GROUNDMAC Design: the software solution for soil stabilization

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Transportation infrastructures typically have an asphalt or concrete surface over a granular base and sub-base supporting and distributing the load. Problems usually occur when subgrade consists of soft soils unable to adequately support applied loads.

Weak subgrades are traditionally replaced with good quality soil or improved by the addition of cement, lime or excess of aggregates. All of them are often costly and always time consuming.

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Geosynthetics have been proven to be a versatile and cost-effective solution to stabilise subgrades, offering the following advantages over traditional methods:

- Cost savings
- Construction time contraction
- Environmental sustainability
- Material quality control

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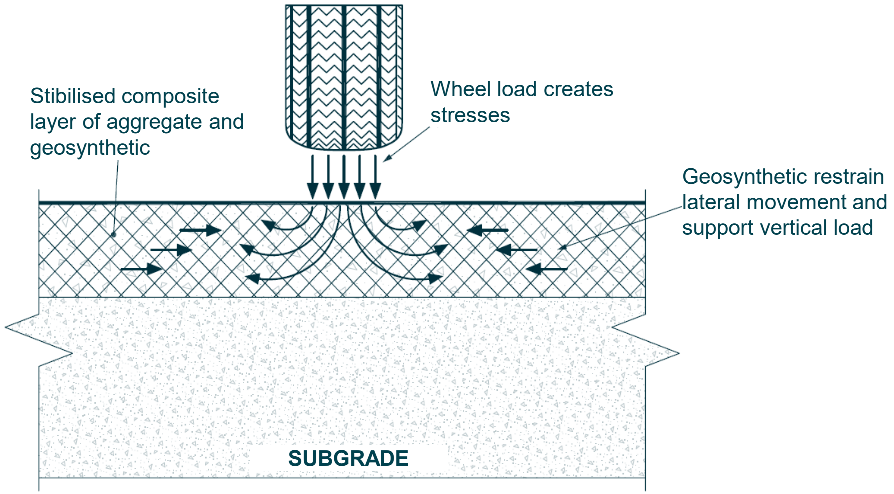
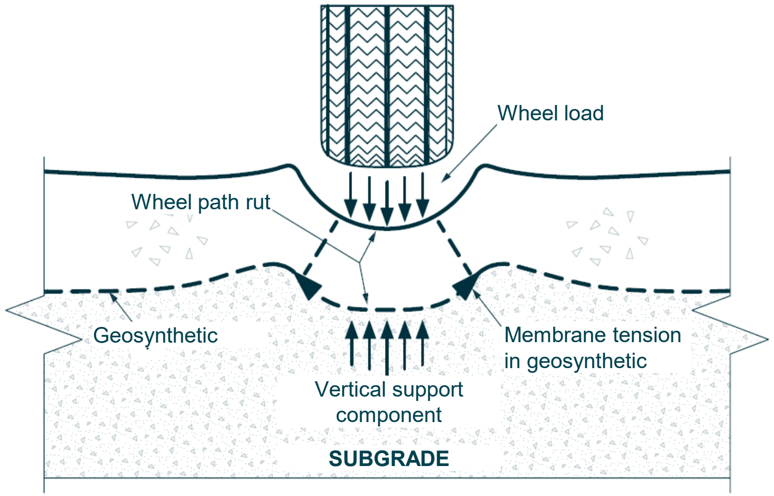
The inclusion of a proper geosynthetic into the unbound granular layers results in a composite layer with higher stiffness and controlled deformations.

SOIL STABILISATION

Stabilisation mechanisms





Confinement mechanism

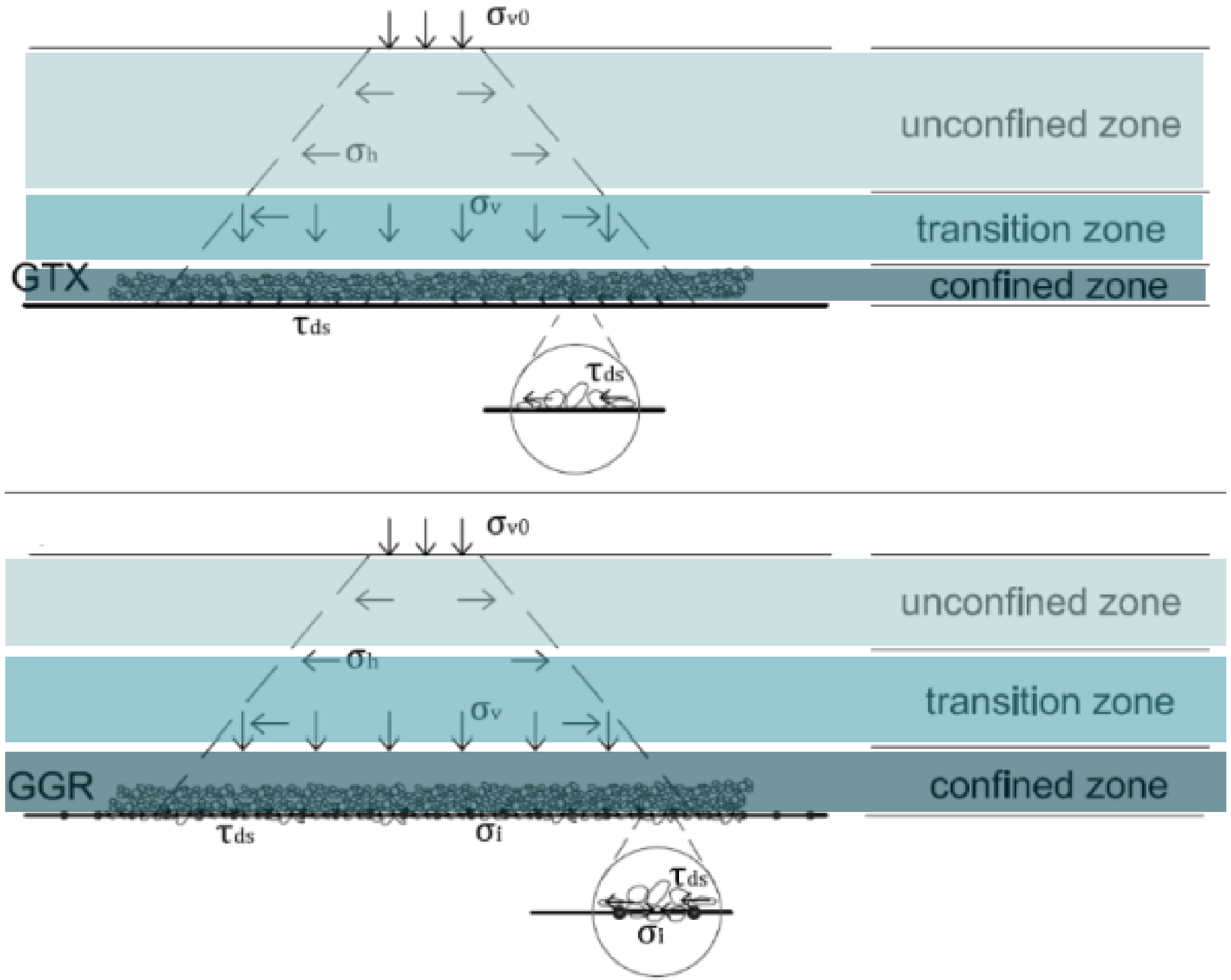
> Limitation of the granular particle movement
> Increase of shear resistance
> Spreading of the load on wider area
> Control on deformations
> Geosynthetic operates at low level of strain

Tensioned membrane mechanism

> Increase of bearing capacity
> Control on deformations
> Geosynthetic operates at relatively high level of strain

SOIL STABILISATION

Confined zone



SOIL STABILISATION

Design approach

ISO TR 18228 - 5

- Unpaved roads
- Paved roads
- Working platforms

Design approach as technical literature

- Railways

Design approach AASHTO method modified

- Airports

SOIL STABILISATION

Design approach

ISO/TR 18228-5:2025
Design using geosynthetics
Part 5: Stabilization

Paved Roads

ROAD STABILISATION

Design approach – Paved roads

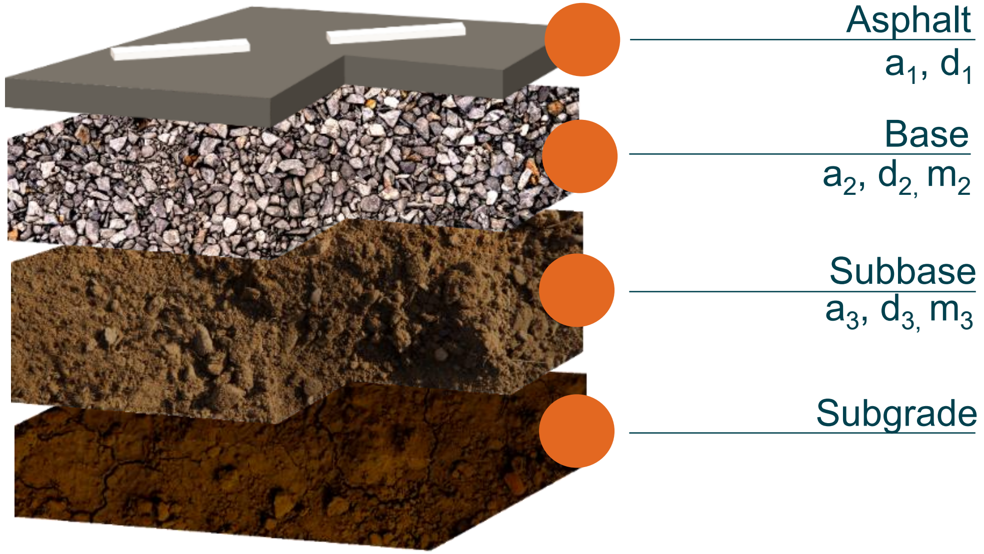
ISO/TR 18228-5 refers to AASHTO design method for paved road design which models road structure through the below empirical equation:

$$logW_{18} = Z_R\,S_0 + 9.36\log(SN+1) - 0.20 + \frac{\log\left(\frac{\Delta psi}{4.2-1.5}\right)}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\log(Mr) - 8.07$$

Where structural number SN, representing the required structural strength of the road pavement based upon subgrade characteristics, traffic and terminal serviceability, is expressed by:

$$SN = a_1d_1 + a_2d_2m_2 + a_3d_3m_3$$

a = layer coefficient
d = thickness of the layer
m = drainage coefficient of the layer



ROAD STABILISATION

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Design approach – Paved roads – Drainage improvement

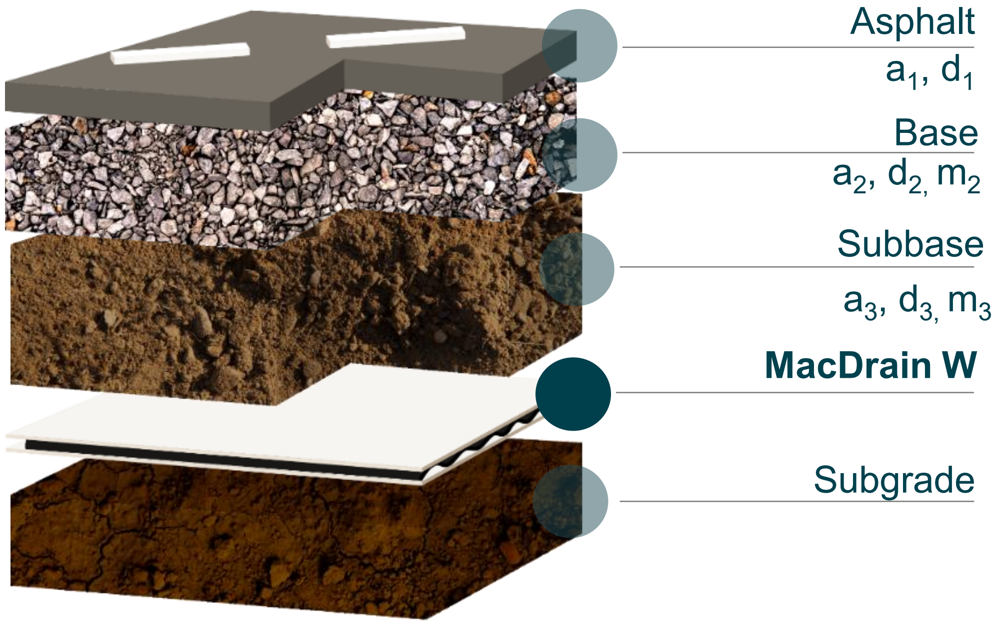
In AASHTO design method the influence of the drainage is included in the SN formula through the drainage coefficients m2 and m3.

$$SN = a_1 d_1 + a_2 d_2 m_2 + a_3 d_3 \boldsymbol{m_3}$$

Quality of Drainage	Percent of time pavement is exposed to moisture levels approaching saturation			
	Less than 1%	1 to 5%	5 to 25%	More than 25%
Excellent	1.40-1.35	1.35-1.30	1.30-1.20	1.20
Good	1.35-1.25	1.25-1.15	1.15-1.00	1.00
Fair	1.25-1.15	1.15-1.05	1.00-0.80	0.80
Poor	1.15-1.05	1.05-0.80	0.80-0.60	0.60
Very Poor	1.05-0.95	0.95-0.75	0.75-0.40	0.40

Recommended m values (AASHTO 1993)

With MacDrain W at subgrade/ subbase interface



MacDrain W → higher m-value → higher SN → lower subbase thickness

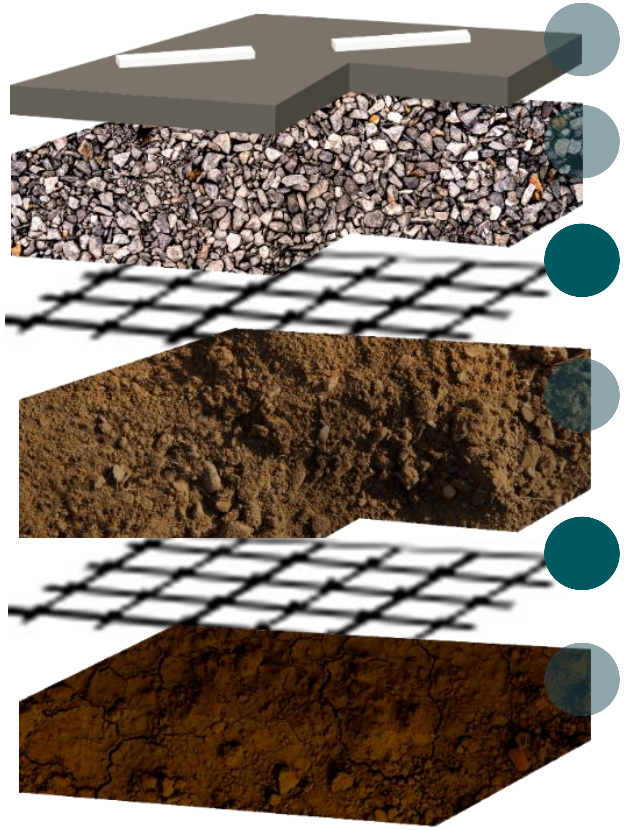
ROAD STABILISATION

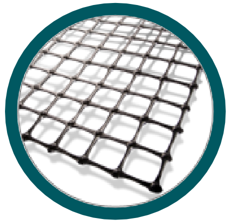
Design approach – Paved roads – Stiffness improvement

The stabilising geosynthetic contribution can be included in the design through Layer Coefficient Ratio (LCR):

$$SN = a_1 d_1 + \boldsymbol{LCR_2} a_2 d_2 m_2 + \boldsymbol{LCR_3} a_3 d_3 m_3$$

derived from empirical data specific to each geosynthetic determined from full scale tests or large-scale lab tests under a cyclic loading set-up independently certified.





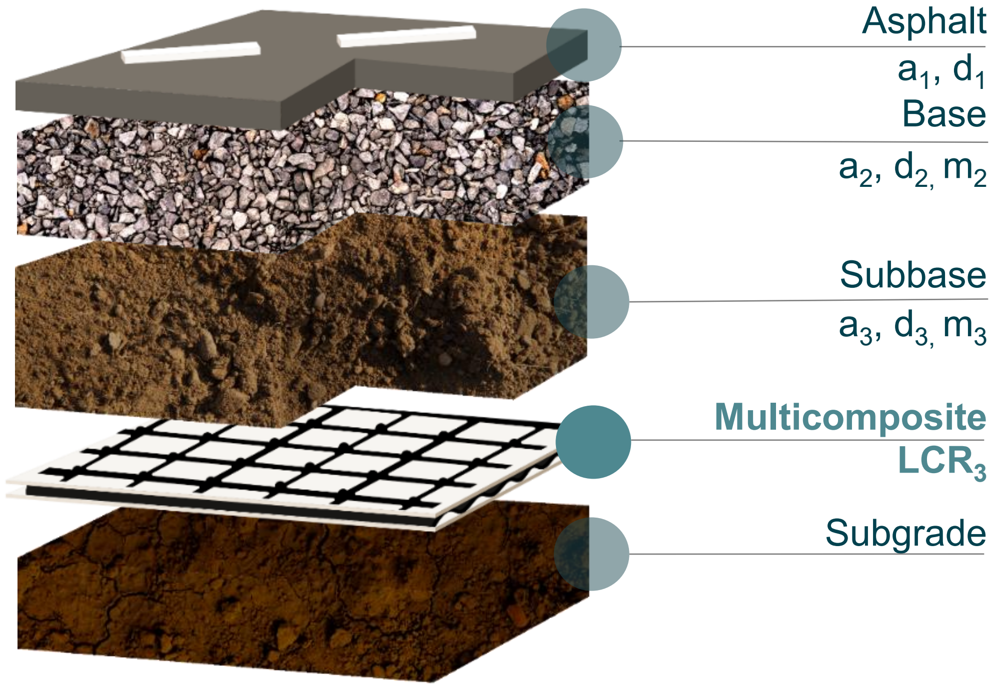
MacGrid EG → higher a value → higher SN → lower base and subbase thickness

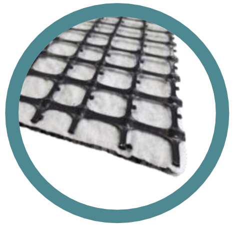
ROAD STABILISATION

Design approach – Paved roads – Stiffness+drainage improvement

Multicomposite resulting from the coupling of MacDrain W and MacGrid EG allows to obtain both benefits deriving from the improvement of the drainage performance and the improvement of the stiffness.

$$SN = a_1 d_1 + a_2 d_2 m_2 + \boldsymbol{LCR_3} a_3 d_3 \boldsymbol{m_3}$$

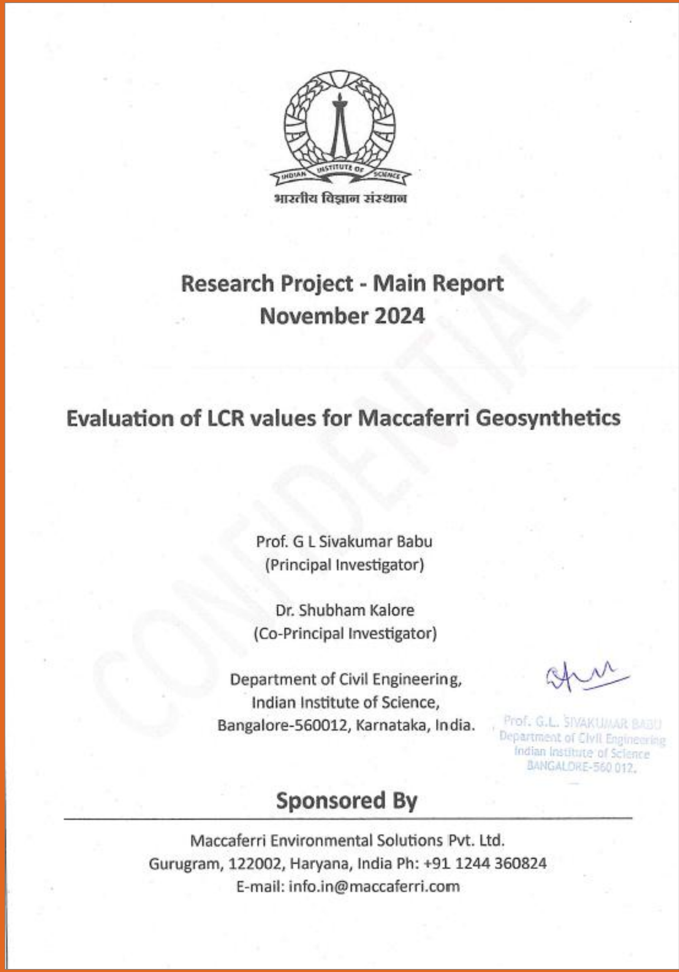




Multicomposite → higher a&m value → higher SN → lower base and subbase thickness

ROAD STABILISATION

Test campaign



भारतीय विज्ञान संस्थान

Research Project - Main Report
November 2024

Evaluation of LCR values for Maccaferri Geosynthetics

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Sponsored By

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E-mail: info.in@maccaferri.com

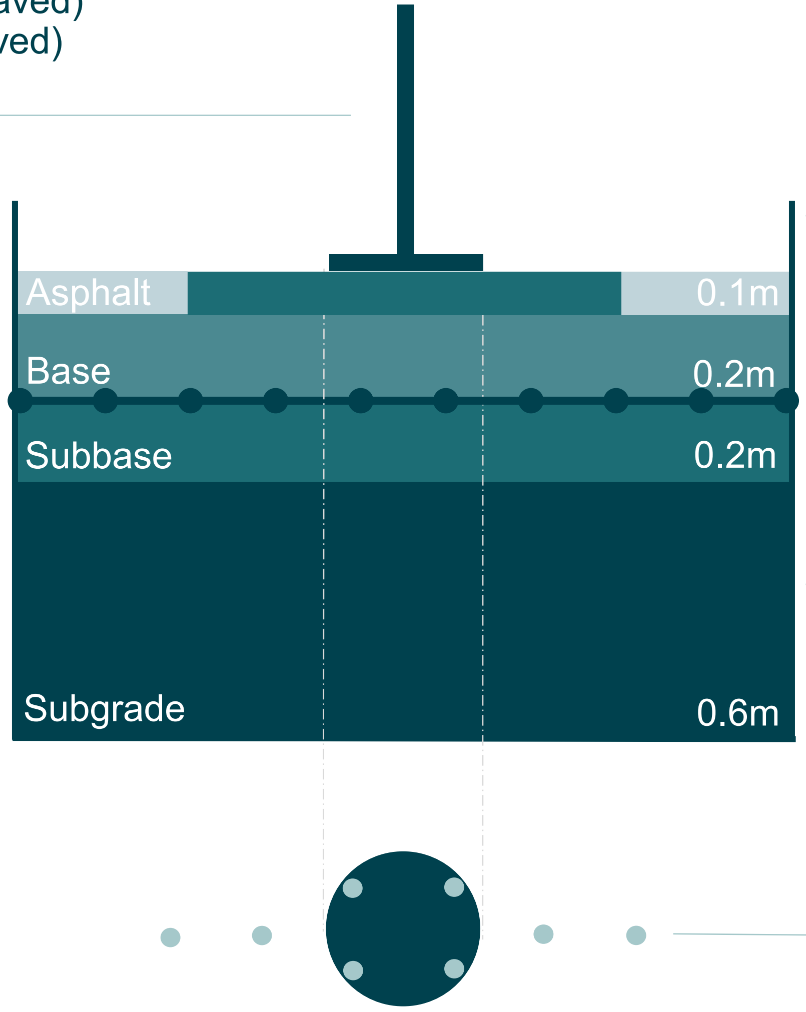
A comprehensive **full-scale testing campaign** was conducted at the Department of Civil Engineering, Indian Institute of Science (IISc), Bangalore (India) to investigate the effectiveness of Maccaferri solutions in improving the mechanical behaviour of unbound granular layers.

The analysis of test data provided **validated LCR** values.

ROAD STABILISATION

Testing set-up (ASTM D8462)

10.000 loading cycles (unpaved)
100.000 loading cycles (paved)
560 kPa, amplitude 40 kN



Testing vessel
2.0mx2.0mx1.1m

MacGrid EG

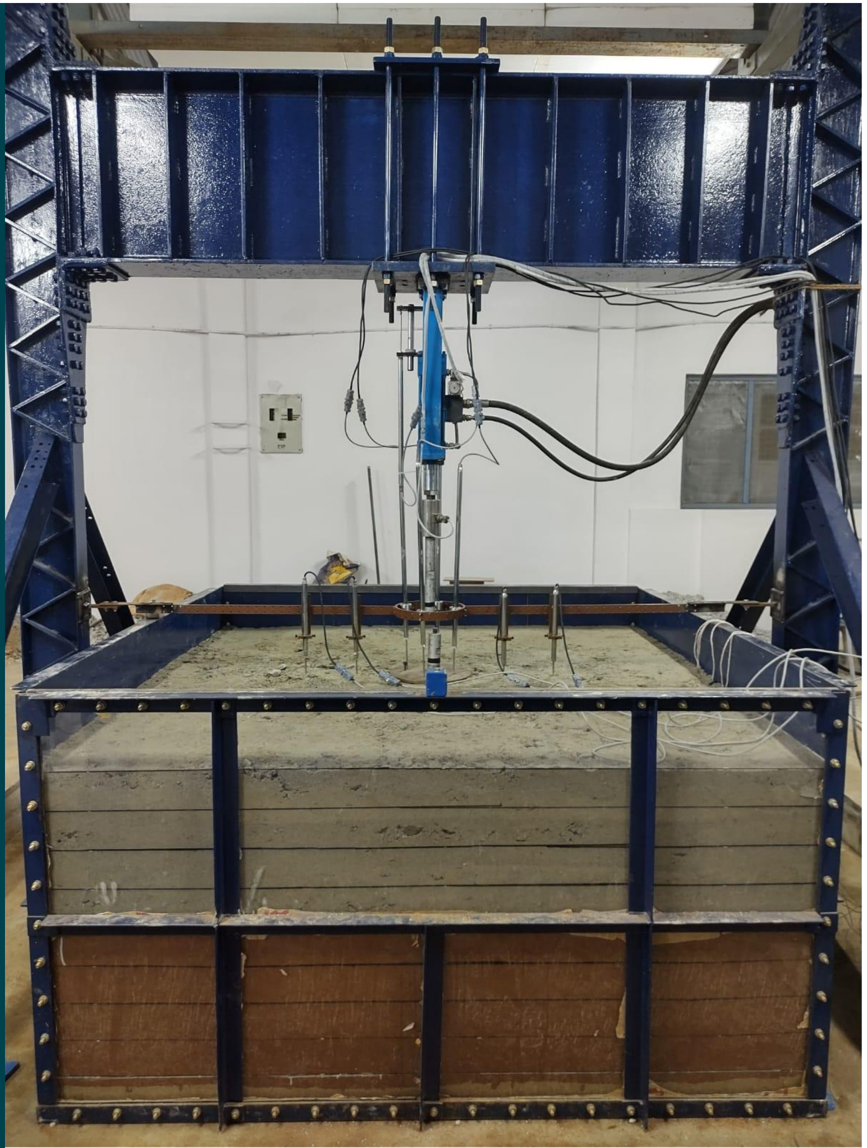
4 different CBR subgrade
1, 2.5, 5 and 10%

8 LVDTs
measuring displacements

ROAD STABILISATION

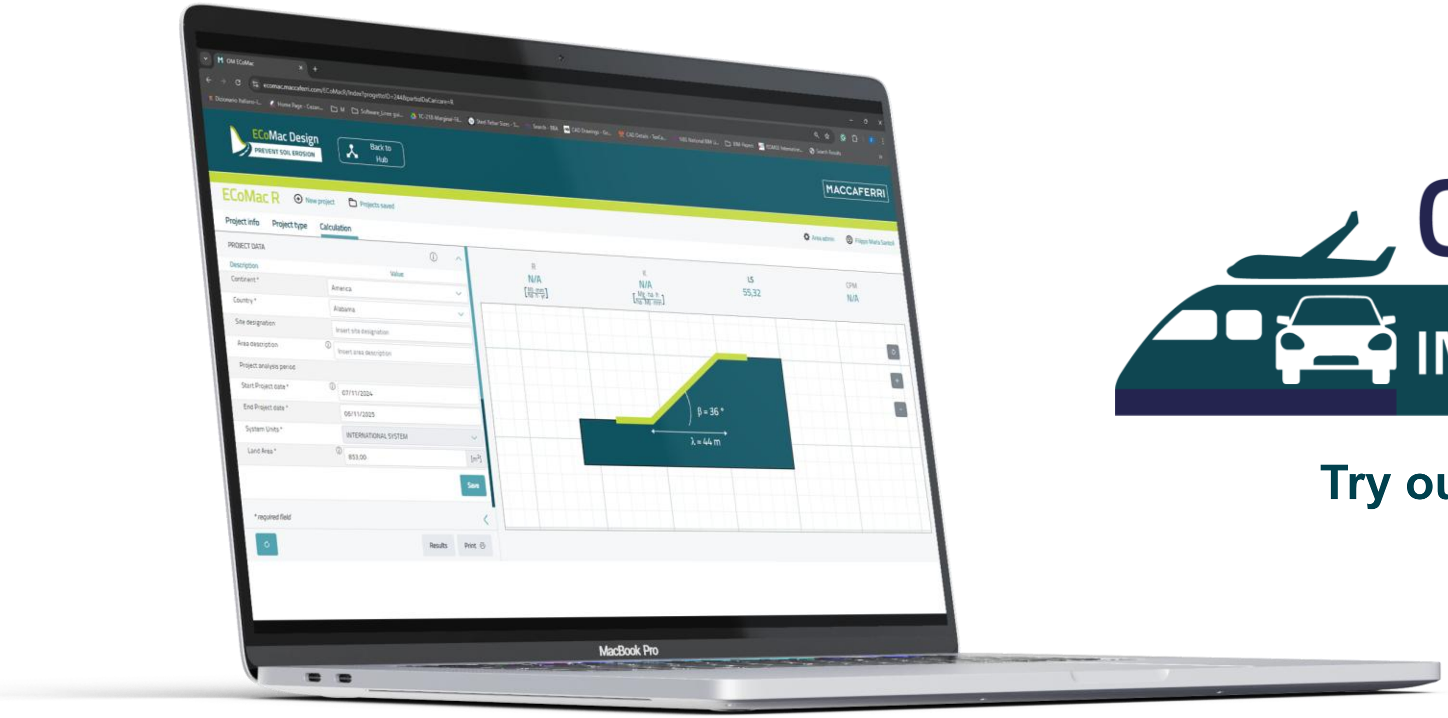
Research findings

- Test results demonstrates that includingof MacGrid EG within unbound granular layers allows to optimize unbound granular layers thickness or extend service life.
- LCR values were observed to be higher for subgrade with lower CBR than that with higher CBR.
- LCR values were observed to increase with the increase of the geogrid tensile strength.
- No influence of the asphalt layer on the results was observed. This makes it possible to conduct tests on unpaved sections, simplifying their execution.



SOIL STABILISATION

GroundMac



GroundMac Design

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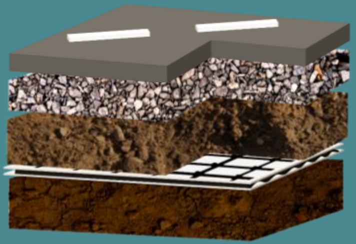
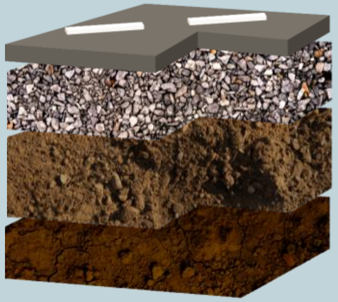
SOIL STABILISATION

Cost effective and sustainable solution

Unstabilised

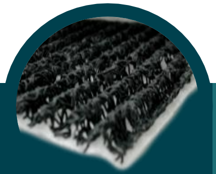
> base=0.60m
> subbase=1.00m





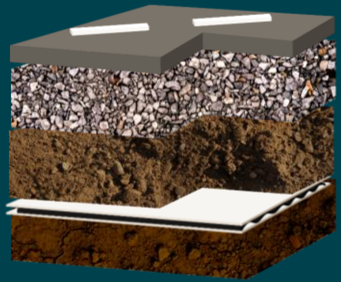
Stabilised with **MacDrain W**

> base=0.60m
> subbase=0.70m



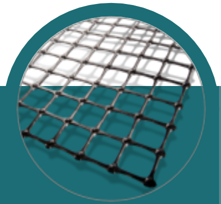
Thickness reduction

> -30% (subbase)
> n.a. (base)



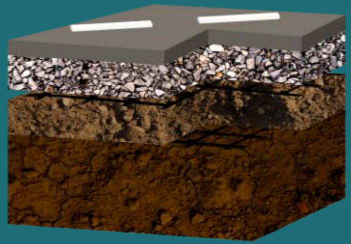
Stabilised with **MacGrid EG**

> base=0.40m
> subbase=0.60m



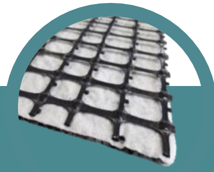
Thickness reduction

> -40% (subbase)
> -33% (base)



Stabilised with **Multicomposite**

> base=0.30m
> subbase=0.55m

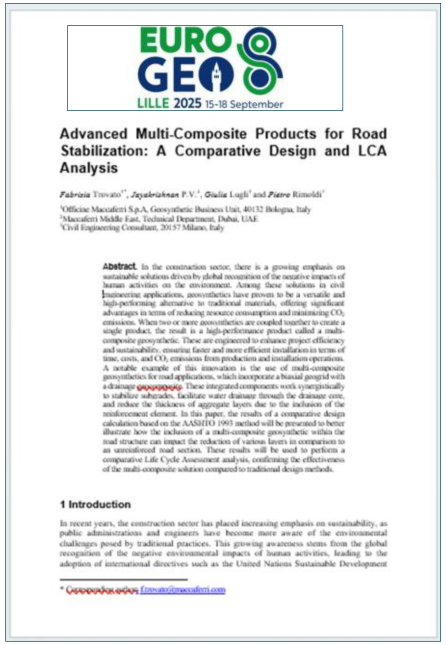


Thickness reduction

> -45% (subbase)
> -50% (base)

SOIL STABILISATION

LCA analysis


EURO GEO 8
LILLE 2025 15-18 September

Advanced Multi-Composite Products for Road Stabilization: A Comparative Design and LCA Analysis

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[3]Civil Engineering Consultant, 20157 Milano, Italy

Abstract. In the construction sector, there is a growing emphasis on sustainable solutions driven by global recognition of the negative impacts of human activities on the environment. Among these solutions in civil engineering applications, geosynthetics have proven to be a versatile and high-performing alternative to traditional materials, offering significant advantages in terms of reducing resource consumption and minimizing CO_2 emissions. When two or more geosynthetics are coupled together to create a single product, the result is a high-performance product called a multi-composite geosynthetic. These are engineered to enhance project efficiency and sustainability, ensuring faster and more efficient installation in terms of time, costs, and CO_2 emissions from production and installation operations. A notable example of this innovation is the use of multi-composite geosynthetics for road applications, which incorporate a biaxial geogrid with a drainage geocomposite. These integrated components work synergistically to stabilize subgrades, facilitate water drainage through the drainage core, and reduce the thickness of aggregate layers due to the inclusion of the reinforcement element. In this paper, the results of a comparative design calculation based on the AASHTO 1993 method will be presented to better illustrate how the inclusion of a multi-composite geosynthetic within the road structure can impact the reduction of various layers in comparison to an unreinforced road section. These results will be used to perform a comparative Life Cycle Assessment analysis, confirming the effectiveness of the multi-composite solution compared to traditional design methods.

1 Introduction

In recent years, the construction sector has placed increasing emphasis on sustainability, as public administrations and engineers have become more aware of the environmental challenges posed by traditional practices. This growing awareness stems from the global recognition of the negative environmental impacts of human activities, leading to the adoption of international directives such as the United Nations Sustainable Development

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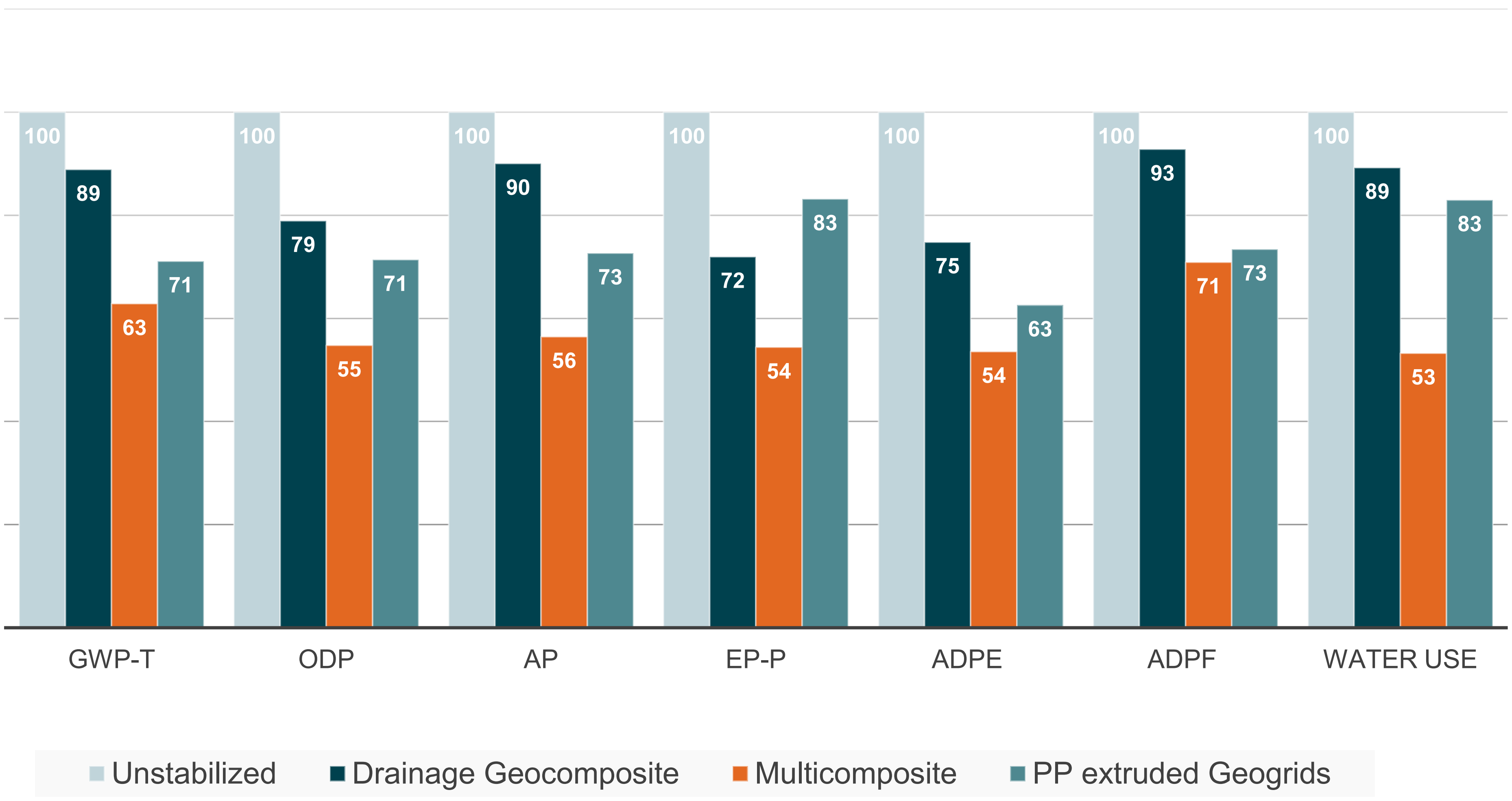

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