PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
TECHNICAL UNIVERSITY OF NORWAY

P O R T O F T R O N D H E I M

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Chief Engineer	Port Authority	Norway

Introduction.

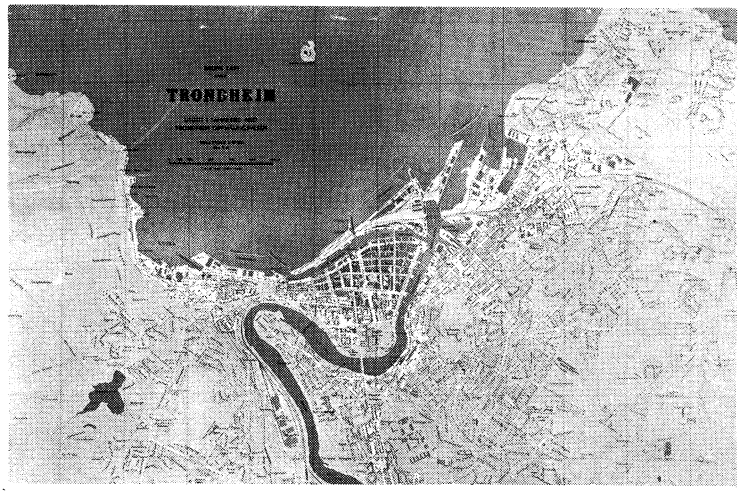
As a representative of the port authorities of the host city, I am pleased and honoured to welcome you to our city and our port - even if it is with some nervousness that I invite so many experts to a round trip in the port.

Here the incisive observer soon will find short comings and defects, but will also, I hope, find traces of the life and the particular atmosphere that inspire us, who are working in the harbour every day.

PORT OF TRONDHEIM 1971.

Quay length		ca.	7.470 m
Max. depth bel. zero		11 m =	35 '
Railway tracks		ca.	9.350 m
Harbour area		ca.	661.000 m²
Shed capacity		ca.	36.658 m²
Cranes:	2.5 - 6 tons	19	
	5 - 15 tons	1	
	30 tons	1	
Goods handled 1970			2.709.818.

Before the sight-seeing I have wished to give a brief information with some slides, particulary because the view of the port varies from season to season and according to the weather conditions, - and because our port is the product of a 1000 years old history, of which one should have a little knowledge to be able to look at it from the right angle.



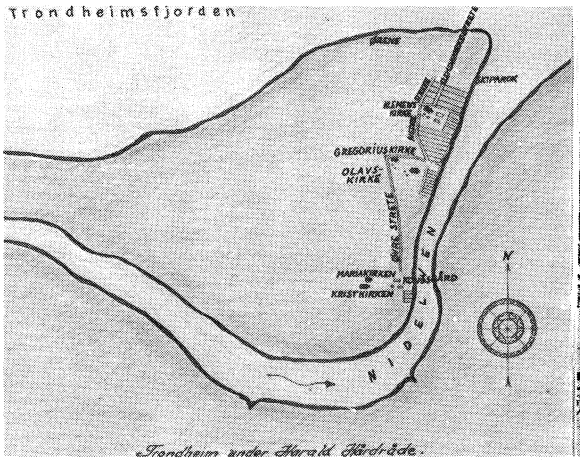
TRONDHEIM
1971

HISTORICAL ACCOUNT.

At the mouth of the river Nidelven, among sheltering frames of ridges, with fertile valleys in the neighbourhood, surrounded by farming land, according to Icelandic historians, we know that:

The first king of all Norway, Harald Hårfagre (Fair-hair), built his home with a royal palace at Lade, earlier than 900 A.D.
The founder of the town, king Olav Trygvason, was elected king at the Øreting assembly in 997.

It is not for no reason that his silhouette has a commanding position in the centre of the market place, where he, with his sword girdled on, is looking towards the fiord and the sea.

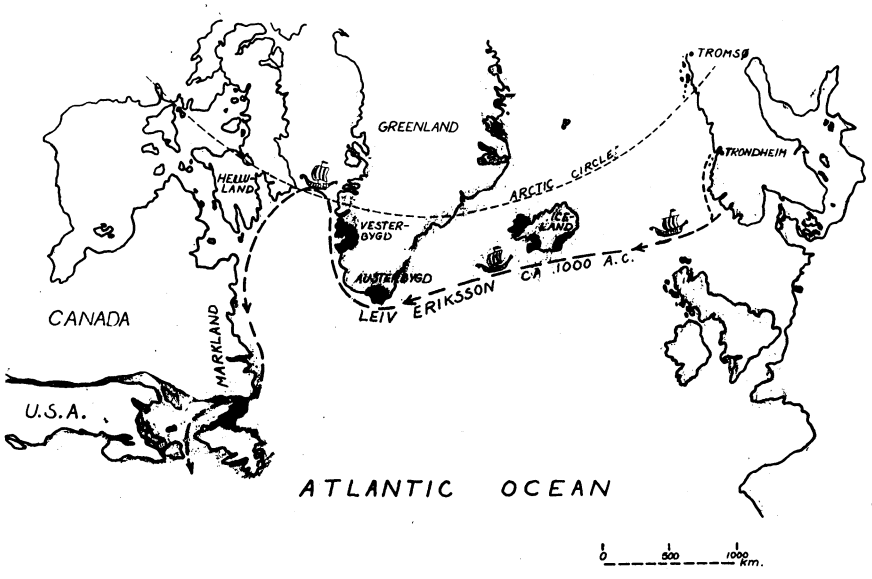


From the time of his reign the name Skipakrok (ship's corner) is mentioned many times, by this is meant the natural harbour at Brattøra where he had his battle-ships as well as the merchant ships. It is said that he once had 30 ships lying in harbour.
The saga describes the building of ships, among others, the work on the vessel "Tranen" on the sand point.

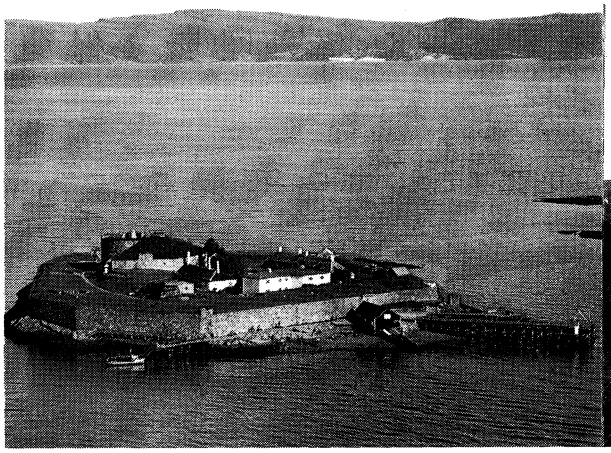
Of no ship in the history of Norway has there been told so many tales and sung so many ballads as of the battleship "Ormen Lange" built by the Ladehammeren, a little previous to the year 1000. It had 34 rooms (pair of oars), a golden dragon's head on the stem and tail on the stern. It was built of selected materials by experts, and when finished, manned with a crew consisting of the most daring heroes.

It was by the royal command of Olav Trygvason that the Icelander Leiv Erikson sailed from Trondheim in the year 1000 to christen Greenland, but driftet out to sea and landed in Vinland on the west coast of North America as the first European 500 years before Colombus.

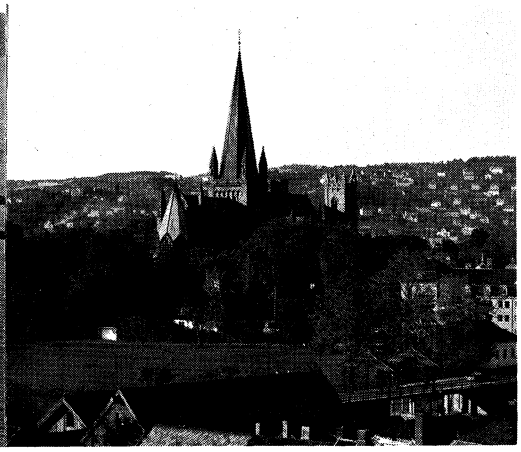
This is a picture of his route.



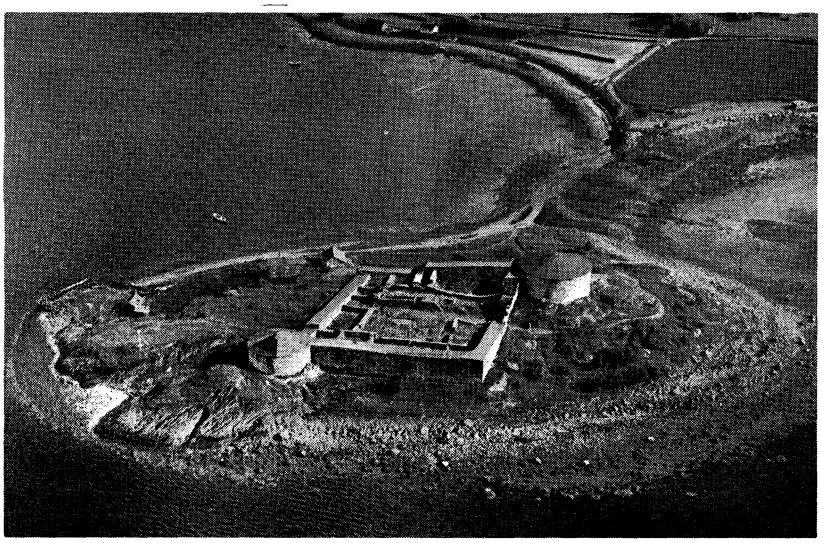
Up to 1250 Trondheim was the capital of Norway and the administrative centre of the Norwegian empire which included Iceland, the Orkneys, the Shetland isles and Greenland.
After the foundation of the archbishop see in Trondheim in 1152 the city was the religious centre of the Northern countries until the last archbishop fled the land in 1536.



The isle of MUNKHOLMEN, outside the port, early mentioned as an execution place, and prior to the year 1100 a Benedictine monastery was founded there.

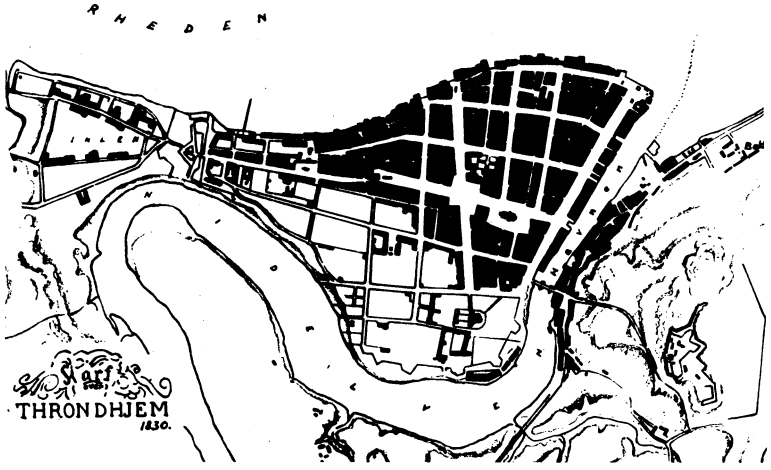


THE NIDAROS CATHEDRAL the relic of Norway.



The last place the bishop held, was the sea castle STEINVIKSHOLMEN about 50 miles nearer the head of the fiord.

During times of war and ravages by fire the city changed its character and was around 1700 more of a fortress.

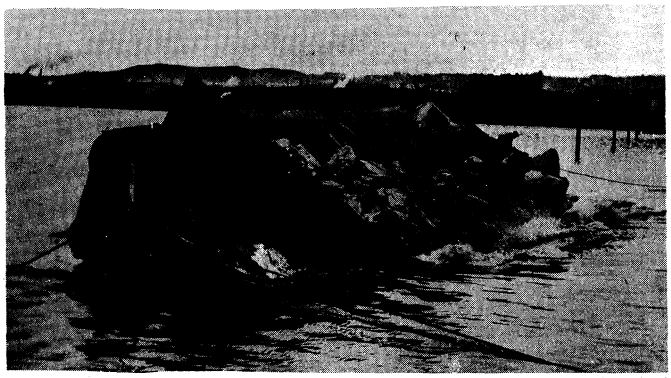


The port area about 1830.

At the end of the 19th century there are two factors that completely change the demands upon the harbour works in Trondheim.
The railway and the regular boats. The navigable mouth of the river became unsatisfactory as a berth, and outside the central town the fiord had shallow water and was exposed to bad weather.

This picture gives an impression of how a northern wind can rage in spite of the piers encircling the port. 1920 when the Finnish bark "Regina" was wrecked.

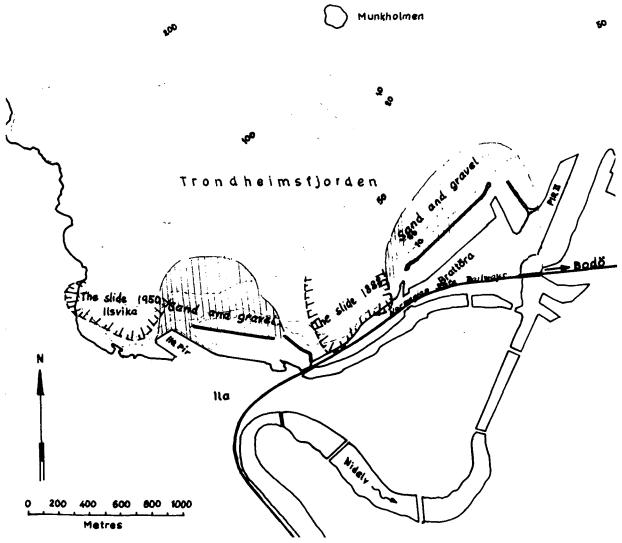
The building of breakwater has at all times been a question of vital importance to our port.



This picture from the building of Skansen breakwater in 1918. The stone load was tilted by filling water in a side hold of the barge. On the established jetty a platform of cut larger stones was laid afterwards. Trondheim port is protected by 2300 m stone breakwaters.

The tidal range averages about 2 m., but is observed between 3.3o m. above and 1.1o m. below Zero. Zero is equivalent to average low tide level.

In the course of this conference others have talked about soil conditions. I might only mention that accesible rock is found only in the west and east direction, the actual port area is situated in loose sediments more than 100 m. thick.



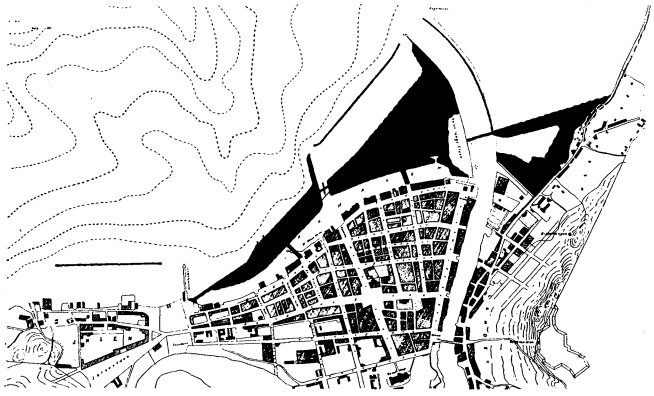
In historical time the port has been affected by large submarine slides both in 1888 and 1950. Fortunately it has been ascertained that 2 large deposits of gravel and sand in the west and middle area seem to give satisfactory security.

Ice is no great problem in our port. The Gulf Stream is warming the fiord, and the salt contents are about 2.5 %.

It is true that the Inner Canal Dock now and then may have a thin crust of ice, but the ice factor has only to be regarded during thaw time in the last winter months for that particular dock and also for the river mouth.

As for the traffic in the harbour, snow on land, in the streets and on the railroads may now and then cause great difficulties, but this differs from year to year. For my own part I remember 1958 when every activity for some weeks was drowned in snow. At the same time Swedish transit trains were rolling in as neither before nor since, because the Gulf of Bothnia was frozen.

In 1864 the first railway was opened in Trondheim, connecting the city with Oslo. Shortly afterwards a motion about building a railway between Norway and Sweden via Storlien was adopted.
This led to the first plan of railroad and harbour works in Trondheim, dated on Christmas Eve 1874, and presented by the city - and harbour engineer at that time, Mr. Dahl.

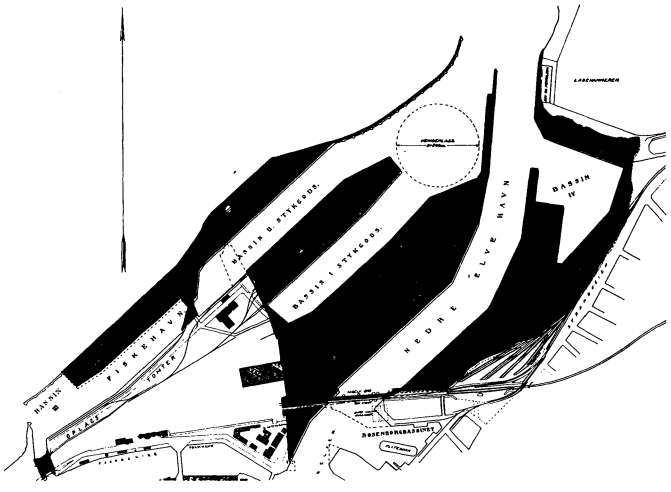


Havneplan av 1874.

The piers and the areas of the railway region were important components of that plan.
The Inner Canal Dock was excavated giving place to smaller vessels. The river bed was maintained and joined together with Outer port berth for larger ships.

The traffic from Sweden never came up to expectations, but other shipping increased, so the port was congested before the turn of the century.

Subsequent to an international railway and port planning competition a new plan was adopted in 1912, which was to be carried through in co-operation with the government.

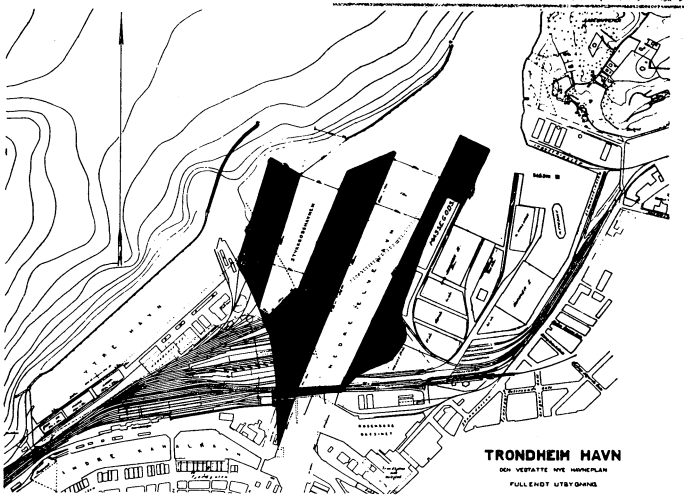


Havneplan av 1912.

The most important was to alter the lower course of the river so that it would form a curve against the east in order to get room for 3 piers on the west side.

<u>The railway bridge then had to be removed.</u>
The first World-war with financial depression stopped this plan.

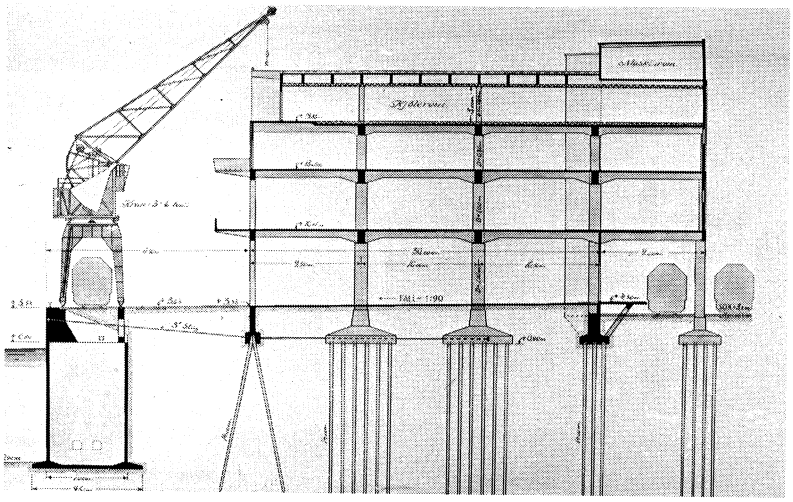
HARBOUR WORKS AFTER 1945.



Havneplanen 1945.

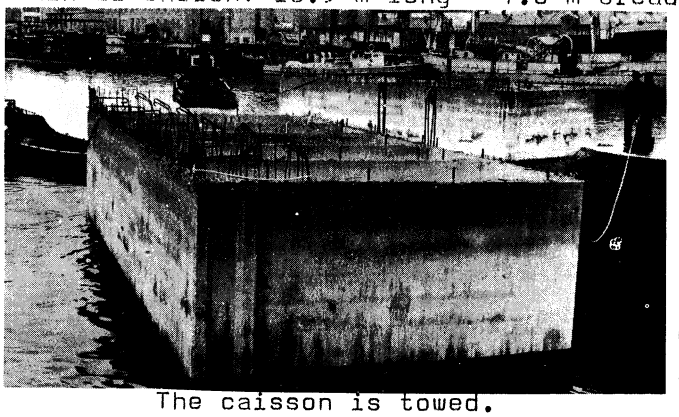
This pictures shows the plan of the station and the port of 1945 which we have largely followed during the years after the last war.
Most predominant is the straight direction of the river and the lay-out of 2 new piers at the west side.

The German submarine bunkers made it possible to "manufacture" caissons of reinforced concrete.



The quays here in town are since 1945 mostly built after a building block system which is apparent from this cross-cut of Pier II.

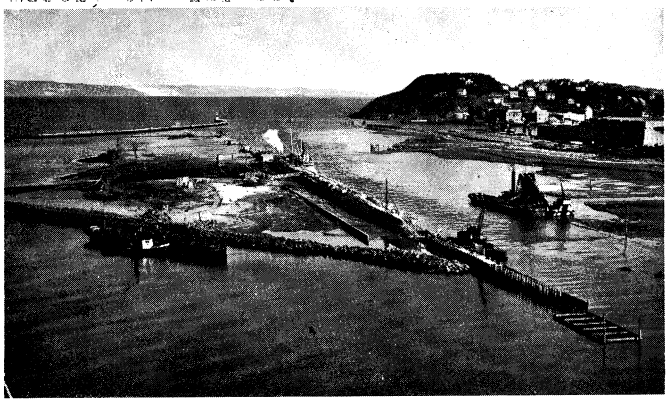
76 caissons with varying heights and bed-plates were in the course of a couple of years poured in moving forms.
Main dimension: 16.5 m long - 7.o m breadth. Height: 7.o - 11.o m.



The caisson is towed.

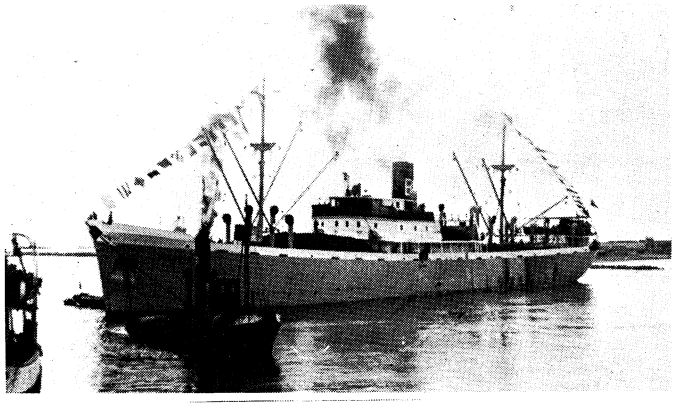
The caissons were filled with water and sunk to a bottom ground, planed and smoothed, then they were filled with sand, and the spacings between them were cast so that they formed a connected quay body.

At first the work on Ila pier was done, where 70 dekar - (70.000 square meters) sea area were won during the years from 46 - 49. The main interest, however, was always centred about the central port outside Nidelven. Between 1948 and 1952, 900.000 m^3 of earth masses were dredged and mainly used as earth fill on new areas, mostly on Pier II.

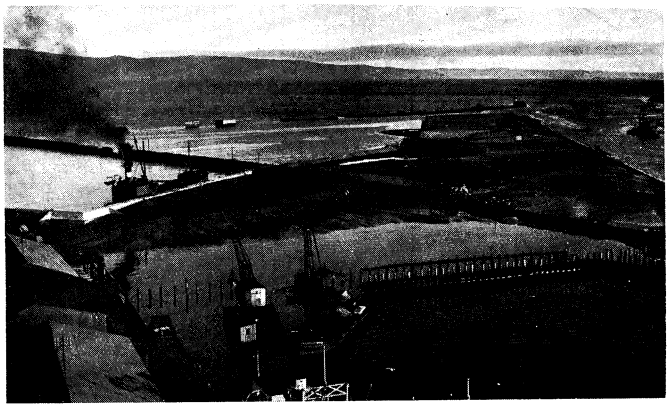


This picture shows the dredging, - bucket chain - and aspirating dredger, our own production. A contracting firm was also hired.

Nedre elvehavn 19. mars 1952.



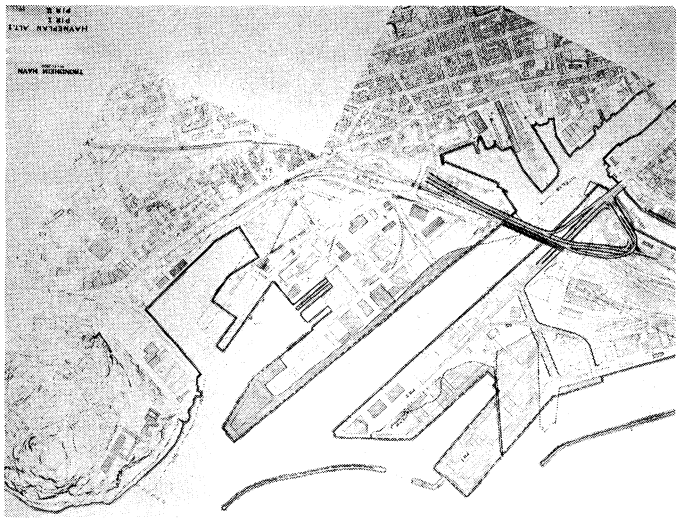
The last ship passed the old river bed 26th June 1952 and the first ship through the new river bed 30th June 1952.



Pir II — 22. oktober 1952.

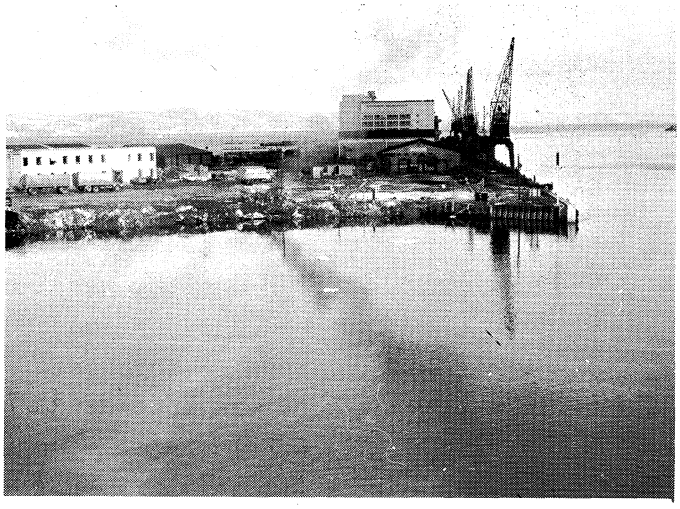
The old bed blocked, the caisson filled and the concrete wall finished.
Injection proceeding.
Unfortunately the co-operation concerning the new bridge across Nidelven did not work as planned. The Port of Trondheim Authorities therefore were compelled to arrange for a temporary blocking between the Brattøra and the Pier II. It took 18 years before the Norwegian Railways in 1970 began to work on Nidelven railway bridge so that this block could be removed.

This picture shows the works now in process or forthcoming:



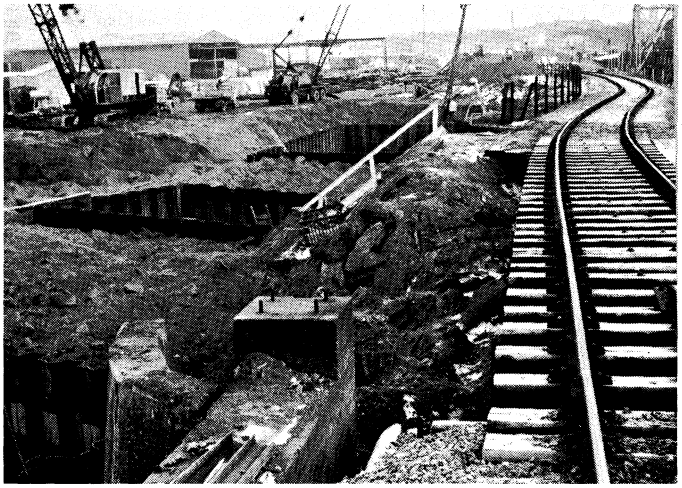
A contractor has finished pouring concrete and is at work with the founding of the bridge a little below the present. As soon as the railway traffic can be transferred, the old bridge will be taken down to give room to a street bridge, - temporarly with 2 lanes, but will when finished, have 4.

The railway bridge is built by the Norwegian Railways, - the street bridge by the Road Administration. The present gateway to the port will be removed. The level of the street in the subway crossing will at high tide be under sea level and is going to be waterproof cast with artificial drainage and pump.

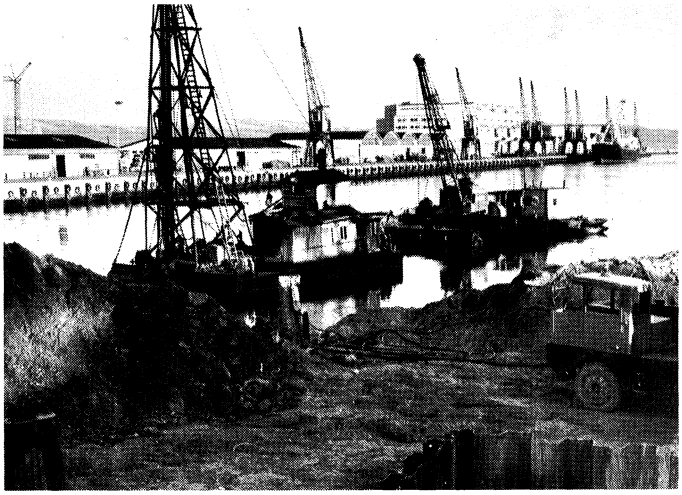


In the autumn 1972 the railway bridge, the street leading to the port and the channel will be finished. Then a rearrangement will take place and the extension of the pier south-wards fullfilled.

About 50.000 cubic meters are filled with earth fill from excavating works in the city, and about 90.000 cubic meters are supplied through dredging elsewhere.

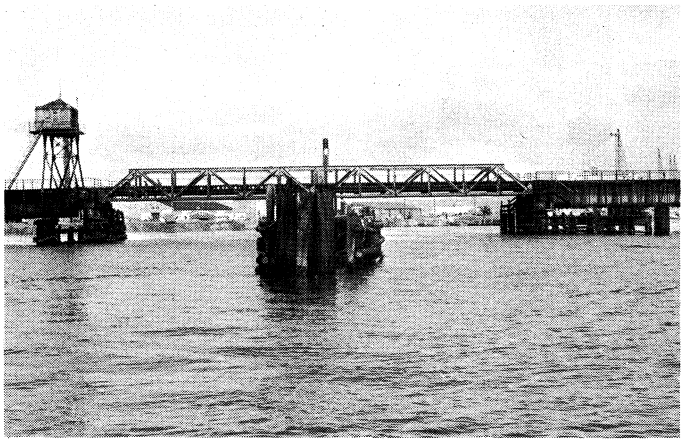


The railway bridge in January 1971.



The situation February 1971. Dredging for the new channel is carried through as far as this is possible without disturbing the building works, not in the least it is necessary to regard the soil conditions.

The present bridge has a swinging width with 2 channels, each of 15 m. The new one will have a bascule span of 24 m.



In the meantime we have some problems in carrying out the traffic smoothly on sea and land. A ship yard offers most difficulties. For instance when the new ship M/S "Bolt", - 15.38 m wide, included fenderborders, - left the yard from the slipway above the bridge point. At high tide the distance between the timbers was sufficient for shifting, even if the official width is only 15.oo m.

WORK AT PIER II.

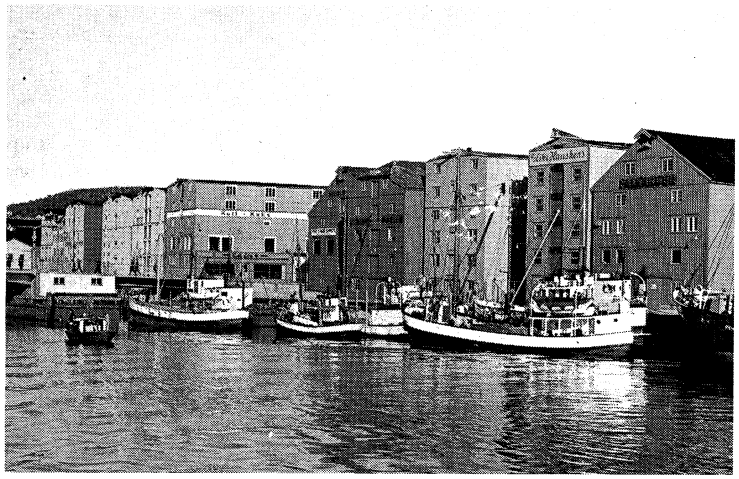
The Port Authorities have taken down a number of old quays and bulwarks. The wood materials that were released - impregnated with creosote and perfectly fresh after 30 - 40 years - we have used for the extension of the Pier II.

During the year 1970 and 1971 the last free caisson was taken from earlier production and wood piles were driven 20 m. inside the final quay line against west. Here present deliveries from excavating works in the city and its surroundings are received, and the land is increased in a cheap way.

STARTING WORKS ON PIER I.

The first loads from barges are already dumped on the future Pier I, outside to the existing Pier II. This will be our main task in the seventies, particulary because the traffic in the port of Trondheim demands larger land areas.

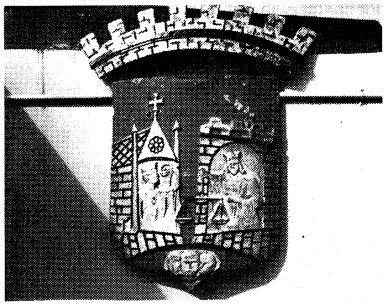
In addition to these long-range works a number of minor, separate works have been fulfilled during the last 3 decades. Locally the establishing of a crossfiord connection in 1955 has been of the greatest consequence. The Port Authorities built Skansen ferry harbour and the Road Administration the corresponding one on the other side of the fiord.
To-day 5 ferries are crossing and a sixth one is ordered.



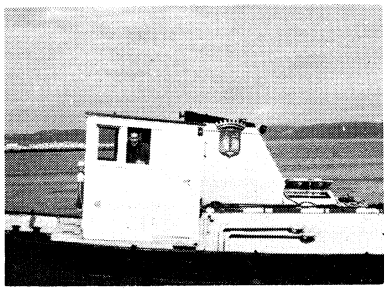
Even if this has substituted many of the local sailings, the Inner Canal Port is constantly occupied by fishing ships and freighters.

Conclusion.

At last I can't keep myself from showing you a picture of the city emblem of Trondheim. This emblem, inspired by the Nidaros Cathedral, you will find on the municipal buildings, lorries and vans, on bridge rails and gifts presented by the City Board.



This old emblem shows the leader of the people reigning humbly - (with one hand upon his heart, and with the other weighing the arguments) - and considering his function regarding the advices of the clergyman.



As a symbol I show you one of the port tugs bearing the same emblem.

It's to be hoped that apparently difficulties and resistance will be overcome and lead to happy results, - to-day as on the day when Leif Frikson on royal command and true to God left in order to christen Greenland,- when power and spirit are working together. This is the motto of the city and the port, - to-day as in the past.