Name of organization CAMERI - Coastal and Marine Engineering Research Institute	**Year of information updating** 2021
Year established 1976	**Year of joining the ITTC** 2021
Address Technion City Haifa 32004 Israel	**Status in the ITTC** TBD
Contact details (phone, fax, e-mail) +972-4-822-0642 sea21@technion.ac.il	**Website** http://www.cameri-eng.com/

Type of facility Towing Tank and Wave Flume	**Year constructed/upgraded** Upgraded in 2018, 2019 and 2020
Name of facility CAMERI - Towing Tank and Wave Flume	**Location** (if different from the above address)

Main characteristics (dimensions of tank/basin/test section; for simulators: full mission, part task or desk top)

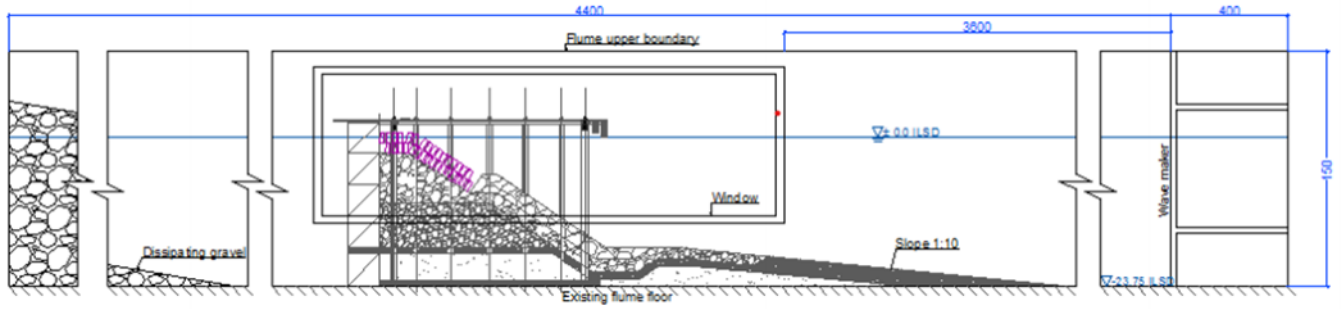
The mission of CAMERI Towing Tank and Wave Flume are to conduct stability tests, floating and submerged vessel towing, and wave-structure interaction tests. 2D stability models investigate specific parameters affecting the subject and its interaction with fluids.

1/ Towing Tank:
The Technion Towing Tank is equipped by carriage which was designed and built by Kempf and Remmers in the late 1950's, Hamburg, and has been upgraded by RAMTA. It has a double purpose of testing small ship models and calibrating water meters. The water level may be set at any desired level up to a depth of 1.5m to simulate a prototype operating in either deep or shallow water. The maximum speed of the carriage is 4.4m/sec. The carriage working distance is 39m (due to wavemaker limitations): First 6 meters accelerations, 32 meters steady speep and 6 meters for decelaration. It is used for estimating the total ship resistance using small scale models.

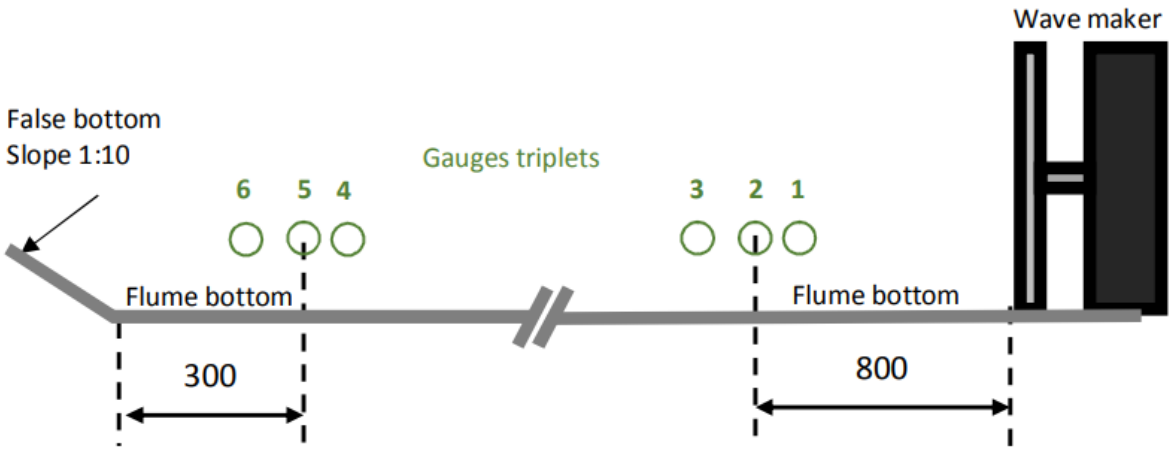
2/ Wave Flume:
The CAMERI wave flume is 48m long, 44 m from the wavemaker paddle front to the rear wall,
2.46 meter wide and 1.5 meter deep. The side walls are concrete with a transparent window of 3 meter long located at a distance of about 36 meter from the wavemaker paddle. The studied structure is located in front of the window. A wave absorbing stone slope is located at the rear wall.
The flume has a piston-type wavemaker with an electric drive system and is equipped with an Active Wave Absorption Control System.

Drawings of facility

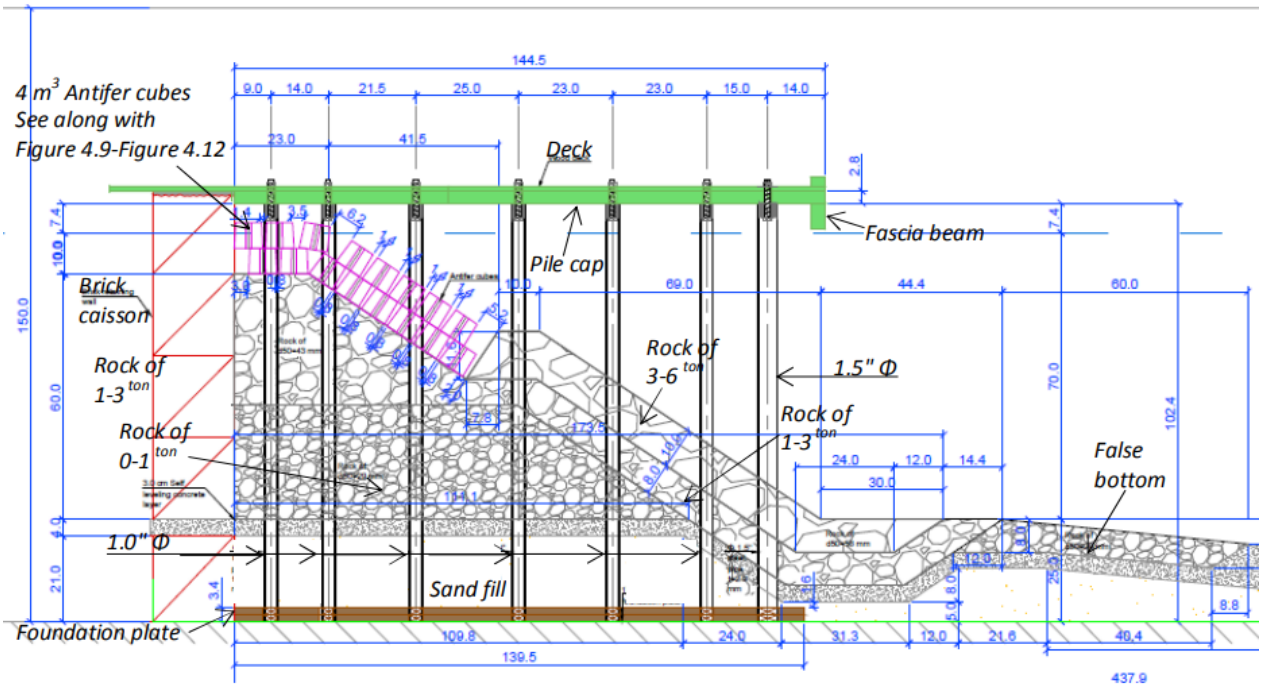
1/ Wave flume general setup drawing



2/ Wave triplet location along the flume

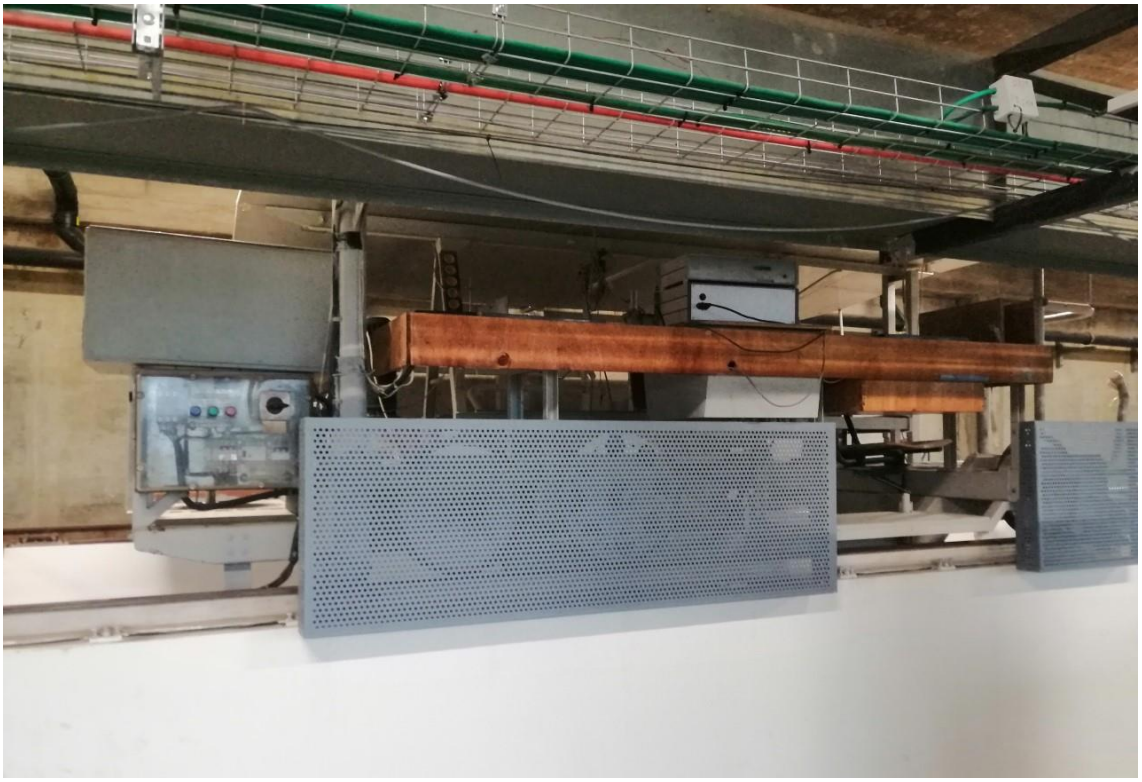


3/ Example: quay model general cross section (Refer to applications section)



Pictures of the Facility:

Picture 1: Wave Flume



Pictures 2 and 3: Towing Tank

Detailed characteristics (carriages, wave/current/wind generators, instrumentations, etc.)

Instrumentations:

1. Wavemaker
The regular waves were generated by the DHI wavemaker of the 080/FE type. This is a piston type wavemaker with an electric drive system. The paddle dimensions are 2.46 m wide and 1.5 m high. The wavemaker capacity limits are: full stroke 0.8 meter, maximal speed 0.75 meter per second, maximal water depth at the wavemaker paddle is 1.1 meter. The wavemaker is equipped with an Active Wave Absorption Control System – AWACS. This digital servo control system enables the wavemaker, while generating the specified regular or irregular waves, to absorb waves reflected (from the rear slope or from the structure of the investigated model) to the wavemaker paddle. Hereby re-reflection of waves on the wavemaker paddle is largely eliminated and the incident wave field is more accurately represented. The system includes four wave feedback gauges integrated in the wavemaker paddle front.

2. Wave data acquisition and analysis:
Wave Synthesizer (Type 460/32-AC, DHI) controls the wave generating system in real-time on the basis of the synthesized wave-maker control signals. Simultaneously with controlling the wave-maker, the wave synthesizer performs data acquisition from the all-test output channels. The sampling frequency is user-defined and may be specified individually for each channel. Acquired data is stored in a binary format for flexible post-processing and display. For easy use the acquired data can be written to an ASCII file as well.

3. Wave gauges: Water levels are measured by a point gauge that are mounted at the wave flume wall. The waves (instantaneous water level) are measured by resistance type wave gauges by DHI 201 series with amplifiers of type DHI 108 and 101e. The wave gauges resolution is <1mm, time stability<0.5% F.S./24 hours. The output amplifier voltage is +/-10 Volt. The wave gauges are calibrated on their linearity (different submersion) at the beginning of each test.

4. Pressure transducers: The hydrodynamic pressures, applied to the structure by waves, are measured by the pressure transducers of 25Y series of Keller AG and of HKM-375M series of Kulite Semiconductor Products, Inc. The pressure range is 1 BAR. The sampling rate as was specified by the client was 1,000 samples per second. The pressure transducers are working with DC measurement amplifiers, type Hottinger HBM KWS 3020B and are supplied with calibration certificates. Built-in amplifiers located in completely shielded amplifier enclosures greatly improve signal-to-noise ratio.

5. Float (lever) Height Variation Sensors
These self-fabricated sensors were designed to measure height variation of floats from wave action. The sensors are mounted both on the front and the rear levers of the floats system. it consists of a bearing with shaft attached to the lever, which motion is associated with the water surface elevation, a potentiometer mounted on the static frame of the tested structure and a crank mechanism allowing to convert the rotational motion of the lever to rotational motion of the potentiometer shaft.
Rotary Precision Position sensors of BEI Sensors from the 5320 series are used as potentiometers. The sensors meet IP67 standard (waterproof), have 240 degrees of electrical travel at +/- 2.0% full-scale linearity. The potentiometers are included in the measuring circuit according to the radiometric circuit, which excludes the influence of fluctuations in the power supply voltage, electrical interference, etc.

6. Flywheel rotational speed sensor - RPM (rotations per minute) Sensor
Dedicated self-fabricated, these sensors are designed to measure, directly, the rotational speed of the flywheel using an encoder-measuring wheel. The sensor consists of an optical encoder with 600 lines per turn attached to a special measuring wheel 9109/10 type of Sensata Technologies (with calibrated diameter and rubberized surface), installed in such a way that it rides on the circumference surface of the flywheel of the tested model. The gear ratio is 320 / 63.66, which corresponds to 3016 pulses per flywheel revolution.

7. High resolution Video Camera and High-Resolution Photo Camera.

Applications (Tests performed)

The flume is used to conduct stability tests, floating and submerged vessel towing, and wave-structure interaction tests. Many physical models was build to represente and simulate different scenarios before implementations of major stuctures.

Applications Examples:

HA'DAROM PORT (2015)
Expansion of the existing ha'Darom Port through the construction of a new container terminal known as the New Marine Container Terminal at ha'Darom Port.

This model study was ordered by the Israel Ports Development and Assets Company Ltd (IPC), and specified by HPA Engineers, P.C., appointed by IPC as its consultant responsible for the planning and design of the marine facilities associated with the port expansion. The study presents a two-dimensional (2D) model of representative sections of Quay 28, a relatively unusual structure combining a pile jetty structure with a rubble mound revetment and Antifer cube armor at ha'Darom Port in Ashdod, Israel. The designer's main concern is an extreme wave event applying forces both on the revetment and on the platform, in a in a multiple cylinder flow regime constrained by the piles. The other concern is the stability of the revetment during construction, when the port breakwater extension is not completed, and the platform is yet to be constructed.
The study was carried out for a construction stage and the final state. During construction, revetment stability tests were carried out with the piles only (i.e. no deck), and in final state, pressure measurements were taken as well.
For achieving these objectives CAMERI built a model of the quay, placed it in the wave flume along with the revetment, and carried out revetment stability tests including pressure measurements for all the states as were specified by the client before and during the tests. The model as was specified by the client includes construction of revetment and structure (piles and deck).

PORT OF HAIFA (2010)
The Main Breakwater and the East Revetment of the New Marine Container Terminal at the Port of Haifa (HNMCT).The model study was ordered by HPA Engineers, P.C., appointed by the Israel Ports. The HNMCT project included reclamation of approximately 650,000 square meters to provide a development area for the new container terminal and ancillary facilities and construction of an extension to the existing Main Breakwater (1100m), as well as a new East Breakwater and East and Lee Revetments. In addition a series of berths will be developed at quays 6 and 7, to accommodate container vessels.
The model included Rubble Mound with Antifers, Caisson wall, stability and overtopping tests.

POLYNOM (2005)
Two dimensional stability model of a section of the main breakwater of "Polynom" project in the Bay of Haifa. The model test objective was to study the hydraulic stability of the armor layers to specified storms series, for two design alternative.
Stability, overtopping, and sensitivity tests were carried out in order to help the client to choose between the two alternatives.

HAYOVEL PORT (1999)
The new north extension of Ashdod port included an additional 1,800 meters of quays, dredging and reclamation works – all sheltered the Main Breakwater, which was extended as well. The study in the lab was carried out in order to examine the breakwater crest and rear stability, the seepage pressure adjacent to the Crown-wall and the hydraulic general stability regarding the revetment and armor units.
The model included stability, overtopping tests, and pressure measurements applied on the Crown-wall, helping the designer to determine safety coefficients.

Published description (Publications on this facility)

Physical Model Study To Assess Wave Conditions In A Staging Harbor For The Ashdod Port 2015 Development Project. Report – P.N. 685

Ha'darom PORT – QUAY 28 PHYSICAL MODEL, 2D Hydraulic Model Studies Of A Quay-Revetment Stability And An Upper, Platform Pressure Measurements. Final Report – P.N. 801/14

"PORTS 2000" Physical Model For The Port Of Ashdod Development Stage "A", Final Report – P.N. 479/98