CASE STUDY

Lyttelton Channel Optimisation

Reducing Dredging with DUKC®

Overview

LPC is currently undertaking the largest redevelopment in its history, including a channel deepening project. Over the last 10 years the size of container ships internationally has virtually doubled. To accommodate larger vessels, LPC has commenced a channel deepening project which will see an increase in the depth of the existing shipping channel of up to 5-6m to allow for these larger, deeper ships.

In Stage 1 of the project the existing 7km shipping channel will be lengthened by 2.5km, widened by 20m and deepened to increase maximum vessel drafts from 12.4m to 13.3m. The project is the result of more than two years of careful planning and stakeholder consultation by LPC.

The Business Challenge

- Over the past decade, container ships have continued to increase in size. Dredging of the shipping channel will allow deeper draft ships to access the port.
- Enabling larger ships to call at Lyttelton Port, providing Canterbury's importers and exporters the best possible and most cost effective international shipping solutions.
- Container vessels visiting Lyttelton carry approx. 4,500 - 5,000 twenty foot equivalent units (TEUs). The dredging project will enable larger vessels carrying up to 5,500-6,500 TEUs.
- The total two-stage dredging project is New Zealand's largest and is estimated to cost between NZD $80 million and $120 million.

The Technical Challenge

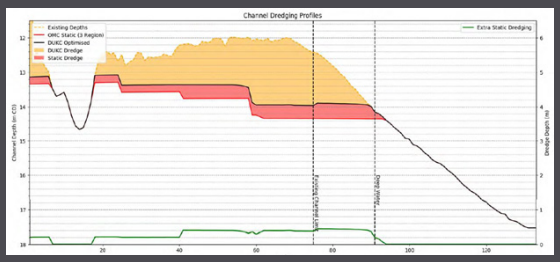
- The existing shipping channel is dredged to 11.9m minimum depth tide and vessels are limited to 12.4m draft around high tide
- To manage grounding risk LPC pilots currently operate a static UKC rule of 10% of draft and apply judgement to avoid sailing some vessels when the swell is high
- Determining the channel depth profile required to achieve 13.3m, and later, 14.5m draft ships
- Assessing options to optimise the channel design and reduce the dredging requirements through application of DUKC® technology to design a more efficient channel and manage under-keel clearance risk in a more precise and scientific manner.

Client: Lyttelton Port Company

Project Location: Christchurch, New Zealand

Completion Date: August 2018

Above: Pilot boarding a container ship at Lyttelton.



Above: Design profiles of (red) the alternate static channel, and (black) the DUKC® optmised channel.

About the Client

Lyttelton Port of Christchurch serves a wide range of importers and exporters with full shipping services 24/7 and is a critical link in both New Zealand and global trade networks. In addition to a container terminal and the country's largest coal terminal, LPC has facilities for loading and unloading bulk products such as petroleum, fertiliser, gypsum, cement, logs, conventional break-bulk, and imported vehicles.

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The Solution

OMC was asked to review the existing channel design and submitted two alternative designs for the channel depths, one based on the port continuing to manage under-keel clearance (UKC) risk based on a simple "static" UKC rule, the other based on implementing state-of-the-art Dynamic Under Keel Clearance (DUKC®) technology which uses precise measurements and modelling of waves, currents, tides and ship motions to provide optimal sailing advice for each vessel transiting the new channel.

The DUKC® optimised channel was designed by first creating a comprehensive digital model of the port including complex hydrodynamic models, spatially transformed wave fields, statistical distributions of tidal residuals, and transit parameters including vessel speeds, headings and rates of turn. Using the design vessel fleet, simulations were performed for 10 years of operations. The vertical motions of each vessel (including squat, heel and wave response) at all points along the channel are calculated to determine the dynamic UKC profile. An in-house optimisation algorithm is run to determine the depth required at all points in the channel to achieve the design channel accessibility.

The Outcomes

LPC performed a cost-benefit analysis and decided to proceed with the DUKC® optimised channel design in conjunction with implementation of an operational DUKC® system. This decision was based on a significant saving in capital expenditure and an ongoing reduction in operating risk.

The original PIANC channel design required a dredge volume of 9.7M cubic metres. The DUKC® optimised channel required a dredge volume of 5.5M cubic metres, a reduction of 4.2M cubic metres or 43%.

The Benefits

- A **43% reduction** in the required dredge volumes from the original PIANC channel design.
- Reduced required Stage 1 dredge volumes compared with next best alternative **by 800,000 cubic metres** – reducing the capital cost of Stage 1 dredging by **15%**.
- Reduced project duration and environmental impacts.
- Detailed science-based calculations, taking into account the latest measured tide and wave conditions and state-of-the-art vessel motion modelling to manage transit risk.
- Mitigate the impact of sedimentation patterns in the deepened channel to schedule optimal maintenance dredging to ensure minimal impact on vessel accessibility to the port

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