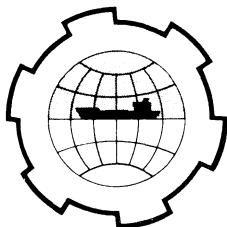


PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS  
TECHNICAL UNIVERSITY OF NORWAY



REVIEW OF WORKS BY THE NORWEGIAN BOARD  
OF MARITIME WORKS IN NORTHERN NORWAY

Sverre Kjelstrup  
District Engineer

Board of  
Maritime Works  
Northern District

Tromsø  
Norway

The Board of Maritime Works has divided the Norwegian coast into 5 harbour districts, and this abstract will explain some of the activities in the northernmost of these districts. The fifth harbour district comprises the coast from the southern tip of Senja to the Soviet border, and our primary task in this area is to establish or enlarge fishing ports, deepen approach channels and supervise all waterworks built in the fishing villages, both technically and economically. There are also some other activities which are our responsibility.

Our conference concerns harbour engineering under arctic conditions, but in spite of the fact that our work is done in such northern latitudes and we should therefore experience great problems, ice and hindrances due to ice are almost non-existent in the ports of the 5th district. The only places ice occurs and causes some problems for shipping are the ports in the Varangerfiord. Some ice floes also drift from the head of the fiords where large amounts of fresh-water is discharged from the rivers.

On the other hand we are up against severe climatic problems during the winter months. From the beginning of October and well into the month of May, the weather is often unstable and storms coming from an unfavourable direction can cause severe wave action on our breakwaters. They must therefore be of a very heavy design if their position is exposed, and due to risk of damage during the construction period and simply because it is too cold and miserable, these constructions can only be carried out during the summer. Since it is necessary that our employees are given work during the whole

year, there is a constant interchange between summer construction work on the coast and winter construction in the fiords, where conditions for building breakwaters during the dark season are favourable.

Our largest construction and the one which has given us most problems is the protection of Berlevåg fishing port. Work here has been going on for a long time, commencing at the start of the century, and the first task was to protect the inner harbour, Vågen. In the beginning of the 1920's, protection work was begun on the outer harbour when construction of the Svartoksen breakwater on the western side of the port was initiated. A railway of about 5 km was laid from a stone quarry on the opposite side of the fishing village and work commenced.

Due to small yearly appropriations and difficult working conditions, progress was not rapid, and the problems encountered when constructing a harbour in such an exposed place was soon felt. The Svartoksen breakwater was seriously damaged in 1932 and 1959 by storms, and the entire superstructure at the extreme end was destroyed down to low water level. After the first storm damage, the breakwater was rebuilt with a more solid profile and the outside was partly covered by natural stone and partly by cubic 15 ton concrete blocks. During the war all tools and equipment belonging to the construction works were completely destroyed and it took some years to get it in order so the work could be continued. After the storm damage in 1959 however, it was decided to rebuild the outer part of the Svartoksen breakwater using a heavier design developed by model tests in Grenoble, and the outer slope was then covered by 15 ton tetrapods; 25 ton tetrapods covering the head. These works were completed in 1964, and because a wave recorder was installed in the sea outside the breakwater, it has been possible to observe the wave action the breakwater has been able to withstand since then. Observed wave heights of about 10 m have not caused damage to the Svartoksen breakwater. Since 1965 intensive work has been done on the eastern side of Berlevåg harbour with the construction of a breakwater using approximately the same design as on the western side. The railway operation has been discontinued and placing of rocks is done by large dump trucks and heavy baggers.

Further east we also have a large project at Vardö, this is a large new fishing port being built on the mainland side of the Busse sound

which divides the Vardö island from the Varanger penninsula. It is a project which economically compares to Berlevåg, but the conditions are easier since the breakwaters are in shallower water and are not as exposed. The Vardö breakwaters are covered by natural stone blocks, but it has been impossible to find them in the surroundings of the harbour. They were first brought from Bugøynes on the southern side of the Varanger fiord and transported in barges towed 43 nautical miles across an open stretch of sea. This made the blocks very expensive and when a workable stone quarry 50 km away on the northern side of the Varanger fiord was discovered, this was used and the blocks now come from this place (Skallelv). They are transported by semi-trailers along the road to the new port of Vardö in the Svartnes bay. Local material is available for the construction of the core, but it is of poor quality and settling problems have been experienced. The entire coastline from the North Cape and east to the Varanger penninsula is very open and exposed, and what makes harbour construction so difficult is due to the fact that quarries with good quality stone are seldom found as the rock ground mainly consists of eocambric sedimentary rock, and the usable stones must come from ledges and benches of hard rock.

