CHAPTER 166

RECENT APPLICATIONS OF ARTIFICIAL SEAWEED IN THE NETHERLANDS

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ABSTRACT

This paper deals with the effects and the method of laying of some recent emplaced artificial seaweed fields in the Netherlands. The weed is placed on the bottom in coastal waters to promote accretion or at least to prevent erosion along beaches and in gullies. The results of the three field trials, and some of the conditions that govern the succesful application of the seaweed, which will be discussed.

INTRODUCTION

For ages measures for coastal protection, such as the construction of groynes, dikes and toe-protection of the dunes have been carried out along the sandy coasts of the Netherlands. However, fixed structures of this kind, because of the secondary effects on the adjacent unprotected beaches, did not invariably turn out to be the ultimate solution to prevent coastal erosion. It is for this reason that other more flexible methods of coastal

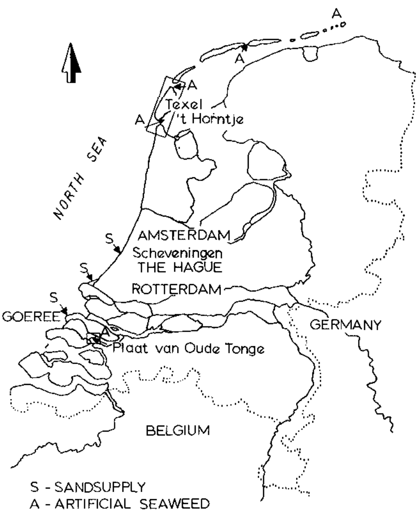

Fig. 1. Map of the Netherlands showing the sites where sand-supplies have been provided and artificial seaweed has been applied.

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Fig. 2. Artificial seaweed.

protection such as artificial beach nourishment, have been tried out at certain locations. One of the largest trials was carried out at the west coast of the isle of Goeree (see fig. 1), where about 3.5 million m^3 of sand were placed in position (see proceedings of the 14^{th} International Conference on Coastal Engineering). In addition to sandsupplies, tests were carried out with artificial seaweed to prevent erosion of banks in tidal waters (estuaries). The beds of artificial seaweed consist of rows of light weight foamed polypropylene tapes (0.2 grammes/cm^3) with an anchoring system that consists of a hollow seam (Ø 150 mm) at one end of the weed tapes filled with a heavy material such as gravel. (see fig.2). Successive anchoring tubes, each having a length of 1.5 or 2 m, are joined up lengthwise, thus forming a row. The distance between parallel rows is less or the same as the weedlength (1.5 - 2 m). When placed on the seabottom the pur-pose of the weed is to promote accretion. Compared with an unprotected bottom, the bottom transport of the sediment will decrease as part of the bottom shear stress will be absorbed by the seaweed. Since 1966 The Dutch Public Works Department has carried out a number of field trials along the Dutch coast. The results were quite variable, depending on local circumstances such as wave-climate and currents.

RESULTS OF SOME RECENT TRIALS WITH ARTIFICIAL SEAWEED.

Seaweed beds around the isle of Texel.

One of the Dutch Wadden islands, situated at the north-western part of the Netherlands called Texel (see fig. 1 and 3), was eroding at its south east side ('t Horntje). A deep gully, crossing the western shallows, was developing under the influence of tidal currents. This caused damage to the eastern bank of Texel, the erosion was mainly occurring during the ebtide. The discharge through this gully is in the order of 1000 million m^3/ tide. The velocities during low tide are more than 1m/sec. The average tidal difference is about 1.34 m. Because this location is fairly well protected from the North-Sea swell wind waves generated on the shallows prevail. These waves vary in height between 3 an 5 m. Initially fascine mattresses were laid to stop the erosion. However the erosion continued in the area adjacent to the mattresses. In 1972 it was decided to extend the area covered by mattresses with an artificial seaweed field. The first part of this trial concerned area A (see fig. 4). The weed was put down on an inclined bottom (1:5) at a depth of 5 to 15m below M.S.L. and covered an area of 80 m x 120 m. It was positioned from a pontoon and not dropped at random as was done in previous years in other areas. Because positioning according to the earlier method was not very accurate at greater depths, a more exact method was developed. An iron beam of about 30 m length on which up to twenty anchoring tubes were laid along its length, was lowered from the pontoon. At a depth of appoximately 1 m above the sea bottom the beam was tipped over and the seaweed slipped from the beam. Emplacement of the weed could be continued during the eb- or flood tide until the tidal current reached 1 m/sec. Depending on the depth of water every 3 to 7 minutes a length of about thirty meters of seaweed screen was laid. The pontoon was then moved 1.5 m in a direction opposite the tidal current and the next row was laid. In this way it took about 24 hours to cover an area of about 1000 m^2. The results of this field trial are shown in fig. 4. Within a few weeks of putting down the weed, there was an accumulation of sand about 35 cm thickness. Till

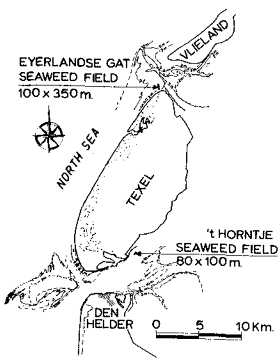


Fig. 3. Position of seaweed fields at "Texel".

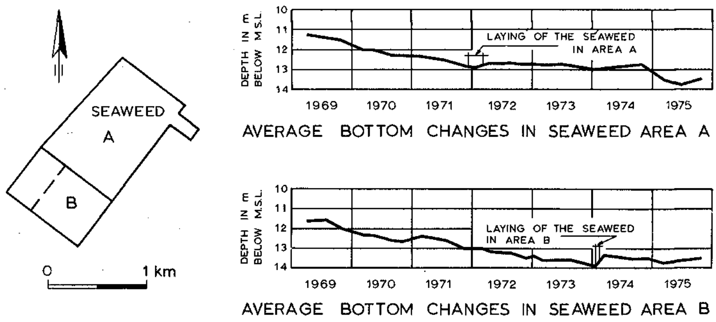


Fig. 4. Average bottom depth in the seaweed area at 't Horntje (Texel).

about the end of 1974 the bottom in area A never scoured below the depth observed immidiately prior to the emplacement of the weed. However in 1975 soundings showed a bottom depth below its position at the start of the measures early in 1972. To find out the reason for this anomaly, divers collected some samples of the artificial seaweed, which was now about four years old. Laboratory tests revealed that an increase in specific weight had occured caused by the filling of the pores in the material by water. Due to this filling the specific weight reached a value of about four times the original value of 0.2 g/cm^3. Growth of organic material on the weed has been negligible. However especially near the top end of the plastic tapes inorganic deposition had occurred. This was not the cause of the increase in specific weight. Further investigations are in progress to improve the material. After the laying of the weed in area A at the beginning of 1972 the adjacent area B (see fig. 4) however kept degrading. For this reason this area has also been covered in the beginning of 1974. In this instance the laying of the weed was done in a more advanced manner than used before: A 21 x 2 m^2 "container beam" which could carry eighty four seaweed sections, could be lowered with the aid of a derrick mounted on a pontoon. At a distance of about 2 m above the sea-bottom part of the lower half of the beam was opened by means of a special hinged valve construction. This had the result that about one third of the total load of weed sections

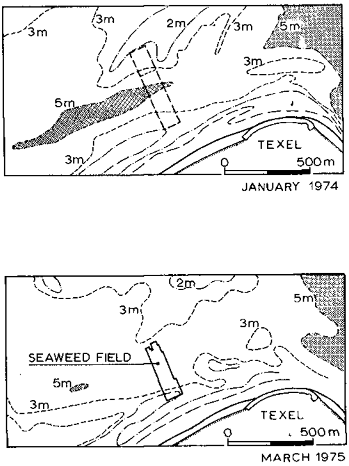


Fig. 5. Position of seaweed field at Eijerlandse Gat. Depth contours 1974 and 1975.

carried out. Then the pontoon moved over about 1.5 m to drop another third of the load, and so on. After this the "beam" had to be refilled again above waterlevel. In this way it was possible to cover in the same time three times as much of the bottom than in the method with a single beam mentioned before. Since the laying of this weed-field, there has been sand-accumulation in location B up till the present time (see fig. 4).

In addition to the erosion problems at the south-east coast of Texel Island, the development of a gully north of Texel, just in front of a dune protection (see fig. 1,3 and 5). It was feared that a connection would develop between this gully and a deeper part of the shallows situated to the east. If this connection did develop, it was quite likely that, because of the higher stream velocities that have to be expected, the gully would extend towards the shore, causing damage to the coastal defence works. Although the conditions in this area are quite different from 't Horntje (the area is subject to strong wave attack); it was decided to lay a strip of seaweed 8 m wide perpendicular to the axis of the developing gully. The favourable results obtained with the weed elsewhere, justified this new trial. In this relatively shallow water, with a maximum depth of about 5.5 m below M.S.L., the weed was put in position in a way different from the one described before.

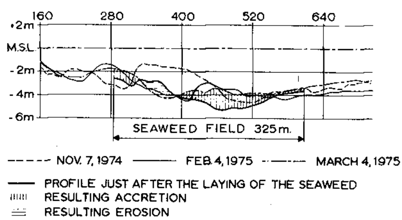


Fig. 6. Changes of the bottom profile in the seaweedfield . Eijerlandse Gat.

At shallow depth (e.g. close to the low-water line) the weed was dumped from a pontoon during high tide. At greater depths, use was made of a special pontoon equipped with eight P.V.C. tubes (diameter 35 cm) which at one end could pivot about a fixed point on the bottom (see fig. 7). After lowering the free end of the tubes to the sea-bottom, the weed is put on to the other end and slides to the bottom. The pontoon is then moved over the length of a seaweed section and the filling resumed. In this way the weed can be laid without losing time by lowering a beam, an additional advantage is the working undependent of the tide.

In the past, the depthcontours in this area used to move frequently and unpredictably. Since the weed has been "planted", the gully has not developed any further (see fig. 5). It appears therefore, that the presence of the weed has had a beneficial effect. However looking at fig. 6, it is evident that the acccumulation of sand in the field cannot only be caused by the weed, as at some places there is an accretion of more than 2 m which cannot possibly derive from the action of the weed. In view of the unpredictability of the bottom movement, insufficient time has elapsed to consider the evidence obtained so far as conclusive in this respect.

Fig. 7. Pontoon with the eight P.V.C. tubes in horizontal position.

Seaweed field at Plaat van Oude Tonge (Delta region).

In the Delta region, situated in the southern part of the Netherlands, the position of some old gullies has recently become very unstable as result of the closure of some estuaries. Between 1958 en 1965 the dam in the Grevelingen estuary, between Goeree and Schouwen, was built. As a consequence considerable morphological changes took place. At Plaat van Oude Tonge for instance (see fig. 1 and 8) a considerable change in direction of the gully "Krammer" occurred, which in future could result in severe damage to protective works in the neighbourhood.

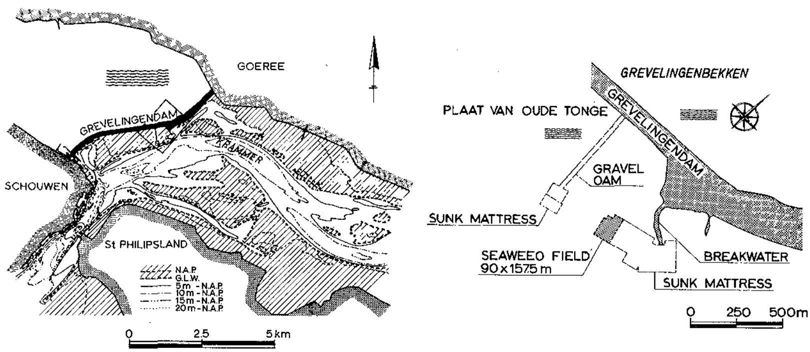
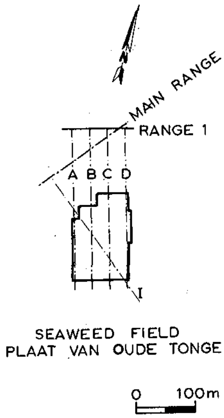


Fig. 8. Position of seaweed field at Plaat van Oude Tonge.

The axis of the gully concerned changed from N - S to NE - SW. As a consequence of the ebb-stream through the gully the Plaat van Oude Tonge eroded heavily. Since 1958 the 2.5 m below M.S.L. depth contour has moved 900 m in the direction of the Grevelingedam, and the gully increased in depth from 8m to 21 m (-M.S.L.). The slope of the western bank changed from 1:22 to 1:3.5. Measures had to be taken to prevent further erosion of this bank in front of the dam. In 1969 fascine-mattresses were placed round the end of an old breakwater over an area of 70,000 m^2, and 600 m to the west of this breakwater a 500 m long.

A submerged dam was constructed to keep the current as far as possible from the Grevelingendam. However in 1971 and 1972 bank-slides occurred. Extra mattresses were laid, without success



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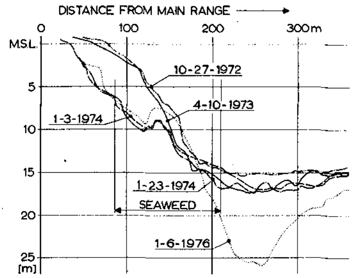

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Fig. 9a and b. Profile I (see fig. 9a) before and after the laying of the weed.

however as the slides continued. Because of the similarity to the conditions at 't Horntje (same wave climate and current velocities) it was decided to "plant" a seaweed bed. This was done at the beginning of 1974.

The situation that has developed since then is shown on fig 9b and fig. 10, which show the observations from October 1972 up to Februari 1976. It is obvious that significant changes in the development of the gully and the banks, since the placing of the weed, have been occurred. Nearest the Grevelingendam erosion has come to a standstill and some accretion has taken place. Only along the edge of the weed-field (deepest part) there has been erosion because of secundary effects. The unprotected gully however has deepened considerably. Bankslides have not occurred up till the present but can be expected if the slopes along the edge are getting to steep.

CONCLUSIONS.

From the results mentioned above, it can be concluded that artificial seaweed can be applied succesfully in gullies where high flow velocities occur. Accumulation is to be expected when there is little orbital motion near the bottom. However secondary effects along the edge parallel to the stream

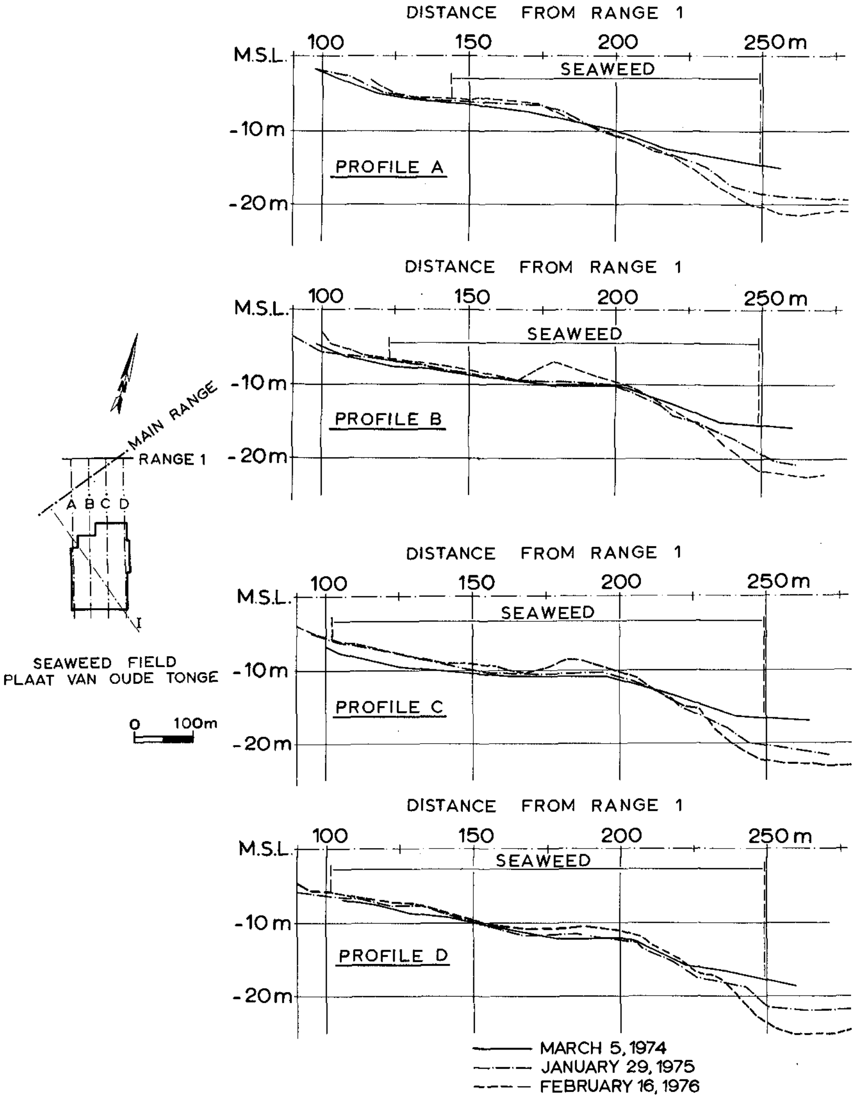

Fig. 10. Changes of bottom-profiles at Plaat van Oude Tonge after the seaweed had been put in position.

can be expected. With bigger wave heights prediction of the results is less certain. The costs of the material and of the emplacement of the weed are rather low. They amount to about one fourth of the conventional bottom protection. With investigations to improve the material proceeding it is difficult to predict what will be the lifetime of the artificial seaweed.

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