



ECOPODE™

"The coastal protection solution that blends most effectively into the surrounding landscape"



"Sharing skills and experience to achieve successful projects"

ECOPODE™

Single-layer system for coastal protection

Environmentally friendly

This single-layer concrete armour unit with a rock-like skin was developed and patented by Sogreah (ARTELIA) in 1996 to enhance the natural appearance of concrete armourings above low water level. Owners can choose the type of rock-like skin and colour which are best suited to the surrounding landscape.

Cost-effectiveness

Thanks to the advantages of the single-layer technology, ECOPODE™ armours require 3 to 4 times less material than natural rock armours, thus reducing the constraints linked to quarrying and transporting large rocks.

Improved hydraulic stability

This concrete armour unit benefits from the technical characteristics of the single-layer design. The uneven surface improves interlocking by friction, thereby increasing hydraulic stability.

ECOPODE™ can thus be placed above the low water line, over ACCROPODE™II units.

At the design stage, the prevailing stability coefficients can be taken to be those of the ACCROPODE™II used in the underwater part of the rubble-mound.

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.

High structural robustness

The structural strength of the ECOPODE™ may differ slightly according to the type of rock-like skin selected. However, the minimum unit strength required will at least match the strength of the ACCROPODE™II used underwater, since the two types of units have a similar geometry.



2D tests

Concrete strength specifications for placing the units

	Min. compressive strength F_c at 28 days	Min. tensile strength F_t at 28 days
Unit volume $\leq 4.0 \text{ m}^3$	25 MPa	2.5 MPa
Unit volume $> 4.0 \text{ m}^3$	30 MPa	3.0 MPa



ECOPODE™ shells made of fibre glass embedded in a spider frame



Shape sculpturing



Formwork

- Two symmetrical shells with bottom plates, assembled with quick assembly bolting system
- ECOPODE™ moulds are specially made of fibre glass shells to obtain the rock-like appearance, backed by a steel spider frame mounted on wheels

Casting

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

Handling

- Forklifting is effective for handling units up to 3 m^3
- Large units are handled with slings
- Min. compressive concrete strength recommended for handling units: 15 MPa for units $\leq 4 \text{ m}^3$, 20 MPa between 5 m^3 and 15 m^3 , 25 MPa sizes $> 15 \text{ m}^3$

Storage

- ECOPODE™ units are stored on one level placed close to each other, on ground with a sufficient bearing capacity.
- Min. area required to store 10 units of height H: $7.1H^2$

Fast placement

The positioning principle is based on a predetermined grid aimed at achieving optimum keying of the units. The grid spacings will match those of the smooth skin ACCROPODE™ II underneath.

Placement above water level is carried out visually or using GPS in order to obtain the proper packing.

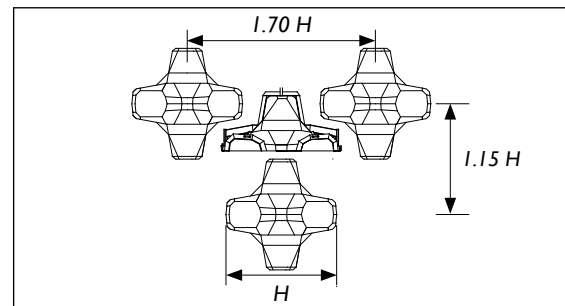
Placement rates (using cable cranes)

	Average placing time per unit
$1.0 \text{ m}^3 \leq \text{Unit volume} \leq 3.0 \text{ m}^3$	6 to 8 mins
$4.0 \text{ m}^3 \leq \text{Unit volume} \leq 8.0 \text{ m}^3$	10 to 12 mins
$8.0 \text{ m}^3 \leq \text{Unit volume} \leq 11.0 \text{ m}^3$	12 to 15 mins

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



ECOPODE™ unit limestone appearance



Plan layout of casting arrangement



ECOPODE™ placed over a crest

Handling with sling





ECOPODE™ projects investigated or built in:

- Caribbean
- France
- Italy
- Spain
- Tunisia
- United Arab Emirates



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