

Barcelona Metro Line 9/10 Expansion, Spain

Barcelona Metro Line 9/10 will be **Europe's longest underground line** at 48km overall. 44km will run through bored tunnels and 4km on an elevated viaduct. Due for completion in 2021, it will provide links to four suburbs as part of a wider **urban regeneration programme**, connecting the airport and city centre. The project is being delivered in an **environment three times more densely populated than London**.



GISA



£1.3bn
(multiple contracts)



2002
- 2023



Design
& Build

Barcelona Line 9/10 is Europe's longest fully automated driverless metro system. We are delivering three of the four sections of new line, with the scope of our works including 14km of 9.33m diameter single-bore tunnels with parallel tracks; 11.5km of 12m diameter single bore tunnels with tracks on two superimposed levels; 26 step-free stations and a train depot. We had overall architectural responsibility for stations, developing an architectural vision, ensuring design elements aligned with a compelling, coherent design philosophy.

The design and construction of Line 9/10 involved the integration of multiple technologies and the co-ordination of many suppliers. We collaborated at the design stage with the client and metro service operator to select a trackform that complied with noise and vibration requirements. In conjunction with the Barcelona Technology University, we developed an innovative construction technique using steel fibres to reinforce station shafts.

Line 9/10 runs below heavily populated, environmentally sensitive locations throughout Barcelona. Adjacent metro lines remained fully operational during construction due to our extensive, effective monitoring regime, allowing very precise prediction of settlements. The alignment also fell within the Zone of Influence of 18,000 historical building foundations, which were monitored in real-time and achieved settlements well within acceptable tolerances.



ADDED VALUE

- We helped pioneer the two-tier railway design that enabled us to thread 11.5km of the new single-bore tunnel through Barcelona, safeguarding the city's historic assets
- To avoid the disruption of constructing additional shafts for changing the TBM cutting heads in heavily congested areas, we used an existing ventilation shaft to perform a horizontal underground change – the first underground change of a cutter head ever performed. This innovation avoided a two-year exercise to construct a 65m deep temporary shaft
- We minimised noise, vibration and dust by installing acoustic dampening, designing micro-blasting procedures to decrease the level of vibrations and reducing the velocity of the TBM when crossing rock to minimise vibrations to neighbouring homes
- We designed lift-on, lift-off precast topping slabs for use on access shafts when not in active use, permitting vehicular traffic to run across the top when they were not in use, facilitating traffic movements
- The stations were constructed using an innovative vertical cylindrical design that intersected the tunnel, minimising disruption to residents and local businesses by reducing excavations. This shortened the programme and minimised the ground level footprint

3×

more densely populated city compared to London

500

functional interfaces within L9 managed successfully

26 stations

step-free

2× TBMs

deploying three different types of cutting wheels

12m

largest TBM diameter

25.5km

of single-bored tunnels