Strengthening coastal defence and supporting offshore economy

The Coastal & Ocean Basin (COB) in the Flanders Maritime Laboratory in the Ostend Science Park is a versatile test facility to support the scientific community in its efforts to tackle climate change and come up with countermeasures to protect coastal communities and offshore investments, such as wind turbines or infrastructures for the breeding of oysters and mussels.

The COB is a joint initiative of Ghent University, KU Leuven and Flanders Hydraulics Research (FHR). This wave tank is able to reproduce wave, current, and wind conditions, offering an unprecedented opportunity for researchers and industry to take a closer look at ocean hydrodynamics, and the structural response of coastal and offshore structures. It also enables them to advance marine renewable energy technologies and to validate numerical models.

Countering the climate change effects

© Ghent University - Prof. Maximilian Streicher, COB Director

© Ghent University - Prof. Peter Troch (Ghent University), Head Management Committee COB

Acceleration in sea level rise and increased intensity of storms have put coastal populations at risk, and pushed the scientific community to come up with better solutions through designing coastal protection structures, developing new ocean renewable energy technologies, or implementing nature-based solutions. “In any case, designers have to go through the integrated research methodology, which combines both numerical and experimental scale modelling,” says Prof. Peter Troch (Ghent University), who coordinated the COB’s design and construction.

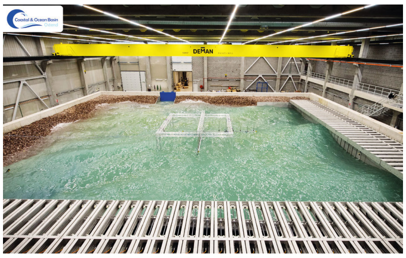
“Flanders has experimental test facilities at Ghent University and FHR, with a limitation to relatively small-scale experiments. Therefore, and to cope with the emerging needs, a consortium led by the civil engineering department at Ghent University, in partnership with KU Leuven and FHR secured funding for a new state-of-the-art test facility. The COB is designed to cover a wide range of experimental modelling needs while minimizing operating costs. This results in a large range of opportunities for academic research and for governmental and private sector projects.”

Interdisciplinary work

“Starting with coastal engineering, scale experiments will offer valuable data on the wave impact loading of structures, the prediction of wave overtopping over dikes and breakwaters and damage to coastal structures. Emerging marine renewable energy technologies including offshore wind, floating photovoltaics and tidal and wave energy converters will be also tested in the COB. Moreover, interdisciplinary work that combines marine ecology with engineering will help shape the role of seagrass vegetation and natural reefs with their habitants. The civil engineering department at Ghent University focuses on these applications. Traditional work of this department concerned wave overtopping, wave energy converters and scour protection. It also pioneers in coastal defences and wave attenuation by vegetation."

The Flanders Maritime Laboratory also hosts a towing tank (174 m x 20 m). This combination offers a unique opportunity to perform multipurpose tests within the same facility, which will create strong research synergies.

The COB laboratory consists in a large technical facility housing the basin and the accompanying systems to operate it. The main wave and current basin covers an area of 900 m² (30 m x 30 m). It is operated by four components: a wave generator, a current generator, a wind generator and a water transfer system. "A fully automated data acquisition system ensures smooth and perfectly controlled set-up, start-up and management of all testing scenarios. Auxiliary systems that improve the efficiency of the experiments have been also installed. These include an access bridge, a crane, an operation control room and a workshop."



© Ghent University – General overview of the COB laboratory, with generated waves inside the wave tank.

Wave generator

The wave generator is a crucial mechanical system for the COB. "This system is composed of relatively narrow wave paddles, capable to generate very realistic waves in any direction. The L-shaped configuration of the wavemaker covering two sides of the basin, enables to test a large variation of short-crested wave angles. Coupled with the current generation system, it can achieve any desired relative angle between the generated current and waves, offering a unique generation system. The COB offers a variable water depth ranging from 0.4 to 1.4 m, enhanced by a central pit with a maximum water depth of 4.0 m. Multi-directional wave generation with a maximum height of 0.55 m is targeted," Peter Troch explains.

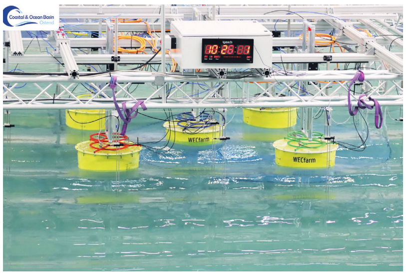
Current generator

The current generation system is a tailor-made solution, dimensioned by the dominating flow conditions in the Belgian coastal waters, characterized by tidal currents with a typical depth-averaged flow velocity of about 1.0 m/s in full scale. "Considering a maximum scaling factor of about 1:8, the flow velocity in the model is scaled down to 0.4 m/s, requiring a total discharge of approximately 11 m^3/s. The current is introduced in the basin through a set of guiding grids flush-mounted in the basin floor. Each grid can be replaced by a lid when the current system is not being operated," says COB Director Prof. Maximilian Streicher.

WEC Farm

Devices designed to harness wave energy and convert it to electricity are called Wave Energy Converters (WECs). Industry and academia spend considerable efforts to bring WECs, and WEC arrays, into the commercial stage. They need available real-life data to validate their numerical models used for design. However, publicly available databases from WEC array experiments are limited, due to the high conducting costs and complexity.

The WECfarm project, initiated by Ghent University, aims to improve the understanding of interactions between the individual WECs within an array, and addresses the need for experimental data on WEC array tests. A team from the Coastal Engineering Research Group performed experiments focused on the extraction of wave energy using an array of five-point absorber WECs. Similar to offshore wind turbines, multiple point absorber WECs are installed in an array configuration, to increase the total capacity, and to benefit from the economies of scale.



© Ghent University - Experimental setup of the five-WEC array. The WECs are attached to a truss structure placed in the wave basin.

The point-absorber WECfarm WEC consists of a floating buoy to capture energy from waves coming from different directions. It is equipped with a permanent magnet synchronous motor (PMSM). The WEC array control and data acquisition are realized with a Speedgoat real-time target machine.

SoilTwin

The SoilTwin project is a collaborative effort between Ghent University and Vrije Universiteit Brussel, funded by the Belgian Energy Transition Fund and VLAIO. It aims to unravel the intricacies of soil behaviour around offshore monopile foundations through in-situ monitoring data and experimental and numerical modelling.

For the SoilTwin experimental model tests, the central pit in the COB tank floor was successfully filled and compacted with sand for the first time, providing a unique dataset of pore pressure measurements, combining geotechnics with hydrodynamics. “This is a significant milestone in our quest for innovative solutions in coastal and offshore engineering,” underlines Peter Troch.

Saving Fort Boyard

For several decades, Fort Boyard –in the French department of Charente-Maritime– has been under attack from waves and tides. To prevent the fort from falling into disrepair, the Charente-Maritime department initiated a major project to renovate the fort’s wave walls and harbour. Commissioned by the design-build consortium, tests on a 3D scale model of fort Boyard were carried out at the COB. The campaign focused on testing how the proposed design performs under storm conditions, including the measurement of overtopping and run-up, pressures on vertical walls, wave transmission and stability of the toe protection. The test results will directly support the design process, ensuring the long-term protection of this historic structure.

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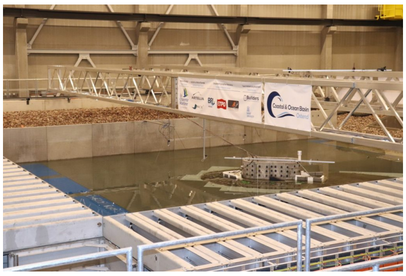

Test with the scale model of Fort Boyard. © Ghent University