

## Coastal Response, a system of detached breakwaters

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The coastline's sedimentary response in the form of a tombolo or semi-tombolo (salient) as a result of the construction of detached breakwaters is an aspect that should be known in the design phase so that these marine structures may be properly designed. In achieving an ecological, social and economic value, such areas must also be properly managed.

All design methods in existence since Dean (1978) are mainly based on hypotheses formulated from geometric studies on existing formations. No relationship at all is established with climate and littoral dynamics typical of the location (only Suh and Darlymple (1987) and the Japanese Ministry of Construction (1986) present relationships depending on wave variables). Neither has the influence on systems with more than two breakwaters been studied. These methods are not fully adapted to the cases existing on the Spanish Mediterranean littoral.

The lines of investigation as proposed by L. Bricio and V. Negro (2010) were continued with for this study. These researchers developed a method for dimensioning isolated, detached breakwaters and their semi-tombolo or tombolo associated formations using all the characteristics of the site (energy, geometric and structural), specific climate and geomorphology and littoral dynamics' characteristics. This methodology is currently acknowledged and accepted in works undertaken on the Spanish Mediterranean littoral.

A linear regression was obtained in the investigation undertaken on the 18 detached breakwater systems along the whole of the 1670 km of the Spanish Mediterranean littoral using the proposals made by L. Bricio and V. Negro. The adjustment of  $R^2 \geq 0.90$  was used for the sandy, tombolo formations behind all the detached breakwater systems between several non-dimensional monomials displaying the most representative characteristics of the site.

$$L/H_{12} + (2 \cdot B)/G = 12,15 \cdot (X/X_c) + 7,3231$$

X: Distance of breakwaters from coastline

X<sub>c</sub>: Distance from coastline where the closure depth is reached

L: Wave length in average statistical regime at foot of breakwater depth

H<sub>12</sub>: Significant wave height only surpassed or exceeded twelve hours a year in average statistical regime

B: Length of breakwater

G: Distance between breakwaters

On being adapted to all cases on the Spanish littoral, this expression proves that tombolo formations are minimally affected by the existence of more than two breakwaters. However, this influence should be even further studied in future investigations requiring the said expression.

Climate and structural geometry parameters are therefore related through the expression mentioned in the form of monomials on unconsolidated, moving sediment bottoms. The distance between detached structures will be established on the basis of sustainability and respect for the environment for the circulation and renewal of sheltered water.