# SUBMERGED BREAKWATERS AS ARTIFICIAL HABITATS

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Marine scientists are constructing elements that are deployed in the sea in order to attract organisms, increase biodiversity, and restore habitats. Structures that mimic characteristics of natural reefs in some fashion but have another primary purpose, such as coastal works, may be described as artificial habitats (Jensen, 2002). Orbital velocities and forcing due to waves are regarded as the most important mechanisms of disturbance in coastal systems determining distribution and abundance of shallow-water and intertidal marine organisms (Siddon & Witman, 2003). Today, a dome-shaped or continuous unimodal functional response of both pelagic and benthic organisms to fluid dynamics has emerged (Ackerman, 1999).

A submerged rubble-mound structure transmits some wave energy over its crest and through its body, and reflects a part of the total incoming energy. These two phenomena, wave transmission and reflection, can mainly describe the hydrodynamic conditions maintained at the lee and sea sides of a submerged breakwater. These conditions were estimated for a variety of cases of a two-layer rock armour submerged breakwater by using recent results (Burcharth & Hughes, 2003). The maximum velocities and pressures were calculated in three areas at both sides of the breakwater. The water velocities at the sides of the breakwater were then compared with the maximum velocities organisms can live with. Representative diagrams are given (Fig 1), where survival conditions are shown for the mussel *Mytilus galloprovincialis* and the sea urchin *Strongylocentrotus nudus*.

In general, the marine organisms examined, mobile or not, select regions with neither extreme wave conditions nor absolute calmness. The wave climate suitable for the living of marine organisms was estimated in terms of velocities and pressures in the vicinity of a two-layer submerged breakwater. It was found for the structures tested that a wide range of wave conditions can satisfy the relevant requirements of marine organisms. For those organisms with vital parameter the pressure, as the depth and the freeboard decrease, the conditions at both sides of the structure are becoming more suitable. In contrast, organisms that are more sensitive to water flow would prefer deeper structures to shelter in. The mussel *Mytilus galloprovincialis* and the sea urchin *Strongylocentrotus nudus*, species abundant in the Mediterranean, can live at the lee side of shallow structures. Seaward side conditions are less 'friendly' to these organisms. It was concluded that structures having as primary scope the protection of coastal zone, can also host marine organisms and enhance, therefore, the living aquatic environment.

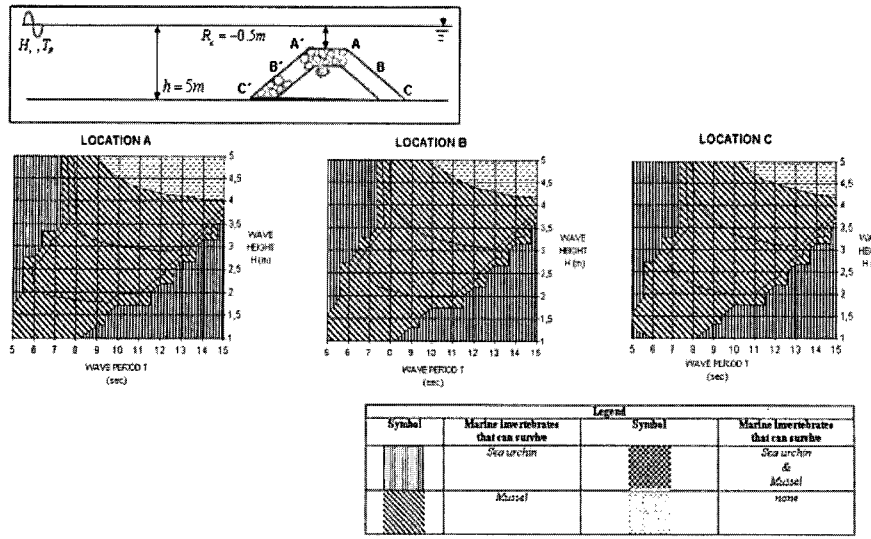


Fig. 1 Survival conditions at lee side for a case examined

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