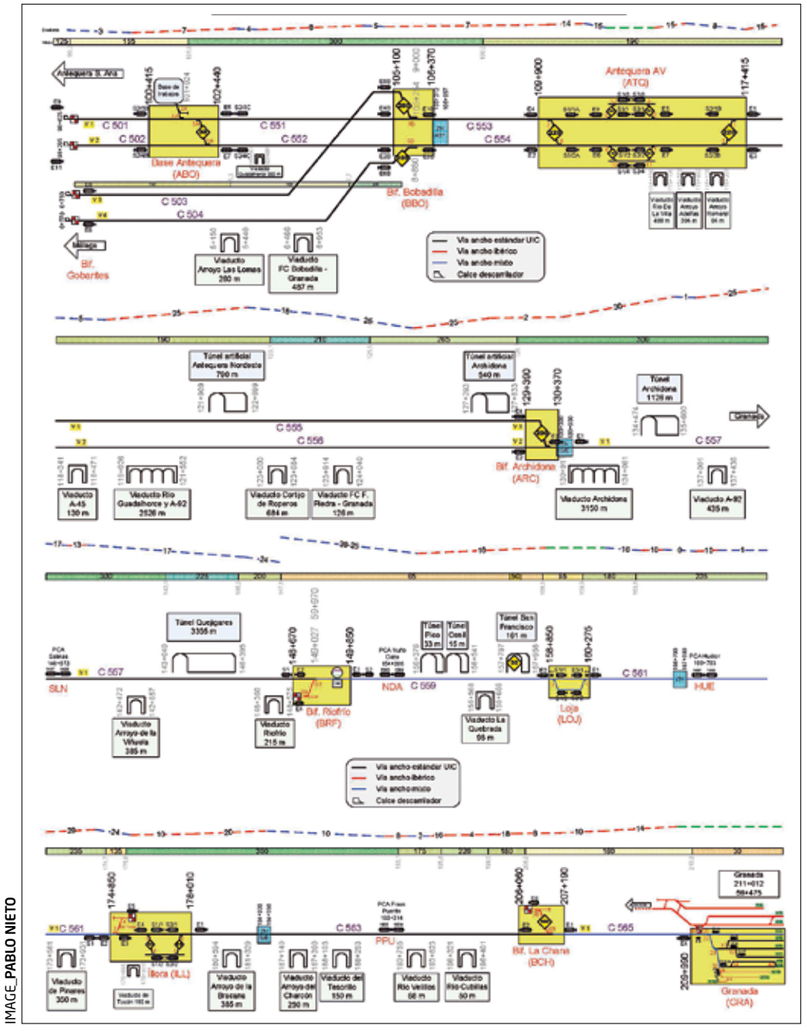
With the opening of the high-speed line, the trip between Madrid and Granada will take 2 hours and 45 minutes. The discovery of archaeological remains near Antequera and complex hydrogeology around the town of Loja were the main challenges to overcome in the final section, where Ineco carried out different works for Adif Alta Velocidad.

By ***ITRANSPORTE***



AVE TO GRANADA
The new high-speed infrastructure will connect Granada directly to Málaga, Córdoba, Seville, Madrid and other Spanish cities. In the image, one of Adif's laboratory trains during traffic tests on the access to Granada.

PHOTO_**FERNANDO DÍEZ (INECO) / COURTESY OF ADIF**



IMAGE_PABLO NIETO

A track diagram of the Antequera-Granada high-speed section and its special features.

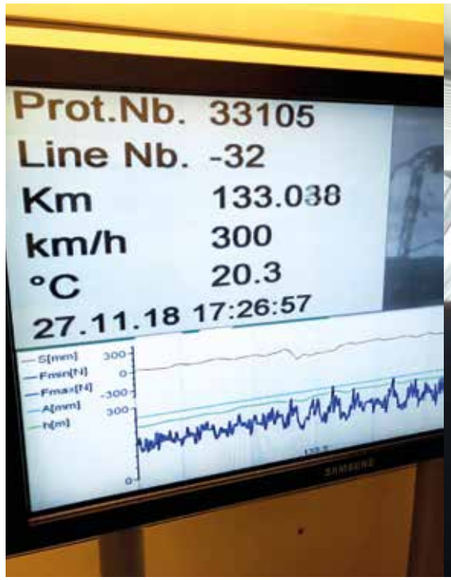
Pre-validation tests on the line between Antequera and Granada ended on 20 December 2018, when traffic control was transferred to Adif Alta Velocidad. The infrastructure manager then gave the green light for the start of a period of internal ERTMS traffic testing between Antequera and Granada, prior to reliability and training processes. Once this phase is complete, the high-speed AVE connection between the capital of Spain and the city that is home to the Alhambra will be a reality.

The 114 kilometres of line between Antequera and Granada and its direct connection to Málaga via the Gobantes Junction have been built predominantly in standard gauge, 33% double-track and the rest single track electrified at 25 kV with a top speed of 300 km/h. The exception is 26.3 kilometres of mixed-gauge line consisting of three rails where the line passes through Loja and at the entry into Granada. With the commissioning of the new line, Granada is now finally connected to the rest of the Spanish high-speed network through the Córdoba-Málaga line.

Ineco has participated in the development and construction of this line since its beginnings, carrying out various projects that include consulting and technical assistance for the environmental management of the entire final stretch in Andalusia; platform construction management, project and construction management of the Antequera, Loja and Granada high-speed stations; clearance studies and adaptation of the Loja tunnels; consulting and technical assistance for the construction management of track assembly, and power, signalling and communications facilities along the entire line.

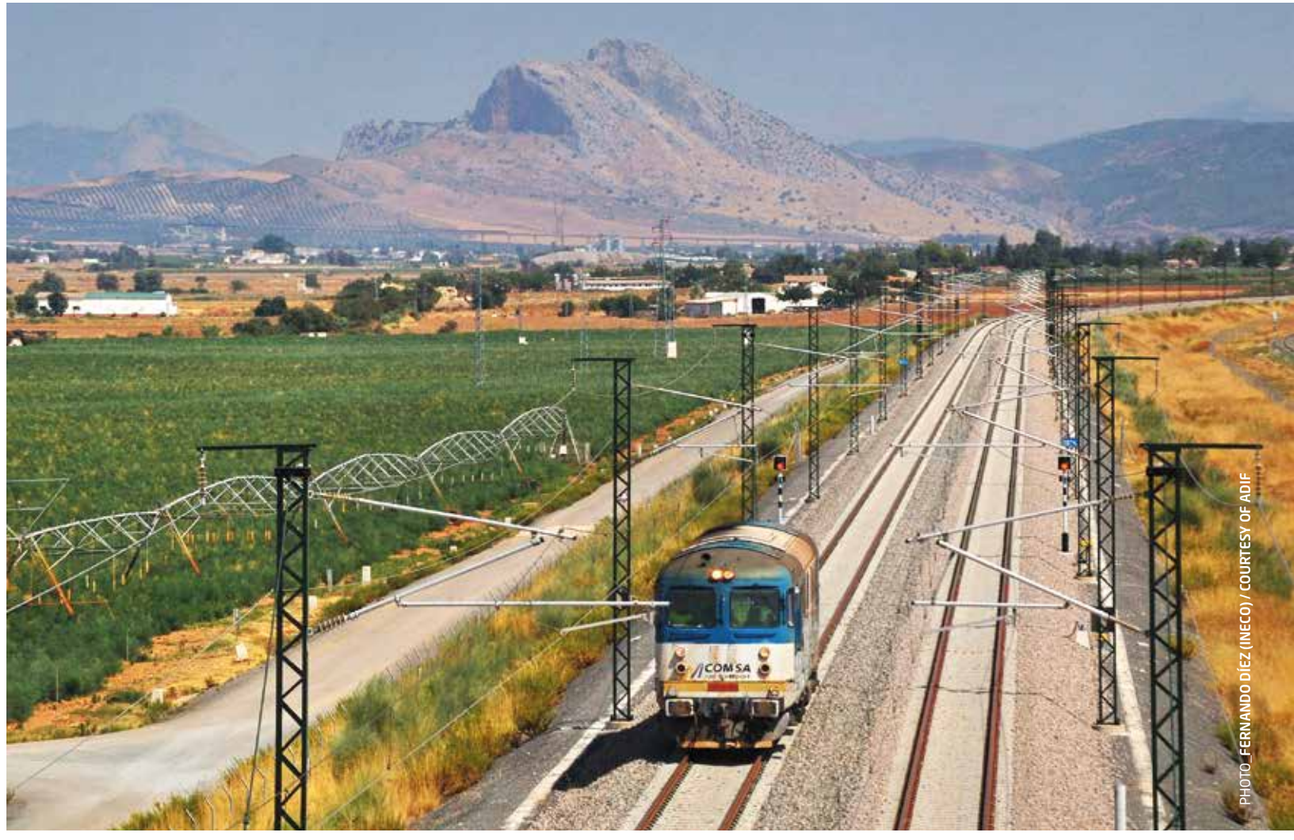
COMPREHENSIVE RAIL TRAFFIC MANAGEMENT

Traffic testing was the final job carried out by Ineco for Adif and Adif Alta Velocidad. In 2018, Ineco's traffic management team directed traffic control and performed functional testing during phase 3 of track assembly, facilities and overhead contact line works on all sections. Ineco's qualified personnel were responsible for comprehensive rail traffic management, which involved directing operations, supervising safety in dangerous areas of the works and ensuring compliance with train safety, construction and testing regulations prior to handover to Adif. The team also managed safety facilities from the CTC located in Granada and was responsible for managing geometric and dynamic testing with laboratory trains to ensure optimum traffic conditions at >10% of the maximum speeds allowed at each point.

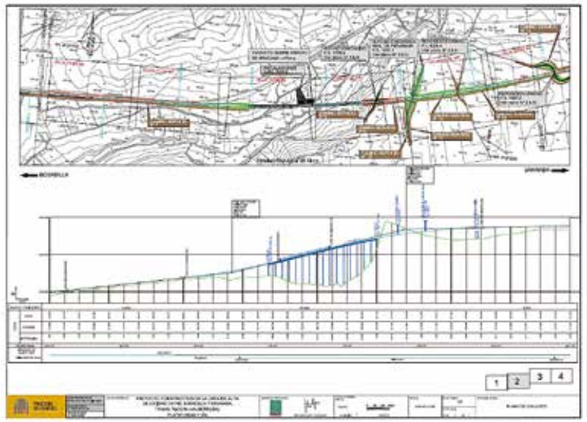


PHOTO_INECO

The screen of a catenary geometry recorder on the laboratory train travelling at 300 km/h; on the right, Pablo Nieto and Pedro Asegurado, Ineco staff who were in charge of comprehensive rail traffic management, managing operations and ensuring compliance with safety regulations. Below, a locomotive equipped with instruments for ERTMS L2 tests in the vicinity of Antequera HS.



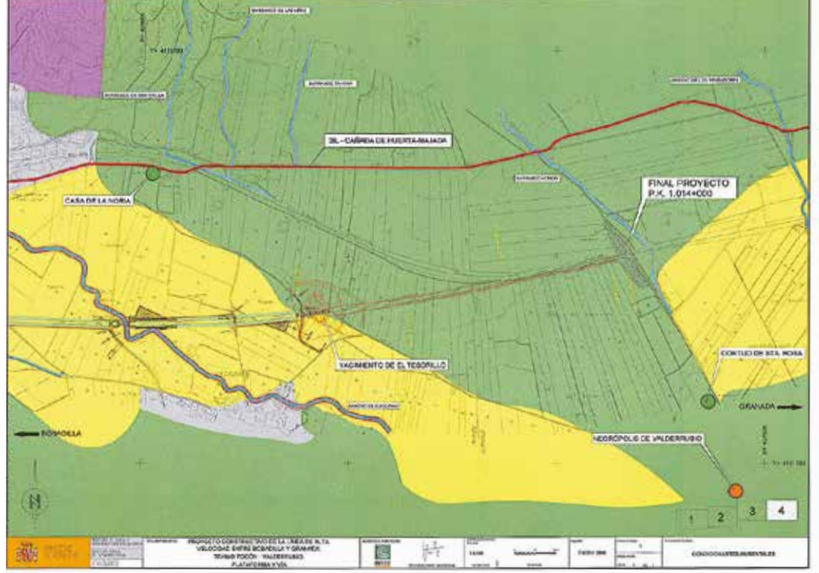
PHOTO_FERNANDO DÍEZ (INECO) / COURTESY OF ADIF



A diagram of the 446-metre Brácana viaduct.

PHOTO_ADIF

The Archidona viaduct.



In the image, a plan of the El Tesorillo viaduct designed with detachable beams in case further excavation is required in the future.

PHOTO_ADIF

A sculpture of the owner of a Roman villa (1st century AD).

THE FIRST STEPS: THE CONSTRUCTION PROJECTS

In 2005, as part of its 2005-2020 Strategic Infrastructure and Transport Plan, the Ministry of Public Works, through a public tender, awarded Ineco the infrastructure and track construction project for the high-speed line between Bobadilla and Granada, part of the Tocón-Valderrubio stretch. The section was designed to allow general speeds of up to 350 km/h and 220 km/h over points. The total length of the section was 14.082 kilometres, with the most significant structures being a 734-metre-long viaduct over the Brácana ravine and the 650 metre Íllora cut-and-cover tunnel. With the project in the home stretch prior to handover, archaeological remains were discovered in the town of Escóznar known as 'El Pago de El Tesorillo,' a place mentioned vaguely in a scientific article as the location of undetermined Roman ruins. In order to minimise impact on the area, the railway gradient was raised, and the embankment was replaced by a 150-metre viaduct. The design of El Tesorillo viaduct consisted of five 30-metre spans, a maximum height of 5 metres and detachable beams, in case further excavation is required in the future.

NEOLITHIC VILLAGE AND ROMAN VILLA

To reach Granada, at an altitude of 738 metres above sea level, AVE trains have to ascend from 380 metres at Antequera, Málaga, crossing gentle plains interrupted only by the complex geography near the town of Loja, flanked by two mountain ranges and crossed by several rivers and aquifers, where the train line has followed a meandering route that dates back to the 19th century.

It is here when they pass through this town - and until the Loja bypass is built - that fast AVE trains have to slow down to travel along the old conventional track adapted with a third rail, a project carried out by Ineco, as well as the 2.3 kilometres of the access to Granada station.

The company approached this complex passage through Loja by carrying out the platform construction and connection route project, including the construction of a new station, renovation of the track and permeabilization of the route. Ineco also adapted and reinforced three small tunnels and the existing geotechnical structures between them for the passage of the AVE high-speed line and several grade crossings were eliminated and replaced by new access routes.

In the construction of this infrastructure, Ineco adopted measures to eliminate or minimise the impact on the environment and cultural heritage, in compliance with legislation. Many affected heritage sites are defined in the construction project, meaning that corrective measures are taken before the works begin. Other elements are found in the subsoil and are only discovered when earthmoving begins, making it necessary to coordinate all of the archaeological activities.

This was the case of the discovery of a Neolithic village near Antequera that affected the route of the AVE high-speed line. A Roman oven from the 1st-century AD was discovered, which Ineco and Adif turned over to Antequera museum in collaboration with the Regional Government of Andalusia's Department of Culture and the local city council. Removal, structure consolidation and final transfer works were done by a specialized company, Taller de Investigaciones Arqueológicas. Another important site discovered in Antequera was the 'Casería Mayorga/Silverio' Roman villa and necropolis, a discovery that highlighted the economic and demographic importance of the Vega de Antequera region in Roman times. One of the most important conservation measures carried out during the infrastructure construction works was the recovery and transport of the most significant elements of this residential villa complex (its mosaic floors and a sculpture of its owner) to the Antequera Museum.

PLATFORM AND TRACK ASSEMBLY WORKS

Construction of the platform began in 2006, with Ineco and Adif in charge of construction management. Track assembly was carried out in several sections: Antequera-Loja, Gobantes-Bobadilla, Loja-Tocón, Tocón-Granada and Granada station and accesses. In the Antequera-Loja and Tocón-Granada sections, Ineco provided track assembly technical assistance to construction management, while, in the Loja-Tocón section and the Granada station and accesses, the company was in charge of construction management for the platform and track.

The goal of the project was to put the track into service on the platforms that would allow high-speed traffic to take advantage of the longer section compatible with the current arrangement. The Antequera work base was also connected using 1.435 gauge to the new high-speed line in order to facilitate maintenance operations on the Antequera-Granada line during the operating phase.

SIGNALLING AND COMMUNICATIONS SYSTEMS

Ineco was responsible for technical assistance in relation to the supervision and oversight of project drafting, execution of works, maintenance and upkeep of signalling control points, train protection systems, CTC and auxiliary detection systems, as well as the technical assistance for fixed telecommunications, protection and security facilities, and GSM-R.

When it begins to operate, the line will have ERTMS Level 2. Ineco is currently participating in the dynamic testing of the ERTMS L2 system, as well as ERTMS/ETCS level transitions between the Córdoba-Málaga and Antequera-Granada high-speed lines.

LSB (lateral signalling block) was used with AVE mode ASFA as a back-up system to the ERTMS, using audio frequency track circuits and axle counters in mixed track areas. On the conventional line, which will be accessed from Antequera-Granada, an automatic single-track release block was established and the automatic single-track block between Granada and Albolote was adapted.

The facilities that were made available for performing the ERTMS tests included Antequera HS, and Íllora and Granada HS electronic signalling control, with their associated trackside and cabin elements, as well as LSB along the entire Antequera-Granada line; the updating and integration of new equipment for the Antequera Santa Ana CTC; falling objects detectors in elevated sections and tunnel mouths, hot-box detectors, lateral wind detectors and their integration into the remote control of auxiliary detection systems on the Córdoba-Málaga high-speed line; fixed and mobile telecommunications network (GSM-R), fibre optic network, SDH transmission systems, IP/MPLS data network, switched telephone network, etc.; video surveillance and access control and the installation and integration of new CTC equipment into the Antequera control and regulation centre and the centralised control centre in Madrid-Atocha.

Prior to these tests, the Córdoba-Málaga high-speed line was connected via the Gobantes junction for integration into the LZB systems, adapting the field elements, electronic signalling control and existing train protection systems in Antequera Santa Ana belonging to the Córdoba-Málaga high-speed line, due to the new connection of the station to the Antequera-Granada high-speed line and the replacement of the electric signalling control of Granada station with ENCE, integrating the connection of the Antequera-Granada high-speed line.

ENERGY SUPPLY AND CIVIL PROTECTION OF TUNNELS

In terms of energy systems, Ineco was in charge of technical assistance on works relating to electric traction substations and auto transformation centres, energy remote control and

PHOTO_**ADIF**

PHOTO_**ADIF**

Civil protection safety facilities in the Quejigares tunnel.

overhead contact lines and associated systems, such as point heating, tunnel lighting and power supply to consumers, in addition to civil protection and safety facilities.

The company was also commissioned to carry out an independent safety assessment (ISA) of the control, command and signalling system, as well as an independent assessment under Regulation 402/2013 (ASBO) of the rest of the TSI subsystems, their interfaces and their secure integration for the commissioning of the line.

THREE HIGH-SPEED STATIONS

Ineco drafted the projects to adapt three stations on the last section of this line to high speed: Antequera, Loja, and Granada. At the Antequera station, the project included a new passenger building, access road, car park, pedestrian connection and track overpasses to connect to the conventional station.

For Loja's new high-speed station, Ineco was responsible for drafting the project and construction management. It also drafted projects for an underpass between platforms and is currently finalising a project for a footbridge in the neighbourhood of Esperanza. The last works on the station include the construction of the canopies over its central platform.

As for the Granada station, the project for the arrival of high speed included the renovation and extension of its passenger building. The result is a building with a U-shaped layout that brackets the track yard and platforms, which are joined by the head house. The extension is carried out by means of a large canopy that joins the existing and new buildings; it extends and looks out over the plaza to mark the new entrance and is curved to protect the new concourse from the passage of the metro. This outer covered threshold is the hinge point between the existing building and the extension. The eastern façade of the boarding area is transparent to enhance views of the Alhambra and Sierra Nevada.

PHOTO_**RAFAEL LÓPEZ (INECO) / COURTESY OF ADIF**

A technical hut with signalling facilities at the Bobadilla junction.

This report was made possible thanks to special contributions by ***Pedro Asegurado*** *and* ***Pablo Nieto,*** *specialized railway technicians;* ***Fernando Díez,*** *traffic expert;* ***Javier Cáceres,*** *biologist;* ***Marisa de la Hoz, Diego Martínez, Aránzazu Fernández*** *and* ***Lidia Sainz-Maza,*** *civil engineers;* ***Carlos Montero, Antonio Sancho, Carlos Palomino*** *and* ***Arantxa Azcárraga,*** *architects;* ***Manuel Fernández,*** *electrical engineer;* ***Rafael Soler,*** *mechanical engineer;* ***Javier Millán,*** *telecommunications engineer;* ***Laura L. Brunner,*** *bachelor of physical sciences;* ***Manuel González,*** *industrial technical engineer;* ***Daniel Pérez,*** *signalling expert;* ***David Carrasco,*** *industrial engineer;* ***Fernando Cardeña,*** *communications, video surveillance and access control expert;* ***Javier Barragán,*** *overhead line technician;* ***Rafael Arévalo,*** *energy expert;* ***Francisco Perrino,*** *auxiliary detection system expert; and* ***Manuel Tirado,*** *ERTMS expert.* ■

MULTIDISCIPLINARY PARTICIPATION

Works carried out by Ineco for the completion of the Antequera-Granada section:

▶**Construction project f**or the Tocón-Valderrubio stretch.

▶**Environmental management.**

▶**Construction management and technical assistance** on platform and track assembly works.

▶**Córdoba-Málaga line** connection project.

▶**Clearance studies** on tunnels and stations in Loja and Granada.

▶**Platform and track assembly** project in Loja.

▶**Track renovation and permeabilization** of the route between Riofrío and Tocón.

▶ **Technical assistance** on works relating to signalling control points, train protection systems, CTC and auxiliary detection systems.

▶ **Technical assistance on works relating to fixed** telecommunications, GSM-R and protection and safety facilities.

▶ **Technical assistance on works relating to electric traction** substations and auto transformation centres, energy remote control and overhead contact lines.

▶ **Technical assistance on the construction** of civil protection and safety facilities in tunnels.

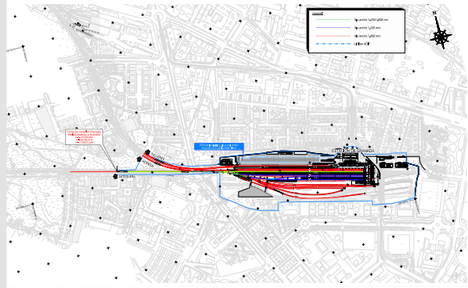
▶ **Construction project** for the redesign of the tracks leading to Granada station for the construction of a new station.

▶ **Projects on the high-speed stations** of Antequera, Loja and Granada.

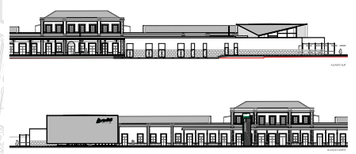
▶ **Regulation and management of train traffic** and works on the track, and testing of trains and facilities on the new line.

Loja station.

PHOTOS_**ADIF**



Plan view of the Granada station as a whole and elevations.



Interior of the Granada station.

PHOTO_**OLGA VALCARCE (INECO) / COURTESY OF ADIF**

Antequera station.

PHOTO_**ALEXANDER SCHIMMECK / FLICKR**

The Magdalena River near San Agustín, 34 kilometres from Pitalito.

Proposal for the development of Pitalito Airport involving runway extension and a new terminal.

Small airports with big prospects

Ineco has drafted a master plan for Germán Olano Airport (Puerto Carreño) and airport planning schemes for San Bernardo (Mompox) and Contador (Pitalito) Airports for the Colombian Civil Aviation Authority. These are three small airports that have great impact for the economy and connectivity of their respective regions, especially thanks to tourism, which is opening up the prospects for a promising future.

By **Manuel Francisco**, civil engineer, **Carlos González** and **Eusebio Gracia**, aeronautical engineers


Pitalito Airport's control tower.

Secondary airports are essential for connectivity in a country with a territory as extensive and rugged as Colombia. The Andes Mountains and large rivers such as the Magdalena, Orinoco and Amazon crisscross the country, and many areas are isolated and have minimal land transport infrastructures. More than a dozen communities across the country depend on air or river transport, including Puerto Carreño (Vichada) in the east of the country, bordering Venezuela. In 2018, Ineco, in consortium with the Colombian consultancy firm Concol (now WSP), produced the Master Plan for Germán Olano Airport in Puerto Carreño and the airport planning schemes for Contador de Pitalito and San Bernardo de Mompox Airports. The three airports are administered directly by Aeronáutica Civil, Colombia's Civil Aviation Authority.

THE THREE AIRPORTS HAVE GOOD GROWTH PROSPECTS LINKED MAINLY TO THE DEVELOPMENT OF TOURISM, WHICH HAS INCREASED THANKS TO COLOMBIA'S PEACE PROCESS, AMONG OTHER FACTORS


Improvements to Colombia's small airports will contribute to regional development, thanks to their great agricultural, commercial and tourist potential and strategic location within the country. In the image, passengers boarding an aircraft at Pitalito Airport.

PITALITO

This is the provincial capital of the southern subregion of the department of Huila, Colombia's main coffee-producing area and one of the most dynamic economic hubs in the region. It is a municipality with a vocation for tourism, strategically located close to the departments of Putumayo, Caquetá and Cauca, boasting several tourist attractions, including the San Agustín archaeological park, one of Colombia's most important archaeological sites. Since the beginning of the peace process, the number of tourists who visit the area has increased and the regional government has set its sights on turning Pitalito into an important node of development thanks to its significant agricultural, commercial and tourism potential and its strategic location within the country.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01. Germán Olano Airport is located in the urban area of Puerto Carreño and is the principal means of access to the municipality.

02. El Tuparro National Natural Park was recognised as a biosphere reserve by UNESCO in 1982.

03. and **04.** Mompox's aircraft parking apron and tower.

LARGE RIVERS SUCH AS THE MAGDALENA, ORINOCO AND AMAZON CRISSCROSS THE COUNTRY AND MANY AREAS ARE ISOLATED WITH SCARCE LAND TRANSPORT INFRASTRUCTURES. MORE THAN A DOZEN COMMUNITIES DEPEND ON AIR OR RIVER TRANSPORT

PUERTO CARREÑO

This is the capital of the department of Vichada, the second largest in Colombia.

The long-term development of the three airports calls for improvements to aspects both in the air and on ground. In the image, Pitalito's new terminal.

It is located on the border with Venezuela. It is an area with great ecological, hydrological and ethnic richness, with some of the principal activities including recreational fishing and commercialisation of ornamental fish. The region is also home to part of the El Tuparro National Natural Park, a national heritage site that was recognised as a biosphere reserve by UNESCO in 1982. The city is surrounded by three important rivers, the Orinoco, one of the most important river systems in South America, the Meta and the Bita, the latter of which is listed as a protected river. Germán Olano Airport is located in an urban environment and is the principal means of access to the municipality as river navigation is only possible at certain times of the year, and because of its location far from other major population centres and the major difficulties for access by land.

MOMPOX

This municipality was listed as a heritage site by Colombia in 1959 and a world heritage site by UNESCO in 1995, thanks to the preservation of its colonial architectural features. The city hosts two important cultural events that currently generate most of the airport's business: the Holy Week celebration, ranked second in importance in the country after Popayán, and the Mompox Festijazz jazz festival. The local economy revolves around fishing, its famous ornamental gold filigree work and tourism, which is one of the most important factors for creating passenger demand. In addition, aviation has great potential due to the area's important tourist attractions and the difficulty of accessing them by land, as well as the best regional integration once the new Bodega-Yatí bridge goes into service, which will improve the area's connectivity by land.

FUTURE PLANS

Proper planning that takes different development scenarios into account is fundamental for organising the future growth of an airport and meeting the expected demand with all of the required guarantees of safety and quality of service. Ineco has extensive experience in this field of planning in airports in Spain and abroad.

In the cases of these three Colombian airports, Ineco studied the current situation of each one and its socioeconomic area of influence, which served as a basis for the development of a traffic projection for the next 30 years. This projection enabled us to determine future needs in the short, medium and long term and, based on the current situation, the design alternatives. Subsequently, an analysis of the environmental, urban and social impacts was carried out, which, together with the rest of the factors studied, determined the alternative to select. Lastly, detailed calculations were prepared to determine the financial investment required by the different actions in the short, medium and long term at each airport. The work was complemented with 3D modelling of the proposed development at each airport and video visualisations of each of them.

The three airports are between 500 and 900 kilometres from the national capital, Bogotá, located in the centre of the country; the airports are used exclusively for domestic traffic and, with the exception of Germán Olano in Puerto Carreño, handle only passenger traffic. The latter, along with the Contador Airport in Pitalito, offers 'social routes' that are subsidised by the government and operated by the airline Satena, while in San Bernardo de Mompox, air taxis account for 100% of the airport's operations, although scheduled flights are expected to begin operation in the near future. As for their airport infrastructures, all three have runways shorter than 2,000 metres and small passenger terminals. In terms of traffic, the airport with the highest volume is Puerto Carreño, with 41,825 passengers and 5,885 tons of air cargo in 2017. Contador de Pitalito Airport, recorded a total of 15,530 passengers, all carried by the airline Satena, while San Bernardo de Mompox serviced 685 passengers, all of them air taxi traffic.

Above: air transport has great potential in Mompox, whose historic centre was listed as a heritage site by Colombia in 1959 and a world heritage site by UNESCO in 1995, thanks to the area's important tourist attractions.

Below: Germán Olano Airport in Puerto Carreño, where work will include an extension of the runway in order to operate flights to Bogotá and a new apron for aircraft and helicopters.

INECO CARRIED OUT A SOCIOECONOMIC STUDY OF THE AREA OF INFLUENCE OF EACH AIRPORT, WHICH SERVED AS A BASIS FOR CALCULATING A TRAFFIC PROJECTION FOR THE NEXT 30 YEARS

PLANNED DEVELOPMENT

According to the studies carried out by Ineco and Concol, all three airports have good growth prospects of around 4% per year over the next 30 years, linked mainly to the development of tourism which, among other factors, has been boosted by Colombia's peace process.

The long-term development of the three airports calls for improvements to airport infrastructure both on the ground and in the air in order to meet demand according to national and international quality standards and to comply with Colombia's current regulations. For the study horizon of 122,800 passengers and 4,580 operations at Germán Olano Airport in Puerto Carreño, the main actions include an extension of the 150-metre runway in order to operate flights to Bogotá, a new apron for aircraft and helicopters, a new cargo area, as well as a new passenger terminal that meets international safety standards in terms of passenger flow and where good passenger service is provided.

At Contador de Pitalito Airport, traffic of 63,000 passengers will be reached with the proposed development, and actions therefore include the extension of the runway by 370 metres in order to operate flights to Bogotá, apron enlargement for the parking of up to three aircraft, a new passenger terminal, a cargo area and weather station, and adequate space has been reserved for a new control tower.

The following actions are planned at San Bernardo de Mompox Airport to meet the long-term demand of 12,360 passengers per year: a runway extension of 370 metres to operate flights to Bogotá, a new apron for parking four aircraft, a new passenger terminal incorporating the current terminal, providing passengers with an example of the municipality's typical colonial architecture, and the reservation of space for a new control tower.

Actions at all three airports include adapting their airfields to current regulations and renovation of road surfaces, new firefighting buildings, car parks and adequate access to each of them, and the necessary facilities for airport operations, such as power plant, fuel storage, hydrocarbon separation plant, water treatment facilities, drainage facilities, etc. ■

JUAN CARLOS SALAZAR

“Over the next four years, there are plans for the investment of 3.8 billion pesos, which will enable us to make great progress in the modernisation of the sector”

An expert in air transport and commercial and tax law, Colombia’s Director General of Civil Aeronautics has 25 years of experience in the sector.

In recent years, passenger air traffic in Colombia has grown continuously. What are the current figures and forecasts for the coming years?
Air transport worldwide has experienced rapid and dynamic growth in recent decades, and the trend is expected to continue in the coming years. These changes are consistent with the strengthening and sustained development of global economic conditions and the generation and implementation of public policies aimed essentially at deregulation and liberalisation of air passenger and cargo transport markets.

With this in mind, from our perspective of Civil Aeronautics, and as described in the 2030 Strategic Aeronautical Plan, it is estimated that by 2030, there will be almost 100 million passengers per year and double the cargo transport, in a clear, competitive, connected, safe and sustainable institutional environment supported by renewed infrastructure, robust industry and highly talented people.

This growth is in line with what has been happening in recent years. For example, according to 2019 figures, we have grown by 9.1%.

A LONG CAREER AS A MANAGER
With a Bachelor of Law degree from Pontifical Bolivarian University in Medellín, Juan Carlos Salazar also holds a Master’s in Aeronautical and Space Law from McGill University in Canada and a Master’s in Public Administration from Harvard University. An expert in Commercial and Tax Law, he has worked in the aeronautical sector for more than 25 years: he has served as general secretary and legal director of Tampa Airlines; General Director of Air Transport at the Ministry of Transport of Colombia; secretary of the Management Board of Civil Aeronautics; and advisor to the United Arab Emirates’ General Civil Aviation Authority (GCAA).

What impact is the peace process having on this growth?
The peace process is one of the main reasons why increasing numbers of foreigners are coming to Colombia, a figure that reached 13.8 million passengers in 2018. But, in addition, it is the clear result of major government efforts to make progress in the modernisation of the airport and aeronautical infrastructure throughout the country and strengthen regional connectivity with an offering that continues to expand. Indeed, in the last few months, two new aviation companies have started operations in Colombia’s regions, and two other companies are in the process of obtaining their operating licences.

And what about airport infrastructure concessions?
The concession arrangement has allowed the country to modernise and adapt its airport infrastructure to the 21st century. The airports that the country has today are a response to Colombia’s present and future aviation needs.

As far as Civil Aeronautics is concerned, we have been investing millions in construction, maintenance and studies and designs for several different airports in the country.

As part of the National Development Plan, an investment of 3.8 billion pesos has been planned for the next four years and this will enable us to make significant progress in the modernisation of the aviation sector and contribute to economic and social development and greater competitiveness.

Currently, trunk airports are being improved with investments in Leticia, Popayán, Armenia, San Andrés and Providencia, Rionegro Cartagena, Yopal, Buenaventura, Pasto, Ipiales, and Riohacha, and Ciudad Región Airport (El Dorado) and 10 regional airports (Amalfi, Urrao, Condoto, Barrancabermeja, Paz de Ariporo, Cravo Norte, Puerto Carreño, Villa Garzón, Nuquí and Pitalito). We hope to continue with this trend, providing the country with infrastructure that is constantly improving.

The Government has announced major investments in the development of regional tourism. Will this create new routes?
These investments are already generating new routes. In 2019 alone, the operation of 58 new routes and frequencies was authorised**.** In addition, the liberalisation of commercial air traffic regulations has enabled new operators to enter and offer their services. Twenty-two new routes have been approved for non-scheduled operators, which shows the dynamism that tourism has given to aviation.

Many of Colombia’s airports are in remote places and difficult to access. Do these destinations benefit from the social routes?
National air connectivity promotes the development of policies that encourage increased competition with gradual processes of liberalisation of markets and the operation of low-cost airlines, among others, and tends to provide air transport services in remote areas of the country, where air transport is the only transport alternative, allowing the movement of cargo and passengers between these regions and the main economic centres of the nation.

Colombia’s system of social routes is provided by the public airline Satena. In this service the operator travels to locations in the country that have limited accessibility and benefits from direct subsidies when there are no other companies that operate these routes. For example, to the month of April of this year, Satena operated 26 social routes, providing air transport to 38,000 passengers.

In addition, through Resolution 890 of 2019, we now allow non-scheduled operators (Aerotaxis) to operate routes with fixed frequencies and direct ticket sales on routes that are not operated by regular operators. This has provided remote regions of the country with new connectivity, thereby improving the quality of life in these regions.

> “The 2030 Strategic Aeronautical Plan estimates that by 2030, there will be almost 100 million passengers per year and double the cargo transport”

What development and investment plans do you have for airports?
In line with our new system of reformulated projects, we see airports as comprehensive functional units (trunk airports) where the aim is to unify all air and ground side systems into a single investment to meet airport infrastructure needs (runways, aprons, taxiways, control towers, firefighting services, security, cargo areas), as can be seen at Ciudad Región (El Dorado Airport), Rionegro and Cartagena, among others.

The headquarters of Civil Aeronautics of Colombia, located at El Dorado Airport, Bogotá. It opened in 2009 and employs approximately 600 people.

Airports strategically selected to contribute to the construction of an efficient air transport services network, taking advantage of the integrating capacity offered by this infrastructure.

In addition, actions are carried out to ensure the maintenance of the existing infrastructure both on the air side (runways, aprons, taxiways, end safety areas, etc.) and on the ground side (passenger terminals and other buildings) with the aim of preserving the condition of this infrastructure and guaranteeing sufficient capacity to continue facilitating the development of the air transport business.

Selection and prioritisation of projects follows identification and assessment of the special and specific needs of each airport to achieve its maintenance, improvement, modernisation and optimisation.

With regard to the above, how far along is the project for the new El Dorado Airport?
Regarding El Dorado II Airport, the Government decided to conduct operational studies on Bogotá’s TMA (terminal manoeuvring area) to determine the most operationally-appropriate project for the solution to meet the growing demand for traffic**.** The 10.9 billion peso contract was awarded to a consortium made up of two Colombian companies and one French company on 29 March of this year and project commencement was signed on 3 May 2019. The contract expires on 31 December of this year, but it is expected that significant results will be obtained before that date.

El Dorado boasts a significant volume of cargo traffic. How is it expected to evolve in the coming years?
Today, El Dorado Airport is the principal cargo airport in Latin America, handling around 742,000 tonnes in 2018. Estimates show average growth of 6% per year for the coming years, one of the highest rates in the world, and very consistent with what we have observed in recent years. ■

Extension of Line 12 of the Mexico City Metro

More stations for the Golden Line

Ineco, through its subsidiary Inecomex, in consortium with Cal y Mayor y Asociados, is managing a project to extend Line 12 of the Mexico City Metro, also known as the Golden Line, the newest line in the Mexican capital's extensive metro network. The new section, with three new stations and 4.6 kilometres of tunnel, will improve connections between the east and west of one of the largest cities in the world.

With contributions by **Magdalena Garrigós** and **Daniel Esteban**, civil engineers

THE MEXICO CITY METRO
The backbone of the city's public transport system is its almost 200-kilometre-long metro network.

PHOTO_ENEAS DE TROYA / FLICKR


A panoramic view of Mexico City.

One of the trains on Line 12 of the Mexico City Metro, also known as the Golden Line.

The Mexican capital, which changed its name in January 2016 from the Federal District to Mexico City, is an enormous metropolitan area with a population of almost 21 million inhabitants, making it the largest city in Latin America and one of the largest in the world. The backbone of the city's public transport system –which includes buses, trolleybuses, trams and commuter rail– is its almost 200-kilometre-long metro network, which transports approximately 8 million passengers a day spread among its 12 lines and 195 stations.

Ineco, through its subsidiary Inecomex, together with its partner in the country, Cal y Mayor y Asociados, is carrying out the comprehensive management of the project (project management) for the management, coordination and monitoring of the Mixcoac-Observatorio extension of Line 12, also known as the Golden Line, the newest line in the CDMX Metro network. This line opened on 30 October 2012, has 20 stations and has a total length of 24.5 kilometres. It is located in the southern part of Mexico City and runs east to west. It connects to other lines in the system: Line 7 in Mixcoac; Line 3 in Zapata; Line 2 in Ermita and Line 8 in Atlalilco.

MANAGEMENT OF LINE 12

A team of more than 80 professionals is responsible for managing the works, which include the construction of 4.6 kilometres of tunnel –with the main tunnel covering 3.6 kilometres– and three new stations: Valentín Campa, Álvaro Obregon and Observatorio, where it will connect to Lines 1 and 9. The section also has 13 skylights, some of which will also serve as emergency exits, rectification substations and larger ventilation units.

Inecomex and Cal y Mayor are providing senior management services for this complex project, with teams of renowned experts at the national and international levels in different specialities to ensure efficiency and compliance with the project's targets in terms of budget, deadlines, scope and quality. The consortium has also collaborated on monitoring environmental and urban impact measures and its tasks also include the coordination of the rolling stock tests.

Once the line is in operation, the new extension will represent a major improvement in mobility between the west and south of the city and will reduce the saturation of Lines 1, 2 and 3. The future Observatorio station will also allow connection to the new Mexico-Toluca interurban train service. From the environmental point of view, it is estimated that the emission of more than 3,700 tons of CO_2 per year, or the equivalent of almost 6 million vehicles, will be avoided. ■

THE PROJECT WILL INCLUDE THE BUILDING OF A NEW 4.6-KILOMETRE SECTION AND THREE NEW STATIONS: VALENTÍN CAMPA, ÁLVARO OBREGÓN AND OBSERVATORIO

Reinforcement of the central wall of the Álvaro Obregón station.

INECO IN MEXICO

Ineco has substantial experience in Mexico, where it has carried out projects such as technical assistance on the Buenavista-Cuautitlán line concession for Ferrocarriles Suburbanos (2005-2008); the drafting of master plans for the development of the 12 airports of Grupo Aeroportuario del Pacífico (GAP); and works on the country's road network. Among them, a contract to become the administrator agent and supervisor on the Guadalajara-Colima highway (2011-2025) and improvement works on the signposting of the Mexico-Veracruz, Mexico-Irapuato and Mexico-Acapulco highways (2010).

Renderings of the future Valentín Campa, Álvaro Obregón and Observatorio stations.


The Ineco-Inecomex team. From left to right, Alberto Váscones, Fernando Vargas, Paloma Nuche, Daniel Esteban, Juan Sempere and Mauricio Sánchez.

THE LINE 12 EXTENSION ROUTE

THE CONSORTIUM

The Inecomex-Cal y Mayor consortium is managing all phases of the Line 12 extension project: design, planning, execution of works and management of material and financial resources. The consortium is also collaborating on monitoring environmental and urban impact measures and will coordinate rolling stock tests.


An aerial view of the Calle E skylight.

Rubén Díaz de Sonseca, a public works engineer who has worked for Ineco since the early 2000s, inspecting points during a track pre-assembly phase - work that the company has been carrying out for Adif on high-speed lines for more than 15 years.

PHOTO_**INECO**

Approval for high-speed material

121 tonnes of rail, 550 tonnes of sleepers and 145 lorries loaded with ballast are just one example of what goes into building just one kilometre of single track on a high-speed line. Technicians from Ineco have been working with Adif and Adif Alta Velocidad for more than 15 years to guarantee the quality and supply of all railway materials used for track assembly. A job that requires maximum rigour and, over time, has resulted in the creation of a proven methodology.

By **Concepción Zurita,** geologist, **Eva Álvarez** and **Salvador Pastor,** public works engineers

The purpose of the control of track material supply is two-fold: on the one hand, to ensure that the quality of the material provided meets the initial specifications, and, on the other hand, to make sure that, through control and management of materials, work deadlines are met. Interestingly, in high-speed track assembly works, the actual laying of the track accounts for approximately 20% of the budget, while materials account for 80% (20% ballast, 20% sleepers, 20% rail and 20% track S&C devices). Technical assistance work therefore focuses on two aspects: supply management and quality control, for which factory or quarry production requires supervision and verification, with regular testing upon receipt in accordance with the regulations in force.

The creation of Spain's high-speed network began more than 30 years ago, and today it boasts more than 3,100 kilometres in service and numerous stretches under construction. Between 1988 and 1990, Ineco began to draft preliminary studies for the Madrid-Barcelona line and the first construction projects started to appear in 1994 and 1995. The Spanish railway infrastructure manager at that time, GIF, commissioned Tifsa –a company linked to Ineco since 1999 and with which it merged in 2010– to undertake the technological definition of the superstructure elements, a contract that, for Moisés Gilaberte, Ineco's Rail Business director, "was a significant milestone because of its size and importance. Since then, the company has provided support to the government in monitoring the production, planning and logistical deployment of supplies to works and quality control of all materials installed on high-speed lines, making us a European benchmark in track technology".

From the execution of track assembly work on the 481-kilometre section between Madrid, Zaragoza and Lleida, which opened in 2003, until today, Adif Alta Velocidad, with Ineco's support, has accumulated extensive experience in the organisation and control of the supply of track materials used on high-speed lines. Spanish industry has successfully adapted to high quality requirements and extremely demanding production and supply deadlines to the extent that it is currently capable of meeting the construction needs of

the entire Spanish high-speed network and, in many cases, exports its output, as was the case with some of the material used on the Makkah-Madinah high-speed line in Saudi Arabia. In Spain, some of the latest track material quality control work has been carried out on high-speed sections such as Venta de Baños-Burgos, León-Variante de Pajares-Pola de Lena, Zamora-Pedralba-Ourense, Plasencia-Badajoz, Monforte del Cid-Murcia, Antequera-Granada and Atocha-Torrejón de Velasco.

From visual inspection, measurement and weighing, to laboratory comparative testing, control of assembly operations and commissioning, the functions of Ineco's technical assistance include verifying compliance of materials with supply specifications and regulations, monitoring for defects in manufacture, and subsequent transportation, storage and use in works. For this, batches are identified by date of manufacture and company to ensure clear traceability, and samples are taken to validate each batch based on measurements and comparative testing, thus ensuring the quality of the material to be incorporated into the works.

A dossier is opened for each material where information (measurements, comparative testing results, etc.) is recorded and this is submitted to Adif as necessary documentation to commission a line. In the case of track devices, all assembly operations are also controlled, generating a acceptance protocol for each device, documentation that is also essential to commission a line. Ineco's experts also provide advice on track materials during the design, assembly and operating phases.

Track consists of ballast, sleepers, rail and track devices. All of these elements make up what is referred to as the high-speed track superstructure, and are located on top of the subgrade.

OVER THE LAST 15 YEARS OF COLLABORATION BETWEEN INECO'S AND ADIF'S TECHNICIANS, MORE THAN 1,100 TRACK DEVICES AND APPROXIMATELY 700 EXPANSION DEVICES HAVE BEEN CHECKED

BALLAST STONE AND ITS METICULOUS INSPECTION

Ballast is used from the beginning of construction of the railway as a support for the tracks, dampening and distributing the loads transmitted by train traffic, ensuring the stability of the track, enabling the rainwater drainage and facilitating levelling and alignment operations. Ballast is extracted from silica-based rock, preferably of igneous or metamorphic origin. Its granulometry is falls almost entirely into the coarse gravel classification, with most of its broken stone elements measuring between 31.5 and 50 mm.

The required characteristics of ballast are mainly related to shape and hardness in order to obtain good permeability, but with a high degree of compactness and numerous sharp edges on the particles that make it up. The goal is for it to behave like an elastic, but extremely stable, bed. For this, the aim is to achieve the greatest number of contacts between stones, which, together with the high degree of hardness required for the material, means that during installation and operation, breakage and wearing of the material are minimised, and consequently, the geometry of the track superstructure is maintained for as long as possible, thus reducing maintenance operations.

Spain has 45 approved quarries for the manufacture of type-1 ballast, which is the type used most commonly across the railway network. Control of this material begins in the quarry itself and includes a weekly sampling plan depending on production. As a general rule, a complete ballast test will be carried out every 6,000 t of new material. Ineco, in collaboration with a laboratory accredited by ENAC for carrying out ballast tests, analyses the results of a complete test including analysis of grain size, fine particle content, fine


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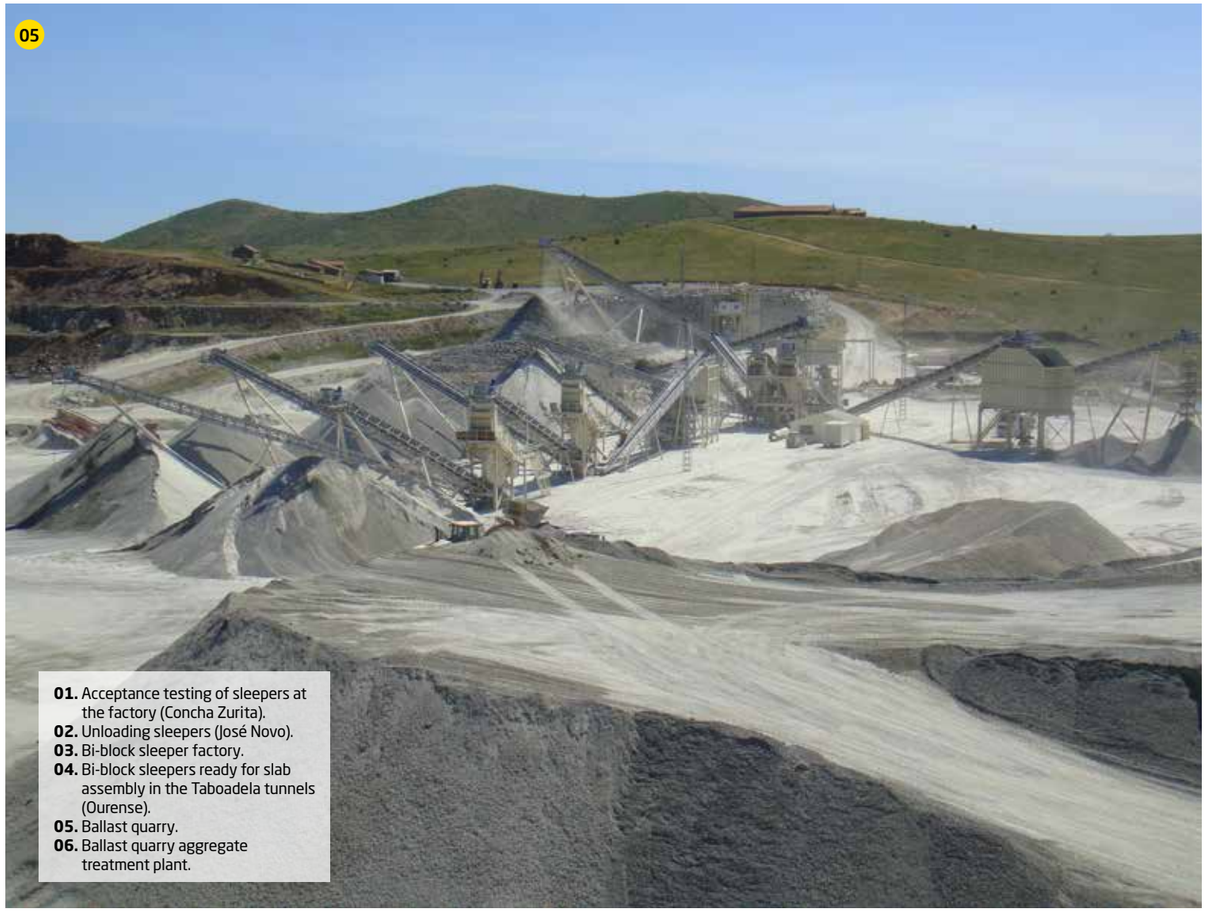
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01. Acceptance testing of sleepers at the factory (Concha Zurita).
02. Unloading sleepers (José Novo).
03. Bi-block sleeper factory.
04. Bi-block sleepers ready for slab assembly in the Taboadela tunnels (Ourense).
05. Ballast quarry.
06. Ballast quarry aggregate treatment plant.


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PHOTO_INECO

content, shape coefficient, minimum thickness of granular elements, particle length, Los Angeles abrasion test and ballast homogeneity. Lastly, ballast tests are carried out during supply to the works to ensure quality and the ballast that is actually supplied is monitored using weighing scales installed for that purpose.

SLEEPER DIMENSIONS AND PLACEMENT

A sleeper is defined as a transversal component of the track that controls track width and transmits loads from the rail to the ballast. For the construction of high-speed tracks, prestressed concrete monoblock sleepers are used, with pre or post-stressed reinforcement used to precompress the concrete. The type most widely used in high speed, AI-VE, is 2,600 mm long and the minimum mass without anchors is 300 kg.

Quality control work includes acceptance in the factories where the sleepers are produced. In summary, acceptance consists of checking external appearance and traceability, geometric verifications affecting track width, geometric verifications of critical dimensions and principal dimensions and mechanical tests, as well as verification of external laboratory tests required by the technical specification. Once on site, it is important to schedule the supply according to the work plan to avoid unnecessary delays and surpluses.

RAIL QUALITY AND WELDING

Once the sleepers are arranged on the ballast bed, the rails are then unloaded from a rail-transport car equipped with a gantry crane.

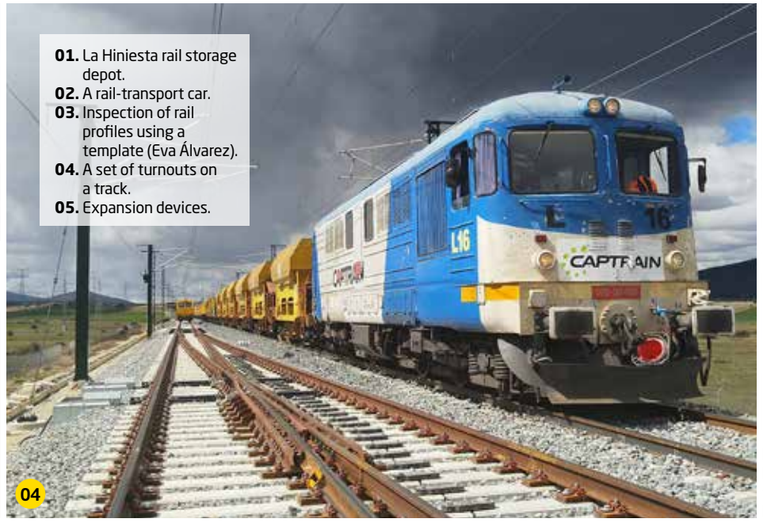
The rail, as a fundamental element of the track, must have a series of characteristics that allow it to withstand a complex set of forces: its profile, length and metallurgical composition must conform to the requirements established for the track. The rail installed on the tracks of Spanish high-speed lines is profile 60 E1 and grade R260, in accordance with European regulations and Adif's technical specifications.

> SPANISH INDUSTRY HAS BEEN ABLE TO ADAPT TO HIGH QUALITY REQUIREMENTS AND EXTREMELY DEMANDING PRODUCTION AND SUPPLY DEADLINES IN ORDER TO MEET THE CONSTRUCTION NEEDS OF THE ENTIRE SPANISH HIGH-SPEED NETWORK AND, IN MANY CASES, EXPORTS ITS PRODUCTION OVERSEAS

Generally, on Spanish tracks, rails are assembled in long welded bars (288 and 270 m), a length that varies depending on the length of the primary bars (36, 72 and 90 m) that make it up in order to reduce the number of welds, which are delicate to perform correctly and generally give worse geometric and mechanical characteristics than the rails, constituting points of disturbance to the rolling of trains which need to be monitored in the maintenance phase. Spanish high speed currently uses 108-m primary bars, which are later electrically welded using a mobile plant. The aim is to maximise the length of the primary rail, making an electric weld using automatic equipment, with no filler metal and minimal human intervention, so that the resulting product resembles a continuously-rolled bar as closely as possible both in terms of composition and defect-free geometry.

The quality control carried out by Ineco on the rails involves, on the one hand, validation at the rail factory (primary bar) and then in the electric welding workshop (welded long bar). For this, geometry and external and internal rail and electric welding checks are carried out, as well as comparative tests in the external laboratory on both elements.

Prior to supplying the rail, the condition of the storage slab, its levelling and the equipment for unloading and installing the rail (gantries and hoists) are checked with the manufacturer and supplier. Once the rail has been deposited on the slab, its arrangement is inspected and a random check of the geometry is carried out using verification templates. Ineco is also in charge of the traceability of the rails supplied to each high-speed line, which is essential for identifying the future physical location of bars produced by the same rolling, which, over time, can lead to the appearance of defects not detected by the usual verifications.



01. La Hiniesta rail storage depot.
02. A rail-transport car.
03. Inspection of rail profiles using a template (Eva Álvarez).
04. A set of turnouts on a track.
05. Expansion devices.

PHOTOS_**INECO**

PART OF THE SUPPLY TEAM
Behind, Salvador Pastor, José Novo and Rubén Díaz; front and left to right, Raquel Salgado, Conchi Zurita, Eva María Álvarez, Marta Martín, Águeda Barajas, Laura Guinea and Mónica Salamanca.

CONTROL OF TRACK DEVICES

Track devices are essential elements for the operation of the railway because they allow trains to pass from one track to another by means of turnouts, and they absorb movements that are generated in hyperstatic viaducts caused by various factors (temperature expansion, braking effects, rheostatic effects, etc.), the so-called expansion devices, which make thermal contraction and expansion movements compatible with the track superstructure installed on top of them. In Spain, there are four companies that manufacture track devices (two in Asturias and two in the Basque Country), and they provide almost the entire national supply and a significant part of the international supply (Saudi Arabia, Turkey, Argentina, Brazil, Mexico, etc.).

Controls and checks are continuous given that the turnouts used on high-speed lines allow speeds of up to 350 km/h on direct track and 80, 100, 160 or 220 km/h over points, depending on the model, meaning that safety must be guaranteed at all times. The controls on these devices begin by verifying compliance with the main parameters during pre-assembly in the workshop, a task that is formalised with the signing of an acceptance protocol. In addition, supply deliveries and deadlines have to be checked and, once at the track assembly base, the same parameters are reviewed before the device is incorporated into the track.

Track devices may be incorporated while the primary levelling of the track is being done. From there, a topographical survey is carried out during ballast laying and stabilisation phases until the final level is reached. Once the topographical parameters have been verified, an approval report is drawn up. Subsequently, the track device is checked again to ensure that all of its components are in perfect condition and working order, lastly checking compliance with the parameters guaranteeing operation with complete safety. At this point, a works acceptance protocol is issued and this becomes part of the documentation submitted prior to the commissioning of the line.

As for expansion devices, in addition to the work described above, viaduct joints must be measured regularly for different temperature ranges. Based on these measurements, together with the temperature at which they were taken, a progression line is obtained and this makes it possible to determine whether the planned expansion device is suitable, or whether another model needs to be used in its place to ensure the required safety and operating conditions. The extensive experience of Ineco's staff makes it possible for them to continuously collaborate with track device manufacturers in order to facilitate the evolution of the models, improve performance and reduce costs without affecting in the least the required safety standards. Over the last 15 years of collaboration between Ineco and Adif's technicians, more than 1,100 track devices and approximately 700 expansion devices have been verified. ■

The EU seeks new regulations for the use of drones

The recreational and professional drone industry has grown exponentially in recent years and this has led to the implementation of new national regulations. As a result, the European Union is seeking to unify these regulations under the Single European Sky programme, SESAR. Ineco is participating in several projects to define the safety requirements that these unmanned aircraft must meet.

By **Víctor Gordo,** airport engineer

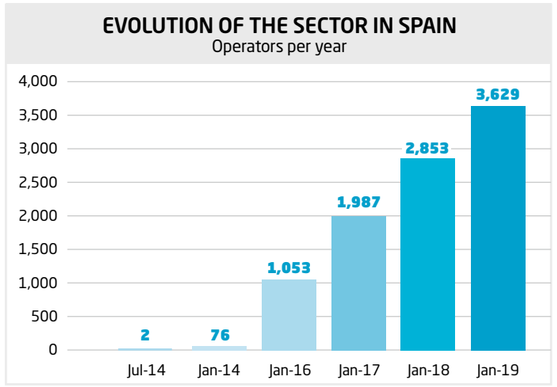
Unmanned aircraft (UAVs, RPAs or drones) are nothing new; these kinds of aircraft have been used as aerial targets to test weapons for more than a century and, indeed, the popular term 'drone' was coined by the British military in reference to the sound that these devices made. This is demonstrated by the fact that they were mentioned at the Convention on International Civil Aviation in Chicago, in 1944, which saw the creation of the International Civil Aviation Organisation (ICAO); in fact, Article 8 prohibited the use of unmanned aircraft without the express authorisation of each state.

However, it was the evolution of microelectronics that enabled the sector to break into the mass market. Since the beginning of the 21st century, drones have been increasingly used by the military, although it was not until this decade that the technology started to become available for civilian use thanks to its gradual reduction in price. The low cost and ease of use of these small remote-controlled aerial vehicles, usually multicopters, has rapidly increased the popularity of their use in both recreational and professional fields. Growth of the sector in the last five years has been exponential, as shown by the number of drone patents issued. This growth is not surprising given that this technology has myriad applications, especially in imaging and photography, cartography and topography, surveillance and security, but also in agriculture, emergency support, environment, infrastructure maintenance, etc.

SPAIN IS ONE OF THE MOST ACTIVE COUNTRIES IN TERMS OF NUMBERS OF AESA-REGISTERED OPERATORS AND IS ALSO THE WORLD'S TENTH LARGEST DRONE MANUFACTURER

INECO PROJECT
In the image, civil engineers Joaquín Muñoz and Leandert de Haan in 2015 during a viaduct inspection test using a drone. Ineco has studied the many possibilities offered by these aerial vehicles to quickly inspect bridges, embankments, trenches and overhead lines, detect obstacles or vegetation on tracks or map road and rail networks.

PHOTO_ INECO _ELVIRA VILA



Spain is one of the most active countries in terms of numbers of AESA-registered operators and is also the world's tenth largest drone manufacturer according to the *Global Trends of Unmanned Aerial Systems* report published by the Danish Technological Institute in 2019. Ineco pioneered the use of this technology for bridge inspections in 2015.

FIRST STEPS

Drones also pose risks, of course, especially if they are operated in residential areas, controlled airspace close to manned aircraft or when drones are flown out of sight of the pilot on the ground. These hazards need to be carefully considered for both recreational and, especially, professional use: they include device failure, loss of control link, in-flight hacking and loss of the navigation or traffic separation systems.

For this reason, the European Aviation Safety Agency (EASA) has stipulated that drones with a take-off weight exceeding 150 kg must undergo a certification process, similar to that for manned aircraft, for both manufacture and operation. However, lighter drones, which are not intended to carry people on board, are not subject to such rigorous safety mechanisms. Consequently, their components and manufacturing are less robust, especially in the case of drones manufactured in large production runs, and standards are more appropriate for toys than aircraft.

In order to minimise the risks, a few years ago, the member states of the European Union began to restrict drone operations through regulations. In Spain, Law 18/2014 regulated the use of drones for the first time, limiting their operations to a height of 120 metres above the ground, prohibiting use near airports and controlled traffic regions (CTRs), in cities and areas with high concentrations of people, and allowing only flights within visual line of sight (VLOS), that is, less than 500 metres from the pilot on the ground. And, of course, drones must be remotely piloted (RPAs) and not operate autonomously.

This regulation greatly limited the type and complexity of drone operations, so three years later Royal Decree 1036/2017 was published to make the development of the sector compatible with safe operation. The new standard still allowed for simple operations, but also more complex ones with prior authorisation by the Spanish Aviation Safety Agency (AESA).

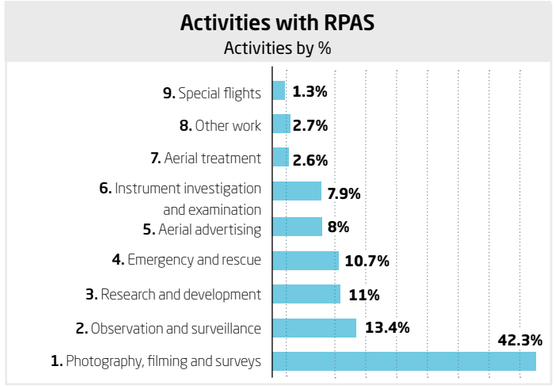
To obtain authorisation, a safety study must be carried out, in addition to specific training and equipment to limit the risk, as well as coordination with those affected, if any, for example, air navigation service providers in the event of operations in controlled airspace. Ineco, in the context of the Ministry of Public Works' Transport and Infrastructure Innovation Plan, has carried out these kinds of safety studies to obtain the authorisation required to perform complex piloting projects such as the recording of data from radio navigation systems in airports.

EUROPEAN REGULATIONS

Operating requirements in different European countries vary widely. To alleviate these regulatory differences, the EU has published a new regulation that divides operations into three categories (open, specific and certified), depending on the complexity of the operation, in order to harmonise requirements in all countries and facilitate the provision of services in any member state.

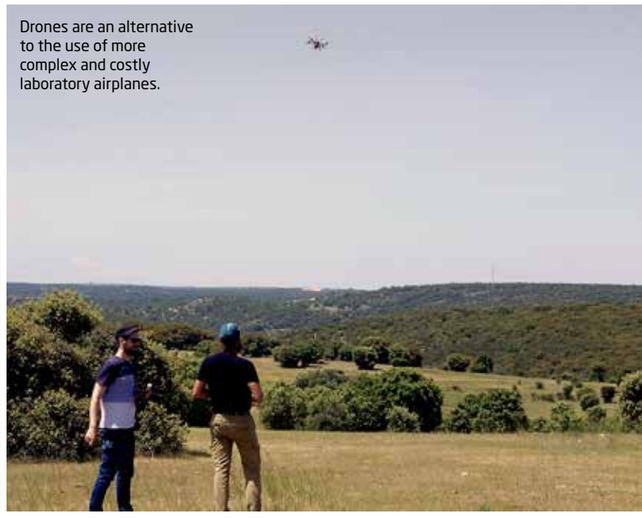
In short, it is now possible to carry out almost any kind of operation with drones in any environment, but only if operations are not carried out simultaneously. This means that if demand continues to grow as expected, it will be necessary to coordinate flights to maintain safety. To make this great development of drone operations possible, the EU, in its Warsaw Declaration of 2016, agreed on the need to develop the concept of *U-space* to allow safe operation of multiple drones at low altitude (below 150 metres) and especially in urban environments.

> INECO IS ACTIVELY PARTICIPATING IN THE SESAR PROJECTS RELATED TO THE DEVELOPMENT OF U-SPACE: TERRA, IMPETUS AND DOMUS



COMFORTABLE AND IN REAL TIME. Drones are operated with a joystick from a command post on the ground and real-time images are obtained with flight control via GPS.

PHOTOS_ INECO_ELVIRA VILA



Drones are an alternative to the use of more complex and costly laboratory airplanes.

> *U-SPACE* WILL MAKE IT POSSIBLE TO COORDINATE DRONE OPERATIONS SO THAT THEY CAN BE CARRIED OUT SIMULTANEOUSLY

U-space is a set of services, technologies and procedures to allow the safe and efficient operation of a large number of drones. The conceptual and technological development of these services is being carried out through the Single European Sky ATM Research programme (SESAR), as the EU considers it vital to provide an adequate environment to exploit all of the benefits that drones can bring to society. It will make it possible to coordinate drone operations so that they can be carried out simultaneously. However, the level of coordination will vary depending on the risk and density of this kind of aerial vehicle in the areas in which they are intended to operate; for this reason, the CORUS project has defined different types of airspace for drones: X, simple operations (VLOS) without coordination; and Y, complex operations in simple environments, so they will only require prior coordination of paths through flight plans, and Z, highly complex operations (urban-Zu, airports-Za) that require coordination in real time due to the risks to people and the number of operations.

Ineco is actively participating in SESAR projects related to the development of *U-space*: it is heading up the TERRA project, which is responsible for defining the ground technologies needed to support the provision of services, is also participating in the IMPETUS projects, whose purpose is to design information systems for the use of drones, and is involved in the DOMUS demonstration project, led by ENAIRE. ■

José Luis Ábalos, Minister of Public Works, opening ENAIRE's terminal area control centre (TACC) in Valencia.

Valencia launches its new TACC to manage more than 200,000 flights

ENAIRE's new terminal area control centre (TACC) in Valencia now boasts the latest technology to control the air traffic in an area of 59,000 km^2, to the airports of Alicante, Valencia, Castellón and Murcia, as well as between Madrid and the Balearic Islands. In 2019, traffic is expected to grow by 4% and the number of flights will exceed 200,000.

By **Bárbara Díaz,** telecommunications engineer

The building, which was opened in February 2019, will provide air traffic approach-control services for the airports of Valencia, Alicante-Elche and VFR aerodromes. The centre is also responsible for coordinating the technical operation services that are carried out in relation to ENAIRE's facilities (air navigation systems, such as VOR and radar, required for aircraft to follow their routes and to allow detection of their location at all times), which are located in the Valencian Community, the Region of Murcia and Albacete Air Base.

The investment made by the Ministry of Public Works, through ENAIRE, in the Valencia control centre totals 26.5 million euros. The new centre boasts cutting-edge technology and redundant systems to control air traffic and ensure the safety and continuity of air navigation services in order to respond to the demands of the major growth of air traffic in the Valencian Community, one of the most popular destinations for international tourism. In 2018, ENAIRE managed 188,000 flights from this centre, 70% of which were international. In 2019, traffic is expected to grow by 4% and the number of flights will exceed 200,000.

Valencia's new TACC will be able to handle the expected air traffic demand, which grows dramatically on Spain's eastern coast during the summer months as a result of increased international tourism.

These ENAIRE facilities provide assistance to important services in the Region, such as flights for organ transplants and medical evacuation from La Fe Hospital and the National Transplant Organisation, the Maritime Rescue Air Base, firefighting, agriculture, the police, the Directorate-General for Traffic, air sports, flying clubs and aviation schools.

WHAT IS A TACC?

A TACC is a centre where the air traffic in a certain area or sector of airspace is planned, organised and managed. Spain's airspace is divided into three large flight information regions (Madrid, Barcelona and the Canary Islands). Each flight information region is, in turn, divided into smaller airspace sectors known as terminal control areas, aerodrome control areas and airways.

THE TACC BOASTS CUTTING-EDGE TECHNOLOGY AND REDUNDANT SYSTEMS TO CONTROL AIR TRAFFIC AND ENSURE THE SAFETY AND CONTINUITY OF AIR NAVIGATION SERVICES

Valencia's TACC has facilities that are sized to meet the major air traffic growth demands of the Valencian Community. This is therefore, as Jose Luis Abalos, Minister of Public Works, pointed out, "a strategic project because it is a replica, in the field of aeronautical infrastructures, of the Mediterranean Corridor, which is a social, economic and political priority".

Different professionals from ENAIRE and Ineco have been working on completing this centre for several years. The work of experts in automation, communications, surveillance, deployment of Automated Air Traffic Control Systems, (AATCS), technical supervision and general matters has made the change to this new TACC possible.

INECO'S PARTICIPATION

Ineco participated in the construction and commissioning of this centre, and since 2008 has provided works management, technical assistance and supervision and surveillance of the works. In recent years, the company has participated in the implementation of TACC, collaborating with ENAIRE's systems department, providing support to the automation division, navigation and surveillance division and technical operations, as well as with ENAIRE's regional management, with a physical presence in Barcelona and Valencia.

Experts from the company have collaborated on the commissioning of radio navigation integration systems (RNS), which allow remote supervision and management of the radio navigation of the Eastern Sector and air traffic management (ATM) systems, which are the technical basis of air navigation and are used directly by air traffic controllers: AATCS which is responsible for the management of air traffic control, voice communication systems (VCS) for air traffic control which provide voice links with pilots and between controllers and last-resort radio and last-resort telephony equipment that guarantee oral communications as an alternative to VCS with limited functionality.

Other work consisted of validation of the software versions of the AATCS and VCS systems, the commissioning of the Orion supervision system and various jobs involving project coordination, plan updating and technical transition coordination, with participation in the commissioning of the systems and forming part of ENAIRE's transition committee. ■

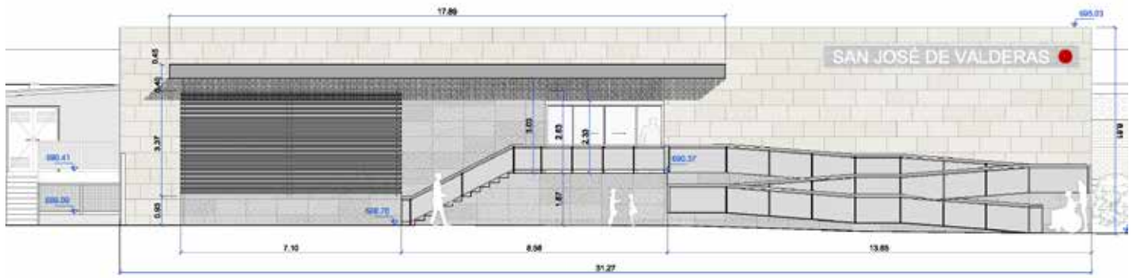
SAN JOSÉ DE VALDERAS STATION
Façade of the San José de Valderas station viewed from Avenida de Lisboa.

An upgrade for the San José de Valderas station

A new façade, ramps, two lifts, enlarged platforms and new tactile flooring are just some of the upgrades in the comprehensive refurbishment of the Cercanías station of San José de Valderas in the city of Alcorcón, south of Madrid, with Ineco responsible for drafting the project, as well as the construction management in one of the busiest stations in the Madrid network.

BY **Carlos Palomino,** architect, and **Manuel Acedo,** civil engineer

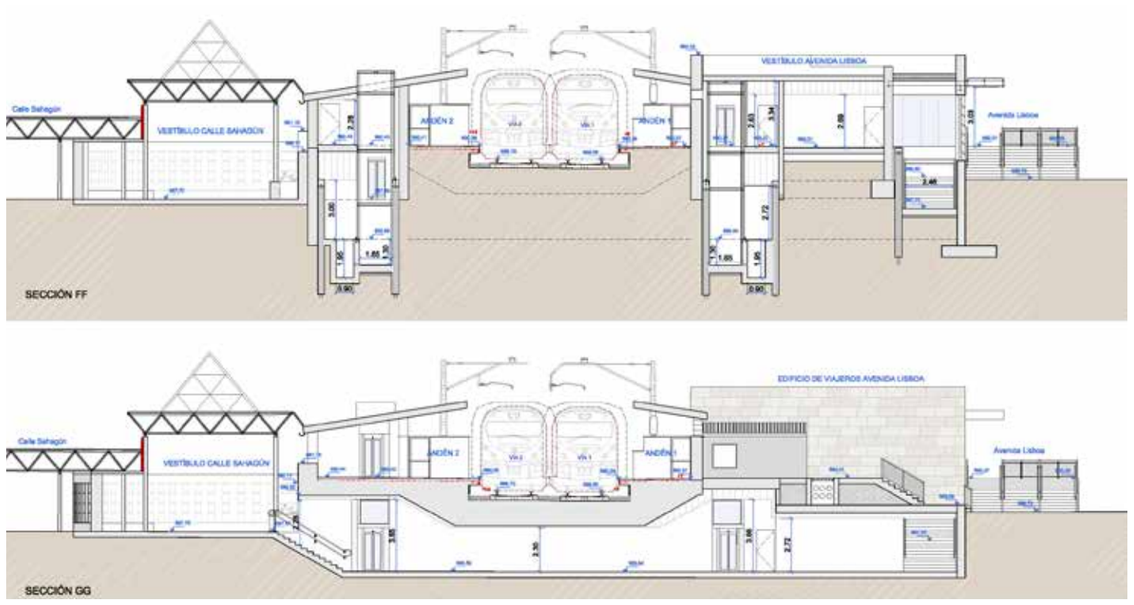
The purpose of the work carried out by Ineco for Renfe Viajeros at the San José de Valderas station, one of the three stations in the city of Alcorcón (Madrid), was to improve accessibility for passengers. The station complex consists of two buildings, one for each traffic direction, as well as two platforms and two tracks. These were connected by an underpass consisting of conventional fixed stairs, with no access for disabled passengers. It was therefore necessary to remove the stairs to make the underpass accessible, which involved the renovation and enlargement of the passageway under the tracks. In addition, two lifts were installed and an access ramp was built in three sections.



Main elevation view of San José de Valderas station.

The San José de Valderas station on the C-5 Line of Cercanías Madrid –located in the neighbourhood of the same name in Alcorcón and to the north of the city centre– is included in the Cercanías Stations Plan approved by Renfe in 2014. This plan consists of improving the accessibility of 109 stations within the Cercanías commuter rail network, in Asturias, Bilbao, Cádiz, Cataluña, Madrid, Málaga, Murcia, San Sebastián, Santander, Seville, Valencia and Zaragoza.

With a length of 45.1 kilometres, the C-5 line handles the largest number of journeys (65.6 million) per year, offers 331,100 seats on a daily basis (according to 2017 data) and runs through the municipalities of Humanes de Madrid, Fuenlabrada, Leganés, Madrid (Atocha), Alcorcón and Móstoles. In total, the Community of Madrid's Cercanías services transport more passengers than any other part of the Spanish rail network, exceeding 192 million users a year.



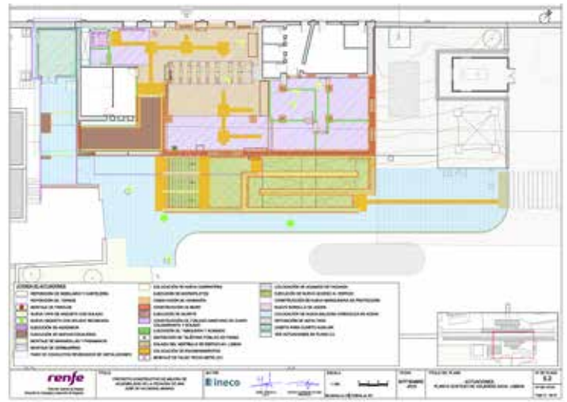
A cross-section of the project carried out by Ineco for San José de Valderas station.

A COMPREHENSIVE REFURBISHMENT

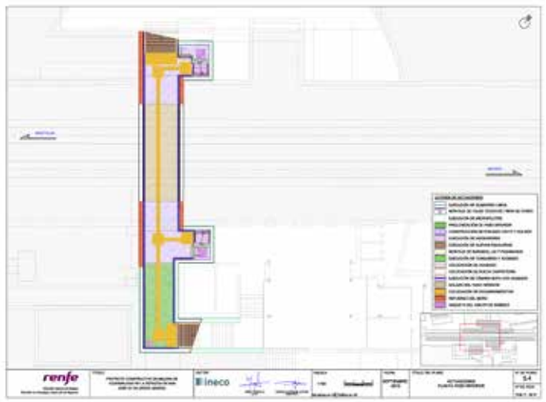
Access to the San José de Valderas station is through two buildings, depending on the street from which passengers enter. From Avenida de Lisboa, passengers enter the building's concourse , which is on the same level as the train platform, by climbing stairs with an elevation difference of 1.60 metres. From Calle de Sahagún, the passenger building is entered under canopies that also connect it to the nearby shopping centre.

The passenger building on Calle Lisboa needed complete refurbishment and enlargement to enable the construction of new stairs and a lift to the underpass. The works carried out also included a new customer service area and the installation of ticket machines.

The refurbishment and enlargement of the building carried out by Ineco also involved rearrangement of the concourse, adapting the exterior access of the passenger building, relocating the turnstiles in the passenger building concourse on Calle de Sahagún and connecting the concourses of both existing buildings with the platforms and underpass, creating an accessible route that connects all of the levels of the station.



Improvement works on the main floor.



Improvement works on the lower floor.

The works on the Calle Lisboa building involved demolishing the façade, extending the concourse area to the outdoor car park and building a new façade with access ramps to the outside, providing the station with a new, modern look for the city, inviting passengers to use rail transport.

With nearly 170,000 inhabitants, the city of Alcorcón and the more than 10,000 residents who use the station, now have more comfortable and modern facilities that have been adapted for people with disabilities. Other works included improvement of the exterior finishes of the platforms and complete replacement of lighting. A new route was also studied to provide access to the station's car park, providing it with parking spaces suitable for the disabled.

Lastly, all of the actions in the construction phase were carried out without affecting passenger traffic. ■

MOBILITY OF PASSENGER TRAFFIC IN THE COMMUNITY OF MADRID IN 2017
SOURCE: COMPREHENSIVE PLAN FOR THE IMPROVEMENT OF CERCANÍAS SERVICES
MINISTRY OF PUBLIC WORKS (APRIL 2018)

OVERALL MOBILITY

DAILY MOBILITY
12.93
MILLION JOURNEYS

29 MIN AVERAGE TRAVELLING TIME

6 KM AVERAGE DISTANCE

2.5 NO. OF JOURNEYS/ PERSON

TYPES OF TRANSPORT

OWN VEHICLE	40.4%	PUBLIC TRANSP.	28.4%
ON FOOT AND BY BICYCLE	30.3%	OTHERS	0.9%

PUBLIC TRANSPORT MOBILITY

1.5%	TRAM AND LIGHT RAIL	23.4 M.
12.8%	COMMUTER RAIL	192.3 M.
15.5%	MADRID REGIONAL COACH	232.7 M.
28.5%	MADRID CITY BUS	427.9 M.
41.7%	MADRID METRO	626.4 M.

MILLIONS OF JOURNEYS IN 2017 **1,502.7**

A greater voice for women

Talks and seminars are among the many initiatives aimed at recognising women in general, and those at Ineco in particular, highlighting the voice and presence of the many professionals who have contributed their talent and efforts to make the company what it is today.

By **Eva Pulido**, Organization and Corporate Services Directorate

With women accounting for 38% of its workforce of more than three thousand professionals and 27% of the employees in its management structure, Ineco is a company that boasts a high level of participation by women in its organisation and a firm commitment and ties to effective equality.

Since 2009, the company has had an Equality Plan with goals and strategies that aim to achieve effective equality between women and men. To achieve this, Ineco has set in motion a range of initiatives and measures aimed at reconciling work and family life, removing all signs of inequality and preventing sexual or gender-based harassment.

Some of the most important measures include the creation of an Equality Committee to monitor progress in this area, the establishment of a channel for sharing ideas and proposing suggestions and the publication of a guide for using non-sexist language in order to avoid discrimination, prejudice and derogatory terms when interacting with people.

In line with these actions, in 2015, the Concilia Plan was agreed upon with the legal representation of the workers, establishing 18 measures to facilitate work-life balance, grouped into four areas: organisation of work time; time off, absences and breaks; corporate benefits; and personal and professional development. The measures include all kinds of initiatives, such as parking spaces for pregnant employees, medical care and corporate services for first-degree relatives, summer camps and day-care centres. With regard to equality, the company promotes increased flexibility of the workday through the implementation of a teleworking system, shared work programmes and the effective application of flexible working hours. These measures are an essential element to achieve a balance between professional and personal life, and to ensure the retention of talent in the company.

The response by staff to these measures has been exceptional, as demonstrated by the fact that thus far, more than 2,200 requests have been made and a total of 436 Ineco professionals benefit from teleworking.

Ineco's commitment to and relationship with equality is absolute and, although much remains to be done, progress has been significant in terms of aspects such as reducing the wage gap between women and men by more than 40% since 2012.

PHOTO_ELVIRA VILA

THE FIRST EDITION OF THE 'IN' WOMEN'S PROGRAMME
The president of Ineco, Carmen Librero, along with 10 of the 11 participants selected for the programme, which received applications from 50 candidates.

ENGINEERS BY AIR, LAND AND SEA

On 8 March, to mark International Women's Day, Carmen Librero, president of Ineco, organised a seminar entitled Engineers by Air, Land and Sea, in which women professionals from the sector, including some from outside the company, shared their stories and experiences.

PHOTO_ELVIRA VILA

ENGINEERING AND EQUALITY
Attendees at the *Engineers by Air, Land and Sea* Seminar organised by the president of Ineco, Carmen Librero, to mark International Women's Day on 8 March.

Carmen Librero began her talk by recalling how certain freedoms and rights that until recently were unthinkable, have been achieved, and she paid tribute to Pilar Careaga, who in 1929 became the first woman in Spain to obtain an engineering degree and work as a qualified engineer in Spanish industry.

Attending this seminar and contributing their stories and experiences were Isabel Maestre, director of the Spanish Aviation Safety Agency, former recipient of the Women and Technology Award for best professional development, and founder and vice president of the association Ellas Vuelan Alto (Women Fly High); Carmen de Andrés, Spain's first female civil engineer and president of business management at Creatividad y Tecnología; Pilar Tejo, naval engineer, former winner of the AINE Award from the Association of Naval Engineers, director of Teirlog Ingeniería; and Sara Gómez, doctor of industrial engineering and first female director of UPM School of Industrial Engineering and advisor to the Spanish Royal Academy of Engineering, where she leads the Women and Engineering project. Representing Ineco were engineers Marta Molinero, Cristina González and Noelia Soriano.

> SINCE 2009, THE COMPANY HAS HAD AN EQUALITY PLAN WITH GOALS AND STRATEGIES THAT AIM TO ACHIEVE EFFECTIVE EQUALITY BETWEEN WOMEN AND MEN.

'IN' WOMEN'S PROGRAMME AND THE 2030 AGENDA

Promoted by the Equality Committee, in April, Ineco launched its IN Women's Programme, in which a group of 11 women with high potential, selected through an evaluation process, will participate in a 12-month mentoring programme. They will receive advice and guidance from certified internal mentors and participate in different workshops focused on addressing key aspects for their development. They will also have the opportunity to share experiences with other women in the business sector, all with the maximum support of those responsible.

This new initiative is part of the organisation's commitment to the 2030 Agenda and gender equality and highlights the work of all the company's professionals. ■

From left to right: the Queen's Dressing Room, the Comares Tower, the Palace of Charles V, the Cube Tower, the Tower of Homage, the Arms Tower and the Sail Tower.

The jewel of Nasrid art

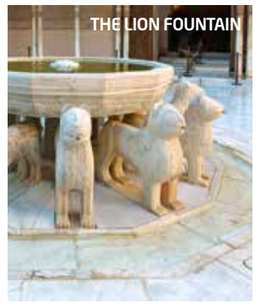
The Alhambra is the second most visited monument in Spain, after the Sagrada Familia in Barcelona, and one of the most famous in the world. The historic complex, a World Heritage Site since 1984, receives about 3.5 million visitors a year.

By ***ITRANSPORTE***

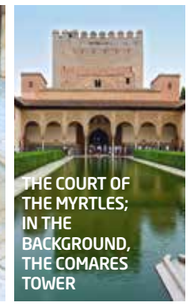
The Alhambra is a palace and fortress complex built between the 9th and 16th centuries on the top of a steep hill facing the Albaicín quarter of Granada. Boasting some three and a half million visitors a year, it is, after the Antonio Gaudí-designed Sagrada Familia in Barcelona (4.5 million visits a year), the second most visited tourist attraction in Spain and it is also usually included in the list of the most popular in the world.

It consists of a military fortress, a medina quarter, several palaces and gardens and other buildings, mostly built by the sultans during Muslim rule over the Iberian Peninsula after moving their capital to Granada. This period ended with the conquest of the Nasrid Kingdom of Granada, the last territory held by the Muslims, by the Catholic Monarchs in 1492, the same year as the discovery of America by Christopher Columbus.

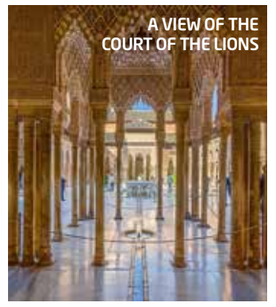
At this point, the complex passed into the hands of Christian monarchs who added some buildings, such as a Renaissance-style palace commissioned by Emperor Charles V in 1526 and the Church of Santa María, completed in 1618 on the site of an old mosque. After a period of neglect, the arrival of the Romantic era in the 19th century renewed interest in the complex and restoration works began. In 1898, ownership of the Alhambra was transferred to the Spanish state and shortly afterwards it was declared a national heritage site. In the early 20th century, the trust that today manages it was created, placing it under the auspices of the regional government of Andalusia, and, in 1984, it was listed as a Unesco World Heritage Site. ■



THE LION FOUNTAIN

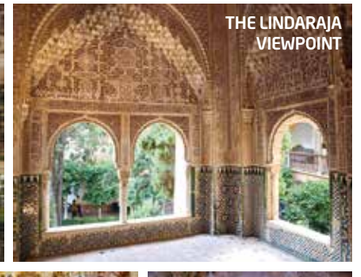


THE COURT OF THE MYRTLES; IN THE BACKGROUND, THE COMARES TOWER

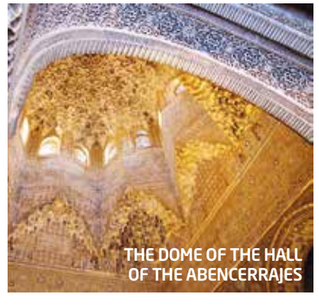


A VIEW OF THE COURT OF THE LIONS

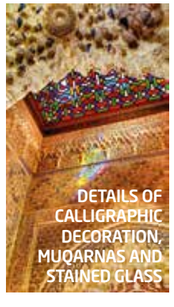
THE GENERALIFE GARDENS



THE LINDARAJA VIEWPOINT



THE DOME OF THE HALL OF THE ABENCERRAJES



DETAILS OF CALLIGRAPHIC DECORATION, MUQARNAS AND STAINED GLASS

A MUQARNAS VAULT IN THE HALL OF THE TWO SISTERS

THE PALATINE CITY

Despite the sprawl of the site, surrounded by two thousand metres of wall and thirty towers, and the variety of buildings of interest from different periods, what has made the Alhambra world famous are its palaces and gardens from the Muslim era and, in particular, the Nasrid dynasty. In spite of the characteristically low quality of construction materials used in Islamic architecture –stone, brick and wood– and the exterior sobriety, the beauty and artistic quality of the interior rooms make it unique. Its gardens and courtyards, adorned with pools, ponds and fountains –such as the famous fountain in the Court of the Lions, perhaps the most recognisable image of the complex– are also responsible for the Alhambra's uniqueness and universal reputation.

It is located on an elevated site known as Sabika Hill that was initially used as a military post, probably beginning in Roman times. The first palace was built in the mid-13th century by the ruler Muhammad ibn Yusuf ibn Nasr, better known as Ibn al-Ahmar, a name from which the name 'Alhambra' is believed to be derived, although other theories suggest that the name means 'red fortress.' Though this is not the colour of the buildings, the name is attributed to the optical effect produced by the torch lighting at night during construction. Successive rulers continued to add palaces and rooms, and reinforced the walled military zone, the **Alcazaba**, which is notable for the Place of Arms, the Sail Tower, the Weapons Tower and the Adarve Gardens. The walled site can be accessed by several gates, the most important of which are the **Gate of Arms**, the **Gate of the Poor Quarter**, the **Gate of Justice** and the **Gate of the Seven Floors**.

The citadel (medina), contained houses for nobles and commoners, as well as public baths (hammam), ovens, workshops, underground stores and water tanks. This is the location of the Generalife Gardens and **Nasrid Palaces**: the **Mexuar**, the **Comares Palace**, or Palace of Yusuf I, and the **Palace of the Lion**s, or of Mohammed V. In this area –and not by chance, but to symbolise the triumph of Christianity over Islam– the Palace of Charles V, noted for its unusual circular courtyard, was erected three centuries later. Opposite the palaces is the entry to the **Rauda**, the royal cemetery, and the **Generalife Palace**, a house of recreation for the sultans of Granada, famous for its orchards and gardens, and adorned with fountains and irrigation ditches. These gardens include an exceptional construction: the Water Staircase, which features handrails containing channels to carry a stream of water.

Some of the most highly representative elements of Islamic architecture that abound in the Alhambra are its courtyards, some of the most notable of which are the **Court of the Lions**, with its famous fountain; the **Court of the Wrought Iron Grille**, with its balcony on the south side; the **Court of Comare**s, or Court of the Myrtles, with its ditch flanked by hedges; and the Court of Lindaraja, over which the viewpoint of the same name looks.

The palaces house the rooms and halls used by the sultans to receive foreign dignitaries, celebrate parties or impart justice, all with fabulous decoration covering the walls, arches, pillars and ceilings, and combining calligraphic elements, tiles and muqarnas (pieces of plaster similar to a honeycomb). Of these, some of the most notable are the **Hall of the Ambassadors**, where the sultan's throne was located; the **Hall of the Abencerrajes**, the **Hall of the Two Sisters** and the **Hall of the Mocárabes**, with its spectacular star-shaped vaults. In the **Hall of the Kings**, the ceilings are adorned with paintings, while in other rooms, such as the **Gilded Room**, the ceiling is made of wood.

Other elements of great interest are its **overlooks**, which offer panoramic views of the city, such as the **Queen's Dressing Room**, originating from the Nasrid period but modified during the Renaissance, and the **Lindaraja** or **Daraxa Viewpoint**, which, in addition to its views, stands out for its sumptuous tiling.

MÓNICA BIELSA

"We have one of the best infrastructure networks in the world"

Since 2013, Mónica Bielsa has been responsible for all of Ineco's infrastructure works in the railway, airport, road and port sectors.

PHOTO_ELVIRA VILA

A TECHNICAL AND MANAGEMENT PROFILE

A civil engineer with 18 years of experience, Madrid-born Mónica Bielsa has worked at Ineco since 2001, first in Track Technology and later on the High-Speed Track Material Supplies team as department head and head of contracts and works management on high-speed rail infrastructures.

Ineco's Infrastructure Area –currently with more than 200 professionals– covers jobs ranging from works management on new railways to the supervision of road projects, environmental management of works, supervision and management of airport works, project management in all areas, health and safety coordination, management of cultural heritage in works, etc.

1 WOULD YOU MIND LISTING ALL OF THE PROJECTS THAT YOU'RE WORKING ON?

It'd be difficult to list them all. We're currently providing works management, environmental management and technical assistance services throughout the country on high-speed, road and airport projects. Abroad, we are present in seven countries, some with major projects, such as the recently opened Paseo del Bajo in Buenos Aires and the Jorge Chávez airport, in Lima.

2 DO YOU THINK PEOPLE OUTSIDE THE SECTOR UNDERSTAND WHAT'S INVOLVED IN MANAGING INFRASTRUCTURE?

Citizens increasingly value the ability to travel in their daily lives and are aware that we have one of the best infrastructure networks in the world thanks to Spanish engineering and construction companies that are among the best in the world. However, they may not be quite so aware of the extremely complex geography that we have in the peninsula.

3 HAVE YOU HAD ANY JOBS THAT HAVE MADE YOU LOSE SLEEP?

More than one; it goes along with the works process. The ones who have to bear the brunt, though, are the members of the technical teams who, with their dedication and commitment, take on great responsibility with very demanding deadlines and works that often pose major engineering challenges.

4 AND WHAT'S THE BEST PART OF YOUR JOB?

The greatest satisfaction for me is being able to be part of a great team of technicians from whom there is always so much to learn, in addition to helping and assisting them in their work by addressing their concerns and giving them specialized support and appropriate training.

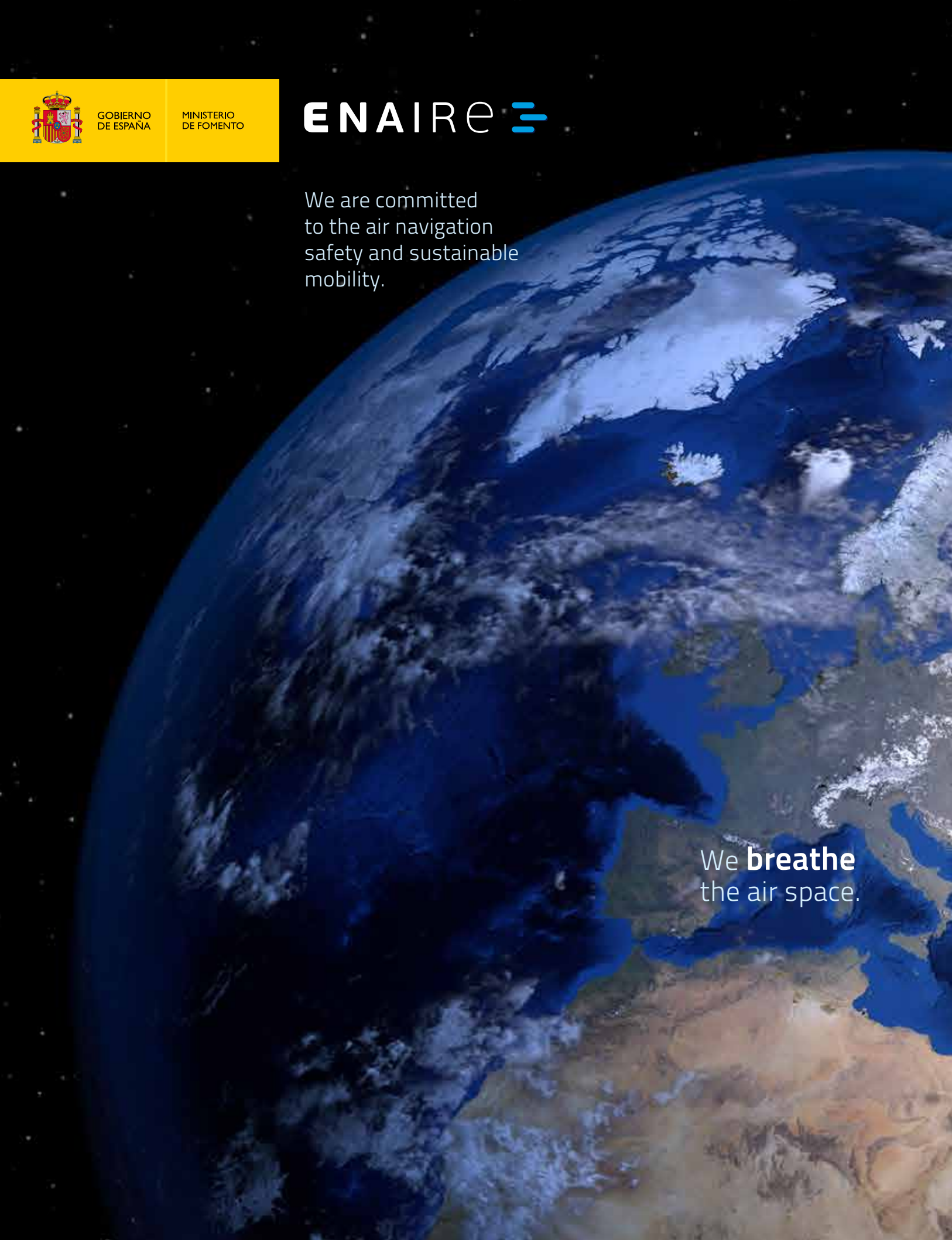
5 IS THERE EQUALITY IN YOUR AREA?

There is equality, but the sector is still dominated by men. We've had women with extensive experience in works, top qualifications and positions of maximum responsibility in management and supervision of works for many years. ■

GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO

ENAIRE

We are committed to the air navigation safety and sustainable mobility.



We **breathe** the air space.