# TABLES

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**Table 1 Comparison of Types of Breakwater**

| | **Rubble Mound Breakwater** | **Vertical Breakwater** | **Composite Breakwater** |
|---|---|---|---|
| Wave Reflection | Rubble mound absorbs part of the wave energy and reduces the amount of wave reflection. | Waves are nearly fully reflected from the vertical face. | Same as vertical breakwaters. |
| Water Depth | A large rubble mound will be required in deep water. | May not be practicable to design a vertical breakwater to carry the wave loading in very deep water. | May be suitable for very deep water where the quantity of rock required for a rubble mound is not available or when it is not practicable to design a vertical breakwater in deep water. |
| Settlement | Able to tolerate settlement. | A certain control on settlement is required. | A certain control on settlement is required. |
| Berthing | Berthing facilities should be provided separately. | The vertical face of the structure can allow vessel berthing. | Same as vertical breakwater. |
| Construction Materials | Large quantity of rock should be available particularly in deep water. | May be suitable if sufficient rock quantity is not available. | May be suitable in deep water if sufficient rock quantity is not available for large rubble mound. |
| Construction Methods | Specialized plant is not necessarily required. | Specialized plant is required for delivery and placing of caissons. | Same as vertical breakwaters. |
| Maintenance | Regular monitoring is required and repair is necessary for dislocated armour units. | Repair is necessary for damaged concrete. Monitoring of displacement of upright section is required after severe storms. | A combination of rubble mound breakwaters and vertical breakwaters. |

**Table 2 Comparison of Types of Foundation**

| Methods | Principles | Properties of Treated Soil | Advantages and Limitations |
|---|---|---|---|
| Dredging (Full or Partial Dredging) | Marine mud or soft alluvial deposit to be totally or partially removed and replaced by suitable fill material. | Marine mud or soft alluvial deposit is completely or partially replaced by fill of better engineering properties. | The method is relatively simple but problematic for soil disposal, in particular for contaminated soil. Less dredging for partial dredging but more detailed investigation and design, close monitoring as well as longer construction period may be required. |
| Deep Cement Mixing | Lime and cement introduced into native soil through rotating auger or special in-place mixer. | Solidified soil piles or walls with relatively high strength. | No dredging involved normally, no lateral displacement of native soil and no additional surcharge on underlying soil. Stringent quality control required. Cannot work if large obstruction is encountered. Study on possible environmental impact required. |
| Stone Columns | Holes jetted into soil and backfilled with densely compacted gravel. | Increased bearing capacity and reduced settlements. | Limited bearing capacity enhancement. Stringent quality control required. Not effective for sensitive clay. Lateral and upward displacement of soil. May not be applicable for soft soil. |

**Table 3 Typical Water Levels in Seawall Design**

<table>
<tr><th>Loading Conditions</th><th>Wave Condition</th><th>Still Water Level<br>in front of Seawall</th><th>Ground Water Level<br>behind Seawall</th></tr>
<tr><td rowspan="3">Normal/ Accident</td><td rowspan="3">Wave condition at tropical cyclone signal no. 3 or within the first few hours of hoisting of tropical cyclone signal no. 8</td><td>Sea water level at return period of 2 years</td><td rowspan="2">Sea water level at return period of 2 years</td></tr>
<tr><td>Sea water level at return period of 2 years minus 0.7 m</td></tr>
<tr><td>Mean lower low water level</td><td>Mean lower low water level plus 0.7 m</td></tr>
<tr><td rowspan="7">Extreme</td><td rowspan="2">Wave condition at return period of 100 years</td><td>Sea water level at return period of 10 years</td><td rowspan="2">Sea water level at return period of 10 years</td></tr>
<tr><td>Sea water level at return period of 10 years minus 1.0 m</td></tr>
<tr><td rowspan="2">Wave condition at return period of 10 years</td><td>Sea water level at return period of 100 years</td><td rowspan="2">Sea water level at return period of 100 years</td></tr>
<tr><td>Sea water level at return period of 100 years minus 1.0 m</td></tr>
<tr><td rowspan="2">Wave condition at return period of 50 years</td><td>Sea water level at return period of 50 years</td><td rowspan="2">Sea water level at return period of 50 years</td></tr>
<tr><td>Sea water level at return period of 50 years minus 1.0 m</td></tr>
<tr><td>Wave condition at return period of 100 years</td><td>Mean lower low water level</td><td>Mean lower low water level plus 1.0 m</td></tr>
<tr><td colspan="4">Notes : 1. The water levels for temporary loading conditions should be determined by designers.<br>2. The critical still water level may be some intermediate levels of the quoted water levels in this table and should be assessed by designers for each case.<br>3. Designers should take into account the worst credible ground water conditions when determining the ground water levels behind the seawall. Hence, the design ground water level may be higher than the levels given in this table.</td></tr>
</table>

**Table 4 Assessment of Possibility of Impulsive Breaking Wave Pressure**

| | | |
|---|---|---|
| A-1 | Is the angle between the wave direction and the line normal to the breakwater less than 20°? | No → Little Danger |
| | ↓ Yes | |
| A-2 | Is the rubble mound sufficiently small to be considered negligible? | No → Go to B-1 |
| | ↓ Yes | |
| A-3 | Is the sea bottom slope steeper than 1/50? | No → Little Danger |
| | ↓ Yes | |
| A-4 | Is the steepness of the equivalent deepwater wave less than about 0.03? | No → Little Danger |
| | ↓ Yes | |
| A-5 | Is the breaking point of a progressive wave (in the absence of a structure) located only slightly in front of the breakwater? | No → Little Danger |
| | ↓ Yes | |
| A-6 | Is the crest elevation so high as not to allow much overtopping | No → Little Danger |
| | ↓ Yes<br>Danger of Impulsive Pressure Exists | |
| B-1 | (Continued from A-2)<br>Is the combined sloping section and top berm of the rubble mound broad enough? | No → Little Danger |
| | ↓ Yes | |
| B-2 | Is the mound so high that the wave height becomes nearly equal to or greater than the water depth above the mound? | No → Little Danger |
| | ↓ Yes | |
| B-3 | Is the crest elevation so high as not to cause much overtopping? | No → Little Danger |
| | ↓ Yes<br>Danger of Impulsive Pressure Exists | |

Source : Reproduced from “Random Seas and Design of Maritime Structures” by permission of Prof. Y. Goda.

## Table 5 Measured Wave Pressure on Top Slab of Wave Absorption Chamber

| | Extreme Condition (10-year Return Period) | Extreme Condition (100-year Return Period) |
|---|---|---|
| With Front Panel : | | |
| Maximum local uplift pressure | $1.9\rho g H_{max}$ | $1.5\rho g H_{max}$ |
| Average uplift pressure | $0.9\rho g H_{max}$ | $0.8\rho g H_{max}$ |
| Average overtopping pressure | No overtopping | $0.2\rho g H_{max}$ |
| Without Front Panel : | | |
| Maximum local uplift pressure | $3.5\rho g H_{max}$ | $1.7\rho g H_{max}$ |
| Average uplift pressure | $1.7\rho g H_{max}$ | $1.3\rho g H_{max}$ |
| Average overtopping pressure | No overtopping | $0.2\rho g H_{max}$ |

Notes :
1. The wave pressure on the top slab is for reference only, and is determined from physical model testing of seawall with a wave absorption chamber and removable perforated front wall (HKU, 1998). The dimension of the wave chamber (measured between the inner face of the front wall and the rear wall of the chamber) is equal to 3 m. The wave chamber is extended to a depth of –2.65 mPD.
2. The perforation ratio of the front wall with uniformly spaced circular perforation of 700 mm is about 26%.
3. The surface and soffit levels of the top slab in the test are respectively +4.35 mPD and +3.65 mPD.
4. The still water level is +3.05 mPD in 10-year return period and +3.45 mPD in 100-year return period.
5. The significant wave height is +0.81 m in 10-year return period and +1.31 m in 100-year return period.
6. Caution should be exercised if these figures are adopted, as the extreme water levels and wave heights vary in different areas, and chamber dimensions, perforation layout and soffit level of top slab may be different.
7. $\rho$ is the density of seawater.