

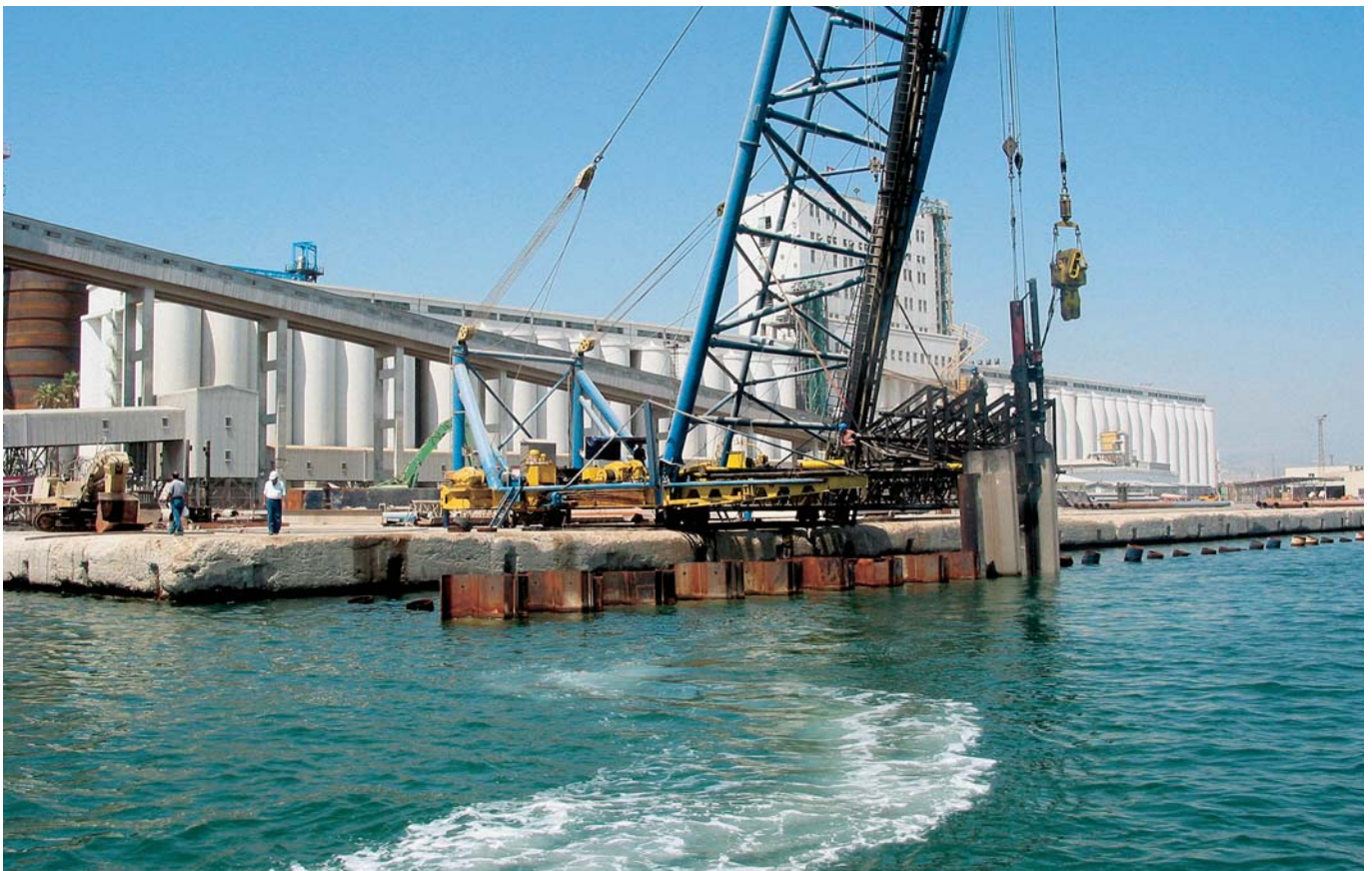
Mersin, TURKEY

Port extension project

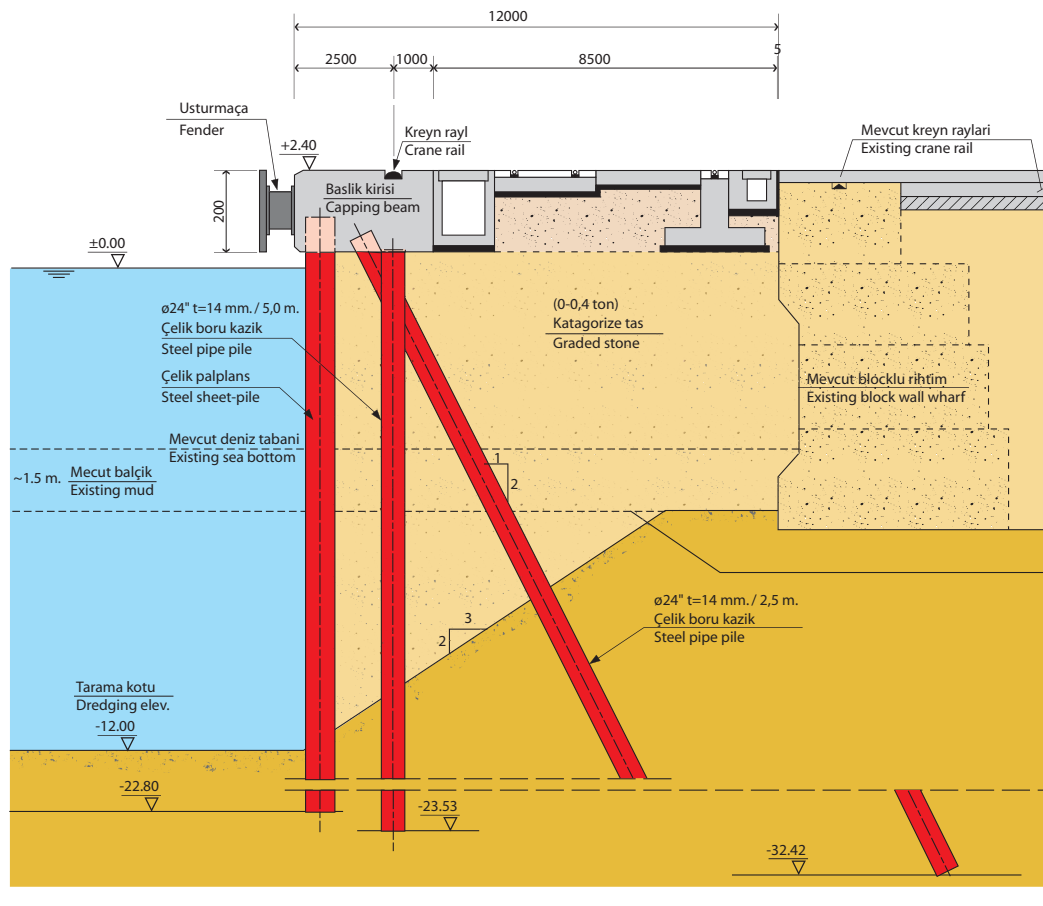
Mersin is situated on the Mediterranean Sea, on the south-east coast of Turkey. Several international contracting companies were invited to bid for the upgrading of the Mersin Seaport of Debarkation. Closing date for the tender was September 2002. The entire project was completed by the end of 2005 after a construction time of two years.

To allow docking of large vessels and installation of new container cranes, both the existing wharf made of heavy underwater concrete blocks and the marshalling area, were modernised. The water depth was doubled to twelve metres. A steel sheet pile wall totalling 624 m in length was installed 12.2 m in front of the existing wharf. The area between the old and new part of the wharf was backfilled with rock. The steel sheet piles were driven into clay soil characterised by cohesive values ranging between 5 and 10 kN/m².

A steel solution was chosen for upgrading of the existing concrete solution partly because the project was constructed in an active seismic region. Being a ductile material, steel offers higher load reserves during earthquakes.



The existing concrete structure was modernised with the help of a jagged sheet pile wall



The sheet pile wall enabled the harbour to be dredged to El. -12 m

Purchase and installation of the steel sheet piles account for roughly 15% of the total project cost.

The following material was required (tender amounts):

- Wall area: 14,968 m²
- Material quality: ASTM A690
- Section modulus: 6,000 cm³/m
- Thickness: 10 mm
- Painting: 3 layers of epoxy coating

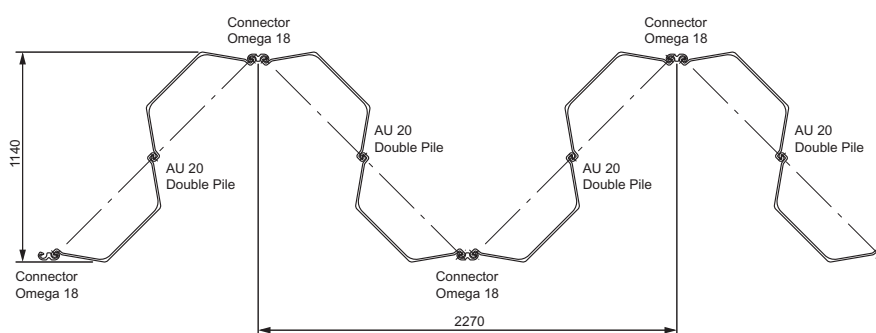
The required section modulus surpasses the capacity of U or Z-type sheet piles. Such high-capacity quay walls can be built using a combined or a jagged sheet pile wall. For the current

project, Arcelor proposed a jagged wall made up of AU 20 sheet piles with the following characteristics:

- AU 20 jagged wall
- Weight: 186.7 kg/m²
- Material quality: ASTM A690, alternative in S 355 GP
- Section modulus: min. 6,365 cm³/m
- Thickness: 10 mm
- Total sheet pile quantity: 2,770 t.

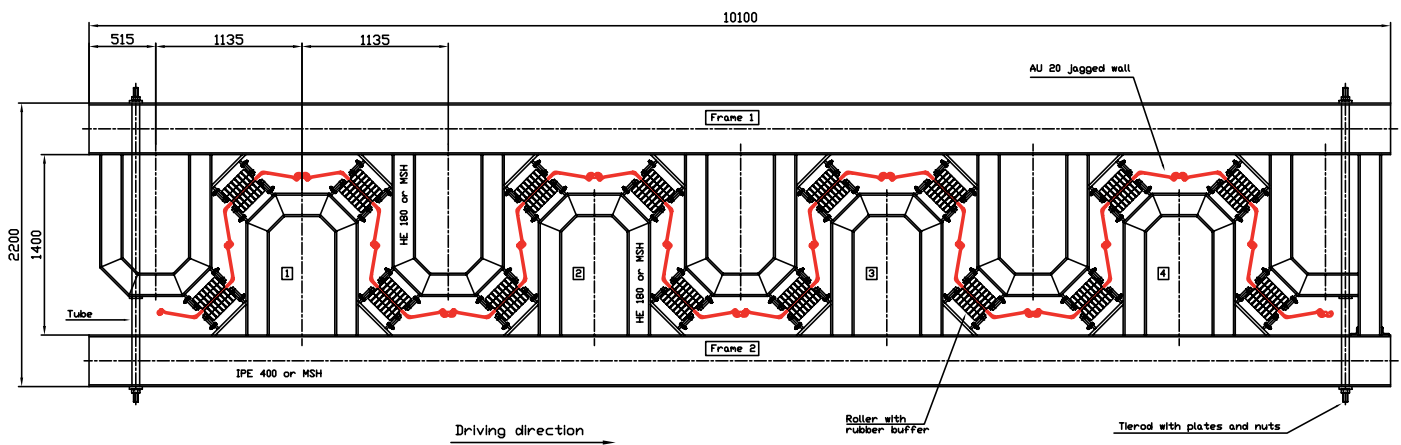
The AU 20 steel sheet piles for the Mersin project were installed in a special layout referred to as a jagged wall. An arrangement of U sheet piles into a jagged wall offers economic solutions where high inertia and

section modulus are needed. The AU 20 elements were crimped together in the mill and delivered as double elements. Crimped double piles allow full shear-force transmission in the “vital” interlocks situated on the central wall axis. The standard crimping configuration of AU sheet piles involves three crimping points every 0.75 m with an allowed shear-force transmission of 75 kN per crimping point. Tensile tests carried out by Arcelor showed that each crimping point can transmit loads of up to 130 kN.



The special configuration of the AU 20 double piles led to a section modulus of 6,365 cm³/m





Arcelor provided the contractor with drawings to assemble a template



The contractor's template features two steel-tube guiding levels fitted with rubber fenders



The rubber protectors prevent damage to the coating system during installation



Vertical and inclined batter piles were also installed with the template

The Omega 18 connector can be tack welded to the AU 20 double piles for handling reasons. In this case its contribution to the section modulus is disregarded. Appropriately designed welds contribute fully to the section modulus, however. The elastic section modulus reaches 7,395 cm³/m (6,365 cm³/m if connectors are tack welded) for a mass of 186.7 kg per square metre of wall. Each AU 20 double pile of the jagged wall contributes 1.135 m to the length of the quay wall.

543 AU 20 double piles in steel grade A690, representing a total of 2,535 metric tons, and 235 t of Omega 18 connectors in steel grade S 430 GP were used to build the 624 m main wall. "Marine" steel grade A690 is characterised by a resistance to seawater splash zone corrosion approximately two to three times greater than that of ordinary carbon steel. The main difference to ordinary steel is the high amount of copper (min 0.50%). This steel with a minimum yield strength of 345 N/mm² is mainly used in marine environments.

Şener Arda Construction is a Turkish contractor specialised in marine construction and piling work. Created in 1968, the company has completed numerous quays, jetties, harbours and breakwaters.

A suitable template is essential for the installation of a jagged wall. Arcelor provided drawings for a template fitting the AU 20 double sheet piles and sent 2 engineers to supervise the installation procedures of the first steel sheet piles. The contractor built the template based on the design provided. The two guiding levels of the template are made of steel tubes fitted with special rubber fenders to prevent damage to the sheet pile coating system during driving.



Both the vibratory and the impact hammer were mounted on the specially designed rail-mounted rig



The driving caps were provided by Arcelor on a rental basis



Quick-release shackles are a timesaving help used on numerous sites

A specially designed rail-mounted rig system was used for the installation of the steel sheet piles and for the 24 inch (61 cm) steel tubes. The vertical piles were installed every 5 m, reaching a depth of 23.53 m. The inclined batter piles spaced at intervals of 2.5 m were driven to a depth of 32.42 m.

A vibratory hammer and an impact hammer were used as driving equipment. Installation proceeded conventionally: the vibratory hammer first drove the piles as far as possible into the soil, the impact hammer then drove the steel sheet piles to the design depth of 22.8 m. The panel-driving technique was used in order to ensure verticality and alignment of the sheet piles. Installation of a group or a "panel" of piles allows individual piles to remain above design depth in the event of obstructions in the soil, without interrupting driving operations. Refusal was defined by reaching an installation progress of just 2 to 3 mm per blow. Further driving at this penetration rate could cause damage to the piles and driving gear.



The installation rig used the existing concrete wharf for support



The 624-m sheet pile wall will enlarge the mooring area

Owner:

TCDD Directorate

Contractor:

Şener Arda Construction Co. Inc.

Designer:

HES Engineering & Unitek Engineering Consortium

Steel grade:

A690 & S 430 GP

Sheet piles:

2,535 t AU 20 double piles

235 t Omega 18 sections

Total quantity of sheet piles:

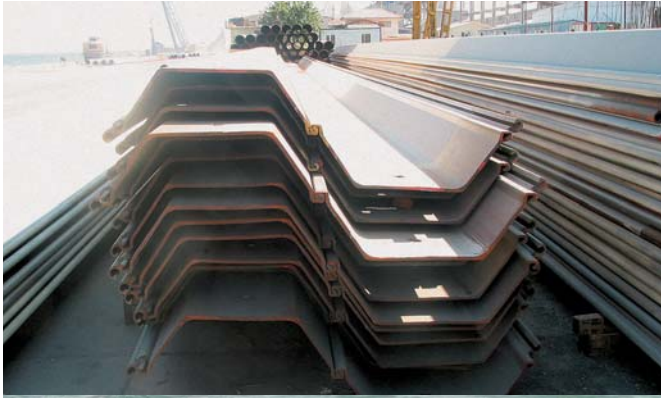
2,770 metric tons

A Japanese TVM-50 Toyoda vibratory hammer with the following characteristics was used:

- Weight: 3 t
- Maximum centrifugal force: 420 kN
- Maximum eccentric moment: 205 Nm
- Frequency: 1,355 min⁻¹

Şener Arda had two German diesel impact hammers available at the site: a Delmag D30 and a Delmag D46 equipped with rams weighing 3,000 and 4,600 kg. Their maximum explosion pressures average 1,050 and 1,650 kN, delivered at a frequency of 37 to 52 blows per minute. Weighing six metric tons, the Delmag D30 is limited to piles of up to eight metric tons, whereas the D46 can install piles of up to 15 tons. The optimum weight of the installation material ranges from two to nine metric tons for the D30. The required driving cap was supplied to the contractor as part of Arcelor's services for the Mersin project.

At the far end of the wall, the contractor had to stop installation before reaching the target depth of 22.8 m because stiff clay slowed the driving progress below the set limit. The design of the jagged wall was revised to take account of the extremely stiff soil layer. Studies showed that the toe depth could be reduced by as much as 3 m because of the superior load-carrying capacities of the unexpectedly favourable soil values encountered at the end of the extension.



The structural system consisted of a sheet-pile soil-retaining wall, steel crane-foundation piles, and deflection-restricting batter piles



A three-layer coating system was applied on the waterside of the steel wall



The AU 20 double piles were arranged into a jagged wall using Omega 18 connectors

The AU 20 jagged wall was capped with a two-metre-thick reinforced concrete beam cast onto the sheet piles, the inclined steel piles that take horizontal loads, and the vertical steel piles that act as a foundation for the crane rails, and also securing the bollards, fenders and container-crane rails. A new pavement was installed behind the capping beam, on top of a 1.5-m layer of stabilising material overlying rockfill. Topping up the area between old and new construction, the rockfill extended to a depth of 12 m.

A coating system was applied on the water side of the steel sheet piles, over a depth of 16 m starting a metre below the pile head. A developed area of 18,656 m² had to be coated with the following three layers:

- Sigmarite sealer (50 µm)
- Sigmacover TCP Glassflake (450 µm)
- Sigmacover DTM coating (200 µm). ■