



PROTECTING PORTS: INNOVATIVE RESEARCH ON SCOUR PREVENTION DESIGN

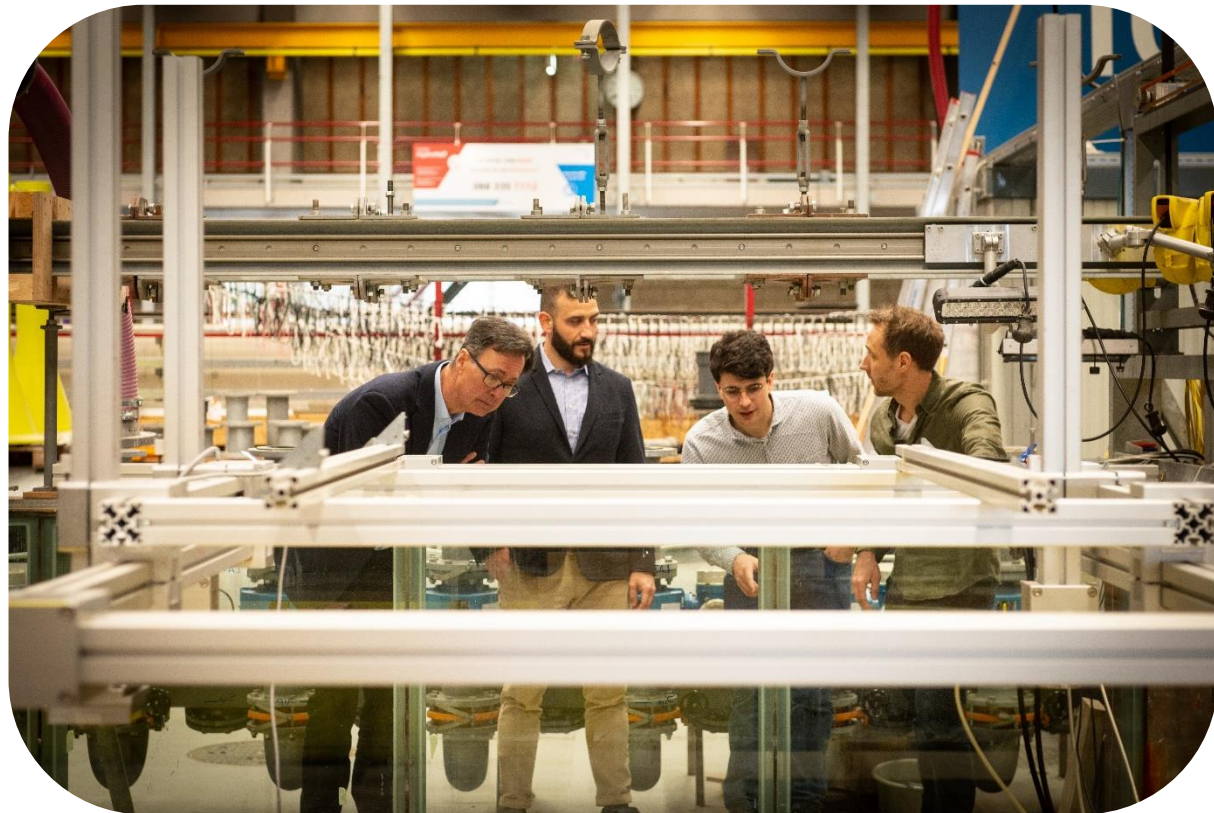
July 11th 2023

MACCAFERRI

MACCAFERRI

with

Deltares





5' Introduction

*15' Our history of testing campaign
and a new innovative one*

*15' Our experience with RenoMac Plus:
a success story*

Q&A session

Speaker

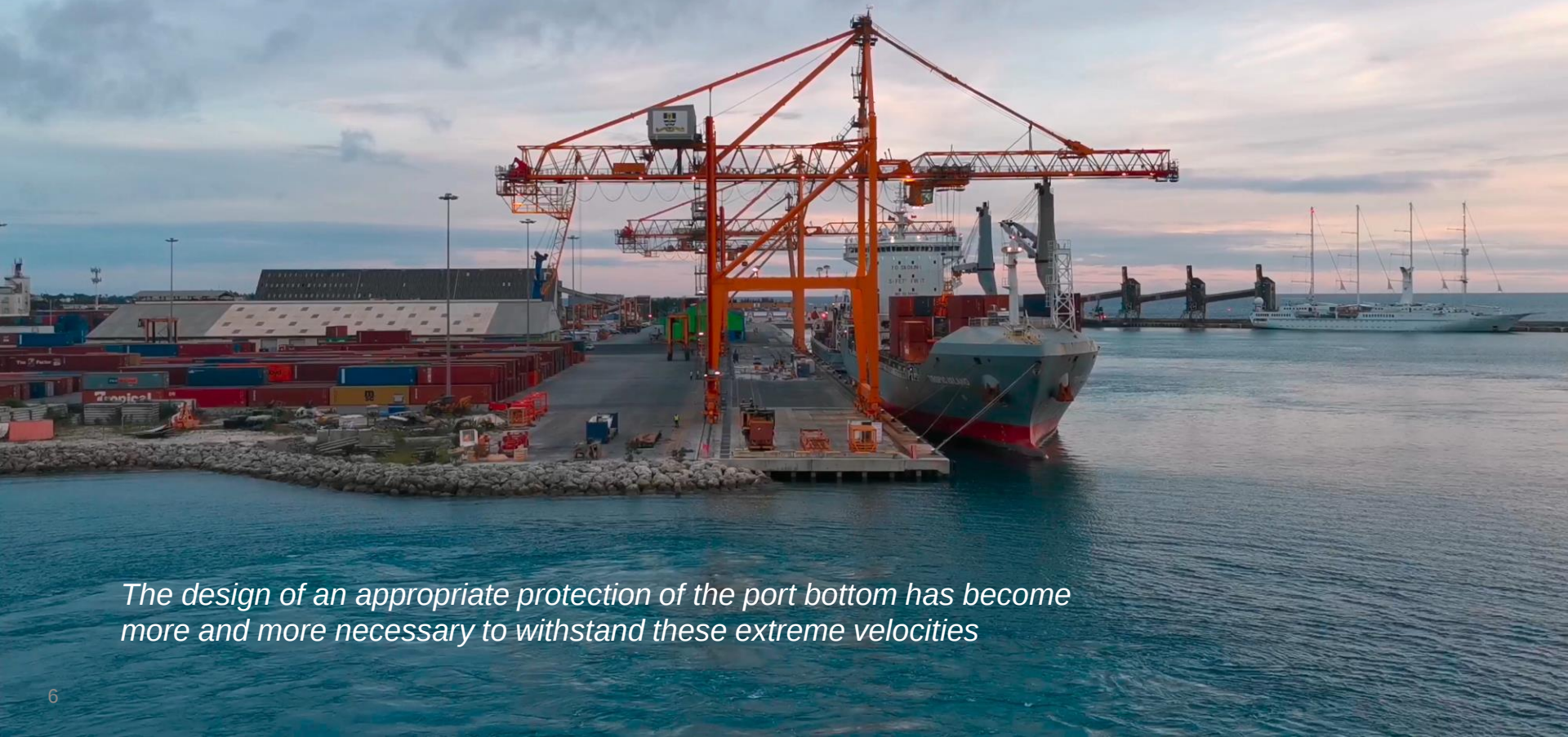
Paolo Di Pietro – Senior Specialist and Know-how Manager



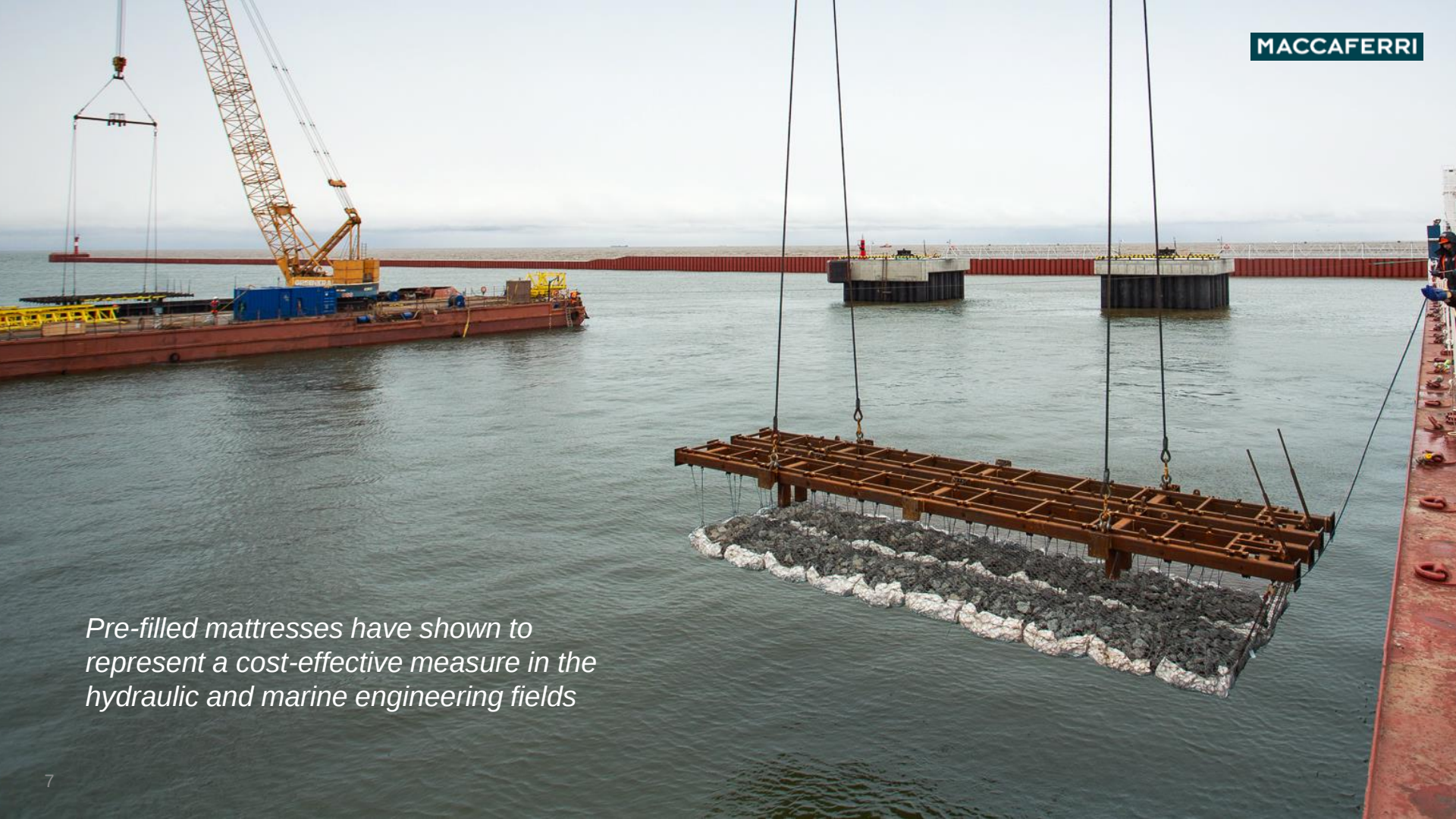
In the last decades ships for marine transport are becoming larger and deeper to answer the demands of the international market

The increased velocities caused by large propellers can lead to an increased bottom erosion and possibly to the quay wall failure





The design of an appropriate protection of the port bottom has become more and more necessary to withstand these extreme velocities



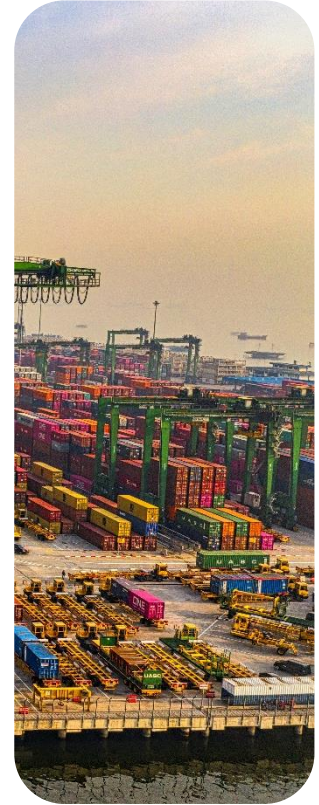
Pre-filled mattresses have shown to represent a cost-effective measure in the hydraulic and marine engineering fields

RenoMac Plus

is a prefilled solution,
designed to provide the
highest effectiveness in
various resource-intensive
conditions

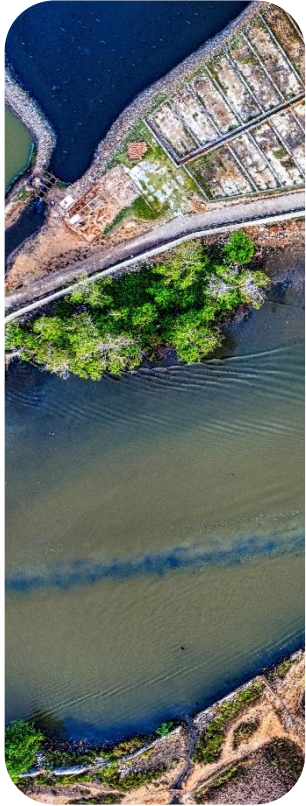


*The **all-in-one solution** for
filtering and scour protection,
specifically designed for
underwater applications*

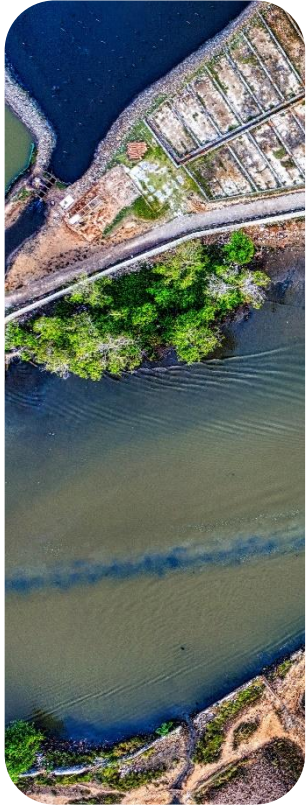




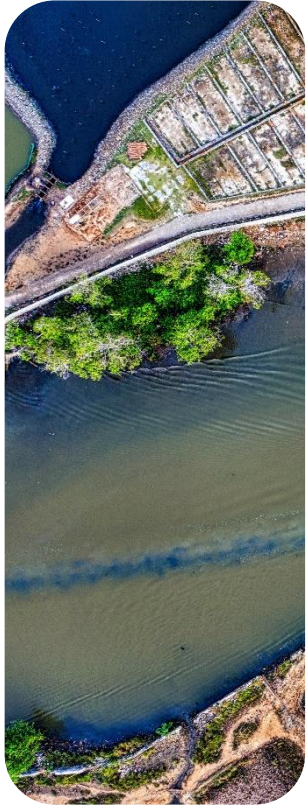
Longitudinal and grade control structures in watercourses



Bridge abutments and piles protections from scouring

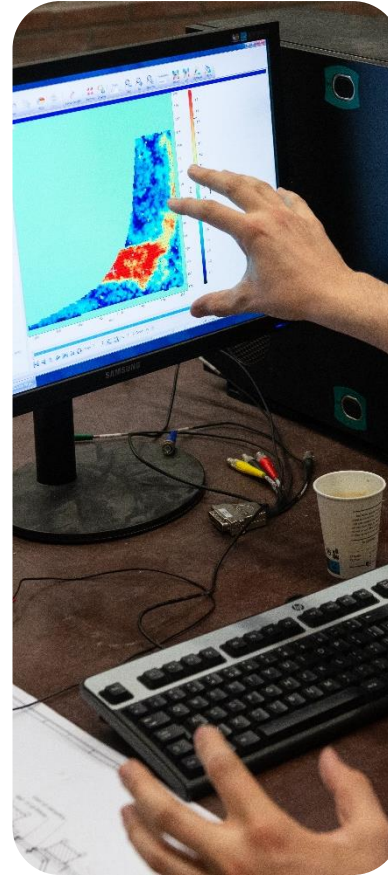


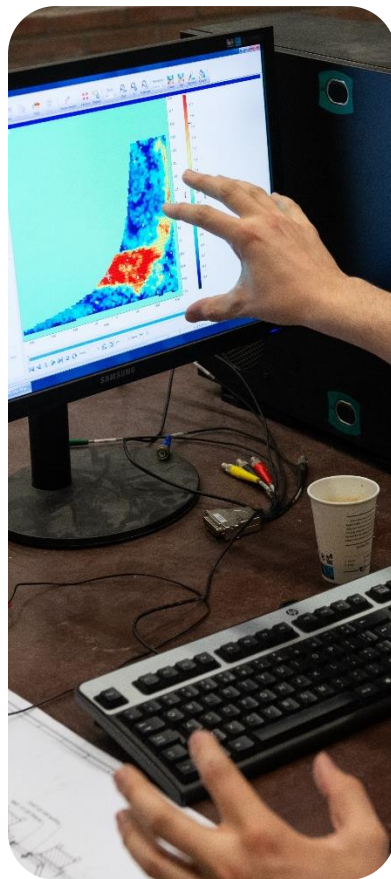
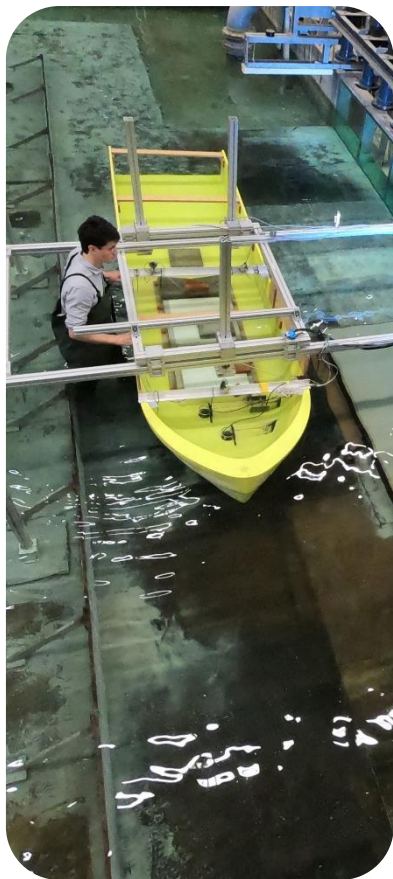
Bottom scour protection in harbor basins



How did we get here?

Maccaferri has constantly driven forward the technological improvement of its solutions to meet the growing needs of the market





DESIGN
THE
CHANGE





Our history of research campaigns and a new comprehensive study

1910

Invention of
«Mantellata
Volga»



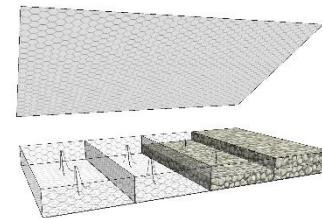
1984

Test Campaign
at Colorado State
University on
**Standard Reno
Mattress**



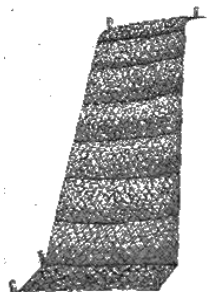
2018-2019

Test Campaign at
Colorado State
University on
double diaphragm
Reno Mattress



1960

Invention of
Reno
Mattress



1990

Development of
double diaphragm
Reno Mattress



2020

**+ Reno Mattress
Plus with X-Ties**

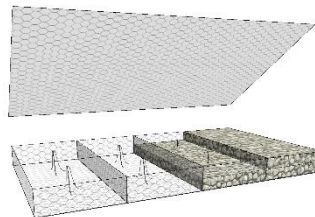
1984

Test Campaign
at Colorado State
University on
**Standard Reno
Mattress**



2018-2019

Test Campaign at
Colorado State
University on
double diaphragm
Reno Mattress



2022

Development of
RenoMac Plus



1990

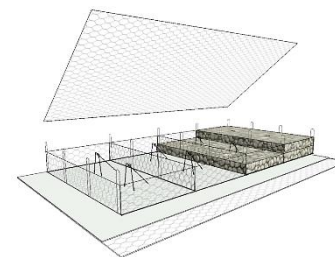
Development of
double diaphragm
Reno Mattress



2020



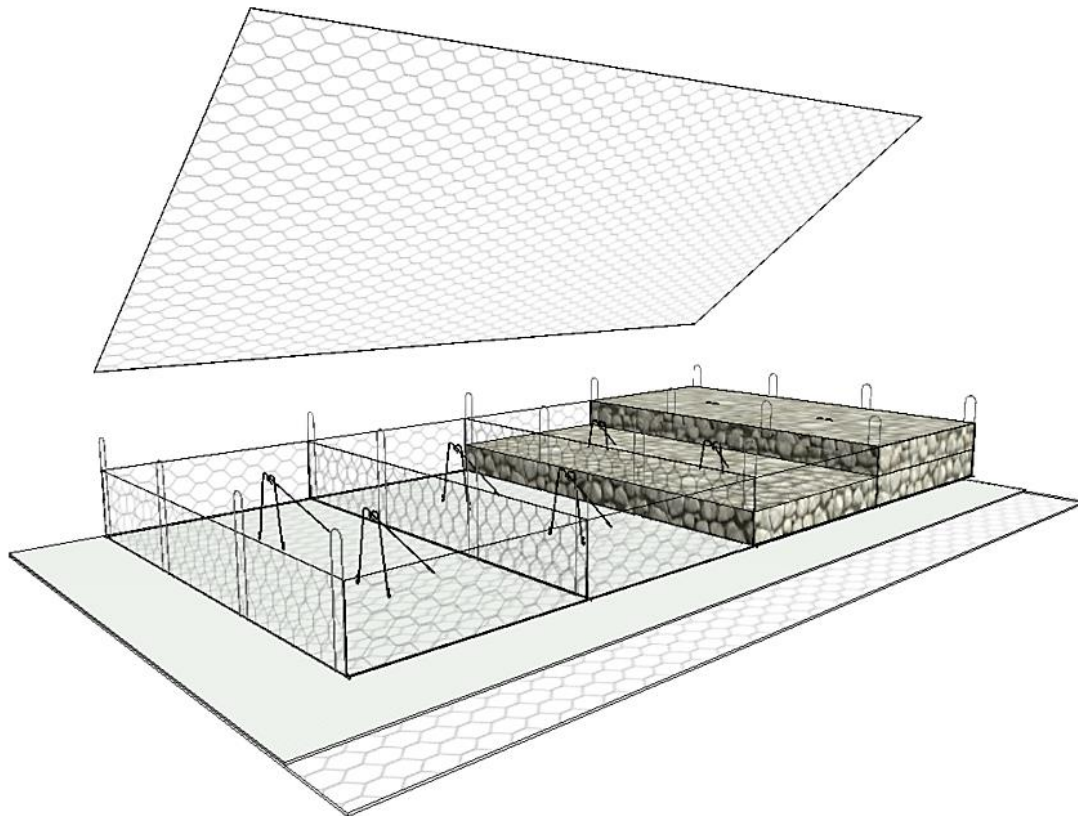
**Reno Mattress
Plus with X-Ties**

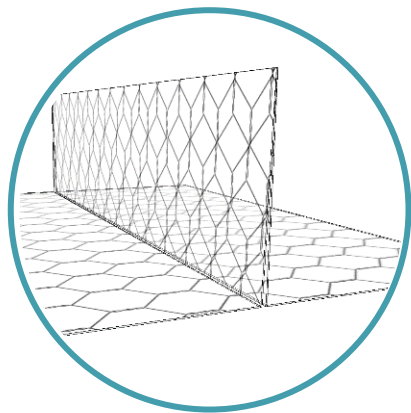


2023

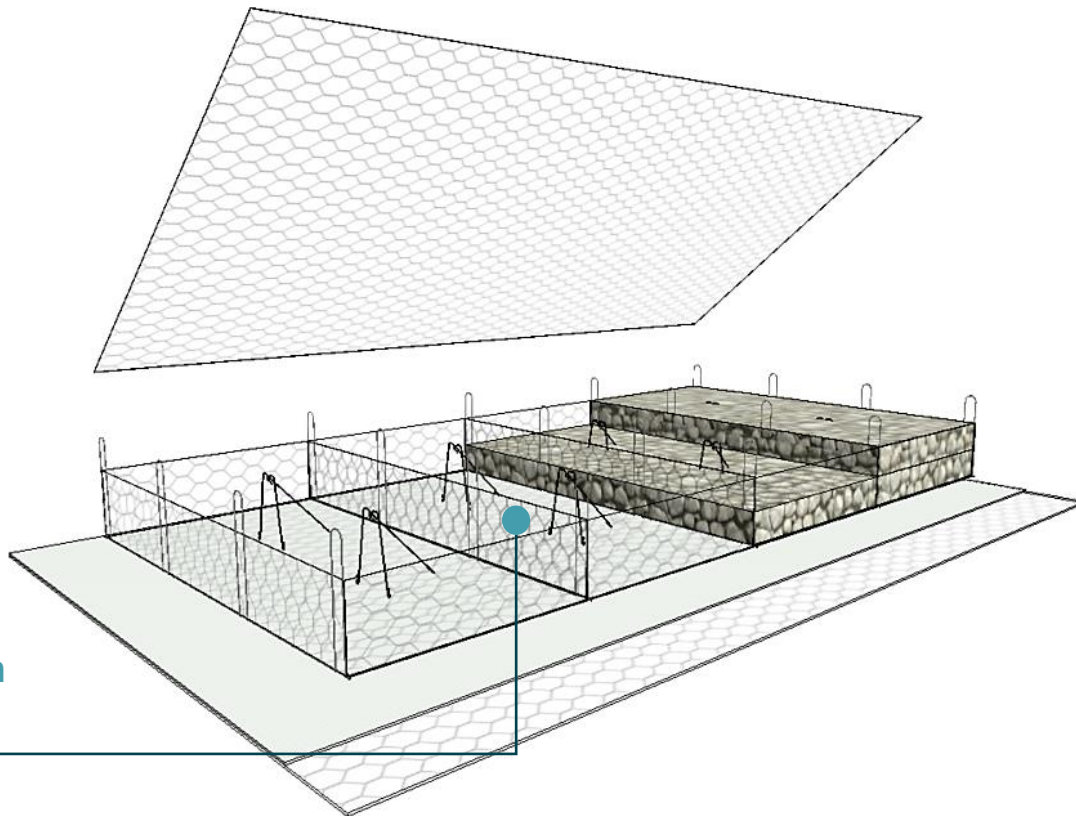
Test Campaign
at Deltares
Water Institute

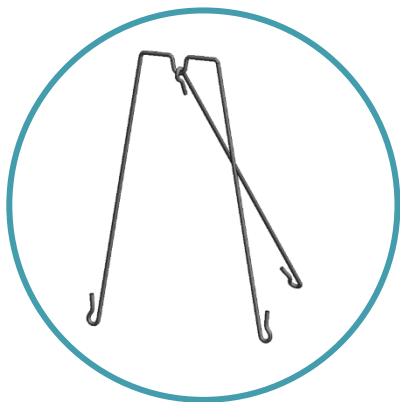
2022 Development of
RenoMac Plus



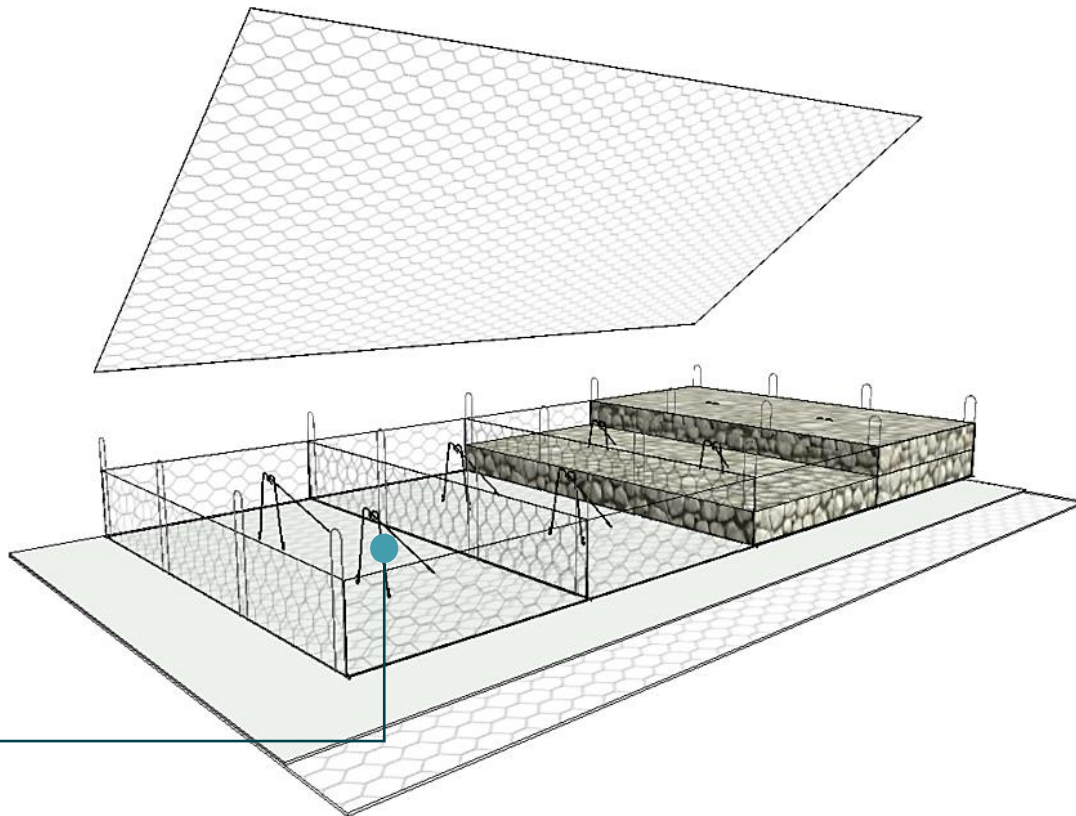


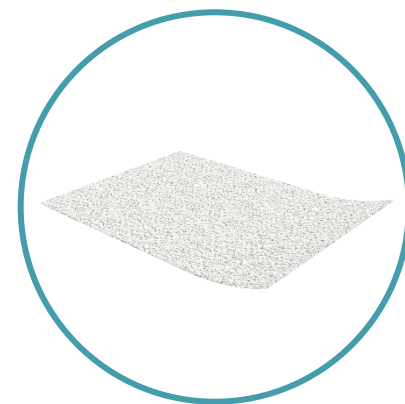
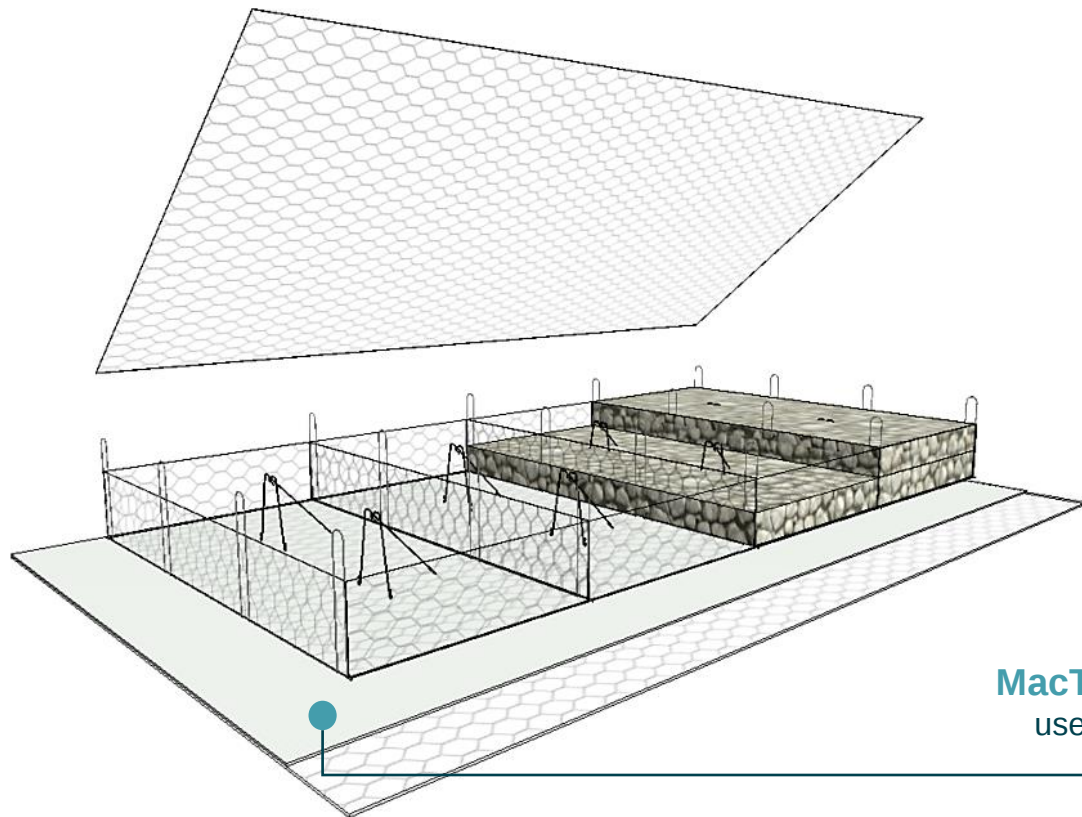
Vertical standing **double diaphragm**
makes filling operation easier



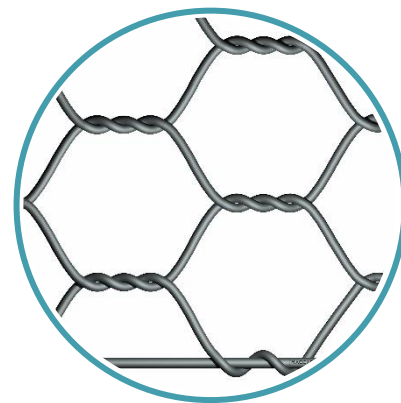
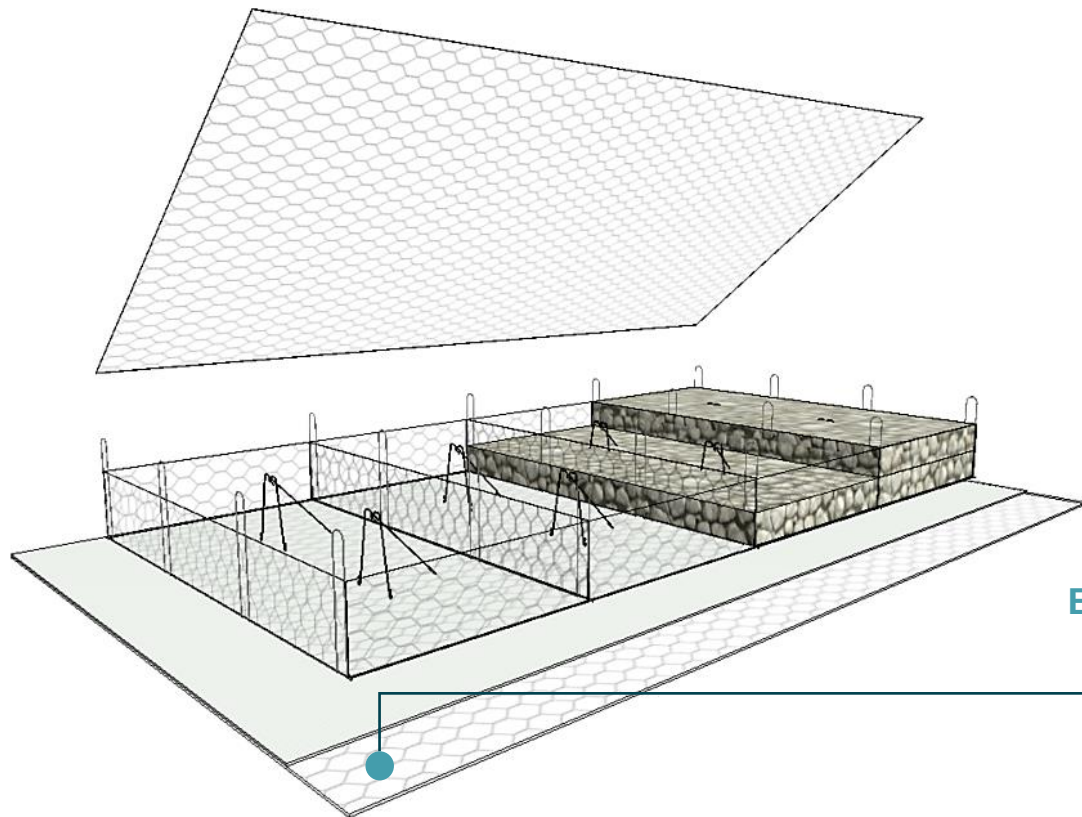


X-Tie is the experimentally developed and patented tie to maximize the structural resistance of the mattress

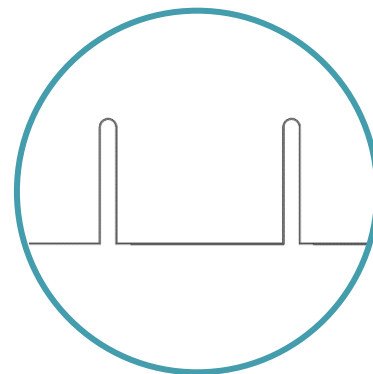
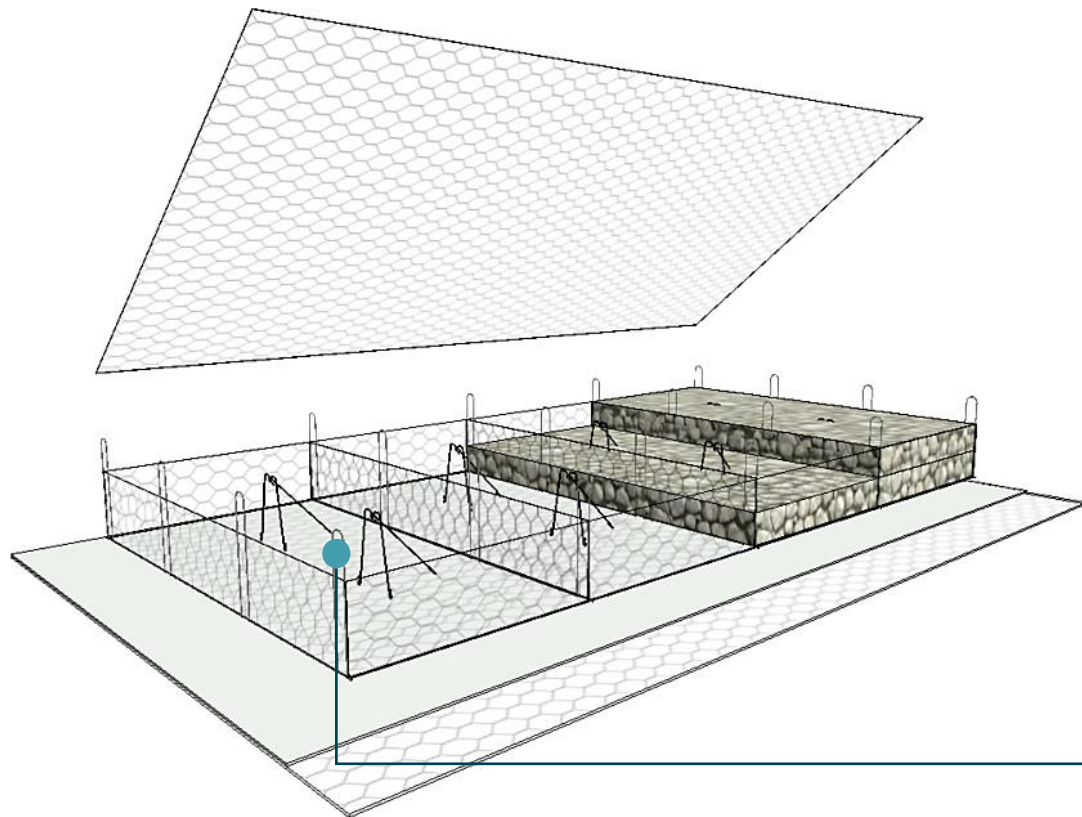




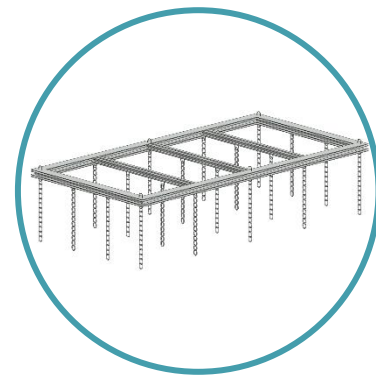
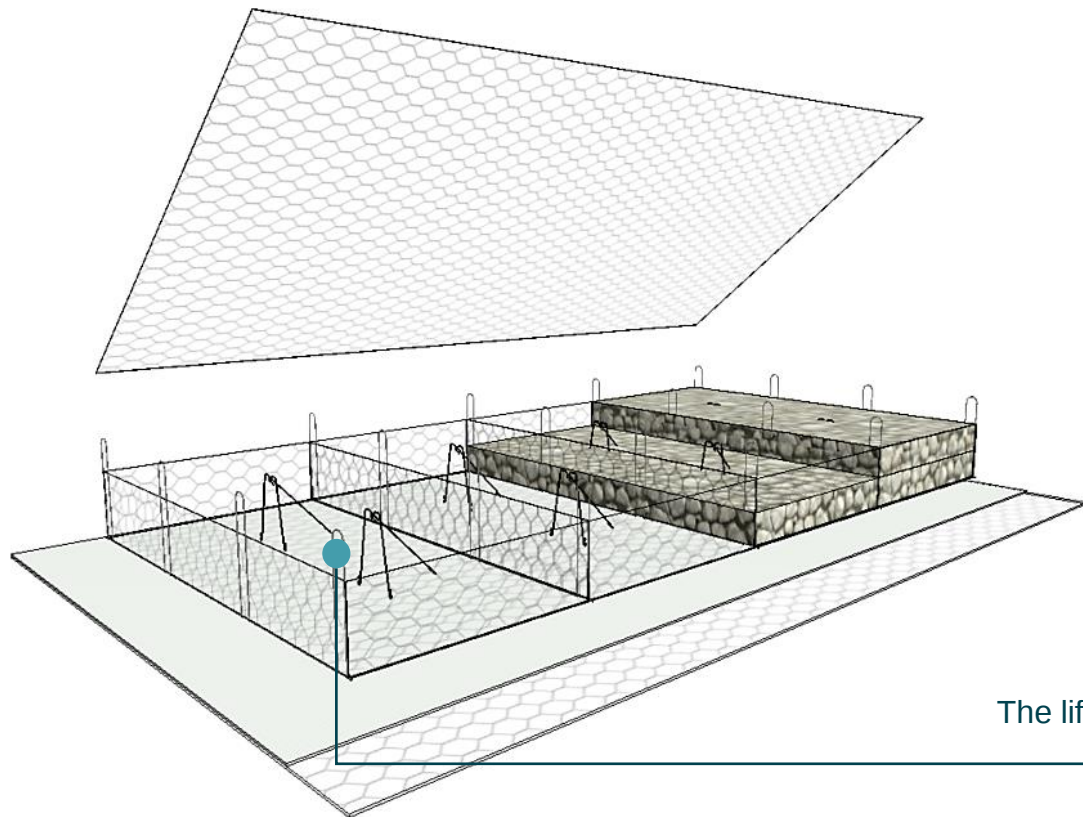
MacTex™ is the high quality non-woven geotextile used for separation and fine sediments protection



Extended double twisted wire mesh **base panel** to guarantee continuous protection



Lifting bars to facilitate the lifting by crane



Lifting Elements and Frame

The lifting bars can fit to various types of lifting frame

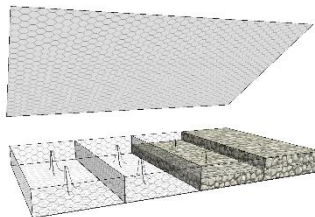
1984

Test Campaign
at Colorado State
University on
**Standard Reno
Mattress**



2018-2019

Test Campaign at
Colorado State
University on
double diaphragm
Reno Mattress



2022

Development of
RenoMac Plus



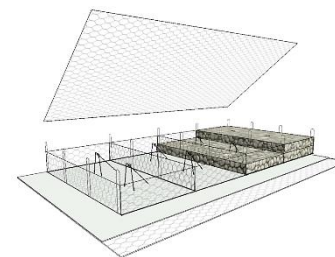
1990

Development of
double diaphragm
Reno Mattress



2020

**+ Reno Mattress
Plus with X-Ties**



2023

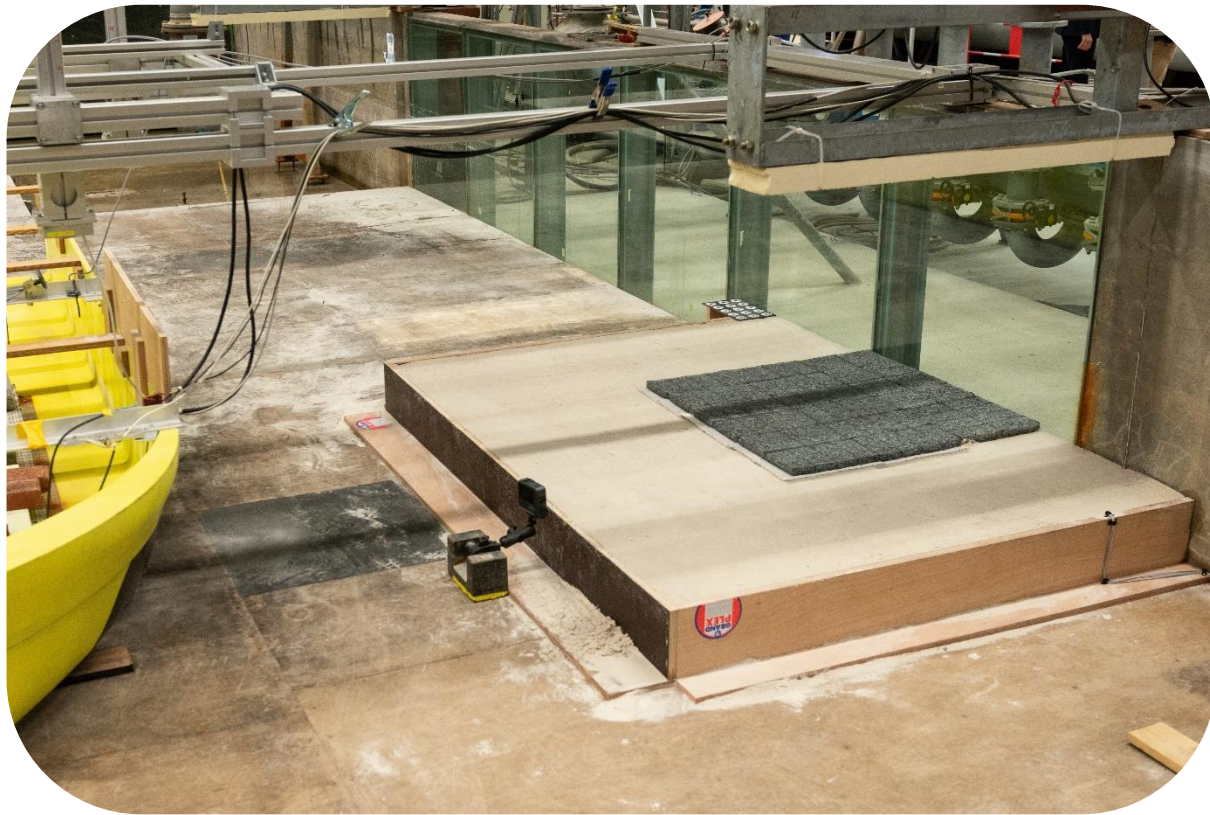
Test Campaign
at Deltares
Water Institute

2023 The beginning of
a new research

MACCAFERRI

with

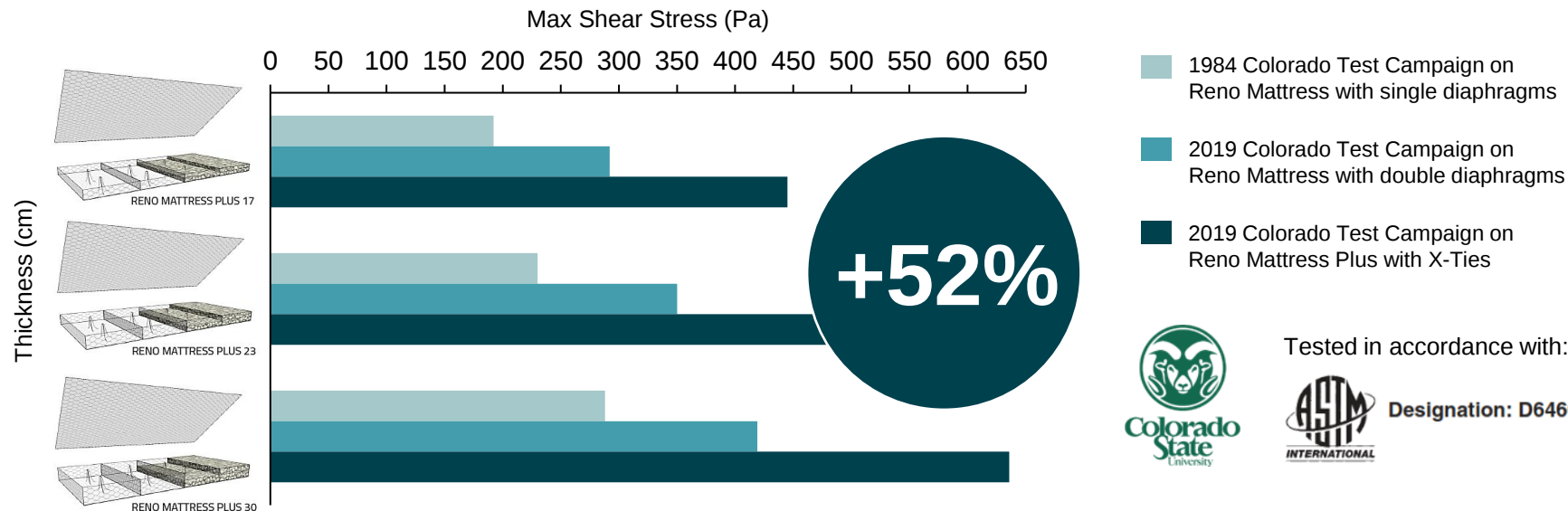
Deltares



TEST CAMPAIGN AT DELTARES WATER INSTITUTE

MACCAFERRI

The aim of the research



From our knowledge

The aim of the research

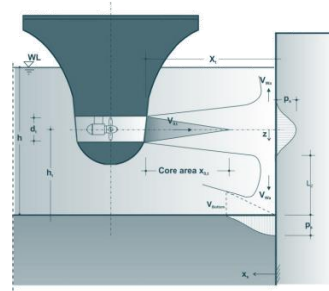
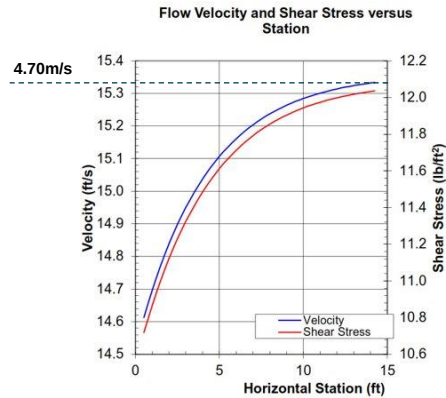


Figure 3.2: Flow field induced by a bow thruster



New **evaluation method** with updated resistance parameters for the design of RenoMac Plus

PIANC report n° 180 (2015) *Guidelines for protecting berthing structure from scour caused by ships*

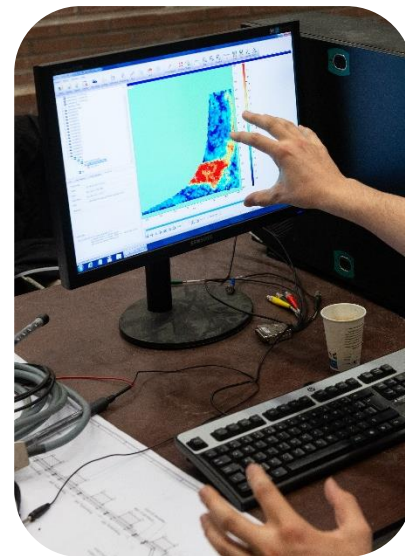
Comprehensive approach and measured values of near-bed velocities provided by the test campaign at Colorado State University

Through a new model

TEST CAMPAIGN AT DELTARES WATER INSTITUTE

MACCAFERRI

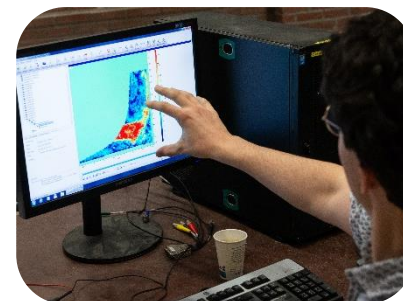
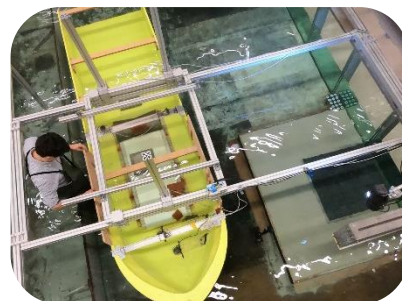
The aim of the research



To a test campaign

TEST CAMPAIGN AT DELTARES WATER INSTITUTE

The development of RenoMac Plus



1 Production of RenoMac Plus scale models
3D printing was used to recreate the double twisted wire mesh. All the unique features like double diaphragm, X-ties and geotextile were built.

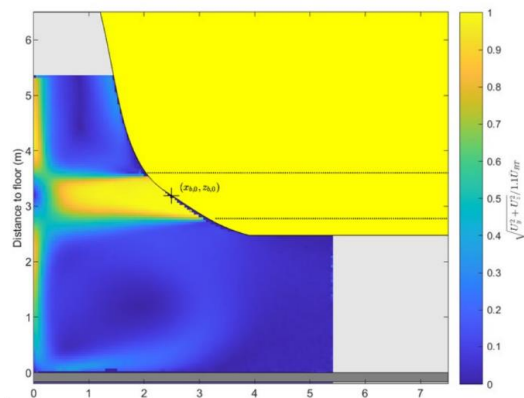
2 Velocity measurements
According to the PIV technique, the flow is illuminated with a laser and traces of small particles are followed. A specific algorithm calculates the velocity magnitude above the RenoMac Plus mattresses.

3 Deformation test
RenoMac Plus mattresses are equipped with accelerometers and placed on a sand bed. Any movement is detected by the sensors and monitored with 3D cameras.

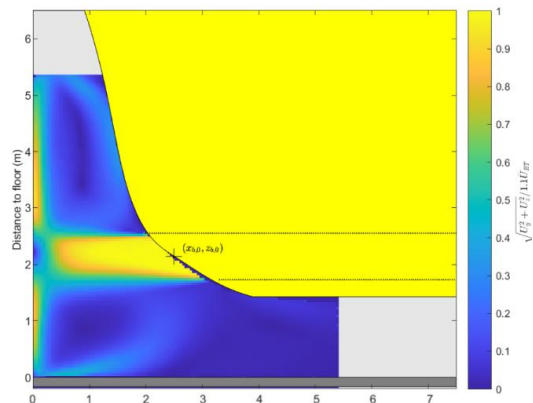
4 Result analysis
Both the results from the PIV test and the deformation test are analysed and discussed in a final report. A comparison is made with the evaluation method and PIANC guidelines.

The results – PIV test

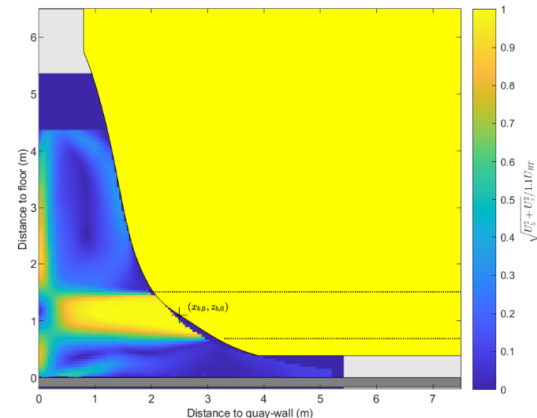
UKC = 2.5 m



UKC = 1.4 m

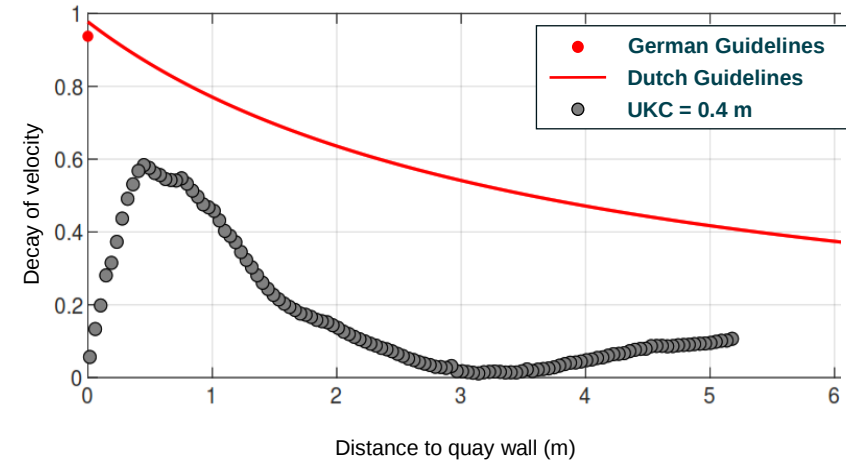
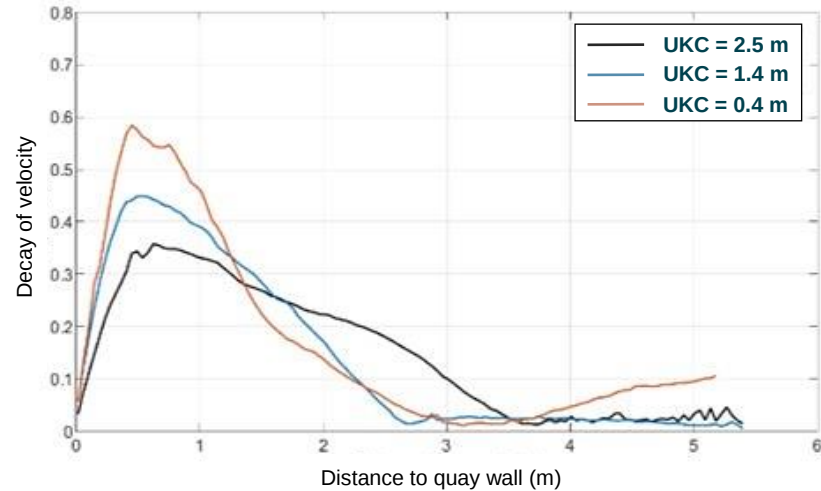


UKC = 0.4 m



Model validated

The results – PIV test



Model validated

The results – Deformation test

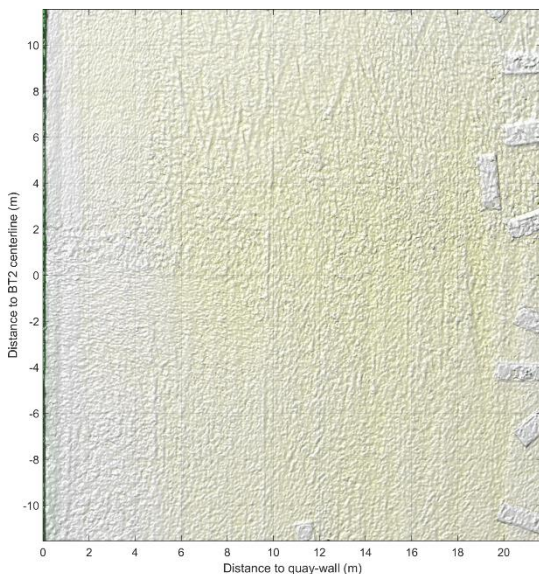
Without protection



Proof of no deformation

The results – Deformation test

Without protection



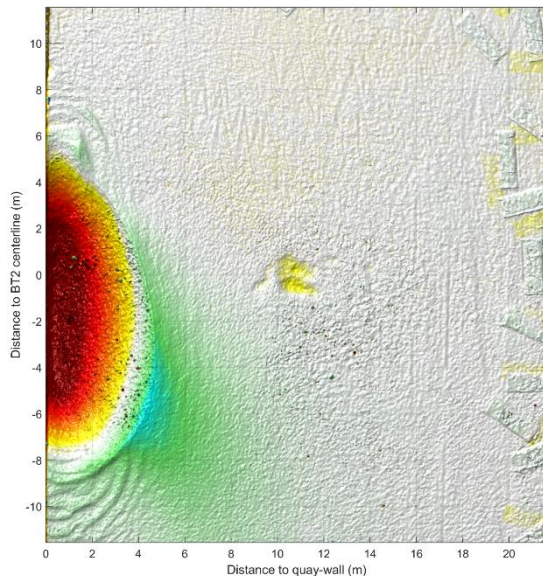
 RenoMac+



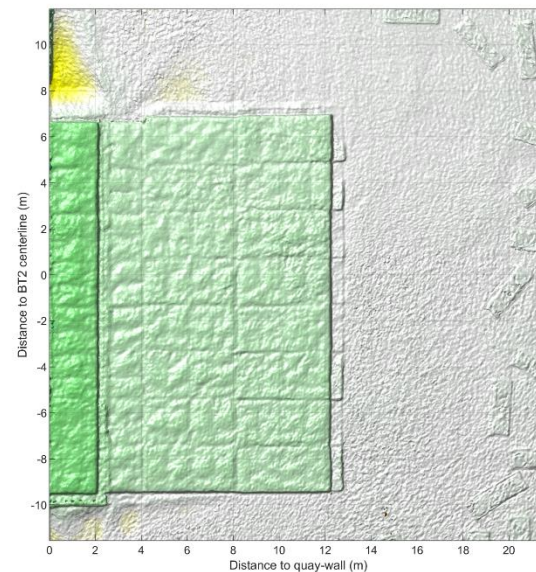
Before

The results – Deformation test

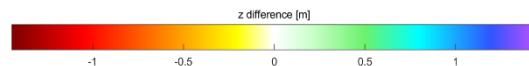
Without protection



 RenoMac+

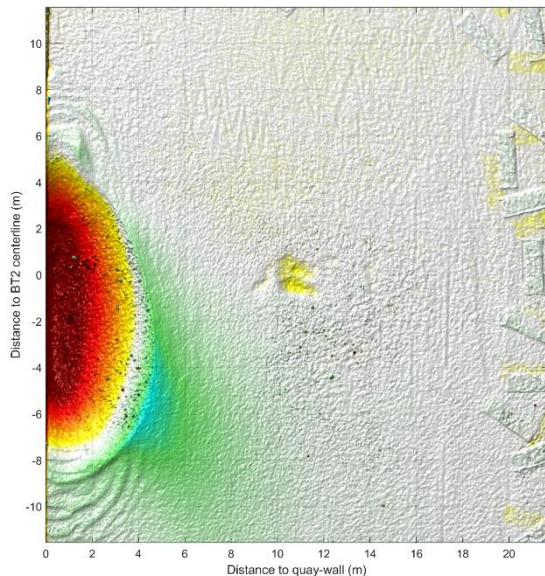


After

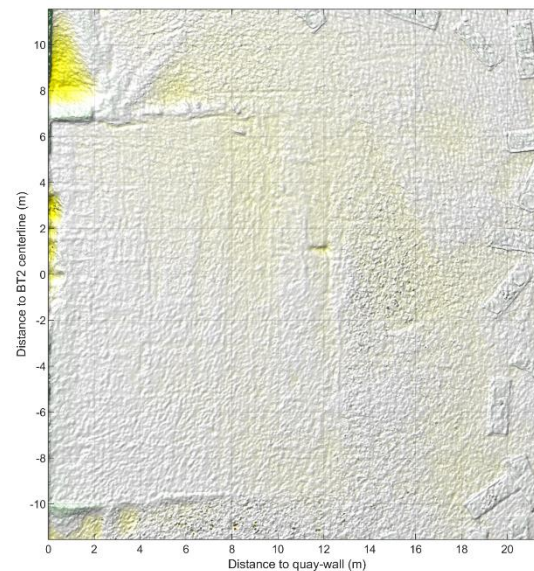


The results – Deformation test

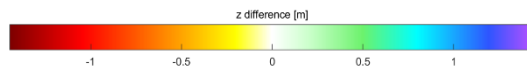
Without protection



 RenoMac+



After



The results – Final considerations

4.70 m/s

surface velocity that
RenoMac Plus can withstand

Final considerations

The results – Final considerations

4.70 m/s

surface velocity that
RenoMac Plus can withstand

Which is the minimum thickness
required to withstand this velocity?

Final considerations

The results – Final considerations

	RenoMac Plus	Concrete mattress	Rip-Rap
Which is the minimum thickness required to withstand this velocity?	0.30 _m	0.70 _m	2,22 _m

Final considerations

The results – Final considerations

Which is the minimum thickness required to withstand this velocity?

RenoMac Plus

0.30 m

Concrete mattress

2 x

Rip-Rap

7.5 x

Reduction of thickness protection

Final considerations



*Our experience
with RenoMac Plus*

OUR EXPERIENCE WITH RENOMAC PLUS

MACCAFERRI

Scour protection of quay wall in Arles, France



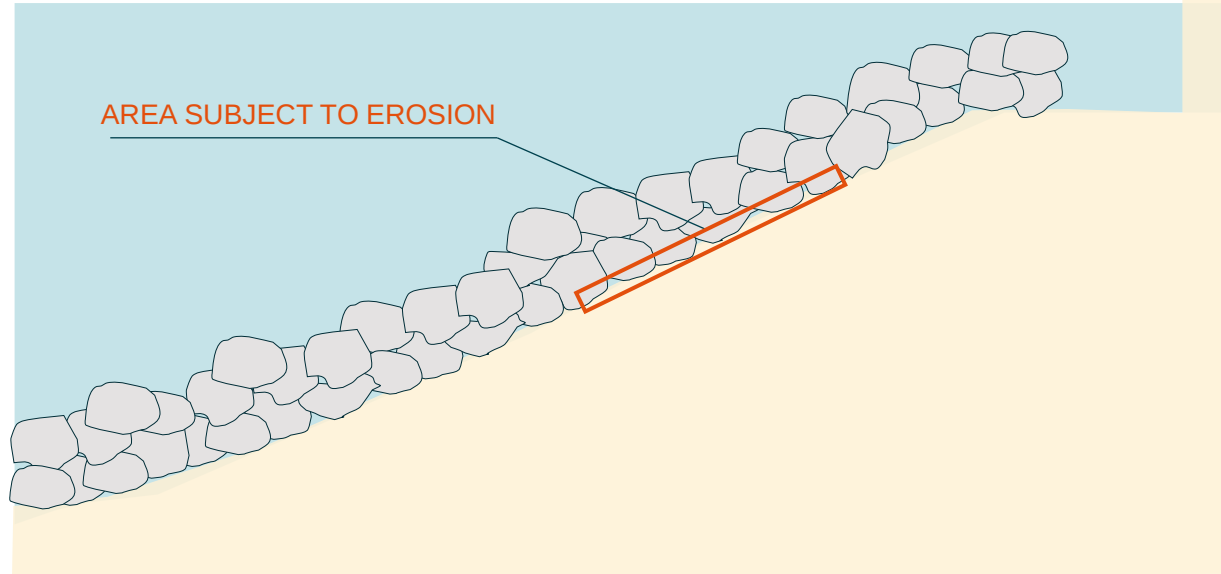
As part of a berthing structure project on the Rhône in Arles, a bank protection solution against the velocities generated by the ship propellers was installed to prevent erosion.

OUR EXPERIENCE WITH RENOMAC PLUS

Scour protection of quay wall in Arles, France

Why is rip-rap less preferable as solution for applications on long sloped banks?

- M** A bigger thickness takes much space (less water conveyance)
- M** Protection requires to be extended along the entire slope, even if unnecessary

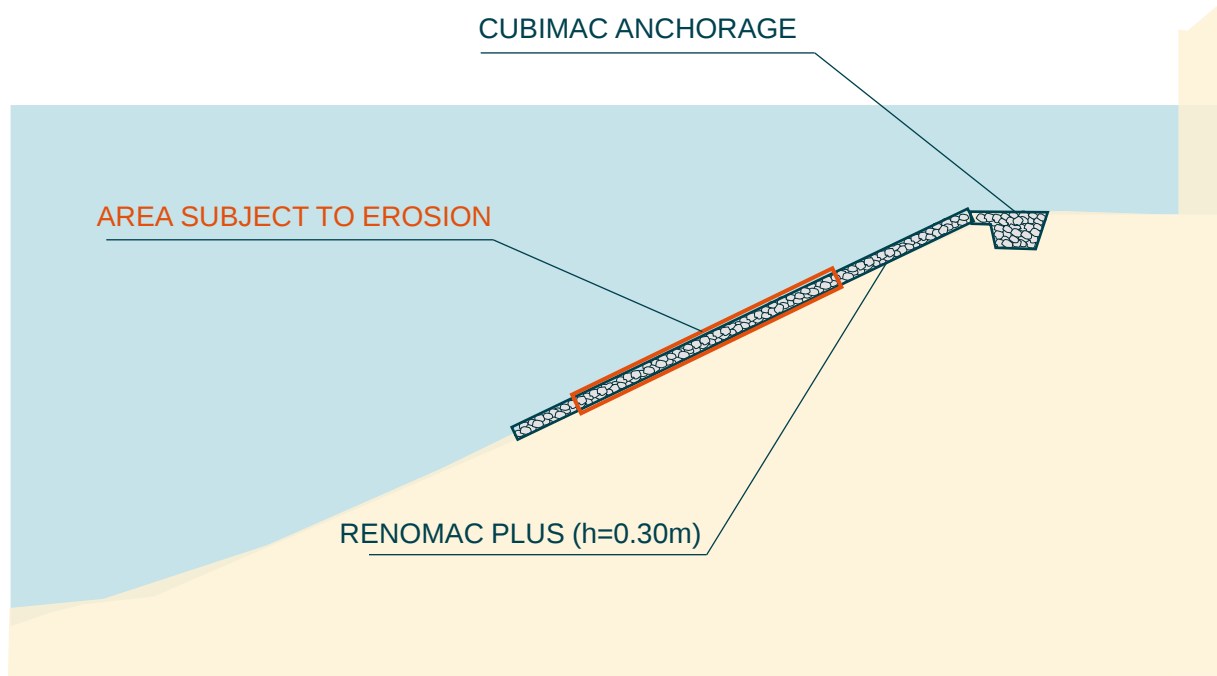


OUR EXPERIENCE WITH RENOMAC PLUS

Scour protection of quay wall in Arles, France

Why is RenoMac Plus a preferable choice?

- Reduced thickness
- Protection applied only where necessary



OUR EXPERIENCE WITH RENOMAC PLUS

MACCAFERRI

Scour protection of quay wall in Arles, France

Why is a RenoMac the winning choice?

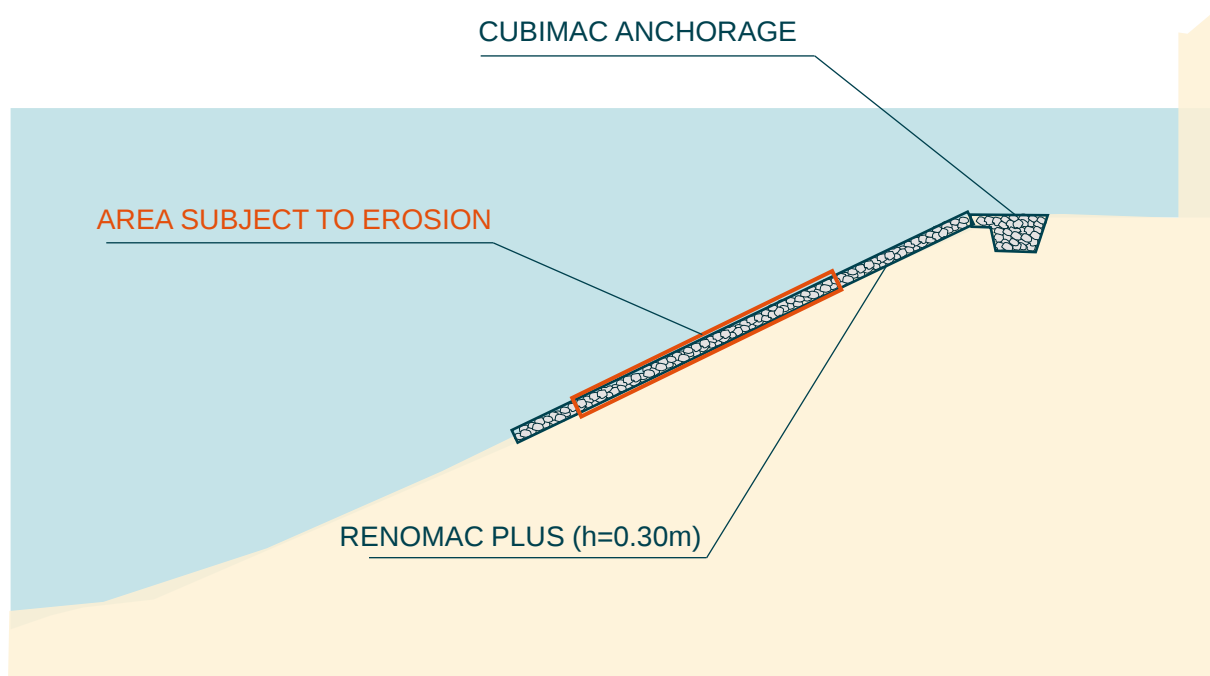
- M** Reduced thickness
- M** Protection applied only where necessary



Hydraulic design in accordance with the PIANC Guidelines

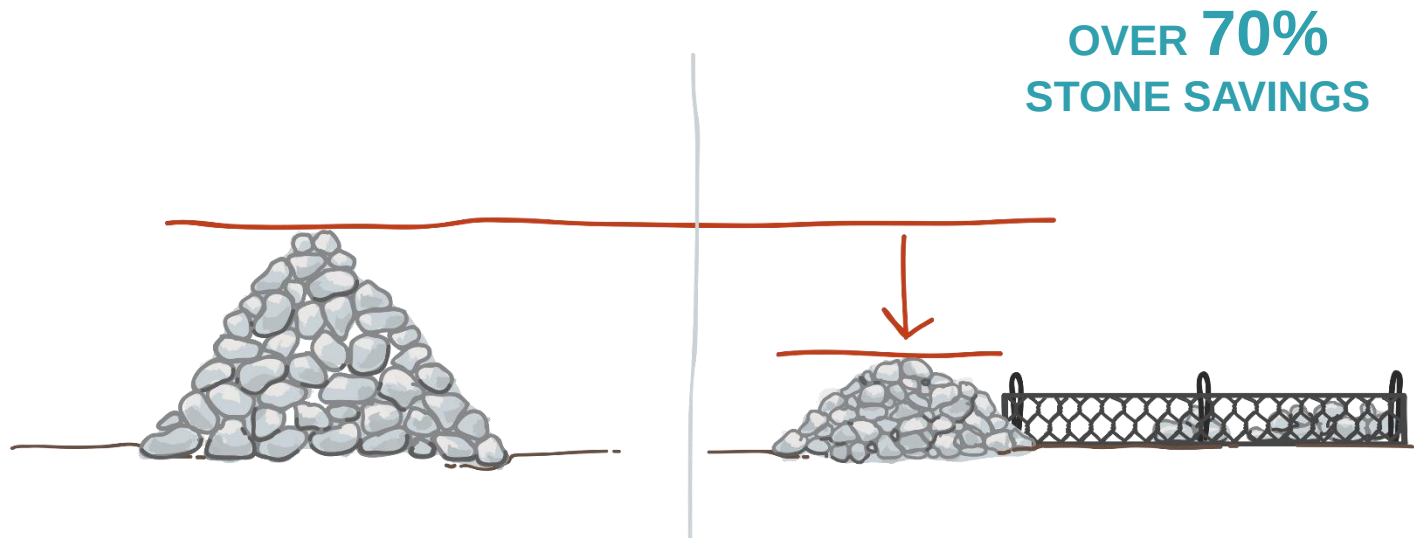


The only one solution tested specifically for deformation



WHAT ARE THE BENEFITS OF RENOMAC PLUS?

Traditional riverbank protection constructed with loose boulders (rip-rap) require thick layers of materials to be effective. RenoMac Plus has a **cost-effective** design, optimizing material usage without compromising efficacy, resulting in significant savings.



WHAT ARE THE BENEFITS OF RENOMAC PLUS?

The unique features of RenoMac Plus eliminate the need for post-installation filling of the mattresses. Therefore, the stones' setting inside the assembled cage can be carried out more **accurately**, minimizing material waste.



NO WASTE OF
MATERIAL

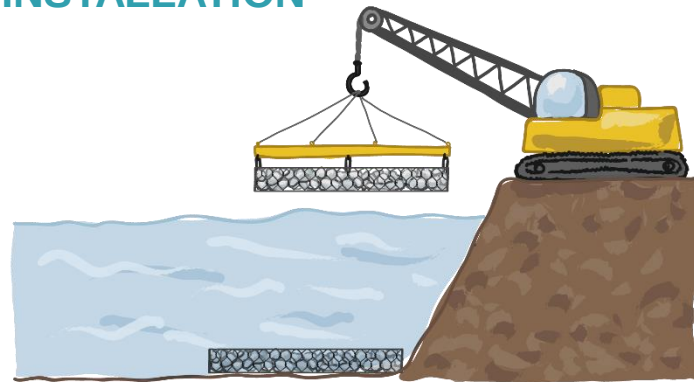


WHAT ARE THE BENEFITS OF RENOMAC PLUS?

The laying and filling of the assembled cages in underwater conditions can be challenging. RenoMac Plus is an **all-in-one** and **ready-to-use** solution that can be moved directly to the construction site; thus, the installation becomes safer and more accurate.

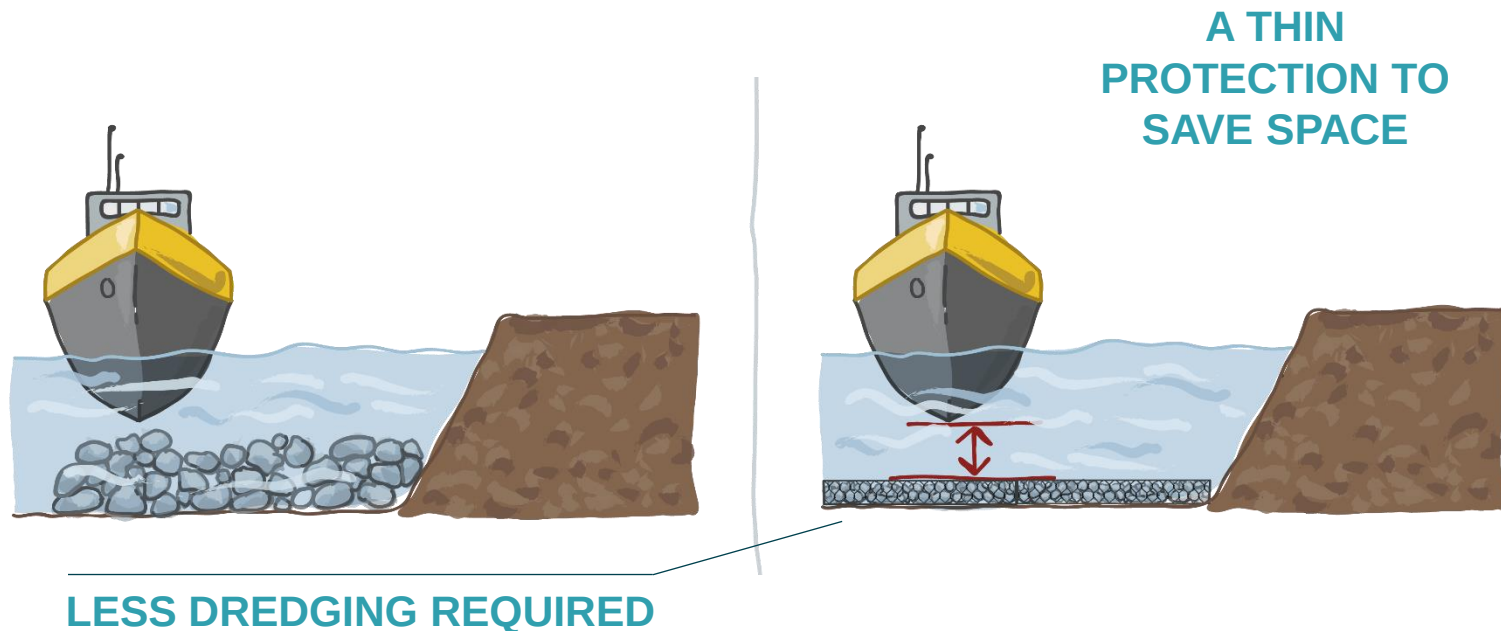


SAFE AND
ACCURATE
INSTALLATION



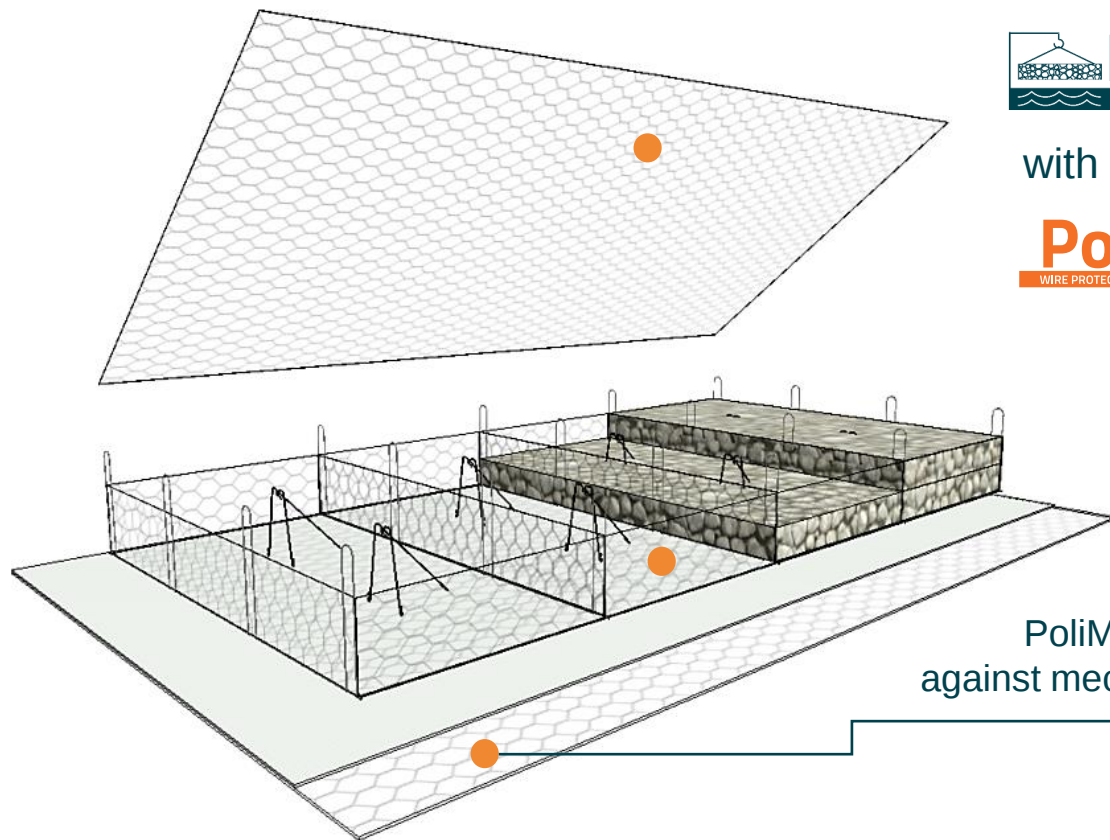
WHAT ARE THE BENEFITS OF RENOMAC PLUS?

When it comes to protecting ports from bottom erosion and quay wall failure, RenoMac Plus allows to build a robust foundation effectively preventing scouring while providing the **adequate space** to accommodate large vessels.





What are the unique features of RenoMac Plus?



with

PoliMac®
WIRE PROTECTION FOR A CHANGING WORLD



PoliMac coating gives outstanding protection
against mechanical loads and chemical aggression

OVER
120
YEARS OF
WORKING LIFE



Great mechanical performance

12x better abrasion resistance than traditional polymer coating

23% harder, providing better resistance to impact and installation damage



Environmental friendliness

Free of heavy metals
Free of PFAs

Designed to integrate with the natural environment without any impact on living species



Weathering resistance

The maximum corrosion length is less than **30%** of the mesh opening

No effects or cracks at temperatures as low as **-35°C**

4x better elongation and **+35%** tensile strength after UV rays' exposure



Design for durability means extending the solution lifetime, which results in resource and emission saving. It is a major component of the transition towards a more **circular economy**. PoliMac® coating offers a better resistance than other traditional coatings and therefore enhances the durability of our solutions.



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



14 LIFE
BELOW WATER



RenoMac Plus optimizes material usage and prevents any waste of material: an **efficient management of materials** is the first step to improve circularity and to cut greenhouse gas emissions.

The use of natural materials creates a natural habitat for living species, enhancing biodiversity. Tests on PoliMac® also verified its **environmental friendliness**.



We put the long-term economical and environmental impacts of a structure at the center of the design activity.

Our design process is focused on test campaigns and investments in performance evaluation of our solutions.



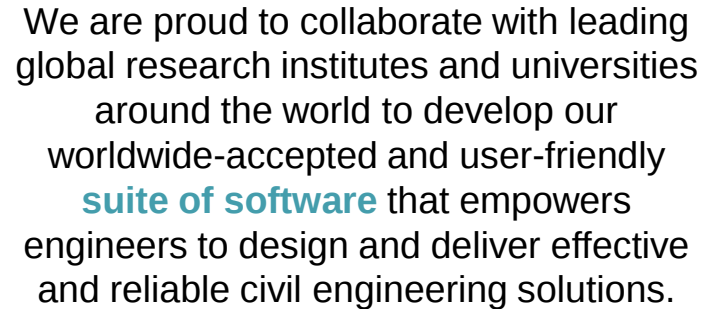
THE INTERNATIONAL EPD® SYSTEM

Certification Number SP 01465

Certification Number SP 01466



Our products are certified and tested by leading institutes and in accordance with the latest guidelines and standards (EN10223-3, ISO 17746, ISO 17745). Product certifications include CE mark, BBA Agrément Certificate (CubiMac), NF mark, COPRO mark, and BAFU-FOEN homologation for snow-barriers. For more information contact our certification office.



OUR SUPPORT AND DIGITAL EXPERTISE

MACCAFERRI

Maccaferri works every day to find better and sustainable solutions for our stakeholders at every degree of latitude and longitude.

