SECOND INTERNATIONAL CONFERENCE ON
PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
UNIVERSITY OF ICELAND
DEPARTMENT OF ENGINEERING AND SCIENCE

A PLANNED EXTENSION OF THE HARBOUR OF JULIANEHAAB, GREENLAND.

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INTRODUCTION.

Julianehaab is situated in the southern part of Greenland, about 1oo miles northwest of Cape Farewell, figure 1 and 2.

Julianehaab and the smaller towns in the district are presently served by a 3o m long deep water wharf (See figure 3). The approach is very narrow and the apron area is limited.

To improve these conditions an extension will be carried out in 1974-75 under the auspices of GTO (The Greenland Technical Organisation). It comprises an extension of the existing wharf by 3o m towards southwest and a new 6o m long wharf as shown on figure 3 and 4. The site is typical of Greenland conditions in exhibiting strong variations in soil conditions within a very limited area.

SOIL CONDITIONS.

Over large areas the bottom consists of bare rock or is covered by a thin layer of sediment. Where the bottom is below ÷ 1o m however the bed conditions are completely different. This affects the wharfs in the region around the southernmost corner.

At this corner the following layers are found (Fig. 5):

From ÷ 11.8 to ÷ 13.2 = Soft mud

From ÷ 13.2 to ÷ 15.3 = Mud with many big stones or layers of big stones. The shear strength is relatively high but the layer will cause some settlement when loaded with the weight of the fill.

From ÷ 15.3 to ÷ 18.6: Layers of clay and sand, which do not present any problems.

It is calculated that a fill to about + 2 will give total settlement in the soft layers of about 7o cm, of which 5o cm occur in the upper layer of soft mud and 2o cm in the layer between ÷ 13.2 and ÷ 15.3. Furthermore it was estimated that it would only be possible to drive a sheet pile wall to about ÷ 13.2 m.

It might be possible, with some difficulties, to drive heavy steel piles through the stony layer. At this location, which is exposed for drifting ice and berthing ships, it was however considered preferable to use a backfilled structure.

STRUCTURAL SOLUTION.

For the reasons given above the following structural solution was selected.

The soft mud will be removed under and to 2o m in front of the wharf. The mud will be replaced by a 5 m thick layer of shingle. The top of the shingle layer will be at level ÷ 8.4 m, which provides sufficient water depth.

The shingle will permit the driving of a sheet pile wall, and the shingle will provide sufficient support for the wall when it is backfilled with sand. It is planned in 1974 to construct a sheet pile cell at the wharf corner to the dimensions 1o x 2o m.

In this way the structure will be stable against forces from ice or berthing ships. A cross section is shown on figure 5.

In 1975 a bridge will be placed to connect the cell to the existing wharf. At this time the cell will have completed the greater part of the expected settlement of about 2o cm.

A cross section in the side wall is shown on figure 6. The steel sheet wall is fixed with anchors in two levels. The diver can easily fix the lower anchors to each double sheet pile. The length of the anchors are controlled with stability calculations, of which one is shown on figure 7.

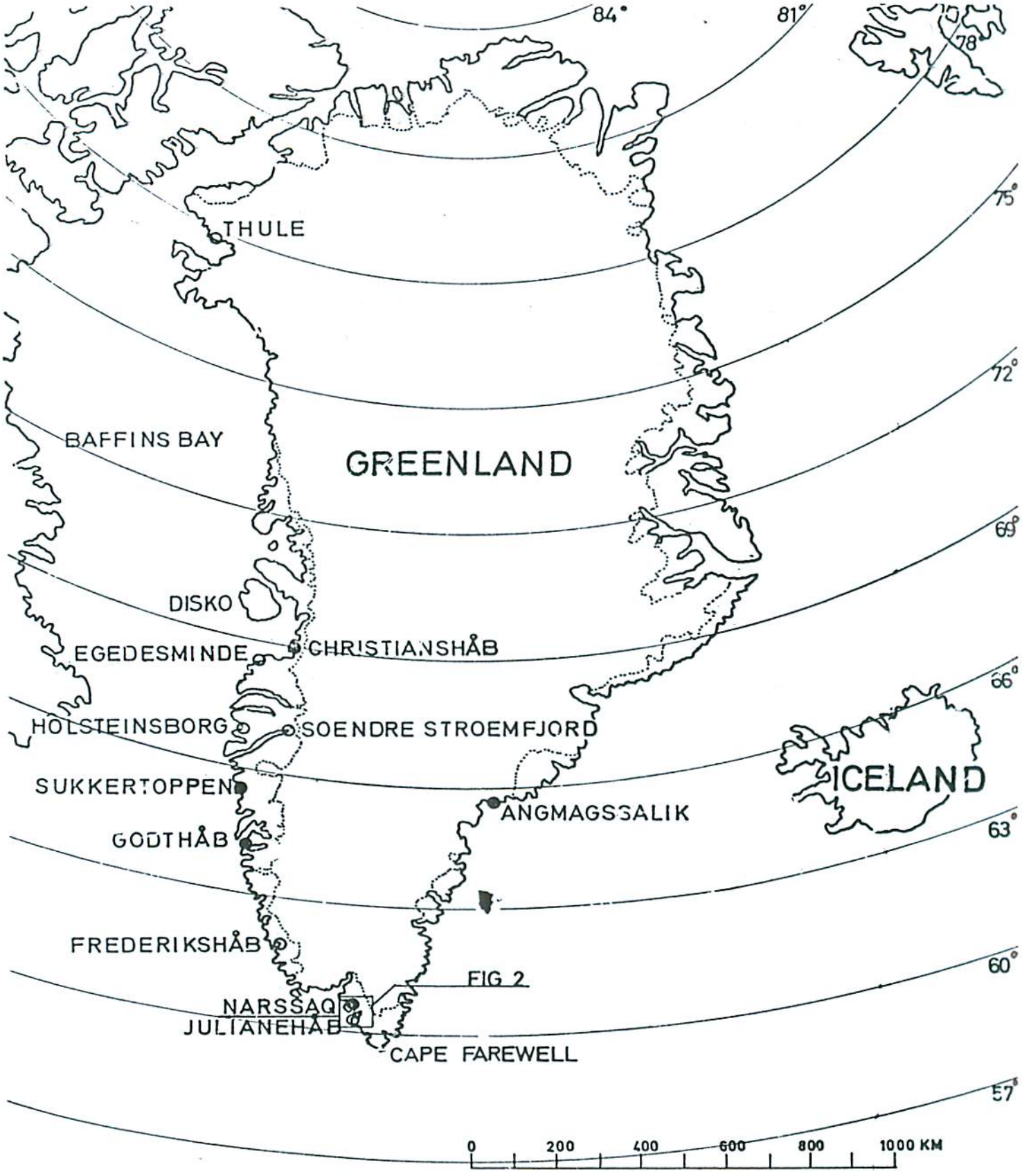

84°
81°
78°
75°
72°
69°
66°
63°
60°
57°
THULE
BAFFINS BAY
GREENLAND
DISKO
EGEDESMINDE
CHRISTIANSHÅB
HOLSTEINSBORG
SOENDRE STROEMFJORD
SUKKERTOPPEN
ANGMAGSSALIK
ICELAND
GODTHÅB
FREDERIKSHÅB
FIG 2
NARSSAQ
JULIANEHÅB
CAPE FAREWELL
0
200
400
600
800
1000 KM

FIG. 1

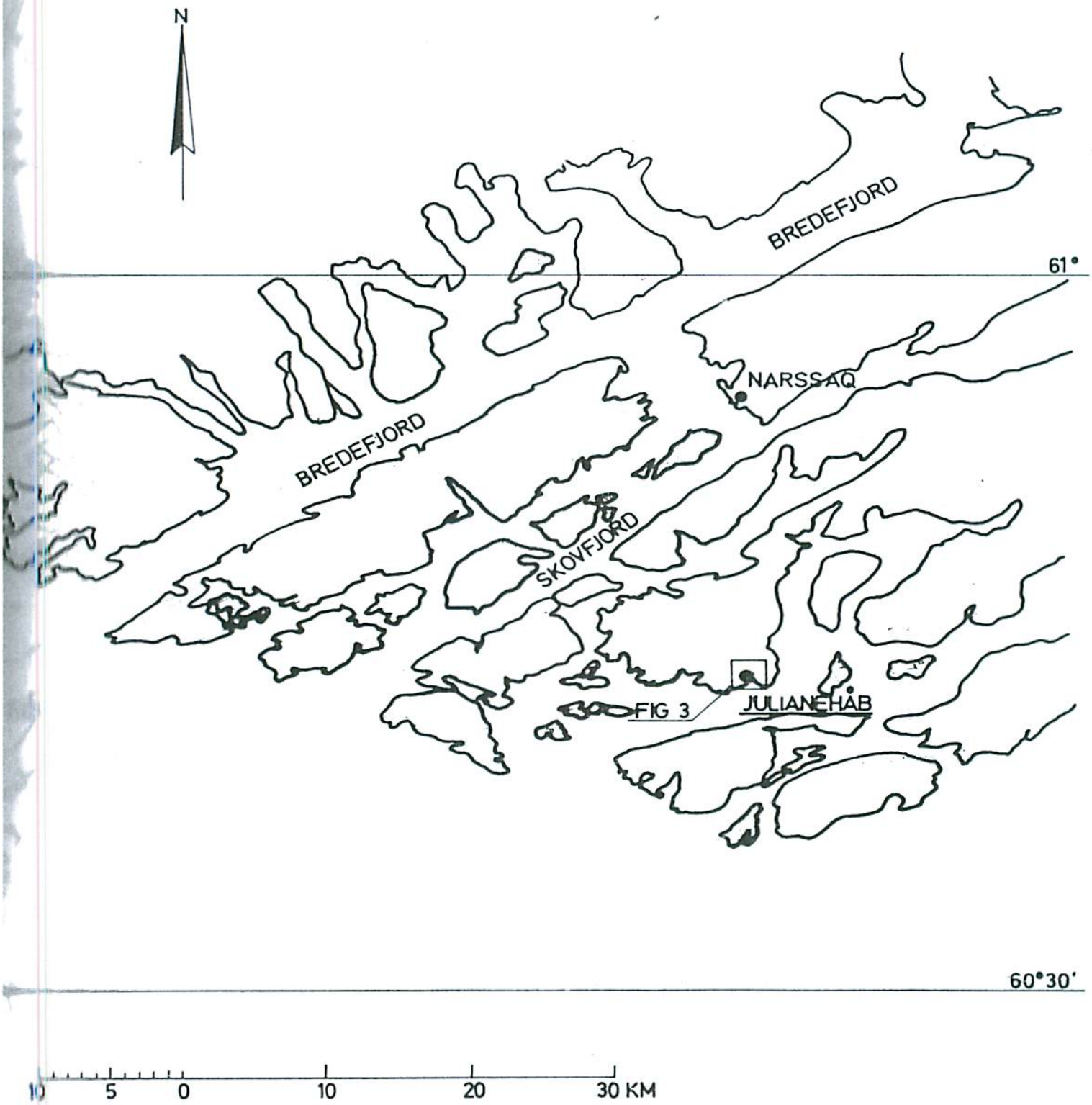

N
BREDEFJORD
61°
NARSSAQ
BREDEFJORD
SKOVFJORD
FIG 3
JULIANEHÅB
60°30'
10
5
0
10
20
30 KM

FIG. 2

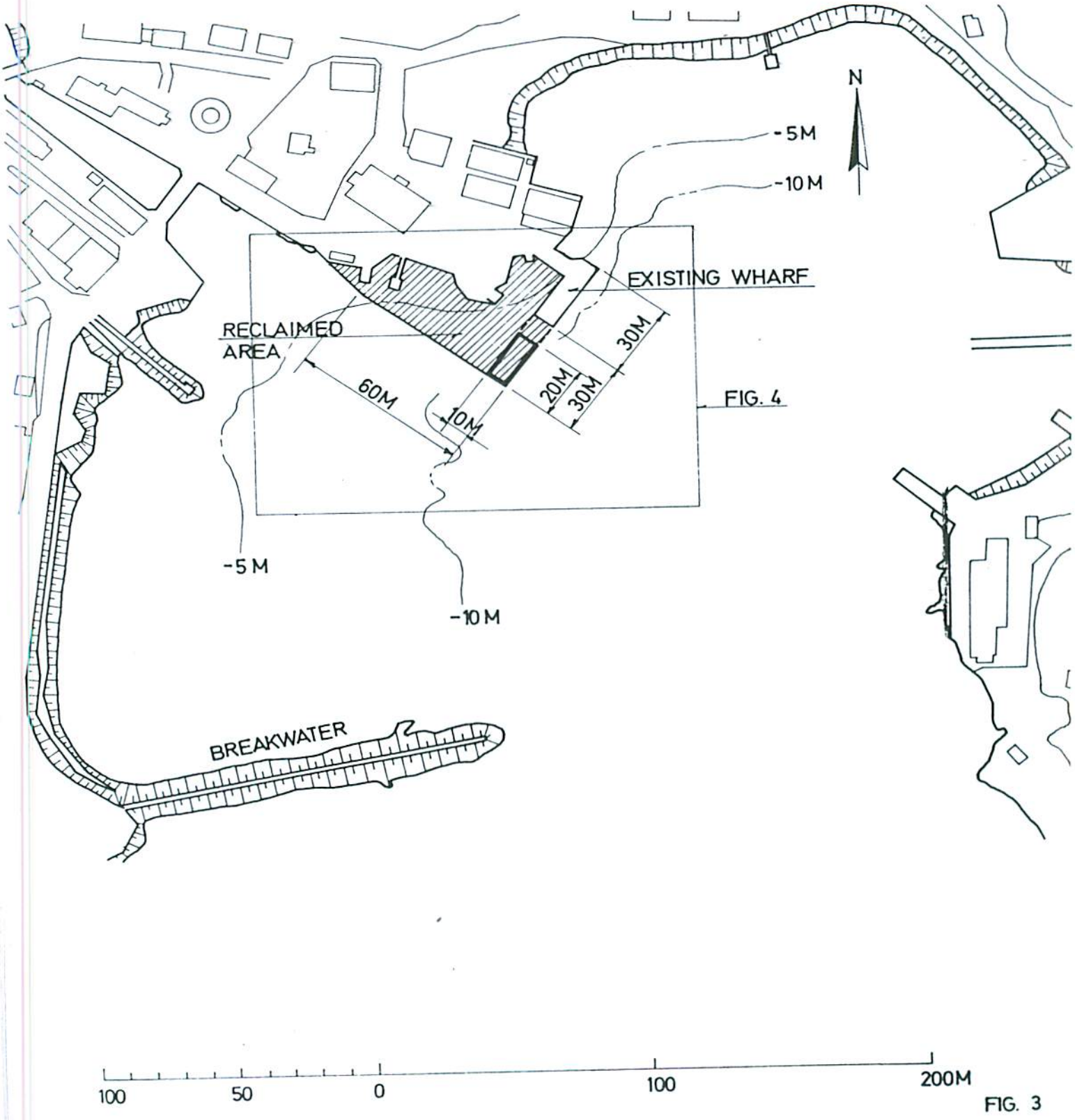

N
-5M
-10 M
EXISTING WHARF
RECLAIMED
AREA
60M
10M
20M
30M
30M
FIG. 4
-5 M
-10 M
BREAKWATER
100
50
0
100
200M

FIG. 3

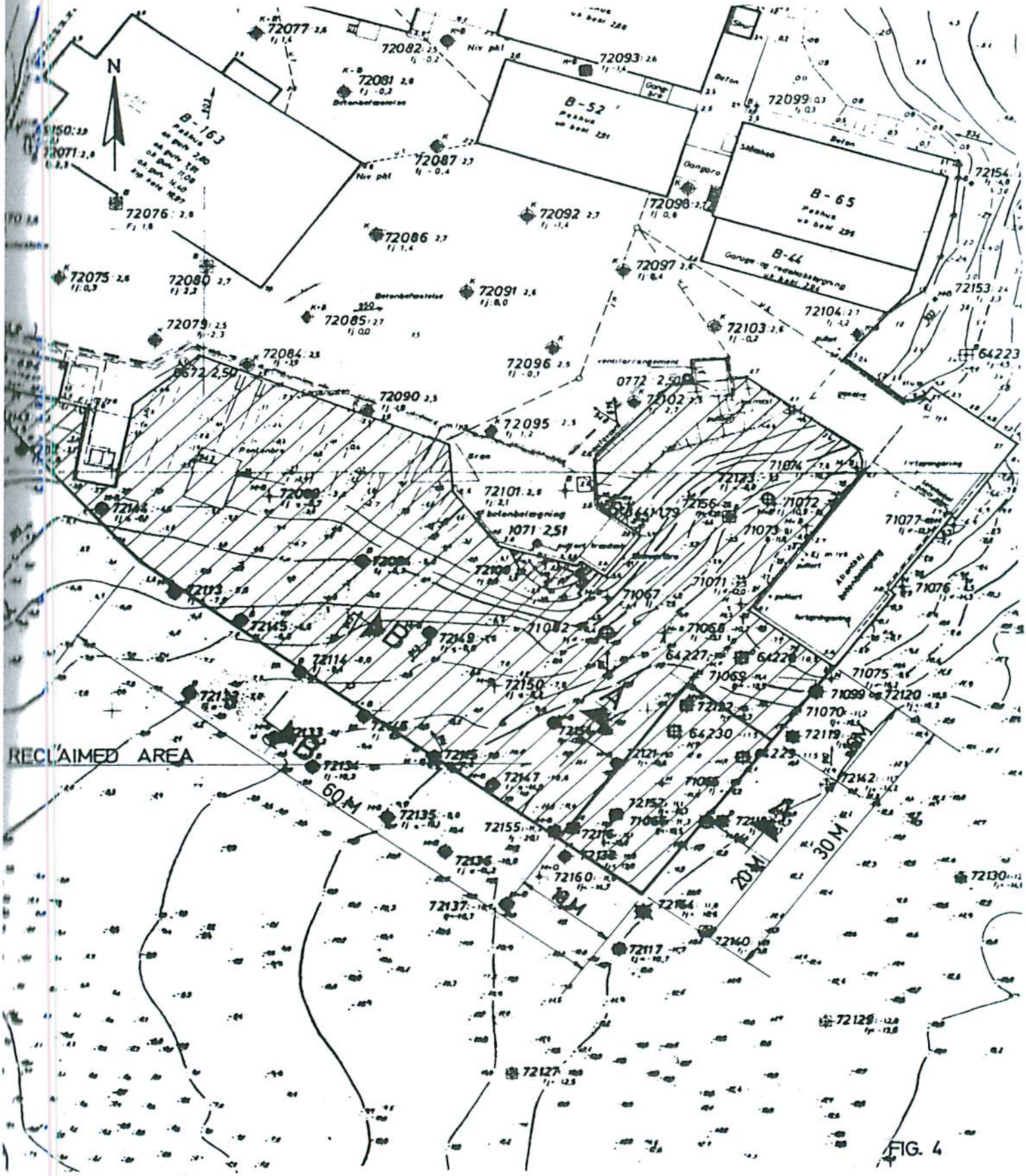
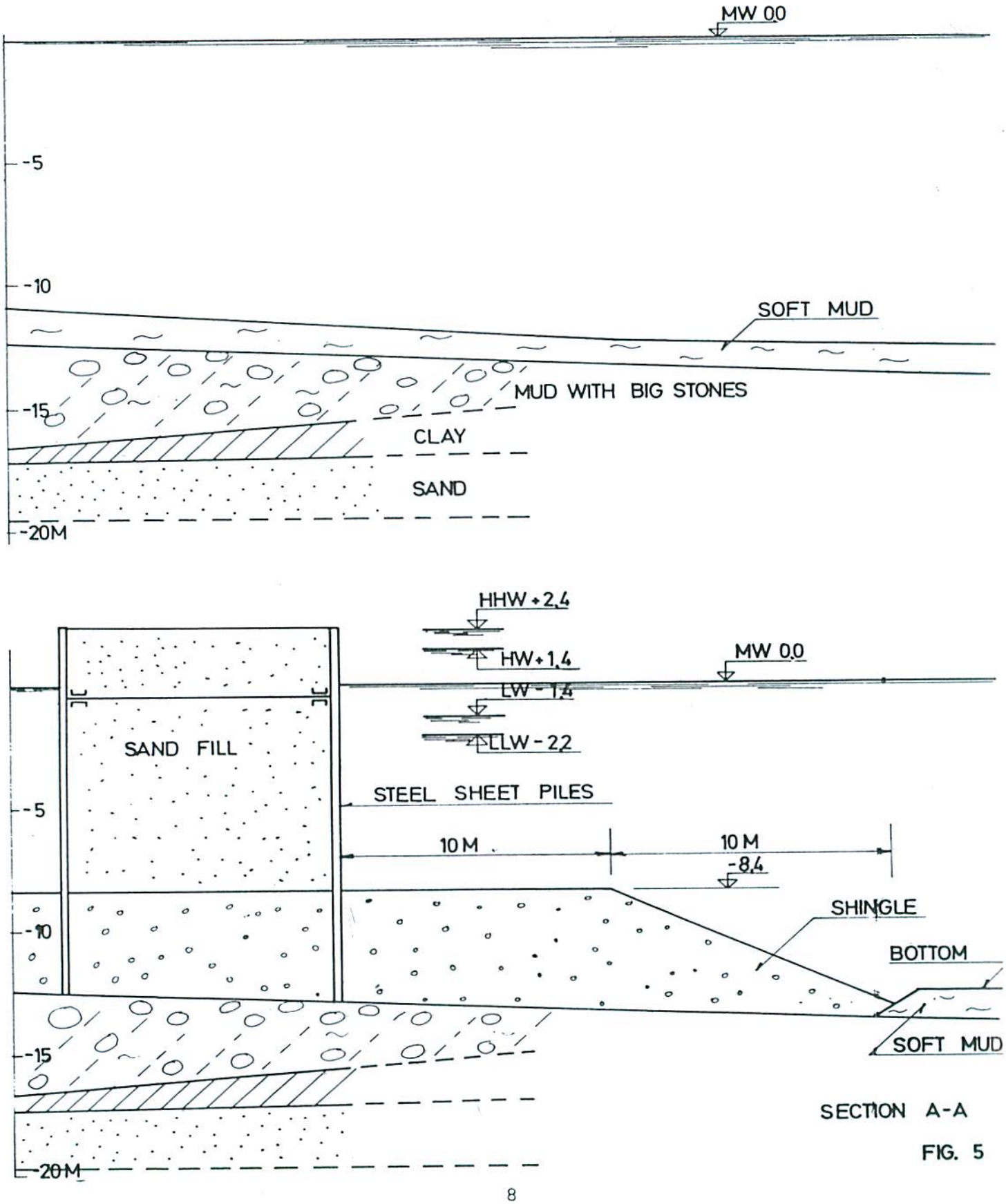
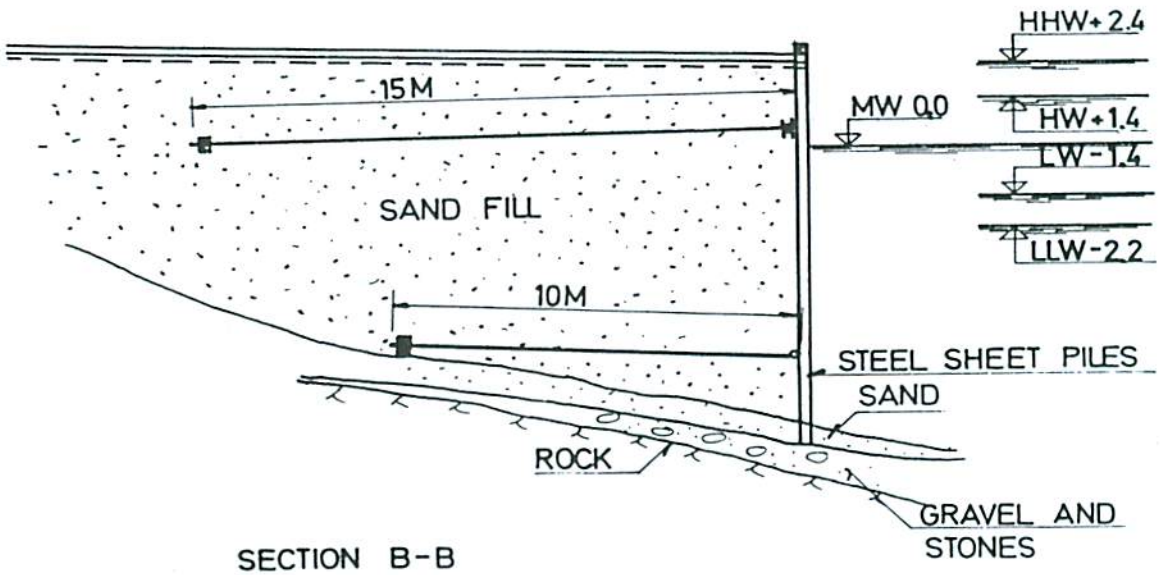


FIG. 4



SECTION A-A

FIG. 5



SECTION B-B

FIG. 6

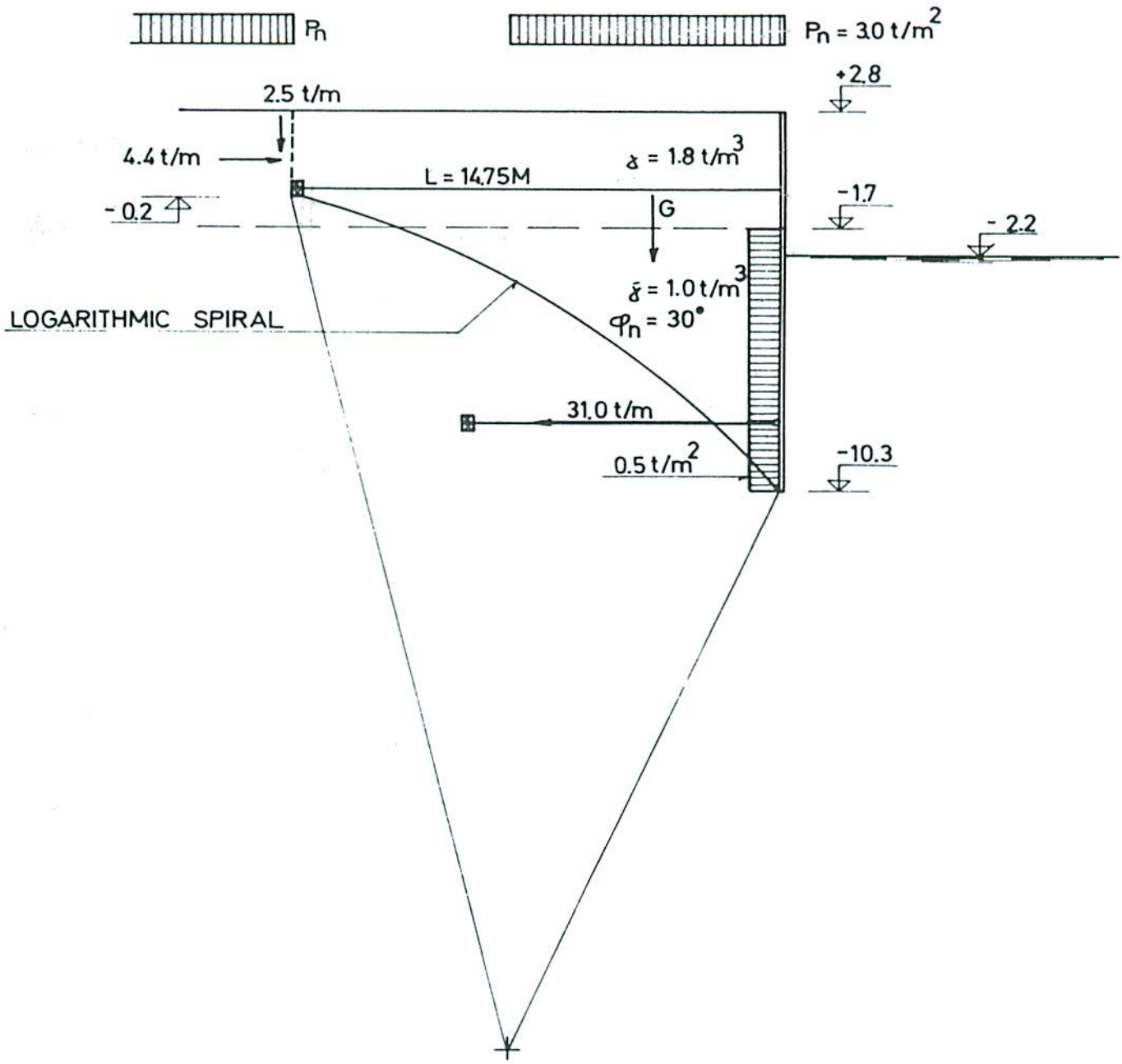

Ph
Ph = 3.0 t/m2
+2.8
2.5 t/m
4.4 t/m
γ = 1.8 t/m3
L = 14.75M
-1.7
- 0.2
G
- 2.2
γ = 1.0 t/m3
φn = 30°
LOGARITHMIC SPIRAL
31.0 t/m
0.5 t/m2
-10.3
MINIMUM STABILITY RATIO = 1.02

FIG. 7

DISCUSSION

Mr. C. P. Olsen, Dansk Geoteknik A/S, Copenhagen, Denmark:

My firm, Dansk Geoteknik A/S, has made the same economical investigations about constructions exposed to icebergs. We can agree with Mr. Hulgaard telling that a cell construction of steel sheet piles with sandfill is a very cheap solution as regards horizontal forces in nearly all horizontal levels.

A pillar or pile solution gives the demand of a concrete decking for vertical forces, which is very costly in addition to the piling.

As regards prices, the cost of a steel sheet piling with sandfill will be 50% higher than under normal Danish conditions, and for 8 m water depth the price should be nearly 1200 - 1500 Danish crowns for every running meter of construction. This price will be the contractors price at the site, but without expenses for administration and supervision.

Mr. E. Hulgaard, Hostrup-Schultz & Sørensen Consulting Engineers, Copenhagen, Denmark.

I think that generally the cheapest solution using steel sheet piles and sandfill is to use anchor bars placed above MW and if possible to drive the sheet piles in the bottom. If it is impossible I will use lower anchors.

A cell construction will normally be more expensive and only be used under special conditions (as for instance the southernmost corner in Julianehåb).

The prices mentioned by Mr. C. P. Olsen are reasonable for normally anchored steel sheet walls in Denmark. Cell construction will be more expensive.

In the actuel case in Julianehåb the total cost is about 6 million danish crowns. For the real wharf construction (including wall, anchors, sand fill, bollards etc. but excluding pavement, installations for electricity, water and oil and administrations) the total cost is about 3 million danish crowns. This is about 30.000 d.c. for every running m, or about 50% higher than normally in Greenland. The reason for the high price is especially the bad soil conditions.