ACCROPODE™

"The benchmark in single-layer armouring technology"

"Sharing skills and experience to achieve successful projects"
ACCROPODE™
Single-layer system for breakwater armouring

Background
The ACCROPODE™ is the first single-layer artificial armour unit developed by Sogreah (ARTELIA). Widely used, this technology has proved to be successful on a great number of breakwater projects worldwide. Technical assistance is systematically provided on all ACCROPODE™ projects.

Hydraulic stability
Good hydraulic stability shown in extensive physical scale-model testing.

Specified stability coefficients at design stage:
- Hudson's design KD values:
  • 15 on trunk sections
  • 11.5 on roundheads
- Van der Meer stability number
  \[ N_S = \frac{H_S}{(\Delta D_{n50})} = 2.7 \]
  where
  \[ H_S = \text{Significant wave height} \]
  \[ \Delta = \text{Relative mass density} \]
  \[ D_{n50} = \text{Nominal diameter} \]

These coefficients are valid for armour slopes from 3H/2V to 4H/3V. However for breaking waves and a seabed slope greater than 1 %, lower values shall apply.

Proven structural robustness
During the development stage, finite-element methods and full-scale drop tests were conducted to check the sturdiness of the unit using ordinary mass concrete.

Experience on many projects has demonstrated the excellent behaviour of the ACCROPODE™.

Concrete strength specifications for placing the units

<table>
<thead>
<tr>
<th>Unit volume</th>
<th>Min. compressive strength Fc at 28 days</th>
<th>Min. tensile strength Ft at 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 4.0 m³</td>
<td>25 MPa</td>
<td>2.5 MPa</td>
</tr>
<tr>
<td>&gt; 4.0 m³</td>
<td>30 MPa</td>
<td>3.0 MPa</td>
</tr>
</tbody>
</table>

Drop tests conducted at development stage
Practical formwork

- Quick stripping and assembly of the two shells

Simple casting

- Min. area required to cast one unit of height H: \(1.50H^2\)
- Min. compressive concrete strength recommended at stripping:
  - 6 MPa for units ≤ 4 m\(^3\), 7 MPa for sizes between 5 m\(^3\) and 15 m\(^3\)
  - 10 MPa for sizes > 15 m\(^3\)
- Typical daily standard production rate: one unit per mould

Storage and handling

- Forklifting is effective for handling small to medium size units
- Large units are handled by sling
- ACCROPODE™ units can be stored one on top of the other
- Min. area required to store 10 units on one level: \(8H^2\)
  - where \(H = \text{ACCROPODE™ unit height}\)
- Min. compressive concrete strength recommended for handling units:
  - 15 MPa for units ≤ 4 m\(^3\), 20 MPa for sizes between 5 m\(^3\) and 15 m\(^3\)
  - 25 MPa for sizes > 15 m\(^3\)

Fast placement

Principle: each unit placed in a random attitude to obtain the specified packing density, using GPS.

Proper packing provides adequate coverage on breakwater slope:

\[
\frac{N_a}{A} = \varnothing V_{accr}^{2/3}
\]

where

- \(N_a = \text{Number of armour units}\)
- \(A = \text{Unit area of breakwater slope}\)
- \(\varnothing = \text{Packing density}\)
- \(V_{accr} = \text{ACCROPODE™ unit volume}\)

<table>
<thead>
<tr>
<th>Placement rates (using cable cranes)</th>
<th>Average placing time per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8 m(^3) ≤ Unit volume ≤ 3.0 m(^3)</td>
<td>5 to 8 mins</td>
</tr>
<tr>
<td>4.0 m(^3) ≤ Unit volume ≤ 9.0 m(^3)</td>
<td>9 to 12 mins</td>
</tr>
<tr>
<td>Unit volume ≥ 12.0 m(^3)</td>
<td>12 to 20 mins</td>
</tr>
</tbody>
</table>

NB: higher rates can be obtained using hydraulic placing equipment with small size units.
Successful applications completed in 48 countries

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