1:50 test plan

D3.5a Tank Test Plan 1:50, M3.5, Report, Detailed laboratory test plan including test points, materials and methods, and sensors/telemetry to be used. Includes schematics of test apparatus and sensor type and locations.

I. Introduction/Background

Previous work by the PIs during ocean deployment of the APEX device indicated local scour of sand under certain locations of the device. Rather than make improvements (esp. scour mitigation) to APEX, and re-deploy in the ocean, it is prudent to evaluate subscale models first. In this case, the subscale models have been preceded by numerical modeling by Sandia, NREL and M3 Wave. While this subscale model work could be done at 1:50 scale, it is prudent to test at larger scale (e.g. 1:25) if possible.

While testing high fidelity, small model versions of APEX is exciting, it is not the correct first step in model testing. A better place to start is using well studied cases of vertical piles, and subsea pipes that make ideal validation tests. Once these idealized cases have been validated, we will be able to compare numerical modeling results to physical results, (possibly) providing validation for the Sandia/NREL/M3 numerical modeling.

II. Facilities / Materials

Small scale tank testing of scour will be done in M3 Wave's wave flume in Salem, OR. This flume was used in previous DOE work successfully, and has recently been updated with a full width sediment test area for studying scour. The flume is nominally 10m long, 1m wide, and 1m deep, with a hinged flap type wave maker, vertical wedges as a beach (similar to the University of Edinburgh curved tank), and a plexiglass viewing area. Wave data is captured with Akamina capacitive wave gages when needed.

Figure 1. M3 Wave's wave flume, with viewing area visible.

The wavemaker is driven by a reciprocating shaft that is ultimately driven by an industrial motor through a worm gear—this mechanical set-up has proven to create very repeatable wave heights and periods.

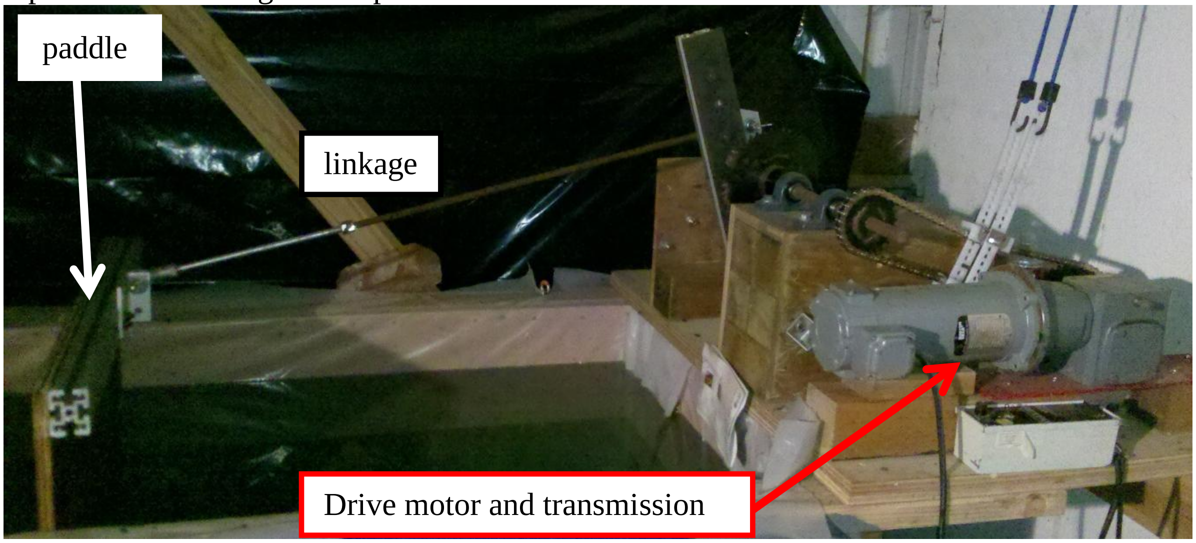

Figure 2. Picture of wavemaker, linkage and drive motor for the M3 wave flume.

Since achieving perfectly scaled sediment is problematic (must match fall velocity, particle size, cohesion and particle mass), we will be using a real world sediment/sand from the Oregon coast. This sediment has a range of particle sizes (~200um), and is "real sand." While it is not scaled down, it is very similar to the same sediment found at the 2014 APEX deployment site, and if the 1:25 testing is able to move it around, we will have evidence of strong scouring forces which will feed into further optimizing the WEC architecture and deployment strategies.

High fidelity WEC models will be made using 3D printing with the M3 Makerbot. A 1:25 replica of APEX (nominally 1 foot long, 3 inches wide, and one inch tall) will be tested to see if we can replicate scour that was observed during 2014 ocean deployment. Variants of that replica will be used to explore device elevation, scour mats, and caisson design.

III. Methods and Telemetry

- Baseline the wave maker and sediment w/o device
- Level the sand
- Run waves with device
- Digitally image scour pattern, and conduct subjective assessments of scour patterns.
- OPTIONAL: Ultrasonic imaging may be performed (similar to Hinsdale)

IV. Test Points / Plan

MODEL:
Geometries currently planned:

- APEX replica,
- APEX on stilts,
- APEX with caisson design variants (as determined from modeling work);

Tank parameters:

- Depth: 23”-25” SWL
- Wavemaker arm setting: 9 ⅜”
- Dial setting: 15-50 (minor waves to storm conditions)
    - Regime 1 and regime 4 waves (scaled) observed during 2014 APEX deployment
- Run for 30 minutes, drain tank, image and measure scour patterns
- Feed data forward

V. Expected Data Analysis
Compare results of scour location and depth to ocean observation; compare to SNL/NREL/M3 predicted data for APEX and variants