LESSONS LEARNED FROM PHYSICAL MODELLING AND OPOTIKI HARBOUR DEVELOPMENT WITH HANBAR UNITS

F FLOCARD, M BLACKA, G PEARCE, T SHAND, R COX

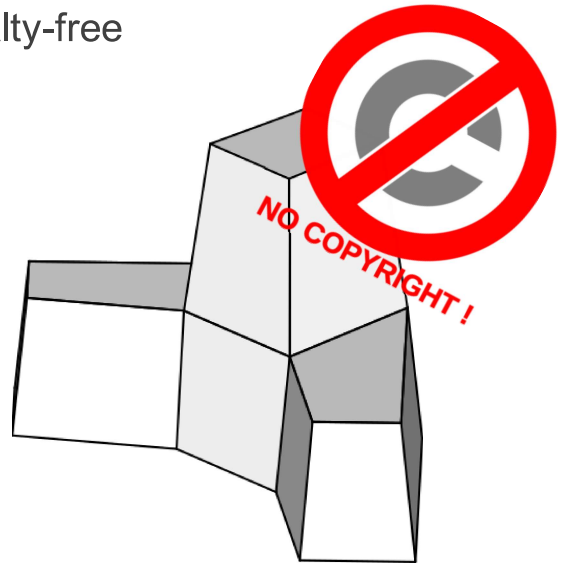
UNSW Water Research Laboratory

Tonkin+Taylor

UNSW SYDNEY

What are Hanbars?

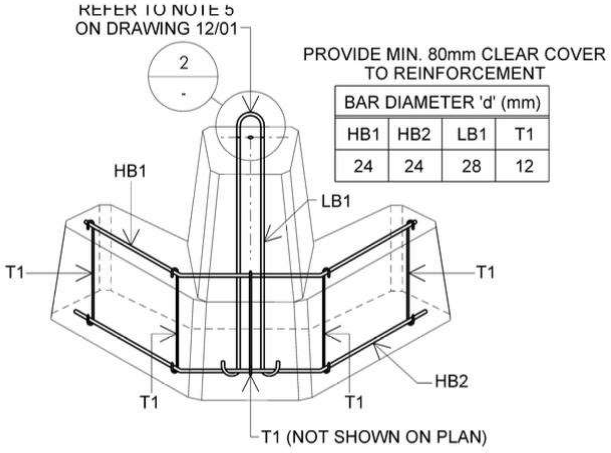
- Three-legged unit developed in the mid-1970s by NSW Public Works Department
- Peter **HAN**ley,George **BAR**boutis
- Royalty-free



UNSW Water Research Laboratory

What are Hanbars?

- Thick three legs (2 wings + 1 chimney)
- High structural strength
- Large range of size/mass
  (from 2 t up to 28 t)



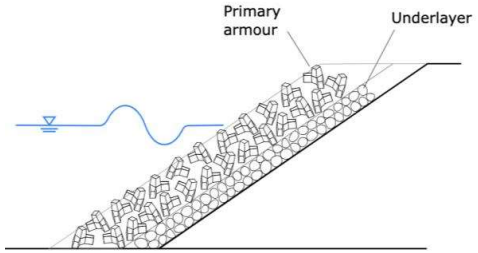
UNSW
Water Research
Laboratory

What are Hanbars?

- Simple to manufacture
  - Open-ended single draw mould
  - 1/10 taper on all sides + flat base
  - Short casting time = high production rate
  - Lifting hook

UNSW Water Research Laboratory

What are Hanbars?



- Random double layer placement

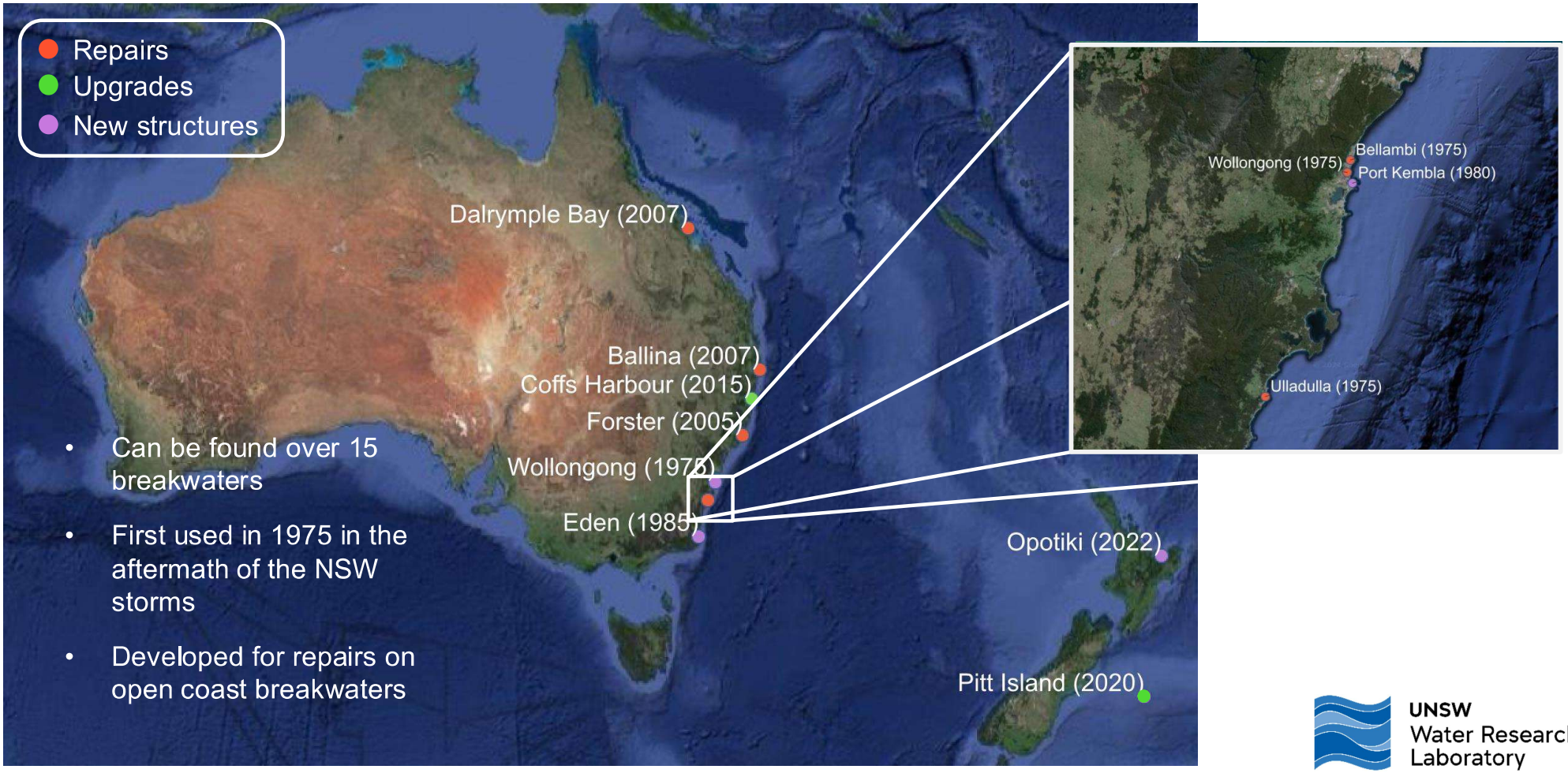
- Placement has been dictated by armour unit construction method

- Lifting hooks cast into the top leg of the armour unit, so that units were always picked up by the top leg, and placed with flat base down first

- Double layer (60% of the units in the bottom layer, remaining 40% in the top layer)

UNSW Water Research Laboratory

A brief history of Hanbar structures – Repairs in the 70s



- Can be found over 15 breakwaters
- First used in 1975 in the aftermath of the NSW storms
- Developed for repairs on open coast breakwaters

UNSW Water Research Laboratory

A brief history of Hanbar structures – New structures in the 80s

-
early 80s

UNSW Water Research Laboratory

A brief history of Hanbar structures – Upgrades in the 2000s

- Used for upgrade works on key NSW coastal protection structures

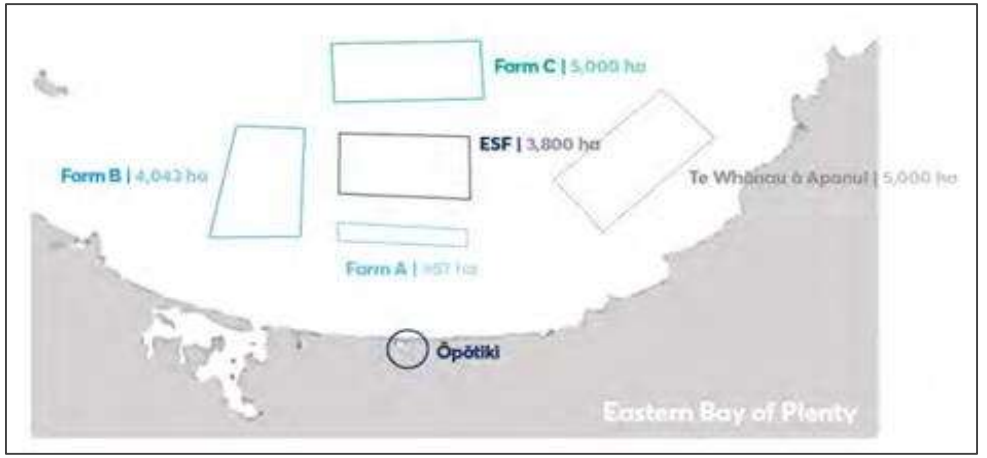
UNSW Water Research Laboratory

A brief history of Hanbar structures – First NZ works in 2020s

Pitt Island (2015)
Scale 1:40

UNSW Water Research Laboratory

Opotiki Harbour Development project



Tonkin+Taylor

UNSW Water Research Laboratory

Opotiki Harbour Development project

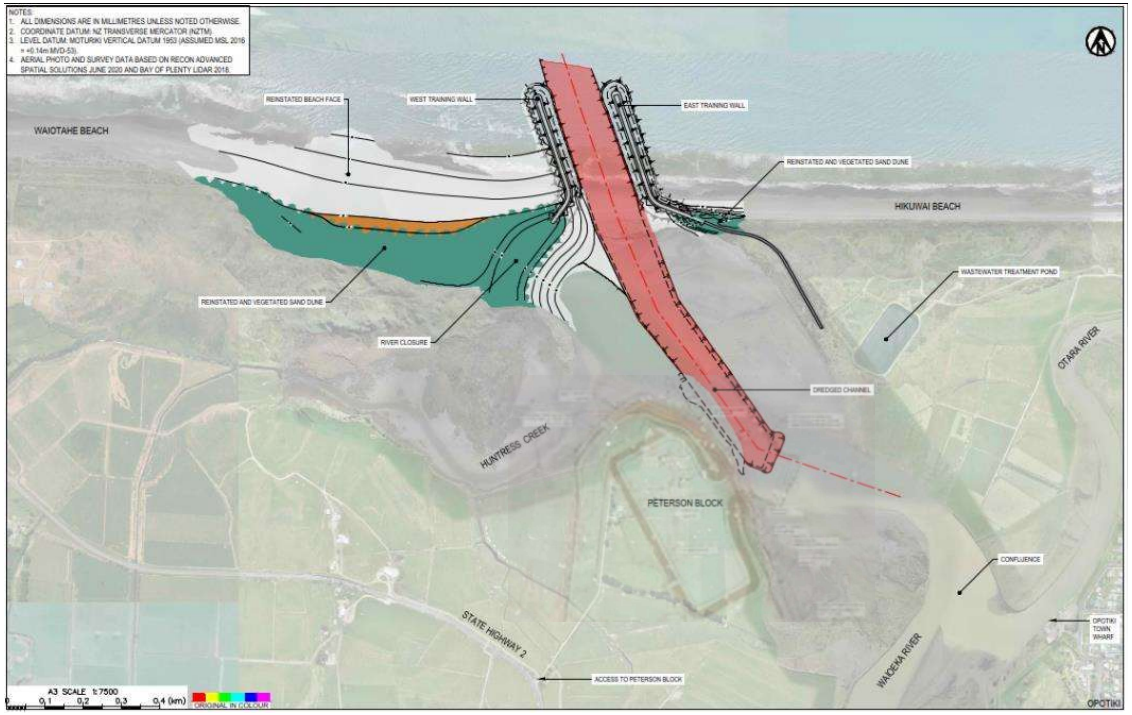
Background

Tonkin+Taylor

UNSW Water Research Laboratory

Opotiki Harbour Development project

Te Ara Moana a Toi (“a pathway to the sea”)



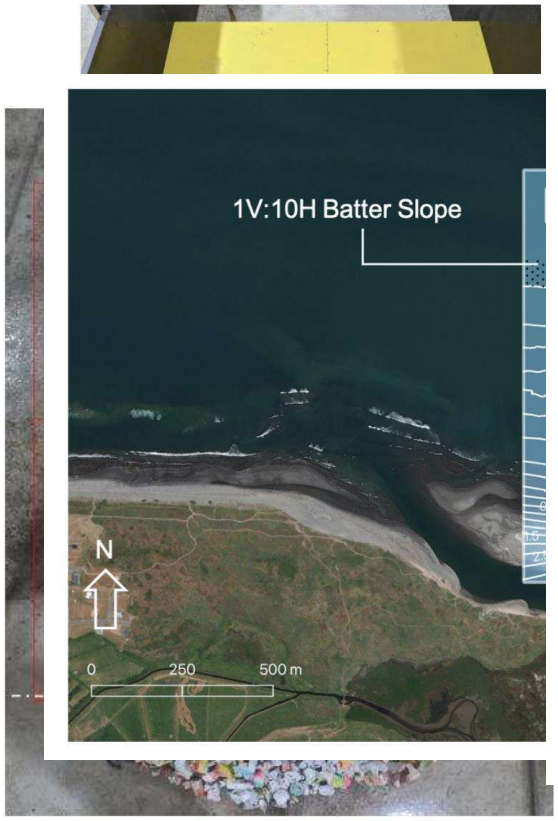
- Twin 400m training wall armoured with hanbar units (2T to 15T)
- 120m wide dredged navigation channel to -3m CD.
- >600,000 m^3 of intertidal and subtidal dredging
- 20 ha of constructed beach, foredune and mid dune to close the existing river mouth

Tonkin+Taylor

UNSW Water Research Laboratory

Opotiki Harbour Development

- Modelling at scale of 1:40.5
- WRL 3D basin 30 m by 20 m with 3D concrete bathymetry (dredged channel)
- Staged approach:
  - Stage 1 - Wave processes
  - Stage 2 - 2D modelling of key sections of the training wall trunks
  - Stage 3 - Quasi-3D modelling of the breakwater head



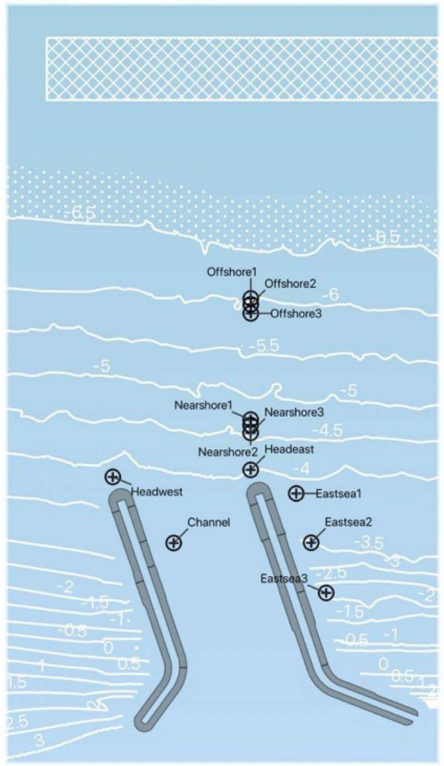


Figure 4.8 Q3D model configuration

UNSW Water Research Laboratory

Opotiki Harbour Development

- Modelling at scale of 1:40.5
- WRL 3D basin 30 m by 20 m with 3D concrete bathymetry (dredged channel)
- Staged approach:
  - Stage 1 - Wave processes
  - Stage 2 - 2D modelling of key sections of the training wall trunks
  - Stage 3 - Quasi-3D modelling of the breakwater head
  - Stage 4 - Full 3D modelling of complete structures

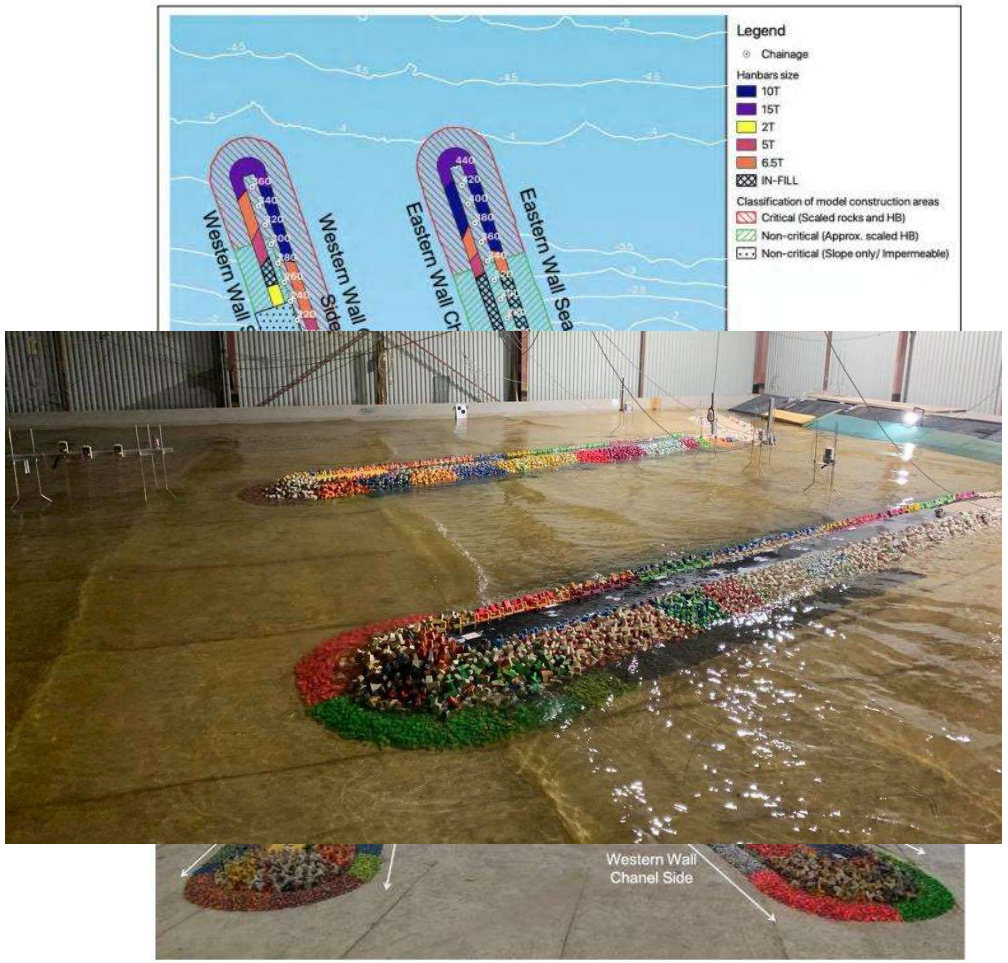


Figure 4.13 3D model overview

UNSW Water Research Laboratory

Opotiki Harbour Development project - Construction Phase

Opotiki Harbour Development

Tonkin+Taylor

UNSW Water Research Laboratory

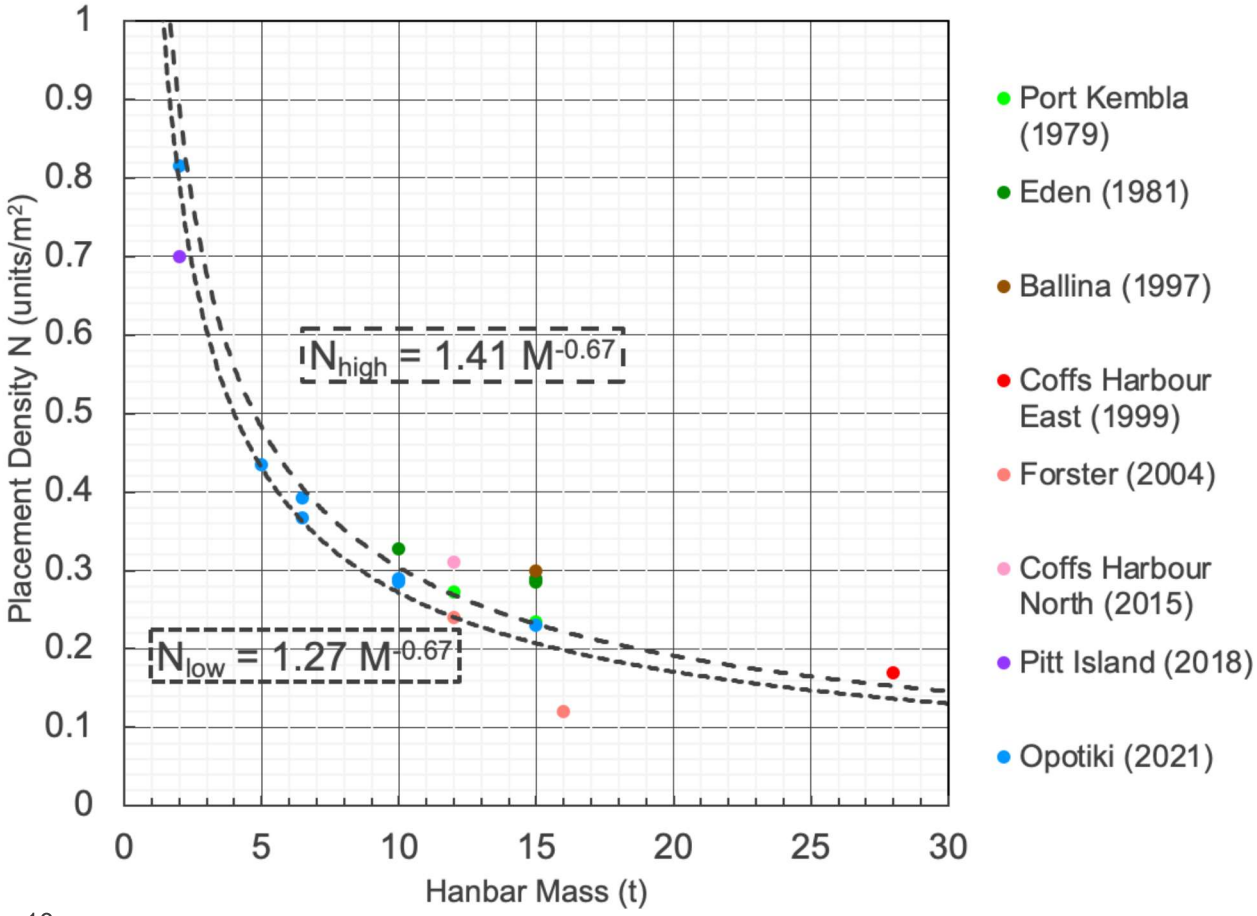
Opotiki Harbour Development

October 2020

November 2023

UNSW Water Research Laboratory

Placement density (double layer 60/40)



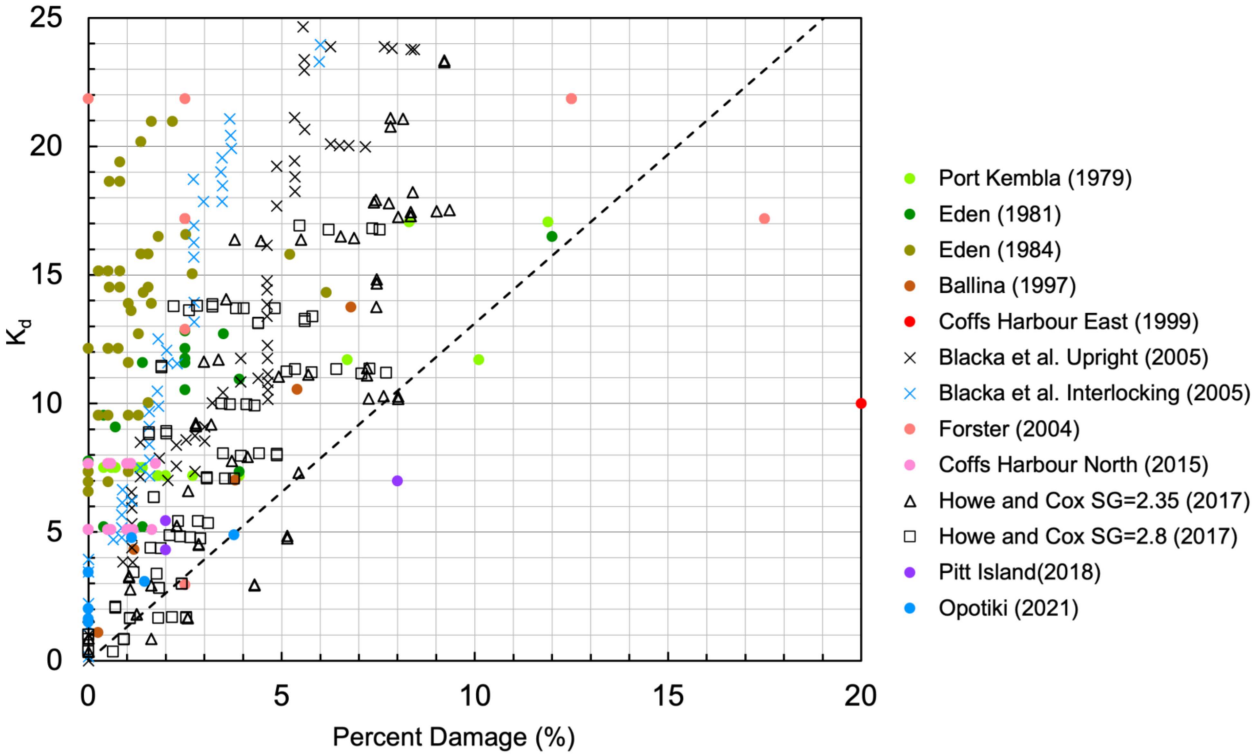
$$N = k_p M^{-2/3}$$

where

- M is the mass of the considered Hanbar unit
- N is the number of units per m^2 of breakwater slope used during double layer placement
- k_p is the packing density coefficient

Damage coefficient Kd

UNSW
Water Research
Laboratory



$$M = \frac{\rho_c \, H^3}{K_d \, \Delta^3 \cot \alpha}$$

where

- M mass of Hanbar unit
- H incident significant wave height
- α structure slope
- ρ_c concrete density
- Δ relative submerged density
- K_d Hudson damage coefficient

Applied research – High-density concrete

UNSW Water Research Laboratory

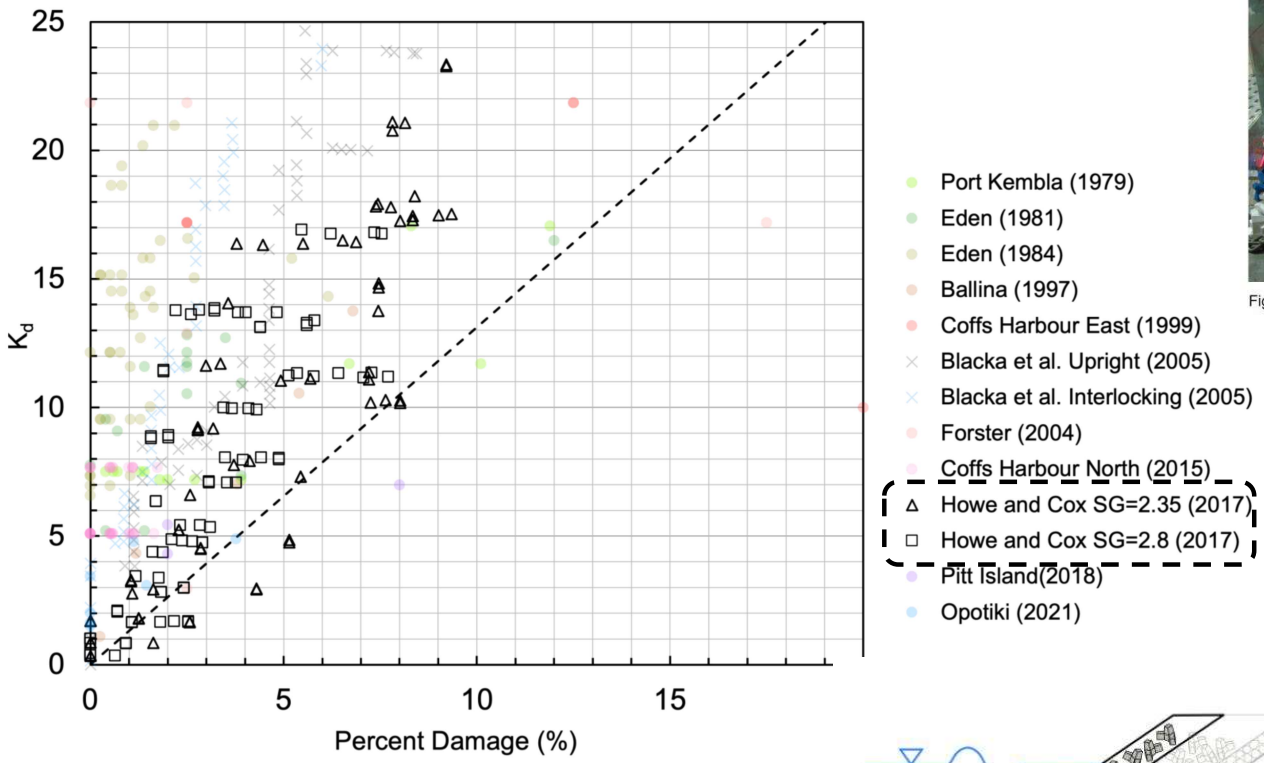
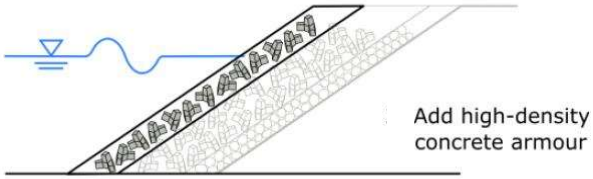
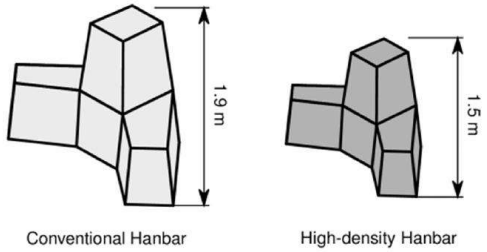


Figure 5. High-density Hanbar breakwater model with 0% damage (left), and 11% damage (right).

	Conventional	High density
Mass[1] (t)	8.0	4.2
Height[1] (m)	1.9	1.5
Density[1] (kg/m³)	2350	2800
Design wave height[2] (m)	4.3	4.3

1. Measurements in prototype scale.
2. Calculated using Hudson's equation.



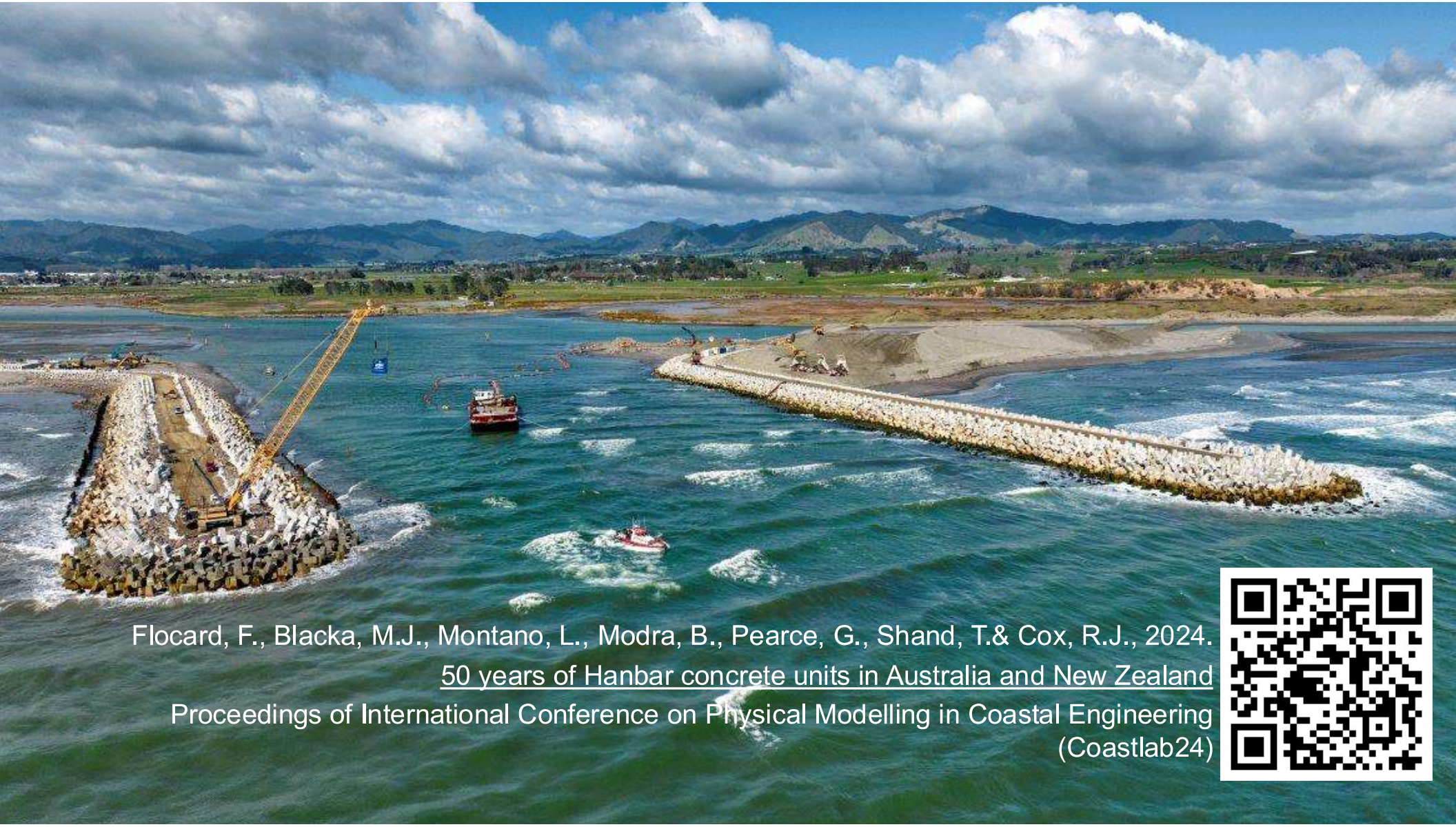


Hanbars

- Robust and simple concrete unit
- Proven multi-function unit (repairs/upgrades/new structures)
- 2 t to 28 t
- Royalty-free
- Expanding knowledge base through 50 years of physical modelling and 15 projects
- Model units available from 30 g to 230 g
- Actively research and developed by UNSW

Session 7A
High-Density Coastal Armour Units for Managing Increased Risk With Climate Change
R. Cox, B. Modra, F. Flocard, P. Ryan

UNSW Water Research Laboratory



Flocard, F., Blacka, M.J., Montano, L., Modra, B., Pearce, G., Shand, T.& Cox, R.J., 2024.
50 years of Hanbar concrete units in Australia and New Zealand
Proceedings of International Conference on Physical Modelling in Coastal Engineering (Coastlab24)