Reconstruction of breakwater in Arzew, Algeria

Client: Ministry of Public Works, Directorate for Basic Infrastructure
Engineer: Nedeco (Netherlands)
Location: Mediterranean Coast, Arzew (El Djedid), Algeria
Period: 1986 – 1992

Boskalis International bv

Rosmolenweg 20
P.O. Box 43, 3350 AE Papendrecht
The Netherlands
Tel: +31 (0)78 - 69 69 232
Fax: +31 (0)78 - 69 69 854
E-mail: royal@boskalis.nl
Internet: www.boskalis.com

Introduction

Built in 1979, the harbour of Arzew (El Djedid) in Algeria is the country's most important harbour for the exportation of liquefied natural gas.

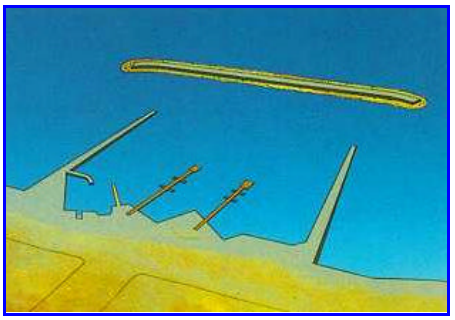
In December 1980 a severe storm caused extensive damage to the breakwater which lies parallel to the coast and which is more than two kilometres in length.
One thousand metres were torn away from the breakwater's superstructure. Moreover, both ends of the breakwater were completely destroyed and the covering layers of stones and concrete blocks were totally broken up.

A temporary repair was made and in 1986 reconstruction of the breakwater started with the help of Boskalis Zinkcon who was awarded a sub-contract to carry out seven key tasks, namely:

- Installation of all positioning systems
- Underwater survey to determine the location of debris
- Design work, involving scale-model laboratory tests
- Placement of 115 mattresses in front of the breakwater, to form the base for the reconstruction
- Placement of two millions tons of stone, with individual stones weighing up to six tons, and almost 45,000 concrete blocks from 12 to 65 tons each
- Blasting the mutilated ends of the breakwater
- Co-ordination of all marine works, including positioning and quality control.

Preparation works

A multi-functional positioning system was set-up to enable five vessels to work simultaneously and a local survey grid was prepared to permit use of a remotely controlled underwater vehicle. Moreover, two loading platforms were constructed so that wheel loaders from both sides could load the stone dumper. To determine the precise nature of the damage, a comprehensive survey was carried out and the position of the debris on the seabed was accurately recorded. Fabrication of the 115 mattresses, each measuring 30x50 metres, involved binding together brushwood and nylon fabric.
Central to the preparatory works were the scale model tests on the head of the breakwater, which were carried out at the Delft Hydraulics Laboratory in the Netherlands.



Location of the detached breakwater.

Left: placement of concrete elements;
Right: summary of quantities.

150.000	m^2 seabed clearance
115	mattresses, each measuring 30x50 metres
1.000.000	tons of quarry run
4.00.000	tons of filter stone, of 10-60 kg and 60-300 kg
3.00.000	tons of 0.2-1 ton rocks
4.00.000	tons of 1-3 ton rocks
7.00.000	tons of 4-6 ton rocks
19.000	concrete blocks of 12 tons each
22.000	concrete blocks of 40 tons each
1.500	concrete blocks of 60-65 tons each

These tests were executed to achieve a more economical design and led to modification of the construction specification.

Reconstruction

The first step in the reconstruction process was to remove the debris lying on the seabed, which was created when the breakwater was damaged. This was done to enable the maitresses to be placed on a clean seabed. Removal was achieved by using a floating grab crane. With data obtained from the underwater survey, performed by the remotely operated vehicle, it was possible to position the crane barge accurately above the debris. A camera fitted to the crane's grab aided the crane operator in the removal process.

The seabed over an area of 150,000 m² was cleared in this way. With the work area completely cleared, the filter mattresses were then placed on the seabed. In turn each mattress was towed to the breakwater and positioned between two special pontoons or between the pontoon and breakwater. One end of the mattress, attached to a sinking beam, was then sunk on the seabed. This allowed the stone dumper to position herself above the mattress and, in a controlled process, to discharge her cargo of stone and thereby sink the remainder of the mattress on to the seabottom. All of the 115 mattresses overlap each other, to form an ideal filter layer between the seabed and the breakwater superstructure.

On the landward, sheltered side of the breakwater 350.000 tons of quarry run was dumped to act as a counter weight to the heavy stone armouring on the exposed seaward side of the structure. This will stabilise the breakwater during earthquakes. The badly damaged superstructure of the breakwater heads at both ends of the breakwater had to be drilled and blasted to enable the grab dredger to carry out profiling works.

Scale model laboratory test.

With these initial stages of the project completed, reconstruction could begin in earnest. Some 400.000 tons of filter stone, of 10-60 kg and 60-300kg, was spread over the mattresses, followed by almost 400.000 tons of rock (weighing 1-3 tons) which formed the toe of the new breakwater construction. Next came 650.000 tons of quarry run, to build up the required breakwater profile, followed by 300.000 tons of 0.2-1 ton rocks and 700.000 tons of 4-6 ton rocks.
All grades of material were placed within the tight tolerances stipulated in the design. During placement of the stone and rock it was possible to start placing the concrete blocks.
A total of 19.000 blocks (12 tons each) were placed along the toe of the breakwater using the floating crane and, partly, the stone dumper.
For the breakwater slopes and the two ends, 22.000 larger concrete blocks of 40 tons each were placed, supplemented at both ends of the structure with 1.500 blocks of 60-65 tons each.

Under Boskalis Zinkcon's experienced and professional management, Arzew is now ready again to meet the future.

Left: spreading of filter stone;
Middle above: scheme of reconstruction of toe;
Middle under: Scheme of placement of concrete elements;
Right: handling of 65 tons elements.