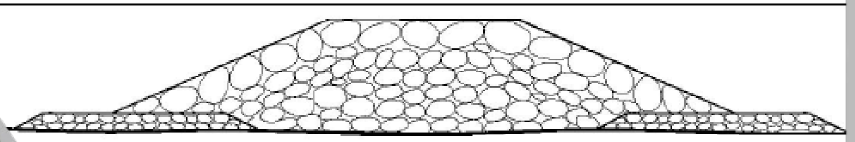
RAPID SCREENING OF PARTIALLY SUBMERGED COASTAL STRUCTURE DESIGNS USING BOUSSINESQ NUMERICAL WAVE MODELING

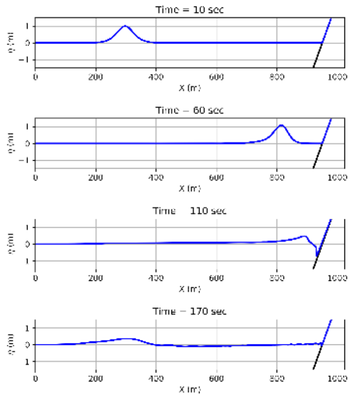
INLET ENGINEERING TOOLS

Marissa J. Torres (CRREL)

Dr. Matt Malej

Dr. Michael-Angelo Y. Lam





COASTAL INLETS RESEARCH PROGRAM

FY21 IN PROGRESS REVIEW

Tiffany Boroughs
HQ Navigation Business Line Manager

Eddie Wiggins
Technical Director, Navigation

Morgan Johnson
Acting Associate Technical Director, Navigation

Mission Support · Technology Transfer · CIRP · Research & Development

District PDT Members

Dr. Andrew Condon, SAJ
Dr. Patrick Kerr, SWG
Rachel Malburg, LRE
Hans Mortiz, NWP
Jessica Podoski, POH
Matthew Wesley, SPL

US Army Corps of Engineers®

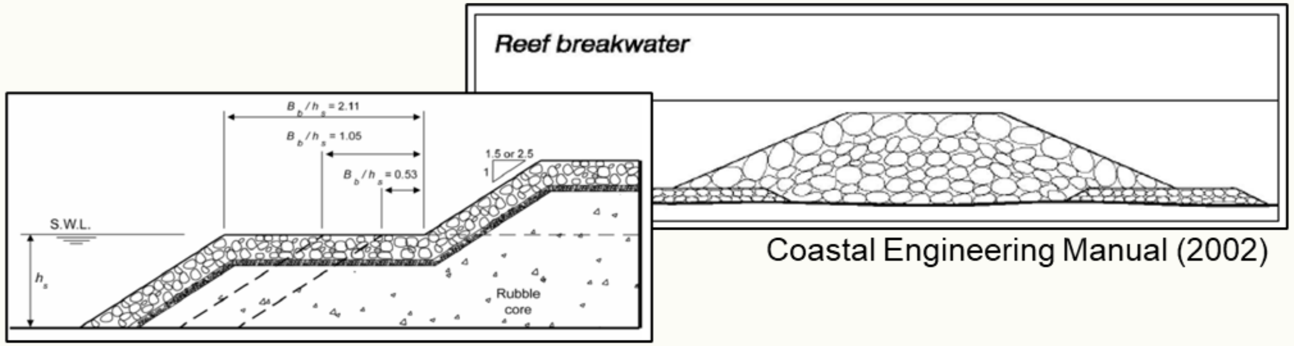
CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | *DEVELOP* | *DELIVER*

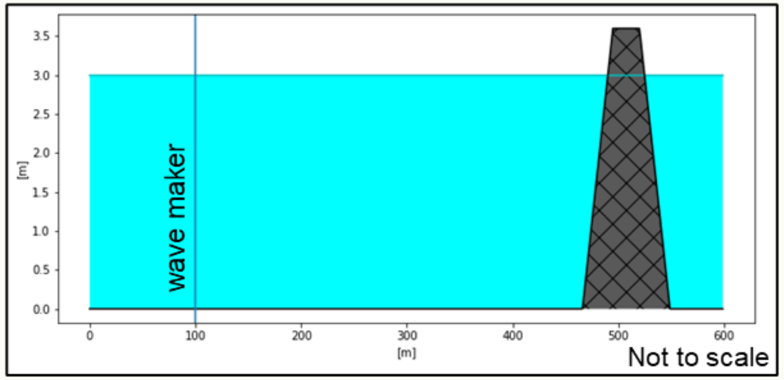
Problem Statement

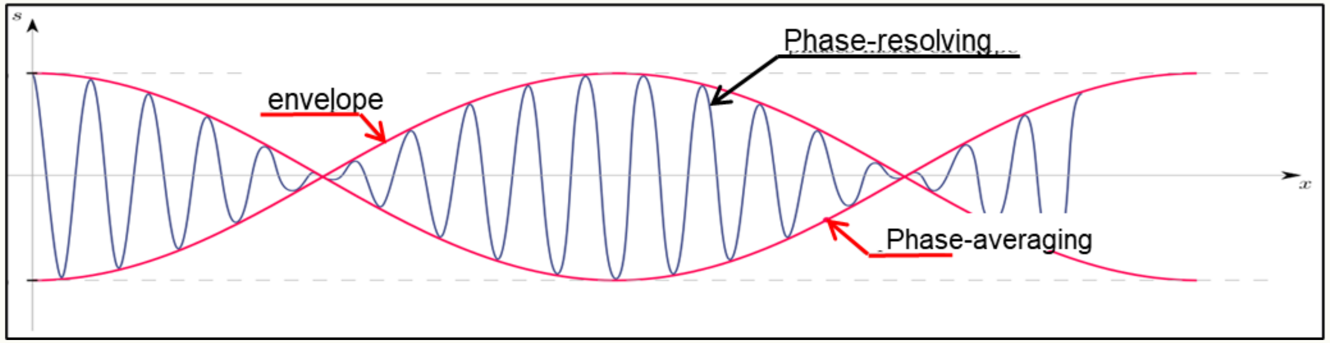
- Coastal structures (e.g., breakwaters and jetties) are vital for navigation, shore protection, and beach stabilization
- There is rarely enough time, money, and resources to execute screening of structure design alternatives or robust assessment of wave-structure interactions
- Connect coastal engineering applications to the phase-resolving, nearshore numerical wave modeling environment & make numerical wave modeling more accessible to practitioners



Coastal Engineering Manual (2002)

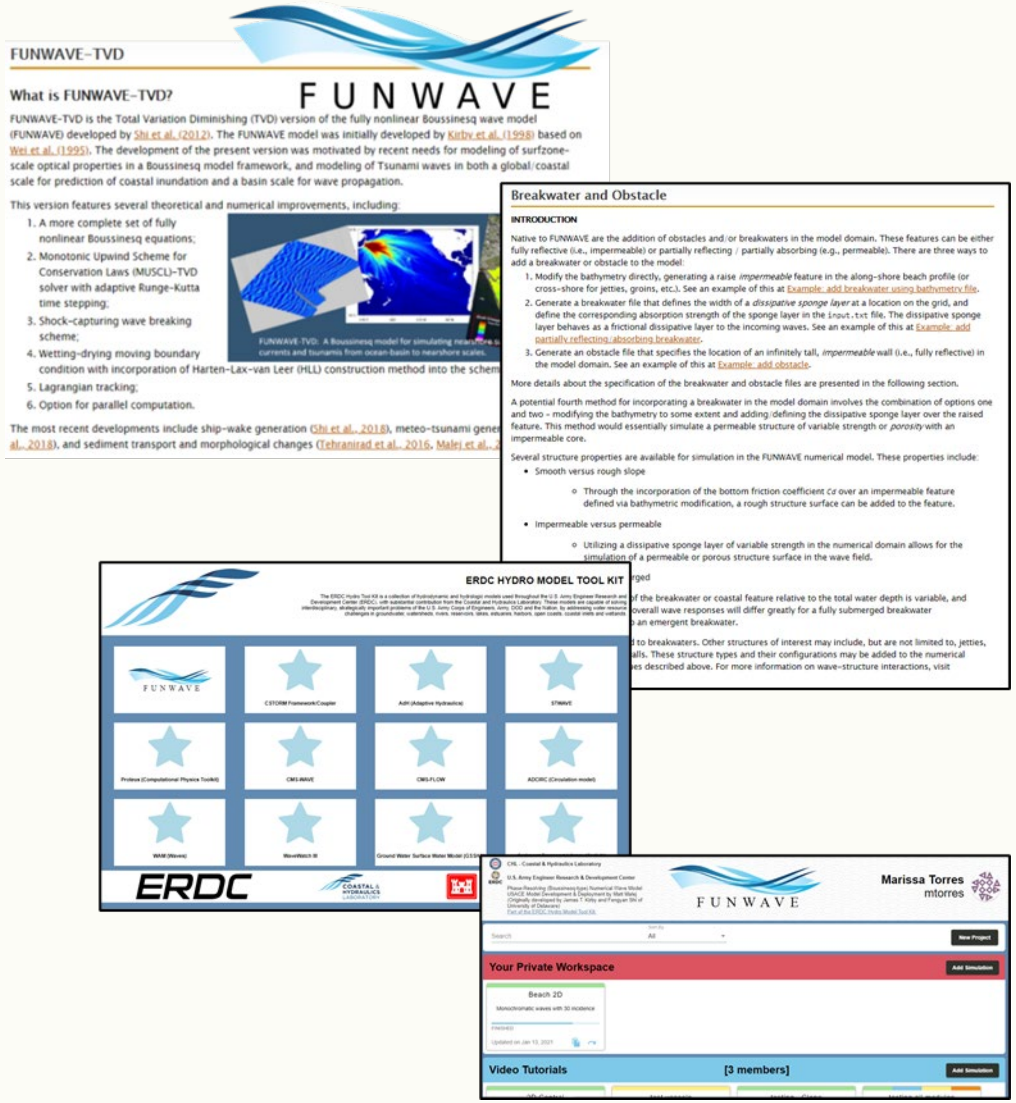
Rock Manual (2005)





Capability and Strategic Impact Statement

- **Empowering, educating, and enhancing** the skillsets of novice and intermediate users to implement complex, nonlinear numerical wave models
- Facilitate rapid screening of design alternatives for **efficient and effective decision-making** under environmental uncertainty
- **Save time, money, and resources** on SMART planning initiatives



Approach

Phase 1 – FY21
Phase 2 – FY22+

+

→ FUNWAVE

- Technical approach:
  - Outline numerical & physical considerations
  - Wave responses:
    - Wave reflection and absorption
    - Wave run-up
    - Wave overtopping and transmission
  - Overall guidance – Value Added:
    - Amount of wave energy dissipation provided by the structure
    - Wave run-up exceedance probability
    - Wave overtopping rate in extreme scenarios

- Single impermeable trapezoidal breakwater
  - Slope – m = 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8
  - Crest width – B = 3, 5, 10 m
  - Crest height – h_s = (1.1, 1.2, 1.3, 1.4, 1.5)*h

Structure Design Properties

Height (freeboard)	Surface	Porosity
Emergent	Smooth	Impermeable
Submerged	Rough	Permeable

Wave Climate Properties

Wave Type	Dimension
Regular (Monochromatic)	1D 2D normal 2D oblique
Irregular (TMA)	1D 2D normal 2D oblique

Ensemble Variables

Structure variables	Wave variables
Crest height Crest width Slope Roughness "Sponge" layer width "Sponge" layer strength	Wave period Wave height Wave direction Peak frequency First moment wave height Water depth*

Summary

FY21 Major Advances in Capability

- Fundamental knowledge transfer of physical and numerical considerations when using FUNWAVE
- Development of simulation test bed and structure design ensemble
- Aggregation of tools and resources in open-source forum – comprehensive Wiki

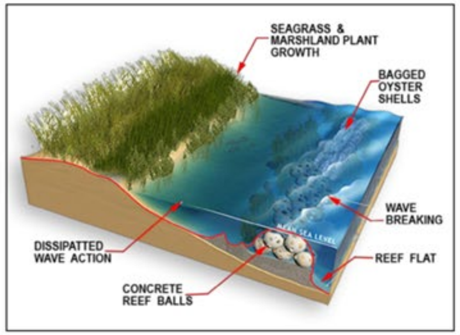
FY21 Major Products & Collaborations

- 1 ERDC TN & 1 ERDC TR
- 1 CIRP TD
- 1 CWG Presentation (date: TBD)
- 10 video tutorials on FUNWAVE HPC Portal
- 6 SoNs related to FUNWAVE in the Super RARG
- Connection to the practitioner

Planned Outyear Products/Advances

- Evaluation of wave-structure response in 1D & 2D applications
- Additional project and/or application specific video tutorials
- Contributions to the functionality of the FUNWAVE HPC Portal App

Figure 1. Examples of Coastal Natural and Nature-Based Features



U.S. Army Corps of Engineers, Engineering With Nature, "Natural and Nature-Based Features," at vn.el.erdc.dren.mil/nnbf.html.