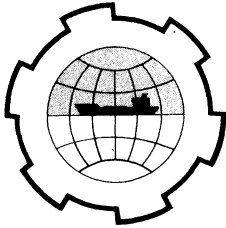


PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
TECHNICAL UNIVERSITY OF NORWAY



EXPERIENCES FROM ENGINEERING WORKS IN
THE PORT OF DRAMMEN

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The Port of Drammen is situated about 50 nautical miles from the strait of Skagerak, at the bottom end of the Drammensfjord, just 25 miles along the highway from Oslo.

In looking for a major port in Norway with icy and Arctic conditions, one probably could not find a more typical and representative place than the Port of Drammen. Every year for a period of about 3-4 months the Drammensfjord is frozen from the Svelvik-stream and about 12 nautical miles into the heart of the port.

Even though the thickness of the ice in the fjord normally reaches 3-4 feet, this part of the Arctic conditions represents hardly any difficulties for the navigation up to the Port of Drammen. Taking the consequences of the port's frozen state, the port authorities already in the 1890's bought a couple of ice-breakers and have ever since invested in the most efficient ice-breaker equipment to be able to handle the ice problem and keep the entrance to the port open with so to speak, pre-cut lanes.

Icebreaking in the fjord and harbor-basin.

The icebreaking in the Drammensfjord is a very interesting chapter in the history of the Port of Drammen, going back to the times before the icebreaker era when hundreds of men every spring used hand-saws to cut a lane in the ice all the 12 nautical miles from Drammen to Svelvik to reach open sea as early in the year as possible. Costly as the modern icebreaking might be, we are today not really considering the icebreaking as a serious technical

problem, having the icebreaker "THOR III" doing an excellent job cutting lanes, and this paper will rather deal with the problems concerning engineering works in - if not Arctic - at least winterly conditions in a typical port of Eastern Norway.

Dredging and construction-work in the wintertime.

The low temperatures creating problems for many sides of running the engineering works in the port, may last from October to April, the months of December, January and February showing chilling 20 - 25 degrees Centigrades below freezing and measuring up to 3-4 feet of snow.

We should not leave the icy water before looking at the nuisance the ice creates for the port's dredgingprogram. A very good example of these problems was the port's dredging work last season. The port planned to dredge about 250.000 cubic meters from the harbor-basin, using the sand in reclaiming of new land for placing containers.

Because of heavy ice in the basin and low temperatures, the dredging had to be stopped by mid-December, postponing the dredging of the last 100.000 cubic meters to April this year. The break was due mainly to icing in the pipelines of the suction dredger, freezing of the machinery and hopeless maneuvering conditions for the dredge-barges.

I could add another example of having the wintertime splitting the timetable for a construction job in the port. An estimated 10 million NK extensionjob planned ready for use in 1972 forced the contractors to put in the bid as follows:

"The job is expected to take 12 months. However, due to the well-known severe winterconditions in Drammen the dredging part of the job can not be done during the three wintermonths, and we will suggest the following timetable:

1. Either start the job in September 1971 and finish the job late in 1972.

2. Or start the job in April 1972, finishing it by June 1973".

As it looks today, it will not be possible to start the construction-works early enough to get the extension ready for use in 1972.

The situation might be the case sooner or later every year and the important point is that being forced to stop the dredging 2-3 weeks earlier than planned, might postpone the conclusion of the works 3-4 months and give headache to everybody trying to fulfill the contracts and timelimits.

Snow- and iceclearing of the quay-areas.

Moving up to the quayareas we find that the wintertime is not only hampering the construction works, but also causing difficulties for the travelling traffic as the snow is pouring down covering the quayfront and storage-areas time and again, day after day.

One certainly doesn't need to point out that these are problems known to every port under Arctic conditions. The question of interest is rather what has been done to solve these problems in order to keep the traffic moving and the construction works going, and next, could future research give us better solutions.

Looking first at the construction works. Claims for steady extensions of the port has in recent years forced the engineering department to revise its old custom of season-works to meet the requirements from the customers and shipowners for a short construction time in order for them to get established as soon as possible.

It certainly is known to everybody that pouring concrete in cold weather gives no problem today using heated mixtures and covered forms. However, when the thermometer drops to - 25 degrees Centigrades and lower, and we are, as last winter, forced to do some immediate repairworks on the crane-rails; extraordinary precautions have to be taken. The most common method when doing construction-work in the wintertime is to use hothouses or tents, heated by airblowing units. This method has also been used when pouring concrete for slabs, foundations for railways and cranerails. Even

when asphaltting extended areas at extreme low temperatures, heating has been necessary not only to give comfortable working conditions on the site, but also for heating up the frozen soil reaching down to frostfree depths 6-7 feet below, to prevent the soil from settling and the paved surface from cracking as soon as spring arrives.

However, although methods are available to keep the construction works going even under extreme winterconditions, one normally will try to avoid this due to increased cost compared to doing the same work in the summertime. And, as a necessity to keep the cargo-handling and traffic going, the manpower is kept busy the whole winter in determined efforts to get rid of the snow and ice covering the waterfront and its installations.

Hence, the topic of snow- and iceclearing of the quay-surfaces is really taking too much of the yearly budget, the expences giving no productive work.

The different ports may use their own system for the snowclearing, but common for all of them is that the snow has to be cleared away fast.

The policy of the engineering department in the Port of Drammen has been to use their own top-trained manpower using the most developed and modern snowclearingmachines - and equipment on the market. The recent requirements for large open areas for placing containers, unitloads and cars, also requires the areas continually cleared giving forklifts and the moving equipment a smooth surface for the travelling traffic.

Several times during a winterseason it might be necessary to clear more than two feet of snow away from the port's open areas, about 125.000 square meters, amounting to about 75.000 cubic meters of snow at a time to be pushed into the harbor basin.

From experiences often learnt the hard way, several mechanical devices and means for precautions have been developed by the port itself. For instance will all the quay-areas after being cleared from snow, be brushed down to the bare concrete or asphalted surface by rotating steelbrooms, again not to hinder the movements of the mobile cargo-handling equipment.

One of the main transportation systems for cargo to and from the ports is in most ports by freight cars on railroads. To give a flush quay-surface, the rails have to be enclosed in the pavement and in the summertime the several miles of enclosed rails cause no problems. However, as the temperature drops and snow starts falling, the rails tend to get clogged with ice and hardpacked snow, many times forcing the freight cars and even the locomotive off the tracks. Different means are now used at different temperatures. If the ice is not too hard, we will use a mechanical track-cleaner, but if the temperatures sink below - 10 to - 15 degrees Centigrades, other means have to be used. Just a few years ago, this was quite a problem and the only thing left was to clear the rails manually, as even salt (NaCl) didn't do much good at temperatures below - 8 degrees Centigrades. However, with the introducing in 1967 of using Calcium Chloride which in a few minutes melts the hardest ice at temperatures down to about - 40 degrees Centigrades, the iceclearing of rails has since been no problem at all.

Pre-laid precautions.

In recent years the port has also more and more taken in use electrical heating wires in all new constructions. Although for the time being on a more experimental basis, these wires already have proved most successful. The electrical heating wires have been used in the railroadswitches and in the cranerailtracks. The secondary external drainagesystem from the warehouses and from the quay-surfaces used to have a tendency of freezing. By installing electrical heating wires in the drainagesystem we now have the drains working on an all-year basis.

Last winter the Port of Drammen constructed a new roll-on/roll-off ramp using electrical heating wires in the concreted ramp. The old non-heated ramps require much snow - and ice maintenance, not allowing them to have slippery slopes. The new heated ramp is a good example of managing a bare, summerly pavement under Arctic conditions.

Other devices for clearing the ice from the waterfront are in use in Drammen as well as in other ports in Norway. These devices are mostly producing circulation of the water from deeper layer up to the watersurface to melt the ice. In the Port of Drammen, having

its own icebreaker, this is not, however, looked upon as a major problem.

Future solutions.

Not even the most modern and efficient means of clearing the snow and ice in a port under Arctic cover, can overcome the fact that the Arctic conditions are creating costly maintenance problems for these ports. The ports are therefore continually looking for better methods to avoid the handicaps of being located at places being stamped as under Arctic conditions.

A technical possible solution today is to put sheds or cover over the whole port-area. But this is hardly any possible economical solution. But, may-be the future will give us a port-area protected by a thermal roof or a radiation-layer, high enough to let ships pass into the port. Maybe the whole port should be moved into large heated halls into the mountainside along the fjord-shoreline as already done with some of the naval bases around the world.

These solutions are, however, far ahead, and in the meantime the port authorities will be looking for improved means to handle the problems created by the Arctic conditions.

One interesting experiment was the successful ice dusting to increase the absorption of solar radiation at Fairbanks, Alaska, in 1966 to reduce the danger of ice jamming at the confluence of the China and Tanana Rivers.

Another most interesting experiment by an international group of architects and engineers is the plan of building an Arctic-city with artificial climate. The whole city is placed under a roof of skylight skin of reinforced polyesters, covering an area of 3 square kilometers at a height of 240 m above the ground. The energy will be powered from an atomic plant, the cooling-water keeping the harbor-basin free of ice.

As a whole, the thermal and radiative means may just be the immediate answer to improved and cheaper methods of handling snow and ice composing the two major items creating Arctic conditions.

From a practical point of view, the engineers in a port will be looking forward to see the research on this topic one day be put into practical use, giving the ports under Arctic conditions a warm hand in many respects. It will therefore be of great importance that the economical gap between research and practical engineering can be closed, giving the ports working under Arctic conditions better possibilities to be run in a tempered way.