

Short Note

# Vertical Breakwaters (Caissons)

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**Abstract:** Throughout history men have been passionate about the sea and sailing, this allowed not only the discovery of distant horizons but also the establishment of port counters along the coast, serving firstly shelters for stationary vessels and also as a link between sea and land transport.

**Keywords:** Caissons, Short Communication

The construction of a port, his equipment, the development of its access, Shoreline protection against the action of the sea is a complex set of operations, generally encompassed under the designation (marine works). In fact, their maritime character comes mainly from the site in which they are made or that they are intended for the reception of ships whose size has become very important. The need to consider the full life cycle of the structure, that is, from conception to decommissioning, when planning and designing marine structures [1,2]. Specific needs are usually defined from feasibility studies who had to integrate various factors such as the economic justification and the physical impacts, social and environmental aspects. These studies - which can be substantial - are often necessary to determine the viability and acceptability of development [2].

Maritime structures are more important structures, harder to dimensioned because it depends on several factors that must be respected, and the movement of the sea one of those factors, the knowledge of this movement is obliged to the civil engineering field [3]. Dykes protect ports from the onslaught of offshore waves and allow (by refraction / diffraction of the incident wave) to reduce internal agitation. They must be built with greater depths than before (up to fifty meters) and must resist waves whose amplitude may exceed ten (10) meters [4], So Dimensioning of a dyke requires a hydraulic, structural and geotechnical analysis, which should cover all identified failure modes.

The dike consists of blocks or caissons made of reinforced concrete that resist (Figure 1), by their own weight, to the forces imposed by the wave: they must be large dimensions to be heavy enough. When the wall is made up of blocks stacked on top of one another, they have a weight of up to a hundred tons, this limit being imposed by the performance of the handling equipment used to put them in place. The reflection of the wave on the vertical walls in doubles amplitude, thus imposing to wear the crest of the coronation, at a sufficiently high level to prevent its wave overtopping [1]. The vertical breakwaters are calculated for the height of the highest wave recorded during 100 years. It is also necessary that the waves do not sweeping against the breakwater, Otherwise, the effort to take into account is much higher: the condition of non breaking is that the depth at the toe of the breakwater is twice the amplitude of this centennial wave and the total depth at the toe of the seat is 2.5 to 3 times this amplitude. (A height of at least 25 meters for waves of 10 m). A vertical breakwater is a vertical siding structure founded on a good quality soil through a rockfill bed always immersed. Their use is subject to the following conditions [4,5]:

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- No vertical breakwaters on soft bottoms because of the great power to scour of the blades in front of the reflective dykes.
- As the volume of materials increases very quickly with the peak of the maximum wave, for economic conditions, dykes are no longer used for 6 to 7m dips.
- As the volume of masonry increases somewhat with the depth, vertical breakwaters are interesting in case of great depth or strong tides of the seas.
- The vertical breakwaters are economically viable in poor areas as riprap.

Depending on the type of subsoil, the breakwater can be built directly on the foreshore or on special filters, consisting of riprap or a geotextile. In case where the subsoil is particularly poor, it may be necessary to apply soil improvement measures (or others) for the structure to be steady from a geotechnical view. Maritime geotechnics is one of the most difficult disciplines and it is part of civil and coastal engineering. The geotechnician is interested in the soil as it is the main element of the context in which the stability of a structure will be conceived [1]. It was therefore quickly considered to improve the mechanical characteristics of the soil to increase their bearing capacity (or lift) and eliminate settlements and risks of liquefaction. Soil improvement methods are one of the tools available to the engineer to solve the stability problems or deformations that encounter when developing a project. Soil improvement methods should be determined only after completed the geotechnical campaign analysis. This campaign includes the movement of the sea (waves), subsoil stratification, capacity and soil's type, consolidation and settlement characteristics, permeability, liquefaction potential and dynamic deformation characteristics.

Most marine structures require ongoing maintenance to ensure an acceptable level of performance. The intervention may consist of measures to improve, extend, replace, repair and / or maintain the structure. Monitoring of the structure is an integral part of life cycle management. A regular monitoring program for the structure and its environment makes it possible to evaluate the safety, condition and functionality of the structure. It also provides the opportunity to schedule repair and replacement activities in a timely manner and can acquire an understanding of the failure mechanism and the evolution of the damage [5]. The performance of a structure is analyzed by comparing the measurements of its state at different times. Ideally, the monitoring program should be elaborated when designing the structure. The techniques used must both be reusable and tolerate slight variations of executions. The Interpretation procedures must avoid any ambiguity in comparison with previous analyzes. The quantitative description of the condition of the structure must be related to the potential failure modes, and must make it possible to identify these different responses. This requires a good understanding of the failure modes and deterioration mechanisms of each component of the structure, as well as those of the structure as a whole. Monitoring should also identify the environmental constraints that lead to these behaviors. It is equally important to understand the physical signs of impending rupture associated with each mode of damage. The monitoring plan must describe the symptoms that precede the failure, prior warning and, if possible, indicate how to quantify the interventions and changes. The management of the monitoring program can provide the following options [4]; periodic monitoring, after failure, as usual, according to the load and in the condition of the structure. With measurements mainly analyze [4]; functional performance, the condition of the structure, environmental stresses and impact of the structure on the local environment. There are three main elements of appreciation that generally apply to the data collected [4]: the accuracy, quality and quantity. The intervals between monitoring must be predetermined by the risk associated with the specific failure mechanisms, to structural elements, the foundation conditions, exposure conditions and criteria of dimensioning [4]. For practical reasons, it may be necessary to combine events to optimize the number of inspections. It is important that monitoring plans

allow some flexibility in scheduling repetitive monitoring elements in order to react to the changing circumstances.



Figure 1. Photos of Fabrication and Installation Steps of Vertical Breakwaters.

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