Hydrodynamic Analysis of a Wave Energy Converter (WEC)

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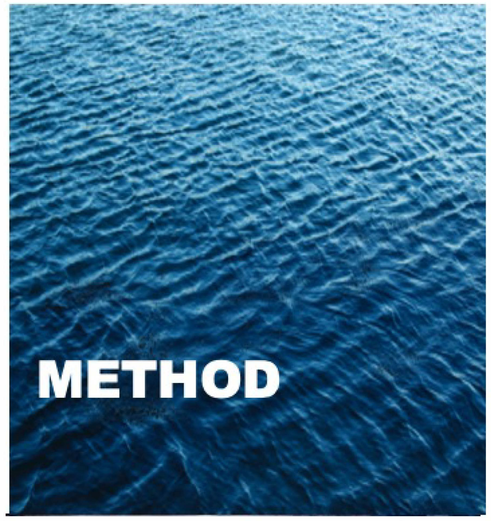
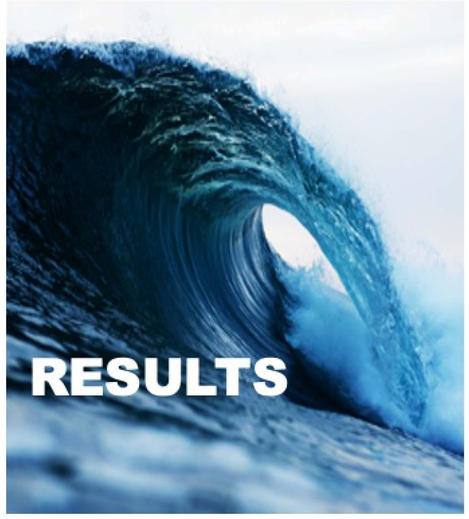
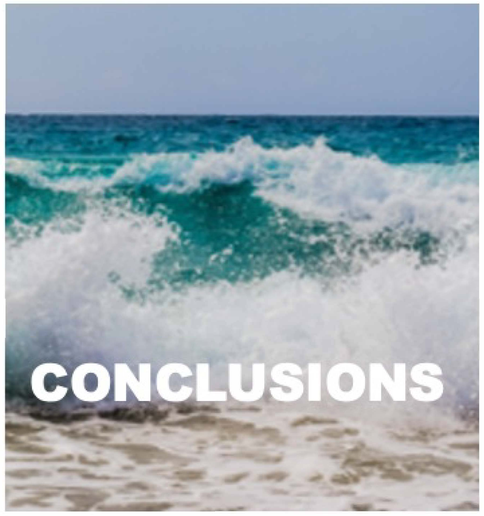






WEC BACKGROUND

WHAT

The team is advancing the marine renewable energy field by developing a Wave Energy Converter (WEC) for quick deployment in disaster relief areas in need of reliable energy.

WHY

A deficiency in deployment of WEC was identified in the marine renewable energy landscape.

DEVICE

Type: Point Absorber
Description:

- Small, easily deployed WEC device that houses magnets and coils of wire.
- Floats up and down atop the ocean surface.
- The motion of the coils with respect to the magnets creates electricity.

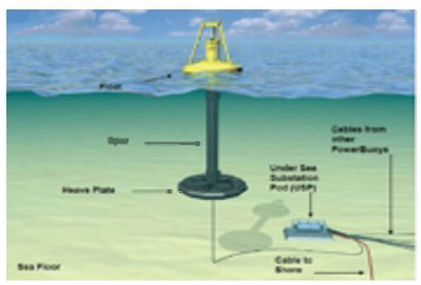


Figure 1. Point Absorber [1]

SIMULATION BACKGROUND

GOAL

Simulate the buoyant forces needed to lift the float up and down in the water.

HOW

AQWA ANSYS software simulated WEC designs in the marine environment.

WHY

- Minimized the waste and cost during prototype manufacturing.
- Float dimensions could be easily changed in AQWA

SIMPLIFICATIONS

WEC designs original geometry were simplified in AQWA.

- Hollowed shafts and floats were neglected
- Mass properties were rounded
- Unidirectional waves were used
- Uniform Regular Waves were modelled.

JUSTIFICATION

Geometry retained similar features to account for the software limitations.

SIMULATION

GEOMETRY

A cylindrical WEC was simulated to allow the users to become familiar with AQWA to generate graphs and animations.

Dimensions:

- Diameter: 1m
- Length: 2 m

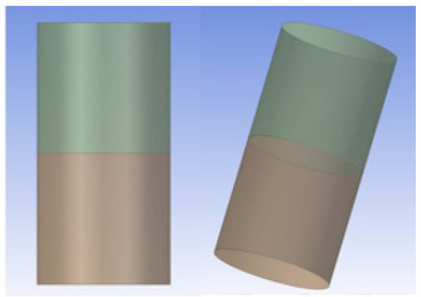


Figure 2. 3D model

The cylinder was cut in half to indicate the water level on the WEC. The green portion is the top half, and the brown is the bottom half.

PARAMETERS

The following parameters were used for the WEC simulation:

- **Water Depth:** 40 m
- **Wave Amplitude:** 0.25 m
- **Cable Stiffness:** 30 N/m
- **Wave Speed:** 0.1 m/s
- **Duration:** 20 s

DATA

PRESSURE DIAGRAM

The pressure diagram illustrates the pressures acting on the WEC above and below the water line. The pressure change varies based on the amount of submerged geometry.

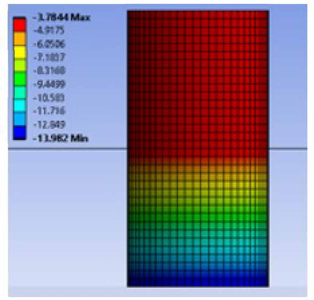
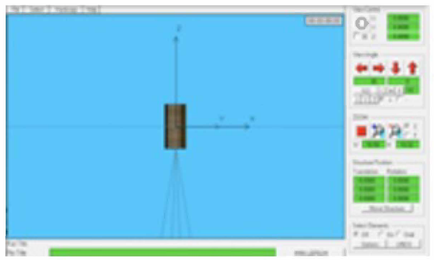


Figure 3. Pressure Contour Diagram

ANIMATION

The animation shows the bobbing motion of the cylindrical WEC in the oceanic environment.



The QR code links to the 22 second animation

DISCUSSIONS

OUTCOME

Simple modeling proved a WEC would react well in simulated conditions.

2D TO 3D

Based on the simulation results, a 3D model was constructed for small scale testing.

FUTURE DIRECTION

- Pursue complex design that involve translational motion
- Investigate
  - Mass-damper system
  - AQWA contact surfaces

The images show the complex intermediate WEC design

REFERENCES

[1] Dynamics and control of ocean wave energy converters - Scientific Figure on ResearchGate. Available: https://www.researchgate.net/figure/Working-principle-of-point-absorber-11_fig1_271949918 [accessed 30 Mar, 2021]

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