Voisey's Bay, Labrador, CANADA

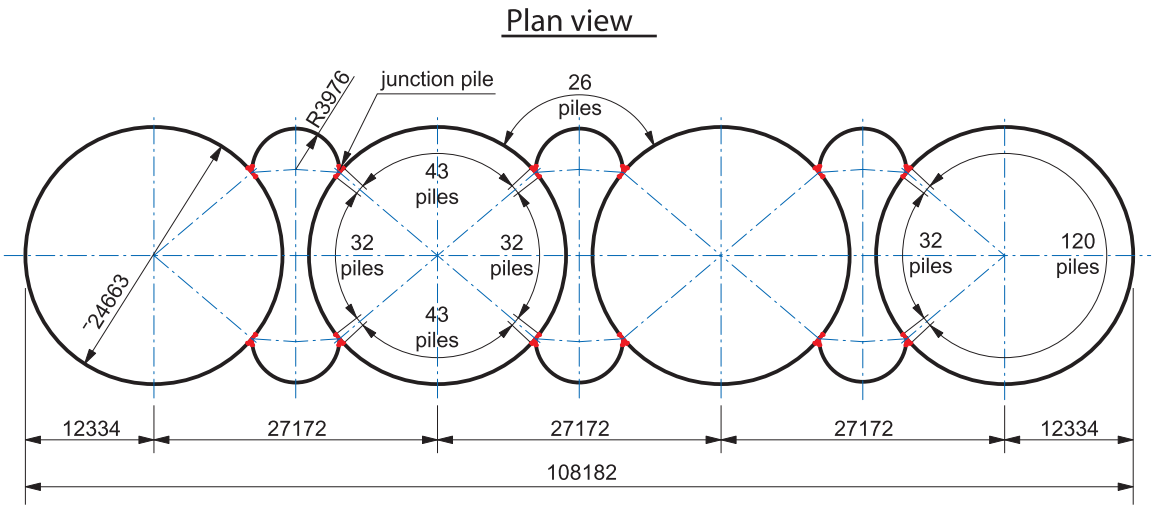
Construction of permanent port facilities

Supply ship docking at the sheet pile wharf in Voisey's Bay

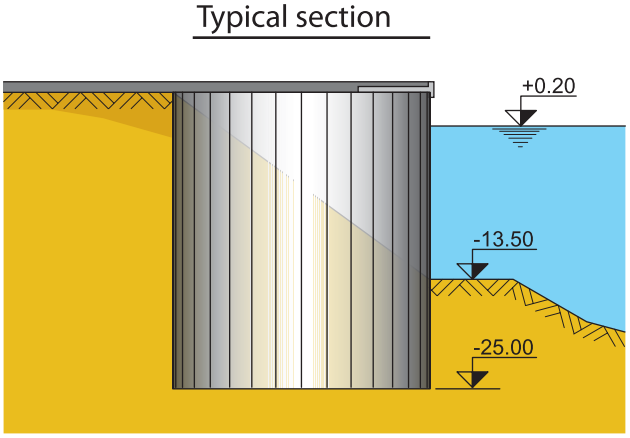
Voisey's Bay is situated in a remote area on the north-east coast of Labrador, in the Canadian Arctic. One of the richest nickel-copper-cobalt finds in the world, the Voisey's Bay deposit was discovered in 1993, some 350 km north of Happy Valley-Goose Bay.

The Voisey's Bay Nickel Company (VBNC) built an integrated mine at the site which is now in operation. A harbour was required in order to import mine consumables and export the nickel concentrate. Construction of the wharf in nearby Anaktalak Bay began in summer 2004, and the main structure was completed in December 2004, with some ancillary work completed in late spring 2005. The new deep-sea wharf received its first ship on schedule in November 2005. The dock has an approximately 100-metre berthing face with a minimum draught of 13.5 metres. Westmar Consultants Inc. (marine structural design) and Jacques Whitford (geotechnical design) jointly submitted the design for a new deep-sea wharf in Anaktalak Bay in order to accommodate up to six supply ships and concentrate carriers per month.

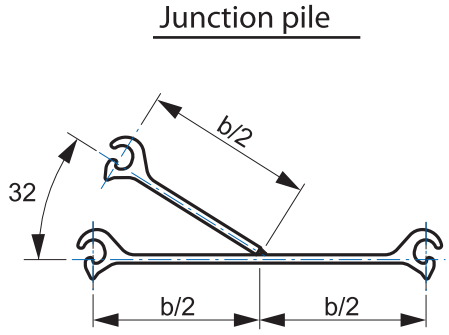
The design of the sheet pile cells had to take account of ice loads



The wharf consists of four cells and six connecting arcs



Cross-section of the AS 500 sheet pile cell



The junction piles were produced by one of Arcelor's subcontractors

A circular steel sheet pile gravity structure was selected as the main structure. Individual sheet pile cells were driven into the predominantly dense sand/gravel soil. Since the AS 500 sheet pile system does not require embedment into lower soil layers for statical reasons, it is a standard solution for extremely hard soil conditions. The design of the wharf was particularly challenging due to the fact that its construction had to be completed within one short ice-free season. Several geotechnical boreholes were not completed before the installation of the first sheet piles.

The geology of the Anaktalak Bay site can be simplified into three distinct soil layers overlying bedrock. The surface is characterised by a significant zone of soft to firm clay overlying a sandy layer containing cobbles and boulders. The rockfill for the cells and the backfill consist of well-graded angular material. Dredging of the very soft sediments had to be avoided. This led to the development of a state-of-the-art instrumentation plan to continuously monitor stability during construction. A set of curved precast concrete ice impact panels with a reinforced cope beam system supplemented the strength of the main structure. A variety of failure mechanisms (overturning, sliding, interlock failure, as well as horizontal and vertical shear failure) were analysed in the design of the sheet pile structure. Ice loads were an essential design consideration due to extreme winters with temperatures dropping as low as -40°C (-40°F). Special ice-impact beams were installed to take the horizontal loads.

The face of the marginal wharf is made up of four AS 500 cells joined together with six arcs. The sheet pile cells forming the face of the wharf also act as a retaining structure for backfill material. Scour protection was placed in front of the cells and the sheet piles were driven into it. Once the cells were placed, the area behind the wharf was backfilled with dredged soil.

For the construction of the four cells and six arcs, the following numbers of sheet piles were delivered by Arcelor's Canadian agent, Skyline Canada:

- 680 straight-web sheet piles
- 72 straight-web sheet piles bent by 7°
- 12 straight-web junction sheet piles.

Each main cell made of 150 AS 500 straight-web sheet piles and 4 junction piles has a diameter of 24.7 m. Each of the six arcs is made of 14 normal AS 500 piles and 12 bent piles in alternate positions. Secometal, a subcontractor of Arcelor, fabricated the bent piles. All the AS 500 sheet

The sheet piles were installed with the help of a template

piles are 26.7 m long and 12.7 mm thick. The piles have a guaranteed minimum interlock strength of 5,500 kN per running metre of interlock. Skyline Canada additionally delivered 19 spare piles including single, bent and junction piles. The new wharf design received an Award of Engineering Excellence from the Consulting Engineers of British Columbia in 2006.

Piles were driven with barge-mounted equipment

Owner:
Voisey's Bay Nickel Company (VBNC)

Contractor:
IKC-Borealis

Designer:
Westmar Consultants Inc and Jacques Whitford

Sheet piles:
AS 500-12.7

Pile length:
26.7 m

Steel grade:
S 355 GP

Total quantity of sheet piles:
1,640 metric tons

General installation procedure for AS 500 cells:

Step 1
- Installation of template and supporting piles
- Temporary positioning of top/lower platform as high/low as possible above/below water level

Step 2
- Positioning of four or more isolated sheet piles (usually the special junction piles)
- Verification of verticality, then fixing by tack welding to upper platform
- Threading of adjacent sheet piles

Step 3
- Closing of cells between special junction piles
- Threading of arc piles (2 or 4)

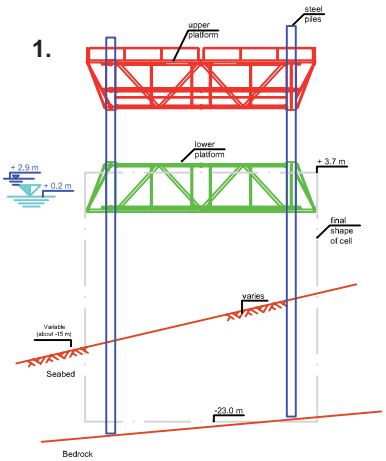
Step 4
- Driving of piles using staggered driving method after closing of the cell

Step 5
- Lowering of upper platform and driving of piles to design level

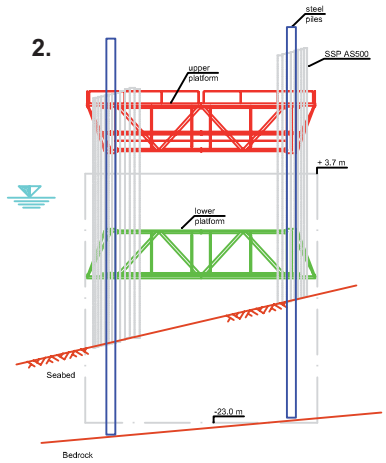
Step 6 & 7
- Filling of the cell
- Raising/Removal of platforms at appropriate times

Step 8
- Backfilling to the top of the cell
- Extraction of supporting piles ■

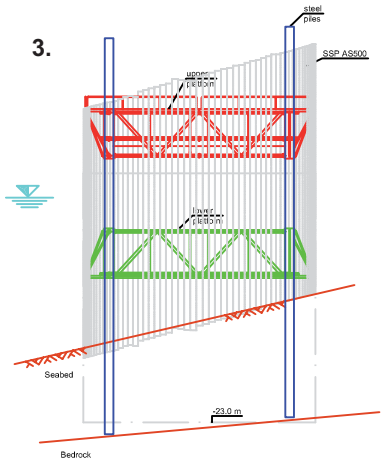
1.


steel piles
upper platform
lower platform
+ 3.7 m
+ 2.9 m
+ 0.2 m
final shape of cell
varies
Variable (about +5 m)
Seabed
-23.0 m
Bedrock

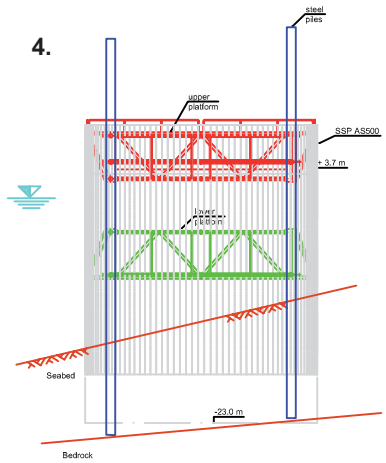
2.


steel piles
SSP AS500
upper platform
+ 3.7 m
lower platform
Seabed
-23.0 m
Bedrock

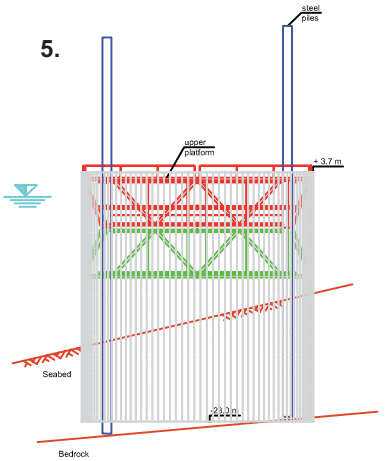
3.


steel piles
SSP AS500
upper platform
lower platform
Seabed
-23.0 m
Bedrock

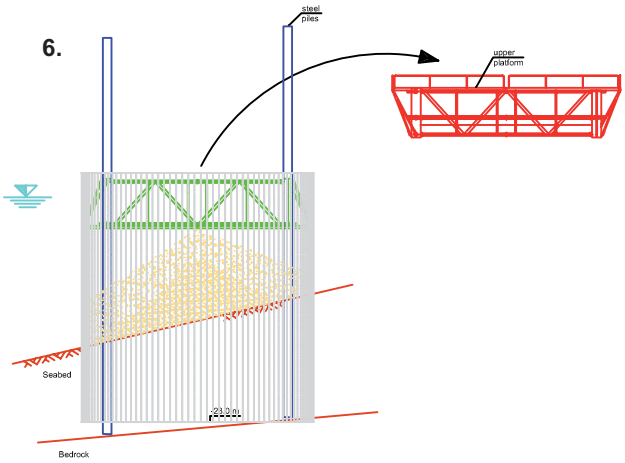
4.


steel piles
upper platform
SSP AS500
+ 3.7 m
lower platform
Seabed
-23.0 m
Bedrock

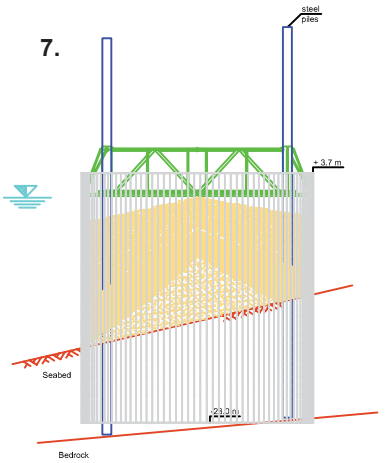
5.


steel piles
upper platform
+ 3.7 m
Seabed
-23.0 m
Bedrock

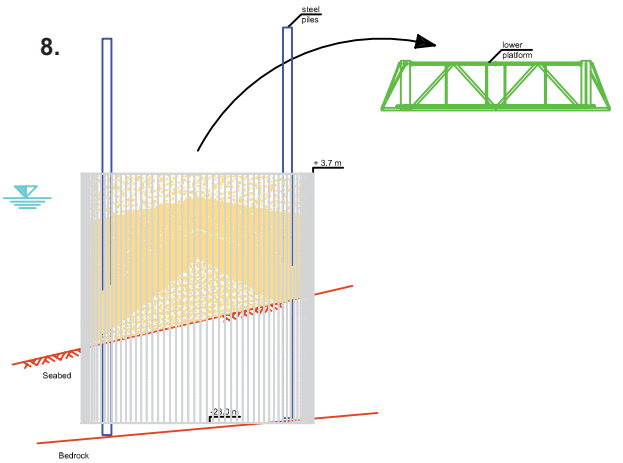
6.


steel piles
upper platform
Seabed
-23.0 m
Bedrock

7.


steel piles
+ 3.7 m
Seabed
-23.0 m
Bedrock

8.


steel piles
lower platform
+ 3.7 m
Seabed
-23.0 m
Bedrock