



# THE ØRESUND FIXED LINK

## MARINE STONE CONSTRUCTIONS



### Facts about the Øresund Fixed Link:

A 16 km long traffic link carrying a railway and a motorway between Kastrup near Copenhagen and Lernacken on the Swedish coast.

### The link comprises:

- a 430 m wide, artificial peninsula at Kastrup.
- a 3,750 m immersed tunnel.
- a 4,210 m long, artificial island called Peberholm.
- a 7,470 m two-level high bridge with a 490 m free span and a navigational clearance of 57 m.

The Øresund Fixed Link is one of the largest infrastructure projects ever built in Scandinavia. All stoneworks on this impressive project were executed by Aarsleff and were part of the "Design and Construct" contract for the dredging and reclamation works.

The stone revetments constitute the protection of the artificial island Peberholm and the Kastrup peninsula. Technically, and because of the very tight project schedule, the revetments were one of the biggest challenges of the Øresund Fixed Link project.

In only 14 months Aarsleff were to build all revetments consisting of two million tons of stone.

The volume of stone combined with the tight schedule, strict tolerance requirements and not least the relatively shallow water depths in the Øresund called for alternative thinking regarding the execution of the works.

Normally revetments are executed from floating plant or from land by means of moving plant. Such methods were inapplicable on the Øresund Fixed Link project, because the majority of the stone volumes were to be incorporated in areas that could not be reached from land and areas that due to water depths as low as two to six metres were inaccessible with traditional, floating marine construction equipment.

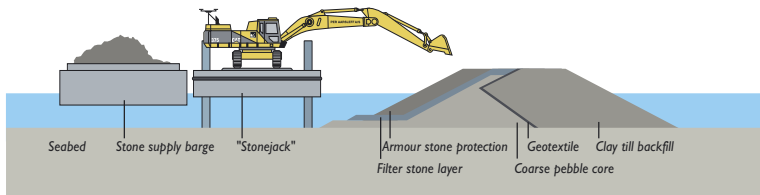
Therefore, within one month of signing the contract, Aarsleff had constructed and deployed two purpose-built semi-jackups called StenJacks. Each StenJack served as the working platform for a Cat 375 excavator. Both excavators were equipped with state-of-the-art equipment including satellite navigational systems, motion sensors and machine control systems.

The purpose-built StenJacks were ideal for working in shallow waters, and the chosen combination of plant, methods and systems resulted in the precise and successful establishment of 13 kilometres of stone revetments.

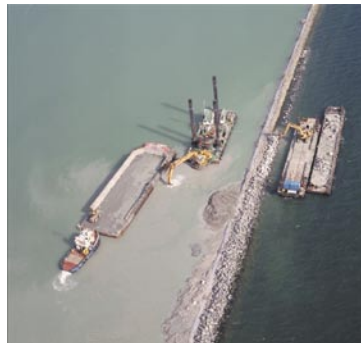


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## Marine stone constructions



Prior to executing the revetments Aarsleff established a module line consisting of driven tubular piles for every 20 metres. The tubular piles formed a visual line for the individual revetment and enabled the positioning and mooring of craft.



Once the 54 m long StenJack had been positioned, the Cat 375 excavator placed and shaped a core of pebble stone. One by one the remaining layers of stone were placed directly from the stone barges by the excavator. The use of barges for transport as well as for depositing eliminated the need for stockpiles and re-handling of materials.

The client's tolerances were observed by means of the excavator's satellite navigational system combined with motions sensors and a machine control system enabling the plant driver to control the bucket position in relation to an onscreen digital design profile. This method allowed for very accurate placement of all stones, and the two StenJacks were capable of producing up to 40 metres of revetments per 24-hour working day.

Another advantage of the StenJack method was the low sediment spillage. It was a contractual requirement that the spillage into the Øresund be limited. The method applied by Aarsleff reduced the spill of sediment to a minimum compared to alternative methods using land-based machinery.

Precisely the environmental requirement concerning sediment spillage strongly influenced the design of the revetments, as the inside of the pebble stone core had to be covered by approx. 1.5 million m<sup>3</sup> of dredged moraine clay. In order to further reduce the sediment spill Aarsleff installed a geotextile membrane on the inside of the core in order to prevent small clay particles from penetrating the stone layers and leak into the Øresund. Furthermore, the rapid advance of the StenJacks ensured that the incorporation of clay always took place in an area enclosed by protective embankments.

### FACTS

#### Peberholm:

- 4 km long, 500 m wide, area of 1.3 km<sup>2</sup>
- Revetments: 1.5 million tons of stone used, in total 9 km

#### Kastrup Peninsula:

- Area: 0.9 km<sup>2</sup>
- Revetments: 0.5 million tons of stone used, in total 4 km

#### Total volumes:

- 2 million tons of stone

#### Contractor

Øresund Marine Joint Venture:

- Per Aarsleff A/S (sponsor)
- Great Lakes Dredge & Dock Co., USA
- Ballast Nedam Dredging, Holland

#### Client

Øresundskonsortiet

#### Construction Period

1995-1996

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