

Cadiz, SPAIN

Extension of existing quay

Cabezuela quay in Bay of Cadiz Harbour originally handled only bulk goods. The Harbour Authority – Autoridad Portuaria de la Bahía de Cadiz – decided to extend the quay in order to increase its bulk handling capacity, thus attracting more shipping lines to the port. The northern end of the wall was extended by 117 m during the first phase of the development project. Construction works for the first phase began in March 1999. The existing “Muelle de la Cabezuela” quay wall built in 1989 is 495 m long. It consists of 17 reinforced concrete caissons founded on rock and gravel 14 m below sea level.

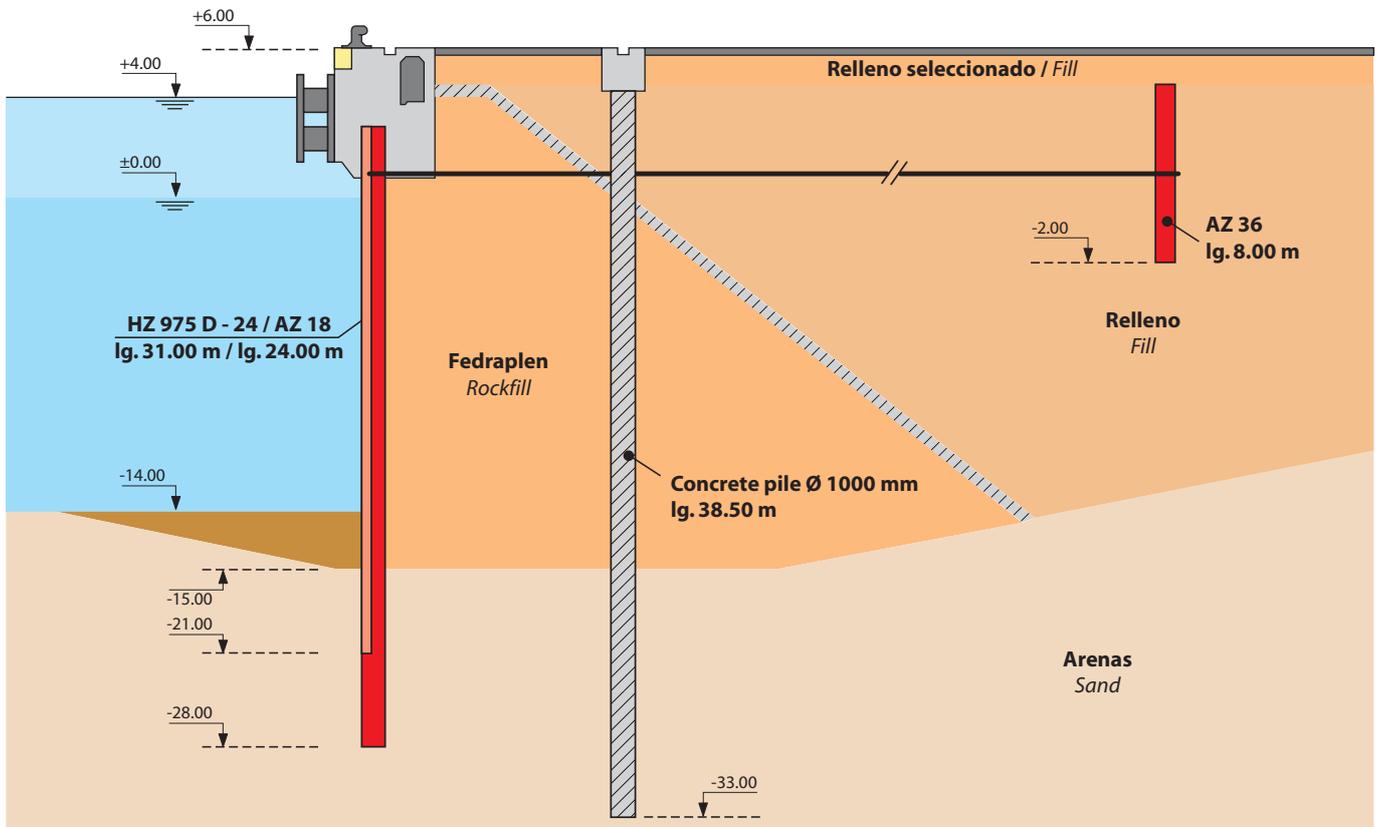
Soil conditions with sufficient resistance to support the caissons were

encountered only at great depths towards the north side of the existing quay. Adopting the caisson solution for the extension would have involved high costs due to the deep foundation required. The owner therefore rejected this solution and was looking for more economical construction methods. Deck-on-pile and sheet pile solutions were studied and compared. Because of advantageous technical and financial aspects, easy installation within short timeframes and minimum environmental impacts, the decision fell in favour of the sheet pile wall.

The great height of the quay wall led to important loads that called for a high-strength-steel sheet pile solution.



Economic advantages led to a sheet-pile-based extension of the concrete quay



A combined steel sheet pile system was used to build the 20-m-high quay wall



A berm of backfilled sand supported the driving equipment

Arcelor's combined-wall system proved to be the ideal structural element for the 20-m-high Cabezueta quay wall. The HZ/AZ solution incorporates two types of sheet piles: HZ king piles that act as a structural support and AZ sheet piles acting as intermediary infill elements. 31-m HZ 975 D king piles combined in pairs were used for this project together with 24-m AZ 18 sheet piles.

An anchor wall made of AZ 36 sheet piles was installed 36 m behind the main quay wall to limit deflections and to increase the loadbearing capacity. The two walls were connected by tie rods with a diameter of 4.5" placed one metre above water level to facilitate installation. The underwater sections of the existing concrete wall were connected to the sheet pile wall by welding the sheet pile's first

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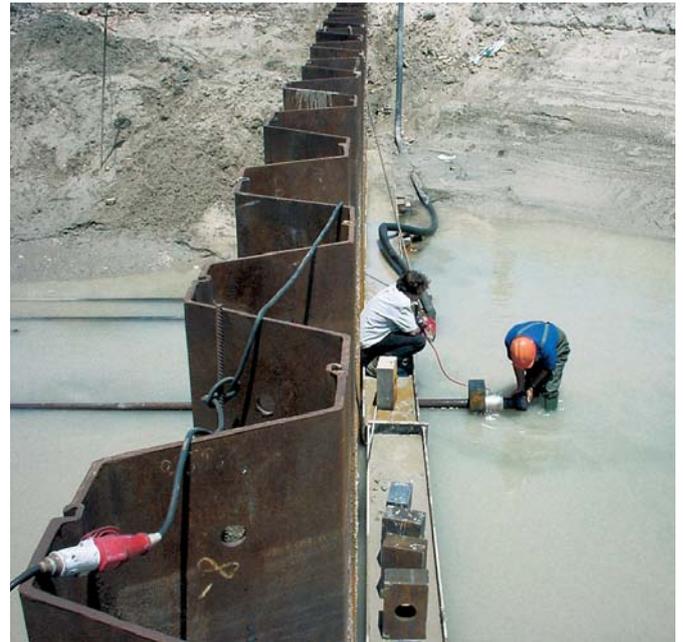


The driving template was placed on the embankment



A finger quay formed the north end of the Cabezueta quay

interlock to a steel plate fixed to the last concrete caisson. Prior to the start of the installation works, a 4-m-thick layer of thick mud (fangos) was removed. An embankment was built along the line of the future wall as installation with a Muller MS 100 F vibratory hammer proceeded to avoid



Tie rods were installed above the water line to facilitate the installation

having to use a barge. The steel sheet piles were sand-blasted and coated with coal-tar epoxy paint on site. The contractor used a two-level template standing 3.5 m high that fitted three double HZ piles to ensure correct positioning of the sheet piles. Two double king piles were used to

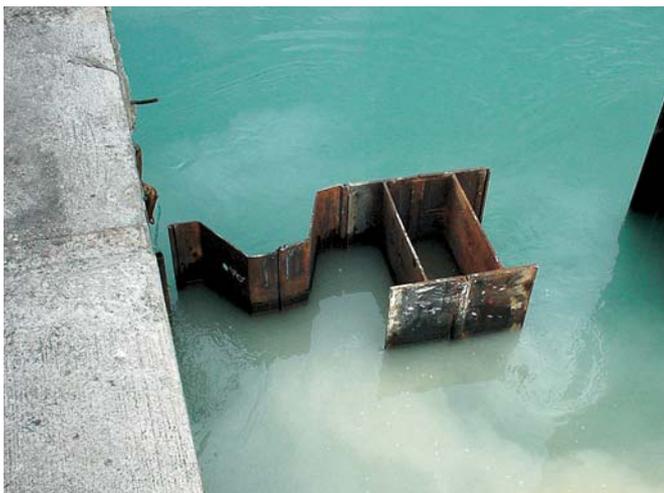
Owner: Autoridad Portuaria de la Bahía de Cadiz
Consulting engineer: CEDEX, Alatec Haskoning
Main contractor: NECSO
Piling contractor: Piacentini (Italy)
Sheet pile system: HZ 975 D -24 / AZ 24 m
Length of sheet piles: HZ 31 m, AZ 24 m
Steel grade: S 430 GP
Total quantity of sheet piles: 1,600 metric tons



The quay extension required 1,600 metric tons of sheet piles



Once the sheet pile wall was installed, the area behind it was backfilled



The connection between old and new quay consists of a steel plate welded to the first sheet pile



The wall's corner consists of AZ 18 piles that were also used as intermediary piles

position the template prior to installation of the first sheet piles. The HZ double piles were driven in approximately 10 minutes, whereas 20 minutes were required to install a double AZ sheet pile. A template consisting of a horizontally positioned AZ 36 sheet pile was sufficient to ensure the straightness of the anchor wall.

The new quay wall required a total of 1,600 metric tonnes of Arcelor's steel sheet piles which were installed in less than five weeks. The front crane loads were carried by the HZ/AZ wall, whereas cast-in-situ concrete piles were installed to take up the weight acting on the rear crane rail. A concrete capping beam with bollards and fenders was installed on top of the sheet pile wall to finish off the structure at an elevation of +6 m. Four inclinometer tubes were installed inside the double HZ king piles to measure horizontal movements. The recordings confirmed the design's predicted construction and service loads. Eight extensometers and two load cells with a nominal range of 135 t were installed to detect the actual tension forces in the tie rods. On site measurements were completed by pressure sensors and six piezometers that evaluated hydrostatic pressures in different locations near the sheet pile wall. ■