Gisborne Port – Twin Berths Project

Summary of effects of reclamation and breakwater upgrade

March 2022
Document History

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1. Introduction

Eastland Port Ltd (EPL) is redeveloping its port infrastructure to allow for an expected increase in log exports. These works include redeveloping Wharf 7 and extending Wharf 8 seaward to accommodate two vessels in the port at the same time, combined with restoring the outer breakwater back to its previous dimensions, and reclaiming the area to the south of it (Figure 1.1).

The interaction of the refurbished breakwater and the reclaimed area with the incoming waves might affect the surfing conditions along Poverty Bay. In addition, fine sediments can potentially be released during the construction of the reclamation area, from fine sediments present on the rock and crushed rocks to be used for the reclamation revetment.

MetOcean Solutions (a division of the Meteorological Service of New Zealand) has been commissioned to undertake a wave modelling and sediment plume study of the area to understand the impact of the planned redevelopment.

Figure 1.1: Eastland Port layout. The proposed developments considered in this study, reclamation and breakwater refurbishment, are highlighted in blue and yellow respectively.
This summary report presents the outcome of the following investigations and associated reports:

- High resolution wave modelling of existing and proposed port configurations – Report P0331-26
- Effects of breakwater upgrade on local wave climate – Report P0331-27
- Assessment of potential sediment plume during Port reclamation works – Report P0331-28
2. Effect of port reclamation on waves

A study on the effects of the reclamation near the inner breakwater (cyan area on Figure 1.1) over the wave height and wave induced currents near the port was documented in MetOcean Solutions, 2020. In this report, we used a validated wave hindcast of the area (MetOcean Solutions 2017) to select representative 10-year return wave events and simulate them in a high resolution SWASH phase resolving wave model.

The assessment was based on the simulations’ results at three reference sites, for the two port configurations (before and after the new reclamation works, Figure 2.1). Note that, apart from the reclamation, there is no further change in the domain’s bathymetry. The simulations were forced by four different 10-year return wave events using low, mid and high tide levels.

![Figure 2.1](image)

In the existing configuration, the incoming wave/port interaction shows southeast-incident waves refracting into Poverty Bay, reaching the port’s southern breakwater. A fraction of the wave energy that interact with the wall is reflected eastwards toward the existing reclamation. Some subsequent reflection back to the south is possible, though with reduced energy due to dissipation over the existing rubble mound revetment.

The reclamation in the proposed bathymetric configuration adds an element with which incoming and reflected waves interact, generally resulting in larger waves heights in the vicinity of the structure, and relatively larger wave energy radiating back towards the south. In contrast, wave heights are relatively reduced within a band along the southern training wall.
Figure 2.2  Difference of significant wave height (left) and wave induced currents (right) between the present port layout and proposed reclamation layout at high tide, for one of the 10-year return wave conditions. Red colours indicate increased wave heights after the reclamation works whereas blue represent decreased wave heights.

For the extreme wave conditions simulated, the significant wave heights are in general 8-10% larger with the new reclamation in place, reaching up to a 10-20% increase for the wave conditions simulated. For higher water levels (Figure 2.2), the same offshore conditions produced an overall increase in wave height of 15%, and up to 25% locally.
3. Assessment of potential sediment plumes during reclamation works

A study on the fate of sediment plumes potentially generated during reclamation works is documented in MetOcean Solutions (2022).

Fine sediments can potentially be released during the construction of the reclamation area from either release of fine sediments present on the rock and crushed rocks to be used for the reclamation revetment. For this purpose, we used a calibrated and validated Delft3D model to estimate the dispersion and fate of sediment plumes potentially generated during the reclamation works.

The modelled scenario proposed in this study represents the protection bund partially built, and a source of sediment discharge representing release of fine sediments from the surface of the rocks.

Based on our model results, sediment plume concentration near the port is likely to be $\leq 0.02 \, \text{kg.m}^{-3}$ above background concentration, which is typically 0.13 to 0.23 kg.m$^{-3}$ (4Sight 2019). The plume represents a minor increase comparatively, corresponding to 5x to 10x less the background concentration range within the port area. Further into Poverty Bay, outside the port area, background concentration is typically 0.02 kg.m$^{-3}$ and the model results show plume of less than 0.002 kg.m$^{-3}$, above background, indicating that plume might have a minor contribution to the background suspended sediment concentration.

Deposition of the fine sediments on the seabed occurs mostly west of the reclamation site, along the southern side of the breakwater, and at the entrance of the port and navigation channel. These areas show most of the deposition is $< 0.001 \, \text{m}$ (1 mm). A narrow depositional area along the southern side of the breakwater shows higher deposition with a maximum of approximately 0.002-0.003 m.
Figure 3.1 50th percentile maps of sediment concentration (kg.m$^{-3}$) at bottom for scenario without flocculation ("plus 65 hydro"). Top panel overviews the entire model domain, bottom panel focuses on the reclamation area.
Figure 3.2  Sediment deposition (m) at the end of 15-day simulation for scenario without flocculation ("plus 65 hydro"). Top panel overviews the entire model domain, bottom panel focuses on the reclamation area.
4. Effects of breakwater upgrade on local wave climate

The MetOcean Solutions, 2021a report assessed the potential changes that the outer breakwater upgrade could cause in the local wave climate and hydrodynamics. The assessment consisted of using a high-resolution SWASH domain to model the present port configuration, the port layout with the reclamation works finished (cyan area of Figure 1.1), and the port layout with the refurbished breakwater (yellow area left of Figure 1.1).

The boundary forcing used to simulate each port layout is representative of the 95th percentile of the offshore significant wave height of Poverty Bay, and was sourced from the port’s Triaxys buoy. The wave parameters used in the assessment were significant wave height, sea surface elevation and wave induced currents. We note that the nearshore wave model was not calibrated using field measurements, hence its results should be interpreted in a relative sense. Furthermore, even though the study accounts for the dredging in the port’s basin, it does not assess the dredging isolated effects over the wave induced currents.

![Figure 4.1 Difference plots of significant wave height (left) and wave induced currents (right) between the present and refurbished breakwater port configurations (reclamation area included). Red colours indicate increased values after the breakwater upgrade whereas blue represent decreased values. Black and white arrows show the currents direction before and after the breakwater works, respectively.](image)

Our results show a local redistribution of the wave height gradients and the current’s vortices in the port’s vicinity (Figure 4.1). The changes in wave height are smaller than 0.1 m near the port and smaller than 0.03 m within the rest of the domain. The displacement of the vortices causes an increase of approximately 0.1 m/s in the current situated westward of the port, and a similar decrease in the nearshore current flowing...
westwards of Midway Beach. In general, the changes observed are confined to the Port's vicinity, with minimal alterations through the rest of the domain.
5. References


