Environmentally Friendly Coastal protection based on Vertical Drains

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Land-based activities and natural physical processes have resulted in significant modifications of the shorelines in many countries, with drastic effects on the coastal geomorphology as well as on the coastal infrastructures. There is an urgent need to introduce new and cost-effective measures that can reduce and mitigate the impacts on the shorelines.
SIC Skagen Innovation Centre has invented an environmentally friendly coastal protection system. The SIC system is based on pressure equalisation modules. A long-term and comprehensive test of the efficiency has been carried out on the west coast of Denmark. Furthermore, a three years scientific research programme was performed in 2005. The obtained result shows that the system is far more efficient than conventional methods such as groins, breakwaters and sand nourishment. Due to the well-known lee side erosion effect, groins and breakwaters create even greater erosion in adjacent coastal areas. Sand nourishment by dredging is in general terms a very expensive approach (about 200,000 USD / km / year in Denmark), but unfortunately it is an inefficient solution since usually the sand will disappear during the first spring tide.
The result is significant already after the first year. The coastal erosion is stopped and a buffer of 476.000 cubic meter sand is built up in the fore shore and the dune front in the drained areas. 139.000 cubic metres is leeside accumulation in ref. 3.

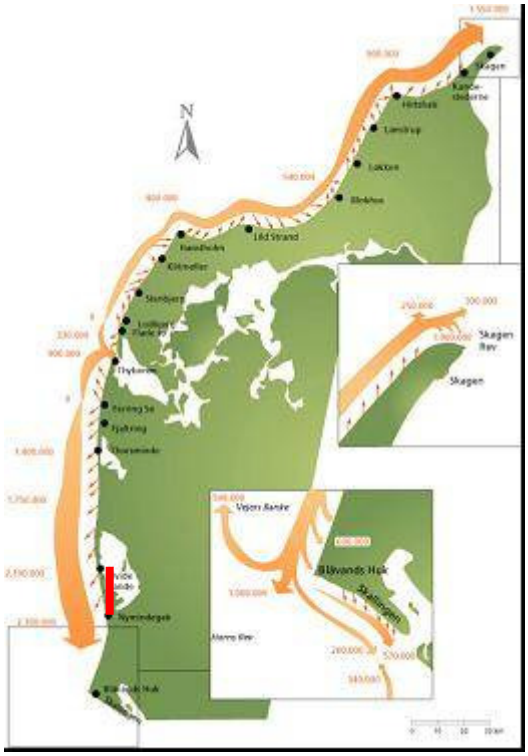


Fig. 1

Fig 2.

The project is placed on the southern Holmsland Barrier on the Danish North Sea Coast marked with a reed line in fig 1. The net. longshore sediment transport is 2.3 mill. cubic metres yearly direction south.

The configuration of the project is shown in fig 2 with 2 drained areas 4700 m and 900 m and 3 reference areas 1800 m each without drain system. The total length of the project is 11000 m placed in the lee side erosion area south of Hvide Sande harbour, marked with a reed line in fig. 1.

The yearly erosion rate in the north of the project area is 4.0 metres yearly and 1.5 metres in the south. The dune system is 1.5 metres high, so the yearly erosion in the area is minimum 330.000 cubic metres yearly.

The drain system is based on vertical drains 1.75 metres long placed in rows with 100 metres between the rows and 10 metres between the drain tubes in the cross. There is max. 11drain tubes in a row.

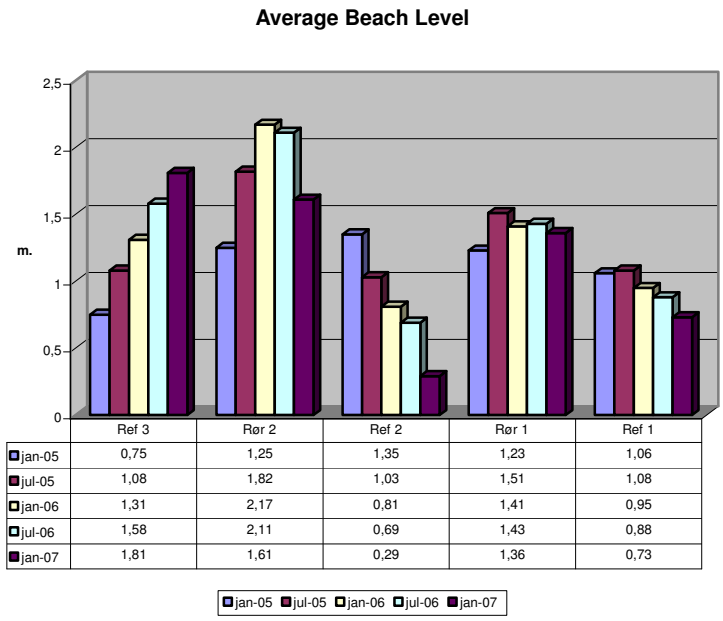
In connection to this project SIC has developed a new evaluation method based on average beach level (ABL) 100 metres wide from the dune foot towards the shoreline.

The dune foot is fixed to level +4,0 at the survey January 2005 by the project start. The total accumulation in the dune front and the beach 100 meters wide is 411.000 cubic metres based on ABL at the beach.

The Danish North Sea Coast was hit of 5 heavy storms from October 2006 to the 20 January 2007 and the last survey at the project is done the 22 January 2007, 2 days after storm number 4 in January 2007.
The average wind speed was up to 26,5 m/sec average and over 30 m/sec in the spit.

Results after 2 years 2005/07

The project survey is made by The Coastal Authority and the independent engineering company Carl Bro A/S, DK.



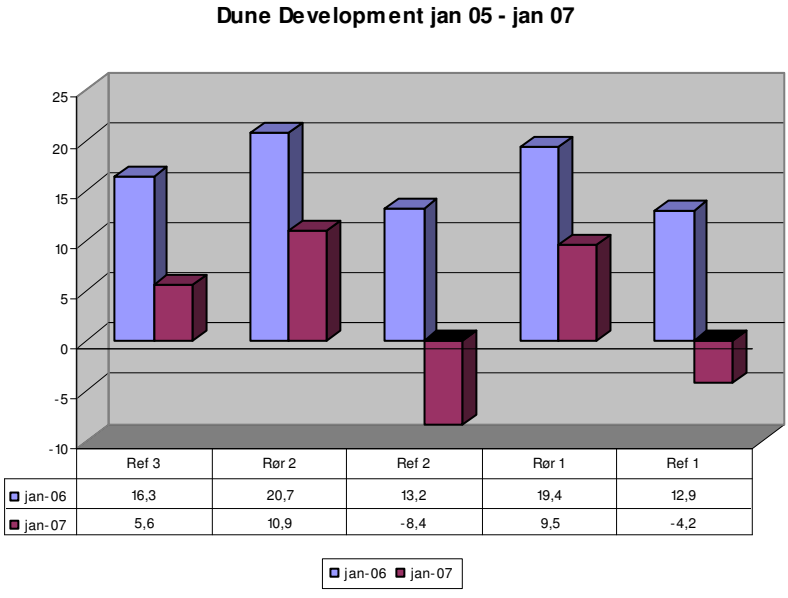
	Ref 3	Rør 2	Ref 2	Rør 1	Ref 1
jan-05	0,75	1,25	1,35	1,23	1,06
jul-05	1,08	1,82	1,03	1,51	1,08
jan-06	1,31	2,17	0,81	1,41	0,95
jul-06	1,58	2,11	0,69	1,43	0,88
jan-07	1,81	1,61	0,29	1,36	0,73

jan-05 jul-05 jan-06 jul-06 jan-07

Fig. 3

The effect of the SIC drain system is very significant, as we see in fig 3, where the ABL is raised in PEM 1 with 18 cm, and PEM 2 with 92 cm in the first year. In contrast the ABL is lowered with 11 cm in ref. 1 and 54 cm in ref. 2. In ref. 3 we have lee side accumulation with washed sand.

After the 5 storms in the winter 2006/07 is the ABL still over 1.3 meters in the PEM 1 and PEM 2 and decreased with 33 cm in ref.1 and 106 cm in ref. 2. We have no sea erosion in the dune systems, if ABL is over 130 cm.



	Ref 3	Rør 2	Ref 2	Rør 1	Ref 1
jan-06	16,3	20,7	13,2	19,4	12,9
jan-07	5,6	10,9	-8,4	9,5	-4,2

jan-06 jan-07

Fig. 4

The erosion in the dune systems after the 5 heavy storm in the winter 2006/7 is very different, as we se in fig. 4.The average erosion in ref. 1 and 2 is about 20 m^3 per m in the dune front. This sand is washed into the sea during the storms in relation to the low ABL.

In PEM 1 and 2 and ref. 3 with ABL over 1.3 m are the wind erosion below 10 m^3 per m. The sand from the dune front is blown to the hinterland by wind drift. The total amount is 69.000 m^3 as still lay in the hinterland.

The solution is to plant helmgrass from the dune foot and 10 m out in the beach, so the sand is protected better in the dune foot. In contrast 260.000 m^3 sand from ref. 1 and ref. 2 is washed into the sea, and the sea survey shows the sand is out of the project area.

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