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THE EFFECTS OF BOTTOM AND FRONT BARRIER THICKNESS ON THE EFFICIENCY OF AN OWC DEVICE

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Abstract

The effects of the bottom and front barrier thickness on the efficiency of an Oscillating Water Column (OWC) device are analysed within the context of linearized water wave theory. Under the potential flow approach, the associated boundary value problem is solved by the Boundary Element Method employing linear elements. Numerical results for the OWC device efficiency for several physical parameters and configurations were obtained. Different geometrical shapes of the bottom and front barrier thicknesses were considered. The effects of the porous depth and the front barrier thickness on the efficiency of the OWC device are discussed in detail. In addition to the structural properties, it is shown that the OWC performance is dependent on the bathymetry properties. In order to verify the computational results, these are compared with results published in specialized literature and very good agreement is achieved.

The Boundary-Value Problem

The origin of the Cartesian coordinate system lies on the undisturbed water surface and the rigid, vertical wall. The OWC is integrated by a rigid wall, situated at $x = 0$, extending down to the bottom and complemented by a thick, vertical, surface-piercing barrier, at $x = b$, with a draft, h_a, as shown in Fig. 1. A turbine is connected to the air chamber formed by the two walls. The porous bottom distribution originates at $x = b + d$, and can be considered either a linear or parabolic variation.

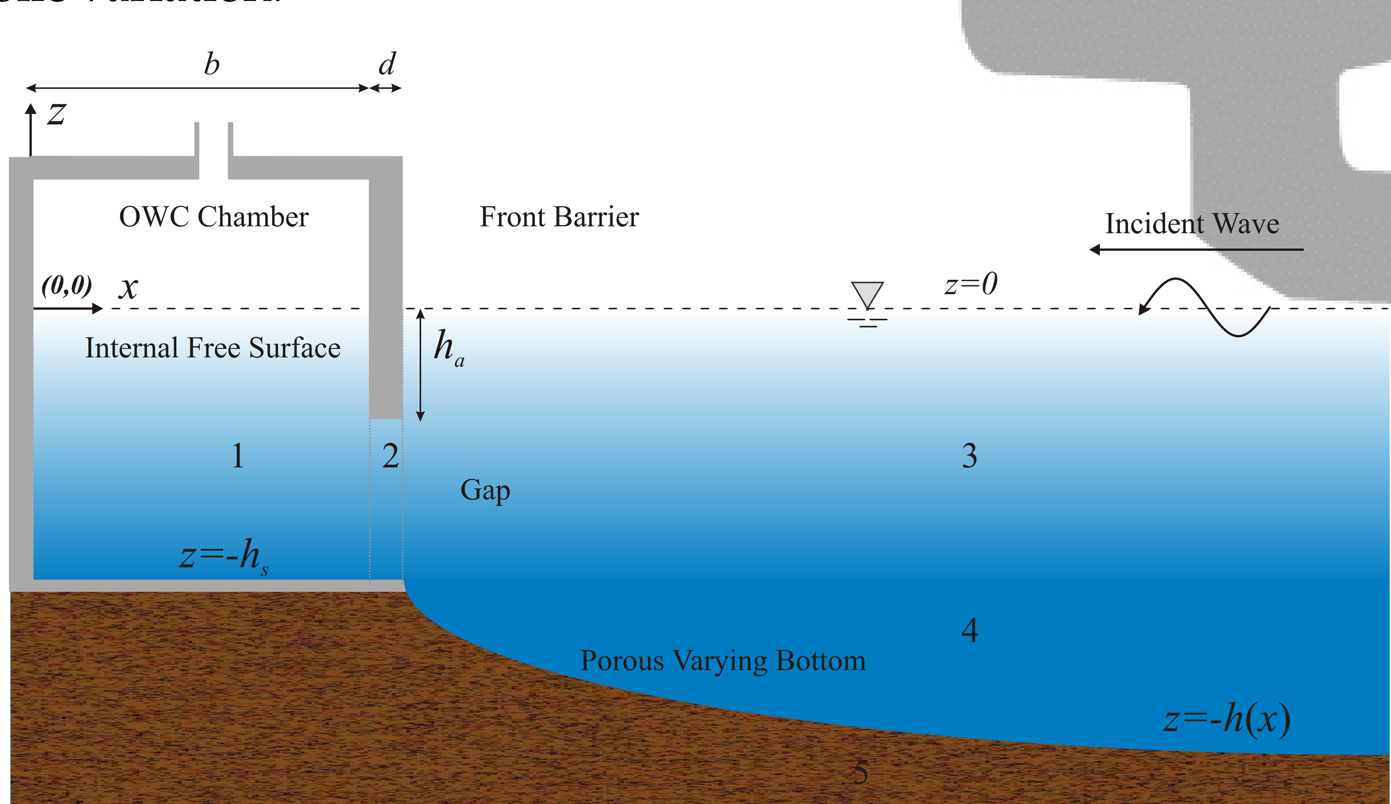

Figure 1: Schematic diagram of an OWC device in a porous varying bottom.

Numerical Implementation

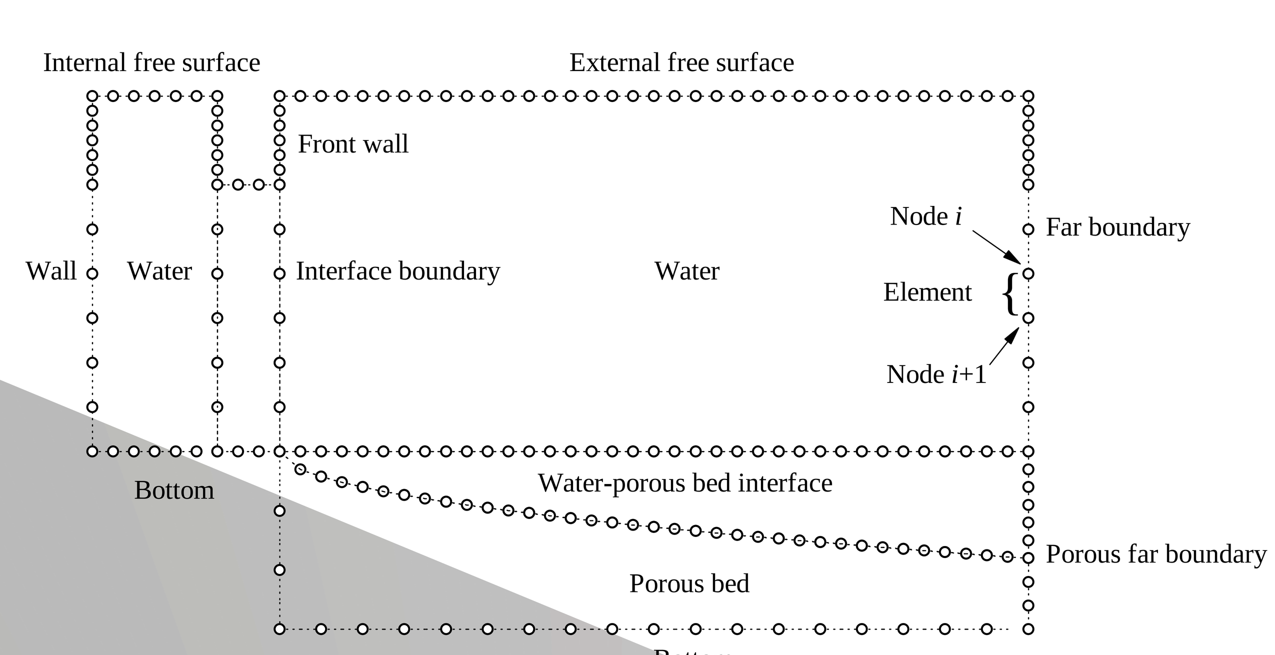

Figure 2: Schematic diagram of the discretized domain employing the Boundary Element Method.

Table 1: Convergence study of η_{max} in case of a parabolic porous bottom for $h_a/h_d = 0.125$, $b/h_d = 1.0$ and $H/h_d = 1.5$

Elements at interface	Total elements	Kh_d	η_{max}
5	185	1.117862091	0.99877
6	222	1.117862091	0.99855
7	259	1.117862091	0.99836
8	296	1.117862091	0.9982
9	333	1.117862091	0.99805

Results

Figures 3 and 4 show the efficiency η_{max} versus Kh_d for an OWC device near a variable porous bathymetry. Firstly, in Fig. 3 the effect of the barrier to wall spacing, b/h_d, on the efficiency η_{max} of the OWC device in a variable porous bathymetry is plotted. Then, in Fig. 4 the effect of the linearized resistance coefficient f on the efficiency of the OWC device in a parabolic porous bottom is shown. Finally, in Table 1, a convergence study of η_{max} for the case of a parabolic porous bottom is carried out.

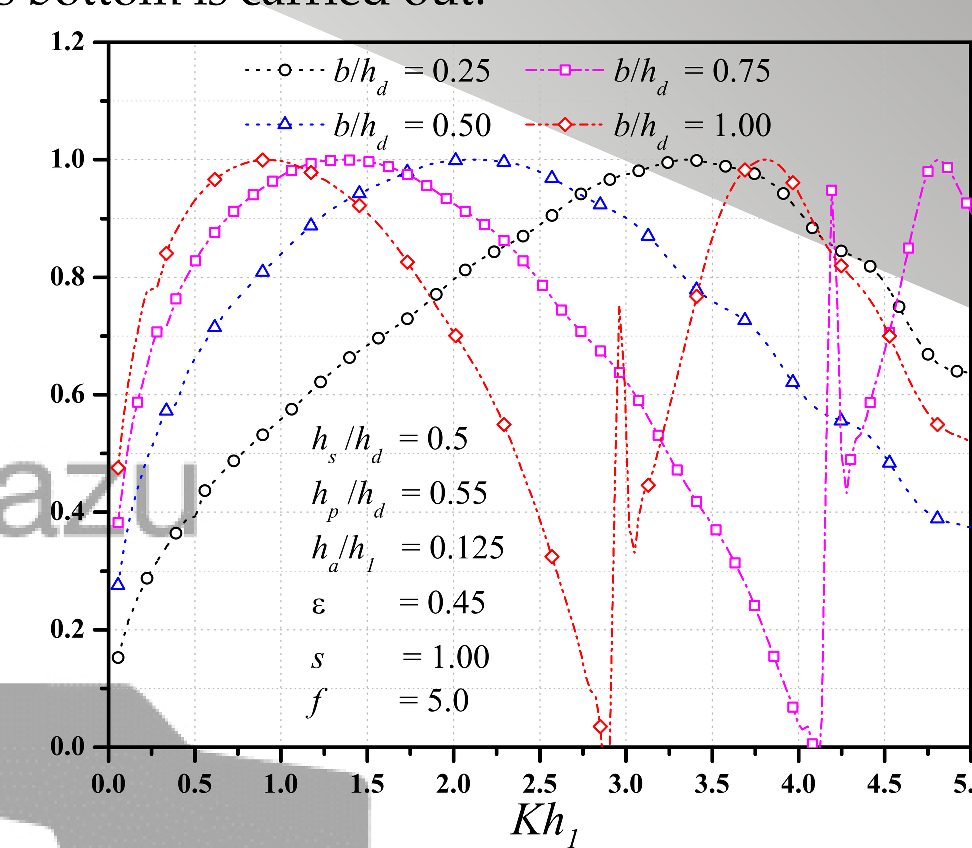

Figure 3: Effect of the barrier to wall spacing b/h_d on the efficiency, η_{max}, of the OWC device in a variable porous bathymetry.

Conclusions

Numerical estimates for the efficiency were obtained for various values of the physical parameters involved in the problem. The analytic results were compared with limiting cases obtained by Evans and Porter [1] and Rezanejad et al. [2] for the case of a horizontal bottom bathymetry, on the efficiency of an OWC device in impermeable bottom and very good agreement was achieved. It was observed that the bathymetry properties and the front barrier thickness affect the efficiency of an OWC device. In particular, for a parabolic porous bottom, the efficiency increases when the distance between the front barrier and the wall b/h_d also increases for small values of the non-dimmensional frequency Kh_d. Finally, it is hoped that the results from this study may provide valuable information for the clean and efficient harnessing of marine renewable energy.

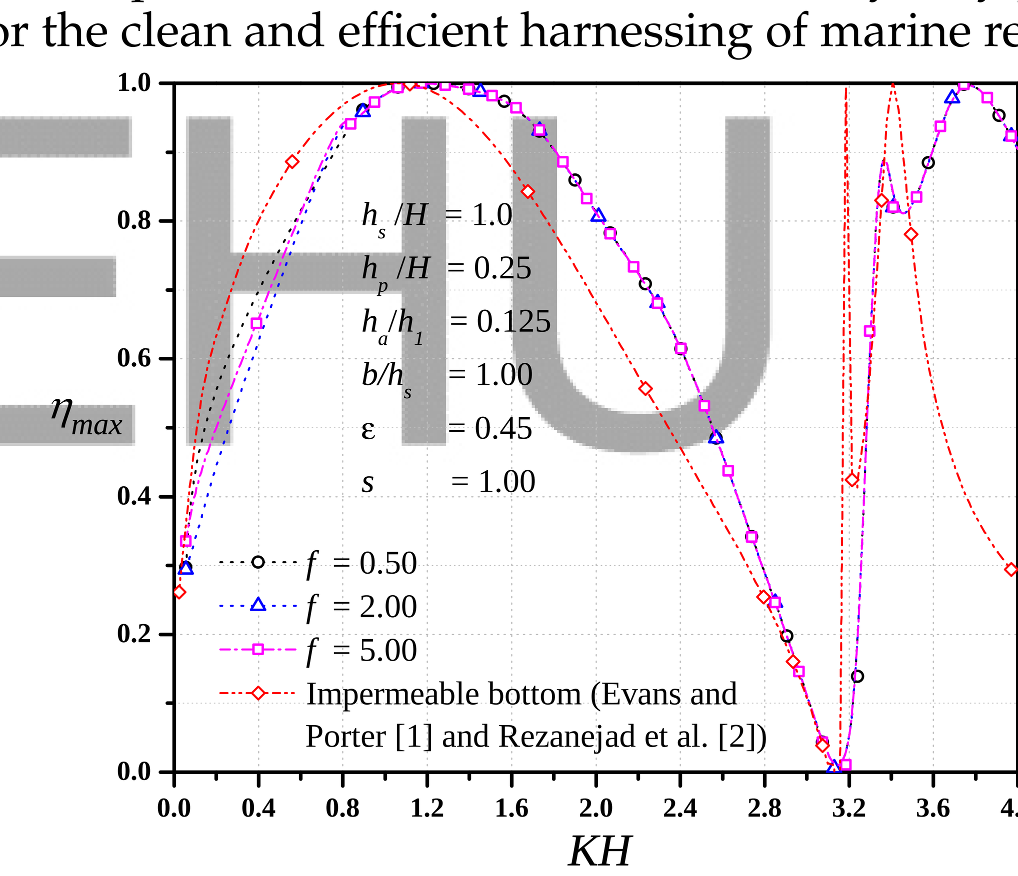

Figure 4: Effect of the linearized resistance coefficient f on the efficiency, η_{max}, of the OWC device in a variable porous bathymetry.

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References

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