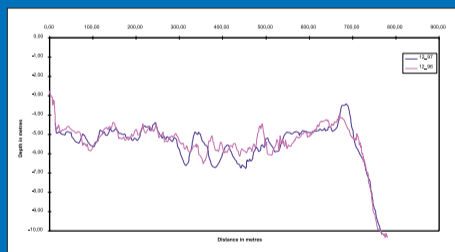
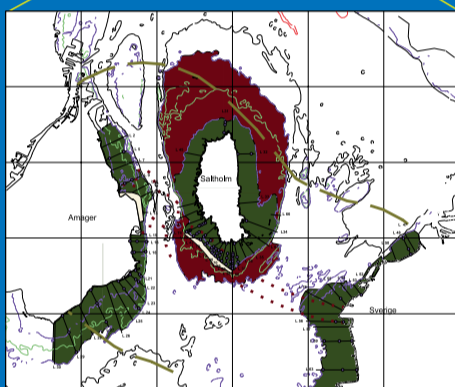


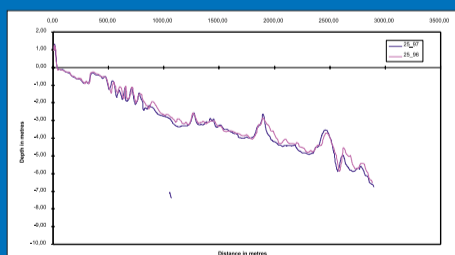
Introduction

During 1996 and 1997 the east-coast of Amager, the coast of Saltholm and the coastal stretch from Malme to Klagshamn in Sweden have been surveyed in order to provide data for an evaluation of any influences on the coasts and the nearshore environment as a result of the construction activities related to the Fixed Link between Denmark and Sweden.

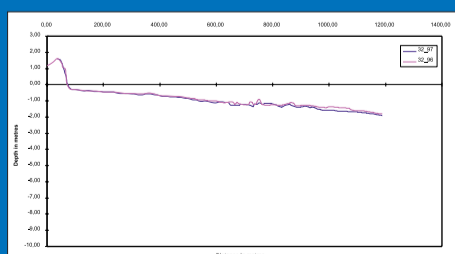
The project is carried out within the SEMAC JV co-operation including GEUS, Bio/Consult A/S, Carl Bro A/S and the National Environmental Research Institute. The investigations are performed as part of the authorities assessment of the environmental impact of the construction activities in Øresund.



Profile no. 12, located outside the artificial peninsula. The seabed topography is marked by substantial changes.



Profile no. 25 is located in an area marked by longshore bars in the inshore zone between water depths of 0 - 2 meters. The deeper parts of the area include larger bars and long, narrow sandwaves. These are active too. The entire coastal stretch of this region is characterised by changes in the bar systems.



Profile no. 32 is located in eastern part of Saltholm. In this area, only minor changes of the small scale bars located on shallow water have been recorded

Methods

The fieldwork is grouped into 5 main categories:

- 1) acquisition of air photographs
- 2) establishment, level measurement and positioning of benchmarks
- 3) levelling the profile lines by mean of a Theodolite, coastal descriptions and photography
- 4) echo sounding in the profile lines from a boat
- 5) collection of sediment samples from the seabed

Re. 1)

The photographs cover the area from at least 100 meters landward of the shoreline and offshore to the position of at least 6 meters water depth. The interpretation of air photographs includes the coast as well as the inshore zone, and focuses on the morphology and other elements relevant to coastal characterisation.

Re. 2)

The co-ordinates of all benchmarks were measured by means of DGPS. The level measurement of all benchmarks was carried out by theodolite.

Re. 3)

The levelling by means of theodolite is performed from the largest accessible water depth, at least 1.3 meter. Together with the levelling, a description of the coast and the profile line was made.

Re. 4)

An echo sounder (200 kHz) was used in the deeper part of the profiles where a DGPS was used for navigation. Echo sounding data (water depths) were recorded 3 times per second corresponding to a distance of approx. 60 cm between two succeeding data points. The recorded echo sounding data were interpreted and digitised due to high concentration of vegetation (eelgrass) on the sea bed. To perform a verification of the applicability of the methods used, 5 repeated echo soundings and digitising of one of the profiles were occasionally carried out, and it is demonstrated, that the method can reproduce results.

The levelled and echo sounded profile sections overlap each other, allowing an extrapolation of the exact level of the seabed, known from the levelled part of the profiles, to the echo sounded part of the profiles. In those situations where the profiles have only been measured by echo sounding, the exact level of the seabed is based on depth data from neighbouring (levelled) profiles.

Re. 5)

Sediment samples were usually collected from 3 positions along selected profiles. However, along two profiles (south and south-west of Saltholm) 10 samples were collected. From each of the sampling positions, 3 sets of sediment samples were collected. One sample was analysed and the rest of the samples are stored frozen. The samples were analysed for dry weight, TOC (total organic carbon), TC (total carbon) and grain size distribution.

Changes in the investigation programme from 1996 to 1997

The programme has been adjusted in 1997.

In 1996, a total of 65 transects normal to the coast line were measured. 30 profiles were located on Amager, 15 on Saltholm and 20 profiles in the Swedish part of the region. In 1997, a total of 58 transects been measured. Of these, 20 are located on Amager, 25 on Saltholm and 13 on the Swedish coast. 47 of the profiles are located identically to profiles measured in 1996. 11 profiles are new compared to the 1996 investigation. 10 of the supplementary profiles were located on the southern part of Saltholm, between Saltholm and the artificial island (Peberholm).

In 1996, sediment samples were collected and analysed from 63 positions. In 1997 the number of sediment samples has increased to 93 locations. The sampling was concentrated in the southern part of Saltholm.

New profiles and sediment sampling positions were established in order to obtain a better monitoring of the environmental conditions between Peberholm and Saltholm, and to provide a more detailed cover of the area close to the abutment on the Swedish side, at Lernacken.

In 1997, the sediment samples were supplementary analysed for TC content in order to calculate the calcium content ((TC - TOC)*8.36) as an indicator of waste material accumulated on the seabed.

Results

During both years of investigation, the coastal morphology has been described, including results from the sediment analysis and an interpretation of the aerial photographs. The results of the collected and analysed data, including profiles and sediment changes between the two investigation periods, match those changes recorded from the interpretation of air photographs.

Transects:

A comparison between the 1996 and the 1997 transects shows that changes of the seabed topography occur at several locations in the area.

The most pronounced changes are located to the seabed near the artificial peninsula close to Copenhagen Airport and in the dynamic active areas in the southern part of Amager.

Changes of the seabed topography have been recorded in 10 profiles at Amager, especially in the areas located outside Amager Strandvej and Dragør. The extension of the changes of the seabed and the coastline configuration of the Amager Strandvej area are not fully recorded because several transects were only measured in 1996. The changes in the 4 profiles located in the southern part of Amager are due to natural adjustments/migrations of the bars and other larger bedforms.

On Saltholm, 15 profiles were measured during 1996 and 1997. Distinctive changes of the seabed topography have been recorded in 10 of these profiles. The most pronounced changes are recorded in the southern and western part of the island.

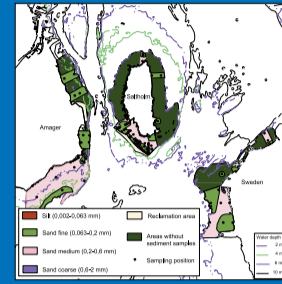
In Sweden, distinctive seabed topography changes have been recorded in 5 profiles, evenly spaced throughout the investigated area. Several transects have only been measured during the 1996 investigation. So, the extension of the changes of the seabed and the coastline configuration are not fully recorded.

Sediment samples:

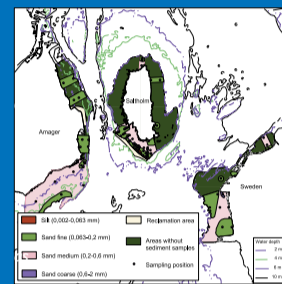
Distinctive changes of the composition of the seabed sediment from 1996 to 1997 have been recorded at several locations in the investigation area.

The largest changes are located in the area between Peberholm and Saltholm and surrounding areas. Distinctive increases of the fine-grained material and the calcium content, have taken place. The recorded silt up (sediment accumulation) and the increase of the calcium content most probably result from the excavation activities and construction activities at Peberholm.

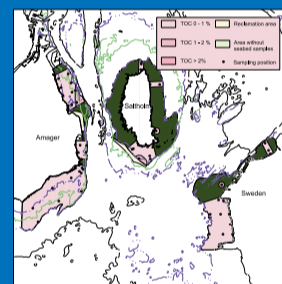
Changes of the seabed sediment composition have also been recorded in the outermost stations located outside the southern part of Amager, where the sediment has become more fine-grained and the content of calcium has changed. Changes in the composition of the seabed sediment have also been recorded outside Amager Strandpark and at several positions Sweden in the Lernacken area and toward south.



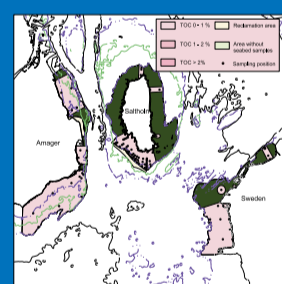
Mean grain size in seabed sediment 1996. The southern locations Amager, Saltholm and the Swedish coast, except for a smaller area between Lernacken and Klagshamn, the mean grain size is primarily medium sand. In the northern part of Amager fine sand is the dominating grain size. The remainder localities in the northern part of Saltholm and the Swedish coast have mean grain sizes of medium- to fine sand.



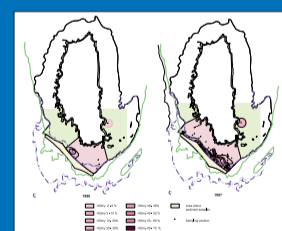
Mean grain size in seabed sediment 1997. The 1997 distribution sediment is almost identical to the 1996 situation in the northern part of Amager, the northern part of Saltholm and on the Swedish coast well. The outermost positions in the southern part of Amager are more fine-grained, the mean grain size is fine sand. In 1997, there is an area between Saltholm and Peberholm where the mean grain size is silt. The difference in grain size distribution from 1996 to 1997 is particularly distinctive in the latter location. Data seem to indicate that a silt up of the area between Saltholm and Peberholm has taken place.



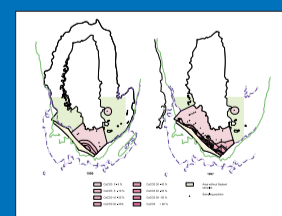
Total organic carbon (TOC) in 1996. In 1996, the TOC values of the seabed sediments were 0-1% on all sides in the investigation area, except for 3 minor areas. North of the artificial peninsula at Copenhagen Airport, in a smaller area north of Peberholm and north of Lernacken, the TOC values were between 1 and 2%.



Total organic carbon (TOC) in 1997. In 1997, values > 1% are recorded in a small area nearby Peberholm, caused by a larger content of undecomposed eelgrass in the samples. In the remainder area, the values are less than 1%. No significant changes in TOC content have been recorded from 1996 to 1997.



Seabed materials < 63 my. The results of the analysed sediment samples indicate that a silt up of the area has taken place. In a few localities, concentrations of more than 60% clay+silt are recorded in 1997.



CaCO₃ in % in seabed sediment. Simultaneously to the silt up of the area, the concentrations of calcium content (CaCO₃) in the seabed sediments have increased from 20% in 1996 to 50-60% in 1997, due to high CaCO₃ content: Spill materials from the bridge-building

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