PIANC
The World Association for
Waterborne Transport Infrastructure

Maritime Navigation Commission

MarCom

WG 250

BREAKWATERS WITH VERTICAL AND INCLINED CONCRETE WALLS

(UPDATE WG 28)

PROPOSED TECHNICAL WORKING GROUP

TERMS OF REFERENCE

1. Historical Background Definition of the problem

Vertical breakwaters are used for ports protection and waterfront protection as an alternate to rubble mound breakwaters. PIANC has produced a report (WG 28,) in 2003, dealing with the following aspects:

- Types of vertical breakwaters
- Failure modes
- Hydraulic response (overtopping, reflection, transmission)
- Wave forces
- Other forces (among which friction, for which a great variability of friction coefficients and safety factors is pointed)
- Design methods, including partial safety factors
- Performance of existing vertical breakwaters
- Materials, construction and maintenance
- Recommendations for improved state of the art or design procedures

Since its publication, state of the art has significantly evolved, especially in relation with overtopping performance, wave loads estimation, accounting for non-standard crest structures. Moreover, interaction between bottom slab and rubble foundation should be re-analysed in relation with actual construction and survey methods.

2. Objectives

This Working Group aims to provide guidelines for vertical breakwaters design, including performance (hydraulic response, displacements …) in relation with construction and survey methods.

3. Earlier reports to be reviewed

- **PIANC MarCom WG 28** : Breakwaters with vertical and inclined concrete walls (2003) including appendices
- MarCom WG 196: Criteria for the Selection of Breakwater Types and their Related Optimum Safety Levels (2016)

4. Scope of work

The following topics should be at least addressed (focusing on the items which need to be updated) :

- Overtopping, based for instance on Eurotop last version and further developments.
- Special absorbing and low-reflection structures, such as jarlan caissons (reflection and forces)
- Wave forces:
    - possibilities and limits of CFD vs physical model test and combined use.
    - accounting for compression shock in physical model tests analysis
    - Impact wave forces acting on an upright wall covered or not with dissipating blocks
    - Impact forces at the port side caused by overtopping
    - Effect of setback of the crown wall
    - Interpretation of results of physical models and signal filtering according to natural frequencies and dynamic properties of the structure and foundation.
    - 3D effects: tips-roundheads and corners
- Foundation design :
    - comparison of PIANC's bearing capacity numerical approach (appendix A of WG28) with more simple and less physic formulae of existing codes
    - Recent developments on analysis of models of failure of the foundations
    - Use of limit equilibrium, soil structure interaction and finite elements (or finite differences) methods for analysis
    - Friction between slab and foundation, including recommendations relative to planeity tolerances and methods to increase friction factor.
    - Estimation of displacements
    - Scour and scour protection design
    - Wave induced liquefaction.
    - Methods to increase friction factor
- Seismic design : relation with WG 225
- Durability : chloride attack on concrete may need to be revised depending on recent developments (analytical formulations with instantaneous or average diffusivity, ageing factor)
- Effects of turbulence.
- Superstructure and structural connections
- Tsunami-proof design, based on the 2011 tsunami in Japan
- Update of partial coefficients
- Response to sea level rise due to global warming; Wave forces and wave overtopping on low-crested breakwater
- Possibilities to reduce the carbon footprint of these constructions.

Simplified models for preliminary design.

5. Intended product

The Working Group report should be considered as a good practice document, giving an overview of state of the art of vertical breakwaters design integrating recent developments.

6. Working Group membership

The following expertise must be covered by the WG :

- Wave-structure-foundation dynamic interaction
- Soil-structure interaction
- CFD and numerical modelling
- Reinforced concrete durability
- Reinforced concrete structural design
- Construction techniques and tolerances

7. Target audience

The intended users of the report are:

- Port authorities
- Port planners
- Engineering companies and consultants
- Contractors

8. Relevance

8.1. Relevance to countries in transition, etc.

Vertical breakwaters may concern both large port infrastructures and small craft harbours.

8.2. Climate Change and Adaptation

This report may be used for new breakwaters, but also for existing breakwaters adaptation to climate change, in relation with :

- Need for raised crest level
- Adaptation to more severe storms or increased erosion in front of structures
- Resilience (response to conditions beyond basis of design)

8.3. Working with Nature

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8.4. UN Sustainable Development Goals

Vertical breakwaters have generally less impact than rubble mound breakwaters (reduced footprint, reduced quarry quantities and associated transport by road …). Possibilities to reduce the carbon footprint of these constructions is part of the scope.

9. References

- Eurotop : Manual on wave overtopping of sea defences and related structures (2018)
- Proverbs: Probabilistic design of vertical breakwaters (2001)