INNOVATIVE AND SUSTAINABLE SOLUTIONS IN HYDRAULIC ENGINEERING WORKS TO MITIGATE THE IMPACT OF NATURAL HAZARDS AND CLIMATE CHANGES

Date April 2025

Author A. Rahman, Business Developer

MACCAFERRI

DESIGN THE CHANGE

WEBINAR AGENDA

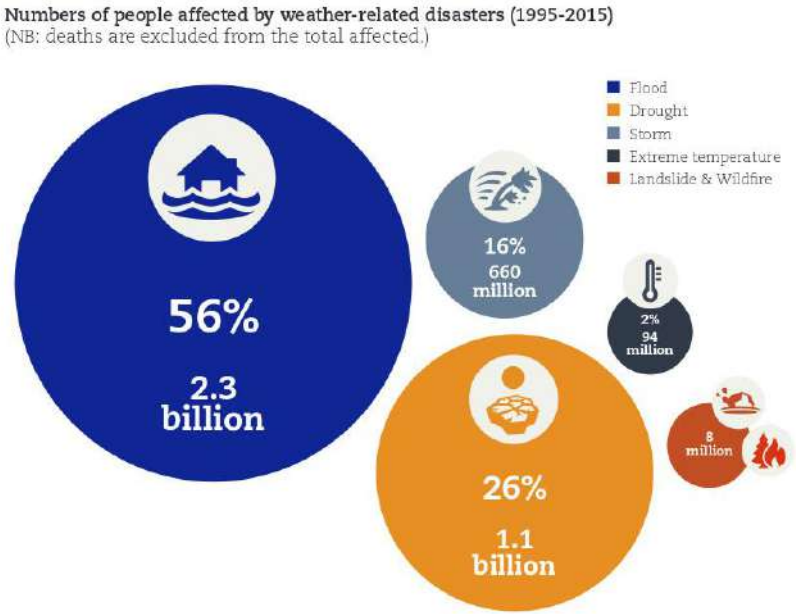
1. *Flood increasing worldwide along with Rapid Urbanization*
2. *Sustainable Solutions for Riverbank Protection*
3. *CSU campaign and development of Reno Mattress Plus*
4. *Introduction to MacRA Design Tool*
5. *Introduction to HELLOMAC Hydro IoT Solution*

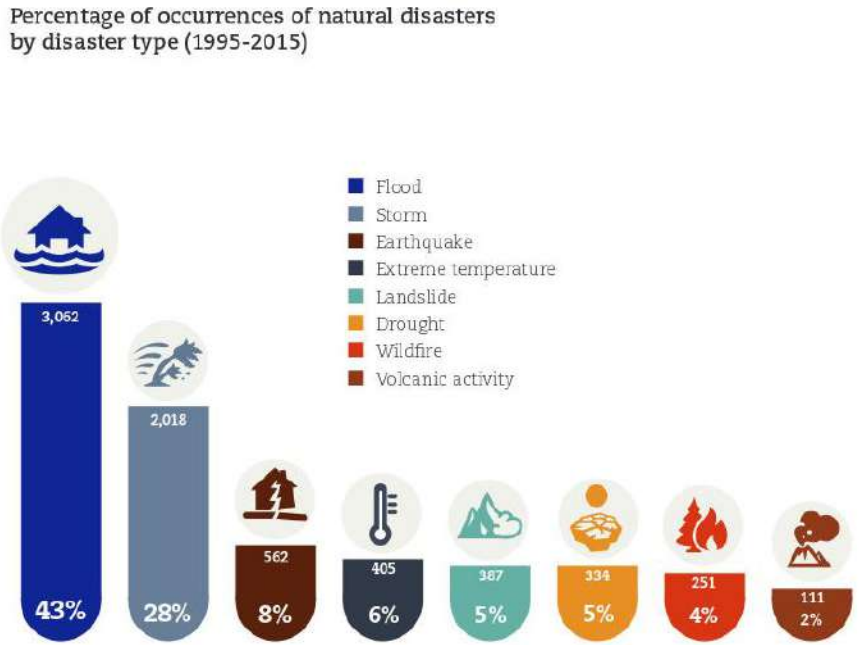
Speaker

A. Rahman – Business Developer

INCREASING OF FLOOD IN THE LAST YEARS

Flood Disasters Affected **2.3 Billion** and Killed **157,000 people**





Source: UN, “The Human Cost of Weather Related Disasters”
http://floodlist.com/dealing-with-floods/flood-disaster-figures-1995-2015

INCREASING OF FLOOD IN THE LAST YEARS

The collapse of the river embankments caused flooding in four villages in Demak (Java Island, Indonesia) in mid March 2024

(Source: https://jateng.idntimes.com/news/jateng/bandot-arywono/banjir-demak-8-170-warga-mengungsi-akses-jalur-pantura-terputus?page=all)

FLOOD IN BOLOGNA, ITALY

Italy, 19 Octorber 2024

Just a few months ago…


Sept 28th, 2024
nepaisite.com
BAGMATI RIVER
(THAPATHALI/KUPONDOLE)

INCREASING OF FLOOD IN THE LAST YEARS

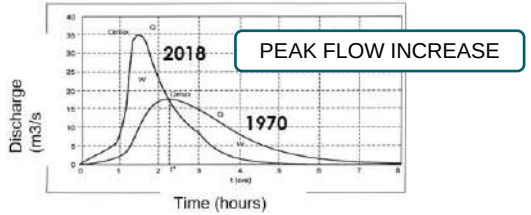
- Severe weather events (Climate change)*
  - ✓ Increase in frequency and intensity
  - ✓ Rainfall, snowmelt, ice jams

- Increase in urbanization
  - ✓ Change in land use
  - ✓ Impervious surfaces
  - ✓ Drainage networks

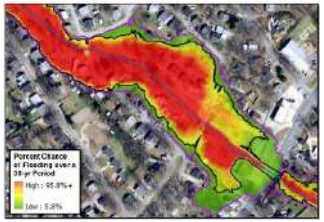
- Modification of watercourse geometry
  - ✓ e.g. alignment, cross-section, grade, bridge crossings

MORE EXTREME FLOOD EVENTS

higher water depth, flow velocity and sediment transport capacity (erosion)



WIDER URBANIZED AREAS SUBJECT TO FLOODING



* Picture source https://www.canadianunderwriter.ca/features/mother-natures-wrath/

HYSTORY AND BACKGROUND

Bank protection along the River Reno at Casalecchio (Bologna, Italy)

A green thought has always driven our engineering mindset.

For over 140 years, we have developed solutions that enhance river ecosystem resilience including the social ability to recover quickly from catastrophic events (flood, natural disasters)

WHO WE ARE

For over 140 years we are **a leading international provider of advanced solutions to the civil, geotechnical and environmental construction markets**. We deliver innovative, long-lasting and environmentally friendly solutions, from retaining walls to hydraulic works and from rockfall mitigation systems to soil reinforcement.

Sales in **130+** countries

Revenues **600+** M€

3,000+ employees

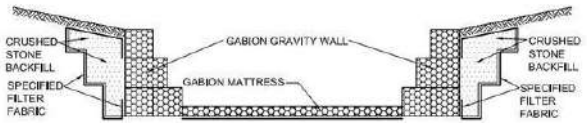
23 factories

60+ subsidiaries

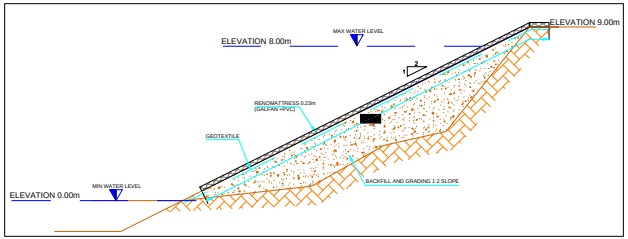
SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

River works design is based on statistical data and risk assessment.
In the river engineering practice it is necessary to identify and analyze different scenarios beyond these data.

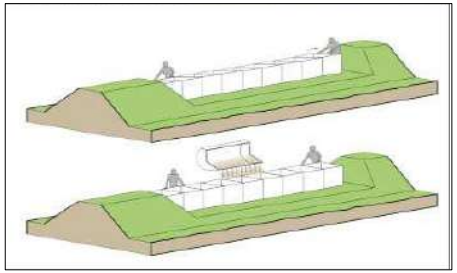
PLANNING



REMEDIATION



EMERGENCY



SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

FUNCTIONS AND APPLICATIONS

ALONG THE RIVER BANK

ACROSS THE RIVER SECTON

DRAINAGE

MEANDERING CONTROL

SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

MACCAFERRI

FUNCTIONS AND APPLICATIONS

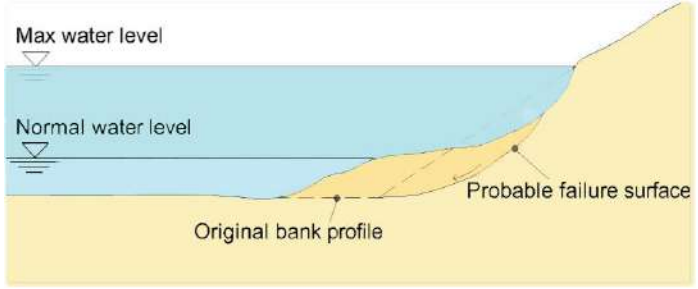
ALONG THE RIVER BANK

ACROSS THE RIVER SECTON

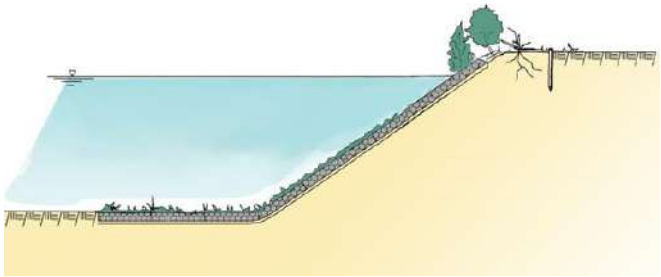
DRAINAGE

MEANDERING CONTROL

- EARTH RETAINING SYSTEMS



- ARMOUR LININGS



SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

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FLOOD RESTORATION WORKS – France – 2020/2021

The passage of storm Alex in October 2020 caused significant damages in different places.

The equivalent of a year of precipitations fell in 24 hours.

Millions of cubic meters of soil have been washed away, and road infrastructures have been cut.

SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

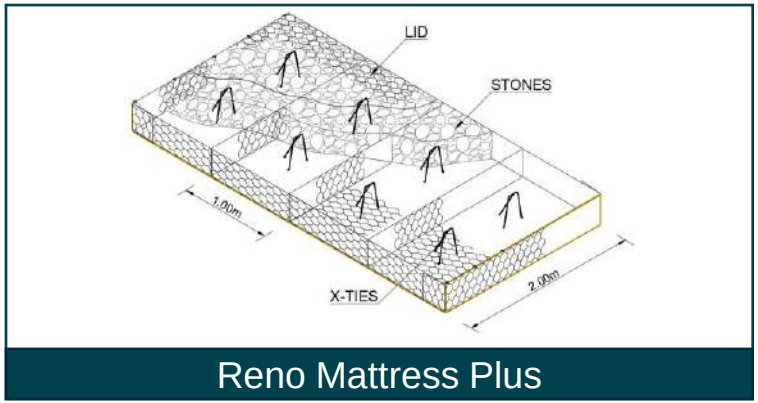
FLOOD RESTORATION WORKS – France – 2020/2021

Bank consolidation by reinforced soil structures was supplied by Maccaferri, to restore the banks up to 12 meters in height.

Earth retaining systems: Terramesh System & Terramesh Green

Anti-scour protection: Reno Mattress Plus & Gabions

SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION



Reno Mattress Plus

SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

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Bagmati River Protection Work Kathmandu

SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

MACCAFERRI

Narayani River Protection

SUSTAINABLE SOLUTIONS FOR RIVERBANK PROTECTION

FUNCTIONS AND APPLICATIONS

ALONG THE RIVER BANK

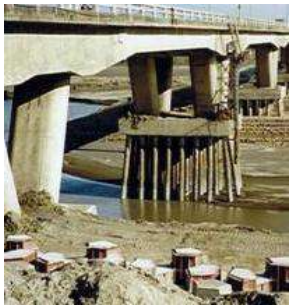
ACROSS THE RIVER SECTON

DRAINAGE

MEANDERING CONTROL

- GRADE CONTROL STRUCTURES

- PIERS PROTECTION
- BRIDGE ABUTMENTS



EROSION CONTROL STRUCTURES: GABION WIERS

MACCAFERRI

SINGLE VERTICAL DROP

STEPPED WEIR

SLOPED WEIR

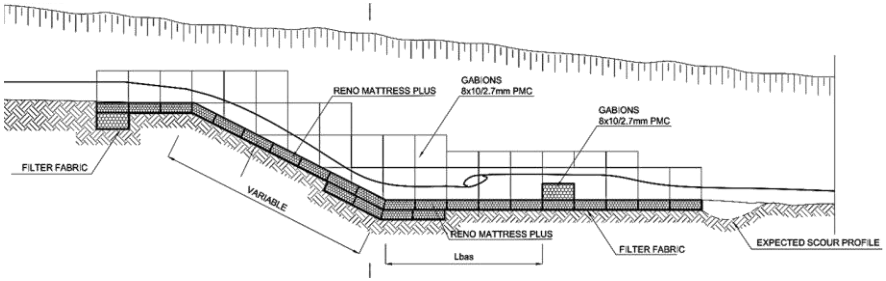
EROSION CONTROL STRUCTURES: GABION WIERS

MACCAFERRI

Melamchi Drinking Water Supply Project

EROSION CONTROL STRUCTURES: GABION WIERS

MACCAFERRI



SINGLE VERTICAL DROP

STEPPED WEIR

SLOPED WEIR

PIERS AND ABUTMENTS PROTECTION

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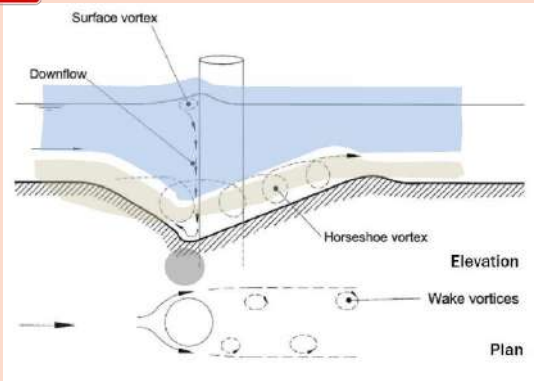
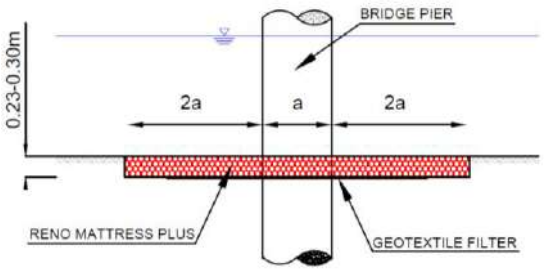
Scour around bridge piers and abutments can cause structure instability





SOLUTIONS FOR RIVERS

FUNCTIONS AND APPLICATIONS

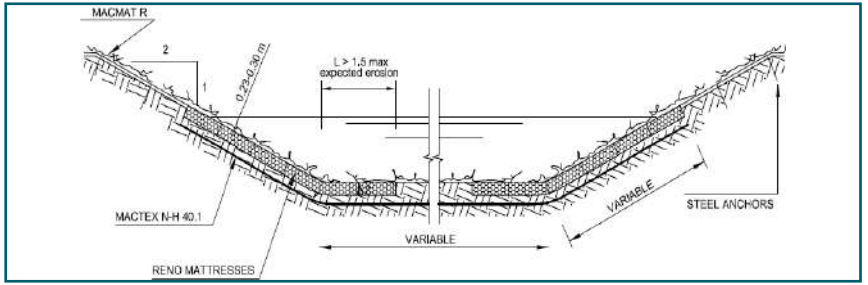
ALONG THE RIVER BANK

ACROSS THE RIVER SECTON

DRAINAGE

MEANDERING CONTROL

- CHANNELIZED STREAMS
- CANALIZATION OF RIVERS



SOLUTIONS FOR RIVERS

FUNCTIONS AND APPLICATIONS

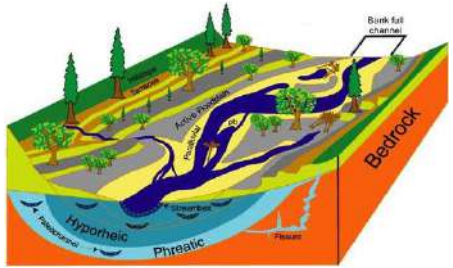
ALONG THE RIVER BANK

ACROSS THE RIVER SECTON

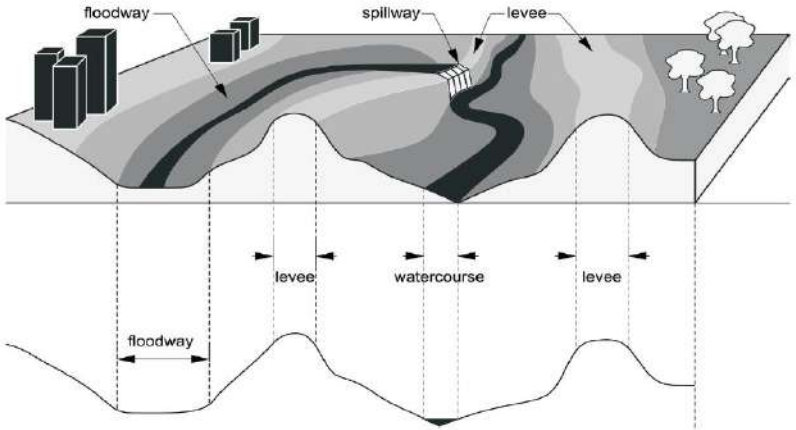
DRAINAGE

MEANDERING CONTROL

- GROYNES
- ALIGNMENT CONTROL



- LATERAL SPILLWAYS

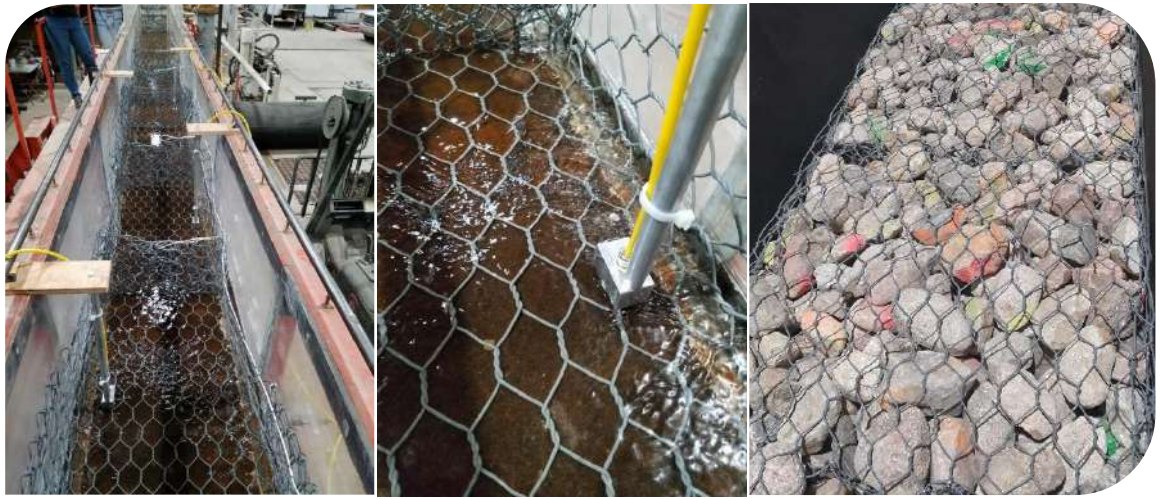


CSU CAMPAIGN AND DEVELOPMENT OF RENO MATTRESS PLUS

MACCAFERRI

TESTED AND INNOVATIVE SOLUTIONS

Design The Change concept started with the physical testing campaign that aimed at finding out a more effective solution to protect river banks from erosion



The physical test campaign was conducted by **Maccaferri Innovation Center** in collaboration with **Colorado State University**

CSU CAMPAIGN AND DEVELOPMENT OF RENO MATTRESS PLUS

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CSU CAMPAIGN - 2020

Step 1

Effect of the mattress wire mesh (only)

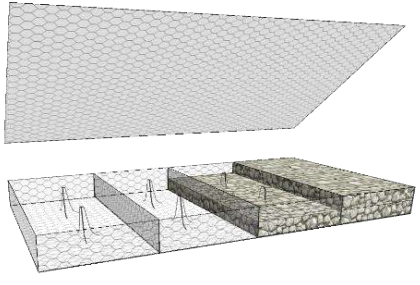
Step 2

Effect of different stones (size & grading) and mattress configurations (diaphragm & spacing)

Step 3

Evaluate the stone movement and trace erosion

Step 4



Development of the new Reno Mattress Plus

CSU CAMPAIGN AND DEVELOPMENT OF RENO MATTRESS PLUS

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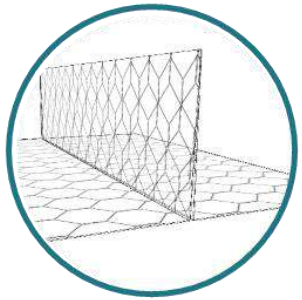
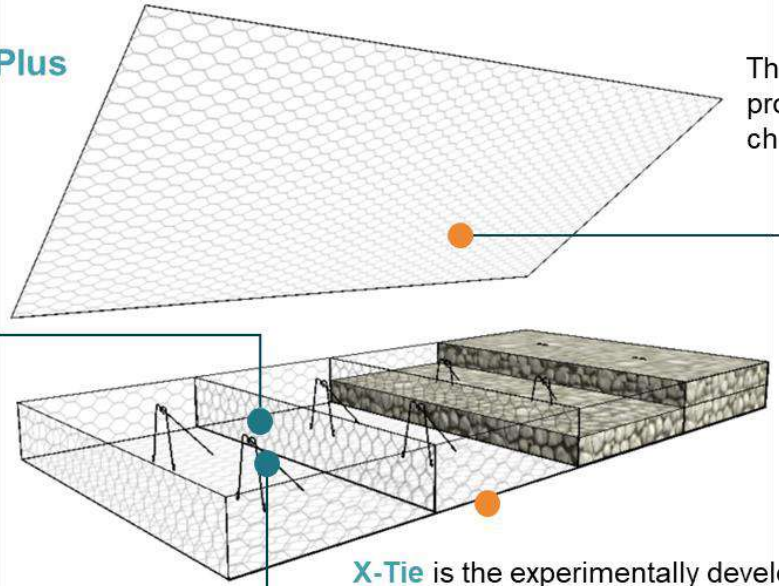
More performance than ever

Reno Mattress Plus with X-Ties

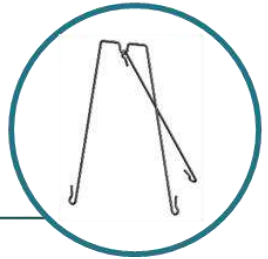
The **PoliMac®** coating gives outstanding protection against mechanical loads and chemical aggression.

Vertical standing double diaphragm make filling operation easier.



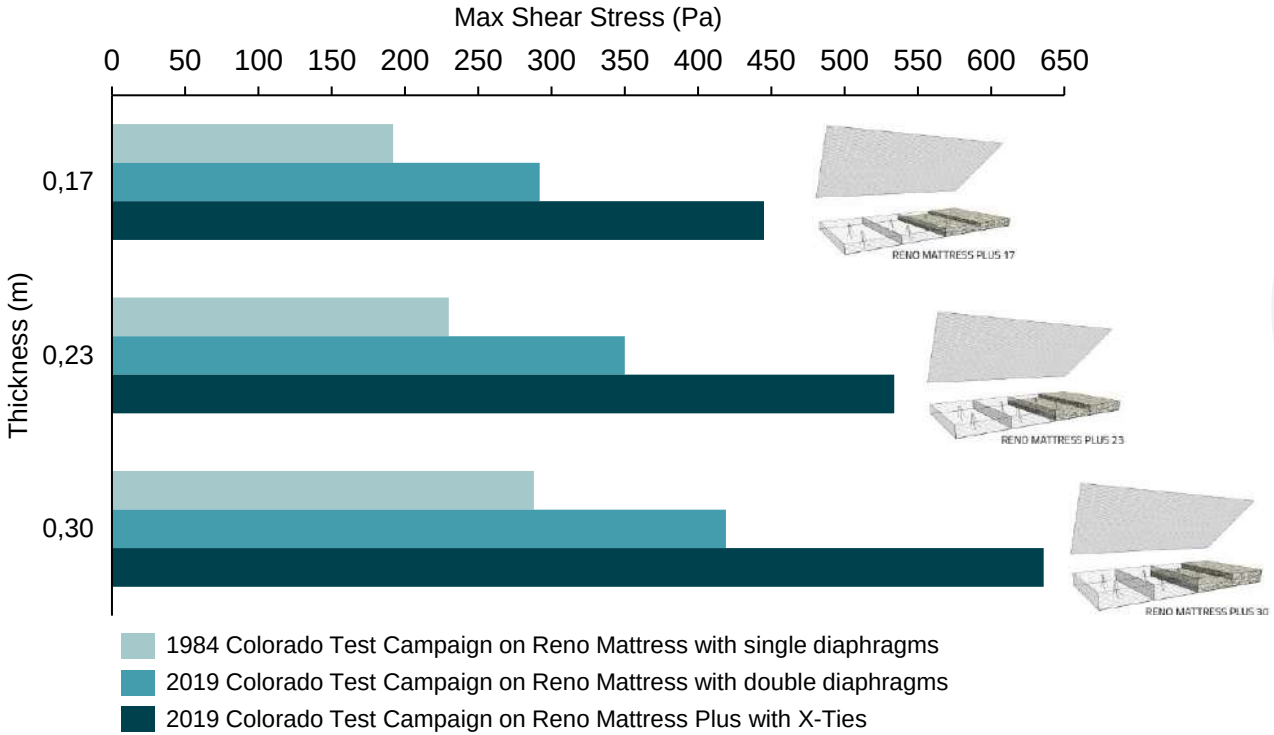


X-Tie is the experimentally developed and patented tie to maximise the structural resistance of the mattress.



CSU CAMPAIGN AND DEVELOPMENT OF RENO MATTRESS PLUS

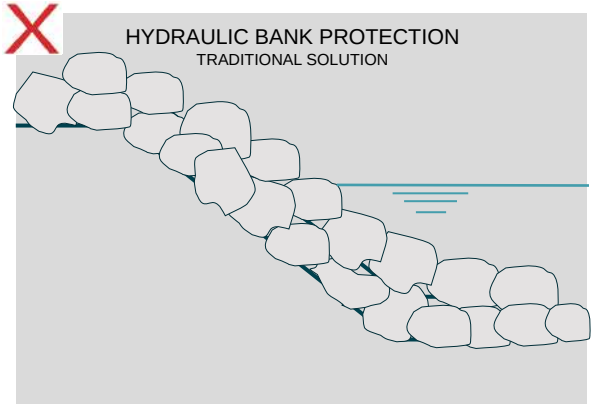
Max shear stress values recorded at CSU in 1984 and in 2019



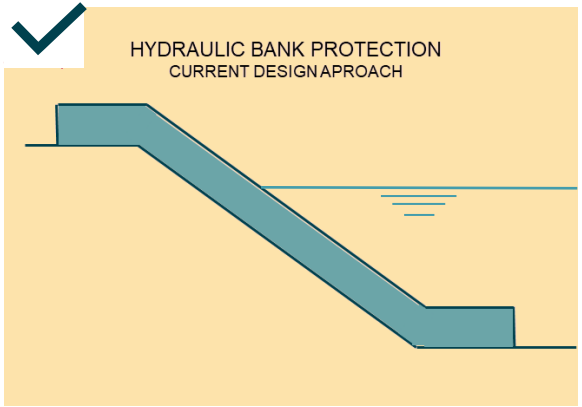
+52%

in perfomance than standard mattress under shear stress

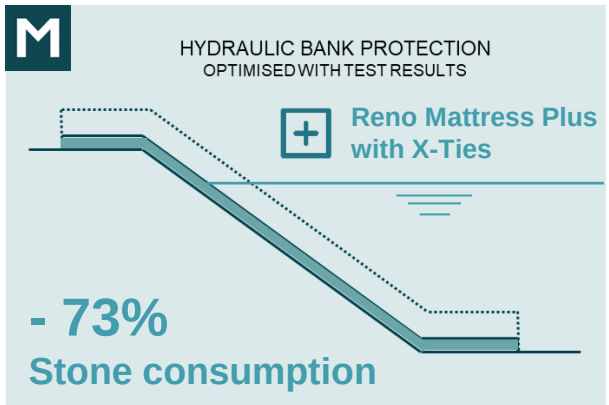
CSU CAMPAIGN AND DEVELOPMENT OF RENO MATTRESS PLUS



Traditional riverbank protection constructed with **loose boulders** (rip-rap) require thick layers of materials to be effective. This is because the boulders are not confined and cannot be accurately placed resulting in the use of more stone and, consequently, an increase in environmental burden.



Standard Mattresses are over designed riverbank protections compared to the actual load they are subjected to.



Reno Mattress Plus is the result of experimental tests. A deeper understanding of the performance of the mattress enable us to make more cost-effective designs that will give to our solutions an increase competitiveness in comparison to equivalent and alternative (traditional) systems.

CSU CAMPAIGN AND DEVELOPMENT OF RENO MATTRESS PLUS

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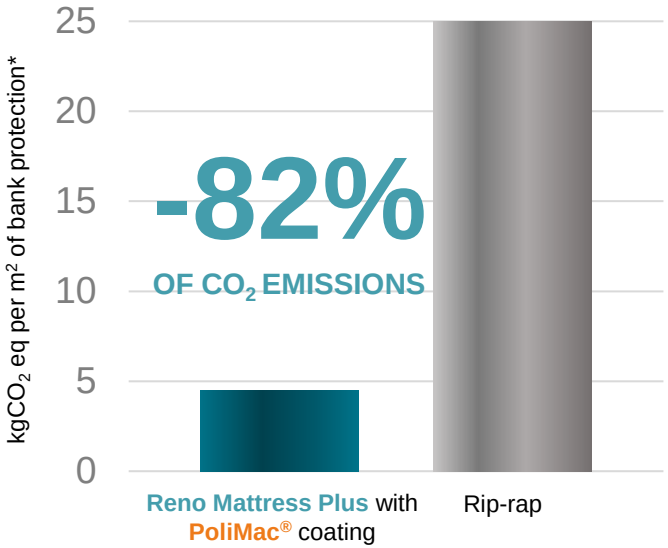
Environmental Benefits – CO_2 emissions



Reno Mattress Plus coated with **PoliMac®** decreases CO_2 emissions of 82% compared to Rip-rap solution

VS

Reno Mattress Plus reduces environmental footprint of river bank protection. This is due to savings of materials and their transport.

Since Reno Mattress enhance the vegetation growth, it additionally produce a **carbon sequestration** of 0.46 $kgCO_2/m^2$ per year**.

*Data are based on Environmental Product Declaration (EPD). Figures refer to specific field condition (shear stress 400 N/m^2). Additionally, not considered in the graph, Reno Mattress enhances the vegetation growth further increasing the environmental benefit of the solution.

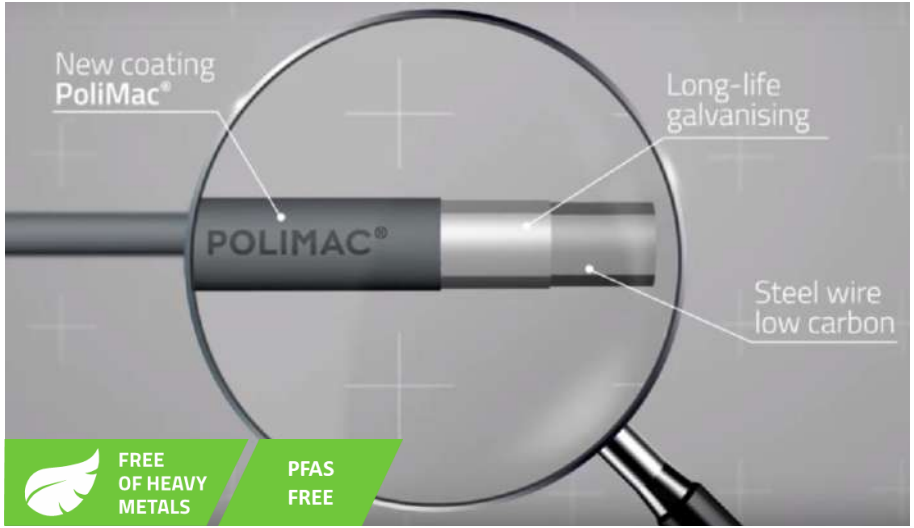
** APMC, 2012. *Carbon Footprint dei Gabbioni e Materassi Maccaferri e confronto con soluzioni tradizionali*

MACCAFERRI SOLUTIONS

MAIN FEATURES

DURABILITY

PoliMac® is the revolutionary coating that can withstand the most aggressive environmental conditions.



PoliMac®

WIRE PROTECTION FOR A CHANGING WORLD

- Better resistance to **abrasion**, including installation damage
- Outstanding resistance to **chemical aggression**
- Excellent performance in **cold weather**
- Proven resistance to **UV rays**

ENVIRONMENTAL FRIENDLINESS

Double twisted gabions and Reno Mattresses are suitable to incorporate **soil bioengineering techniques.**

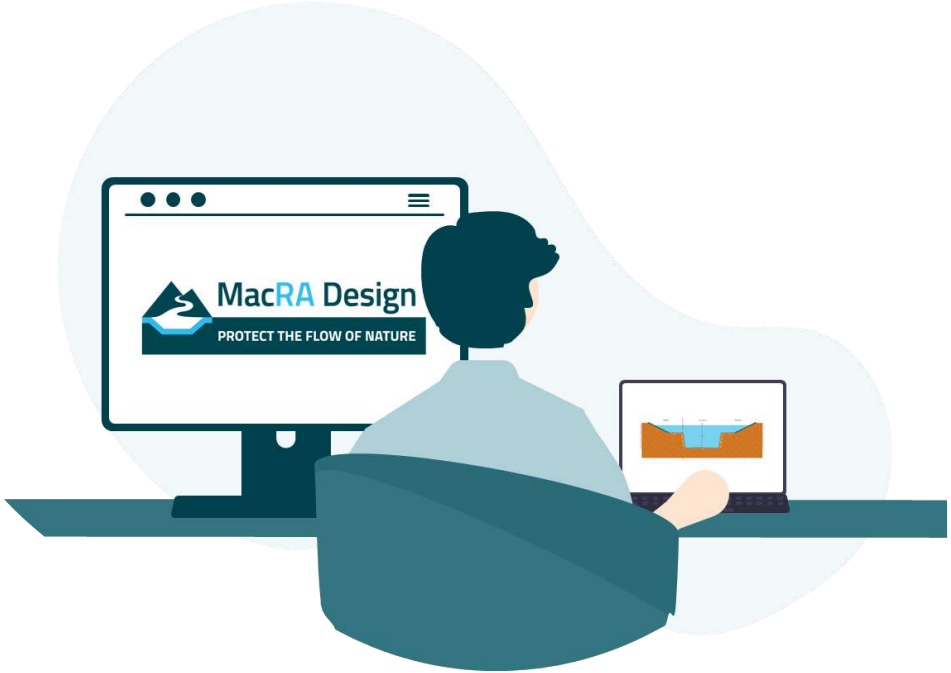
They easily integrate in natural ecosystems, as vegetation provides a sheltering effect during the initial growth.

Additionally, vegetation will increase **structural and hydraulic performance**.

Being filled with stones, soil and roots find a **favourable environment** during the recovery stage.

MACRA DESIGN

A brand-new software for hydraulic engineering



MacRA Design

PROTECT THE FLOW OF NATURE

Maccaferri **R**iver **A**nalysis is a suite of design software for hydraulic engineering, which focuses on the design of river works for erosion control in natural or artificial watercourses, using Maccaferri solutions specifically developed and tested for these challenging applications.

Available on **edesign.maccaferri.com**

MACRA DESIGN

MACCAFERRI

A few input data

Geometry

Cross-section templates

Hydraulic

Discharge
Slope

Materials

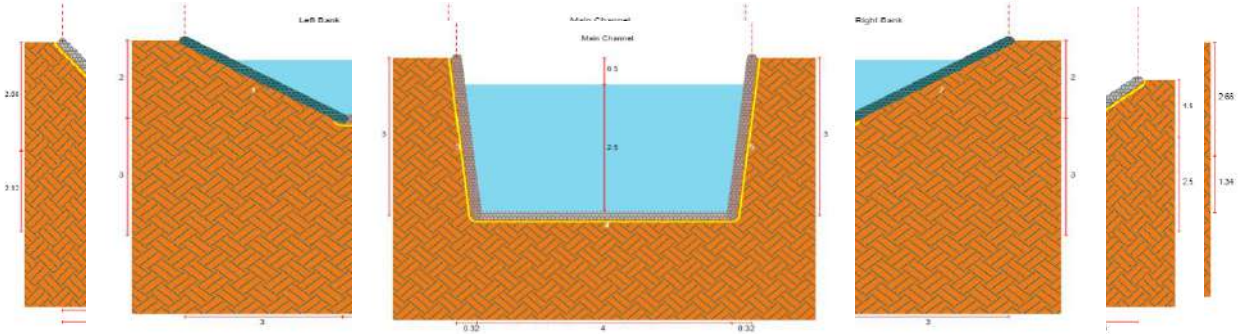
Shear stress and roughness of erosion protection available from a database

MACRA DESIGN

MACCAFERRI

CHANNEL AND
BANK PROTECTION

When designing a channel and bank protection, the software analyses cross-sections for longitudinal works, for free surface channels with uniform flow.



- Rectangular section
- Simple and double trapezoidal sections
- Sections with subsectors
- Sections with vertical banks

MACRA DESIGN

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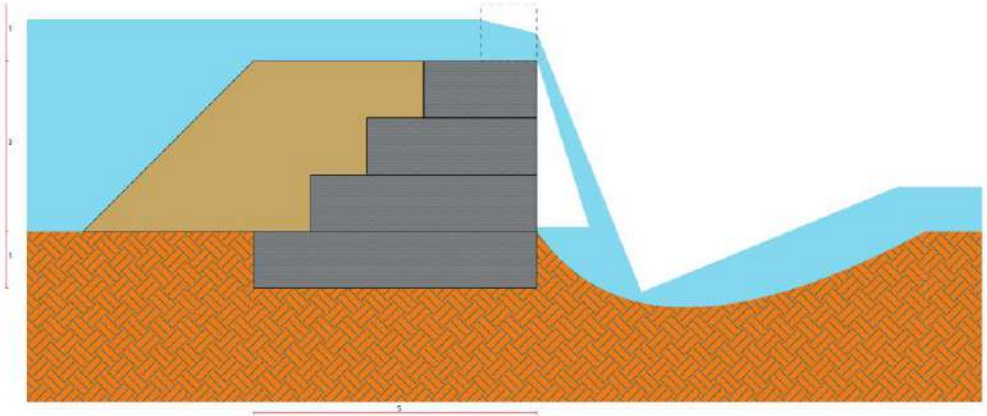
GRADE CONTROL
STRUCTURES

MACRA DESIGN

GRADE CONTROL STRUCTURES

The software allows to check many flow conditions and to design different types of erosion control structures and their dissipation basins.



- Sloped weir
- Stepped weir
- Weir with vertical drop


MACCAFERRI
Smart quay monitoring
Smart quality monitoring
Smart bridge monitoring
Smart bank protection

MACCAFERRI

Smart bank protection

Smart bridge monitoring

MACCAFERRI

Smart quality monitoring

MACCAFERRI

Smart Engineering

Smart Engineering

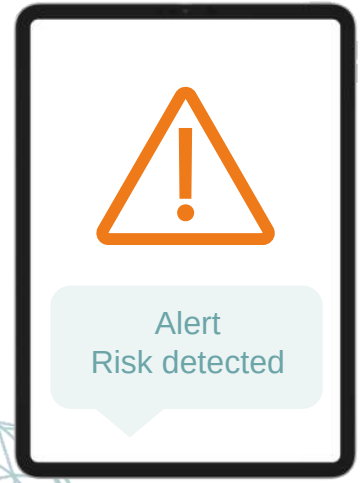
MACCAFERRI

5 networks

GPRS, 4G, Satellite, Lorawan, Wifi.
High connectivity guaranteed.

Smart Engineering

MACCAFERRI



5 seconds

Instant signal transmission,
to ensure timely alerts

Smart Engineering

MACCAFERRI

App, SMS, Email

Get alerts your way.
Instantly.

Smart Engineering

MACCAFERRI

Real-time insights at your fingertips

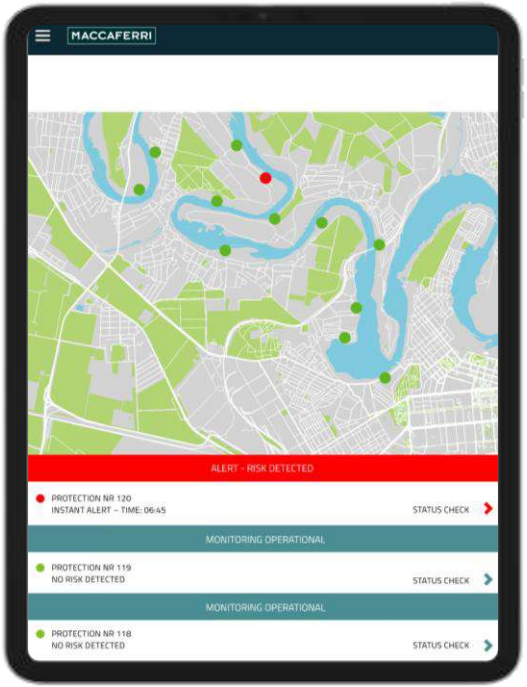
Always in the know with the HelloMac App.

Monitor your hydraulic protection and sensors

anytime, anywhere

Download on the App Store

GET IT ON Google Play



MACCAFERRI

THANK YOU

DESIGN
THE
CHANGE

Brittlestars populating Reno Mattress, South Africa