Ōpōtiki Harbour Development Project – Construction monitoring in a digital age

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Summary

The Ōpōtiki Harbour Development Project involves stabilising the entrance of the Waioeka River to allow reliable and safe access for maritime activity. This project is the first major river training works to be designed in New Zealand in over 100 years and involves construction of twin 400 m long training wall breakwaters, dredging a navigable channel into the Harbour, and closing the natural river mouth. This paper describes monitoring undertaken during the construction phase to confirm the design profile of the structure is being achieved in a dynamic and varying environment, and to monitor shoreline response and adjust predictive models.

Keywords: coastal structures, breakwater design, harbour entrance, concrete armour units, hanbars.

Introduction

The Ōpōtiki Harbour Development Project will improve maritime access for the Ōpōtiki region by stabilising the Waioeka River mouth using twin training wall breakwaters ("training walls"). These will be located to the east of the existing river outlet and extend out to approximately 350m from the existing shoreline, with dredging to provide a navigable channel from the nearshore towards the town (Figure 1).

Design of the works was undertaken using a variety of field data, best practice guidance and a combination of empirical, numerical and physical modelling as described within [1, 2 and 5]. Key risks during construction included achieving the design geometry and profiles given the highly dynamic seabed profile and the shoreline response to works which was known to vary considerably depending on specific environmental conditions. This paper focusses on the monitoring of construction works and the environment using a combination of traditional and contemporary methods and the opportunities to use near real-time

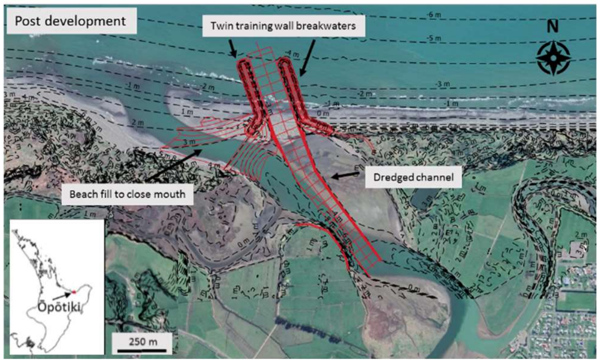

Figure 1: Site overview showing the Ōpōtiki river mouth at present (pre-development) and with the design works to control the river entrance.

Construction monitoring

Several bathymetric surveys were collected during the planning and design stages. These confirmed that the seabed profile could vary considerably in response to environmental conditions. This posed challenges in providing design models for construction where the location of the seabed surface was variable. Ultimately a variable excavation depth was allowed for, but the required layer thickness and final elevations were fixed requiring accurate and frequent survey to confirm these were being achieved. Combining traditional survey with UAV-derived imagery and point clouds allowed comprehensive temporal and spatial records to be assembled and continually compared with a project design model, or digital twin, to confirm progress and adjust expected quantities and/or methods (Figure 2).

Shoreline Response

The Ōpōtiki shoreline experiences a high gross littoral drift but low and variable net drift dependent on wave climate with strong seasonal and inter-annual relationships evident. Construction of the twin training walls will interrupt the littoral drift along this coast causing the profile and shoreline position to respond. The location and fluctuation of the shoreline during and following completion of the project is important for completion of the work themselves, operation of the harbour, and coastal hazards to development and ecologically sensitive areas up and down the coast. Initial projections of immediate nearshore profile response and term shoreline response were undertaken using the morphodynamic model Xbeach [3] and shoreline response model, ShorelineS [4]. ShorelineS simulates the 1D profile response to wave forcing but can include the effects of structures including wave shadowing, sediment trapping and bypassing and is currently being developed by an international collaboration including Tonkin + Taylor.

Monthly UAV surveys extending some 1km either side of the works are collected. These provide a digital elevation model and orthomosaic from which the shoreline position as defined by high tide position can be extracted. This can be supplemented by higher temporal, but lower spatial resolution satellite imagery. Using these records of shoreline position, Shoreline S can be re-run using wave nowcast information to compare prediction and calibrate long-term projections.

Discussion and Conclusion

Construction in the coastal environment is inherently uncertain with changing topography and bathymetry and variable environmental conditions. Improved monitoring data, collected at high spatial and temporal resolution enables progress to be closely tracked and compared to design models or ‘digital twins’ to minimise the likelihood of discrepancies between the end product and design. Likewise, projections of environmental response can be monitored and models calibrated to better agree with observation during construction.

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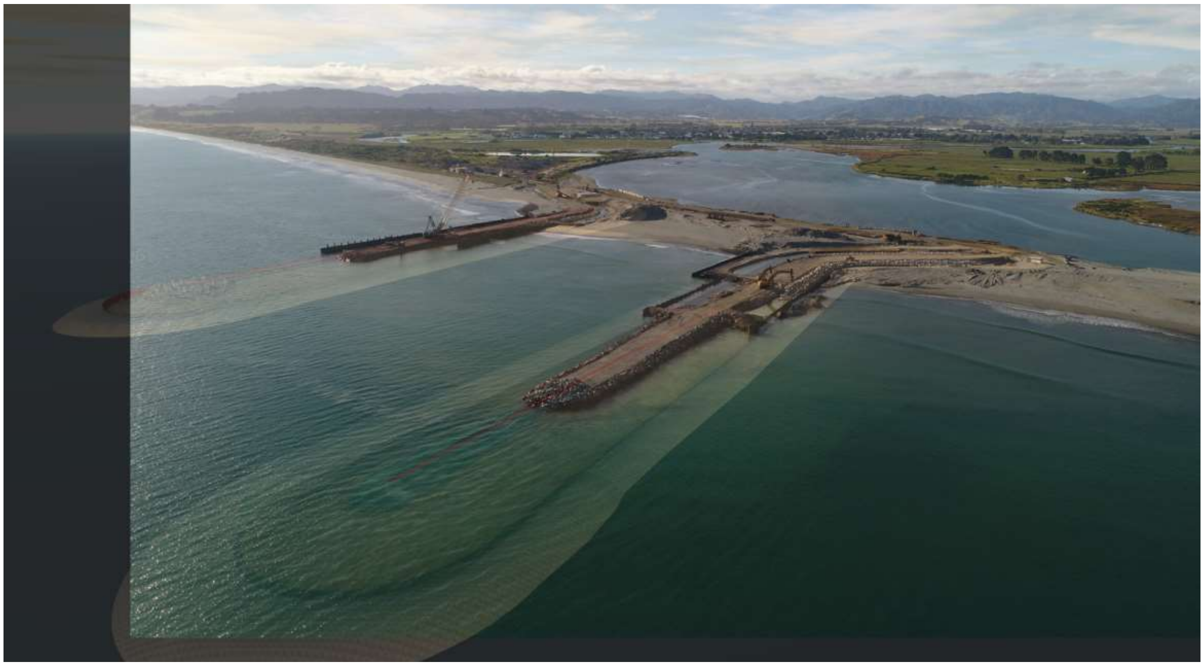

Figure 2 Comparison of the constructed breakwater extent (March 2022) with the design model