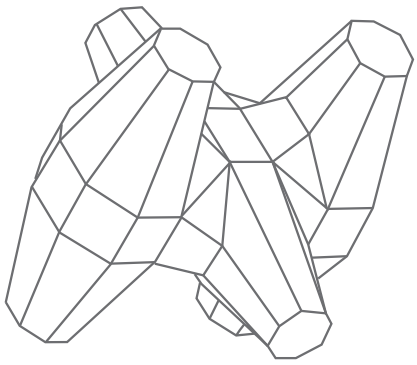
CORE-LOC™

"Highly dissipating and cost-effective system for breakwater armouring"



CLI
Concrete Layer Innovations

"Sharing skills and experience to achieve successful projects"

CORE-LOC™

Single-layer system for breakwater armouring

Background

The CORE-LOC™armour unit was developed and patented in the mid-1990s by the U.S. Army Corps of Engineers (USACE) Coastal and Hydraulics Laboratory. It is now widely considered for breakwater projects requiring reliable and cost-effective protection. This armour unit is ideally suited to sites exposed to moderate waves.

Superior hydraulic stability due to high interlocking capability

USACE research has involved extensive hydraulic model studies. Since then, most hydraulics laboratories have conducted physical modelling on specific projects using CORE-LOC™system.

Specified stability coefficients at design stage:

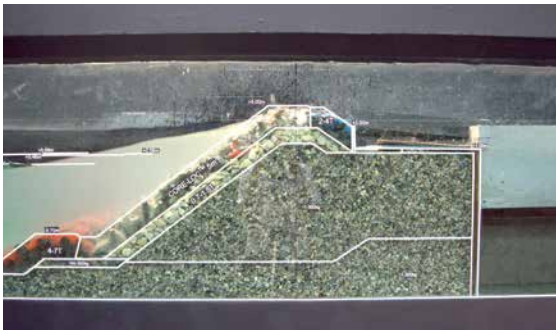
- Hudson's design K_D values:
  - 16 on trunk sections
  - 13 on roundheads
- Van der Meer stability number

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

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.

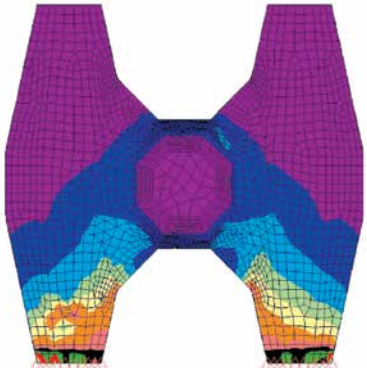


2D tests

Roundhead during 3D testing

Reduced overtopping

Due to a high porosity ratio (60% air voids) within the armour, wave energy dissipation is very effective.



Stress contours

Proven structural robustness

Stress distribution in the unit was analysed using finite-element methods and full-scale drop tests were conducted to check the sturdiness of the unit using ordinary mass concrete.

Concrete strength specifications for placing the units	
Min. compressive strength Fc at 28 days	Min. tensile strength Ft at 28 days
35 MPa	3.5 MPa

Mould ready for assembly

Practical formwork

- Quick stripping and assembly of the two shells
- Wheels reduce the use of handling equipment on the casting yard

Simple casting

- Min. area required to cast one unit of height C: **$1.65C^2$**
- Min. compressive concrete strength recommended at stripping: 10 MPa for all units sizes
- Typical daily standard production rate: one unit per mould

Minimum storage and easy handling

- Forklifting is effective for handling small to medium-sized units
- Large units are handled by slings
- CORE-LOC™ units can be stored nested on one or more levels in a "*herringbone*" fashion
- Min. area required to store 10 units on 1 level: **$5.2C^2$**
  where C = CORE-LOC™ unit height
- Min. compressive concrete strength recommended for handling units: 25 MPa for all units sizes

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

where

Na = *Number of armour units*
A = *Unit area of breakwater slope*
Ø = *Packing density*
V_{cl} = *CORE-LOC™ unit volume*

Placement rates (using cable cranes)

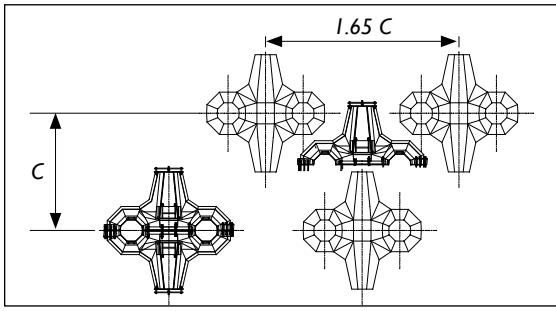
	Average placing time per unit
0.7 m^3 ≤ Unit volume ≤ 3.9 m^3	5 to 8 mins
3.9 m^3 ≤ Unit volume ≤ 6.2 m^3	8 to 10 mins
6.2 m^3 ≤ Unit volume ≤ 11.0 m^3	10 to 15 mins

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

Placement in progress

Casting using a conveyor belt

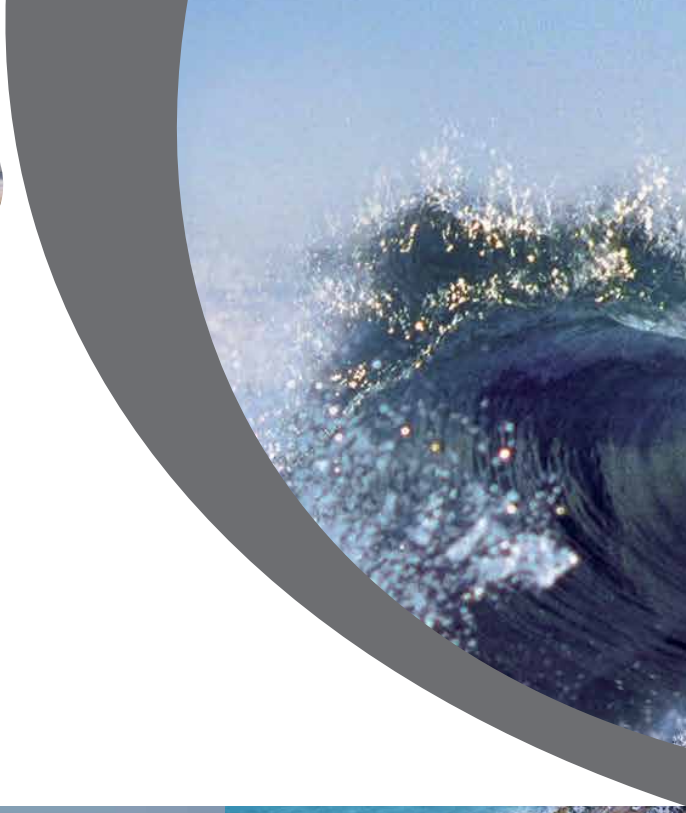
Forklifting a medium-size unit



Plan layout of casting arrangement

Placement on a roundhead

CORE-LOC™ armouring in progress



Recent CORE-LOC™ projects built (within CLI territory) in:

- Argentina
- Australia
- Chile
- Egypt
- FRANCE
- India
- Ireland
- Italy
- Kuwait
- Oman
- Qatar
- Saudi Arabia
- South Korea
- Sri Lanka
- United Arab Emirates
- United Kingdom
- West Indies

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