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PERFORMANCE ASSESSMENT OF TWO ACTIVE ABSORPTION SYSTEMS IN A LARGE WAVE FLUME

PEDRO LOMONACO[1], UNA SAVIC[2], TIMOTHY MADDUX[3]

1 O.H. Hinsdale Wave Research Laboratory, Oregon State University, USA, Pedro.lomonaco@oregonstate.edu
2 GHD, USA, Una.Savic@ghd.com
3 O.H. Hinsdale Wave Research Laboratory, Oregon State University, USA, Tim.maddux@oregonstate.edu

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1 INTRODUCTION

The quality of most coastal or ocean laboratory experiment depends on the accuracy, uniformity and stability of the generated waves. Generation of waves in the laboratory seems simple, but it should consider the spatio-temporal variability of the wave profile. As they propagate, waves interact with the boundaries, i.e. changes in water depth, lateral walls, test specimens, instrument supporting structures, passive absorbers, etc., as well as with varying hydrodynamic conditions (wave-induced currents, wave-wave interactions, or nonlinear energy transfer, among others). Reflected, scattered and radiated waves may propagate back to the wave generator and reflect back. Re-reflections from the wave generator may be a non-realistic representation of the intended wave field, to the extent that the total energy content in the testing facility may increase significantly and uncontrollably.

Theoretically, for weakly nonlinear unidirectional waves propagating over a relatively small number of wavelengths, and as long as the still water depth and facility width does not change, the wave properties should remain constant in space and time, which can be identified as the uniformity and stability of the waves. Under these conditions, nonuniform or unsteady wave properties can be associated to an inadequate selection of the wave theory (Airy, Stokes n-order, Cnoidal, Stream Function, etc., e.g. Fenton 1999), the approximation of the wave generation technique (first or second order, nonlinear - see e.g. Mohtat et al., 2020), formation of wave instabilities (e.g. Benjamin-Feir, 1967), wave reflection, scattering or radiation, and the performance of the active wave absorption system. It can be said that the performance of the active wave absorption control system is one of the responsible factors that can affect directly the quality of the generated waves.

Many laboratories have implemented different passive and active wave absorption systems, but the performance on the uniformity and stability of the generated waves, as well as the performance of the active wave absorption system used, have not been assessed in a systematic way, and related published data and information is quite scarce, with few interesting exceptions, e.g. (Lykke-Andersen, 2016; Spinneken 2010; Schäffer and Skourup 1996). However, a direct comparison among the different available active wave absorption control systems is still missing.

This paper presents a thorough experimental study on the performance assessment of two different active wave absorption control systems (MTS and Awasys7) as a means to establish the quality of the experiment in terms of the uniformity (space) and stability (time) of generated wave parameters (descriptors) in the laboratory.

2 METHODOLOGY

The experiments have been conducted in the Large Wave Flume at the O.H. Hinsdale Wave Research Laboratory (HWRL), Oregon State University. The flume is equipped with a piston-type dry-back wave generator manufactured in 2009 by MTS Systems Corp. It includes a built-in wave generation and active absorption control system based on a correction of the drive signal using the free surface measured at the paddle board. Waves are synthesized with HWRL-developed routines incorporating advanced second-order wave generation and evanescent modes (e.g. Zhang and Schäffer 2007). More recently, in 2016, the HWRL acquired Awasys7, a state-of-the-art wave generation system, developed by Aalborg University, that includes second-order wave generation and nonlinear wave absorption, among other features.

A total of 25 different tests (Figure 1) were executed with regular and irregular waves, comprising a wide range of wave periods and wave heights, where in most cases the absorbing beach has been removed and the bottom remained flat and horizontal, aiming the full reflection of waves at the opposing end of the flume, while propagating over a constant depth (Figure 2). Both generation and absorption methods were used, and measurements of the surface elevation were made along the flume to assess the performance of the absorption systems.

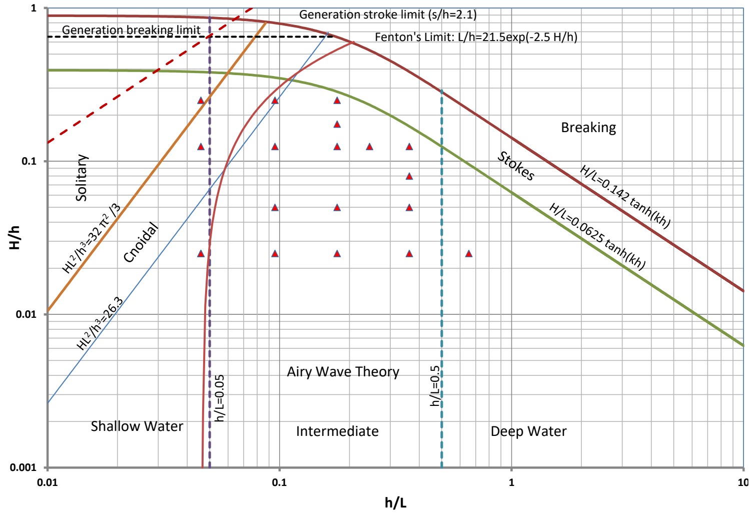

Figure 1. Wave conditions tested for the performance assessment of the active wave absorption systems.

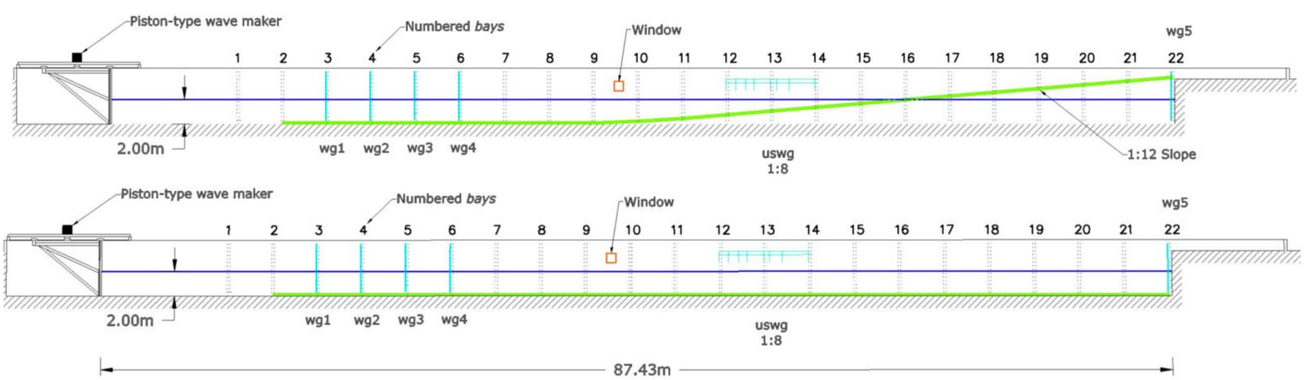

Figure 2. Instrument layout and bathymetry configurations in the Large Wave Flume. Top: 1:12 slope absorbing beach. Bottom: Full reflective wall and horizontal bottom.

The methodology was not only able to comparatively assess the performance of both active wave absorption control systems, but also to identify the parameters to describe the uniformity and stability of the generated waves.

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