



DESIGN AND CONSTRUCTION OF BREAKWATERS ON SOFT SEABEDS

Terms of Reference

1. Background

Soft seabed layers are frequently observed in coastal areas because of the active deposition phenomenon. These deposits include unconsolidated muddy, soft silt and/or clay, loose sand, and multilayered ground. Design and construction of breakwaters on seabeds are associated with many problems like sinking of rock into the seabed, general instability, large settlements, and complex behaviour under seismic loads.

There are some strategies for dealing with the aforementioned problems: pouring rock without any special action (gravity replacement), dredging and replacement of soft soil, basal reinforcement by sand mattresses and/or geosynthetics, preloading, ground improvement (e.g. sand compaction, rock or grout piles, deep mixing and jet grouting), and staged construction (to allow consolidation of soft foundation layers).

Improvement of soft clayey seabeds is challenging and expensive. Therefore, the method dealing with soft seabeds must be carefully chosen. Although codes, standards and literature have general recommendations in this regard, there is a lack of technical guidelines for selecting effective and optimum approach(es) for different circumstances.

2. Objectives

The objective of the proposed Working Group (WG) is to review existing technical information, literature, codes and standards, and case study documentation, and to produce a technical report entitled: *Guidelines for Design and Construction of Breakwaters on Soft Seabeds*. Such a manual will be of interest to marine consultants and contractors especially those involved in the field of port and harbour construction and protection of shorelines.

3. Earlier Reports to be Reviewed

Current state of the art, including codes and standards, guidelines and manuals, technical and research publications, needs to be reviewed. The main references include (but are not limited to) the following:

- Technical Standards and Commentaries for Port and Harbor Facilities in Japan (OCDI)
- British Standards for Maritime Structures (e.g. BS6349)
- Analysis of Rubble Mound Breakwaters (PIANC, MarCom WG12, 1992)
- State-of-the-Art of Designing and Constructing Berm Breakwaters (PIANC, WG40, 2003)
- The Stability of Rubble Mound Breakwaters in Deeper Water (PIANC, PTC II, 1985)
- Guidelines for the Design and Construction of Flexible Revetments Incorporating Geotextiles in Marine Environment (PIANC, MarCom WG21, 1992)
- The Application of Geosynthetics in Waterfront Areas (PIANC, Report No. 113, 2011)
- Conference Report: Geotextiles and Geomembranes in River and Maritime Works (PIANC Conference Report, 1997)
- The Rock Manual (CIRIA/CUR/CETMEF)
- Coastal Engineering Manual (USACE)
- Geosynthetic Design and Construction Guidelines (US Federal Highways Administration - FHWA)
- Probabilistic Design Tools for Vertical Breakwaters (PROVERBS), H. Oumeraci et al (Balkema 2001)
- Breakwaters with Vertical and Inclined Concrete Walls (PIANC, Report No. 28, 2003)
- ROM 0.5-0.5, Geotechnical Recommendation for Design of Maritime & Harbour Works (Puertos del Estado 2005, [http://www.puertos.es/es-es/BibliotecaV2/ROM%200.5-05%20\(EN\).pdf](http://www.puertos.es/es-es/BibliotecaV2/ROM%200.5-05%20(EN).pdf))

4. Scope

The Working Group will investigate the geotechnical issues relating to breakwaters on soft seabeds such as unconsolidated muddy, soft silt and/or clay, loose sand, and multilayered grounds. The WG will focus on the replacement and base reinforcement approaches like gravity replacement, sand mattresses and geosynthetics, and ground improvement. In this regard, the settlement of rock into seabeds and its reduction by application of sand mattresses and/or geosynthetics will be of concern. Static and dynamic stability of breakwaters with and without basal reinforcement and anticipated consolidation settlement of breakwaters will be studied. The WG will not carry out new basic research.

5. Intended Product

The intended product is a technical report that can be used as a guideline for design and construction of rubble mound breakwaters on soft seabeds. The report will be produced within two years of the formation of the WG and will include:

- Background
- Overview of case histories and lessons learnt

- Overview of existing codes, standards, and guidelines
- Survey of existing research and summary of outcomes (physical modelling and numerical simulation)
- Construction considerations and the choice of soil improvement methods
- Design criteria
- Identifying needs for further research

6. Working Group Membership

To maximize the usefulness of the report, the WG should include members from the countries engaged in the following sectors:

- Marine consultants and contractors
- Port managers and operators
- Maritime authorities and regulatory bodies
- Professional organizations.

The WG should also include young professionals (YPs) from national sections.

7. Relevance to Countries in Transition

Development of ports is an essential need of developing countries and countries in transition. One of the main problems in this regard is the high cost of construction in coastal areas with soft seabeds. Using the proposed report, breakwater design and construction on soft sediments can be undertaken in a cost-efficient manner.

8. Climate Change

Potential climate change impacts include sea level rise and increased storm intensity, affecting wave heights and seabed stability. Potential consequences of climate change should be considered by the WG.