		Lauwerszee Zuidwal	Brielse Gat Division Dam	Brielse Gat Major Dam	Noord Pampus	Springers-diep
Mean tidal range	m	2.6	2.2	2.2	1.85	2.60
Length of closure gap	m	3351	1720	1820	400	1000
Area of closure gap	m^2	4280	390	1120	2430	4280
Volume of closure dam	$10^6\ m^3$	1.04	0.22	1.19	0.75	1.62
Volume of final dam	$10^6\ m^3$	1.24	0.23	3.28	1.10	3.34
Total production of dredgers during closure	$10^6\ m^3$	1.56	0.27	1.72	0.97	1.87
Total production of dredgers in overall work	$10^6\ m^3$	1.75	0.28	3.10	1.50	3.60
Total observed loss of sand during closure	$10^6\ m^3$	0.52	0.06	0.53	0.22	0.25
Total observed loss of sand in overall work	$10^6\ m^3$	0.51	0.05	+ 0.18	0.40	0.26
Time of closure operations	days	70	36	63	37	66
Maximum number of dredgers		3	1	2	2	3
Maximum production per tide	$10^3\ m^3$	16	10,5	20	25	25
Maximum predicted loss of sand per tide	$10^3\ m^3$	1.48	6	12	6	7.8
Number of sides of sand fill		2	1	2	1	1
Mean grain size of supplied sand	microns	130	-	-	135	200

Table 1. Data of closure gaps and dredging operations

section of the final dam. It may be noted that the actual side slopes of the sand dam may deviate from the designed ones. If there is any wave action, almost an equilibrium beach profile is developing during the operation. The material eventually deposited outside the design cross-section contributes to this equilibrium profile and therefore should not be considered as lost to the volume of the dam. Moreover, the dredger production is measured as volume of spoil, consisting of sand and mud. The mud, however, is hardly found in the sand dam. So a part of the observed sand loss consists of the mud suspended in the spoil.

The predicted sand loss is that which has been calculated before the works started. The data are estimates, derived from tidal computations or model experiments. These data may deviate from the actual ones, operating during the closure procedure. Furthermore the outline of the closure procedure may deviate from the planning and the data introduced in the calculation of the predicted sand loss are no longer reliable. Moreover, variations in weather conditions cannot be included in the computation.

Therefore, the calculated sand loss was introduced. This is the sand loss computed from data derived from actual measurements made during the closure operation (hindcast).

The discrepancies between calculated and observed sand losses are then mainly due to the inaccuracy of the method or that of the current measurements.

From some closure operations there were enough acceptable data to compare the predicted, the calculated and the observed sand losses. Table 2 gives the results. In figure 4 the dredger production and losses are illustrated.

It may be concluded that in most cases the calculated and observed sand losses are of the same order of magnitude. The predicted sand losses deviate in most cases considerably from the observed losses. This indicates that much care should be given to the data on which the prediction is based.

From table 1 it can be learned that successful operations were executed when the maximum dredger production per tide was at least four times the predicted maximum losses of sand per tide.

			Lauwerszee	Brielse Gat Division Dam	Brielse Gat Major Dam	Noord Pampus	Springers-diep
Total dredger productions	(D)	$(10^6\ m^3)$	1.56	0.27	1.72	0.97	1.87
Observed losses of sand	(O)	$(10^6\ m^3)$	0.52	0.06	0.53	0.22	0.25
Predicted losses of sand	(P)	$(10^6\ m^3)$	0.90	*	*	0.20	0.70
Calculated losses of sand during closure operation	(C)	$(10^6\ m^3)$	0.45	0.10		0.06	0.35
Percentage O $\div$ D			33	22	31	25	15
Percentage P $\div$ D			60			20	42
Percentage C $\div$ D			29	37		6	21
$\frac{P - O}{P}$			0.43			- 0.20	0.64

* Execution of closure operation deviated very much from planning; predicted losses of sand unreliable

Table 2. Dredger productions and losses of sand

Some illustrations of the optimalization of the closure operations can be presented here.

lt appeared that in most cases an increase in dredger capacity results in a reduction of the sand losses during closing. This is indicated in table 3.

Assumed dredger productions m^3/week	Time of closure operation weeks	Calculated loss of sand 10^6 m^3
230,000	5	0.50
300,000	3½	0.35
350,000	2½	0.25

Table 3. Calculated loss of sand. Dam through Springersdiep for several dredger productions.

Furthermore the computations may show at which stages of the closing the largest sand losses are to be expected (figure 5). It may be wise to reach this stage during neap tide conditions.

This determines the beginning time of the operation. The difference in sand loss during spring and neap tide is illustrated in figure 6 for the closure of a gap from one side. It can be seen that during the ten weeks closure operation the actual losses vary with the tidal range.

Also the computations may indicate the most feasible way of operations viz. closing from one side to the other, or tbe reverse or from both sides together. There can be a great difference in current pattern and velocities in the closing gap for different ways of operations.

Table 4 shows for example that in the North Pampus channel the calculated sand losses are much higher when proceeding the dam from N to S than from S to N.

	Loss of sand in 10^6 m^3
Operation from S to N	0.10
Operation from N to S	0.19

Table 4. Calculated loss of sand, Dam through Noord Pampus.

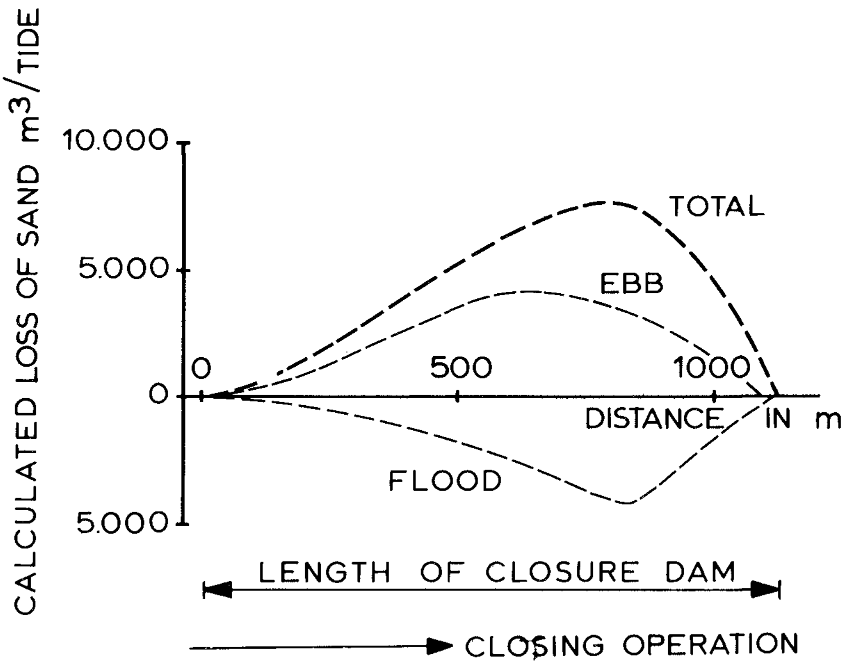

Fig. 5

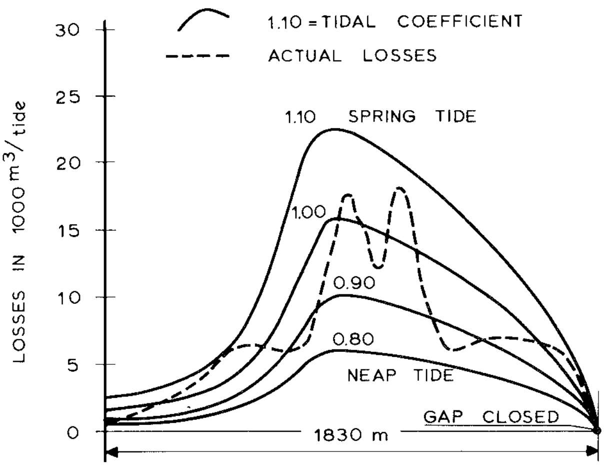

Fig. 6 CALCULATED LOSSES DURING THE CLOSURE OF A GAP

The representative grain size, which may be introduced into the computations may be established as follows. From samples of borings of the winning pit the variation of grain size with depth can be found (figure 7) and schematized. The schematized data of several borings can be put together in order to obtain an overall indication of the variation of the grain sizes with depth. Then an overall grain size distribution of all the material can be determined.

For each grain size fraction the sand transport capacity per unit of time can be calculated taking into account the percentage material present in that particular fraction. The cumulative distribution of the transport capacities of all fractions gives the total sand transport for that grain size distribution ($q_{cap\ f}$) (figure 8).

Furthermore the sand transport capacity can also be calculated for each fraction assuming a uniform grain diameter $q_{cap\ u}$. (So in every fraction there is 100% of material). The representative diameter is that one for which $q_{cap\ u} = q_{cap\ f}$ (figure 8).

Finally it was observed that the submerged slopes of the dumping site were 1 : 15 to 1 : 20 for grain sizes of .15 to .20 mm, whereas the emerged slopes were about 1 : 30.

From experience and calculations it appeared that usually the most favourable location of the final gap of the sand dam is a shallow part of the cross-section. This is due to the fact that the current velocities in the final gap situated in a shallow area are lower compared with those in a deep final gap. Moreover, the length of the sloping fill head is less and consequently also the losses of sand.

Furthermore the sand volume needed for the final stage of the closure operation is lower. Altogether, shorter time is needed with the final stage in a shallow area. Then both the amount of erosion in the gap and the losses out of the base of the dam are reduced while the current velocities reach their maximum values.

Success of the operation also depends on the working method, the layout of the pipelines, the sand-water ratio of the spoil

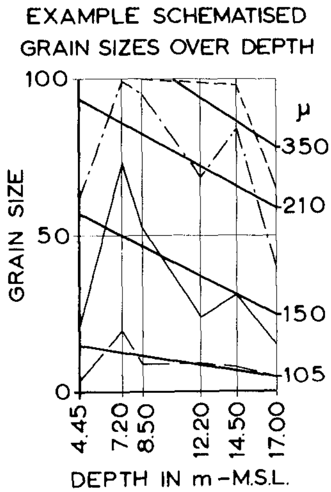
EXAMPLE SCHEMATISED
GRAIN SIZES OVER DEPTH
GRAIN SIZE
100
50
0
μ
350
210
150
105
4.45
7.20
8.50
12.20
14.50
17.00
DEPTH IN m -M.S.L.

Fig. 7

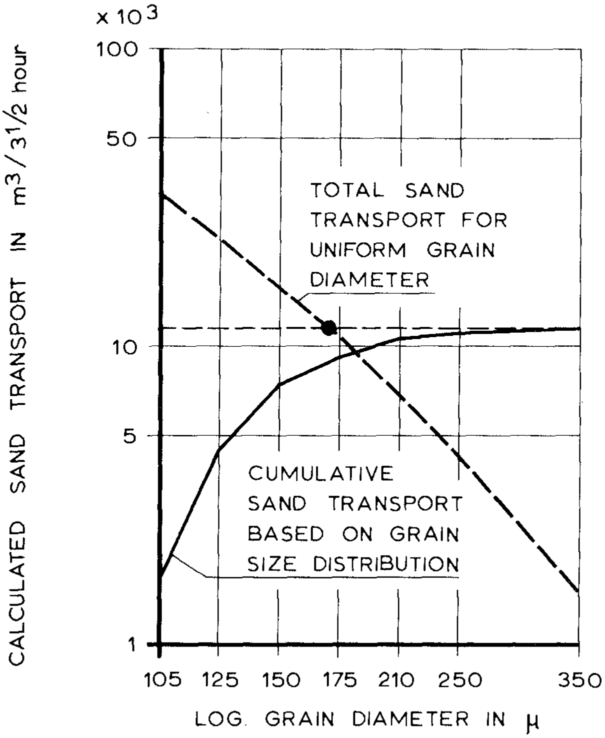
x 10³
100
50
10
5
1
CALCULATED SAND TRANSPORT IN m³ / 3½ hour
TOTAL SAND
TRANSPORT FOR
UNIFORM GRAIN
DIAMETER
CUMULATIVE
SAND TRANSPORT
BASED ON GRAIN
SIZE DISTRIBUTION
105
125
150
175
210
250
350
LOG. GRAIN DIAMETER IN μ

Fig. 8

and the working time of the dredgers.

In the final gap, bulldozers and draglines should operate on the fill to control the sand deposition above the water level, (see photo 1).

A special problem is to control the supplied water eroding channels while running down the fill, especially when dredgers with large discharge capacities are used. Normally these channels are rapidly filled when the tide is rising.

The method of computation presented above can be of great help to determine the feasibility of the closing of a tidal channel by means of a sand dam. Further it gives reliable data on the optimum dredger capacity and the time involved in the closure operation. Finally it fcan contribute to the choice of the best operational scheme.

Reference:

Dronkers, J.J., 1970. Research for the coastal area of the Delta region of the Netherlands. XIIth Conf. on Coastal Engineering, Washington D.C.

Photo 1. Final gap. Bulldozers and draglines operating on the fill

MODELING SEDIMENTATION AT INLET AND COASTAL REGION

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ABSTRACT

Sediment transport in the vicinity of inlets and coastal regions depends on the combined bottom shear stresses due to both currents and waves. The modeling of the movement of bedload is controlled by the Froude law, bottom shear stress, wave steepness, and friction factor. Assuming Einstein's theory of bedload function can be applied to this study, an analysis was performed after conducting experiments in the flume and model basin. A series of results obtained from the flume tests is to insure the relationship between the fluid characteristic and the movement of bedload. The final results concerning the longshore sediment transport appeared satisfactory with the estimated curves. The bottom configurations in the inlet after each test were also shown satisfactorily similar. The sedimentological time scale for the three bed materials were not in satisfactory agreement, however, more discussion of the results was presented in this paper.

INTRODUCTION

Problems dealing with sediment transport in the vicinity of inlet and coastal region are very comlex and difficult. Very often, analytical solution fall short because of insufficient knowledge of phenomena, or because of complex geometry. In such cases, a model study with a movable bed is desirable and is a valuable quide to the engineer in the design of coastal structures and navigational channels.

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