# *The use of Gabions and Mattresses to Provide Stabilization and to Prevent Seepage Losses in Water Courses*

MACCAFERRI

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## SUMMARY

**RIVER WORKS PRINCIPLES**

**SOLUTIONS FOR EROSION CONTROL**

**THE RESEARCH**

**THE 4 IMPORTANT FEATURES**



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# RIVER WORKS PRINCIPLES

## EFFECTS OF FLOODS




Calamities occur even more often in urban contexts ....



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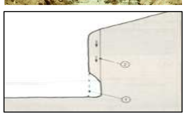
# RIVER WORKS PRINCIPLES

## EROSION AND CAUSES

| PROBLEM | CAUSE | WHERE | EFFECT |
|---|---|---|---|
| **DRAINAGE** | SURFACE RUN-OFF | NATURAL SLOPES | LACK OF VEGETATION PROGRESSIVE SOIL INSTABILITY |
| **SEEPAGE** | REDUCED SOIL SHEAR STRENGTH | EMBANKMENTS & SLOPES | GLOBAL INSTABILITY |
| **SCOUR** | FORMATION OF SCOUR HOLES | RIVERBANKS, ABUTMENTS & PIERS | PROGRESSIVE SOIL INSTABILITY & UNDERMINING |
| **WET/DRY CYCLES & TEMP. VARIATIONS** | FORMATION OF CRACKS | COHESIVE SOILS & ROCK SLOPES | PROGRESSIVE DEBRIS |





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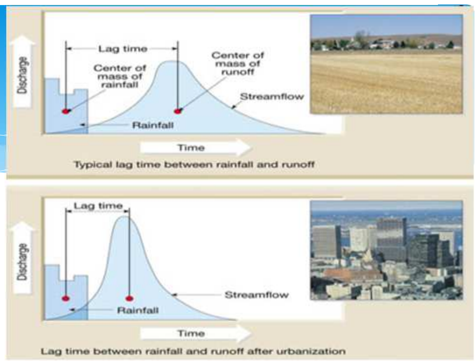
# RIVER WORKS PRINCIPLES

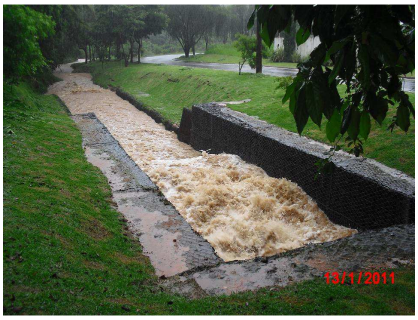
## THE TIME FACTOR

### FLOOD DURATION & URBANIZATION

Typical values:

- ✓ Small rivers & drainage channels: < *10 hrs*
- ✓ Medium size rivers: *10 – 24 hrs*
- ✓ Large rivers: *24 – 120 hrs*



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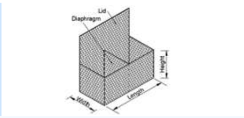
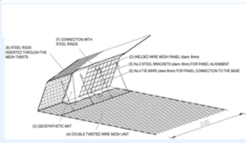
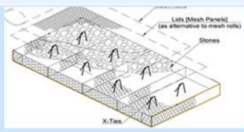
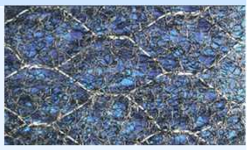
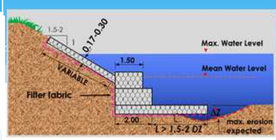
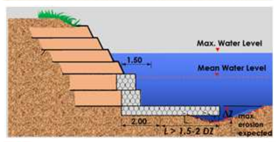
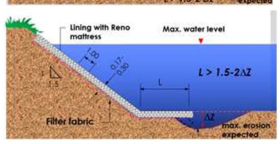
# SOLUTIONS FOR EROSION CONTROL

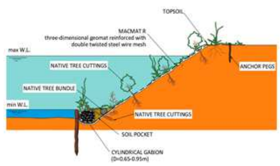
## BANK STABILIZATION SYSTEMS

| FUNCTION | APPLICATION | EROSION CONTROL SYSTEMS | |
|---|---|---|---|
| EARTH RETAINING SYSTEMS | GRAVITY WALLS | GABIONS |  |
| | MSE STRUCTURES | TERRAMESH |  |
| LININGS | HEAVY DUTY | RENO MATTRESS PLUS |  |
| | RECP EROSION CONTROL SYSTEMS | MACMAT R |  |





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## SOLUTIONS FOR EROSION CONTROL

### CHANNELS (SLOPED BANKS)

DRAINAGE

CHANNELIZED STREAMS & CANALIZATION OF RIVERS




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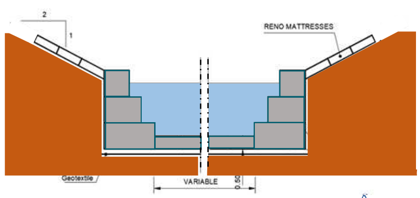
## SOLUTIONS FOR EROSION CONTROL

### CHANNELS (STEEP BANKS)

DRAINAGE

CHANNELIZED STREAMS & CANALIZATION OF RIVERS



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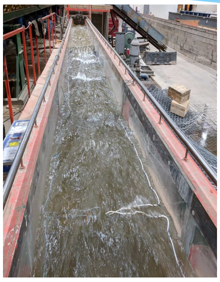
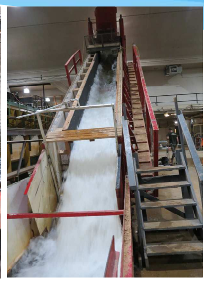
# THE RESEARCH

## COLORADO STATE UNIVERSITY (TEST CAMPAIGN 2019)






- MODERN APPROACH IN LINE WITH STATE-OF-THE-ART (ASTM D6460)
- CORRECT BOUNDARY BETWEEN GB, RM, & TRMs
- FURTHER IMPROVE PERFORMANCE
- ENVIRONMENTAL SENSITIVENESS

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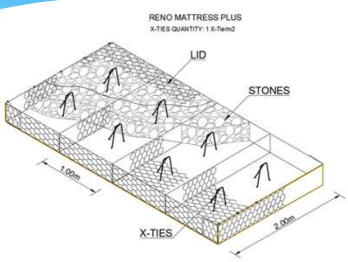
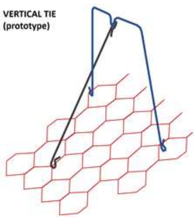
# THE RESEARCH

## COLORADO STATE UNIVERSITY (TEST CAMPAIGN 2019)




Max allowable shear stress depends on:

- Uniformity of stone fill
- Mattress thickness (rock layers)
- Mattress partition (single or double)
- Vertical ties (tighter packing)

$$\tau_{all} \propto f\,[d_{50}, C_u, \gamma_s, t, v_{ties}]$$

$\tau_{all}$ = *allowable shear stress*
$C_u$ = *uniformity coeff. for rock ($d_{60}/d_{10}$)*
$\gamma_s$ = *stone specific gravity*
$\gamma_w$ = *specific gravity of water*
$d_{50}$ = *average diameter of rockfill*
$t$ = *mattress thickness*
$v_{ties}$ = *amplification factor for X-Ties*

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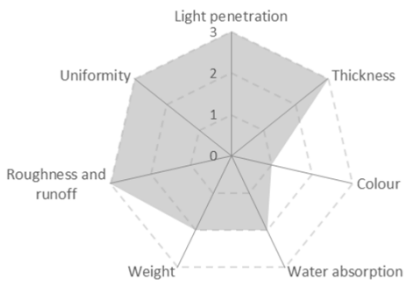
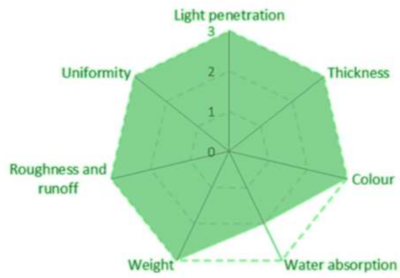
# THE RESEARCH

## COLORADO STATE UNIVERSITY (TEST CAMPAIGN 2019)

* Why a geocomposite combining a polymer with steel wire mesh?

Erosion Control Geomat average performances




MacMat R Steel



THE RESEARCH

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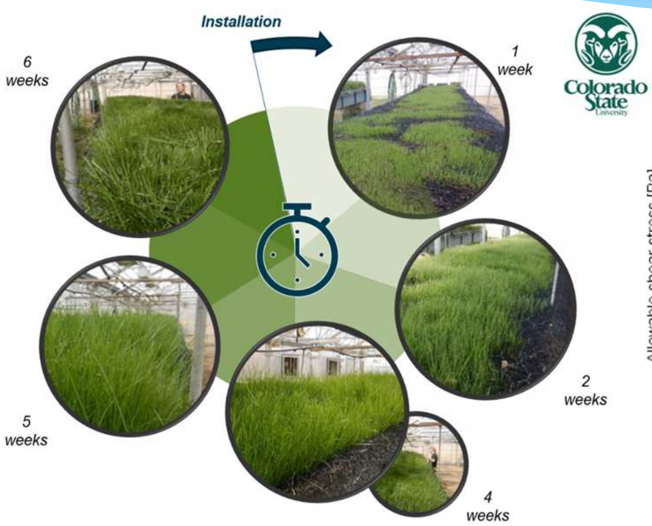
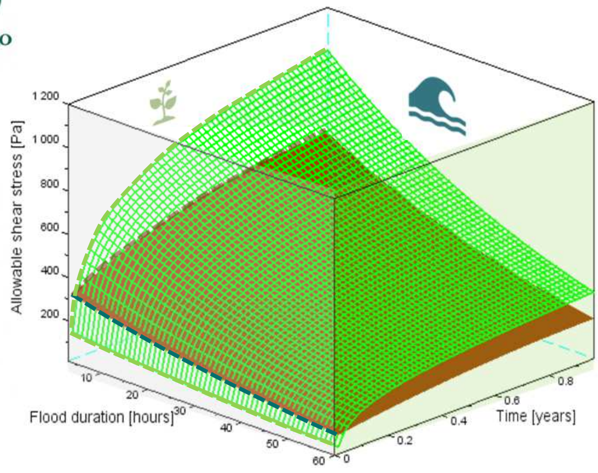
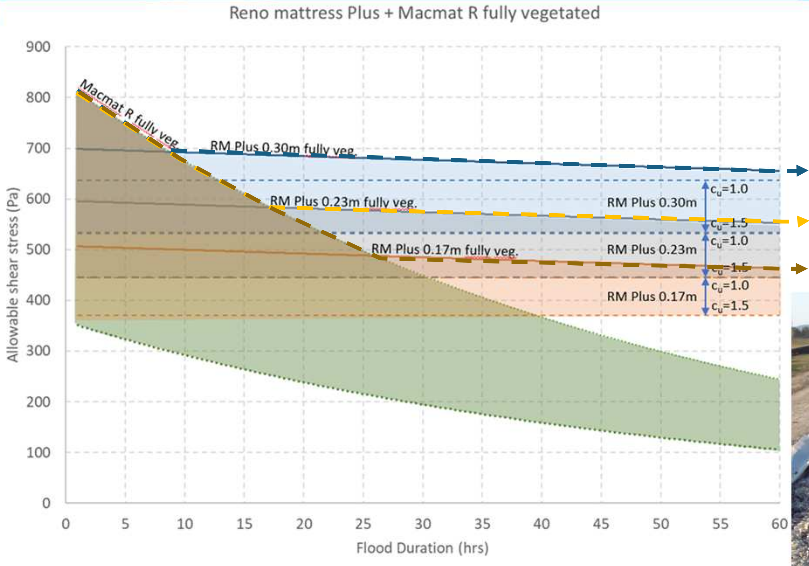
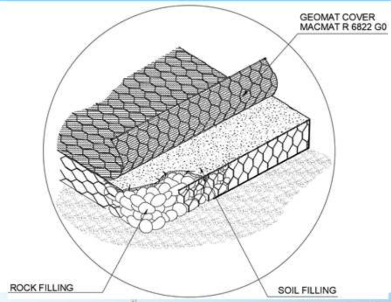


## THE RESEARCH

### COLORADO STATE UNIVERSITY (TEST CAMPAIGN 2019)

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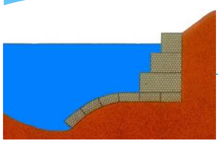
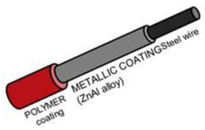
## THE 4 IMPORTANT FEATURES



FLEXIBILITY & STRUCTURAL CONTINUITY

FILTRATION & PERMEABILITY




DURABILITY (EN 10223-3)


ENVIRONMENTAL FRIENDLINESS

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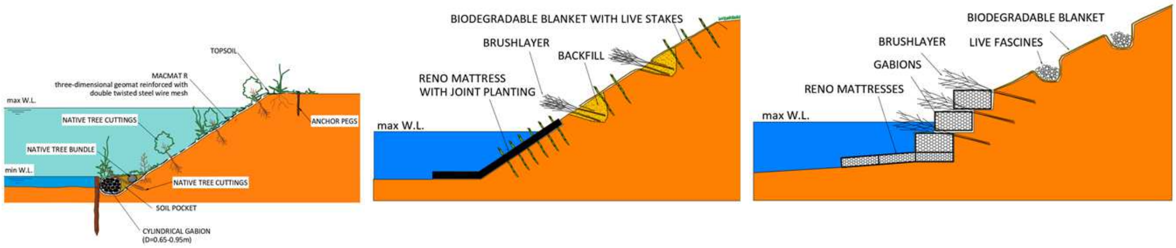
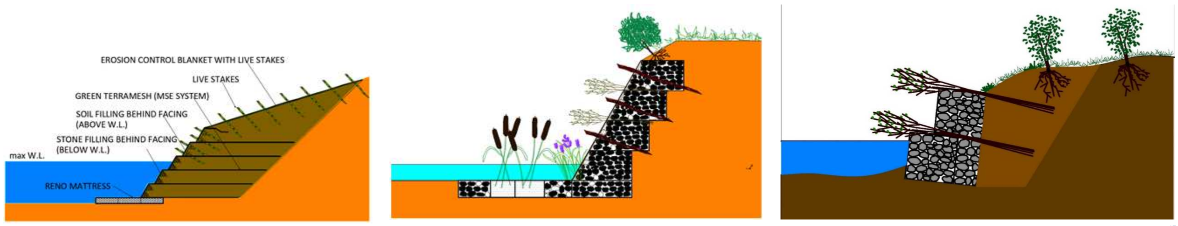
# THE 4 IMPORTANT FEATURES

## ENVIRONMENTAL FRIENDLINESS

LININGS




WALLS

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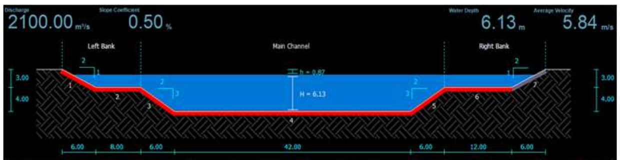
# SUMMARY

## LESSONS LEARNED

### HYDRAULIC REQUIREMENTS

- *Geotechnical and hydraulic stability*
- *Sound engineering principles*
- *Design criteria on risk assessment*
- *Erosion impacting on environment*




| ID | Bed materials | Roughness | Rock d50 [m] | Cu | Castoro | X-Ties | Geotextile | Time [h] | Shear Stress [N/m²] Allowed | Shear Stress [N/m²] Calculated | | Velocity Under Lining [m/s] | Length [m] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Coarse gravel | 0.025 | | | | | - | | 32.00 | 43.36 | ✗ | 0.00 | 6.71 |
| 2 | Coarse gravel | 0.025 | | | | | - | | 32.00 | 84.70 | ✗ | 0.00 | 8.00 |
| 3 | Cobbles and shingles | 0.035 | | | | | - | | 52.60 | 204.23 | ✗ | 0.00 | 7.21 |
| 4 | Cobbles and shingles | 0.035 | | | | | - | | 52.60 | 272.31 | ✗ | 0.00 | 42.00 |
| 5 | Cobbles and shingles | 0.035 | | | | | - | | 52.60 | 204.23 | ✗ | 0.00 | 7.21 |
| 6 | Cobbles and shingles | 0.035 | | | | | - | | 52.60 | 89.96 | ✗ | 0.00 | 12.00 |
| 7 | Cobbles and shingles | 0.035 | | | | | - | | 52.60 | 46.05 | ✓ | 0.00 | 6.71 |

### ENVIRONMENTAL REQUIREMENTS

- *River is a dynamic environment*
- *Introduce minimal disturbance*
- *Sustainable systems*
- *Balance the eco-system*

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# Thank you!

***The use of Gabions and Mattresses to Provide Stabilization and to Prevent Seepage Losses in Water Courses***

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