ACCROPODE™ II

"Technology, experience and cost-effectiveness condensed into a single armour unit"

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

Background
The pioneer in single-layer technology, the ACCROPODE™ technique has become the benchmark for modern breakwater armouring. Feedback from extensive experience on a substantial number of single-layer projects has led to the refinement of the original concept and design. A new armour unit, the ACCROPODE™ II has been patented by Sogreah (ARTELIA) in 1999, further improving the practical use and cost-effectiveness.

Enhanced hydraulic performance
The optimised shape, and roughening by means of pyramids acting as friction enhancers on the faces of these armour units, increase ACCROPODE™ II interlocking, while new features include:
- minimised rocking and settlement,
- maximised energy dissipation,
- reduced wave reflection and run-up/overtopping,
- improved structural strength.

During the design stage, the stability coefficients are selected as a function of the achievable packing density on site.
The standard Hudson’s design $K_D$ values for breaking or non-breaking wave conditions are:
- 16 on breakwater trunk sections
- 12.3 on breakwater roundheads

Alternatively, the recommended Van der Meer stability number is:
$$ N_S = \frac{H_S}{(\Delta D_{n50})^{3/2}} = 2.8 $$
where:
- $H_S$ = Significant wave height
- $\Delta$ = Relative mass density
- $D_{n50}$ = 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.

Improved structural robustness
Comparative finite-element studies have demonstrated that the ACCROPODE™ II unit has improved robustness compared with the first-generation ACCROPODE™, which in itself is recognized worldwide for its excellent records and reputation.

Concrete strength specifications for placing the units

<table>
<thead>
<tr>
<th>Unit volume</th>
<th>Min. compressive strength $F_c$ at 28 days</th>
<th>Min. tensile strength $F_t$ at 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\leq 4.0, \text{m}^3$</td>
<td>25 MPa</td>
<td>2.5 MPa</td>
</tr>
<tr>
<td>$&gt; 4.0, \text{m}^3$</td>
<td>30 MPa</td>
<td>3.0 MPa</td>
</tr>
</tbody>
</table>
**Reliable, easy formwork**
- Two symmetrical steel shells
- No base plates required
- Quick-assembly bolting system
- Ease of stripping and reassembly

**Simple casting**
- Min. area required to cast one unit of height H: \(1.55H^2\)
- Min. compressive concrete strength recommended at stripping: 6 MPa for units \(\leq 4\) m\(^3\), 7 MPa between 5 m\(^3\) and 15 m\(^3\), 10 MPa for sizes \(> 15\) m\(^3\)
- Typical daily standard production rate: one unit per mould

**Safe storage and handling by crane or forklift**
- Units can be stored one on top of the other or nested on one or more levels, provided that ground conditions are suitable
- Min. area required to store 10 units on 1 level: \(7.1H^2\)
  \[H = \text{ACCROPODE™II unit height}\]
- Min. compressive concrete strength recommended for handling units: 15 MPa for units \(\leq 4\) m\(^3\), 20 MPa between 5 m\(^3\) and 15 m\(^3\), 25 MPa for sizes \(> 15\) m\(^3\)

**Simplified placement**
The new ACCROPODE™II shape enables units to be placed more rapidly on site using simple rules, since the random attitude of each unit is naturally obtained, with the theoretical grid shown on the placement drawings and allowing reliable QA/QC procedures.

Proper packing provides adequate coverage on breakwater slope:

\[
\frac{Na}{A} = \phi \frac{V_{accrII}}{2/3}
\]

where
- \(Na\) = Number of armour units
- \(A\) = Unit area of breakwater slope
- \(\phi\) = Packing density
- \(V_{accrII}\) = ACCROPODE™II unit volume

**Placement rates (using cable cranes)**

<table>
<thead>
<tr>
<th>Unit volume</th>
<th>Average placing time per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1.0) m(^3) (\leq) Unit volume (\leq) (3.0) m(^3)</td>
<td>4 to 6 mins</td>
</tr>
<tr>
<td>(4.0) m(^3) (\leq) Unit volume (\leq) (8.0) m(^3)</td>
<td>7 to 10 mins</td>
</tr>
<tr>
<td>Unit volume (\geq 11.0) m(^3)</td>
<td>10 to 20 mins</td>
</tr>
</tbody>
</table>

NB: higher rates can be obtained using hydraulic placing equipment with small size units.
ACCROPODE™ II projects investigated or built in:

- Angola
- Cyprus
- FRANCE
- India
- Italy
- Mauritius
- Morocco
- Polynesia
- South Korea
- Sri Lanka
- Uruguay

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ACCROPODE™ II armour units are protected by patents worldwide

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