General Santos, PHILIPPINES

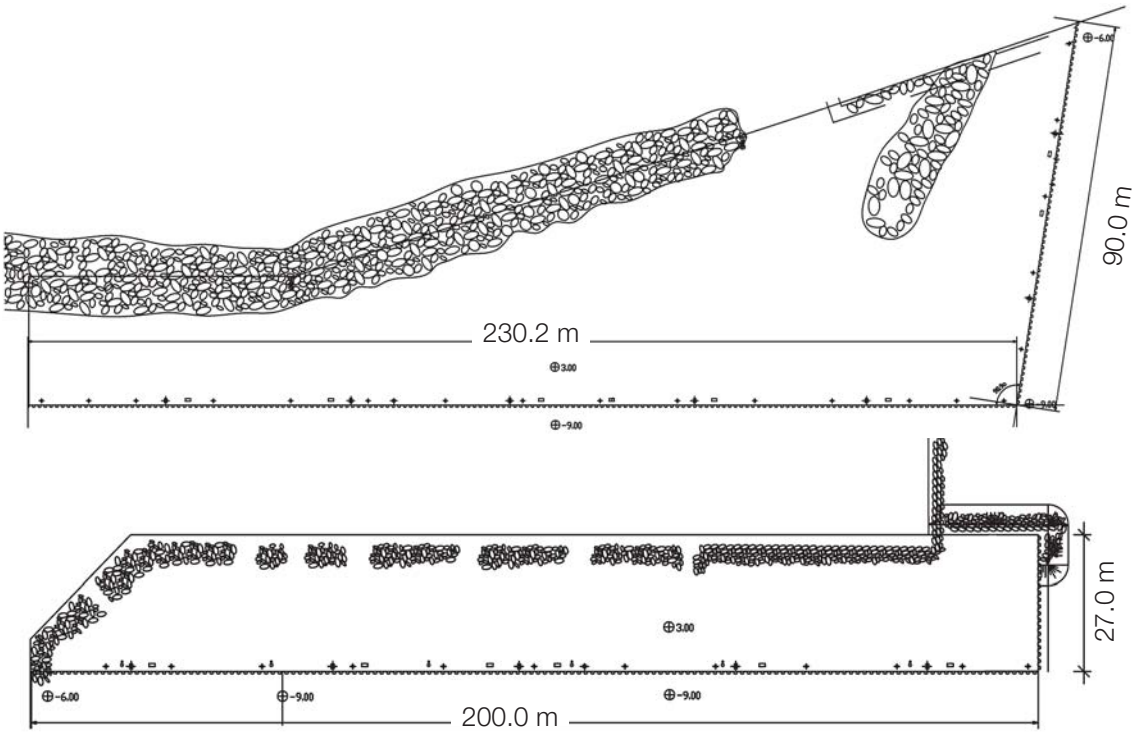
Fishing quay expansion project

General Santos City in the southern part of the Philippines, 1,000 km south of the islands' capital Manila, was founded in July 1968. Some 26 years on, in 1994, construction began on the General Santos City Fish Port Complex (GSFPC), funded by the Overseas Economic Cooperation Fund (OECF) of Japan. It was completed just over four years later in March 1999. The port provides good trade access to major foreign markets in southeast Asia, Australia, continental Europe and the United States. The harbour features a 32,000-m² container yard equipped with modern container-handling facilities and additional provisions for holding livestock.

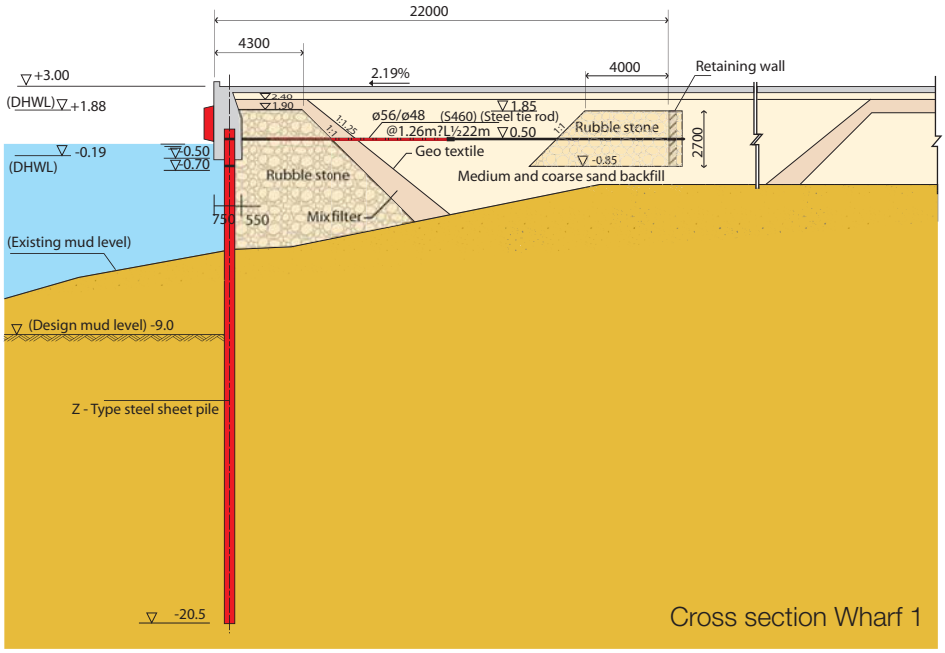
Tuna from General Santos

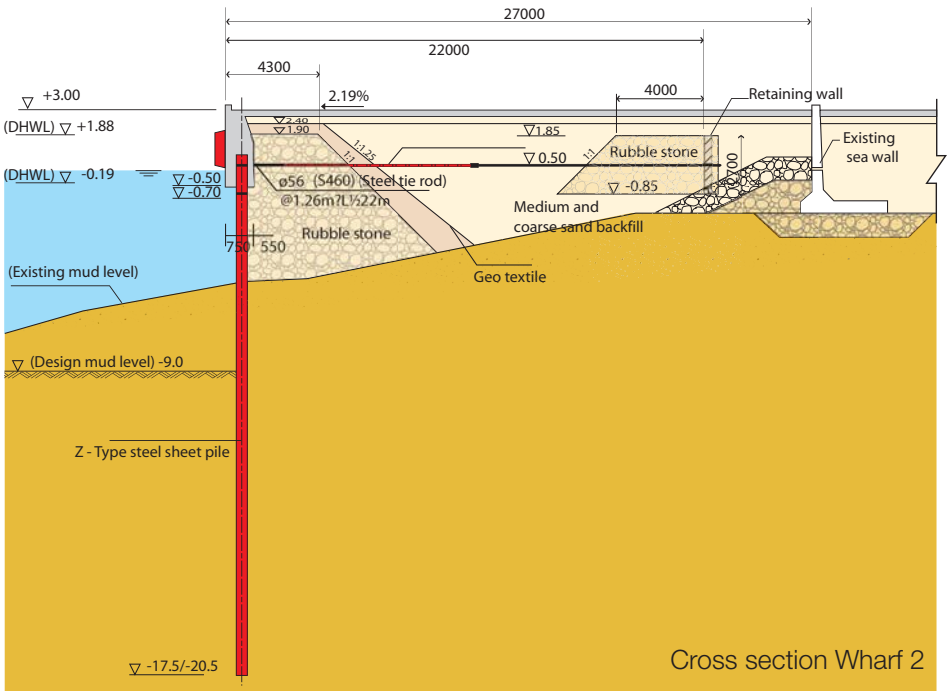
With annual production of 2.4 million metric tons, the 700-million-euro fishing industry accounts for 4% of the Philippines' gross national product. Considered the most modern fishing port in the country, General Santos is also the nation's second-largest fishing harbour. Fishing is the prime industry in the so-called "Tuna Capital" of the Philippines and is largely responsible for the city's economic boom. There are more than 50 commercial fishing companies located in General Santos, producing a collective

Two AZ sheet pile quay walls were required by the growing tuna fishing industry



The 2 new wharves offer a combined mooring length of over 500 m





Modern fishing vessels can now dock at General Santos thanks to the water depth of 9 m

volume of 8,000 metric tons of sashimi-grade tuna per month. General Santos City Fish Port Complex offers a 750-metre quay and a 300-metre wharf for 2,000-GT refrigerated carriers. Among the harbour's infrastructure are several refrigeration facilities, an ice producing plant, market halls, and fish container storage yards.

The Philippine Archipelago lies between two of the world's major tectonic plates, the Pacific Plate and the Eurasian Plate. Interactions and movements along the active faults cause strong earthquakes in the Philippines. General Santos City is situated about 20 km from the active Mindanao fault which is responsible for an average of six perceptible earthquakes per year. Important seismic loads had to be considered for the design of the expansion project. Steel solutions have an important advantage compared to concrete wharves; ductile steel can to a great degree absorb the energy input resulting from an earthquake's horizontal accelerations.

In a single delivery, all the sheet piles were shipped to the site where they were unloaded and stored

The tidal variations in the General Santos City Fish Port are not very substantial. The following tidal levels based on observations from nearby Davao Port were considered for the design of the sheet pile quays:

- Design high water level: 1.88 m (high tide accumulated frequency: 10%)
- Design low water level: -0.19 m (low tide accumulated frequency: 90%).

According to observations from the logs of 15 boreholes drilled at the site of the two new fishing quays, and to geotechnical tests, the strata structure in the area is relatively simple. The onshore area consists of made ground: medium to coarse sand ranging from +3.4 m to -3.2 m.

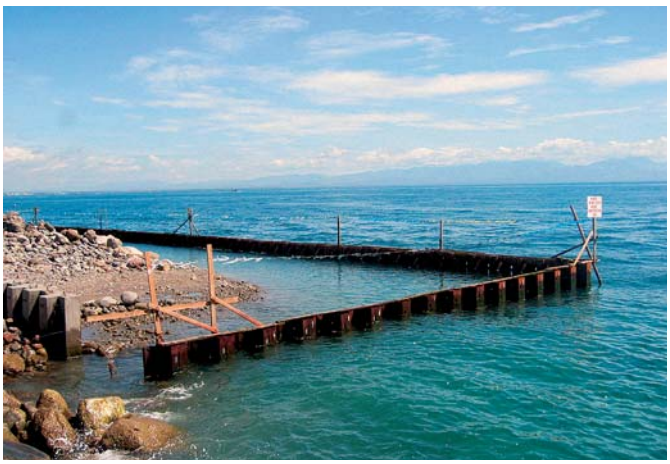
Further boreholes were drilled in the offshore area where the seafloor drops to a depth of -8.3 m. They showed a homogeneous layer of medium to coarse sand mixed with a small amount of angular coral gravel down to a depth of -2.7 m. Further below, medium to high density silty clay with angular gravel continues to -42.6 m.

The project comprises the expansion of two wharves:

- Wharf 1: main wall length: 230 m, return wall length: 90 m
- Wharf 2: main wall length: 200 m, return wall length: 27 m.

Wharf 1 is a new structure, whereas the second wharf is built in front of an existing wharf. This existing structure offers a water depth of just over one metre, far too shallow for the modern fishing vessels that dock and unload at General Santos.

Both wharves were built with Z-type steel sheet piles provided by Arcelor from Luxembourg. Two different profiles were used: AZ 34 with a section modulus of 3,400 cm^3/m and AZ 26 with a section modulus of 2,600 cm^3/m. A high steel grade (S 430 GP) was used to provide an economical



The new steel quay wall of Wharf 2 was placed 27 m ahead of the existing concrete wall

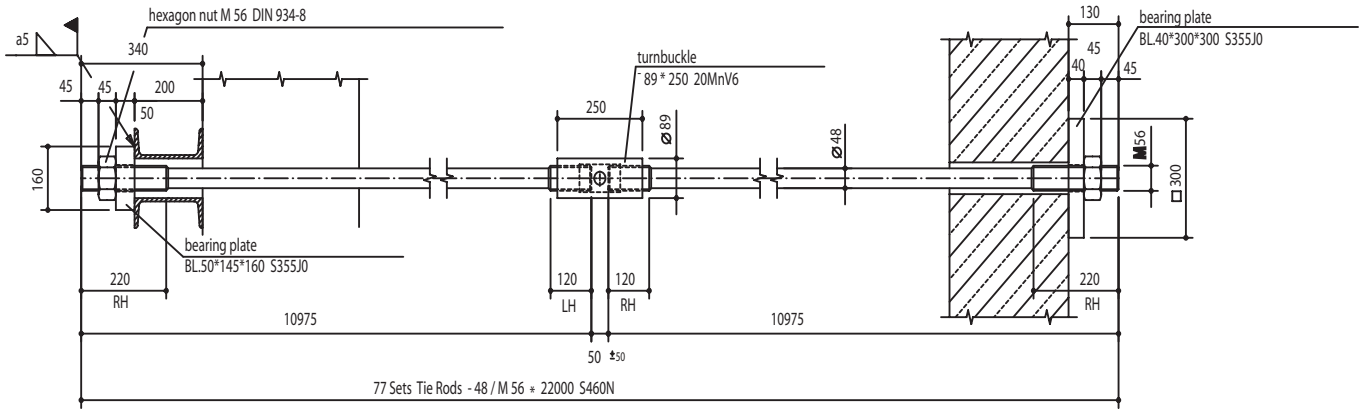
AZ double piles up to 21.5 m long were installed with barge-based driving equipment

The two wharves were built using 380 AZ 34 double sheet piles as well as 80 AZ 26 double sheet piles

A vibratory hammer was used first; a diesel hammer then completed the installation process

solution by optimising the weight of the sheet pile wall as far as possible. The 380 AZ 34 double piles delivered are 21.5 m long; the 80 AZ 26 double piles are 18.5 m long. In order to connect the sheet pile walls made of 1,260-mm-wide double piles, two C9 and one Omega 18 corner sections were used. A total of 2,180 t of steel sheet piles were delivered by train from the rolling mill to Antwerp Harbour where they were loaded onto M/V Wilma heading directly to General Santos.

Both the main and return walls were connected to concrete anchor plates by 22-m tie rods. The German manufacturer Anker Schroeder provided 485 tie rods in high-strength steel S 460 N. The weight of the tie-rod solution was further minimised by providing upset tie rods. Two different sizes of anchors were provided: M64 thread with a shaft diameter of 48 mm: 22 and 12 m. To allow both easy handling and transportation in containers, the tie rods were made of two pieces shorter than 12 m. The two separate anchor pieces were joined together by turnbuckles and tightened horizontally between the two walls. This is normally done above the water level to reduce the risk of corrosion. The turnbuckle also allows for correction of inaccuracies in the distance between the main and anchor walls.



The 48 and 56 mm shaft diameter tie rods were provided by Anker Schroeder, Germany

The tie rods consisted of several parts suitable for transportation in 40-foot containers

The new quay walls required 485 high-strength-steel tie rods

Owner:
Department of Agriculture, Philippine fishing development authorities

Contractor:
CAMC (China National Construction & Agricultural Machinery I/E Corp.)

Steel grade:
S 430 GP

Sheet piles:
1,890 t AZ 34, 290 t AZ 26

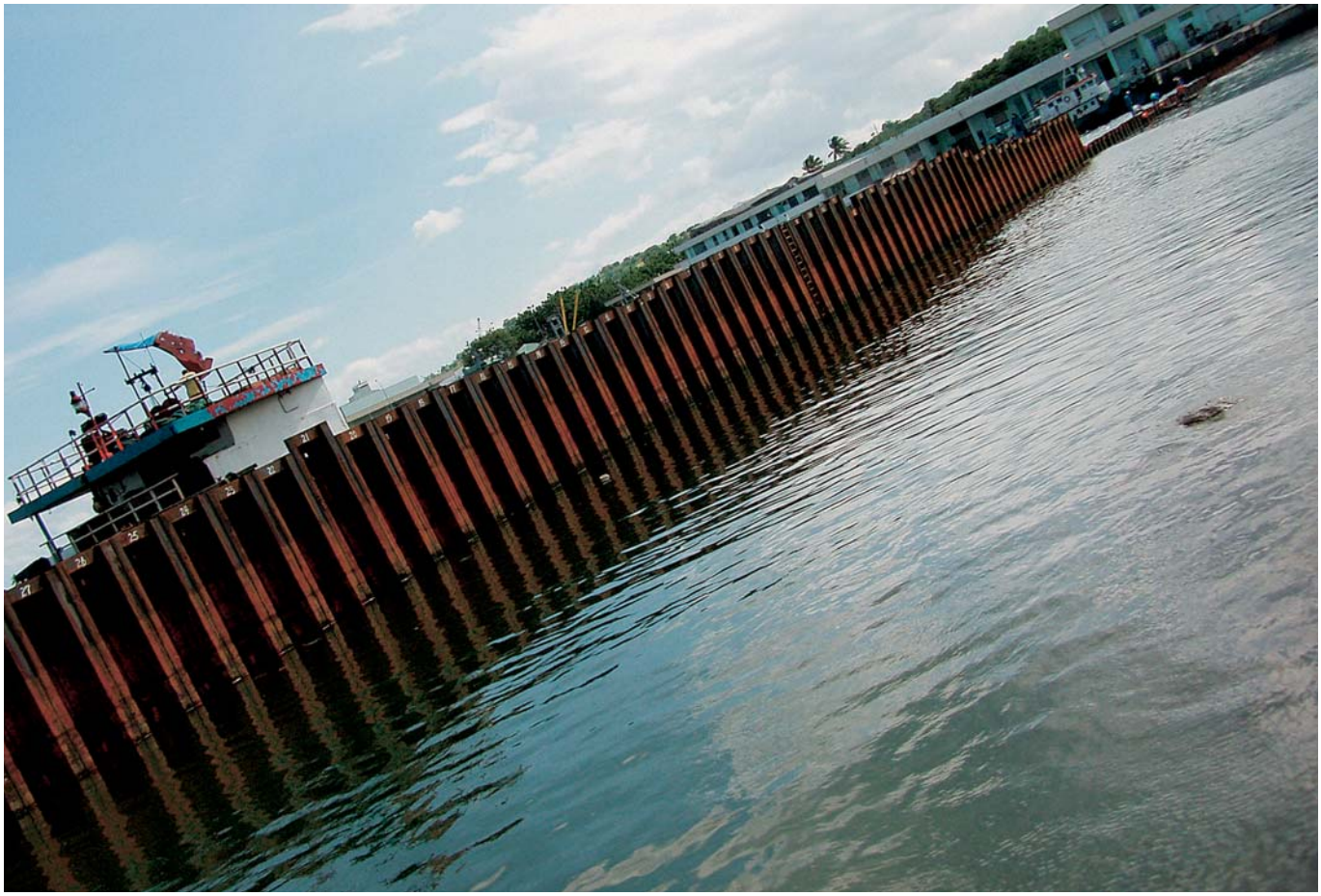
Total quantity of sheet piles:
2,180 metric tons

The area behind the AZ wall was backfilled carefully so as not to damage the tie rods

The anchor sets including upset-end tie-rods (diameter 56 mm / M64, total length = 22 m) with a working load of 615 kN were made up of the following pieces:

- 1 front upset-end tie-rod 56 mm / M64, RH-LH-thread, 10 350 / 120 / 250, S 460 N
- 1 rear upset-end tie-rod 56 mm / M64, RH-RH-thread, 11 600 / 120 / 250, S 460 N
- 1 turnbuckle, M64, length 250 mm, adjustment ± 50 mm, 20 MnV6
- 1 bearing plate on waling: 160 x 155 x 55 mm, S 355 J0
- 1 bearing plate on concrete: 300 x 300 x 45 mm, S 355 J0
- 2 x M64 hexagonal nuts according to DIN 934–8.

The steel sheet pile walls were installed the conventional way: a Japanese KN2-90 vibratory hammer drove the AZ piles until refusal. A second installation team followed with a Delmag D62 diesel hammer equipped with a 6.2-t ram to drive the piles to the design depth. ■



Extreme local seismic loading had to be considered when designing the new wharves