Miraflores AVE viaduct- Spain

Heavy lifting,
supply of bearings and post-tensioning works.

▲ *Half-arches during lowering operation*

In March '05 CTT-Stronghold S.A. (VSL Spain) was awarded a package including the supply of bearings and the execution of the post-tensioning and heavy lifting Works for the construction of the Miraflores viaduct.

The project was carried out by CTT in co-operation with the specialised team of VSL Heavy Lifting (Switzerland).
The viaduct is one of the main structures to be constructed for the High-Speed railway link between Madrid and the cities of Segovia and Valladolid. The viaduct is supported by 25 piles and the key of a central arch. It has a total length of 1755 m, with a typical span of 66 m and a central span of 132 m.

It crosses a highly protected area close to the mountains in the province of Madrid and is surrounded by a special variety of oak trees.

The design of the viaduct included the construction of a concrete arch that covers the central span of 132 m. This arch is the biggest in Spain and the third of its kind in the world. The arch solution is highly effective for multi-span railway bridges: the key works as a virtual abutment that enables transmission of braking forces to the foundations.

The arch was constructed in two halves that were erected vertically close to an adjacent pile onto a hinged articulation. These segments had to be lowered into position before closing the key segment with a final pour that included a pile segment.

After the execution of the piles and the central key segment, the viaduct was built with a movable scaffold system with a total length of 153 m and a weight of 950 T that spanned over the 66-m span between the piles.

A more classical approach (i.e. building the half arch on scaffold and then lifting each part) was discarded for this project.

Two main reasons explained such a choice:

- firstly, it was necessary to minimise the environmental impact of temporary piles for scaffolding; and

- secondly, the necessary forces to lift the structure would have been multiplied by a factor of two.

Each half arch had a hollow rectangular shape with outer dimensions 3m x 6m and a weight of 1400 T.

Scope of works performed

- Arch heavy lifting works
- Supply of pot bearings
- Post-tensioning execution

Two pulling cables with 43 strands 0.6” 1860 MPa were installed on top of the pile onto special pieces that allowed rotation and movement of the cables. The pile was securely anchored to the foundations of a preceding pile with two retention cables with 42 strands each.

At the beginning of the operation the half arch was vertical, which meant that its centre of gravity was directly above the articulation.

For this reason it was necessary to install two additional cables of 12 strands each that were used in the initial phase to generate a minimum force of 160T in the system and lower the half-arch in a controlled manner.

▲ *Heavy lifting equipments on pylon head*

▼ *Viaduct construction general view*

▼ *Half arch initial construction position*

▼ *Another view of heavy lifting equipment*

OWNER
Ministerio de Fomento de España - ADIF (Spanish Ministry of Civil Works Administrator of Railway Infrastructures)

ENGINEER
PROES

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VSL ENTITY
CTT-Stronghold S.A.

The equipment necessary to lower one half arch included two main units SMU 580 (lowering units) for the main cables, two SLU 580 jacks for the retention cables, two SLU 120 jacks for the auxiliary cables and 5 high capacity hydraulic pumps. All these equipment were operated from a central control unit that was situated on a temporary structure on the top of the pile.

The forces involved increased from zero at the starting point to a maximum at the end of the operation of 860T (main lowering cables) and 1150T (retention).

After having lowered the first half arch in just one day, lowering operations continued with the second half arch. The closing pour took place once the position of the two parts was adjusted with millimetre precision.

The sequence of introduction of forces and the final de-tensioning were carefully monitored during the whole process. In particular it was necessary to control forces and maintain deflections on the pile below a strict value of 64mm.

The lifting works were completed in September 2005 to the full satisfaction of all parties involved and with the presence of national authorities and media.

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