

Talk Program celebrating 175 years of establishment of IITR
Organized By
IIT Roorkee Alumni Association Nepal (IITRAAN)

PRESENTATION ON SOIL REINFORCEMENT

Er. Basu Dev Pokhrel – GS, IITRAAN

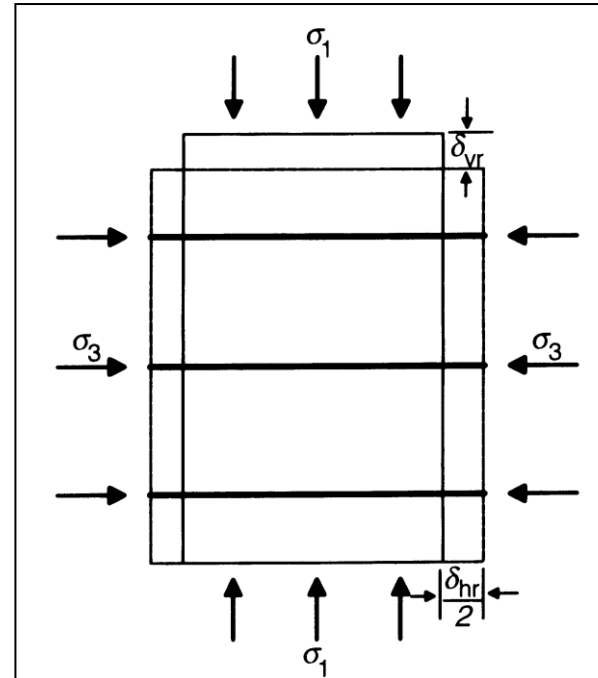
June 25, 2022

Basic Principles: Reinforced Soil

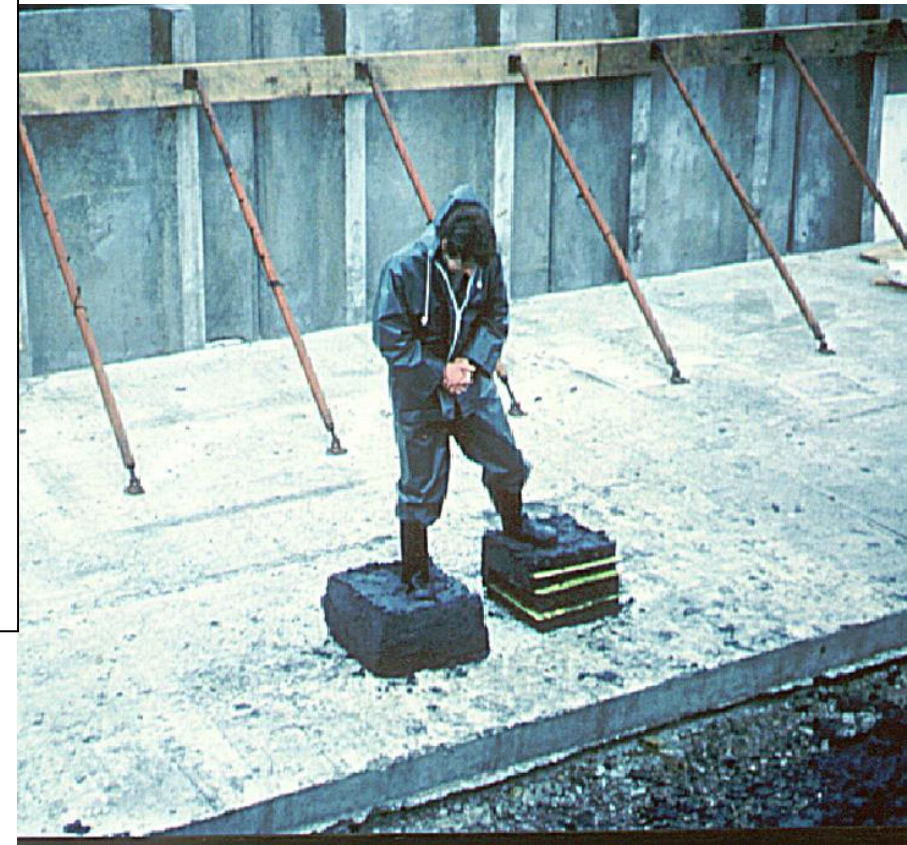


- Resistance to tensile strain can be provided by reinforcement

- Soil is strong in compression (when confined) but weak in tension

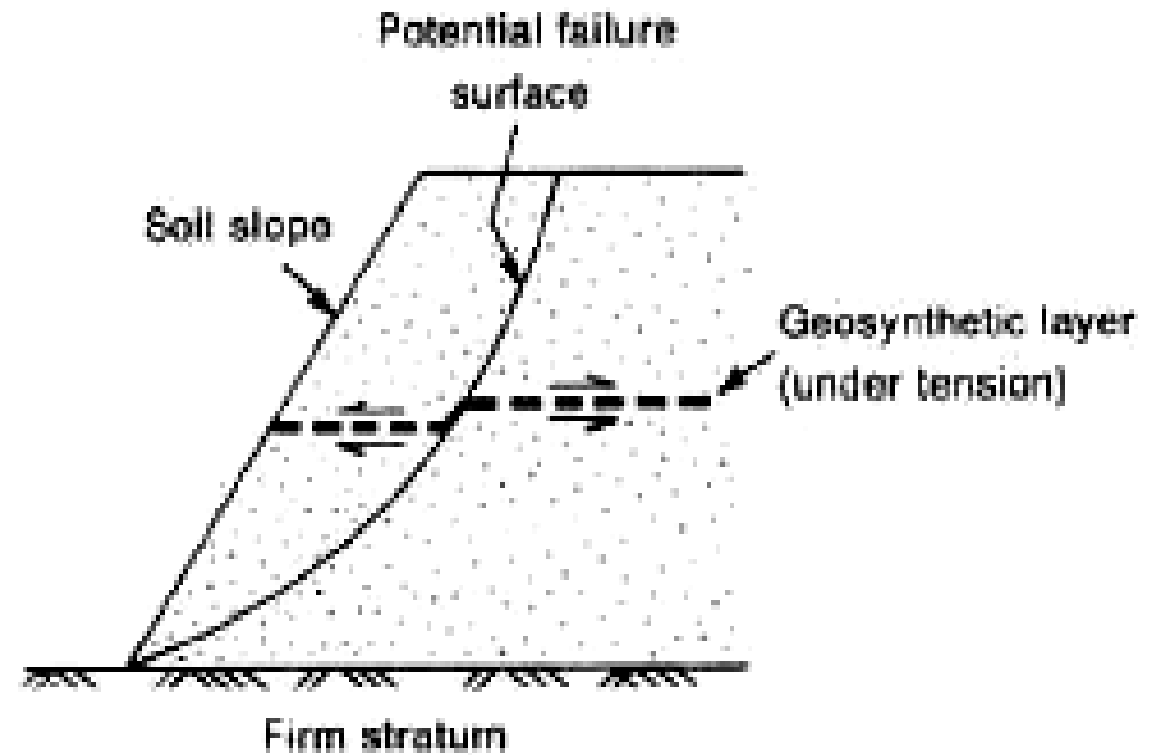


- Interaction between reinforcement and soil is by friction or mechanical interlock



Basic Principles: Reinforced Soil

- Resistance against shear stress:
Strength of reinforcing material
- Resistance against pull out:
Friction between soil and reinforcing material



Reinforcement Function

ANCIENT USE OF SOIL REINFORCEMENT



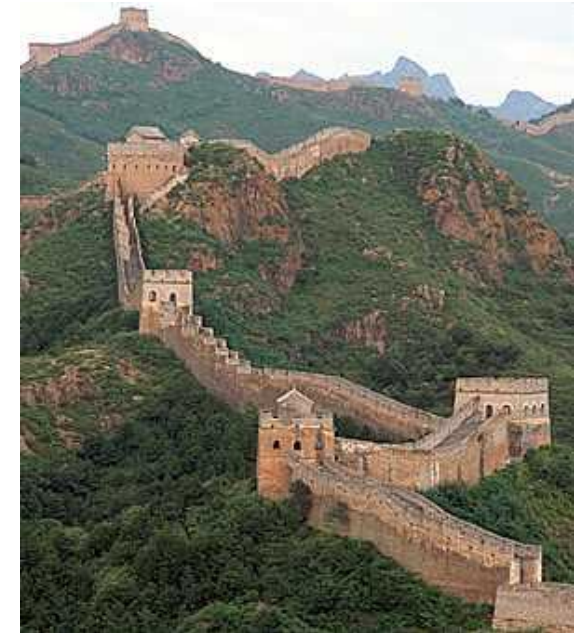
- Wooden Fascines, Cotton
- Straw, Natural Fibers



**Ziggurat- Reinforced Soil
Structure using Natural Straw**

Limitations:

- Poor Durability
- Not suited for permanent / long term performance
- Variable material property inhibits assured designs.



**The Great Wall Of China
was constructed using
Reeds to reinforce
bricks**

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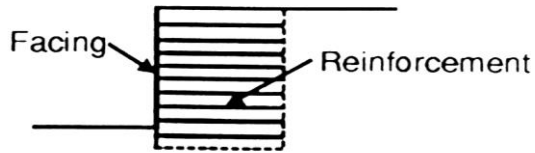
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It is the generic term for reinforcement inclusions

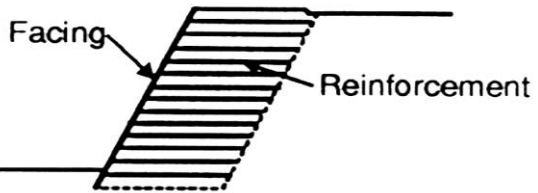
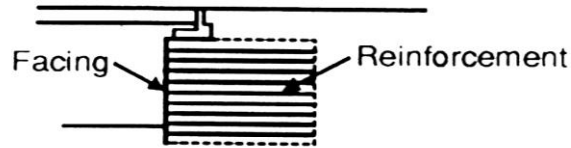
inserted into ground or incorporated into fill providing tensile strength and/or shear resistance

WHAT IS A SOIL REINFORCEMENT ?

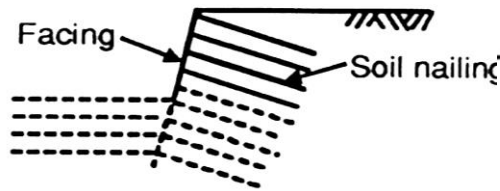
VARIOUS APPLICATION OF SOIL REINFORCEMENT



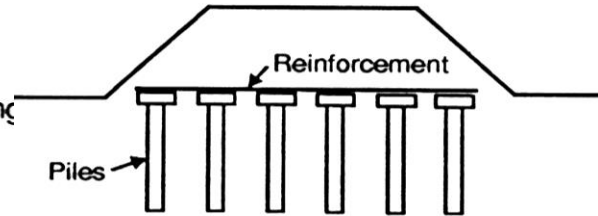
a) Retaining walls and abutments



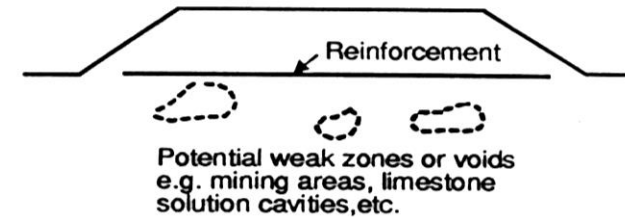
b) Fill slopes



c) Soil nailed slopes



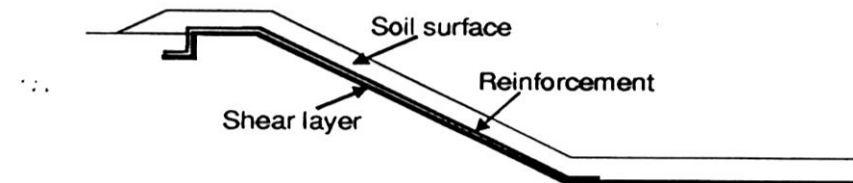
e) Basal reinforced piled embankments



f) Basal reinforcement spanning voids



d) Basal reinforcement on soft foundations



g) Interface shear layers

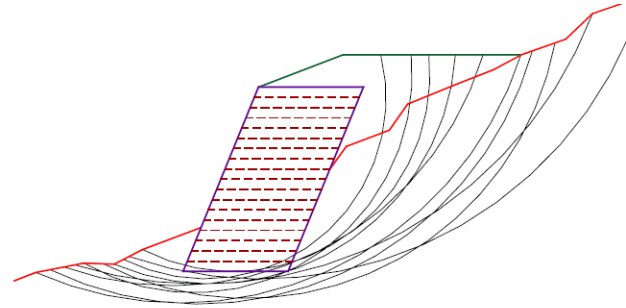
DESIGN CRITERIA

DESIGN METHOD : **BS 8006**
 FHWA

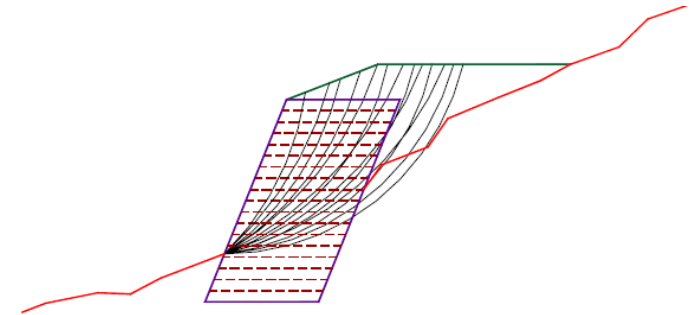
TYPES OF STABILITY ANALYSIS (CHECKS)

- Global stability Analysis
- Internal stability Analysis
- Wall Stability Checks

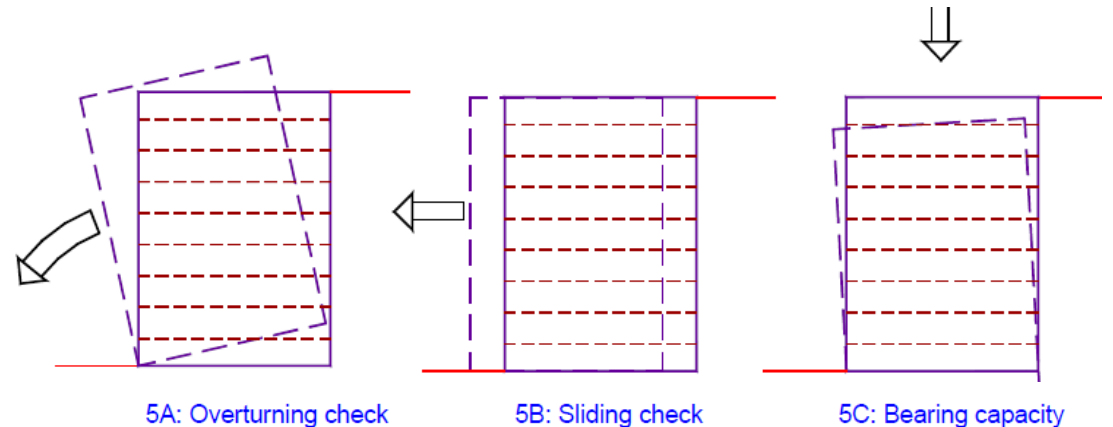
Global stability Analysis



•Internal stability Analysis



Wall Stability Checks



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Type of Soil Reinforcement Material, Available

Metallic reinforcements

Geosynthetics reinforcements

Combination of the Above

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Metallic reinforcements:

**Metalic Strips were being
used as Soil
Reinforcement material in
the early days**



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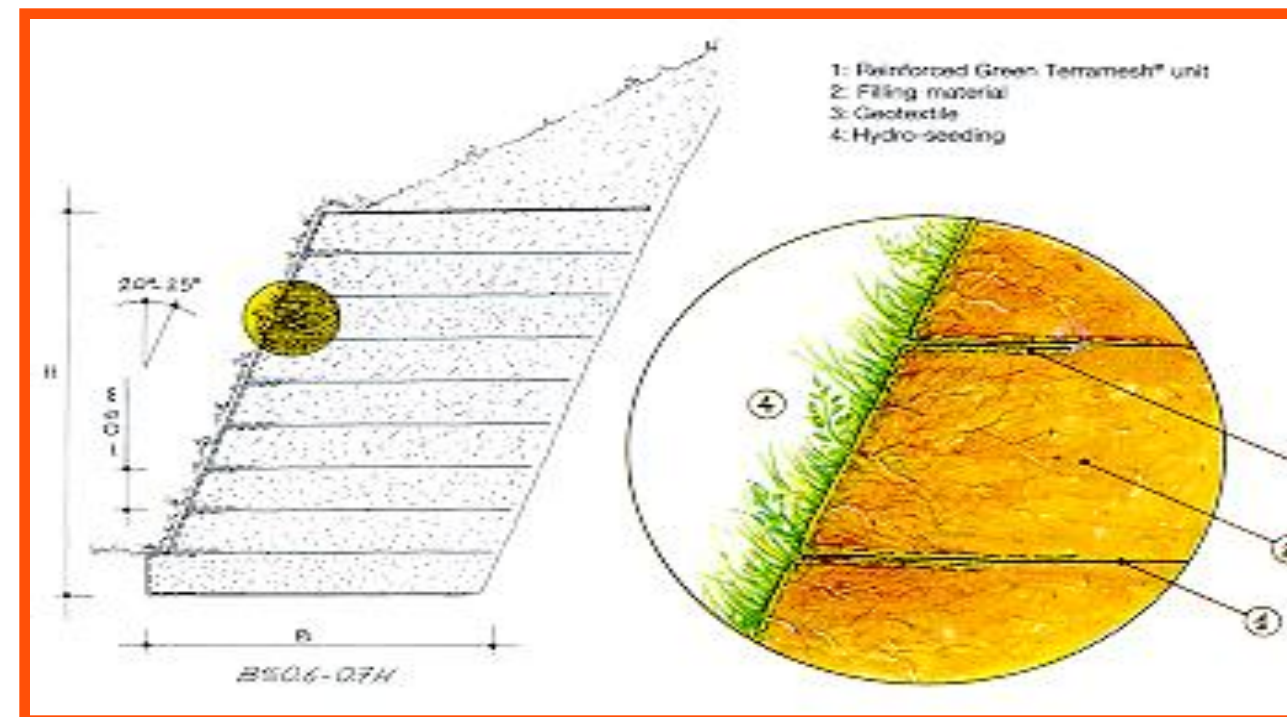
Metallic reinforcements:

Steel Wire mesh are in use for Soil Reinforcement

GABION FACING



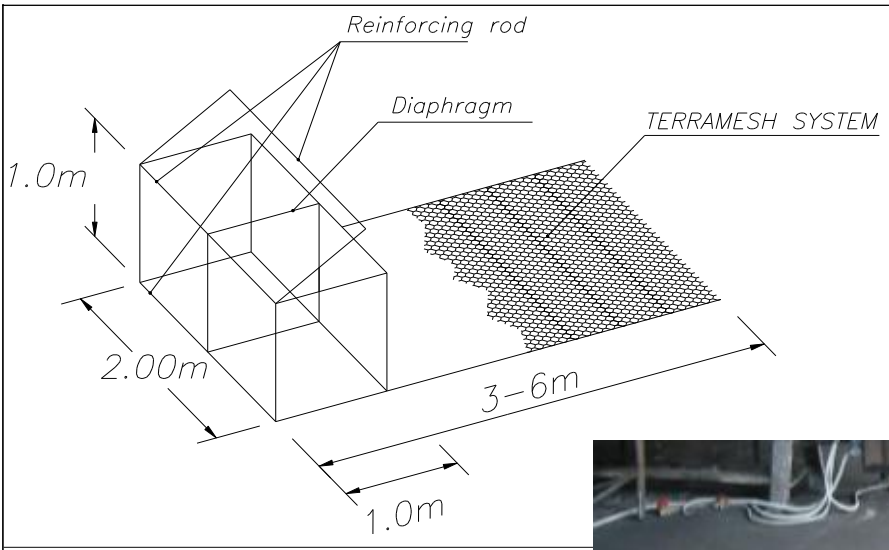
GREEN FACING



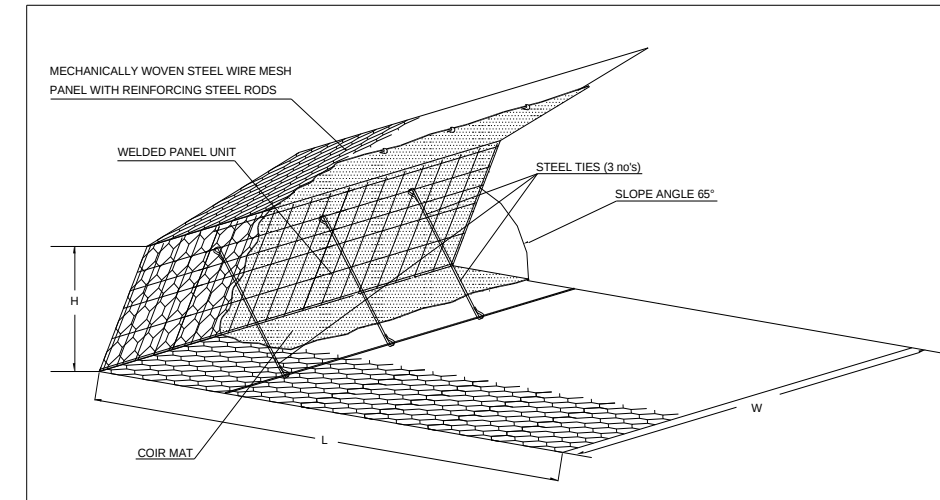
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Steel Wire mesh as Soil Reinforcement

GABION FACING

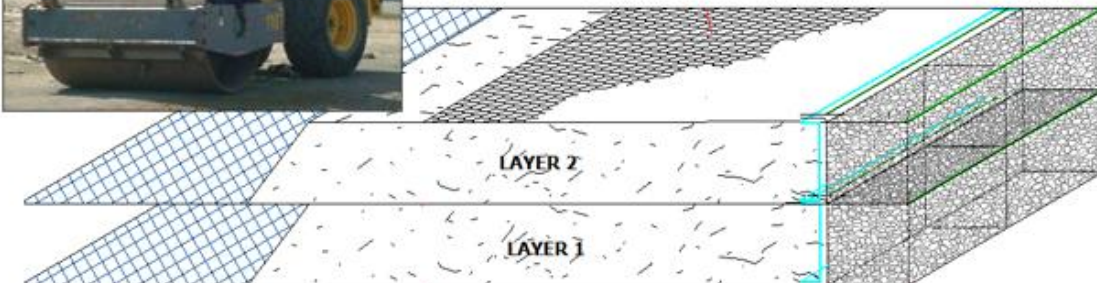
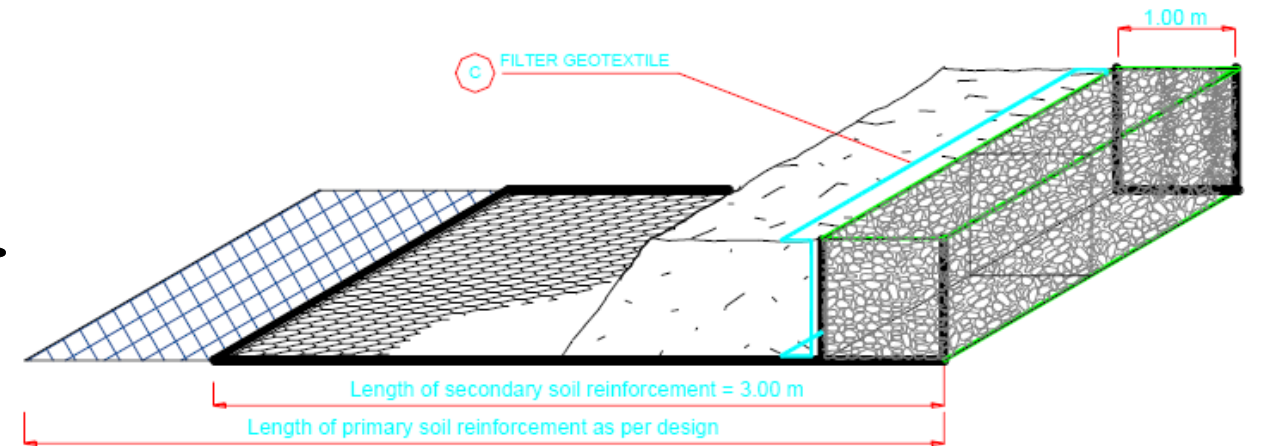
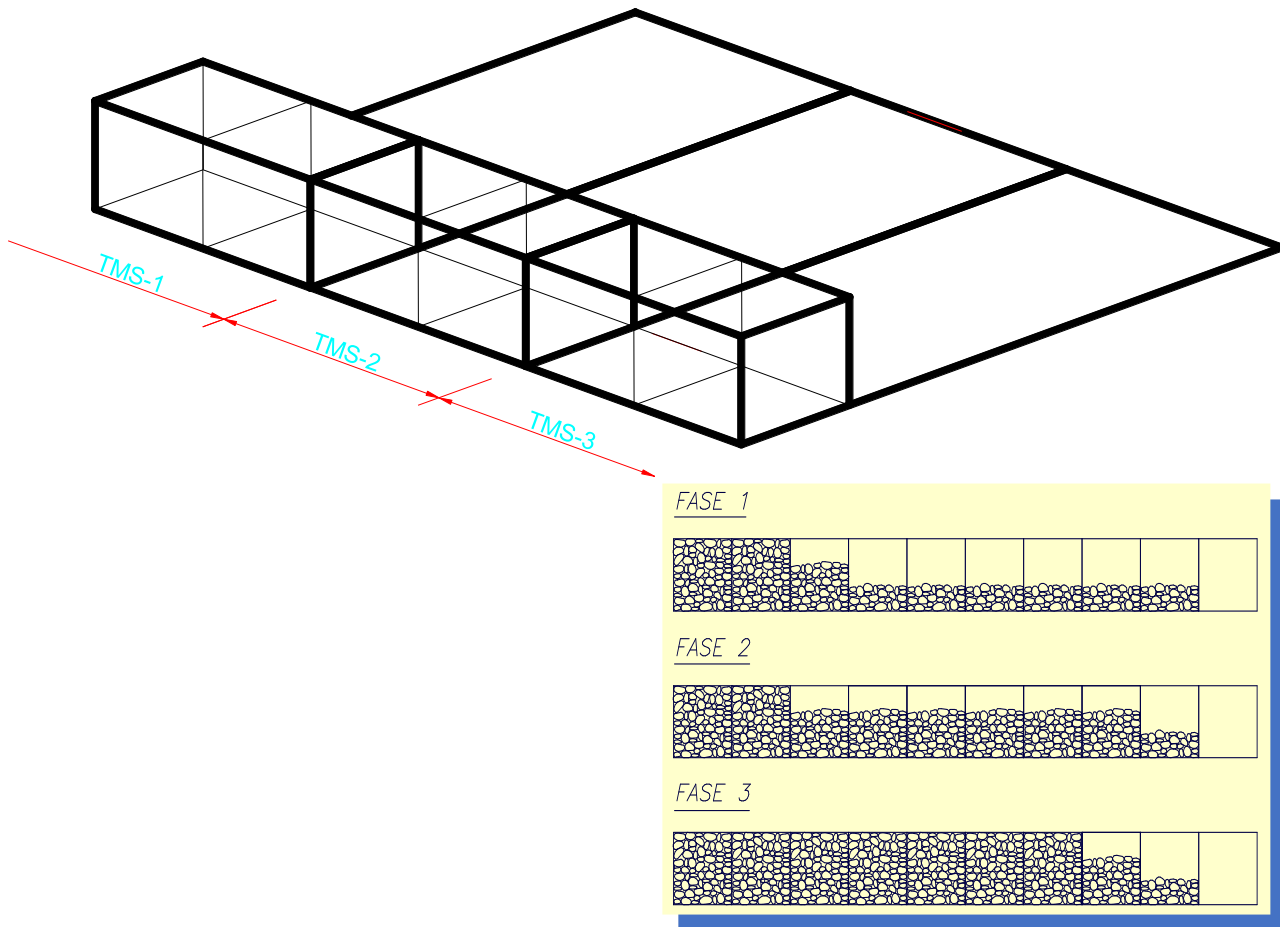


GREEN FACING



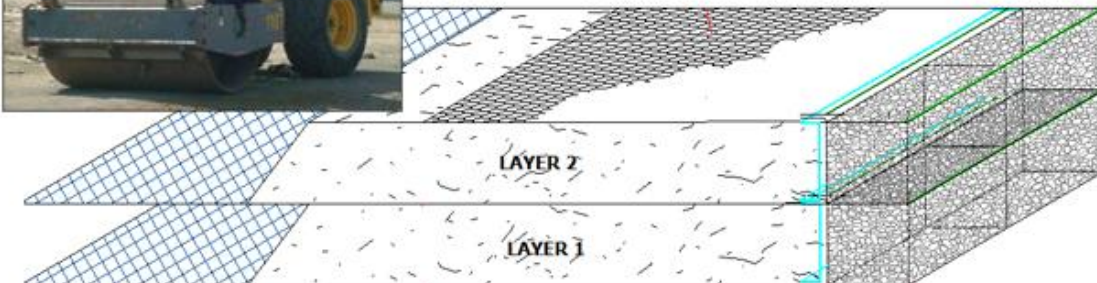
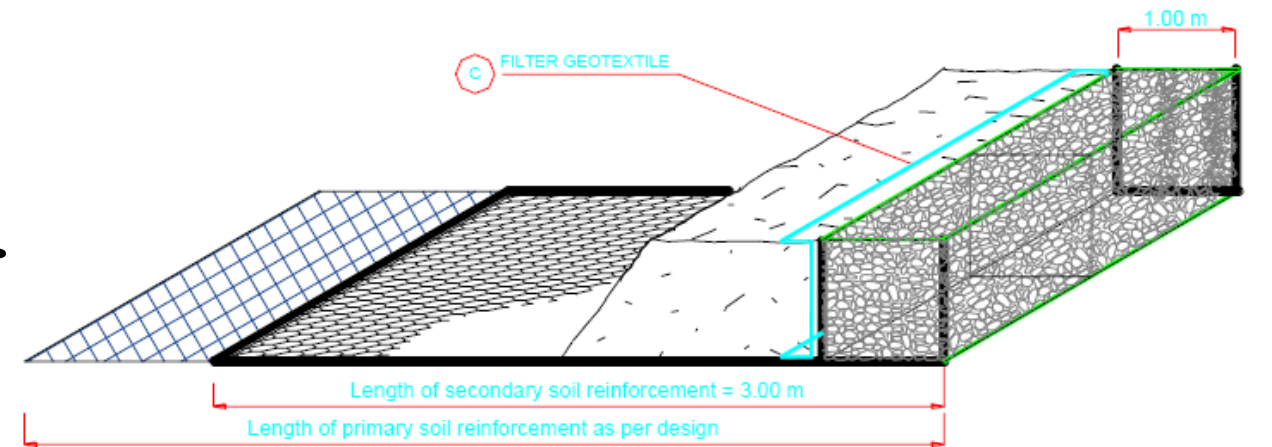
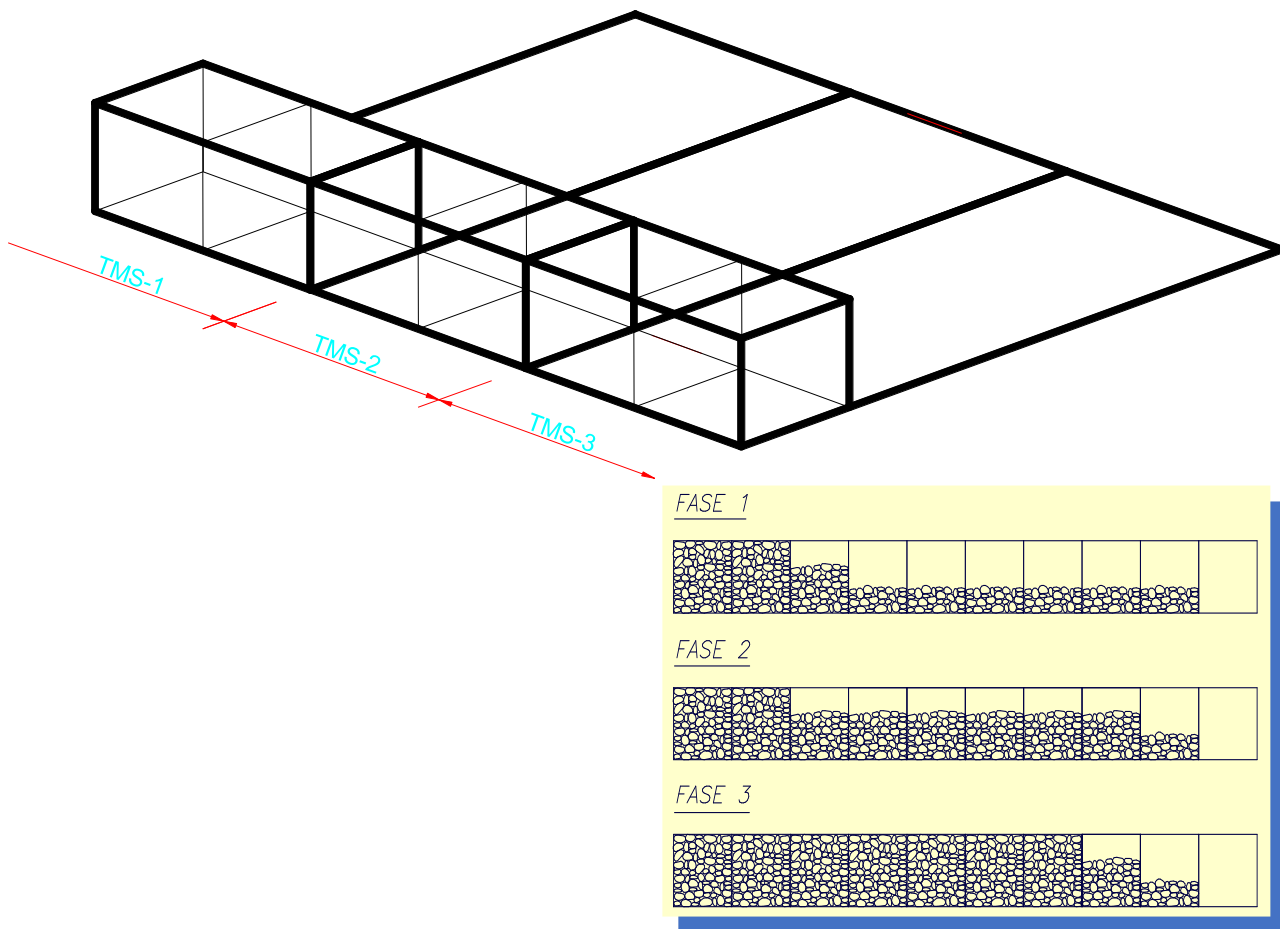
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CONSTRUCTION OF REINFORCED SOIL STRUCTURE



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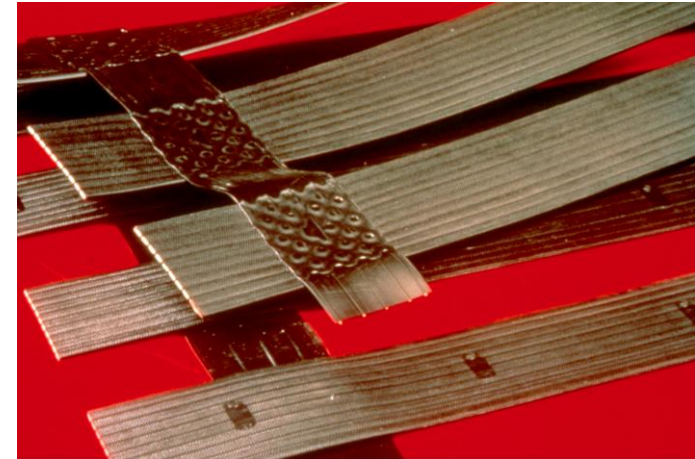
CONSTRUCTION OF REINFORCED SOIL STRUCTURE



GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

MONOAXIAL GEOGRID: PARA-LINK

- Para-links have planar structure consisting of monoaxial array of geo-synthetic strips
- Para-link has good uni-directional strength – 100kN/m to 1350kN/m.



• Bi-directional strength can be

- obtained by installing two
- layers at right angles to each other.
- Para-Grid has good bi-directional strength.
- Longitudinal Strength – 30kN/m to 200kN/m.
- Transverse Strength – 5kN/m to 100kN/m.



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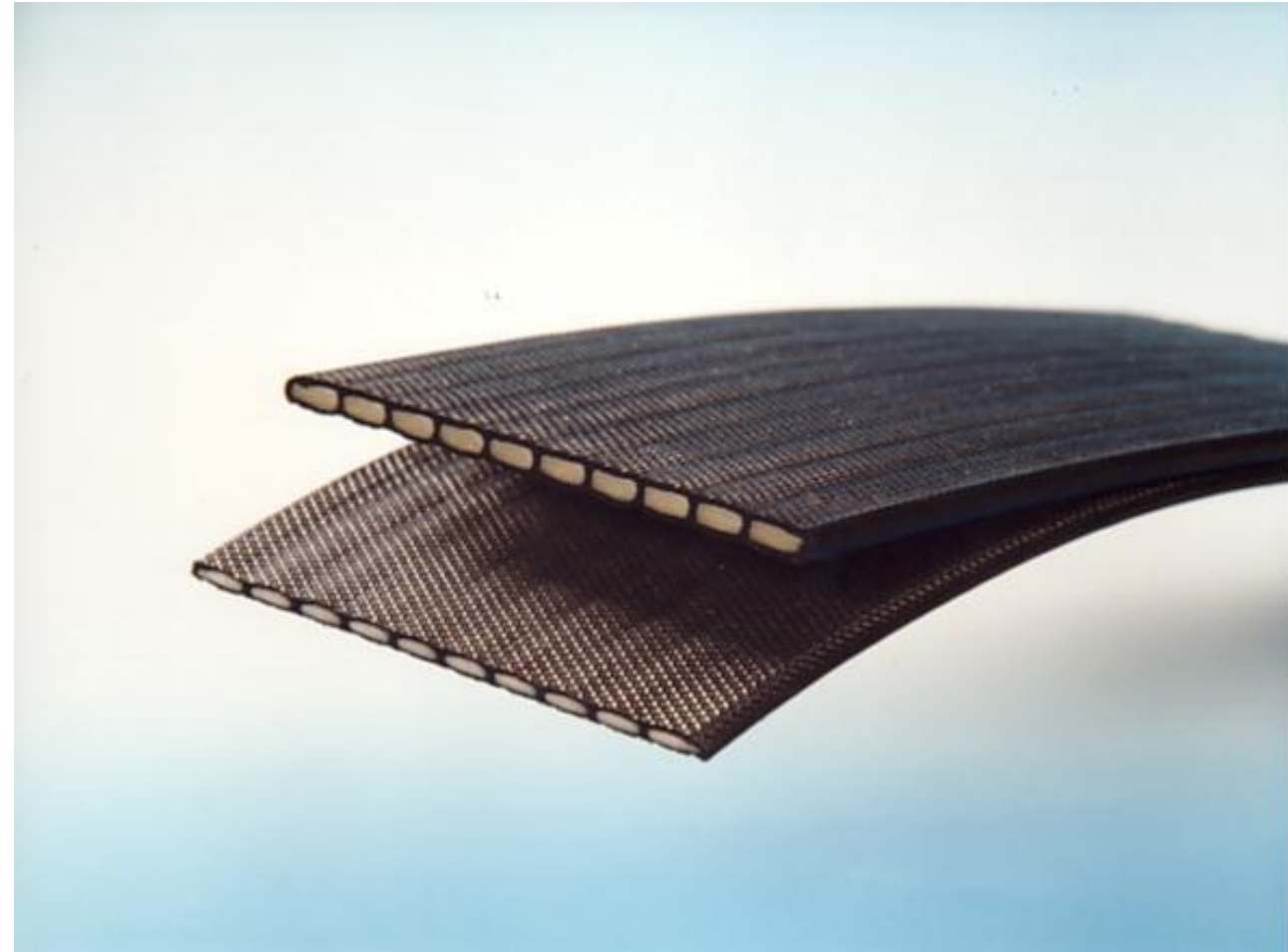
GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

PARAWEB/GEOSYNTHETIC STRAP

Flat Strip of 85 to 90mm

bundles of High tenacity Polyester tendons
encased in durable Polyethylene sheath

Width of 30kN & 40 kN strip is 85mm rest
other are 90mm wide. Strength 30kN,
40kN, 50kN, 75 kN and 100 kN are
commonly used.



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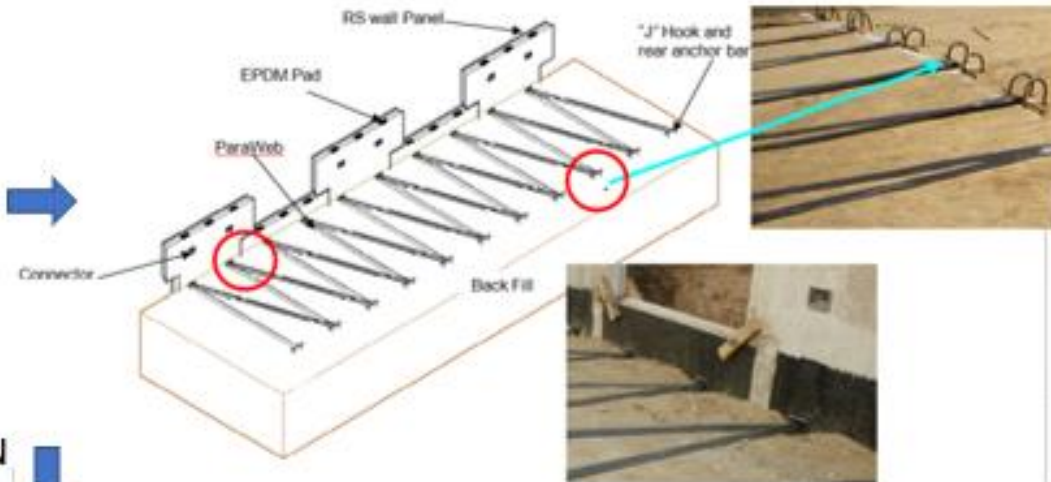
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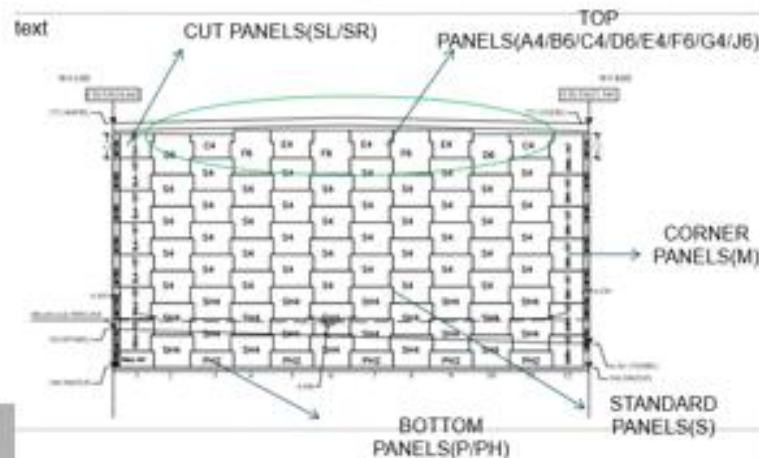
GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

COMPONENTS OF REINFORCED SOIL STRUCTURE WITH CONCRETE FACIA

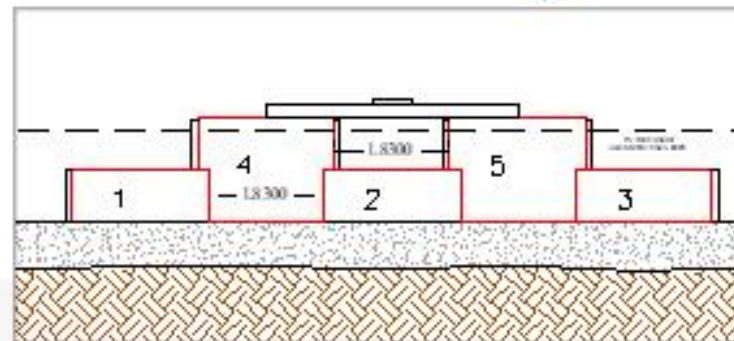
TOP PLAN



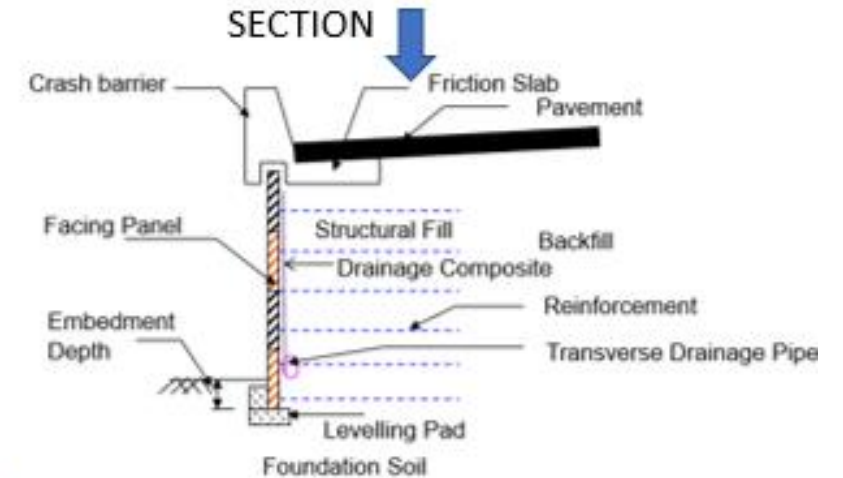
FRONT ELEVATION



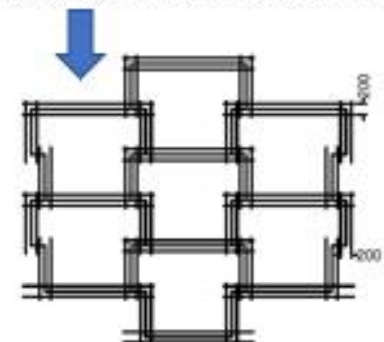
DETAIL AT BOTTOM



SECTION



LAYING OF STANDARD PANELS



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GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

LAYING OF LEVELING PAD



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GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

MOULD READY TO BE CAST



FRESHLY CAST RCC PANEL



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GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

CURING OF PANELS IN WATER TANK

HANDLING OF PANELS



STACKING OF PANELS



TRANSPORTATION OF PANELS TO SITE



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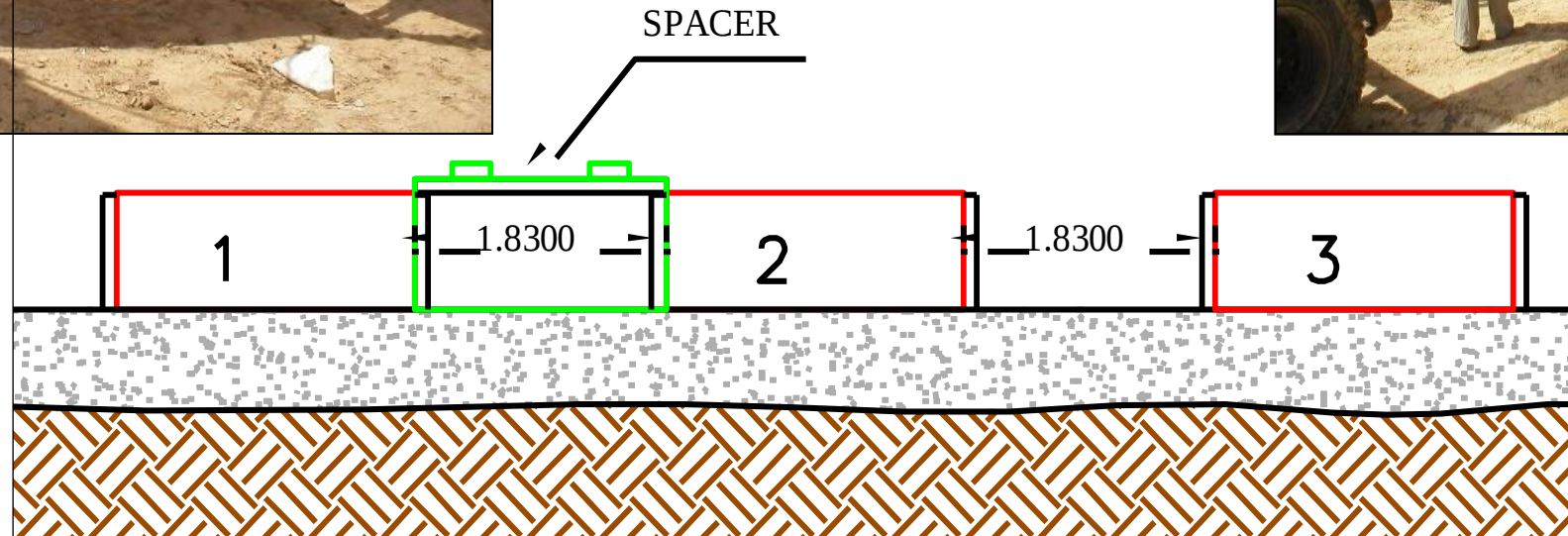
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GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT



PLACEMENT OF FIRST
ROW PANELS



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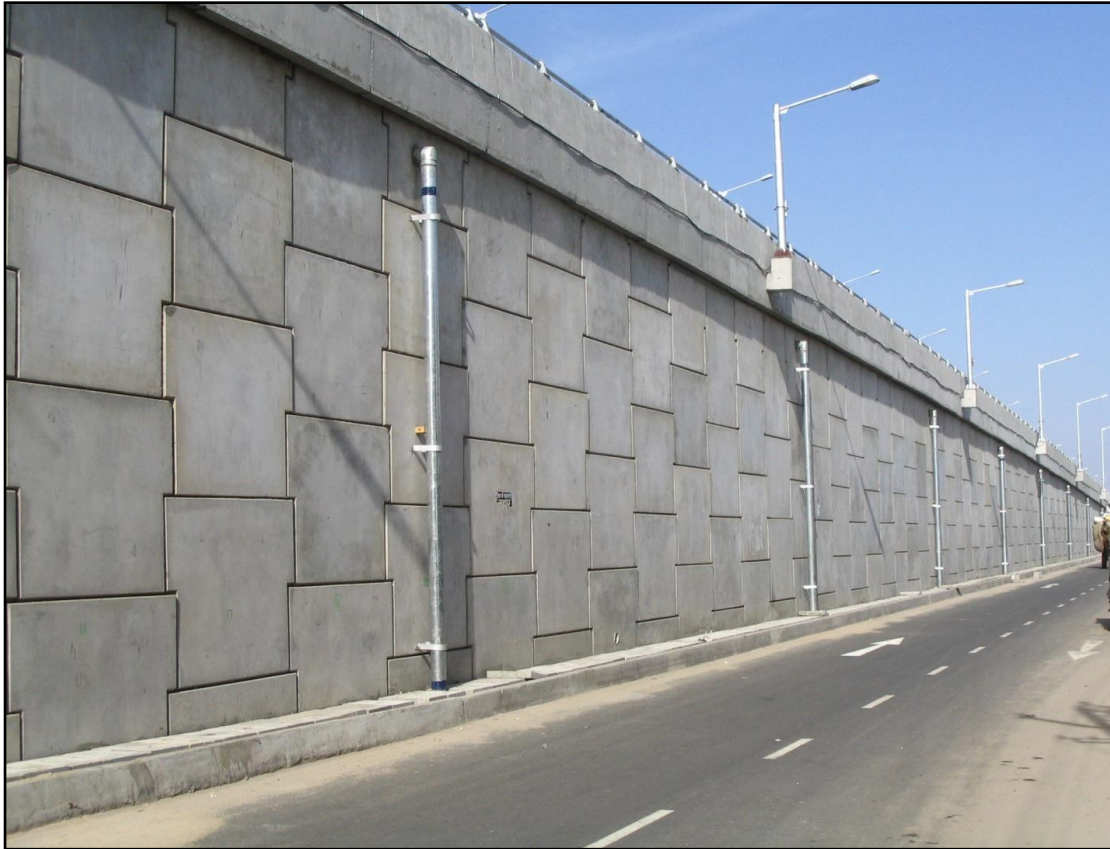
GEOSYNTHETIC-PRODUCTS AS SOIL REINFORCEMENT

LAYING OF PARAWEB/GEOSTRAPS



MACCAFERRI

ParaWeb RS Wall



Kathmandu Bhaktapur Road, 2010



**Jaipur-Kishangarh Expressway,
2004**

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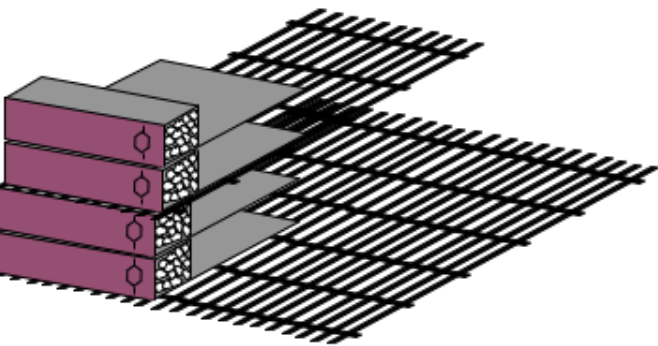
COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT

BACKGROUND OF DEVELOPMENT OF PARAMESH SYSTEM

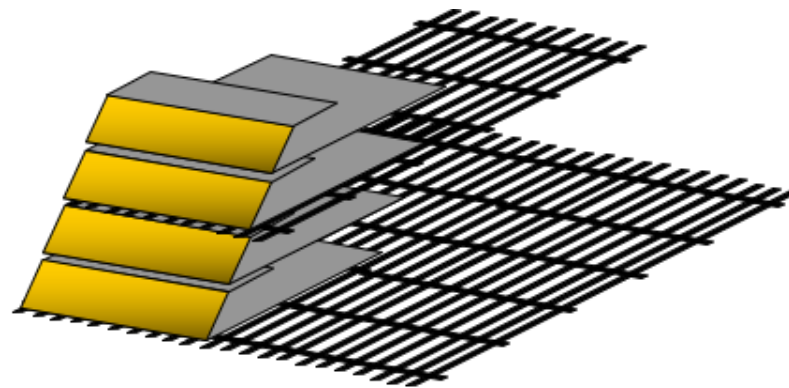
- Developed in late 90's
- Development of this system stems from the need to analyze how a more efficient use of the reinforcements will work in favor of the overall project's economy.
- It is now well established that, for structures higher than 10m, there is a large potential for cost effectiveness in using wire mesh and grids combined, in place of a 100% Geogrids or a 100% steel mesh reinforcement solution only.

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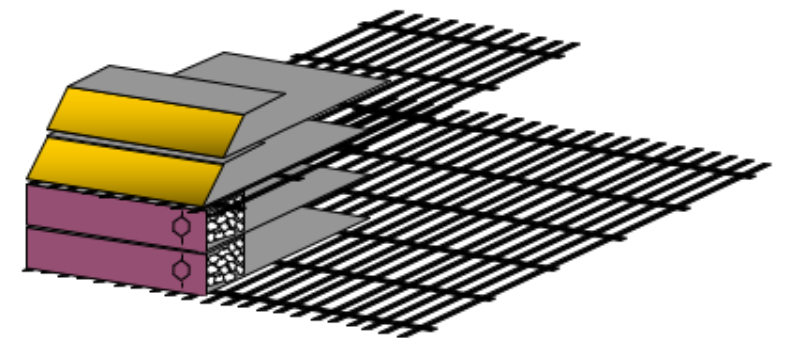
COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT



PMS with Gabion Facia



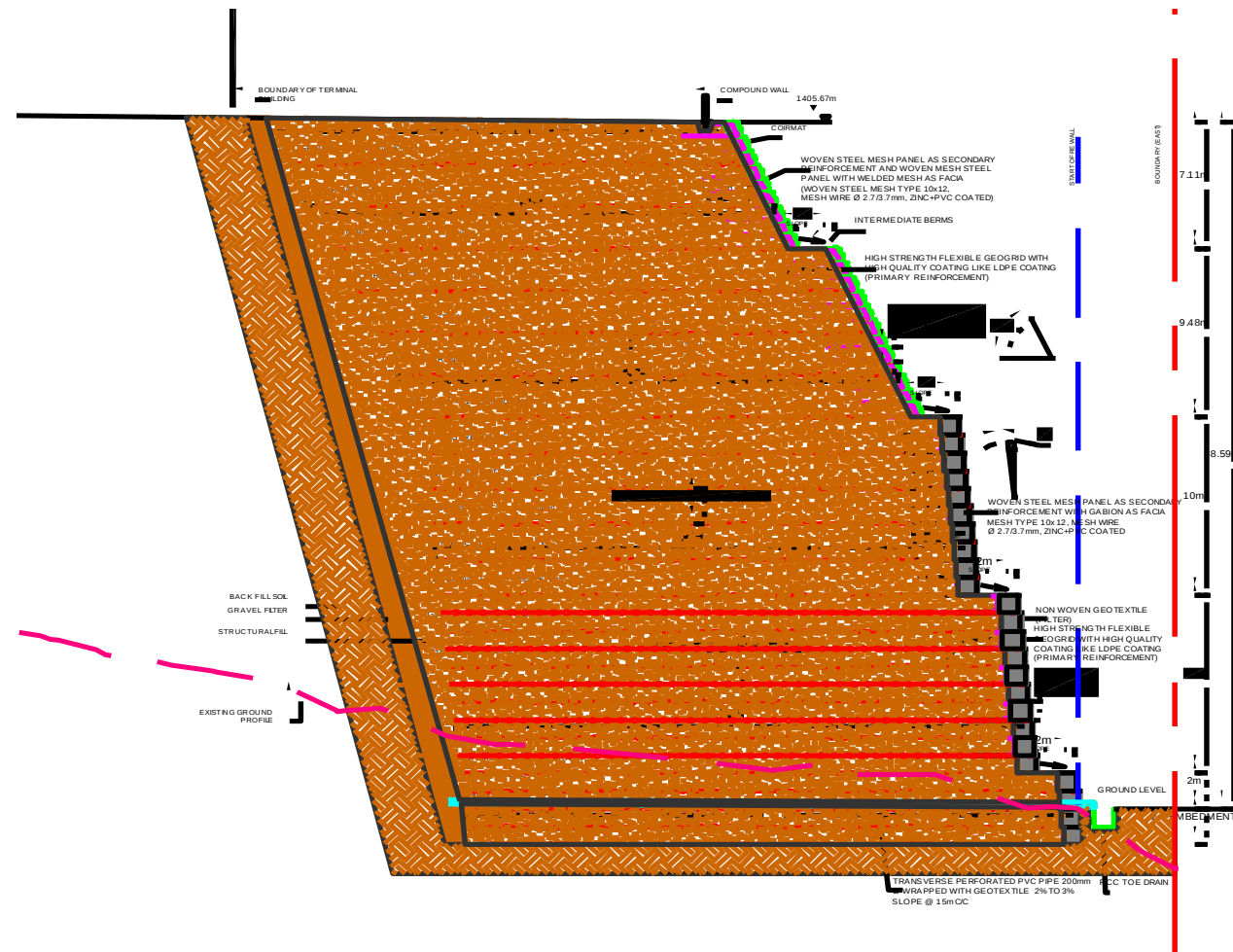
PMS with Green Facia



PMS with combined (gabion and green) Facia

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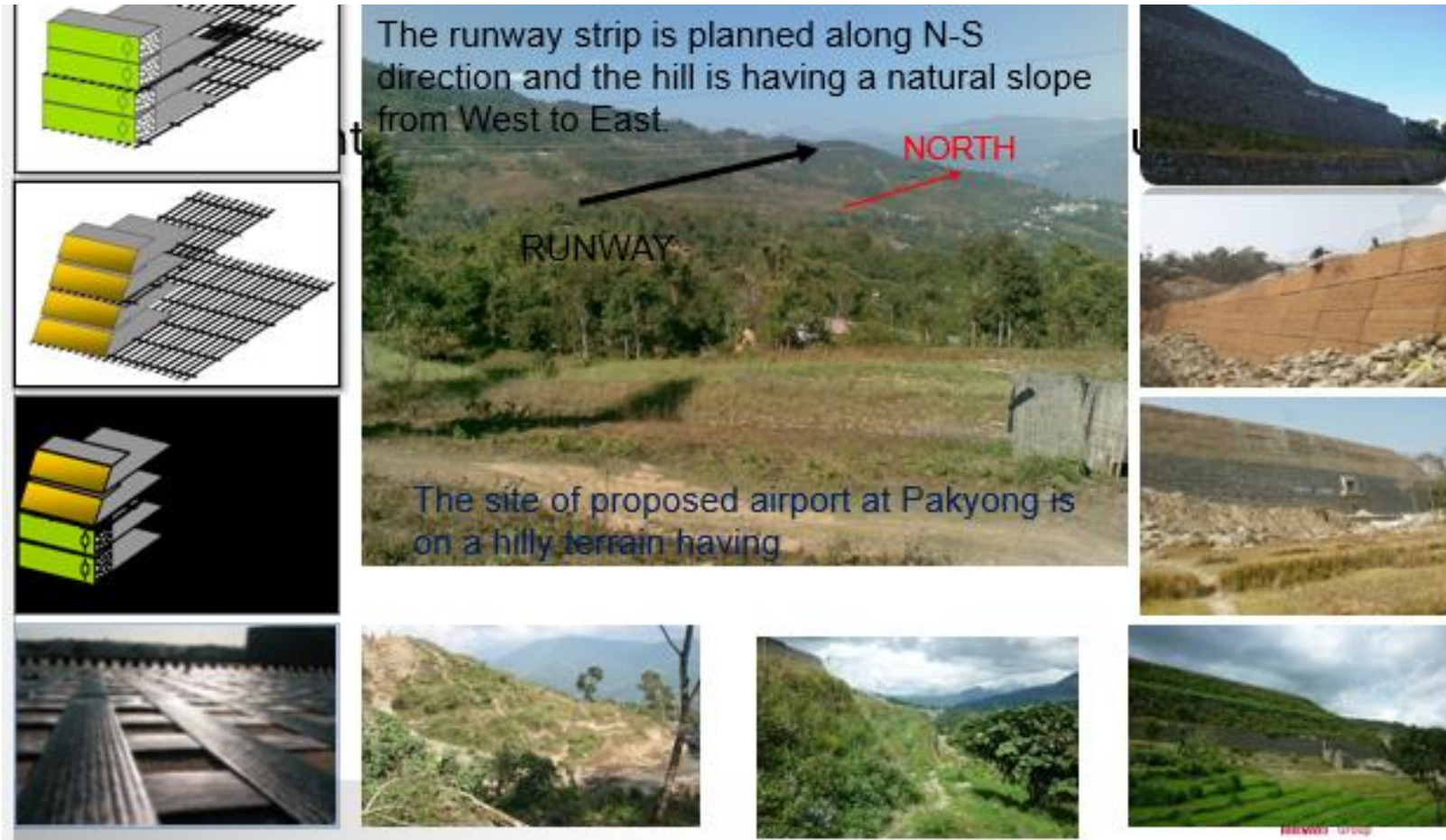
COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT

CONSTRUCTION WITH CASE REFERENCES

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COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT

SIKKIM AIRPORT, SIKKIM, INDIA



MAC

PARAMESH STRUCTURE: PAKYONG, SIKKIM, INDIA



Maccaferri
Industrial
Group

PARAMESH STRUCTURE: PAKYONG, SIKKIM, INDIA





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COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT

Expansion of international apron
south of bay no 1 at TIA



MAC



Maccaferri
Industrial
Group

MAC



Maccaferri
Industrial
Group







MAC



Maccaferri
Industrial
Group







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COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT KTFT



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COMBINATION OF THE METALIC AND GEOSYNTHETIV PRODUCTS AS -SOIL REINFORCEMENT KTFT



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MUGLIN NARAYANGHAT @ CH 17 KELO



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COST COMPARISON

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COST COMPARISON: Reinforced Soil Structures vs Masonry and RCC Structures

Structure type	Structure Height, m	Cost per SQM of Structure	Cost per RM of Structure	
	m		NRS.	%
Gabion Retaining wall	6.0	14026.07	84156.42	22.73
Gabion Retaining wall	10.0	18672.85	186728.45	28.20
Reinforced Soil Structure: TMS	6.0	11428.23	68569.38	0.00
Reinforced Soil Structure: TMS	10.0	14565.60	145655.99	0.00
Reinforced Soil Structure: GTM	6.4	12674.27	81115.32	18.30
Reinforced Soil Structure: GTM	9.6	13647.33	131014.37	-10.05
Stone masonry, 1:6 CM	6.0	23851.20	105000.00	53.13
Stone masonry, 1:6 CM	10.0	36701.08	278000.00	90.86
RCC, 1:2:4 (reinft @ 2.0%)	6.0	34707.70	208246.20	203.70
RCC, 1:2:4 (reinft @ 2.0%)	10.0	60680.78	606807.79	316.60

Q & A

THANK YOU FOR YOUR PATIENCE!