ARPEC: A NOVEL STAGGERED PERFORATED CAISSON FOR WAVE ABSORPTION AND TIDAL FLUSHING

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INTRODUCTION

Perforated multichamber r.c. caisson breakwaters are widely used for deep harbour protection from waves, often in microtidal conditions. The openings at the seaward chambers allow a partial dissipation of wave energy due to resonance, viscous friction losses, flow separation, eddies, vortex shedding and turbulence; such hydraulic dissipations and the related reflection performance are mainly governed by the porosity of the perforated walls and by the “chamber width/wavelength” ratio. The landward chambers can also be perforated to absorb residual wave disturbance in the harbour basin.

The proposed innovative geometry (patent pending) named “ARPEC” (Anti Reflective PErmeable Caisson) includes openings at all external and internal walls and at lateral (cross) ones, yet in a staggered pattern, to provide a labyrinthian hydraulic communication between the open sea and the internal waters. The complex sinuous water-flow within the consecutive permeable chambers thus favors wave energy dissipation as well as port water flushing and quality, with very low reflection and transmission coefficients. The water exchange can be an important aspect in semiclosed harbour basins along microtidal coasts. Figure 1 shows an example geometry.

MODEL TESTS

A first series of 2D model tests have been performed in 2019 in the random wave flume of Roma Tre University. The wave channel is 20 m long, 0.605 m wide and 1 m high, equipped with the advanced Awasys active absorption system for wave generation.

The ARPEC model was reproduced in plexiglass at a scale of 1:35.33 (in Froude similarity), with reference to a specific design case, see fig.2. Regular and random waves tests with prototype periods between 4 and 12 s were reproduced for two reference water levels (+0.00 and +0.50 m), with variable incident wave heights.

Similar tests on a traditional impermeable perforated caisson with variable porosities were presented by Franco et al. (2019), also accounting for the flow through the bottom rubble footing. Comparison of test results were also made with the ARPEC geometry of fig.1 having the landward wall porosity reduced to 50% and to zero (impermeable perforated traditional case).

Moreover, flow measurements at the port side were made within a “dam break” type test, as well as analytical descriptions of the velocity fields, in order to estimate the discharge and the flushing potential.

CONCLUSIONS

The measured reflection coefficients were in the range of 0.2-0.6 (increasing with wave period), while the transmission coefficient was rather influenced by porosity and is in the range 0.1-0.2. Results are promising for further studies and design applications.

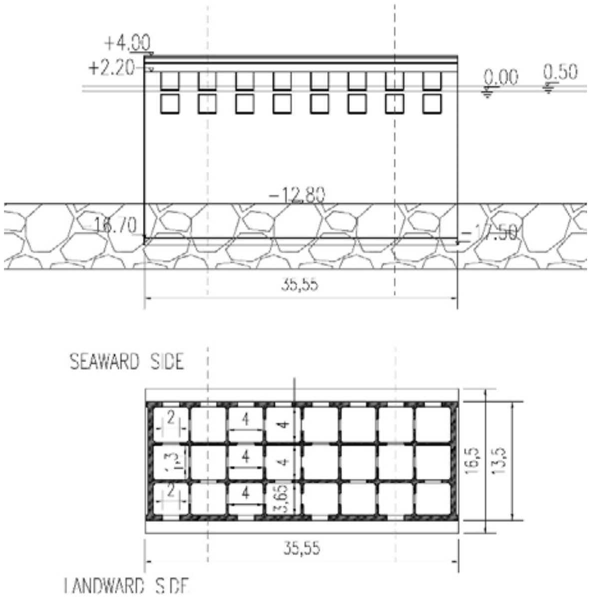

Figure 1 -View and horizontal section of the tested ARPEC caisson (prototype size). Outer wall porosity = 12%

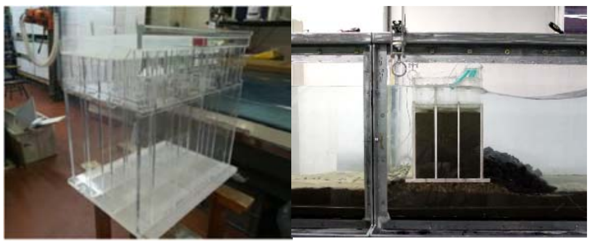

Figure 2 - ARPEC model tested in the random wave flume

REFERENCES

Franco L., Bellotti G., Cecioni C., Lykke Andersen T. (2019): Laboratory tests on the reflection coefficient of a perforated caisson, Coastal Structures, Hanover.