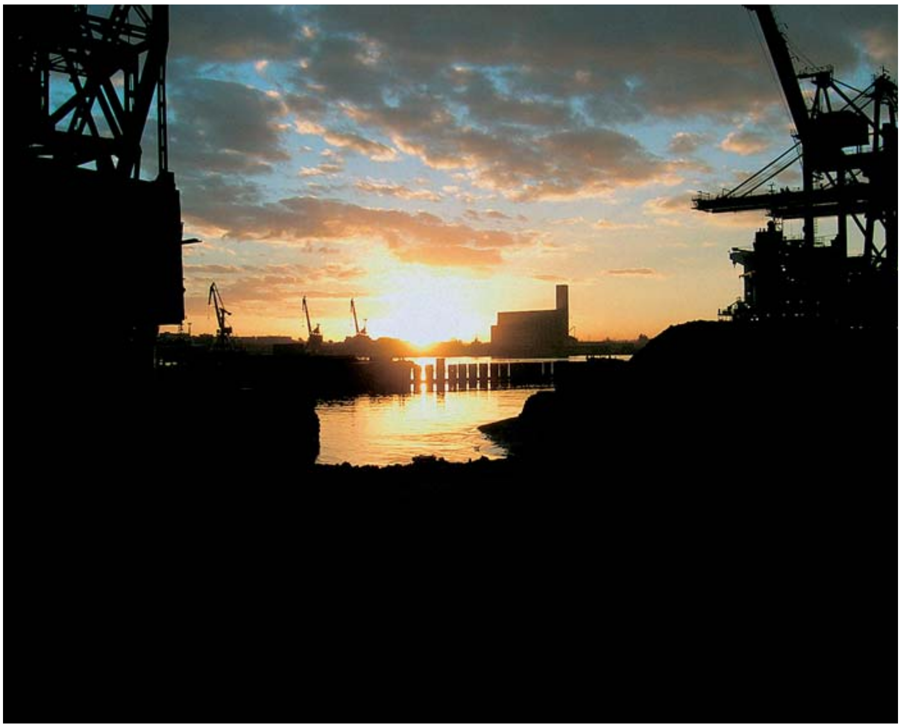
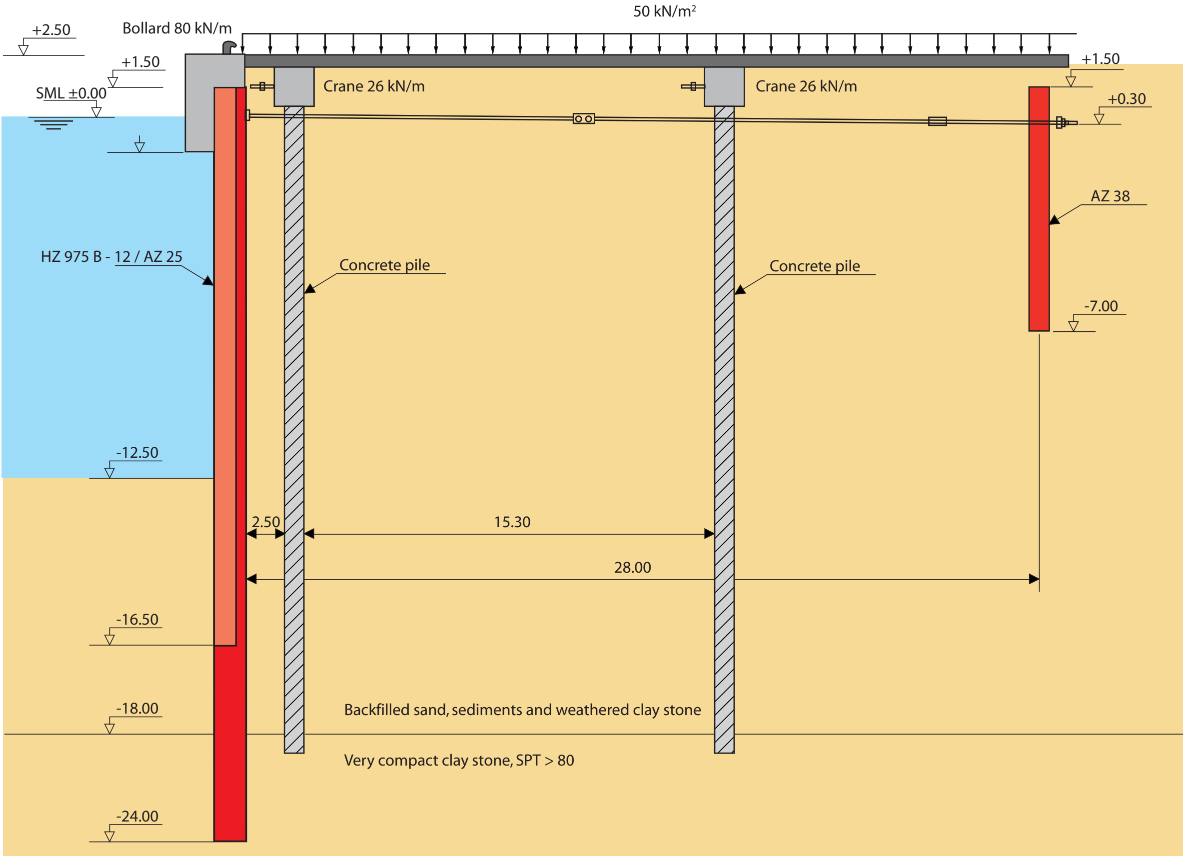
Havana, CUBA

Container terminal extension

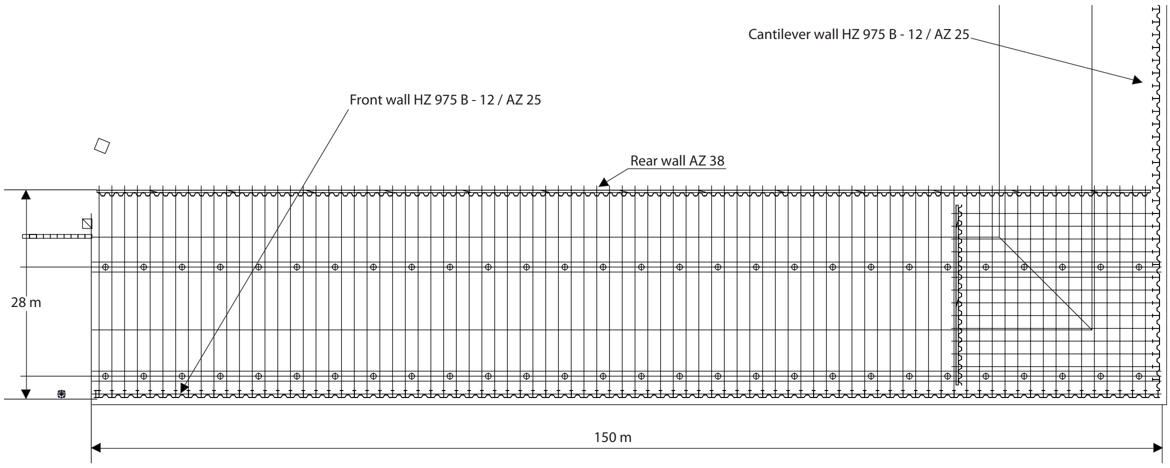


The Caribbean island of Cuba is currently experiencing an economic boom. Global economic ties, especially with individual European nations, continue to flourish. Construction of the Havana Container Terminal (Terminal de Contenedores de Habana - TCH) is a typical example of Cuba’s recent development: The project started in 1990 as a Cuban-Soviet project until the collapse of the former Soviet Union. In 1993, the Transport Ministry bidded out the concession for the container terminal.

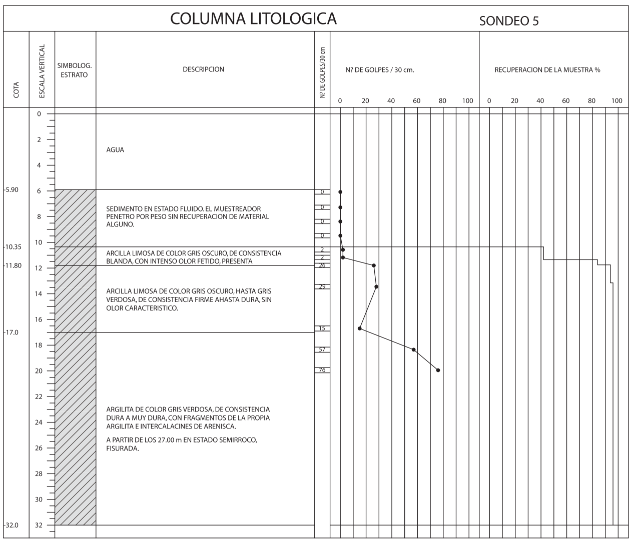
Cuba’s booming economy called for a new container terminal



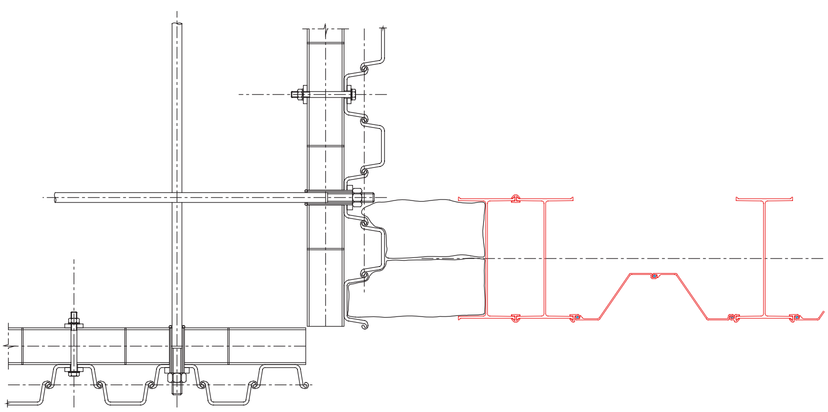
Cross-section: combined HZ/AZ main wall anchored with an AZ 38 wall



L-shaped combined sheet pile quay wall consisting of a tie-back front wall and a cantilever return wall



Boreholes were drilled to evaluate the soil conditions

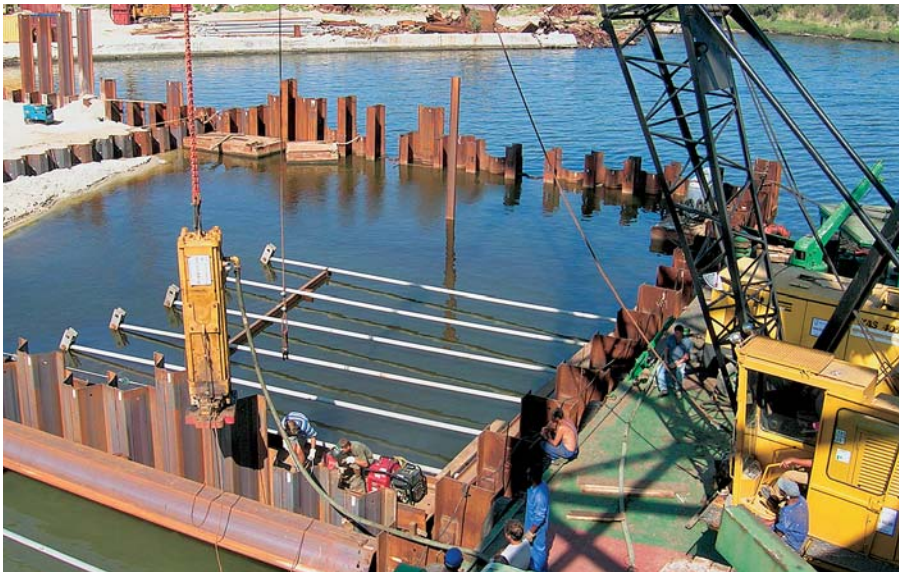


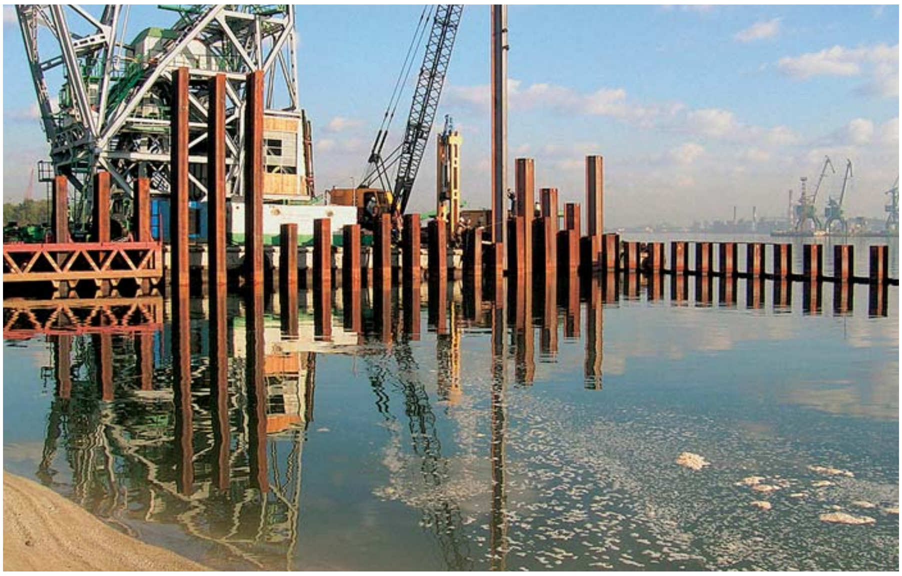
Connection detail: existing Larssen wall / new combined wall

Being Cuba's only container terminal, TCH was approved for a fifteen-year project in 1996. Only four years later, the goals of the fifteen-year plan were reached; the first container vessel called at the terminal as early as 1998. In phase one, an initial investment of $14 million upgraded the terminal and enabled it to receive 150,000 containers per year. In phase two, after an investment of $16.8 million, the annual traffic can now attain 300,000 TEU. Growth is so significant that a further $7.5 million is to be invested to further increase the container-handling capacity of the TCH.

The port's latest proposed investment is for a 150-m extension of the existing container terminal quay wall. In addition to the materials, most of the special technologies and services were not easily available in Cuba. The quay wall was thus supplied as a complete solution by the Bauer Group, a German company specialised in geotechnical and foundation construction worldwide as well as in the sale of foundation construction equipment. The package included the supply and installation of a combined sheet pile wall together with the tie rods. The sheet piles were produced by Arcelor's "Mill 2", in Belval, Luxembourg. The remaining civil works such as backfill and concrete structures were performed by the Constructions Division of the Cuban Ministry for Transport.

The new quay wall had to be connected to an existing wall made of Larssen 5 piles produced in Russia. These heavy 420-mm piles have a section modulus of 3,000 cm³/m and

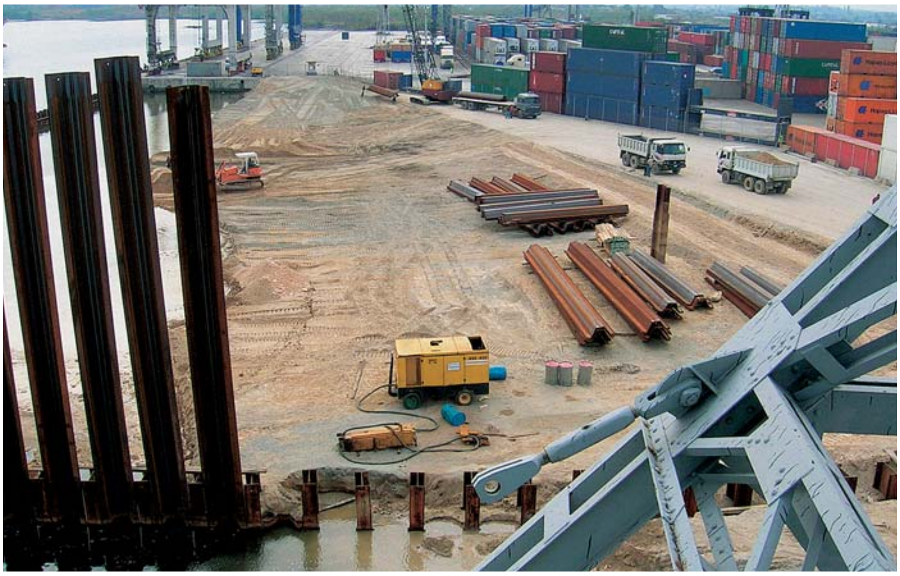

Driving of steel sheet piles with barge-mounted equipment


Driving of HZ king piles at the corner of the L-shaped wall


The area behind the quay wall was backfilled with dredged sand

Bauer's pile-driving equipment: impact hammer and vibratory hammer

A locally hired floating crane assisted the installation of the combined sheet pile wall



The AZ piles were inserted between the HZ piles then driven to design depth

a weight of 238 kg/m^2. They have a huge weight disadvantage compared to modern piles and are therefore far less economical. The superior width of today's piles allows faster driving progress enabling the contractor to complete quay walls more rapidly.

To meet the requirements of the permanently growing dimensions of vessels, the new quay wall is designed with a water depth of 12.5 m. Apart from the geometry of the future construction, soil analyses are a vital point in the design of quay walls. The results showed that the geology in the area consists of sediments overlaying claystone which is completely weathered in the upper four to five metres. Very compact claystone with SPT values (Standard Penetration Test) of 80 to 120 blows per 30 cm penetration is prevalent below -18.0 m.

The extension of the container terminal consists in the construction of an L-shaped sheet pile wall. The shorter side of the L-shape is a combined wall composed of 25.5 m HZ 975 B king piles and 18 m AZ 25 intermediary piles, partly cantilever and partly anchored to an AZ 38 wall. For the longer side of the L-shape, an HZ 975 B-12/AZ 25 solution with HZ king piles with a web height of 975 mm as load-carrying elements and AZ 25 sheet piles as intermediary soil-retaining elements was chosen. The HZ king piles, delivered in S 390 GP steel grade, were driven to a depth of 24 m, whereas for the AZ infill elements in steel grade S 270 GP a shallower depth was sufficient to ensure wall stability. The front wall is attached to the anchor wall with a

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Precise positioning of the HZ king piles was guaranteed using a double-level template

single layer of 28-metre tie rods. The tie-back wall is made of 8.5-metre AZ 38 double piles in steel grade S 430 GP.

A small number of spare piles were delivered from Luxembourg to the site in Havana to prevent a standstill of the construction site as a result of any possible damage to piles during transport or installation.

The new and existing walls were connected with two concrete blocks. These blocks fitted into the valley of the Larssen pile at one end and in between the flanges of an HZ caisson at the other.

The execution of the project can be divided into two main phases: the off-shore works and the finishing works on land. The combined sheet pile wall was installed with a locally hired floating crane. A Bauer base carrier equipped with a vibratory hammer was used for the initial installation of the HZ piles. A hydraulic hammer drove the piles to their final depth. A template was used as a guiding frame to ensure the exact positioning of the king piles. To finalise the container quay wall, the double sheet piles forming the anchor wall were installed with a simple service crane mounted on a second floating pontoon in places where land-based installation was difficult. Due to the high accuracy during installation of the HZ piles, the sheet piles fitted perfectly into the gaps between the king piles so that a small hammer was sufficient for the driving of the final metres into the compact soil strata.

After the completion of the combined wall the main equipment was set-up on land to install major parts of the anchor wall. Backfilling of the new quay area proceeded simultaneously.

Owner:
TCH S.A. Terminal de Contenedores, Cuba

Contractor:
Bauer Spezialtiefbau GmbH, Germany

Steel grade:
S 430 GP, S 390 GP, S 270 GP

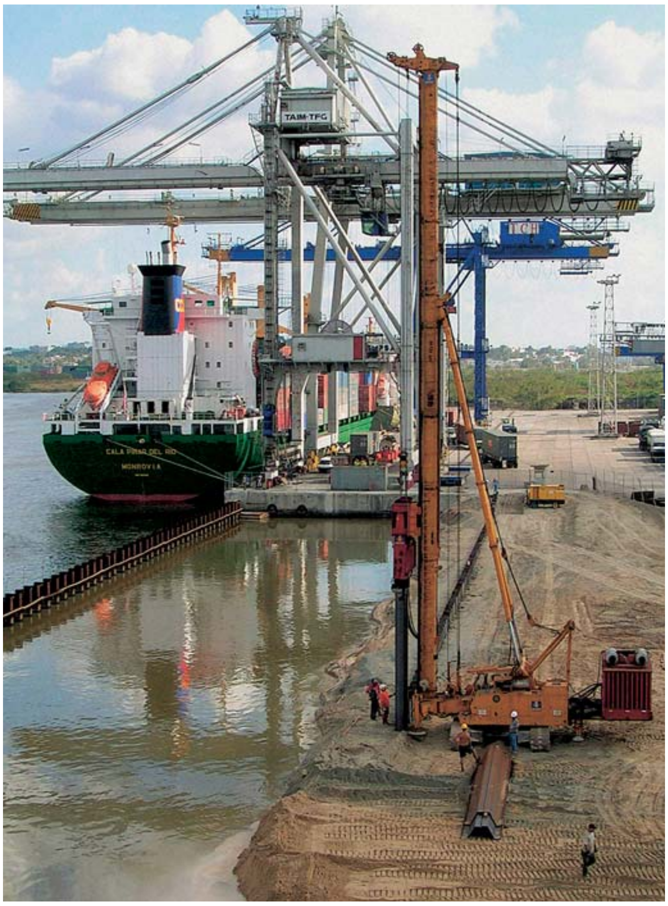
Sheet piles:
870 t HZ 975 B, 410 t AZ 25, 320 t AZ 38

Total quantity of sheet piles:
1,600 metric tons

The complete solution provided includes front wall, tie rods, and anchor wall

The HZ piles were driven by vibratory hammer until refusal, then taken down to design depth by impact driving

The sheet piles forming the anchor wall were driven into the backfilled soil. This facilitated attachment of the tie rods that connect the king piles of the front wall with the AZ anchor wall. A continuous waler beam transferred the anchor loads uniformly into the anchor wall assuring the stability of the system whilst minimising deformation of the main wall. ■



Several sheet piles were installed from a barge; others were driven with land-based equipment