

Status Identification and Optimum Adjustment of Performance of Moored Floating Breakwaters

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In this paper a numerical model is developed for the status identification and optimum adjustment of the performance of a moored floating breakwater (MFB) during its operation. The optimum adjustment is achieved through the appropriate modification of the current total unstretched length of the mooring lines, L_{tot}^{cur} . The model consists of 2 modules. The first includes the identification of the current status of the MFB, which is implemented through the adoption of artificial neural networks. The second includes the determination, through the development of an optimization algorithm, of the optimum adjustment of L_{tot}^{cur} , in terms of satisfying the design requirements.

INTRODUCTION

Moored floating breakwaters (MFB) are nowadays considered a viable, environmentally friendly, alternative solution to conventional bottom-fixed structures that can be effectively used for the protection of coastal and inland water areas with mild-to-moderate wave environment conditions. Their dominant design target, which is related to their operational design requirements, is to increase their effectiveness up to the most possible degree, i.e. the effective reduction of the transmitted wave energy (design objective). At the same time, however, the satisfaction of this design objective is constrained by the strength design requirements of the moored floating system, that is, the avoidance of any structural failure (design constraints). The simultaneous satisfaction of the above design objective and the corresponding strength design constraints represents the desired performance of the MFB.

The increased effectiveness of the most commonly used type of MFB, which consists of rectangular pontoons moored to the sea bottom with cables or chains, is usually implemented either through the modification of the type—i.e. the geometric and the material characteristics of the floating pontoon—or through the modification of the layout and characteristics of the mooring lines. For example, dual-pontoon MFB have been proposed by Williams and Abul-Azm (1997) and Bhat (1998), while Malleswara and Madhav (2006) describe the effective performance of perforated and cage floating breakwaters. Liang et al. (2004) introduced the spar buoy floating breakwater; Jung et al. (2006) proposed a floating breakwater made of polyethylene. On the other hand, the effect of the layout of the mooring lines on MFB performance is described by Sannasiraj et al. (1988). The main characteristic of all these cases is that the improvement of MFB performance is achieved in a rather static way, based on the fact that all these alternatives can be implemented only during the design stage and before MFB installation and operation. Thus, the on-site adjustment and control of the dynamic characteristics of the MFB are not possible whenever the design requirements of the floating system are not satisfied.

In recent years, there has been a general trend towards the design of moored floating structures in a manner that enables the improvement of their performance during the operation, through the direct adjustment and the appropriate control of their hydrodynamic properties (Borges de Sousa et al., 1999; Fajinmi and Brown, 1999).

Following this trend, the feasibility of adopting such a different design concept for an MFB has been demonstrated by Loukogeorgaki and Angelides (2005a and b); they have shown through extensive parametric studies that the improvement of the performance of an installed, single-pontoon MFB can be achieved with the appropriate on-site modification of the total unstretched length of its mooring lines that leads to the simultaneous change of the MFB's draft. This modification affects straightforwardly the stiffness and drag damping of the mooring lines and, consequently, changes the MFB's dynamic response and effectiveness. Further, Loukogeorgaki and Angelides (2005b) introduced a decision framework demonstrating that for an incident wave of specific frequency, the current total unstretched length of the mooring lines can be properly modified in order to ensure: (a) minimization of the wave elevation behind the MFB, and (b) satisfaction of the constraints introduced by the mooring lines. Hence, it is possible to develop a system for the optimum (in terms of satisfying the design requirements) adjustment of the MFB's performance during its operation.

The purpose of this paper is to develop an integrated numerical model capable of identifying the current status of a single-pontoon MFB and adjusting its performance in an optimum manner during its operation. The required definition and mathematical formulation of the corresponding physical problem are initially implemented. Next, the 2 components of the proposed numerical model

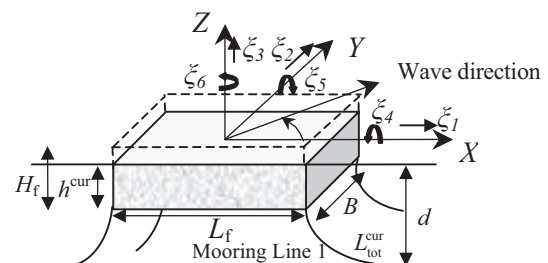


Fig. 1 Configuration of typical MFB and definition of basic quantities

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