

## CHAPTER 66

### LAND RECLAMATION AND GROIN-BUILDING IN THE TIDAL FLATS

by

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#### COASTAL PROTECTION BY RECLAIMING LAND

Along the North Sea coast of Germany there are two large areas where land reclamation work in the tidal flats is being carried out. One is on the coast of Schleswig-Holstein and the other in Ostfriesland, on the coast and along the estuary of the river Ems near the border with the Netherlands. Conditions and working methods for land reclamation in tidal flats as well as the development of new groin constructions on the Ostfriesian coast are described below.

Before the middle of this century, land reclamation was done mainly for reclaiming new fertile soil for agricultural purposes on the tidal flats. Nowadays, the aim of reclaiming land is for coastal protection, for the reclaimed foreland has many favourable effects on the dikes:

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1. The run-up of waves on the dike is reduced as the waves break on the foreland with spilling breakers (FÜHRBÖTER 1966) and are thus prevented from reaching the slope of the dike with all their vehemence. During the storm surge on Febr. 16<sup>th</sup>, 1962 for instance, this was observed distinctly as to be seen in figure 1.
2. Wave-wash on the slope of the dike becomes considerably smaller.
3. The land before the dike, in the case of a dike failure in a storm surge, also prevents a failure of the base from taking place so that even at mean high water level the sea cannot enter the land.
4. An expensive rubble slope for the protection of the dike is not necessary.
5. For the upkeep of the grass and clay covered dike, it is important to find sods and clay near the dike on the reclaimed land.

For coastal protection a 200 m wide strip of land in front of the dikes is needed. This was found in research works carried out by Prof. Hensen, Technical University, Hannover.

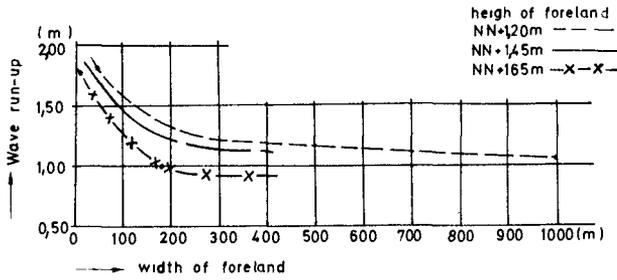
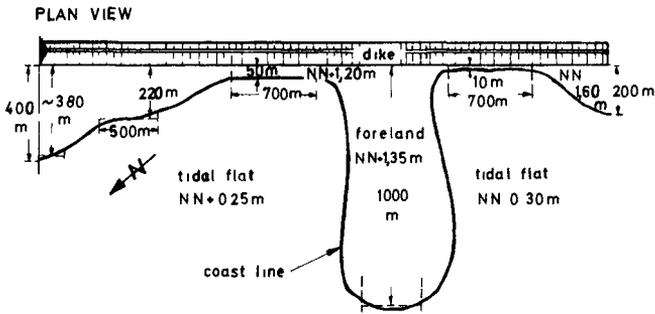
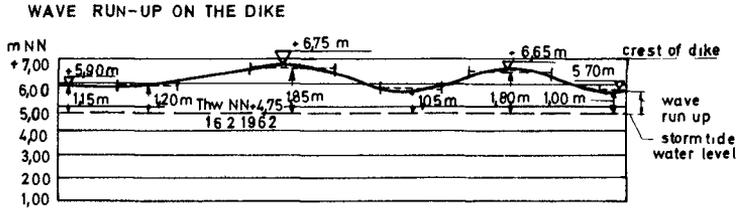


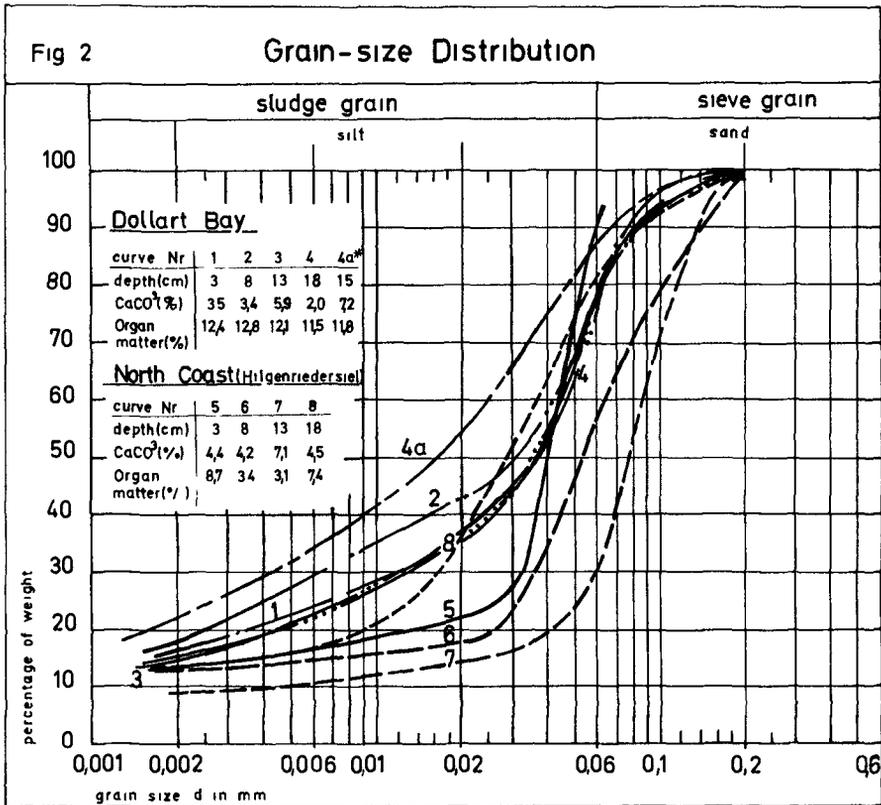
Fig 1 Relation between wave run up and width and height of the foreland (KRAMER, LIESE LUDERS 1962)

## CONDITIONS AND WORKING METHODS FOR LAND RECLAMATION

For reclaiming new land, rectangular sedimentation fields, measuring about 100 by 200 m, are constructed of groins. Hence, the fields are saved from strong currents and wave movements so that the sedimentation of sand and silt can be allowed to take place unhindered. Through the inlet in the groin on the sea-side, called "cross groin", the water can enter and leave the field quickly. During the calm period, the settling and a part of the suspended solids precipitate on the soil.

It is of interest to know something about the origin of the solids which could be classified as Sand, Clay Minerals, Organic Matter and Calcium Carbonate. The composition of the sediment varies considerably along the Ostfriesian coast. Near the brackish water region of the river Ems and the Dollart Bay the clay mineral and organic material contents are relatively high. Along the North coast the sediment contains more sandy material (Figure 2).

The rate of sedimentation and the composition of the sediment depends also on the work of the molluscs, which prepare the fine organic material and clay minerals by building small lumps of silt (KAMPS, 1962). The gills, which are used by these creatures for breathing, also



\*Sample 4a from the sedimentation field, all the other samples from grass covered foreland

serve the purpose for the collection of food, which they sieve out from water. In this process, sand and mud components, which are of no value to the creature are collected and covered with slime, out of which the coarse material, which in this case would be sand and some or-

ganic matters is ejected at the inlet, while the fine material, including the mud, is discharged together with the other remnants of digestion in the form of tiny lumps, strongly joined together. For reclaiming land it is very important that these lumps effect a higher rate of sedimentation which is rich in clay and organic matter. The important molluscs on the Ostfriesian tidal flats are Mussels (*Mytilus edulis* L.), Cockles (*Cardium edule* L.) and Gapershells (*Mya arenaria* L.).

Our knowledge in this difficult matter is not complete. For instance Mr. Raudkivi of New Zealand is of the opinion, that in brackish water the rate of sedimentation is dependent upon the change in the electric charge of the single solids as they come in from fresh water (RAUDKIVI, 1967).

It is relevant to mention some aspects of plant-growth and ditch-building in the sedimentation fields. When the terrain in the fields has reached a height, at which plant-growth can be expected, that is about 30 to 40 cm below mean high water level, ditches are dug at regular intervals by special excavators.

Figure 3 shows the hydraulic excavator, mounted on a pontoon, which is cable-operated and slides on the ground. On the higher fields with vegetation a ditch-milling-cutter is used for making ditches. The earliest natural

plants to take root in the sedimentation fields are Glasswort (*Salicornia herbacea* L.) and Cordgrass (*Spartina Townsendii*). A rank plant-growth effects a greater calmness on the field, facilitating better sedimentation and hence a more clayey soil.

When the terrain has reached mean high water level, the first plant of the grass-family to take root is the Sea Poa (*Puccinellia maritima* Parl.).



Fig. 3

#### THE CONSTRUCTION OF THE GROINS

Although methods of land reclamation are not different on shallow and deeper tidal flats, the construction of the groins depends on the level of the flats. Formally, the reclamation of land for agricultural purposes was done mainly on shallow tidal flats. The groins were built of brushwood and earth. They were constructed of two rows of wooden piles with compact brushwood in between and wooden planks at the leeside to prevent permeation. The piles are held together on top with wire (figure 4).

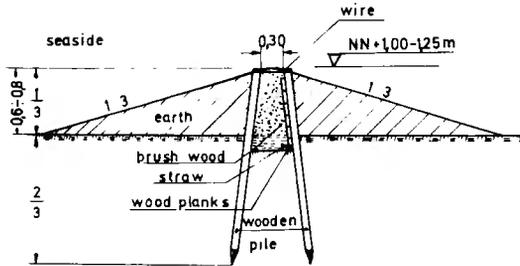


Fig 4 Brushwood groin

Occasionally the cross-groin at the sea-side is strengthened with fascine mattresses (figure 5).



Fig. 5

In deeper tidal flats it was necessary to construct the groins

more solid by using new materials. So far five types of groins have been developed for this purpose:

1. A precast concrete unit with a height of 50 to 90 cm. Each unit has a length of 1 m, the weight is 900, 1200 and 1800 kg (figure 6).

They are set on top of a wooden sheeting on either side. The joints between the single units are made close

with a special joint ribbon of foamed Polyäthylen held in a groove at one side of the unit.

2. A flexible tube of plastic web with a diameter of about 1 m is filled with sand

by hydraulic dredging and takes the form of a sausage (figure 7). The plastic web is woven of small strips of a polyäthylen membrane. Normally, the sandy soil can be taken from the ground of the tidal flat at a small distance to the building site. It is an inexpensive method to construct groins.

Besides, the following construction works are made use of, when the abovementioned types are not high and heavy enough.

3. A groin with a core of earth, with plastic mem-



Fig. 6



Fig. 7

brane (Polyathylen) around this and concrete blocks interlocking horizontally and vertically on top. A wooden sheeting and wooden planks fastened to the wood piles encloses the groin on both sides. A woven mat of reed above the plastic membrane, protects these from getting damaged (figure 8) (ERCHINGER, 1967).

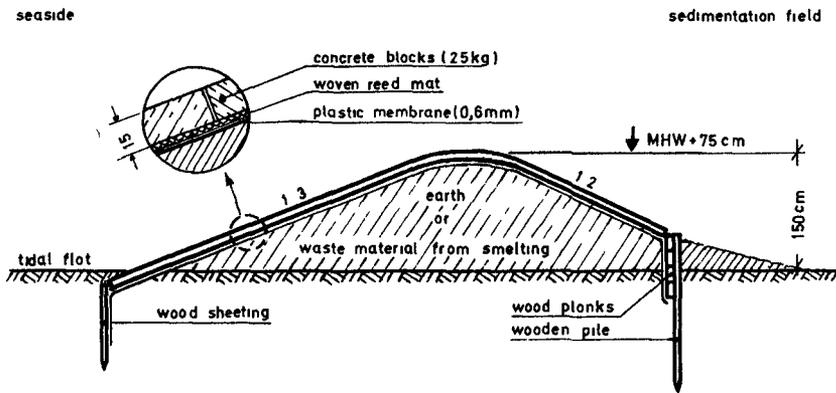


Fig 8 Section through a groin

4. This type is nearly the same as the third, but the surface is covered with quarry stones instead of concrete blocks and with steeper slopes. As the layer of the stones is about 40 cm thick, this construction needs much more material than the type with concrete blocks, which is to be transported to the building site. Transport on the flats is difficult and expensive.
5. This construction is chosen when the area in front of the dikes is to be filled up by hydraulic dredging and an embankment is to be built at the sea-side. Instead

of the plastic membrane, we take a plastic web which is woven very close, so that even the finest particles of sand and silt cannot get through (figure 9). However, it is necessary for the outlet of the water and for preventing water pressure under the surface.

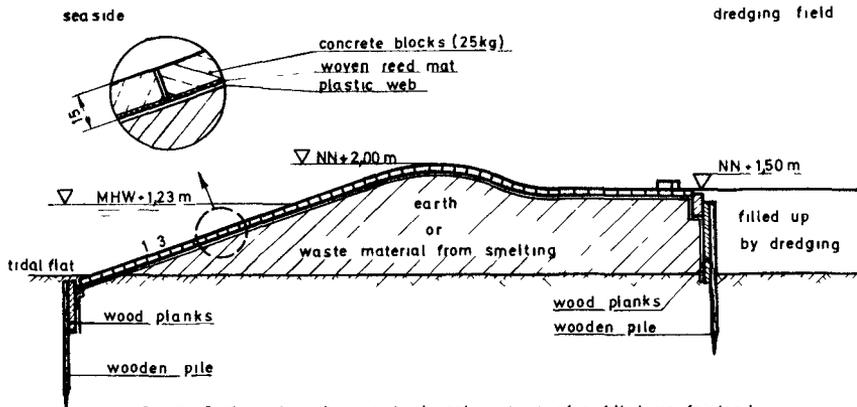


Fig 9 Section through an embankment in front of a filled up foreland

In some cases of groin construction of the last three types, waste material from smelting has been taken for the core of the groin. This material has been found to be very usefull. Its hydraulic substance, which formed a 50 cm thick and hard layer on the tidal flats was so stable, that even loaded heavy motor vehicles could use this as a road to transport the material to the building site. This ist a great advantage, considering that it is derived from waste material.

In 1965, the smelting industry, the Hoesch Concern, made a test with 100 000 t of waste material, containing residues and scrap heaps as well as mud and dust from the smelting process. A forefield in front of a dike was created with this material. This was done in the expectation to make the waste products useful for dike protection and also as a means to get rid of this substance from the vicinity of the foundries, with insufficient storage capacity for this (HAUKE, 1968).

Several scientists have inquired into the chemical and biological consequences of this waste material at the surrounding tidal flat area. No unfavourable effect has been found (KÜSTENAUSSCHUSS, 1969).

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