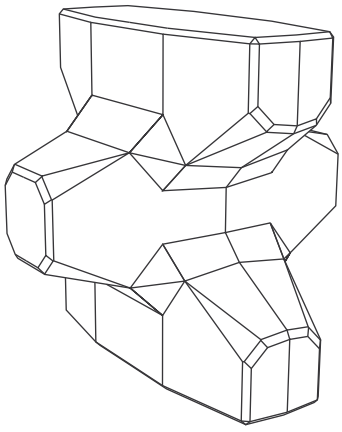
ACCROPODE™

"The benchmark in single-layer armouring technology"



CLI
Concrete Layer Innovations

"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 K_D values:
  - 15 on trunk sections
  - 11.5 on roundheads
- Van der Meer stability number

$N_S = H_S/(\Delta D_{n50}) = 2.7$

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.

2D tests

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™.

3D tests

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

Drop tests conducted at development stage

Assembled mould

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 and 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 = 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 and 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: $\frac{Na}{A} = \emptyset V_{accr}^{-2/3}$

where

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

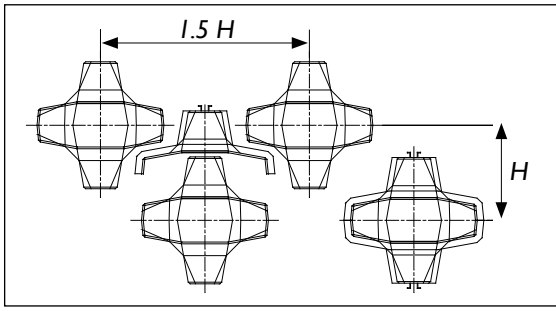
Placement rates (using cable cranes)	
	Average placing time per unit
0.8 m^3 ≤ Unit volume ≤ 3.0 m^3	5 to 8 mins
4.0 m^3 ≤ Unit volume ≤ 9.0 m^3	9 to 12 mins
Unit volume ≥ 12.0 m^3	12 to 20 mins

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

Side view of single layer under construction

Form ready for casting

Hauling large units with a low trailor



Plan layout of casting arrangement

Placement in progress

Armouring being completed

Successful applications completed in 48 countries

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