

Coastal Hazard Management at Fremantle Ports

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Summary

Fremantle Ports is responsible for the management of over 12 kilometres of coastline, including approximately 5 kilometres of seawalls, breakwaters and revetments. Historically, coastal hazards have been predominately managed using conventional forms of coastal protection e.g., seawalls and breakwaters. In addition, improving existing conventional forms of coastal protection, Fremantle Ports is commencing works on a beach nourishment Program at Port Beach. The Port Beach nourishment program is expected to be one of the first sand nourishment projects of its scale using dredged material in Western Australia.

Keywords: Coastal Hazard Management, Seawall, Sand Nourishment, Fremantle Ports

Introduction

Fremantle Ports has marine infrastructure assets located in the Inner Harbour at Fremantle and at Outer Harbour in Cockburn Sound. Key infrastructure includes dredged channels, breakwaters, seawalls, jetties and wharves that are affected by the changes in coastal environment and local weather systems.

There is an increasing risk of inundation of the port assets by changing sea conditions (like storm tides, flooding, erosion, and sand drift) that may potentially impact human life, property and wildlife. To effectively manage this risk, Fremantle Ports has recently deployed a mix of long, medium and short term approaches in both proactive and reactive formats.

Fremantle Ports in collaboration with technical consultants for hazard management assessment, involving assessing relevant climate changes (predictions available at the time) and forecasting number of effects and changes in sea level, storminess, ocean waves and currents, rainfall and extreme rainfall and river flooding. Some of the recommended controls were the two projects: Port Beach Sand Nourishment project and an upgrade to the existing seawall in Kwinana Bulk Terminal (KBT).

Port Beach Sand nourishment

Port Beach Road is the only access road servicing the Rous Head industrial park and DP World container terminal at Fremantle Ports. Port Beach Road runs parallel to Port Beach, the southernmost section is protected by 200 m of seawall; however, the remaining coast has minimal dunes and vegetation between the beach and the road reserve (see Figure 1)

Port Beach was identified as being at extreme risk for erosion in the short term due to an annual net loss of 7,500 to 10,000 cubic meters of sand caused by longshore sediment transport to the north (towards Leighton Beach) [3].



Figure 1 Dune Erosion During Winter

Four options were evaluated: Retreat and Protect, Protect, Headlands / Groynes and Sand Nourishment (via truck or dredge).

Through a multi criteria analysis, four potential adaptation options were evaluated on the following criteria: technical, social, environmental, and economic factors [4]. The option of Sand nourishment using dredge was ranked as the highest-ranking option.

A detailed investigation on the preferred option was then conducted in 2020. This investigation determined the feasibility of the project by simulating the local wave climate, the sediment dynamics and the shoreline change [5]. The final design consists of 150,000 cubic meters to be dredged from Fremantle Port's Deep Water channel and placed along a 750 m section of Port Beach. This design is estimated to provide 7-8 years of protection before returning to present day conditions. However, to extend the life further, a maintenance program is recommended by moving the sand from the accreting Leighton beach on the North to the Port Beach area. This additional maintenance program is estimated to extend the protection period for another 10-20 years.

With Environmental requirements approved in February of 2022, sand nourishment of Port Beach is estimated to commence in June - July of 2022 with a completion date of October 2022.

Kwinana Bulk Terminal Seawall Upgrade

In 2013, Fremantle Ports had constructed a 120 m seawall at Kwinana Bulk Terminal (KBT), as an interim/emergency shore protection works to protect the import/export conveyor and transfer tower assets.

Following several storms during late April and May 2020, particularly the storm on 25 May 2020, that caused severe damage to the KBT seawall, like, loss of crest elevation, roll out of armour rocks and failure of sections of the structure.

Considering the proposed major infrastructure development projects in and around KBT, like Westport and construction of a new jetty, a 10-year design life has been chosen for the seawall. Australian Standard 4997 Guidelines for design of maritime structures provides guidance on design of marine structures and based on the design life guidelines a 20-year ARI wave and 20-year ARI water level conditions have been used for the seawall design.

From this assessment, the 20-year ARI wave height was estimated as 1.13 m and water level is estimated to be 1.48 m AHD with the sea level rise allowance for the coming 10 years is estimated at 0.05 m.

Limestone armour rock with density of 2.20 tonnes per cubic metre and layer thickness Coefficient (kt) of 0.8 was proposed for the seawall upgrade project. Standard and best practice rubble mound and seawall design would include a geotextile, overlain by one or more filter layers and multiple layers of armour. Due to the temporary and short-term nature of the proposed seawall upgrade, it was decided to exclude the filter layer and place armour layers directly on the geotextile (see Figure 2).



Figure 2 Completed Seawall of KBT

Analysis shows that levels of the beach adjacent to the seawall toe may erode to -0.5 m AHD during the 20-year ARI design event. Hence a design toe level of -0.5 m AHD was selected to ensure the structure will not be undermined during the design event.

The project was a great success because it was executed using locally sourced materials (armour rock), specialist contractor and was completed with minimal interruptions to port operations and was completed one week ahead of schedule.

Discussion and Conclusion

Two different examples of coastal hazard management have been recently adopted by Fremantle Ports.

Port Beach sand nourishment is on schedule to be completed in 2022 and hopefully the success of this project will encourage further sand nourishment projects recycling dredged material in Western Australia. These types of projects encourage the use of dredged material for coastal protection rather than dumping in a spoil ground (environmentally friendly option).

Construction of the new seawall has successfully restored the storm damaged shoreline at KBT and enhanced the protection of KBT infrastructure. Decision to engage locally sourced contractor and material (armour stones) proves to be a big success, as construction work was carried out during Covid pandemic period without any interruption.

Fremantle Ports leadership team are constantly reviewing such coastal hazards and proactively implementing risk mitigating projects such as the two projects above. These projects will be monitored regularly over the next few years to assess their performance and effectiveness as part of Fremantle Ports Coastal Hazard Management.

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