CHAPTER 68

PROTECTION OF SANDY COASTS IN DEPENDENCE OF THE DUNE - BEACH - TYPE

by

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ABSTRACT

Barrier dunes are the natural protective structures against flooding the low-lying land during storm tides. Their strength and resistance are to be estimated in consideration of the total dune-beach-profile. For standardization of dune-beach-profiles 3 types are to be distinguished. For each of these types the necessary and the possible actions for stabilization of the barrier dunes and also of inshore dune areas are described.

INTRODUCTION

On sandy coasts the ridges of sand dunes are often the natural protective structures against flooding the low-lying land, the villages or towns during storm tides. The strength and resistance of these barrier dunes, which are found just landward of the beach, is to be estimated in consideration of the extent and the height of the dunes as well as of the width, the height and the stability of the beach. As in many cases on the beach in consequence of altering sea and wave conditions and different littoral drift the supposition for erosion or aggradation varies, dunes and beaches have to be observed constantly. The beginning of a considerable erosion of the dunes has to be seen in connection with

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the development of the beach. A systematical research of the reasons and the further development has to be done. The research has to include the total dune-beachprofile.

STANDARDIZATION OF DUNE-BEACH-PROFILES

To find a system and to ease the discussion three different dune-beach-types are to be distinguished.

- Type 1 with surplus of sand and a filled up, wide and high beach,
- Type 2 with a balanced statement of sand conditions,

Type 3 with sand deficiency and beach erosion.



Fig. 1 Dune-Beach-Profiles of the Isle of Spiekeroog

Dune-Beach-Profiles of the Isle of Spiekeroog, one of the East Friesian islands of the German North Sea Coast, are chosen for examples of the single types of the dune and beach. The main wind direction during storm tides is about North-West. The dominant littoral drift is from West to East. The sandbars pass the inlets to the tidal flats in a curve, cambered to the North. The point, where the bars reach the beach, varies. On the eastside of this deposit point we have a natural beach fill up, and on the westside a sand deficiency as a rule.

Therefore, type 1 is to be found on the eastside and type 3 on the westside of the deposit point of the bars. (Fig. 2).

<u>Type 1</u> is a high and wide beach filled up by surplus of sand. The foredunes increase by aeolian deposited sand. The new built dunes or the new sand layers are stabilized with vegetation by nature.

<u>Type 2</u> has a balanced statement of sand conditions and, therefore, a less high and wide beach than Type 1.

<u>Type 3</u> has a low and narrow beach and a cliff at the seaside of the eroding dune. During storm surges it runs up to a considerable eroding of the dune.

The following datas are typical for the dune-beachtypes with dune and beach sand grain size about 0.2 mm:

TYPE 1 TYPE 2 TYPE 3 Inclination of the beach between MHW and MHW - 1 m 1 on 40 1 on 90 1 on 60Distance between MHW on the beach and the toe of the dune 65 m 110 m 20 m Inclination of the slope: of the natural deposited overgrown dune 1 on 2 of the cliff 1 on 1.3

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In November/December 1973 21 storm tides attacked our coast, 5 of them have been very high, about 2,5 m higher than MHW. These storm tides result in a considerable wave wash of the dunes and an accretion on the beach especially on the beach sections of type 3.

On the dune beach type 1 only a very small effect could be remarked (Fig. 3). On type 2 there was a remarkable cliff, which meanwhile is filled up by aeolian deposited sand (Fig. 4). In type 3 most of the foredune was eroded with a width in the base of about 20 m and about 230 m³ loss per linear m. But this sand nourished the beach, which increased considerably (Fig. 5).



Fig. 5 Type 3 with considerable erosion and accretion

STABILIZATION OF BARRIER DUNES

And now the question, what is to do for stabilizing sand dunes to prevent the loss of their protection, for the sand dunes may provide more effective protection at a lower cost than either a bulkhead or seawall.

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For each dune-beach-type there are different suitable measures to be taken.

<u>Type 1:</u> The foredune at the landward side of the high and wide beach increases by aeolian deposited sand. The new built dunes or the new sand layers are stabilized with vegetation by nature, in general with two dune grasses: agropyron junceum at the toe of the dune and the lower parts, and ammophila arenaria on the slope and the higher parts. Protective actions are not to be taken as a rule. To get uninterrupted ridges of dunes it may be favourable to promote sand deposition in lower parts by constructing sand fences and planting dune grasses.

<u>Type 2</u> has a less high and wide beach than Type 1. As a rule in storm surges a small cliff at the toe of the dune is created by wave action. It has to be filled up by sand. For this fill up and the artificial construction of dunes sand fences of brush or plastic fabrics a.s.o. are to be placed on the beach. Formerly sand fences have been constructed of natural products like brush or reed mats. Nowadays plastic fabrics are preferred. Plastic mats like foils or plates of polyethylene (PE) 2 mm thick with holes about 2 times 8 cm for coarse-grained sand are used (Fig. 6).

The plates are fastened on wooden piles or reinforcing steel bars. The holes inclose 28 % of the surface. Another plastic fabric is a polyester-web, known as Trevira; it is preferred for fine-grained dune-sand about 0.2 mm and fastened on wooden piles. This web of small threads has openings about 70 % of the surface. (Fig. 7). The height of these plastic sand fences measures between 60 und 120 cm, they are cheaper than brush fences and they are more durable and even nearly imperishable.

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Fig. 6 Sandfence of polyethylene



Fig. 7 Sandfence of the polyester-web "Trevira"

The fences are to construct parallel to the toe of the dune in one or few lines with side spurs or perpendicular fences between them.



Fig. 8 Sandfences at the toe of the barrier dune

After the sand has deposited it should be stabilized with vegetation. The most satisfactory plants of dune grasses, ammophila arenaria, are long-lived perennials, with extensive root systems, spreading rapidly and maintaining the surface increasing by farther deposits. A rank growth of these dune grasses is to be expected after steady new sand deposition as the plants get the nutritive substance out of the sand. The dune grasses are to be planted in lines with a distance of about 30 cm and 30 cm distance between each plant in the line. In spring, autumn and winter there is no problem of growing up in the described climate region. <u>Type 3</u> has a low and narrow beach and a cliff at the seaside of the eroding dune. During storm surges it runs up to a considerable eroding of the dune (Fig. 9).



Fig. 9 Cliff of the barrier dune of type 3

There practically is no chance for any method of artificial construction of dunes. Constructing sand fences and planting dune grasses may be effectful, only if aeolian sand deposition is to be expected after a remarkable accretion in result of dune erosion in a storm surge. Planting of dune grasses on the steep cliff means no stabilizing against storm surges. What can be done is to make the slope of the dune less steep for rendering possible an aeolian redeposit of the dune to cover the sand from loss by littoral transport (Fig. 10). On the Isle of Spiekeroog an inclination of the slope of the l2 m high cliff with aeolian redeposit about 1 on 1.9 to 1.4 in the upper part was found.



Fig. 10 Dune-beach-profile type 3 with aeolian redeposit

Another way of redeposition is proved in the Netherlands. On the Isle of Texel the eroding dune is redeposited by bulldozers.

If in the case of farther eroding of the barrier dune of type 3 human settlements, buildings a.s.o. would be destroyed by the sea and the development of the beach and the littoral drift remain unfavourable, protective structures like groynes, seawalls or revetments to the flattened slope of the dune have to be carried out. A wide dune area at the beachside kept free of any buildings provides that the eroding of the dune can be borne for a long time before suitable protective actions have to be taken. As there are coasts with alternating phases of beach erosion and aggradation, these areas without buildings can render it possible to stand out without protective actions. But if protective actions are inevitable, massive constructions should only be built, if there is no other possibility of protection, for such gearing in the natural development of the beach can cause unwelcome secondary effects and inefficacies like lee erosion, wave reflection a.s.o. Protective actions which are according to nature like artificial beach fill up are to be preferred to massive constructions like groynes and revetments as a rule.

STABILIZATION OF INSHORE DUNE AREAS

But not only the front but also the back of the foredune has to be covered from aeolian erosion. At the back of the barrier dune the dune area has often been blown out onto the ground water level after the dune vegetation has been destroyed. To prevent further erosion sand fences are constructed reticularly over the dune surface each field measuring 25 times 25 m. Dune grasses are planted in the single fields in reticular strips or the field at all (Fig. 11).



Fig. 11 Stabilization of inshore-dune-areas

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By fences and plants the roughness of the surface increases, so that wind, erosion and deposition are influenced and wind movement is deflected or screened. Then typical plants in this special location are to be taken root and the dunes are stabilized by vegetation.

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