Non-linearities and Coupling Effects on Floating Breakwaters Eigenvalues

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1 Introduction

We use floating breakwaters to enlarge pleasure harbours with respect to environmental protection, including zones open to sea swells, and even relatively inhospitable zones such as even cyclonic regions. Naturally breakwaters are designed to protect harbours only against the usual wind waves, but survival conditions must include extreme sea states. As eigenmodes have a capital importance on behaviour, efficiency and security of the floating breakwaters, we must analyse the consequences of mechanical couplings and non-linearities on their values and on design of structures and their anchorages.

To be efficient, a floating breakwater must have eigenperiods significantly different from characteristic periods of the design sea states. We have two options: the inertial approach with very large floating bodies moored on lines, or the stiffness approach with smaller bodies anchored on piles under cyclic lateral loads [1]. The last solution is more economical in terms of space and cost, especially if the period range of design sea states is not limited. As soil stiffness decreases when stress amplitude increases and therefore when hydrodynamic loads and breakwater motions increase, both pile bending eigenperiods and hull viscous damping increase with them. Then we must evaluate the respective contributions of the two phenomena, which have opposite effects.

The difficulty comes from the multiplicity of couplings and non-linearities with viscous damping and anchorage stiffness. In some cases, motions and anchorage forces can be analysed by an extensive use of numerical non-linear time domain simulations. However, this method is inefficient in case of parametric instabilities with existence of multiple solutions. Then we must institute an analytical analysis of stability in terms of different parameter ranges. In practice, another limit arises from the disparity between the importance of the theoretical studies required and the project significance, always restricted for breakwaters of pleasure harbours. Thus, in order to evaluate an accurate domain of parameters variations, with event overestimations of motions and forces, it is appropriate to dispose of linearized expressions.

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