PIANC Mediterranean Days
and Conference «Port of the future» by Cerema
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SEABIM®, the digital twin for rubble-mound breakwater construction and asset management

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Context

- Single-layer Concrete Armor Units (CAU) rubble-mound breakwaters
- Block placement must fulfill precise **geometric and interlocking rules**
- Regular monitoring required as any damage worsens quickly

State of the art

- Subsea inspections carried out by divers
- Time consuming and costly process for long infrastructures
- Subjective and partial analysis of the breakwater

The use of a 3D model

- New high resolution scanning methods available
- 3D shape of the CAU is known
- Application of shape-matching algorithms based on computer vision
- Automatic detection of all the blocks positions in the point cloud – patented process
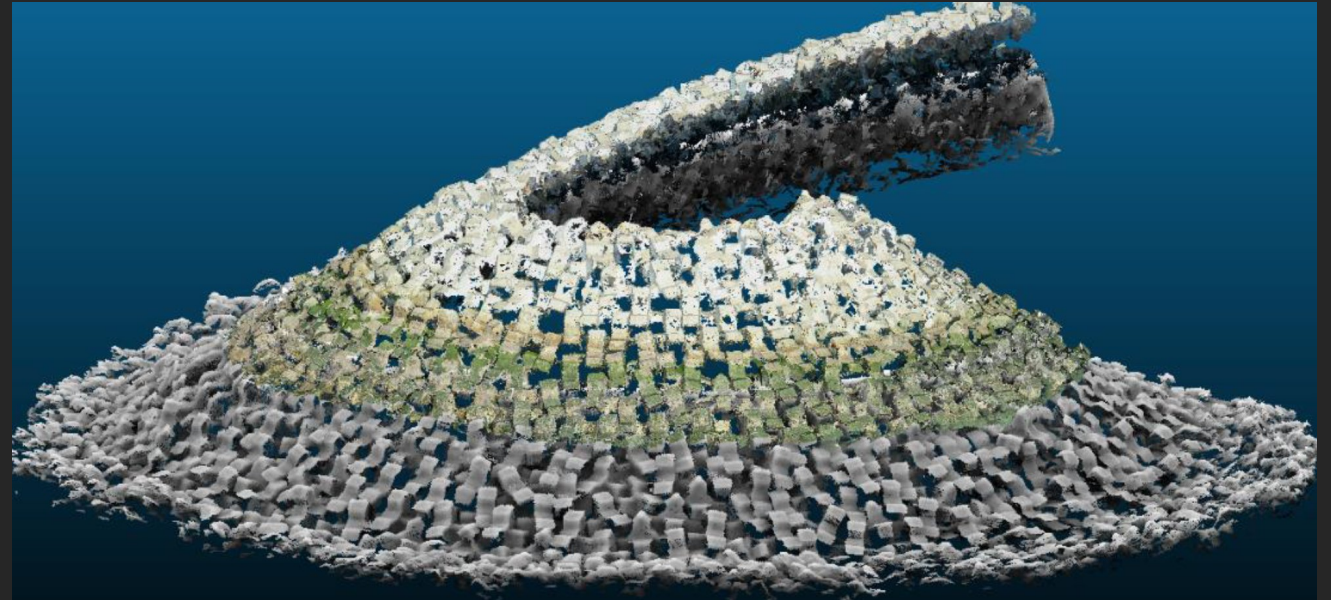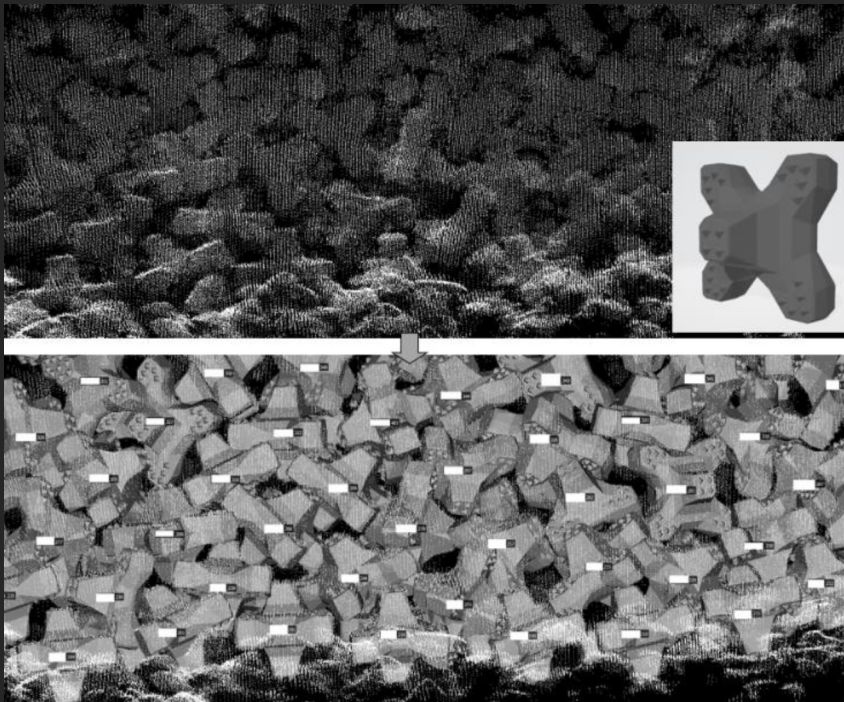
SEABIM by ID OCEAN
Breakwater Scan to BIM

3D model construction

Step 1 : External surface Scan

-Multibeam sonar at high tide

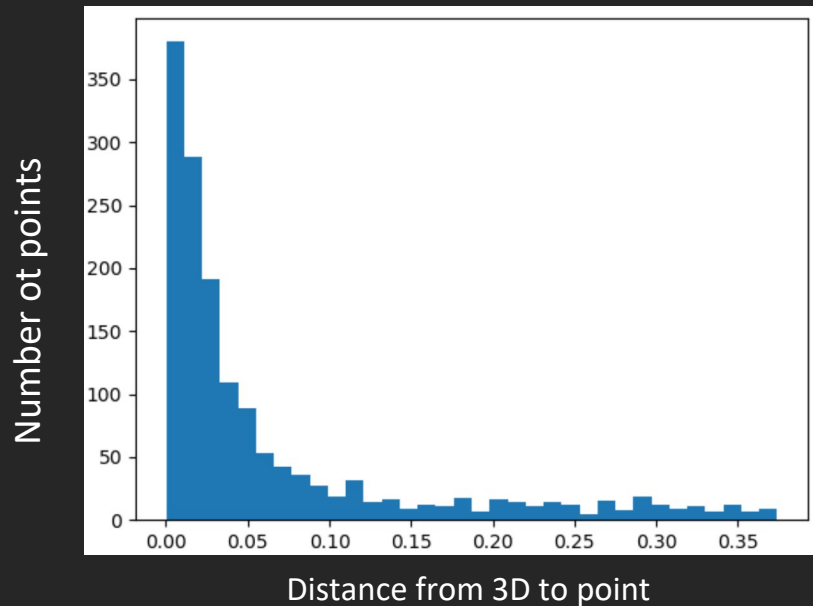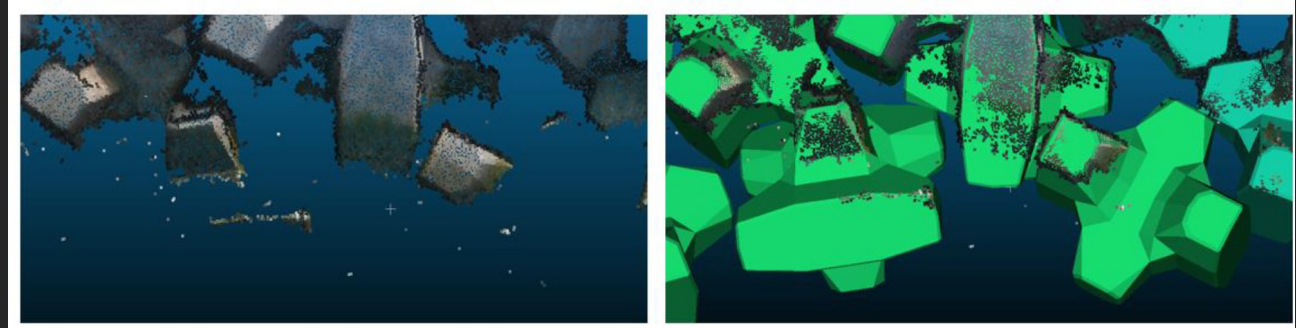-Photogrammety or LiDAR at low tide

Step 2 : Automatic 3D shape-matching

-Identification of all the blocks position/orientation in the pointcloud

-Full 3D visualization of the armour

3D model construction

- Partial point cloud is sufficient on the waterline


Number ot points

Distance from 3D to point

- Statistic point distribution calculated for each block (median, number of points used for the shape-matching)

- Automatic filtering based on statistic criteria

Placement controls during construction

Filters:
- Off-profile
- Column placement
- Block orientation
- Contacts with neighbours
- Placement density
- Hole detection
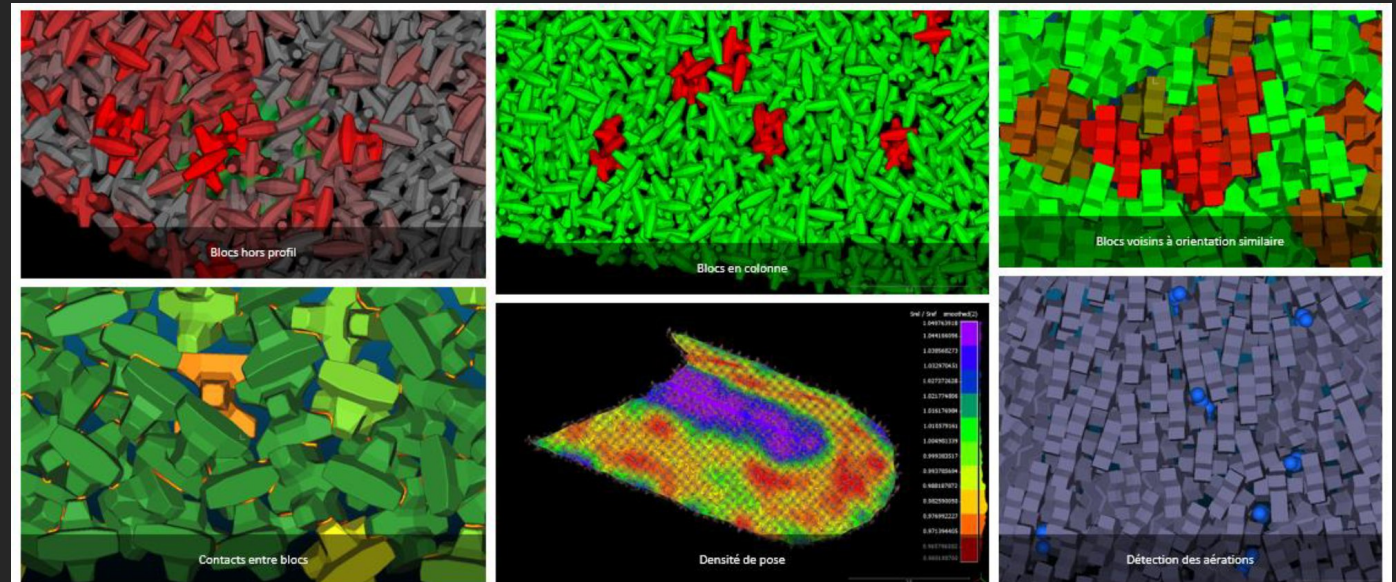
Armour placement validation throughout the construction by all stakeholders

Avoids costly dismantling operations

Asset management applications

Detection of broken units from the differential point cloud
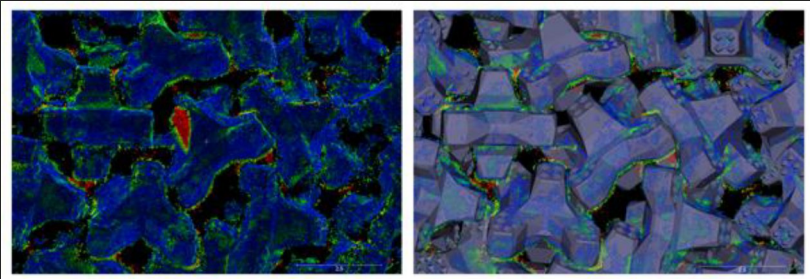
The color coding represents the distance of each point to the 3D model (blue = less than 2 cm)
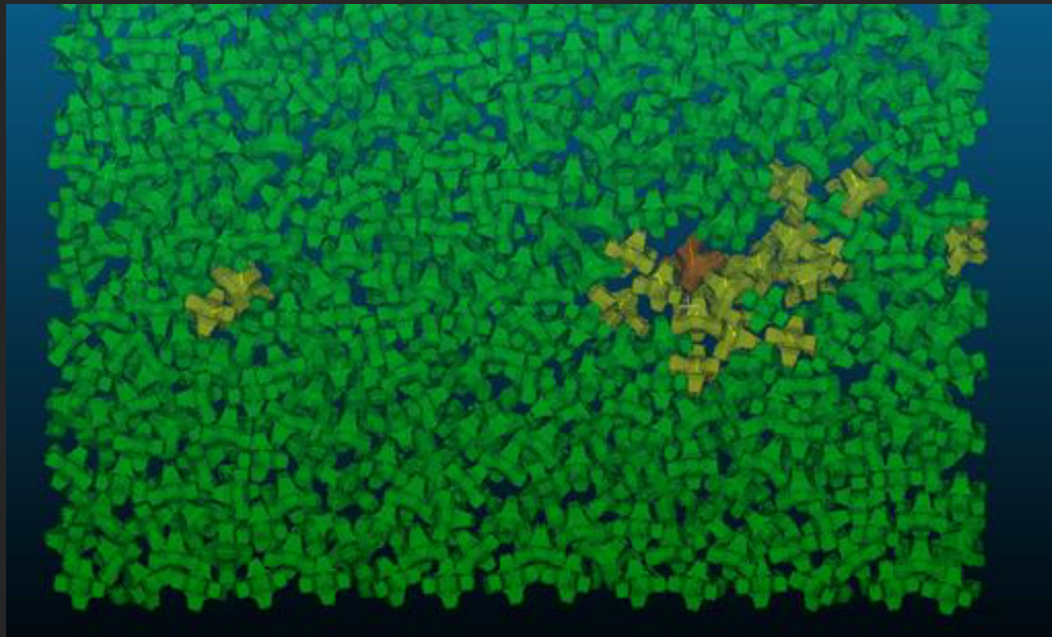
Breakwater digital insurance policy

Vectorization of the blocks movements between 2 scans

The color coding represents the displacement of the block CoG between 2 models –scale in m

Application to wave flume physical models

| Dry scan with a static LiDAR or by photogrammetry | 3D model generation of the physical model | Update of the 3D model after each wave serie | Representation and export of each block movement |

Enables to identify rocking, settlement, sliding etc
Validate the breakwater design with accurate measurements

Rip-rap segmentation

The challenge: Natural rocks do not have a regular shape like CAU

- Use of an in-house segmentation algorithm
- Each rock is isolated from the pointcloud
- Calculation of metrics from the rock manual
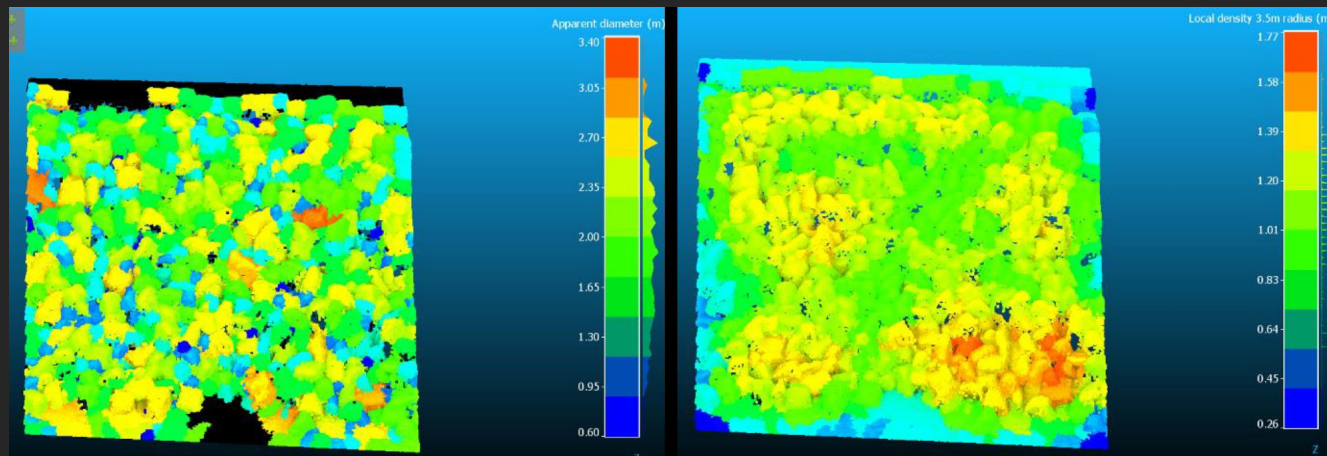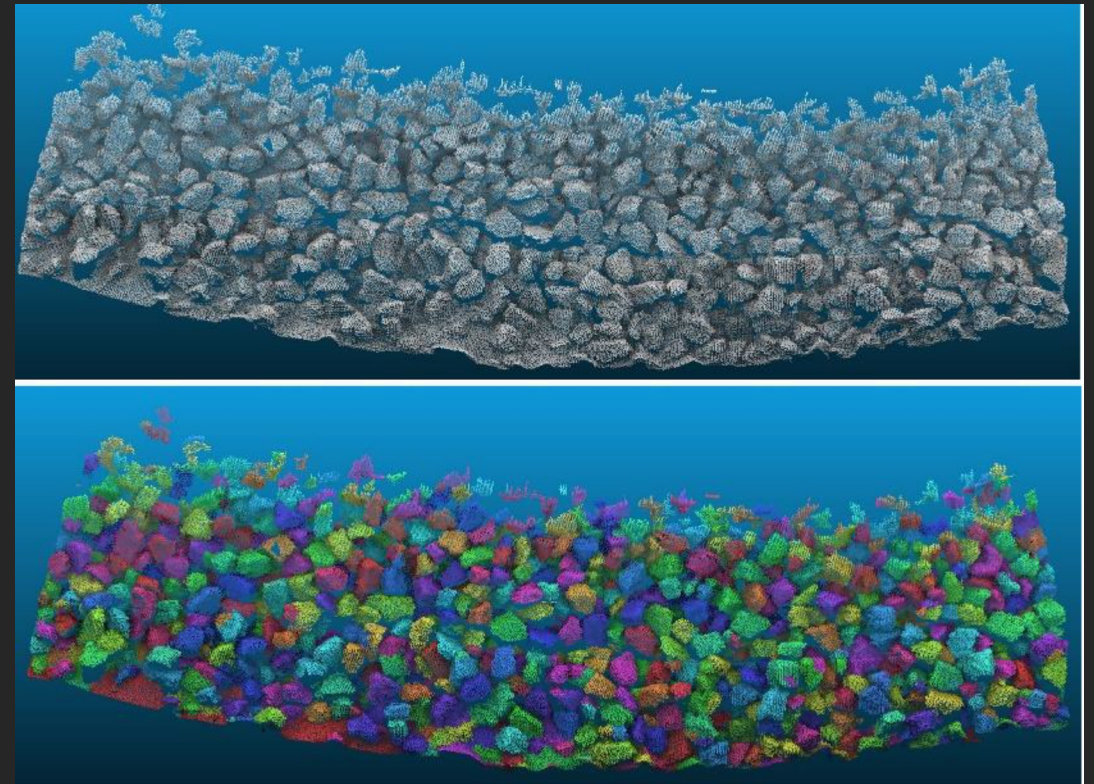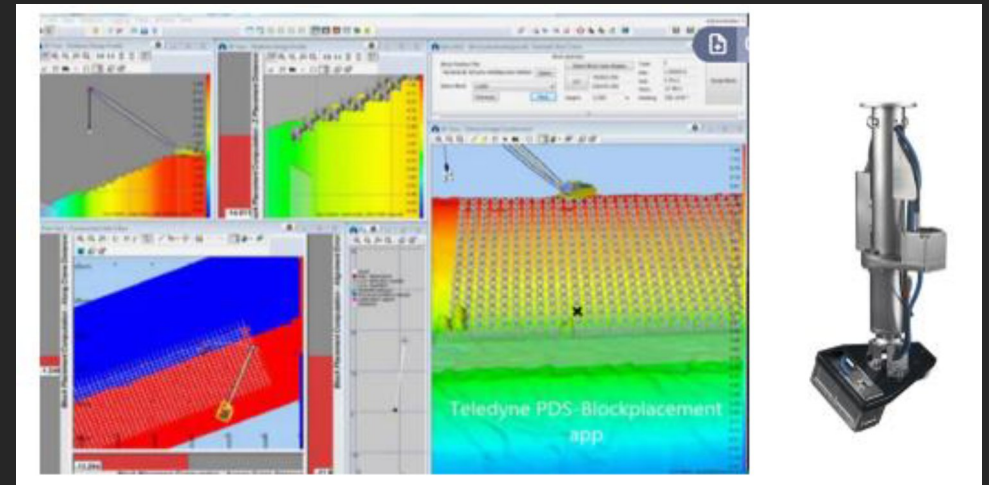

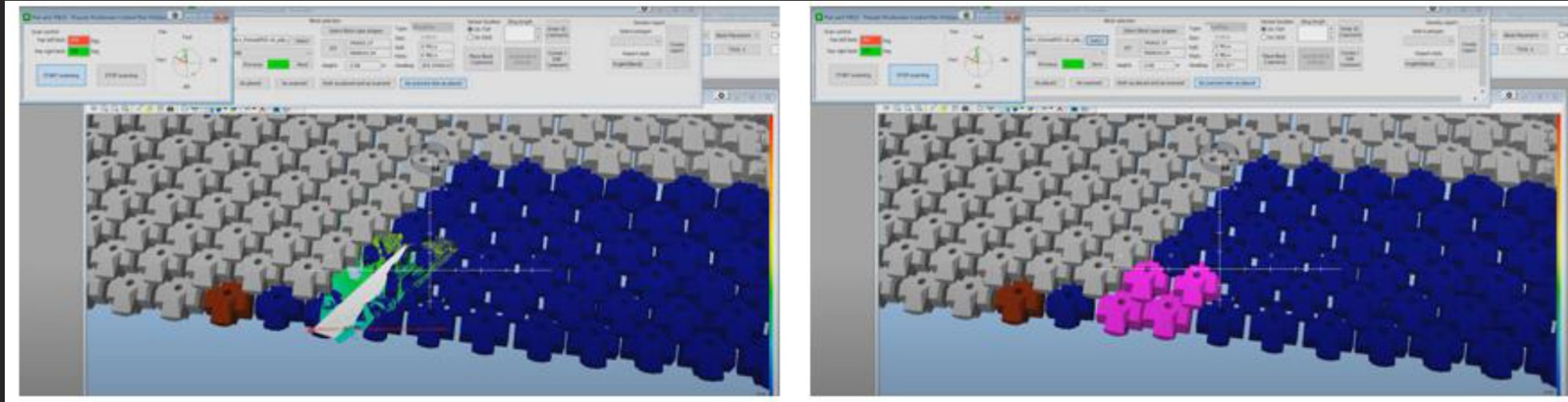Apparent diameter   Local rock density

Near real-time block placement control

The challenge: generate the as-built 3D model along the placement

- Partnership with Teledyne Marine
  - PDS construction software for machine guidance / scan / block management
  - Motionscan rotating sonar hardware on an excavator

Near real-time block placement control

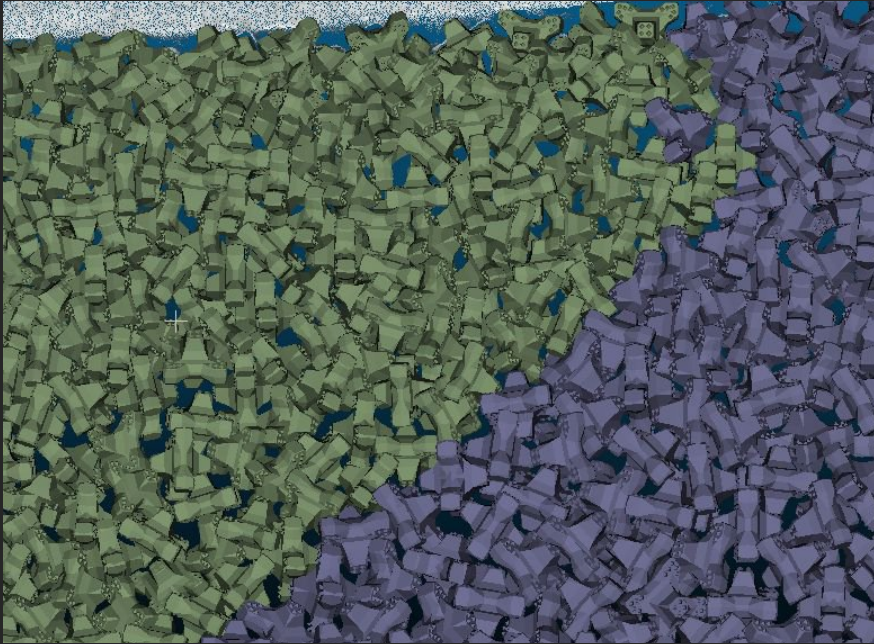

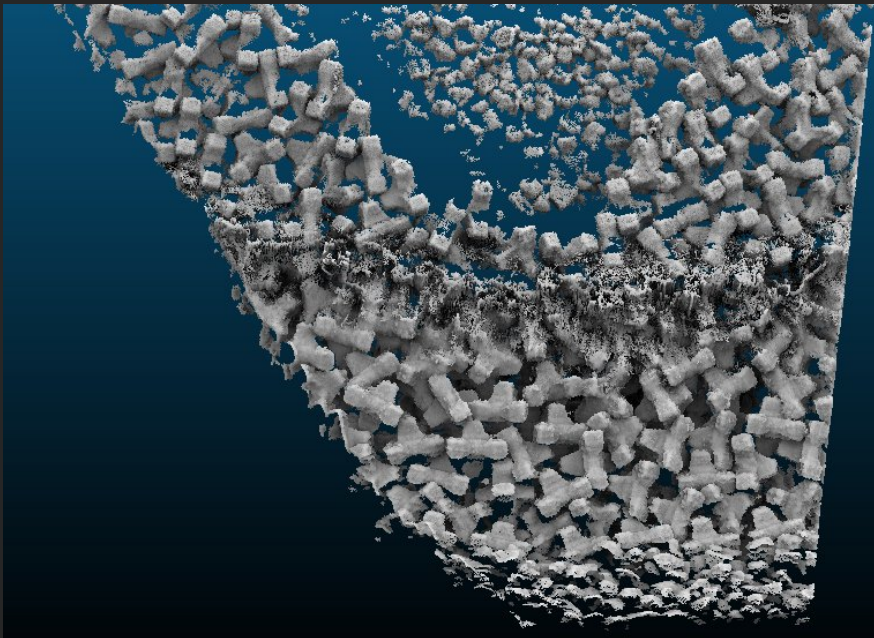| Scan of a block once it is placed | Automatic block detection from the scan with SEABIM | As-built 3D model displayed in PDS | Post-processing with SEABIM Editor software |

Application examples

Scope:
- Regular MBES and LiDAR surveys
- 3D model – 21 000 blocks – updated after each cyclonic event

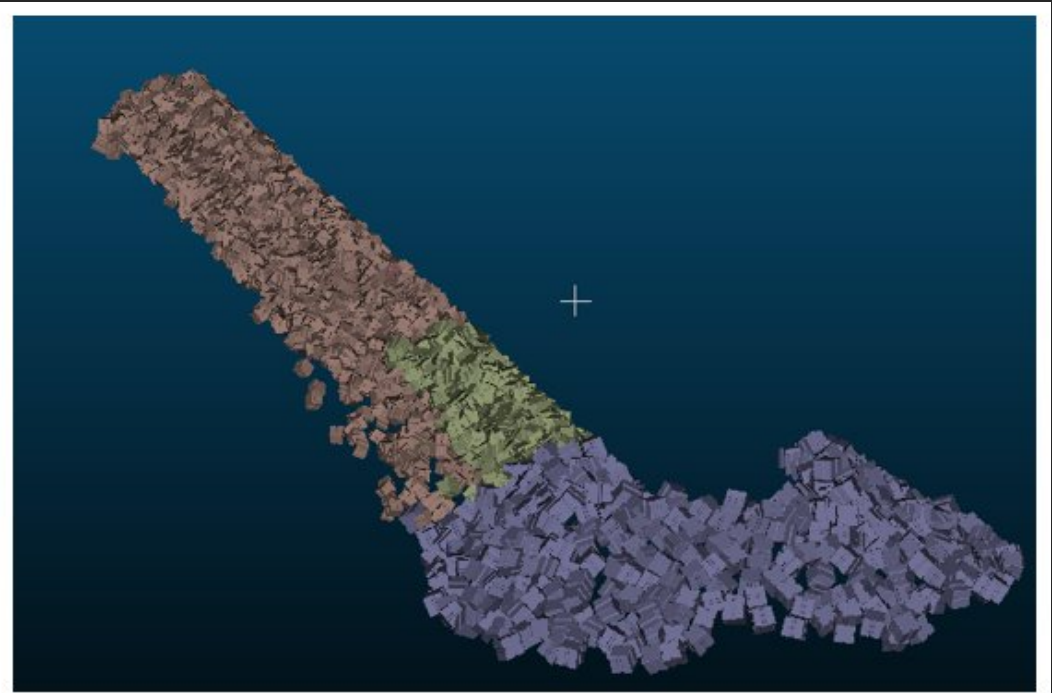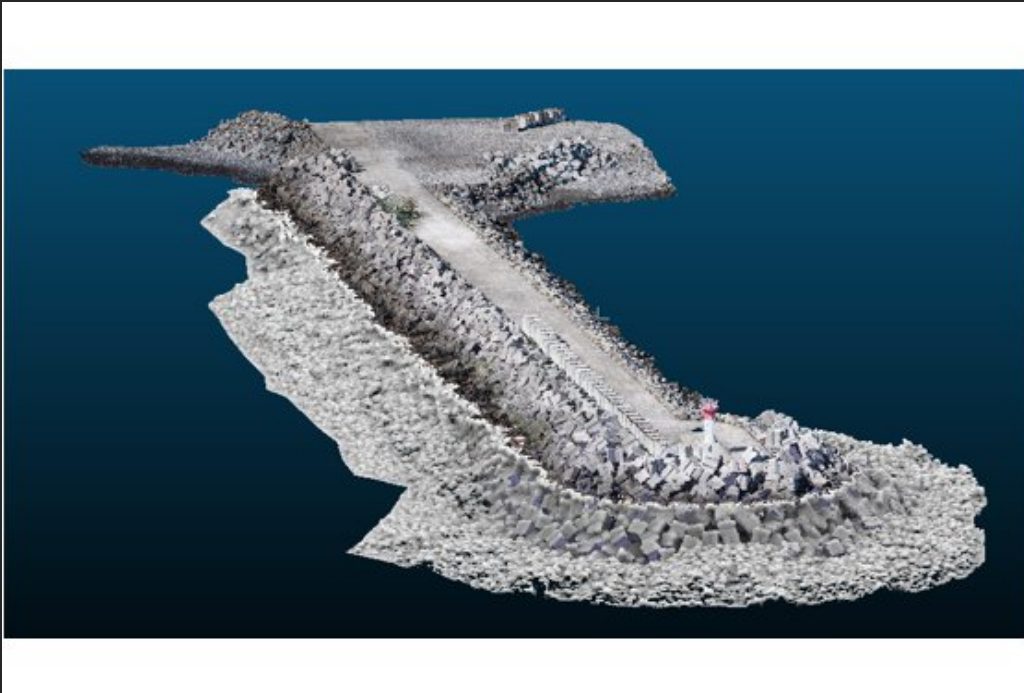Application: construction control and handover

Accropode™ II – New Coastal Road – La Réunion
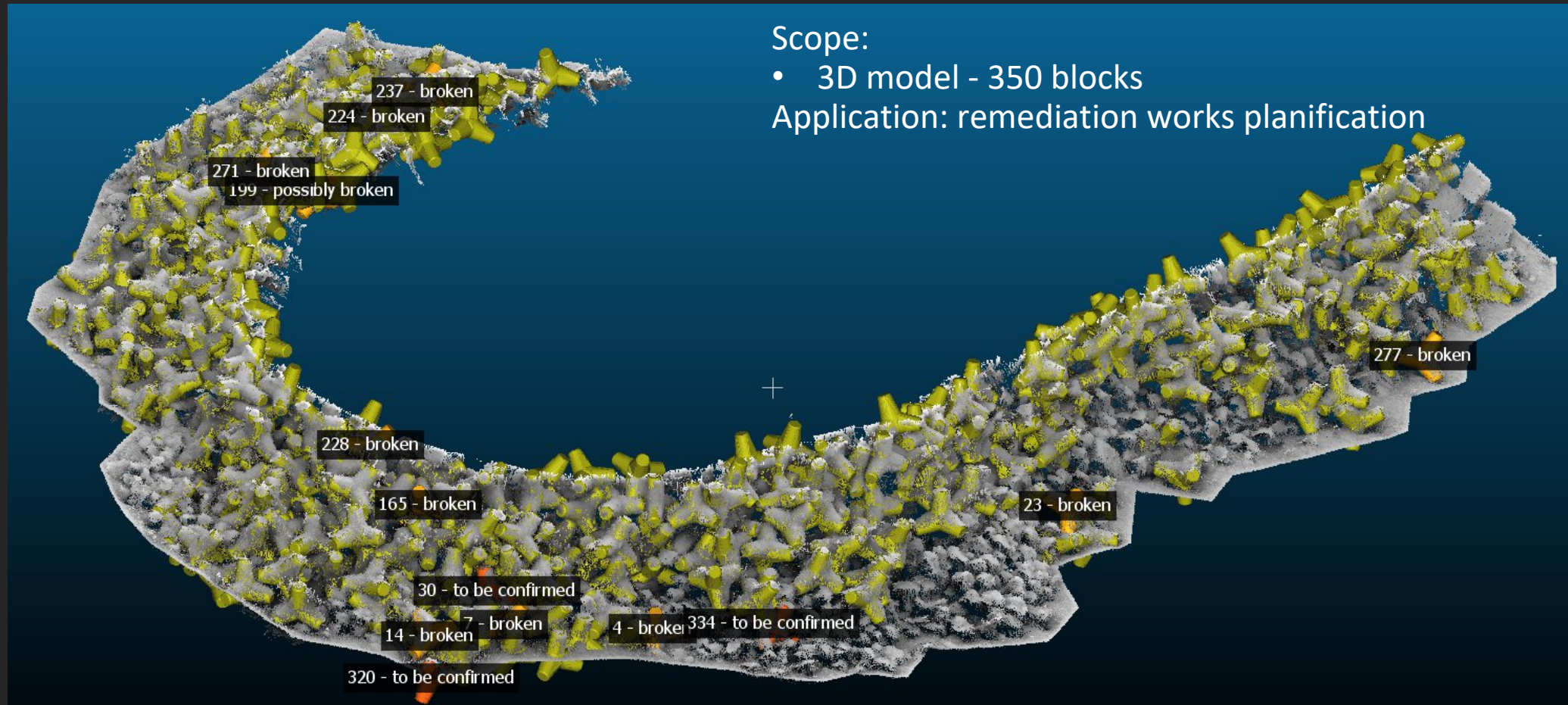
Double layer Antifer blocks –La Réunion harbour
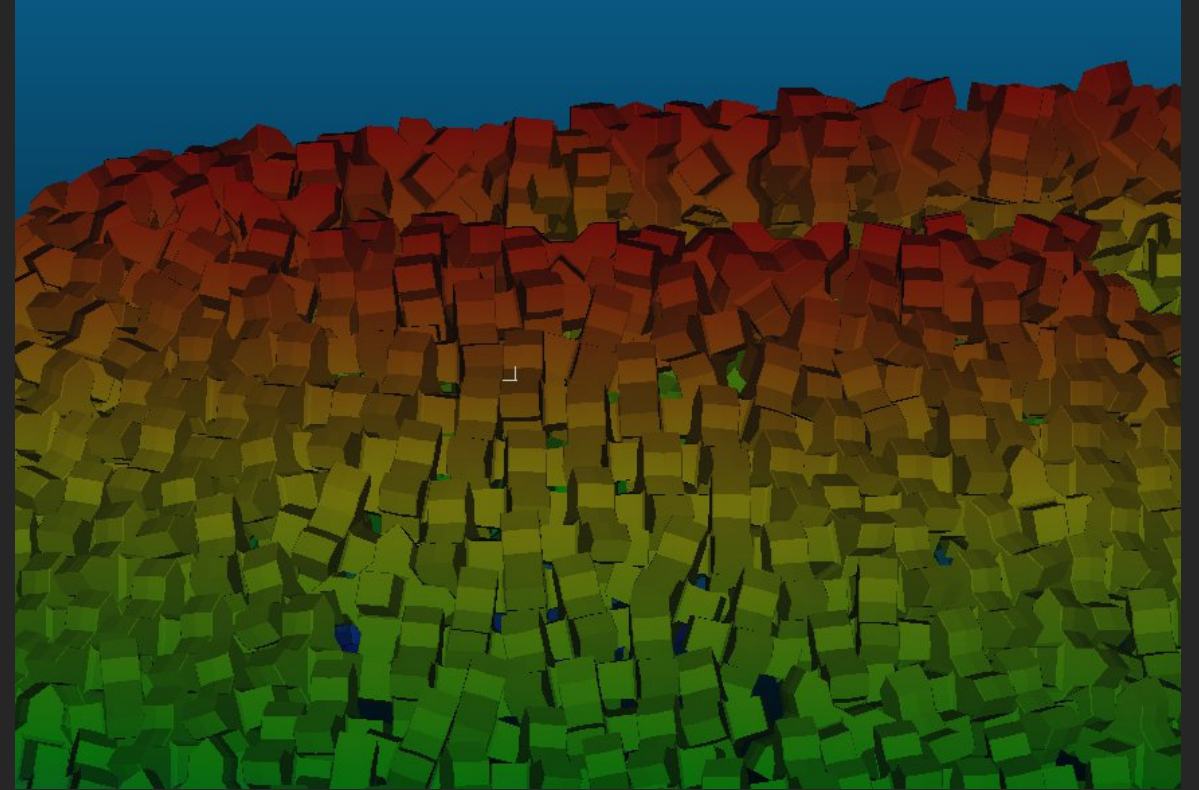

Scope:
- MBES and photogrammetry scan
- 3D model – 4 000 blocks

Application: remediation works planification

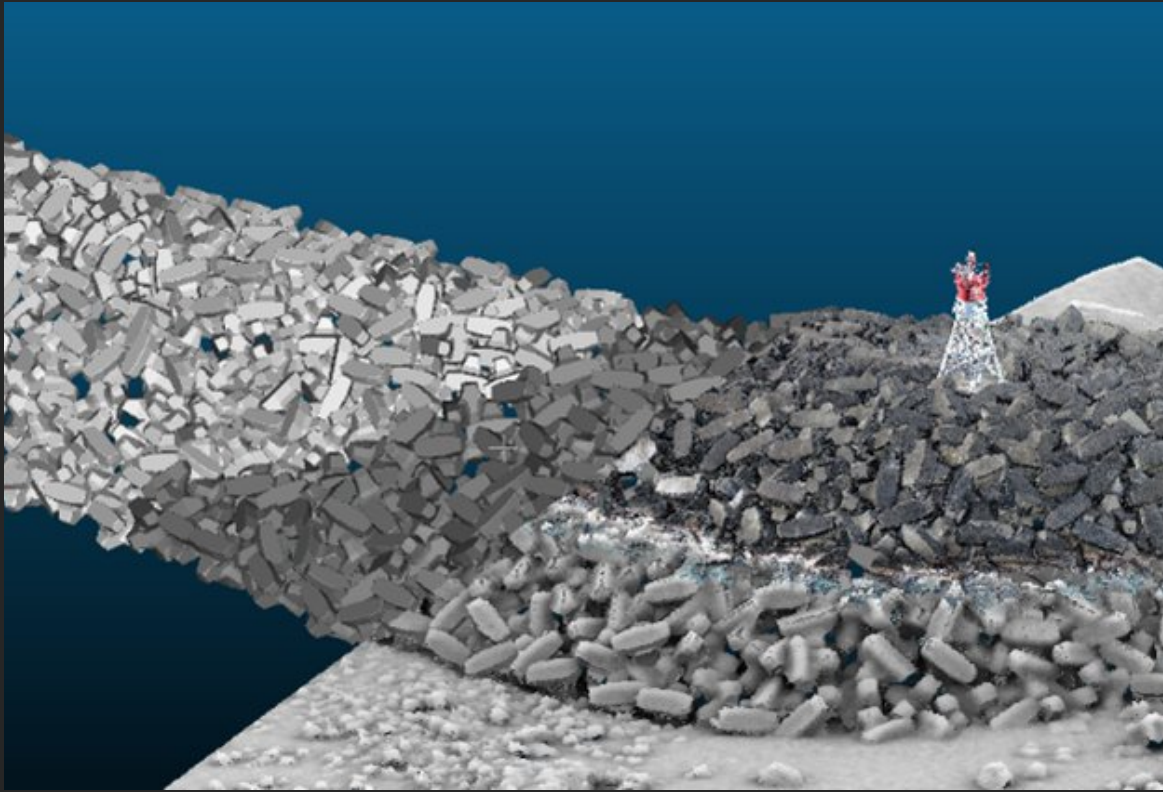# Double layer tetrapodes – Port-La-Nouvelle, France

Scope:
- 3D model - 350 blocks

Application: remediation works planification

Xbloc® - Calais harbour, France

Scope:
- MBES and photogrammetry scan
- 3D model – 16 000 blocks

Application: handover and contractor liability phase control

Accropode™ - Sainte-Rose, La Réunion

Scope:

- MBES and photogrammetry scan

- 3D model – 1 000 blocks

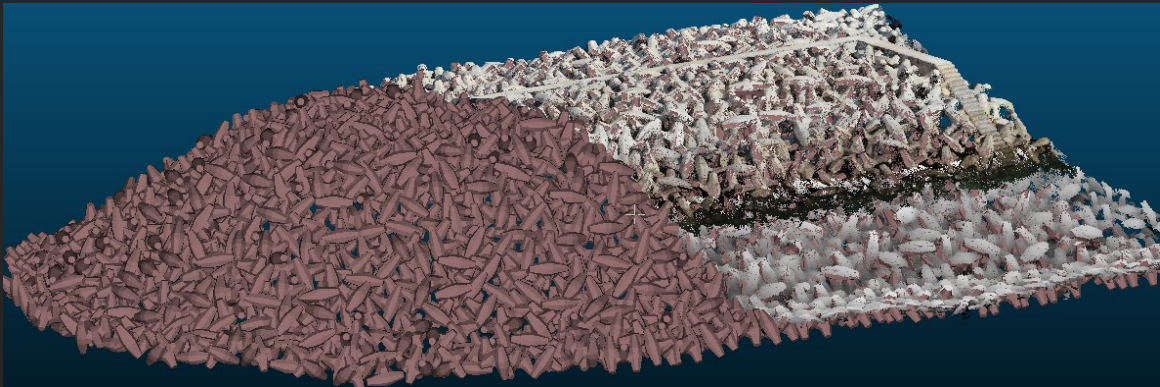Application: asset management, structure diagnosis 20 years after installation

Core-Loc™ - Oman

Scope:

- MBES and LiDAR scan
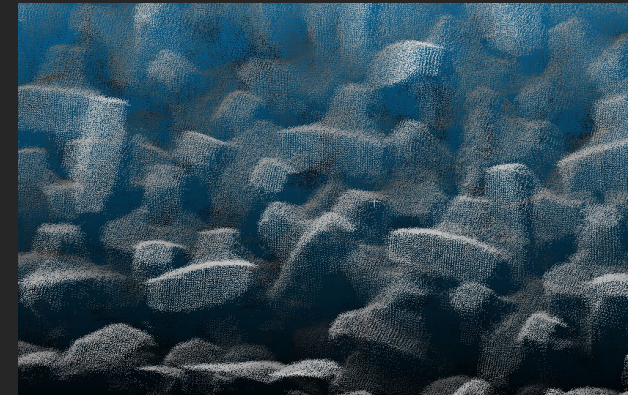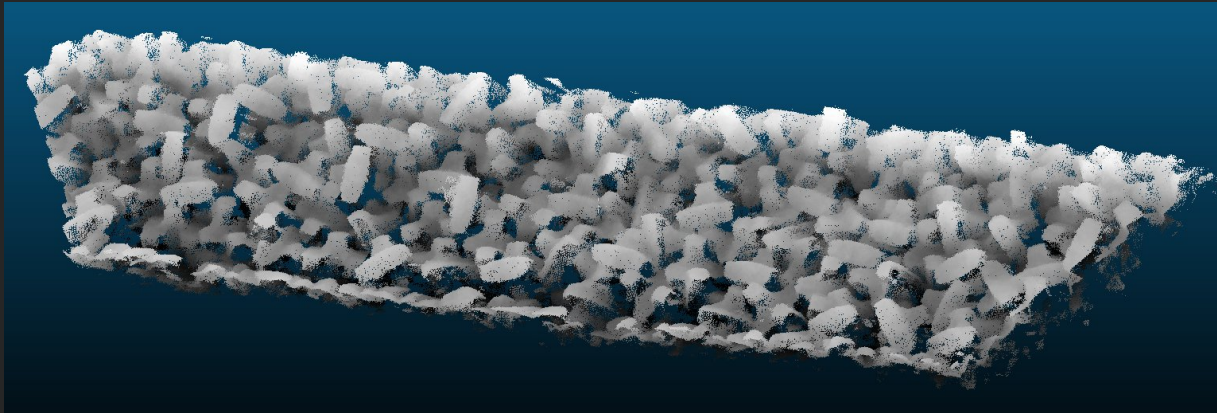- 3D model – 32 000 blocks

Application: handover
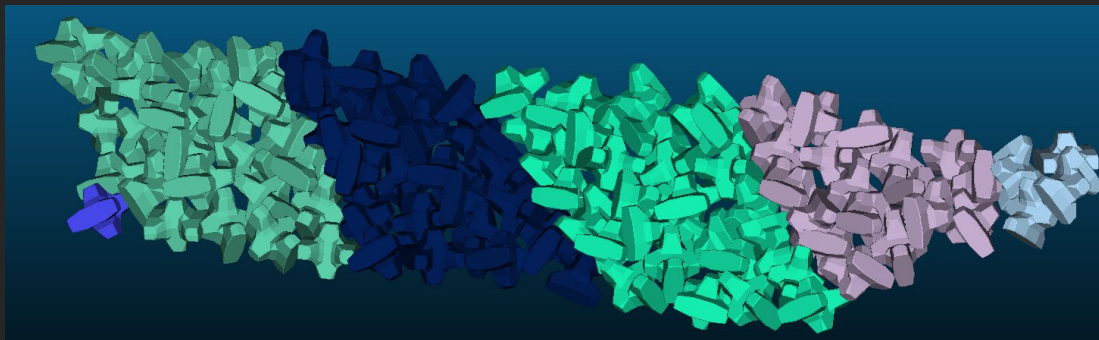
Accropode™ - UAE

Scope:

- 3D model – 67 000 blocks
- Audit and recommendations on survey

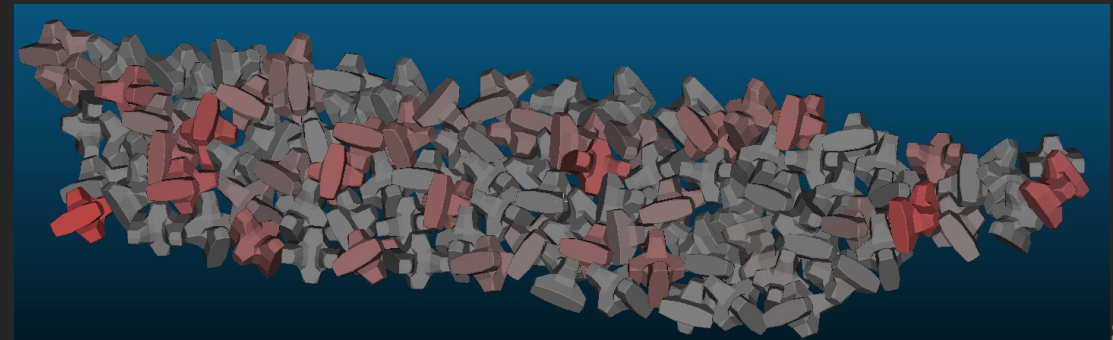Application: block placement control during construction

1/ Regular reception of MBES and photogrammetry surveys by the contractor

2/ 3D model sent back at Day+1 for up to 1000blocks/day

3D model with placement panels, each block is numbered according to the as-built coordinates list

Off-profil control automatic filter

# Numerical retro-engineering simulation

A Cloud-Based native SaaS solution for CFD

Our Mission: To offer companies an innovative solution for performing numerical simulations in fluid mechanics via the cloud, with a user-firendly approach.

Our Specialty:

- Design and development of an in-house simulation code adapted to modern challenges of fluid mechanics
- Design of an accessible Native SaaS platform for use even by novices

A Cloud-Based native SaaS solution for CFD

WINTS
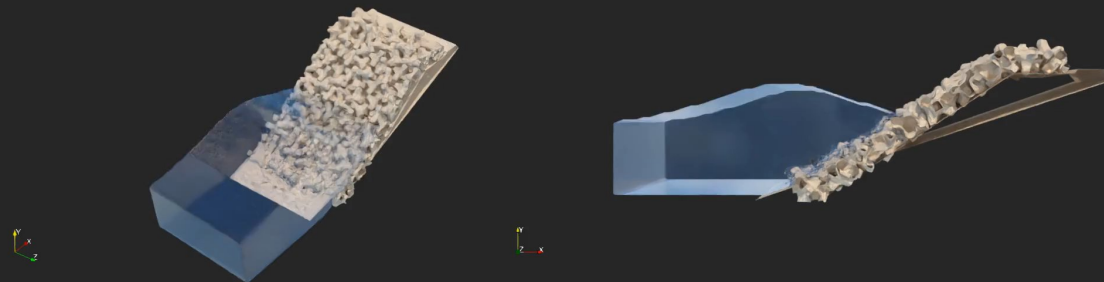Web INTerface for Simulation
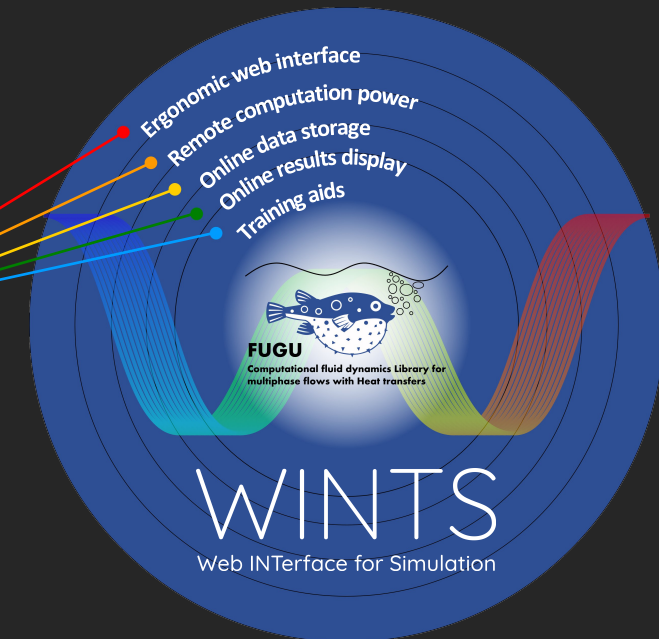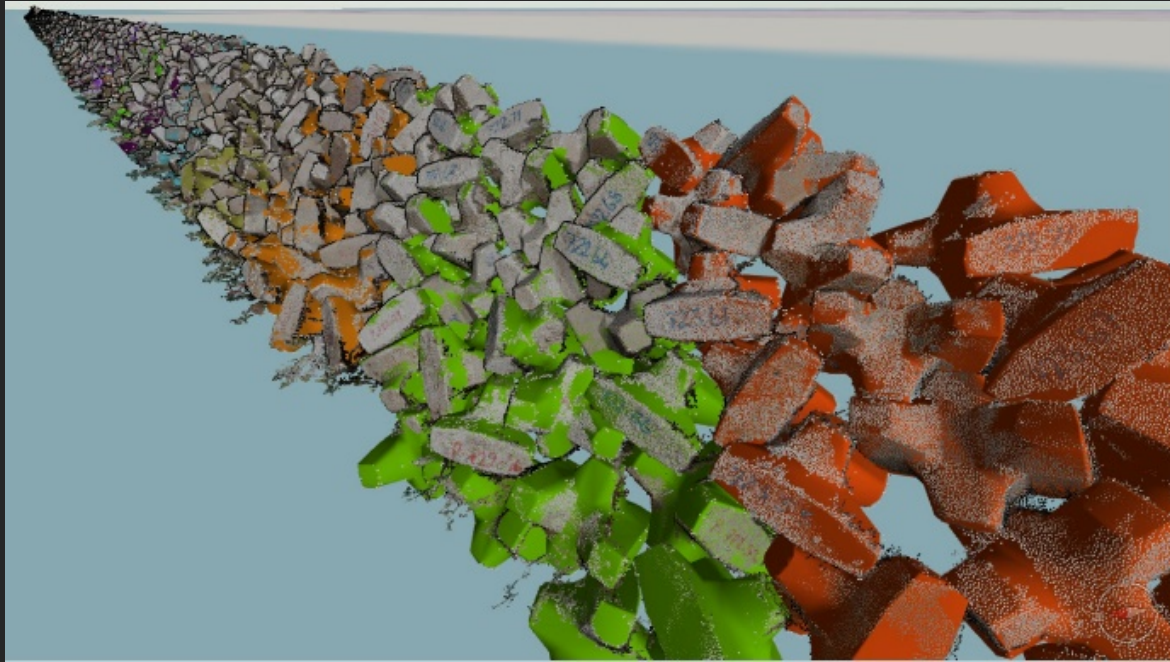
Use case - Wave breaking

Description: CFD Model simulation of a wave breaking on a seawall from an as-built SEABIM 3D model. Our technology enables to predict and analyze the effects of waves on coastal infrastructures.

Examples of quantities you can estimate:
- Wave overtopping
- Pressure applied to the seawall
- Wave propagation path

Thank you for listening

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SEABIM by ID OCEAN
Breakwater Scan to BIM

Take control of your breakwater
Digital twin | Block placement control | Asset management

www.seabim-breakwater.com