CHAPTER ONE HUNDRED FORTY THREE

BEACH FILL BY TURNING THE COURSE OF SANDBARS

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ABSTRACT

The paper discribes the littoral drift along the Eastfrisian Islands. The inlets between the islands are crossed by offshore bars which migrate round the deep channel of the inlet northwards on a bow. Their point of approaching the next island scatters. That causes periods of accretion during the approach of the bars on the beach and of erosion in certain beach sections without bar approach and sund supply.

When an offshore bar approaches a beach it moves a swash channel ahead as a rule. This causes a rising beach erosion by currents and wave wash and hinders the settling of the bar on that beach section. This paper reports a field study on influencing the migration of a bar by building a sand dam through such a swash channel. It was intended of feed the eroded section of the beach by the steered approach of the bar. The accretion by the desired approach of the bar on the eroded beach section was higher than expected and measured more than 270 m³/m.

1.0 Introduction

On sandy coasts the littoral drift often crosses inlets as bars. Their point of approaching the beach of the next islands is important for the natural nourishment of the beach. The scattering approach causes periods of beach erosion in sections passed by offshore bars without approach. In case of severe erosion of the beach and the front dune expensive protective measures are often necessary.

In 1982 on the Isle of Langeoog, one of the Eastfrisian Islands on the German North Sea coast (Fig. 1), the winter storms effected a severe erosion of the beach and the barrier dune.

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As an offshore bar was passing that section we looked for a possibility to steer the bar directly onto the beach. We imagined it could be reached by a sand dam through the swash channel as a connection from the beach to the offshore bar. That should interrupt the currents in the swash channel and influence the wave climate as a refraction groyne.



Fig. 1: The Isle of Langeoog - one of the Eastfrisian Islands on the Southern North Sea Coast -

2.0 LOCAL CONDITIONS

2.1 Littoral drift along the Eastfrisian Islands

Along the seven Eastfrisian Islands the littoral drift moves from west to east. The tidal inlets between the single islands are passed by sand bars migrating round the deep channel of the inlet northwards on a bow. When the bars leave a western island at first the influence of the strong ebb current in the deep channel of the inlet dominates and pushes them far to the north. Then the effect of the wave wash increases and moves the bars across the channel and towards the beach of the next island (Fig. 2). The point of the approaching that island depends on the inlet and sea conditions.

The migration of the bars depends on tidal currents as well as on storm conditions and wave action. In average they move about 430 m per year (6). Their volume and their point of approaching the beach is scattering (Fig. 3). As the beach is heightened and widened by

an approaching bar, the strenght of the dune-beach-system against wave action rises after the bar approach and on the further way of the littoral drift from that section (3). But on the opposite side of this section without sand supply erosion of the beach and the front dune takes place. That happened 1982 near beach profile 24 on the isle of Langeoog.



Fig. 2: Littoral drift along the Eastfrisian Islands.



Fig. 3: Island to island migration of offshore bars and scattering of beach approach (6).

2.2 Beach conditions on the Isle of Langeoog

The Isle of Langeoog is a dune island with natural beaches and barrier dunes as natural protective structures against flooding the low lying land and the village during storm surges. This function of the barrier dunes is important, as the storm surge water level can increase to 3.8 m higher than MHW. The barrier dunes must be wide enough to keep a sufficient strength after very severe storm surges, when the extremely strong wave attack might have eroded a 10 to 20 m wide strip of the frontdune.

On the Isle of Langeoog the sand bars approach the beach on its west end. That normally effects an overall sand ballance on this beach(7). But in spring 1982 we found the barrier dunes near the village eroded by wave attack during the winterly storm surges. The beach in front of them was steep and narrow, so further erosion had to be expected. To prevent the slight barrier dune from further erosion and from breaking through protective measures had to be carried out. Normally sand bars feed the beach, but in 1982 the bar passed the eroded beach section near Profile 24 in a distance of 350 m. Its approach could be expected in an acute angle further to the east.

The following solutions seemed to be conceivable:

- ~ a construction of a revetment and groynes,
- an artificial beach fill,
- a nourishment of this beach-section by turning the migration of the bar directly onto the beach.

A revetment and groynes could not be taken into consideration seriously as the erosion would be temporary until the next bars approach the beach. Besides such constructions would have infavourable effects by lee-erosion and reflexion and also by disturbing the natural dune-beach-landscape and its developement according to nature. Last not least they would be very expensive.

An artificial beach fill in the normal manner must include the fill of the swash channel to prevent a high rate of erosion by the rising velocity of the currents in the partly filled narrow channel. Such a fill needs $600 \text{ m}^3/\text{m}$ sand, that is a volume of $600,000 \text{ m}^3$ on the about 1 km long beach section.

As the creation of a dam through the swash channel and the fill of the backbeach was calculated only to need less than 40 % of that volume of sand it was decided to try the turning of the migration of the bar.



- Fig. 4: Aerial view of the newly created connection of the offshore bar to the beach of the Isle of Langeoog by means of a sand dam.
 - 3.0 SAND MOVEMENT

3.1 Movement of the bar

Under wave action the sand of the bar moves on its outer slope in easterly direction and deposites at its end. During higher tide water levels another part of the eroded sand is washed across the surface of the bar by wave wash and deposites on the landward steep slope. This material might be moved further by tidal and wave currents in the swash channel mainly to the east end of the bar (1). That effects the approach of the bar in an acute angle further to the east.

3.2 Currents in the swash channel

No tidal currents faster than 0.4 m/s were measured in this swash channel which is 100 m wide and 1.8 m deep at half-tide- water level.

During wave attack they would be higher and more effectively. But the currents in the swash channel hindered the deposit on the beach as the currents move the sand to the end of the bar. Therefore it should be favourable for the deposit of the bar to stop the currents in the swash channel. This could be effected by filling a dam across the channel.

During constructing the dam by hydraulic dredging the sand loss by the tidal currents had to be calculated. In the swash channel the rate of sandtransport was found as

0.1 m³/h by a current of 0.4 m/s and as 2.2 m³/h by a current of 1.0 m/s (2, 4).

These dates show, that it is possible to build the dam across the channel by hydraulic dredging with a usual capacity of the dredger pump of more than 500 m³/h.

4.0 THE DAM AND ITS EFFECT

4.1 Fill of the backbeach and the dam

In July 1982 the 300 m long dam was filled with 120 000 m³ sand, medium grain size 0.2 mm, with a shape of a groyne (Fig. 6) with a 20 m wide crest 80 cm above MHW. The dam should close up the swash channel and put an end to the currents as well as effect an influence on the wave climate by this type of a refraction groyne a discribed by FÜHR80TER (4) on the ICCE 1974 in Copenhagen.

But not only the dam but also the backbeach at the toe of the barrier dune was filled by $100\ 000\ m^3$ sand. As the approach of the bar would last a while, which depends on the storm conditions and the wave action, the backbeach was filled to prevent a rupture of the slight dune during the early winterly storm surges.

To get sand with the same grain size it was taken from the forebeach 5 m below MHW and 2.5 km to the east.

4.2 Approach of the bar and the dam

During the following winter 1982/83 37 storm surges have been registrated. That means more than three times the normal number of about 11 storm surges per year. During the autumn happened a severe erosion of the artificial fill of the backbeach. But during the further stormes after December accretion began and rose by the approaching bar just in the desired beach section.

Fig. 7 shows, that five months after building the dam the bar had moved 75 m right onto the beach. The dam had turned to the east round its root at the beach and still kept its function as a refraction groyne. In February 1983 after long lasting strong wave attack the bar and the dam had been deposited on the beach totally, so that the beach has become wide and strengthened. After the winter storms the further accretion has continued, but not with such high rates as during the wave attack of the storm surges (5).



Fig. 5: Sand dam through the swash channel from the beach to the offshore bar and fill of the backbeach.



Fig. 6: Dam through the swash channel



Fig. 7: Approach of the bar and accretion of the beach after steps of meassurement in July 82, Dec. 82, Febr. 83.

The developement of the beach was observed in beach profile 24 (Fig.8). The following dates have been registrated compared with the original profile of July 1982:

| | | accretion (+) | result |
|-----------|-----------------------------------|-------------------|--------|
| | | m ³ /m | m³/m |
| July 1982 | artificial beach fill | + 93 | 93 |
| Dec. 1982 | erosion of the back- beachfill | - 63 | 30 |
| Febr.1983 | accretion | + 232 | 262 |
| July 1983 | accretion | + 44 | 306 |



approaching offshore bar after measurements in July 82, Dec. 82, Febr. 83 and July 83 in beach profile 24.



Fig. 9: Developement of beach profile 24 - Erosion and, since Dec. 82, accretion of the beach by the approaching bar regarding to the original cross section -.

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The accretion by the approach of the bar was higher than expected and measured more than 270 m³/m. This succes shows, that it is possible to influence the migration of the bar and to accelerate its approach by the combined effect of interrupting the currents in the swash channel and influencing the waves by a refraction groyne.

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