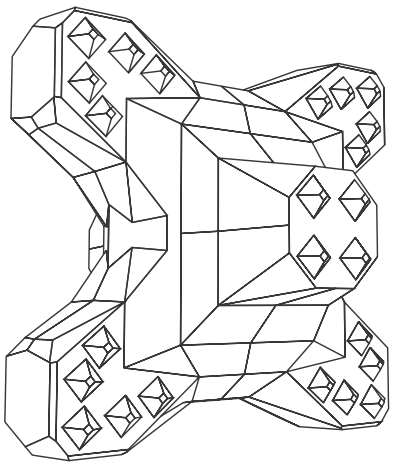
ACCROPODE™ II

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



CLI
Concrete Layer Innovations

"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:

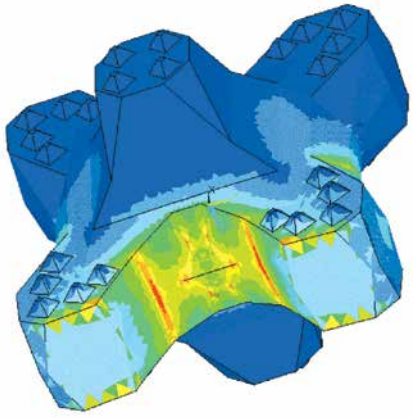
$$N_S = H_S/(\Delta D_{n50}) = 2.8$$

where

H_S = *Significant wave height*
Δ = *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.

3D tests



Stress contours

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

	Min. compressive strength Fc at 28 days	Min. tensile strength Ft at 28 days
Unit volume ≤ 4.0 m³	25 MPa	2.5 MPa
Unit volume > 4.0 m³	30 MPa	3.0 MPa

Mould ready for casting

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 ≤ 4 m³, 7 MPa between 5 m³ and 15 m³, 10 MPa for sizes > 15 m³
- 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: **$7.1H^2$**
  where H = ACCROPODE™ II unit height
- Min. compressive concrete strength recommended for handling units: 15 MPa for units ≤ 4 m³, 20 MPa between 5 m³ and 15 m³, 25 MPa for sizes > 15 m³

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 fe theoretical grid shown on the placement drawings and allowing reliable QA/QC procedures.

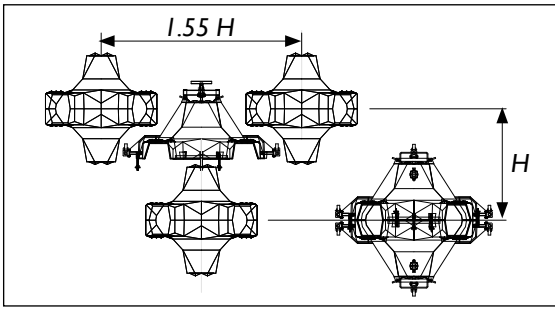
Proper packing provides adequate coverage on breakwater slope: $\frac{Na}{A} = \emptyset V_{accrII}^{-2/3}$

where

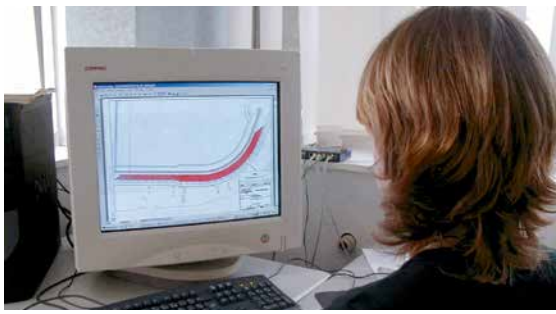
Na = Number of armour units
A = Unit area of breakwater slope
Ø = Packing density
V_{accrII} = ACCROPODE™ II unit volume

Striking operation

Transport by barge



Plan layout of casting arrangement



Drafting of positioning drawings

Placement rates (using cable cranes)

	Average placing time per unit
1.0 m³ ≤ Unit volume ≤ 3.0 m³	4 to 6 mins
4.0 m³ ≤ Unit volume ≤ 8.0 m³	7 to 10 mins
Unit volume ≥ 11.0 m³	10 to 20 mins

NB: higher rates can be obtained using hydraulic placing equipment with small size units.

Placement using a floating crane

ACCROPODE™ II projects investigated or built in:

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

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