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The State of the Art and Science of Coastal Engineering

The Need for Physical Models in Coastal Engineering

NSW GOVERNMENT | Manly Hydraulics Laboratory

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Overview – The Need for Physical Models in Coastal Engineering

- Summary of What We Already Know
- Littoral Drift Transport (submerged groynes) – Case Study Example 1
- Harbour Seiching – Case Study Example 2
- Submerged Rock Berm – Case Study Example 3
- Importance of Model Validation – Another Case Study
- Conclusions and Recommendations

What We Already Know

Hughes (2014), Kamphuis (2016) and others:

BENEFITS

(1) confirming coastal designs
(2) developing empirical design guidance
(3) contributing to numerical model development by elucidating physical processes
(4) verifying numerical models

➔ Superb demonstration and education tool

LIMITATIONS

(1) Impossible to attain complete similarity
(2) Similitude by one law (Fr, Re, W_e or Ma scaling) violates others (scale effects)
(3) Inability to represent full orchestra of processes simultaneously

➔ An art as well as science

Littoral Drift Transport - Case Study Example 1

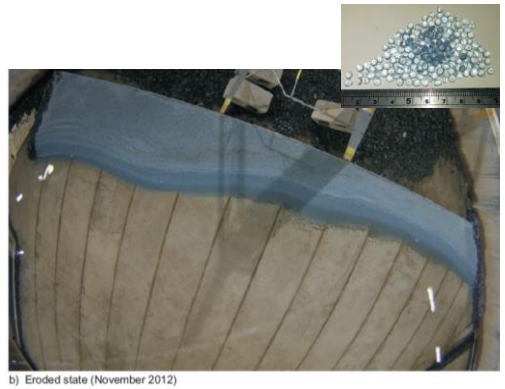
- Constructed beach, Port Botany
- Complex bathy/waves & proposed submerged groynes →num. model incapable?... (Arun Kamath, 2018)
- Small scale (1:80), phys. Model using LW sediments
- Modelled existing beach to fine tune wave energy gradients
- Assessed "Do-Nothing"
- Added structures and achieved accurate planform prediction

SALIENT PRECEPTS:

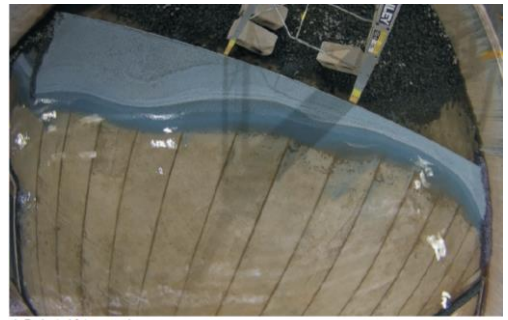
➔ Representative wave climate →nearshore energy gradients

➔ Ability to mobilise sediments

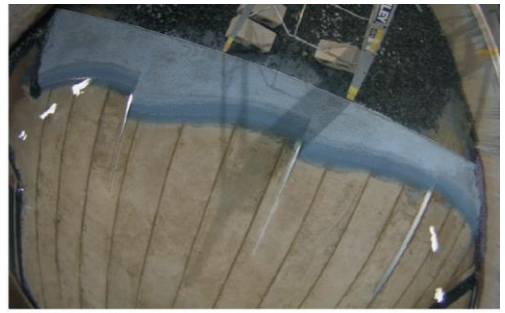
➔ Cross-shore profile using analytical methods



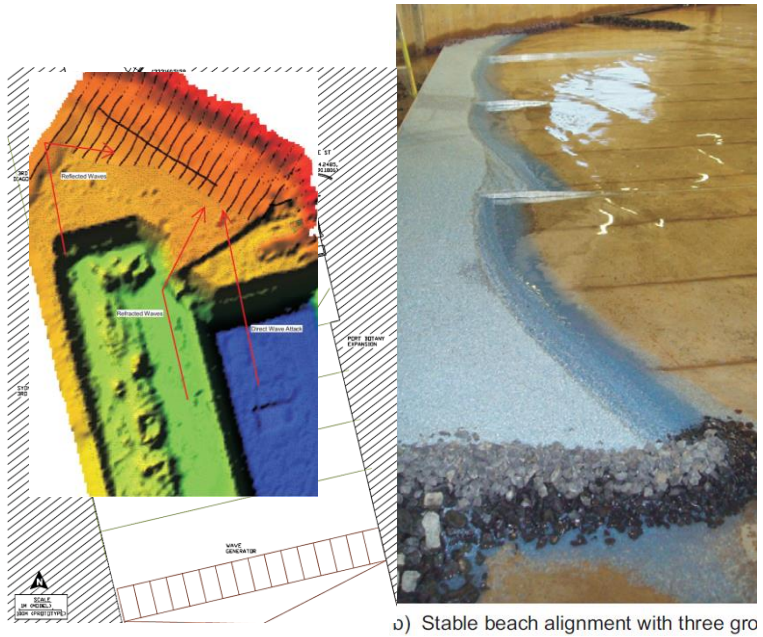
b) Eroded state (November 2012)



c) Projected future erosion



b) 3-groyne design final



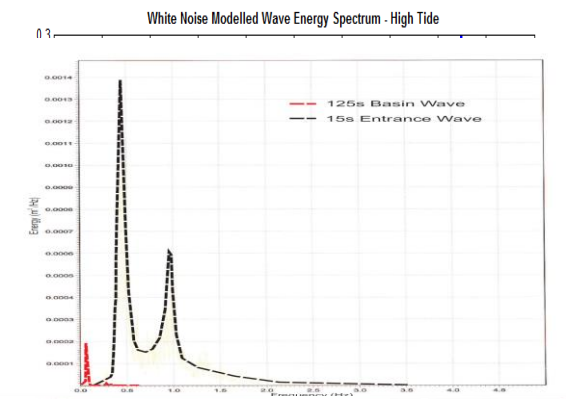
b) Stable beach alignment with three gro

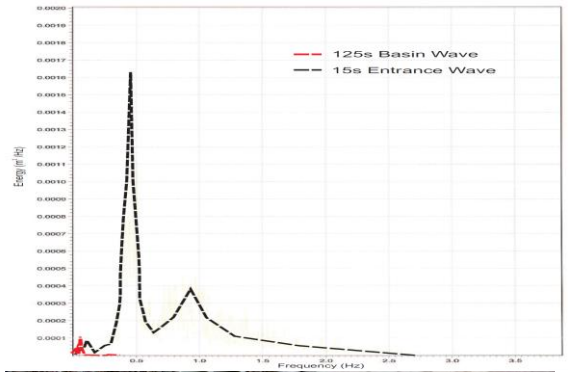
Seiching in Coffs Harbour NSW - Case Study Example 2

- Boat ramp basin within main harbour
- Seiche issues since construction ‘70s
- Num. model: 50% ↓ via basin reconfig^{n}
- 700s, 130s & 65s observations → Helmholtz
- Concerns re numerical model BCs…
- 1:58 F_r phys. model (existing + options)
- Impulse F^{n} (white noise) & Jonswap BC

KEY OUTCOMES:

- ➔ <30% resonance ↓ (all options)
- ➔ B’water extension/configuration dredging options had low effect
- ➔ Short wave (Jonswap) BC effective
- ➔ Oceanographic forcing (700s) omitted
- ➔ Field data since construction (2017) confirmed up to 30% resonance ↓



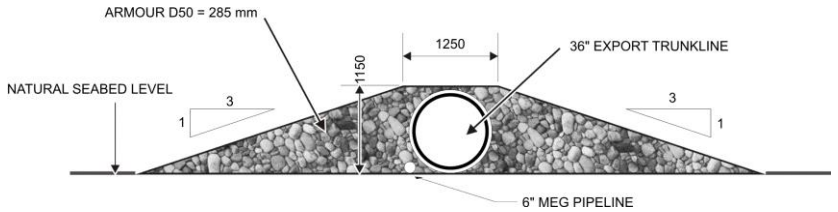


Submerged Rock Berm - Case Study Example 3

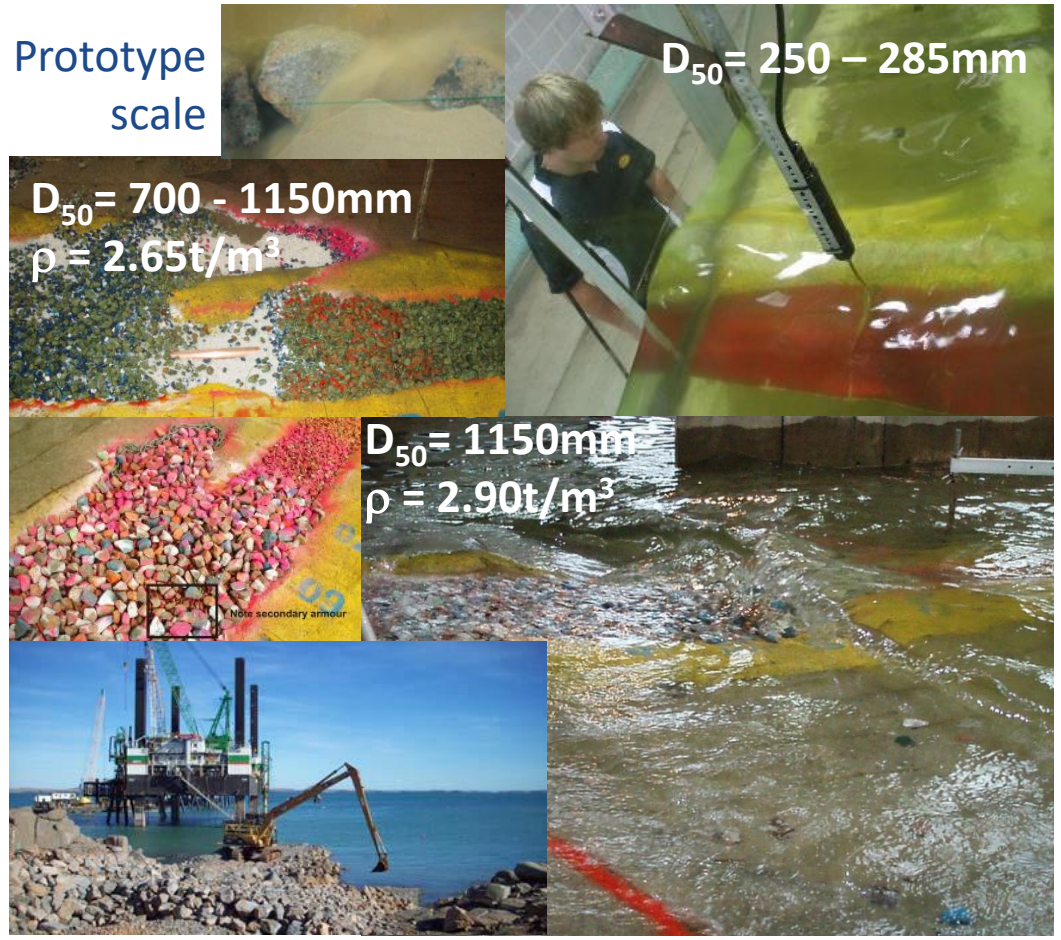
- Gas pipeline 8 – 10m depth + shore Xing
- H = 6 – 10m, T = 14 – 18s, u = 2 – 4m/s
- 2D models 1:35 & 1:40 F_r (Re = 3.2k – 5k)
  → Armour stability & underlayer efficacy
- 3D model 1:35 F_r (Re = 3.2k – 5k)
  → Shore crossing stability

KEY OUTCOMES:

- ➔ Analytical methods undersized armour in both 2D and 3D cases (avoided failure)
- ➔ Underlayer ☑ despite NA filter rules ☒
- ➔ Adjusting local 3D effects & increasing armour ρ led to acceptable stability
- ➔ Understand scale effects
- ➔ Pipeline successfully constructed by dump barge (285mm) & shore excavator (1150mm) with sig. ↓↓ $ and avoided potential failure!

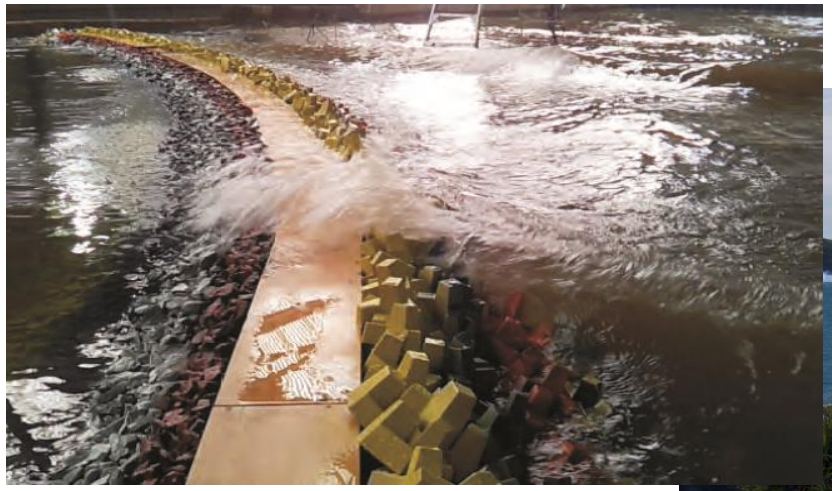


Prototype scale



Importance of Model Validation - Another Case Study

- Coffs eastern breakwater (model & prototype)
- May 2009 storm prototype & modelled damage
- June 2015 Storm (model and prototype)



- $25M saving

damage replicated …

➔ Don’t forget to consider the capability of the existing asset!

Conclusions and Recommendations

- Great value and no foreseeable end to physical modelling in Coastal Engineering
- It provides an engaging communication tool
- Recently more cost effective than some numerical models
- Can provide observations to codify numerical models/process understanding
- Integrated physical and numerical modelling is now best practice
- No matter what model, you must understand key physical processes operating and what temporal/spatial scales are involved

➔ and please let's never omit field based observations ☺

Thanks for listening

see yah

in Sydney

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13-18 September 2020

International Convention Centre

Sydney, Australia

KEY DATES

Abstract Submissions Open	1 Apr 2019
Abstract Submissions Close	15 Sep 2019
Registration Opens	13 Apr 2020
Earlybird Registration Closes	3 Jul 2020

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