Journal of Coastal Research	SI 39	424 - 427	ICS 2004 (Proceedings)	Brazil	ISSN 0749-0208

Sedimentation in Babolsar and Pozm Fishery Ports in Iran

N. H. Zaker† and A. Etemad-Shahidi‡

†Faculty of Environment
University of Tehran
Tehran, Iran
nhzaker@chamran.ut.ac.ir

‡ Department of Civil Engineering
Iran University of Science and Technology
Tehran, Iran
etemad@iust.ac.ir

ABSTRACT

ZAKER, N.H. and ETEMAD-SHAHIDI, A., 2006. Sedimentation in Babolsar and Pozm Fishery Ports in Iran. Journal of Coastal Research, SI 39 (Proceedings of the 8th International Coastal Symposium), 424 - 427. Itajaí, SC, Brazil, ISSN 0749-0208.

Since 1980 the development of fishery ports along the Iranian coastlines in the Persian Gulf, Oman Sea and the Caspian Sea has been a high priority in Iran. The Iranian government has invested extensively in construction of fishery ports to help local communities near the coast and boost the fishing industry. In addition, capacity building in coastal engineering, design and construction of marine structures has been supported. Several fishing ports along the Iranian coastline were constructed and significantly helped the economic growth of the coastal areas. A few of the new constructed ports, mainly due to the deficiencies in design considerations, faced severe problems due to considerable sedimentation in the entrance and inside of the basin. This paper discusses the sedimentation in the Babolsar Port on the Caspian Sea and Pozm Port on the Oman Sea. The process and causes of severe sedimentation are discussed, the studies conducted on sedimentation are explained and the methods selected and executed to control the sedimentation are presented.

ADDITIONAL INDEX WORDS: *Caspian sea, Babolrood River, Oman Sea, sediment transport, breakwater, quay.*

INTRODUCTION

The expansion of fishing ports along the Iranian coasts in the Caspian Sea, the Oman Sea and the Persian Gulf has been among the priorities of Iran in the past 23 years. This has resulted in the construction of several fishing ports, but, a few of them faced severe problems due to considerable sedimentation in their basins and entrances. They include Babolsar Port on the Caspian and Pozm Port on the Sea of Oman.

Babolsar Port is situated on the southern coast of the Caspian Sea, at the mouth of Babolrood River, at latitude 36°, 42', 29" N and longitude 52°, 38', 58" E (Figure 1). The port is sheltered by two rubble-mound breakwaters with lengths of 1100 m and 150 m respectively. The breakwaters protect the port against the dominant waves from the west and the northwest directions. Babolrood River washes considerable amounts of sediment into the sea during the rainy season between October and May. The Caspian Sea as the world's largest inland body of water does not experience any tidal activity. However, the sea level undergoes slight seasonal and annual fluctuations. The port is constructed to accommodate fishing vessels specializing in kilka fishery.

Following the completion of the breakwaters in 1996, a high rate of sedimentation began within the port's basin. The pace of sedimentation proved to be much faster than was projected, thus the construction of the quays was halted, pending further studies to devise methods for controlling the high rate of sedimentation. These were conducted on the basis of numerical modeling using Mike21 (DHI, 2000; DEIGAARD *et al*., 1996) and comparative investigation of the port's bed topography at various junctures.

Pozm Port is located on the northern coast of the Oman Sea, at latitude 25°, 21', 27" N and longitude 60°, 17', 30' E (Figure 2a). The coastal region's morphology is characterized by a series of bays including the Bay of Pozm. The Pozm Port is situated on the eastern headland of the Bay of Pozm, and is protected by a 450-meter rubble-mound breakwater. The north-south breakwater extends approximately along the coast of the Sea of Oman adjacent to the Bay (Figure 2a). The 160-meter quay of the port is inline with the breakwater and starts at 50 meters from its head (Figure 2b). An access road along the eastern coast of the Bay and then over the breakwater connects the quay to the land (Figure 2b). The port's single breakwater protects it against the waves from the southwesterly, southerly and southeasterly directions. The region is affected by monsoon waves that approach the bay from a southwesterly direction and last from late May to October. Pozm Port was constructed with a view to the development of the region's fishing industry and became operational in 1991. However, the heavy sedimentation around the head of the breakwater adjacent to the quay forced the closure of the quay after 2 years.

The present article will discuss the factors responsible for the heavy sedimentation at Babolsar and Pozm fishery ports, the methods of analysis of the problem, and the recommended control mechanisms and their implementation.

METHODS AND RESULTS

Figure 1 represents the bathymetric configuration at Babolsar Port in 1999, three years after construction of the port's breakwaters. A comparison between the bed topography in 1999 with that before construction indicates that the average depth of the port's basin has decreased from 3 m to 1 m. This has been caused by 300,000 cubic meters of sediment accumulated in the port basin, a yearly average of 100,000 cubic meters. The heaviest deposition occurred in the southwestern part of the basin, and the slightest adjacent to the eastern breakwater where the river flows towards the sea. A comparison between the sediment samples from inside the basin and those collected from the surf zone adjacent and outside the port indicated that the sediment accumulated in the basin was transported by the river.

The studies indicated that the heavy sedimentation in the port's basin was due to the layout of the breakwaters at the mouth of the river. The flow of the river into the port's basin results in a significant reduction of the flow speed which, in turn, leads to the considerable sedimentation of the suspended load carried by the river. Therefore, it was decided to consider the methods to separate the river in its way to the sea from the port's basin. Numerical studies using Mike21 module of ST (DHI, 2000; DEIGAARD *et al.,* 1986) were carried out with various lengths of a separating wall extending along the western side of the river and parallel to the eastern breakwater (Figure 1). The results under different river flow and wave conditions pointed to the fact that the termination of the separating wall at any point inside the basin would result in deposition of sediments at the terminus of the wall, and that the only viable solution was to extend the separating wall up to the head of the main breakwater.

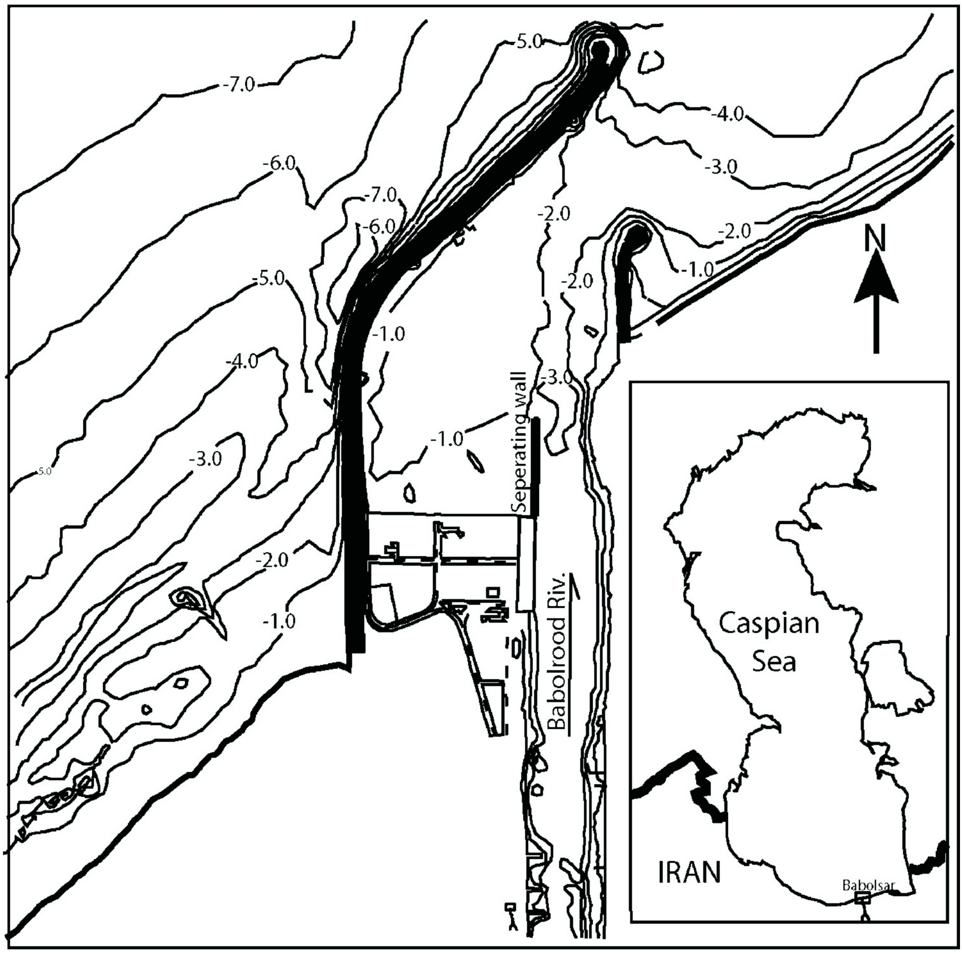

Figure 1. Bathymetric configuration at the location of Port Babolsar in 1999.

The bed topography at the Pozm Port before the start of the Port construction (1989) is shown in Figure 2b. In low water depth adjacent to the breakwater ranged between -3 to -4 meter and the basin had an average depth of more than 2 m. The bathymetric configuration at Pozm Port in 2000, ten years after the construction of breakwater, is shown in Figure 2c. The difference in bed topography in 2000 and that of 1989, before construction, is presented in Figure 2d. The figures show considerable sand deposition around the breakwater. Landward of the breakwater, sedimentation has formed a triangle, with the vertex adjacent to the initial point of the breakwater and the base extending eastward from the head of the breakwater (Figure 2d). Deposition of 3 to 5 meters sand has created a permanent dry area around the head of the breakwater. The dry area next to the breakwater's head extends 220 m eastward in the low water (Figure 2c). Figures 2c and 2d also show considerable sand deposition seaward side of the breakwater. The results indicate that in the period of 1991 to 2000 some 395,000 cubic meters of sediment have accumulated in the landward side of the breakwater. An additional 124,415 cubic meters of sand have also gathered on the seaward side of the breakwater. However, sedimentation was confined to the immediate adjacent areas of the breakwater. Landward of the breakwater no sign of sand deposition was found after the area of sand accumulation around the breakwater. Seaward side of the breakwater deposition was limited to the area with the depth less than -5 m (MLW).

A comparison of bed topography around the breakwater in 1989, 1997 (not presented here) and 2000 showed a progressive sedimentation landward side of the breakwater during the whole period. However, the results pointed to the stabilization of the sedimentation process on the seaward side of the breakwater.

DISCUSSION

The annual deposition of 100,000 cubic meters of sedimentation at Babolsar Port with a maximum concentrations in the vicinity of the projected quays, led to the conclusion that without the implementation of a sediment-control mechanism it is not possible to maintain the Port operational. As was presented in the previous section the results indicated that the main cause of the high sedimentation in the port was the layout of the breakwaters at the mouth of the Babolrood River. Also it was pointed that the effective alternative for controlling the high sedimentation in the port was the separation of the river from the port basin in its way to the sea with a separating wall. The wall should extend along the western side of the river parallel to the eastern breakwater up to the head of the western breakwater with a length of 800 m. Steel sheet-piles were suggested for the construction of the wall in this variant. The variant also required the removal of the eastern breakwater so as to create an obstacle-free path for the river all the way to the sea. In addition, the variant called for the initial dredging of 300,000 cubic meters of sediment accumulated in the basin. These measures called for a very high level of investment and a long period of construction which were not acceptable.

The bed topography of the port three years after its construction (Figure 1) indicated that the bulk of sedimentation had taken place on the western part of the basin, with little sedimentation in the pass of the river adjacent to the eastern breakwater. It also indicated that the heavy accumulation of deposits on the western side of the basin had created a de facto wall separating the river from the rest of the basin; a development which, as shown by the topography, has resulted in minimal sedimentation in the direction of the river.

In order to make the port operational at the earliest possible

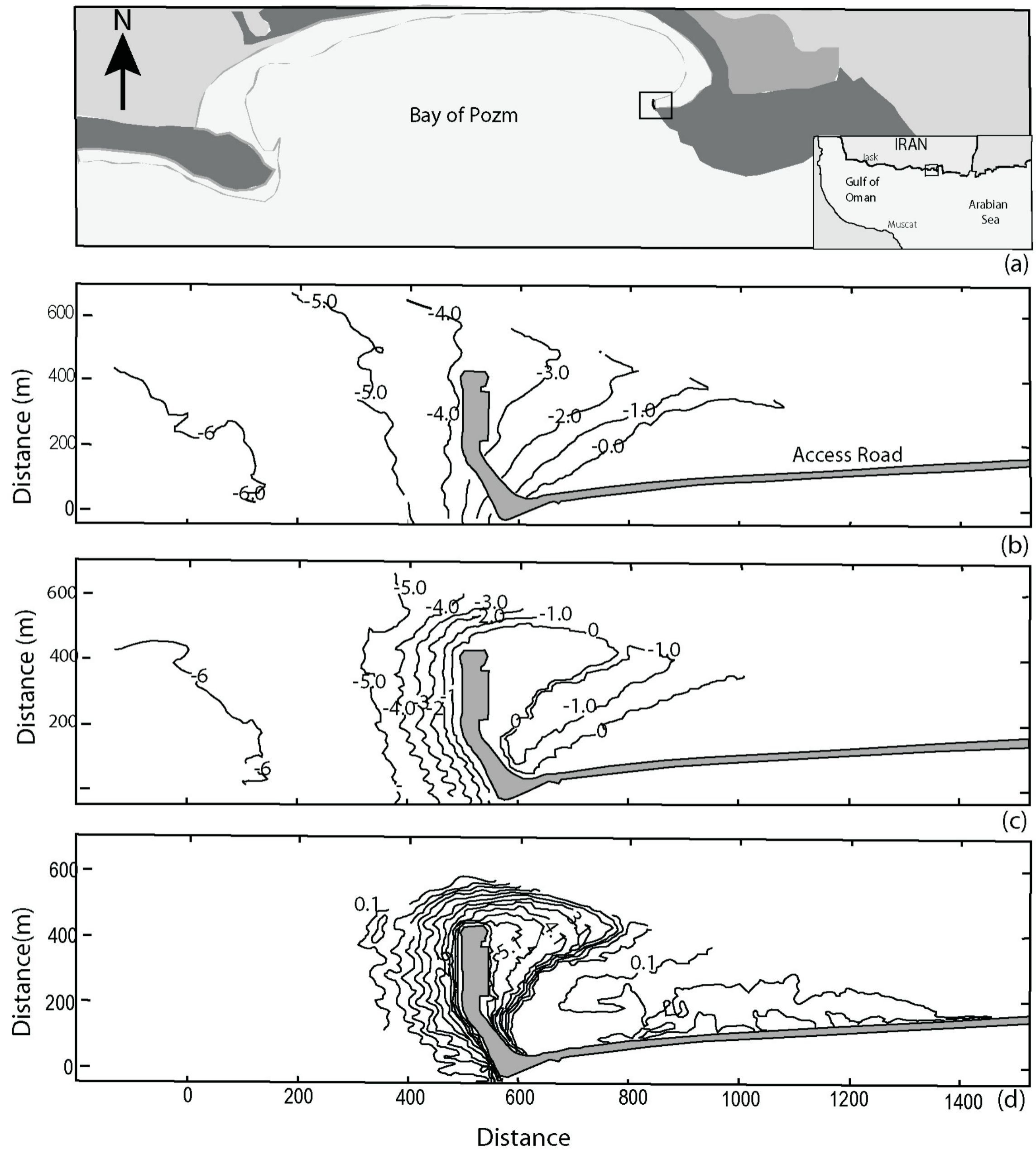

Figure 2. (a) Location of Pozm Port at the eastern headland of Bay of Pozm; (b) breakwater, access road of Pozm Port and the bathymetry of the Port in 1989 before construction; (c) bathymetry of the Port in 2000; (d) sedimentation in Pozm Port obtained from subtraction of the bathymetry in 1989 from that of 2000.

time and with the minimum investment, it was decided to take advantage of the existing sediment deposit configuration in the basin. It required that the operational area be limited to the pass of the river adjacent to the eastern breakwater. This alternative plan entailed the construction of a 125 m quay along the western shore of the river, the rehabilitation of the section of the basin abutting the quay and the main breakwater, the dredging of the basin in the direction of the river adjacent to the eastern breakwater and the construction of a 125-meter separating wall on the northern part of the quay to prevent sedimentation around the final section of the quay (Figure 1). Steel sheet piles were used for construction of the separating wall and the quay. The implementation of the alternative scheme has proven a success and the port has been in continuous operation ever since. Topographic comparison of sediment conditions in 2002 with that of 2000 indicates the need for an annual dredging of 20,000 cubic meters which is an acceptable amount for the maintenance of the Port.

The bathymetric configuration of the Pozm Port showed that the deposition of sand was confined to the adjoining areas of the breakwater. The lack of sediment accumulation inside the port basin, at the initial point of the breakwater, indicated that sedimentation around the breakwater has not originated from inside the Bay of Pozm, but that they have been drifted in from the adjacent coastline on the Sea of Oman.

A comparison of the bed topography of Pozm Port in 1989, 1997 (not shown here) and 2000 provided an accurate picture of sedimentation pattern around the Port. Sediments drift along the Oman Sea coastline and reach the breakwater. Given the position of the breakwater inline with the upper shore and the absence of any obstacles, they are transported along the breakwater to its head where under wave diffraction are pushed into the lee of calm water behind the breakwater and are deposited. This process has resulted in a total of 395,000 cubic meters of sediments in a 12 year period, an annual rate of 33,000 cubic meters. Though the amount appears to be manageable the pattern of sedimentation and the position of the quay near the head of the breakwater have disrupted the operations at the port.

The rates of littoral sediment transport calculated on the basis of CERC Formula (US ARMY, 1984) were rather controversial and were not used in the studies for controlling the sedimentation in the port. However, the results clearly showed that sedimentation in the Pozm Port from inside of the Bay was negligible indicating that any scheme for reducing sedimentation at the Port must only stop littoral sediment transport from the adjacent Oman Sea coastline to the Port. This finding led to a major modification in

the scheme for the sediment control of the Pozm discarding the need for any second breakwater inside the bay and to the north of the existing one. Consequently, the best method for controlling the sedimentation at Pozm Port was found to be the construction of a groin in the path of sediment transport, perpendicular to the coastline at the initial point of the breakwater. The groin with a length of 350-meter is currently under construction and will be completed in early 2004. The dredging of the port as a part of the plan will follow the construction of the groin.

CONCLUSIONS

The analysis of the cause of heavy sedimentation at Babolsar Port and Pozm Port indicated the deficiencies in the design of the ports, mainly related to the layout of the breakwaters, leading to disruption of marine operation. Comparisons of bed topographies at the location of ports within a span of several years played a significant role in validation of the results of numerical studies and determination of ways to overcome the sediment problem.

In Babolsar Port, separating the river pass from the port basin was found the basic solution to prevent damaging sedimentation in the basin and make the maintenance possible. However, cost and time considerations led to the implementation of a cost-effective plan within an acceptable period of time by focusing the marine operation over the pass of the river in the basin. This plan benefited from sedimentation configuration within the basin as a de facto wall separating the river pass from the rest of the basin. The plan was implemented and the port has been operational with an acceptable annual rate of dredging for maintenance.

In Pozm, the main source of sediment deposit was found to be the long-shore sediment transport outside the Bay of Pozm that due to the layout of the breakwater without any obstacle reached the head of the breakwater and entered the Port due to wave diffraction. It was found that there was no source of sedimentation in the Pozm Port from inside the Bay of Pozm. This led to a comprehensive modification of the original sediment control plan of the Port and the sediment control scheme of the Port limited to the construction of a groin at the initial point of the breakwater.

ACKNOWLEDGEMENTS

Most of the studies presented here were conducted under supervision of the Scientific Committee, Fishing Port Engineering Department, Iranian Fisheries Corporation while the first author was the head of the Scientific Committee.

LITERATURE CITED

DEIGAARD, R.; FREDSOE, J. and HEDEGAARD, I.B., 1986. Mathematical model for littoral drift. Journal of Waterway, Port, Coast. and Ocean Eng., ASCE, vol. 112, No. 3, pp. 351-369.

DHI, 2000. MIKE 21, Non-Cohesive Sediment Transport Module, User Guide.

U.S. ARMY. COASTAL ENGINEERING RESEARCH CENTER, 1984. Shore Protection Manual.