Railway Infrastructures

MONOGRAPH

Trebovice railway corridor. Czech Republic.

AirportLink railway connection. Florida. USA.

2014 Edition

www.ohl.es
OHL is a large international concession and construction group. It has more than 100 years of history and operates in nearly 30 countries on five continents. The Group is a benchmark in the execution of railway infrastructures, with projects in Europe, Asia, Africa, and the Americas. OHL is the first Spanish company to undertake the construction of a section of high-speed railway abroad, specifically in Turkey. It has also completed the first construction project awarded to a Spanish company in the United States, extending the Miami metro to the city’s international airport.

In addition to these achievements, OHL also constructed the railway connection between Europe and Asia, under the Bosphorus Strait (Turkey), participated in the Saudi-Spanish consortium Al Shoula to construct the second phase of the Haramain High-Speed Rail project in Saudi Arabia, and the execution of large projects to modernize the railway corridors in the Czech Republic.

To execute these projects, OHL relies on specialized subsidiaries. OHL ŽS and ŽPSV, with more than 60 years of experience, are taking part in the modernization and development of railway infrastructures in the Czech Republic and in the nearby markets. Since it was established, Guinovart & Oshsa has been constructing railway infrastructure and superstructure, with station remodeling, high-speed sections, track installations, railway maintenance, electrification, and signaling. EyM Instalaciones is focused on the execution of railway electrification projects (aerial contact lines and electrical substations), electrical installations (electrical plants, high and low-voltage distribution, transformer substations, lighting, signals, etc.), telecommunications and radio installations.

The positioning that OHL has achieved, with one of the most modern fleets of specialized machinery for the installation, overhaul, and maintenance of railways, is strengthened by the significant technological advances that it applies to its projects. These include the research and development project of a multipurpose precast slab track, Sulabu, which marks a milestone in the generation of know-how in regard to slab track systems for railways at the international level. The R&D&I consortium Arid-Lap is aiming to develop new technological solutions to minimize the effects on the customary railway infrastructure in areas like the Middle East due to extreme climate conditions.

The excellence that OHL has achieved in the area of railway infrastructures is backed by more than 70 years of experience in this sector, and it is this excellence that has brought the company many prestigious awards. For example, Engineering News Record named AirportLink the Global Best Project, in the railway category, and the West Light Rail Lines in Madrid received the award for Best Light Rail Initiative Worldwide, from the International Union of Public Transportation.
Mecca-Medina High-Speed Line. Saudi Arabia.
**HARAMAIN HIGH-SPEED RAILWAY. PHASE II. MECCA - MEDINA. SAUDI ARABIA**

Client: Saudi Railways Organization  
Completion date: under construction  
Budget: €619 million

As part of the Spanish-Saudi consortium Al Shoula, OHL is participating in the execution of phase two of the Haramain High-Speed Rail (HHR) project in Saudi Arabia.

This *lump-sum* contract includes the design, construction, installation, outfitting, operation, and comprehensive maintenance for a period of 12 years, of a railway with average daily traffic of 160,000 passengers.

The civil works include the construction of 450 km of double track on both ballast and on Rheda 2000 slab track, designed for speeds of 320 km/hour.

The project includes workshops, tanks, technical buildings, five installation bases and three maintenance centers.

<table>
<thead>
<tr>
<th>Main units</th>
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<tbody>
<tr>
<td>450 km of double track from sub-ballast</td>
</tr>
<tr>
<td>64 km of double track on slabs (RHEDA 2000)</td>
</tr>
<tr>
<td>16 km of embedded double track</td>
</tr>
<tr>
<td>1,500,000 sleepers</td>
</tr>
<tr>
<td>115,000 tons of rails</td>
</tr>
<tr>
<td>4 work bases (three of them permanent)</td>
</tr>
<tr>
<td>4,800,000 t of ballast</td>
</tr>
<tr>
<td>175 turnouts</td>
</tr>
<tr>
<td>80 km of ballast protection wall</td>
</tr>
<tr>
<td>6 substations</td>
</tr>
<tr>
<td>20,000 catenary poles</td>
</tr>
<tr>
<td>35 kV power line</td>
</tr>
</tbody>
</table>
MARMARAY CR3 PROJECT. TURKEY

Client: Ministry of Transport, Directorate-General for Construction of Railways, Ports, and Airports of the Republic of Turkey (DLH)
Completion date: under construction
Budget: €1,042 million

Remodeling of the Istanbul commuter rail system. This will provide an uninterrupted connection between Halkali, on the European continent, and Gebze, on the Asian continent. It will allow transit by high-speed trains, commuter trains, and cargo trains between the two continents.

OHL, with a 70% stake in this joint venture, is leading the project, which basically consists of the expansion of all of the existing infrastructure and platform along a 63 km section (20 km in Europe and 43 km in Asia), to increase it from the two existing tracks (which will be dismantled) to a three-track cross-section.

Main units
- Remodeling of a 63 km line of triple track
- Remodeling and upgrading of 37 surface stations
- Overhaul of the entire electrification system
- Overhaul of the entire signaling and communications system
- New operations control center
- Depot and parking zone for intercity and commuter trains
- Overpasses and underground underpasses
- Bridges for vehicles and pedestrians
- Relocation of bridges and historic buildings
- Relocation of public services
ANKARA-ISTANBUL HIGH-SPEED LINE. PHASE I: ESKISEHIR-ESENKENT. TURKEY

Client: Railways of the Republic of Turkey (TCDD)
Completion date: 2009
Budget: €654.9 million

Construction of a new high-speed railway line (250km/h) between Ankara and Istanbul, in the Eskisehir- Esenkent section (Phase I), with a length of 206 km.

Turnkey execution of the construction project and execution of infrastructure work, buildings, and platforms, track installation work, electrification, signaling, and communications.

This was the first railway project of these characteristics carried out by a Spanish company abroad.

### Main units

<table>
<thead>
<tr>
<th>Main units</th>
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</thead>
<tbody>
<tr>
<td>206 km of double track</td>
</tr>
<tr>
<td>1,435 mm international track gauge</td>
</tr>
<tr>
<td>3,500 m minimum radius</td>
</tr>
<tr>
<td>1.6% maximum slope</td>
</tr>
<tr>
<td>24,100,000 m³ of earthmoving</td>
</tr>
<tr>
<td>989,000 m³ of ballast product</td>
</tr>
<tr>
<td>368 units of constructed works, including four viaducts and one tunnel</td>
</tr>
</tbody>
</table>
MÓSTOLES-NAVALCARNERO SUBURBAN TRAIN PROJECT

Concession information
Concessionaire Company: Cercanías Móstoles-Navalcarnero, S.A.
Client: Consejería de Transportes, Infraestructuras y Vivienda de la Comunidad de Madrid

This 15 km line will provide service to close to 225,000 inhabitants of the southern area of Madrid and will have seven stations.

In order to avoid an environmental impact, 46% of the line will run underground and a viaduct of 320 m long will be built over the Guadarrama River, offering an alternative to passenger transport by bus or automobile.

MODERNIZATION OF THE NOVÉ MESTO NAD VÁHOM-PÚCHOV RAILWAY LINE. STAGE I AND II. TURECKY TUNNEL. SLOVAKIA

Client: Railways of the Republic of Slovakia
Completion date: 2013
Budget: €263.8 million

Execution of a tunnel using the new Austrian tunneling method. Projected to use Rheda 2000 slab track in the tunnel, extended to the viaduct. The construction of the tunnel reduces the length of the route by 400 m and increases the travel speed from 80 to 160 km/h.

<table>
<thead>
<tr>
<th>Main units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.5 km long, 130 m² of cross-section for double track</td>
</tr>
<tr>
<td>244,000 m³ of excavation in the tunnel</td>
</tr>
<tr>
<td>71,000 m³ of concrete and 3,100 t of rebar steel</td>
</tr>
</tbody>
</table>

TRACK OPTIMIZATION PLZEŇ-STŘÍBRO. CZECH REPUBLIC

Client: Railway Transportation Administration
Completion date: 2009
Budget: €144.5 million

This project, included in the modernization of The Czech Railway Corridor III, serves as an important connection to Germany and other countries in Western Europe.

<table>
<thead>
<tr>
<th>Main units</th>
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</thead>
<tbody>
<tr>
<td>Construction of 56 km of infrastructure</td>
</tr>
<tr>
<td>53 km of superstructure</td>
</tr>
<tr>
<td>49 units change crossings</td>
</tr>
<tr>
<td>41 bridges</td>
</tr>
<tr>
<td>51 culverts</td>
</tr>
</tbody>
</table>
NORTH-NORTHWEST HIGH-SPEED CORRIDOR.
OURENSE-SANTIAGO AXIS. LALÍN-SANTIAGO
SECTION. BOQUEIXON-SANTIAGO SUBSECTION.
SPAIN

Client: Administrador de Infraestructuras Ferroviarias (ADIF)
Completion date: 2008
Budget: €86.2 million

The project includes the construction of:

- Platform: 5.8 km long
- Marrozos Tunnel: 1.3 km long
- Santiago Tunnel: 638.5 m long
- O Eixo Viaduct: 1.2 km long and 84 m height of piles
- Five overpasses and one underpass in restoration of roads and highways

LEÓN-ASTURIAS HIGH-SPEED LINE. SECTION:
LA ROBLA-PAJARES TUNNEL. SPAIN

Client: Administrador de Infraestructuras Ferroviarias (ADIF)
Completion date: 2011
Budget: €128.3 million

The project includes the construction of:

- Castro Tunnel: 493 m long
- Alba Tunnel: 1.1 km long
- Peredilla Tunnel: 711 m long
- Buen Suceso I Tunnel: 736 m long
- Buen Suceso II Tunnel: 251 m long
- Nocedo de Gordón Tunnel: 701 m long
- Ollero Viaduct: 112 m long (4 spans)
- Alba Viaduct: 271 m long (6 spans)
- Huergas Viaduct: 398 m long (8 spans)
- Three underpasses using frame structures
- Two overpasses in highway restoration
- Railway restoration of the La Robla connection
NORTH AND NORTHWEST HIGH-SPEED LINES. GUADARRAMA SOUTH TUNNEL. MADRID. SPAIN

Client: Administrador de Infraestructuras Ferroviarias (ADIF)
Completion date: 2008
Budget: €365.2 million

Execution of high-speed railway infrastructure and superstructure (350 km/h) and single track 16.7 km long, of which, 13.4 km were constructed using a 9.5 m of diameter TBM. The project includes the construction of the Majalahita Viaduct, with 16 spans and a total length of 702 m.

Main units

- 941,623 m³ of hard-rock tunnel excavation
- 12,987 m² viaduct deck
- 22,477 monoblock sleepers
- 13,486 m slab track
- 127,010 m³ concrete in segments

RAILWAY ACCESS TO NORTH AND NORTHWEST SPAIN. SECTION: COLMENAR VIEJO-SOTO DEL REAL. SAN PEDRO WEST TUNNEL. MADRID. SPAIN

Client: Administrador de Infraestructuras Ferroviarias (ADIF)
Completion date: 2007
Budget: €336.2 million

Construction of the platform for the new railway access to North and Northwest Spain. Civil works and installations of the San Pedro West Tunnel. Initial excavation method with TBM, changed due to geotechnical requirements to NATM with an intermediate tunnel opening.

Main units

- 8.54 km long
- 420,000 m³ of excavation
- 22,000 m³ of tunnel excavation with TBM
- 710,000 m³ of excavation with the NATM
- 48,000 m³ of shotcrete
- 120,000 m³ of concrete in lining
BUENAVENTURA-CUAUTITLÁN SUBURBAN RAILWAY. MEXICO

Client: Constructora Mexicana del Ferrocarril Suburbano
Completion date: 2009
Budget: € 78.7 million

OHL participated in the design and construction of this PPP project that connects the central zone of Mexico City to the northern part of the Metropolitan Area, along a length of 26 km, distributed as follows:

- 7 km in the Federal District, through Cuauhtémoc and Azcapotzalco delegations
- 19 km in the municipalities of Tlalnepantla, Cuautitlán Izcalli and Tultitlán in the State of Mexico
- Capacity of 320,000 passengers/day

TORONTO-YORK SPADINA SUBWAY EXTENSION. CANADA

Client: Toronto Transit Commission
Completion date: under construction
Budget: €271.5 million

As part of the project to extend the metro for the connection between Toronto and York, OHL was awarded the contract to build the Highway 407 station and the North tunnels.

Highway 407 Station
This station will be converted into a multi-modal transportation center with 600 parking lots and 18 bus platforms.

North Tunnels
This is the most complex section in the project to extend the metro, and it consists of the 7.3 km of TBM (EPB) excavation, divided into twin tunnels measuring 3,640 m each, at an average depth of 18 m.
AIRPORTLINK RAILWAY CONNECTION.
# FLORIDA. USA

Client: Miami Dade County Transit
Completion date: 2012
Budget: €315.4 million

The project includes the construction of 3 phases, with a total of 39.6 km.

The first phase, executed by OHL, consists of:

- A 3.8 km long section
- Elevated line, 19 m high, double track, connecting the Earlington Heights Metrorail station to the Miami Intermodal Center of the Miami airport
- Three-level Metrorail MIC passenger station
- Commissioning of operating system for coordination and integration of the new section into the existing Metrorail system

Orange Line Station
- 7,200 m² of cylindrical open-air structure that turns and twists
- Main roof with 156 panels similar to a curved steel beam, all different and more than 12 m long

Awards and recognition

Awarded The Global Best Project by the publication ENR in 2013. Railway category.

### Main units

<table>
<thead>
<tr>
<th>Item</th>
</tr>
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<tbody>
<tr>
<td>3 electrical traction substations</td>
</tr>
<tr>
<td>2,134 t of steel</td>
</tr>
<tr>
<td>4,161 m of precast girders</td>
</tr>
<tr>
<td>1,762 t of precast tunnel segments</td>
</tr>
<tr>
<td>15,000 m of in situ piles</td>
</tr>
<tr>
<td>3,303 m of acoustic barriers</td>
</tr>
</tbody>
</table>
WEST LIGHT RAIL LINES. MADRID. SPAIN

Concession information
Concessionaire Company: Metro Ligero Oeste, S.A.
Client: Consorcio Regional de Transportes de Madrid (CAM)
Works completion date: 2006
Concession period: 2006-2036
OHL Concesiones Stake: (51%)
Total managed investment: €594 million

Metro Ligero Oeste, S.A. (MLO) manages the lines ML2 and ML3 that connect and serve as the backbone of large population centers in Madrid by connecting them to the Metro network and Renfe Commuter Rail network.

Line ML2, with 8.7 km long, and 13 stops, runs through the municipality of Pozuelo de Alarcón. Line ML3, with 13.7 km long, operates in the municipality of Boadilla del Monte and has 16 stops. These two lines provide service to a population of approximately 128,000 inhabitants.

Awards and recognition
- *Best Light Rail Initiative Worldwide*, given by the International Union of Public Transportation (UITP). 2010
- *Best Light Rail Operator in Europe at the European Rail Congress*. 2013
- Recognition at the II Awards for the Promotion of Public Transportation and Sustainable Mobility of the Consorcio Regional de Transportes de Madrid for its educational project on sustainable mobility. 2014

Main units*

| 1 overpass, with composite deck |
| 7 underpasses 16 stops, one of which, P-5, is located in the underpass at KM 2+600 |
| Multipurpose building |
| 6 drainage wells located at low points of the underpasses, except 2+600 |

*Main construction units.
REHABILITATION OF THE CULVER LINE VIADUCT. NEW YORK. USA

Client: New York City Transit Authority (NYCT)
Completion date: 2012
Budget: €140 million

Rehabilitation of a 1.6 km section of the Culver Viaduct in the New York subway, in Brooklyn. The works were executed between Carroll Street and 4th Avenue stations on the F and G lines of the NYCT.

The works included:
- Waterproofing of the structure
- Replacement of concrete protection and guard rails
- Construction of new installations
- Renovation of the ballast substructure
- Replacement of track on ballast with LVT slab track with anti-vibration insulation
- Signaling and communication
- Upgrading of transportation signaling and safety systems

DOHA METRO. MAJOR STATIONS. QATAR

Client: Qatar Railway Company
Completion date: under construction
Budget: €1.100 million

Design and construction of Musheireb and Education City stations in the Doha metro network, which will consist of modern intermodal transfer facilities connecting multiple metro lines to other modes of transportation, such as the long-distance railway.

Musheireb Station
Located in the heart of Doha, known as the Musheireb Downtown Doha, the historic city center where an ambitious remodeling process is underway.

Education City Station
Located in what is becoming the center of the educational excellence in the region, Education City is an initiative of the Qatar Foundation. It will connect with the long-distance railway and will receive students from all areas of the Gulf Cooperation Council.
METRONORTE. MADRID. SPAIN

Client: Madrid Infraestructuras del Transporte (MINTRA)
Completion date: 2007
Budget: €137 million

Construction of a tunnel for the Metro network between the municipalities of Alcobendas and San Sebastián de los Reyes (Madrid).

Construction of 5.05 km of double track and four intermediate stations. The project includes three emergency exits, four ventilation, launching, and work shafts.

<table>
<thead>
<tr>
<th>Main units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.37 km of line tunnel</td>
</tr>
<tr>
<td>200 m of launch shaft tunnel</td>
</tr>
<tr>
<td>111 m long each</td>
</tr>
</tbody>
</table>

REGIONAL METRO OF VALPARAÍSO. CHILE

Client: Merval, S.A.
Completion date: 2005
Budget: €60 million

Construction of the civil works of sector III of the tunnel, sections D and E, as part of Project Stage IV, railroad interconnection Valparaíso-Viña del Mar.

The construction of a tunnel for the railway route undergrounding between Puente Capuchinos and El Salto sector, was one of the main objectives of Project IV Stage.

<table>
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<tr>
<th>Main units</th>
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<tbody>
<tr>
<td>1.7 km of tunnel length</td>
</tr>
<tr>
<td>22 m long: Hospitalet Station</td>
</tr>
<tr>
<td>122 m long: Chorrillos Station</td>
</tr>
<tr>
<td>179 m of trench length</td>
</tr>
<tr>
<td>152 m of containment wall</td>
</tr>
</tbody>
</table>
REHABILITATION OF COLUMBUS CIRCLE STATION. NEW YORK CITY. USA

Client: New York City Transit Authority (NYCT)
Completion date: 2012
Budget: €36 million

The project includes the construction of:

- New accesses to the existing subway station
- Rehabilitation of structure, platform, and track
- Construction of an access on 60th Street that includes a control area, and allows passengers on the metropolitan subway network to access the northeast corner of 60th Street with Broadway from the platform
- Construction of a direct access to the Trump International hotel, located in the northern section of Columbus Circle

EXTENSION OF LINE 2 OF THE MADRID METRO BETWEEN VENTAS AND LA ELIPA STATIONS. SPAIN

Client: Madrid Infraestructuras del Transporte (MINTRA)
Completion date: 2007
Budget: €80 million

The project includes the construction of a tunnel, the design architecture of the station, and the civil works corresponding to the ventilation, pumping, emergency exit, and drainage system installations.

It also covers the construction of the track superstructure and lighting of the tunnel and the technical rooms.
LINE 9 OF THE BARCELONA METRO. SECTIONS III AND IV. SPAIN

Client: Infraestructures Ferroviàries de Catalunya (IFERCAT)
Budget: €590 million

Section III crosses Barcelona, from Sagrera to Zona Universitaria. Section IV is located in the center of Santa Coloma de Gramanet.

The line is equipped with tracks at different levels in both directions of the electrified traffic. The entire section between stations runs underground and it was excavated with a TBM with an inner diameter of 10.9 m, which was also used in the excavation of the 9.2 km of tunnel in Barcelona.

The contract also includes the construction of 4.3 km of tunnel in Santa Coloma de Gramanet.

The works include:

- Intermediate structure of the tunnel
- Structures corresponding to ventilation and emergency exit installations
- Track and catenary
- Electrical installations
- 152 m of containment
- Technologies for the construction of concrete segments with fibers in a new optimized reinforcing system
- Innovative system for bypassing aquifers
Arid-Lap Project
Construction technology and solutions for railways, metro systems and tunnels

The prestigious reputation of OHL in the railway sector is the product of its many years of experience and the talent of its specialized subsidiaries. OHL develops and applies the most advanced technology in its railway infrastructures construction processes. Among the various developments owned by OHL and undertaken in this area stand out:

- Design and validation of multipurpose precast plates
- Solutions to minimize the impact of aggressive environments on high-performance railway infrastructure
- Technological improvements in tamping, leveling and alignment operations
- Railway track installation systems without prior installation of auxiliary track
- Advanced safety systems for maintenance tasks
- Current collection on high-speed lines
- Use of braking energy on tramway lines
- Techniques for ecological restoration of areas affected by the construction of railway infrastructure
- New technologies for tunneling and underground work
- Control systems to detect the environmental impact on nearby buildings caused by railway tunneling works
- Construction procedures in areas such as the injection of waterproofing into tunnel lining panels with integrated reinforcement, or execution of connection galleries in non-consolidated ground
- Development of proprietary structural solutions to guarantee track gauge and height and adaptation of tracks
- Improved safety in tunnels affected by underground aquifers
- Ventilation systems upgrade in metro stations without interaction of the tunnel with the platform
Ankara-Istanbul High-Speed Line. Turkey.