Calais, FRANCE

New passenger berth

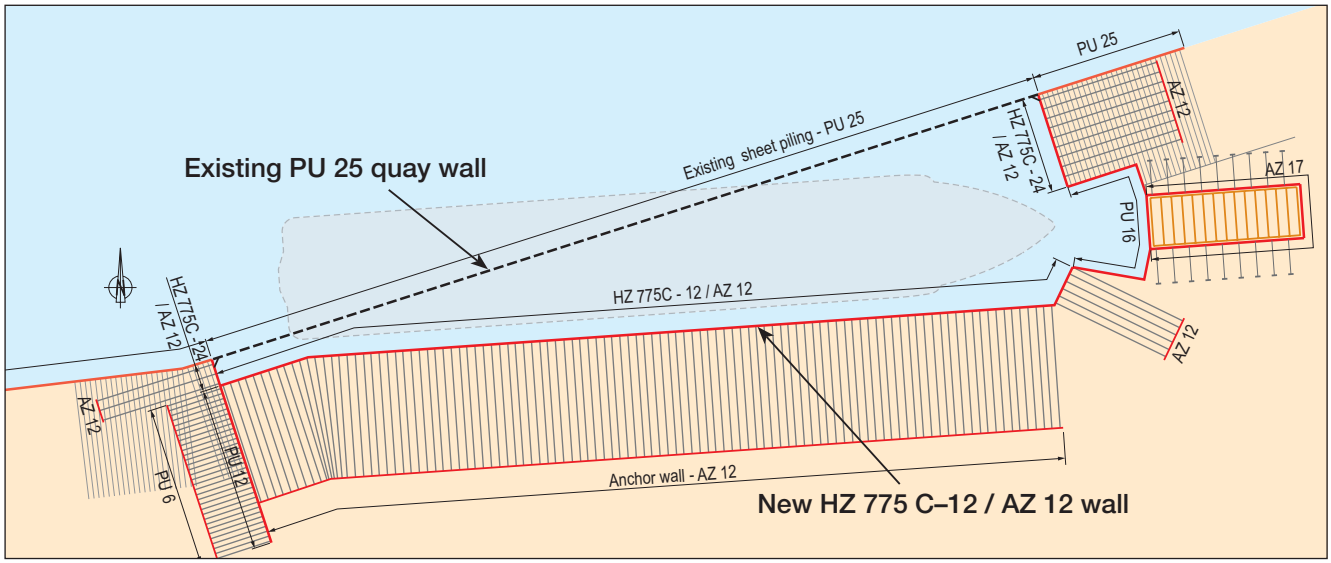
The new Berth 9 is equipped with larger ramps and is able to handle bigger ships

The Port of Calais is situated on France's North Sea coast, at the point closest to England (22 nautical miles). Calais, together with the Port of Dover, provides the main maritime link between the UK and Western Europe.

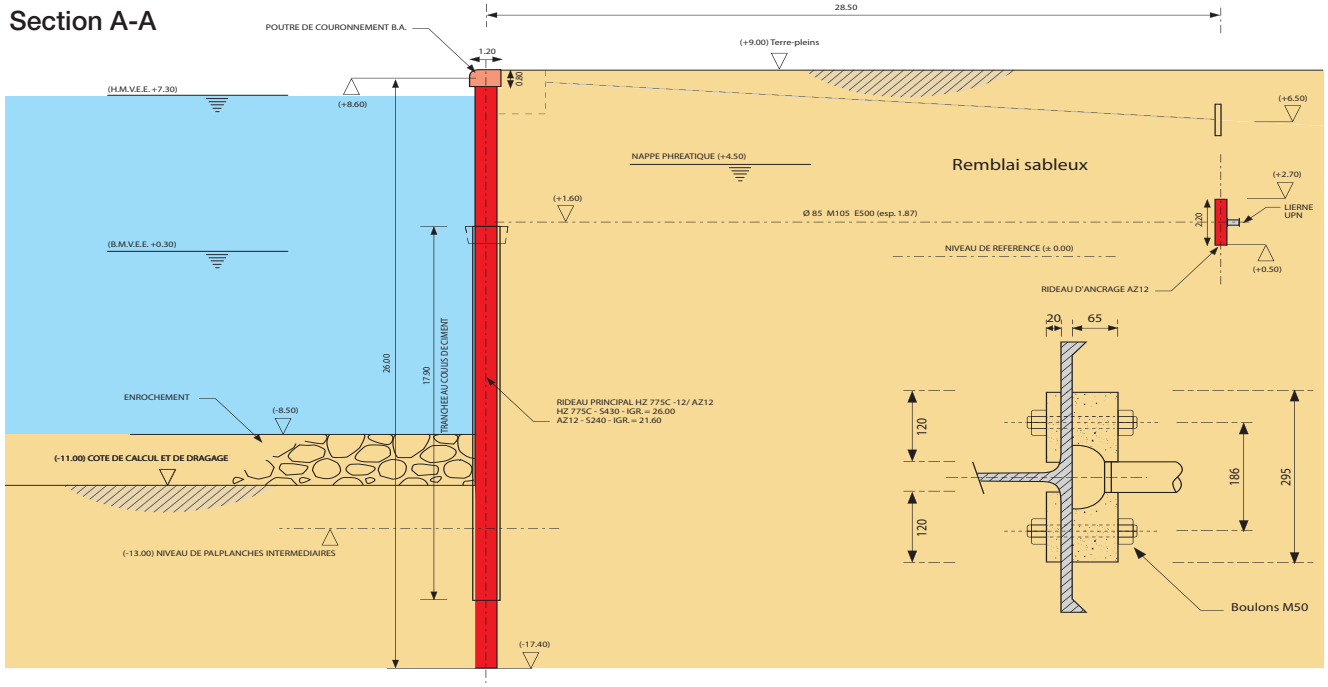
The two ports find themselves in the unique global position of taking first and second place in port classifications in terms of passenger transport. Handling an average of 65 car ferry departures per day and up to 20 million passengers per year, Calais is also France's fourth largest mercantile port with 38 million metric tons of goods handled annually.

The opening of the Channel Tunnel in 1994-1995 prompted shipping companies to review their operations in order to tackle this new competitor head-on: the frequency of crossings has been increased and embarkment procedures have been improved.

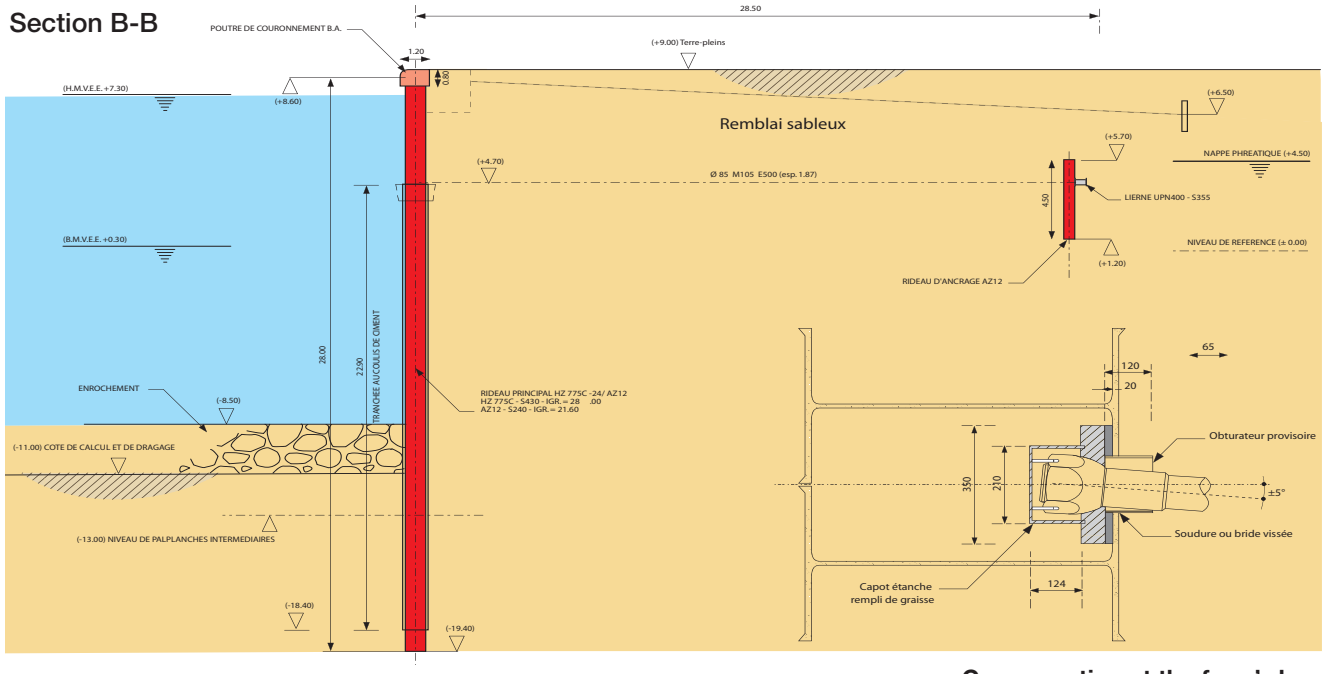
The ports of Calais and Dover are the world's busiest passenger ports



The new Berth 9 replaces the outdated berth from the 1970s



Cross-section along side the ferry vessel



Cross-section at the ferry's bow

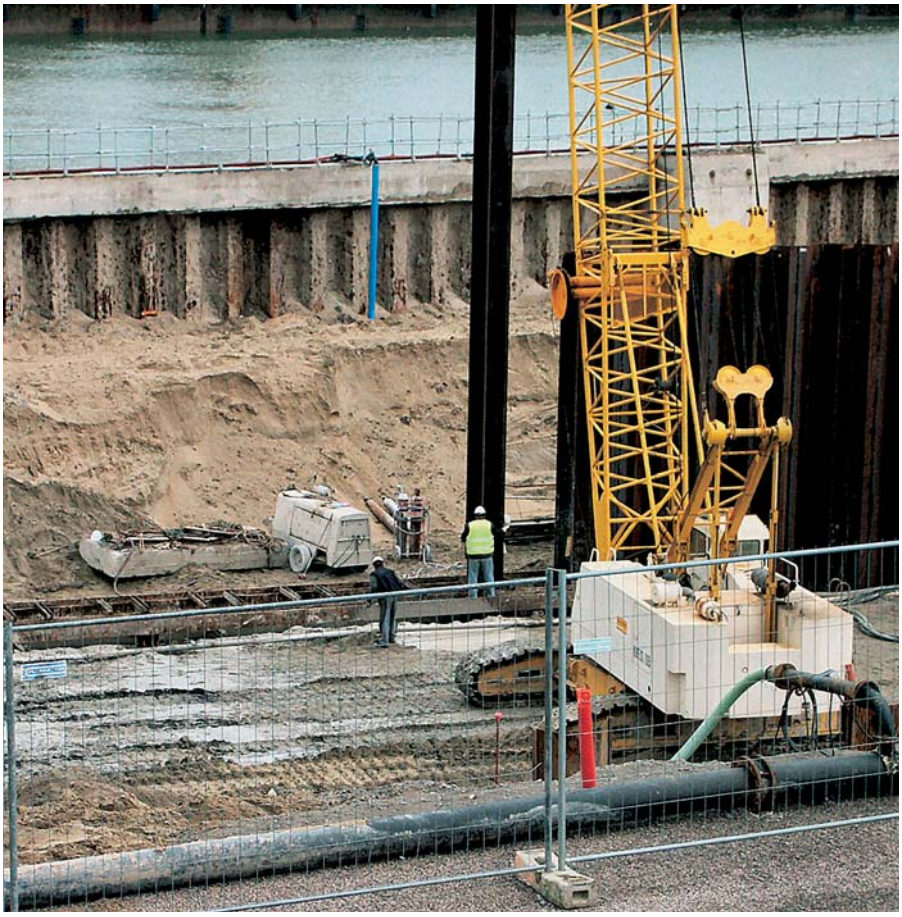
The existing PU 25 quay wall allowed the new wall to be driven in the dry

The old anchor wall had to be removed before the piles for the new Berth 9 were driven

The rocks forming the old harbour bed were removed by a crane mounted on a barge

The Port of Calais comprised seven ferry berths in 1994. Berth 5, the first berth to be built (commissioned in 1975), in the outer harbour, featured two single-lane links for loading and unloading docking passenger ferries. Initially designed for vessels 168 m long and 6 m deep, it became unsuitable for modern cross-Channel traffic.

For operational and strategic reasons, it was impossible to interrupt traffic through Berth 5. In 1995, the operator of the port – the Chamber of Commerce and Industry of Calais – therefore decided to build a new Berth 8. As soon as it had been commissioned, it was possible to start upgrading Berth 5 to a length of 200 m and a dredge level of -8 m. Due to the increased capacity of the latest generation ferries and the requirements to optimise turnaround time, two levels with two lanes each were provided to deal with the roll-on/roll-off



A bentonite trench facilitated driving so that a simple template was sufficient

Bentonite and other filling materials prevented the possibility of the very fine sand washing out through the interlocks

Vibratory driving of the 21.6-m AZ 12 intermediary piles

traffic at the new berths. Both Berth 5 (HZ 775 B, 26/11 combination) and Berth 8 (PU 32) were constructed using steel sheet piles provided by Arcelor from Luxembourg.

The 100-million-euro investment project for the port launched in 2004 was scheduled for completion by 2006. With its new 180-m car-ferry terminal, Berth 9 is at the heart of Calais' redevelopment project. It was operational at the end of 2005, after a construction time of just over a year. The new pier completes the current range of 4 large-sized and one small berth. Another smaller part of the project is the construction of a new Ro/Ro berth for catamarans and roll-on/roll-off vessels.

The new Berth 9 with a water depth of 8.5 m is built right next to Berth 8. The existing structure at the location of the new berth had to be removed. With a water depth of merely four metres, it was no longer suitable for modern ferries. To allow docking of passenger vessels, the new structure had to be L-shaped. The existing straight berth comprised a PU 25 main wall (top: +9.0 m, tip: -16.1 m) and a PU 16 anchor wall (top: +4.7 m, tip: +0.9 m). Rocks of different sizes had been placed on the waterside in front on the main sheet pile wall. The existing structure facilitated construction of the new Berth 9: the old main wall acted as protection from the sea, enabling the contractor to work in the dry. After removing the backfill material behind the old PU 25 piles, the exposed anchor wall and tie rods were removed easily.

French contractor Spie Batignolles then proceeded with the installation of the new L-shaped combined-wall system. The longer side of the L forms the wall alongside the ferry and is 174 m long. The following sheet piles were installed: 93 HZ king piles with length of 26 m and 92 AZ 12 intermediary piles with a length of 21.6 m. The design of the sheet pile wall provided by Arcelor's technical team showed that an HZ 775 C-12 solution made of HZ king piles with a height of 775 mm and AZ 12 intermediary sheet piles fulfils the static requirements. More details can be seen in cross-section A-A.

The shorter side of the L-shaped structure measures roughly 48 m and comprises the ramp as well as a sheet pile wall on either side of the ramp. An HZ 775 C-26 solution, as shown in cross-section B-B, formed the quay's front wall.

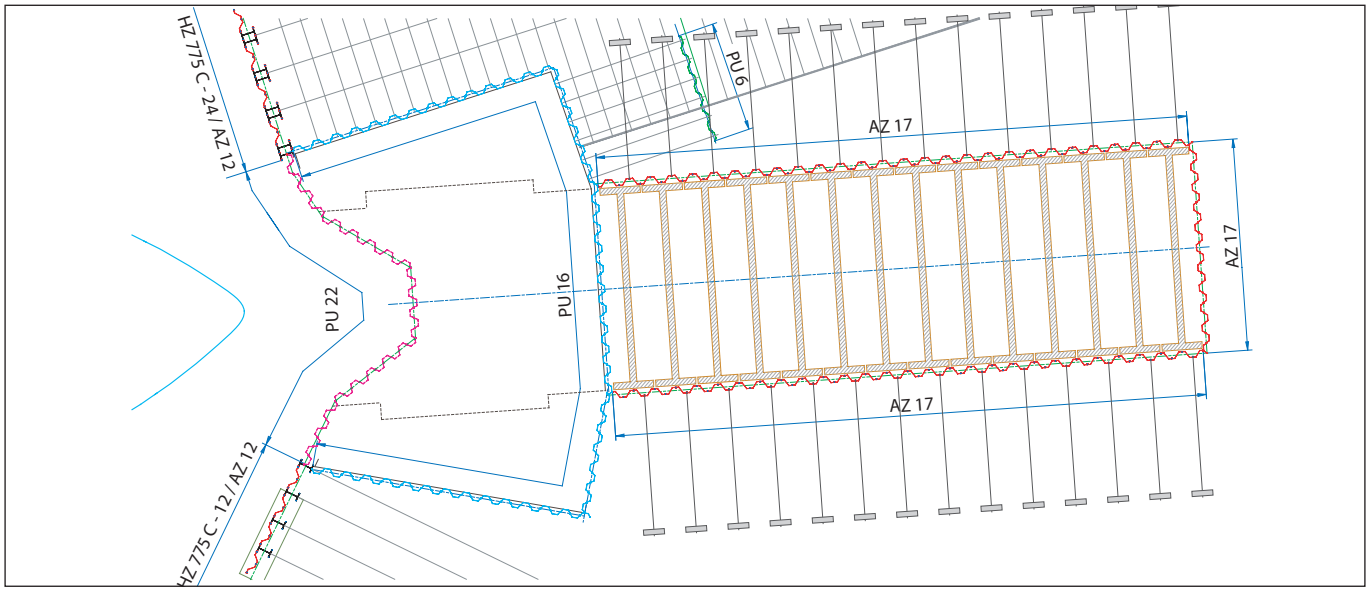
All HZ king piles were ordered in high-strength steel S 430 GP. AZ 12 sheet piles were used for the anchor wall and as intermediary elements for the main quay wall. The AZ piles of the front wall mainly have a load distributing function; which is why a lower steel grade (S 240 GP) was chosen. The AZ 12 piles in steel grade S 355 GP forming the anchor walls are 2.2 m and 4.5 m long respectively.

There is no special corrosion-protection system in the Port of Calais. It was decided to use an extra thickness that will be allowed to corrode away during the lifetime of the sheet pile structure. The following corrosion reserves were chosen: 1.75 mm on the sea side and 0.25 mm on the soil side of the piles.

The steel tubes driven in front of the quay wall act as fenders

HZ 775 C -26 / AZ 12 quay wall offering a water depth of 8.5 m

In November 2003 several boreholes were drilled to a depth of 35 m to investigate soil conditions. The geological properties such as internal friction angle, cohesion and density coefficients that are necessary for the elasto-plastic design of the sheet pile wall were analysed by pressuremeter, penetration and laboratory testing. For the design of the foundation piles, toe resistance and lateral friction were also evaluated.



Berth 9 features a two-level ramp for faster loading and unloading of the Ro/Ro vessels

The 35 x 14 m sheet pile trench accommodates the lower access ramp

Operator:
Chamber of Commerce and Industry of Calais

Contractor:
Spie Batignolles

Steel grade:
HZ & AZ 17: S 430 GP, AZ 12: S 240 GP

Sheet piles:
HZ 775 C -12 / AZ 12, HZ 775 C - 26 / AZ 12, AZ 17, PU 22, PU 16, PU 6

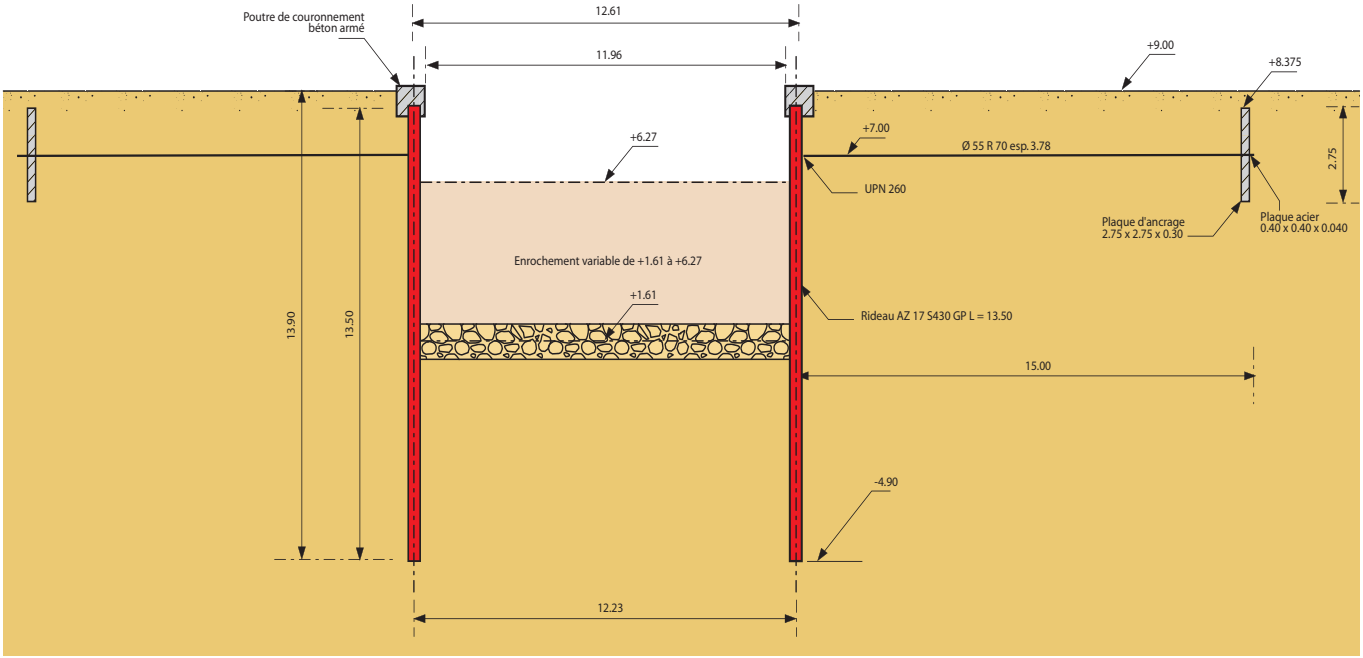
Total quantity of sheet piles:
1,500 metric tons

The results of the geological investigation revealed three different types of soil:

- 1. +9 m to -5 m: soft backfilled sand with shells, friction angle: 36°, density: 17.5 kN/m³.
- 2. -5 m to -20 m: compact "Flandrian sand", friction angle: 37°, density: 19 kN/m³.
- 3. Below -20 m: silty "Flandrian clay", friction angle: 10°, cohesion: 25-50 kPa.

The combined-wall sheet piles were driven into a trench filled with bentonite cement to prevent the fine sand particles washing out through the pile interlocks. Above the top of the trench, the sheet piles were filled with a bituminous material called Beltan, adding to the impervious quality of the steel wall. This unconventional way of installing the piles also had the positive effect of considerably facilitating driving through the hard sand layer. The trench was 1.22 m wide and reached a depth of -16.4 m. This alternative installation method allowed very precise placement of the steel sheet piles without need for an elaborate template.

A high-strength (yield strength: 500 N/mm²) steel tie rod connects the two sheet pile walls. Common round steel tie rods have a weak point: the reduced cross section at the thread. In order to provide tie rods with tensile strength corresponding to the shaft diameter, the anchors' ends were upset. These upset tie rods thus combine reduced weight, easier handling and lower costs. The Berth 9 project used upset tie rods with a shaft diameter of 85 mm upset to 105 mm at the thread. They were equipped with T-shaped connectors, bolts and eyes at the front end. The anchors connect both sheet pile



Arcelor supplied AZ 17 sheet piles in six different lengths for the trench

Junction tie rod / AZ 17 sheet pile

Lower access ramp of neighbouring Berth 8

Upper access ramp under construction

walls over a length of 28.5 m. The horizontal tie rods were attached to the AZ 12 anchor wall with the help of a waling made of two UPN beams.

Being exposed to tidal variations ranging from +0.30 m to +7.30 m, the deck of Berth 9 offers an elevation of +9.0 m to enable year-round operation. A water depth of eleven metres was assumed for the design of the quay. A 2.5-m-thick, 42-m-wide bed of rockfill was placed in front of the main sheet pile wall to serve as scouring protection deemed necessary due to numerous ship movements.

A special 14-m-wide trench with sheet pile walls was built for the placement of the steel access ramp. AZ 17 sheet piles were driven on both sides of the 35-m-long inclined trench. The piles were supplied in a variety of lengths: 11.5 m, 10.5 m, 9.5 m, 8.5 m, and 7.5 m for the side walls; 6.3 m for the return wall. The AZ piles were anchored to concrete plates. The two-level ramp allows fast car and truck access to the ferries, optimising docking times in the Port of Calais. ■