CHAPTER-IX-INTRODUCTION TO SOIL REINFORCEMENT TECHNIQUE

CONCEPT OF REINFORCED EARTH (R.E.)

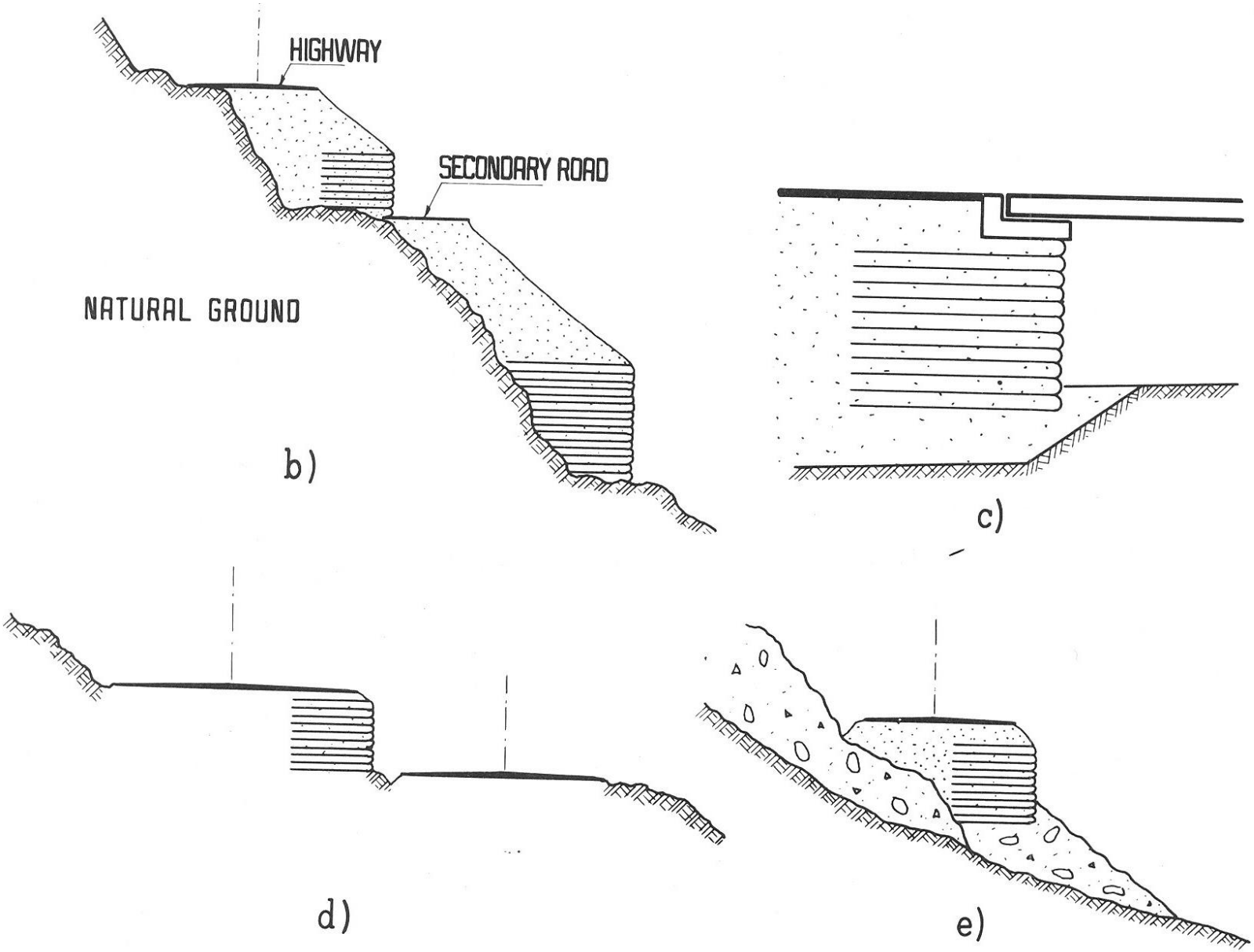
Reinforced earth is a composite material formed by the friction between the earth and the reinforcement. By means of friction the soil transfers to the reinforcement the forces built up in the earth mass. The reinforcement thus develops tension and the earth behaves as if it has cohesion.

Application of Reinforced Earth

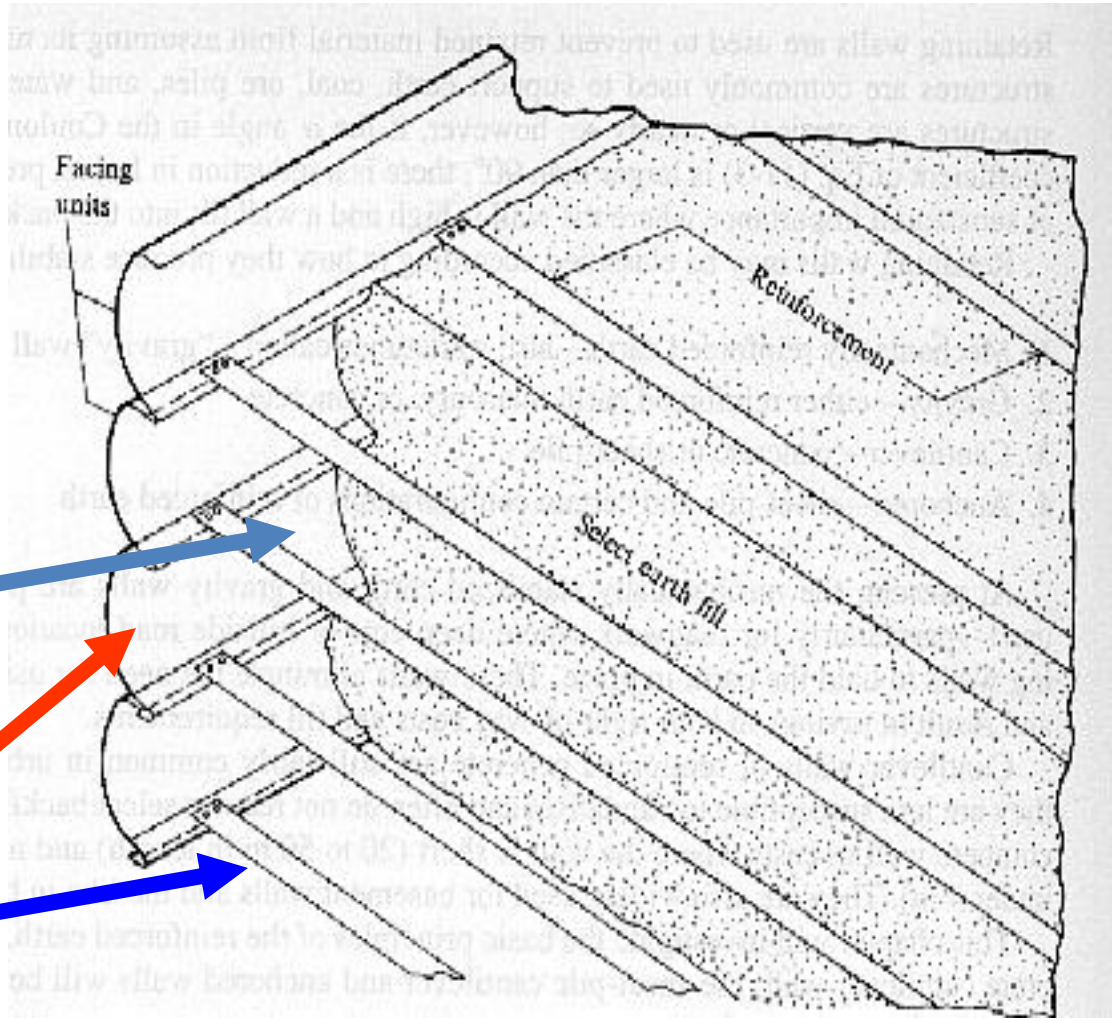
- **Bridge works**
- **Dam Embankments**
- **Foundations**
- **Highways**
- **Industrial sites**
- **Military (Army Bunkers)**
- **Root Pile system**

- Land Reclamation
- Pipe works (Buried pipe structure)
- Housing on hill slopes
- Sports Structures
- Sea wall & Waterways structures

Locations for use of Reinforced Earth



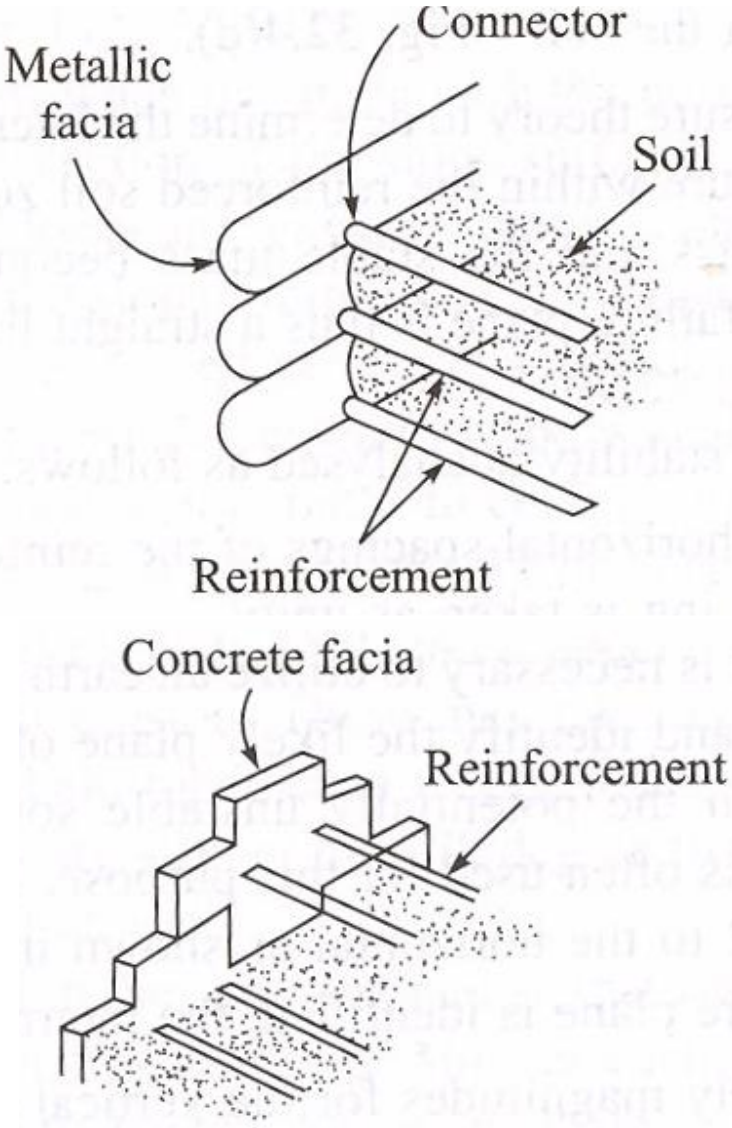
COMPONENTS OF R.E.



- **Compacted Soil**
- **Wall Facing Elements**
- **Reinforcing Elements**

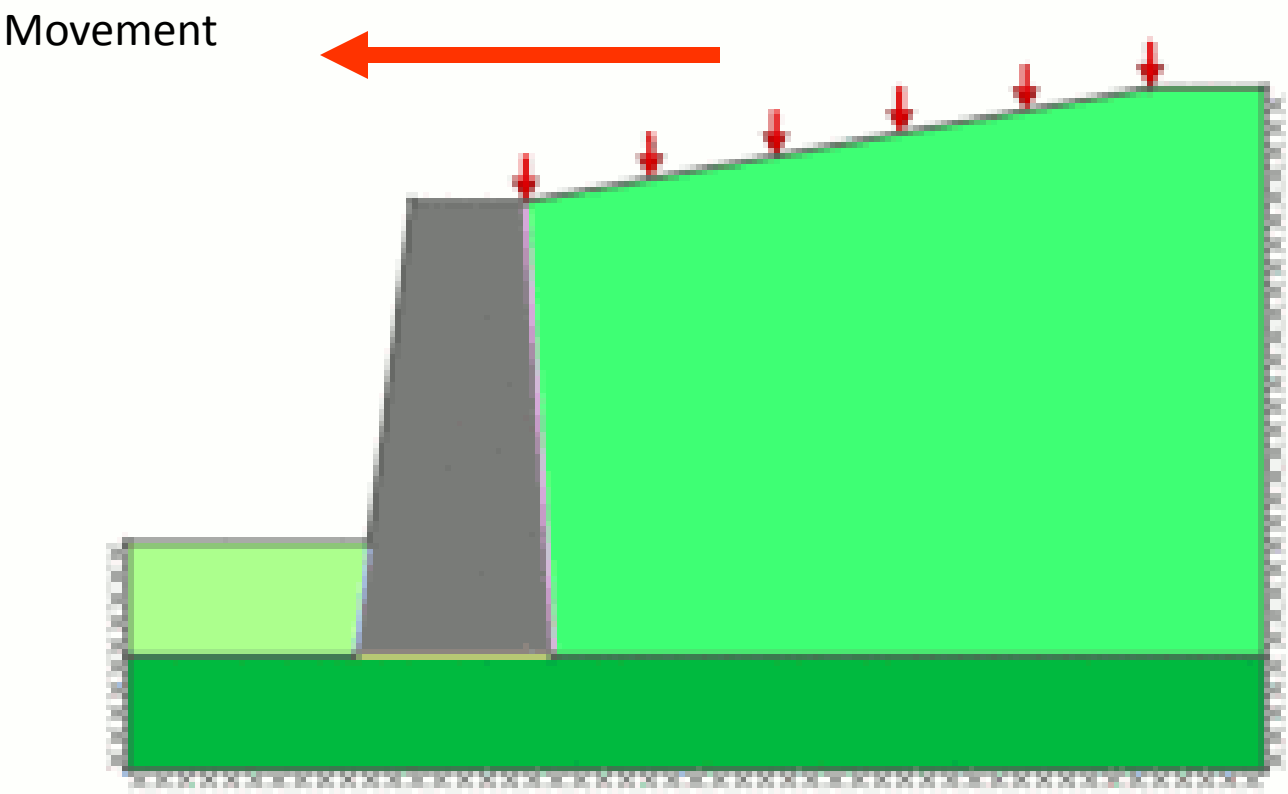
COMPONENTS OF R.E.

Traditional
Earth Reinforcement

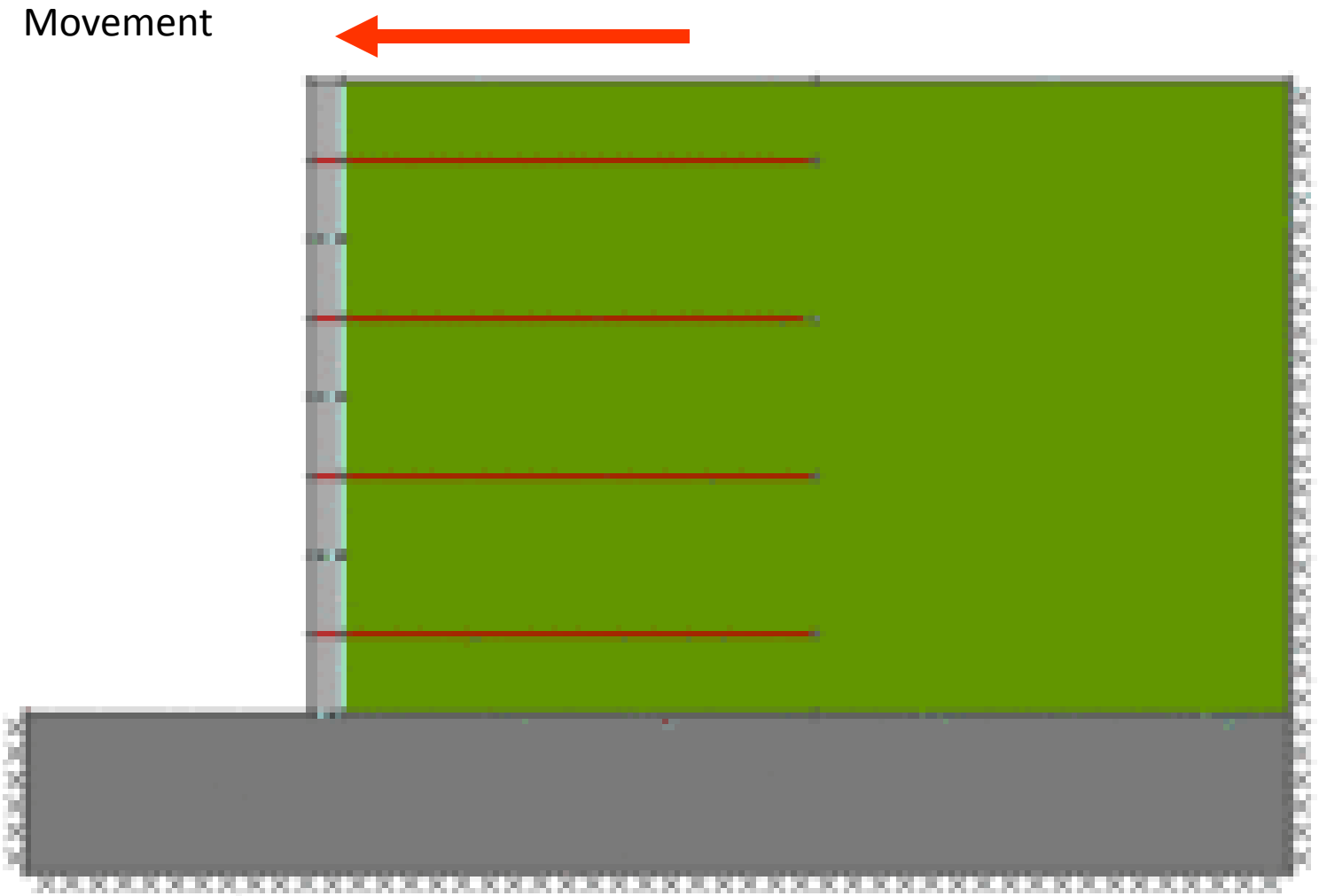


Modern Earth Reinforcement

Animations of Gravity wall Slipping



Animations of Reinforced Earth wall Face failure



MATERIAL SELECTION

1. SOIL

- **Development of sufficient friction between earth and reinforcement.**
- **No interstitial pore water pressure develops within the reinforced earth structures**
- **The placing and compaction of the earth fill layers can be accomplished easily**
- **The soil must conform to certain electro-chemical conditions to avoid corrosion**

- The backfill should be from non-organic soils such as sand and Gravel which are not affected by biological activity.
- Have good drainage.
- Primarily cohesion less soils are used.

MATERIAL SELECTION:
Requirements of Reinforcement For R.E.

- Reinforced members are composed of thin wide strips also called ties.
- Should be flexible to ease placement.
- Should have adequate tensile strengths.
- Should have adequate service life taking in to account corrosion and weathering.

MATERIAL SELECTION:
3. REINFORCING STRIPS/MATERIAL

- **Based on electro-chemical properties of back fill.**
- **Can be chosen from metal, geo-synthetics etc based on durability criteria.**
- **Select fixtures accordingly used to connect strips to the facing elements.**

MATERIAL SELECTION:
4. FACING ELEMENTS (outer skin)

- **Should retain the back fill between the layers of reinforcements.**
- **Made of either metal units or precast concrete panels.**
- **It should be able to deform without distortion.**

- Can be chosen from metal and concrete.
- Based on durability and stability criteria.
- Aesthetics can be equally important when used in urban areas.

Types of Reinforcement Material (wall facing & Reinforcing elements

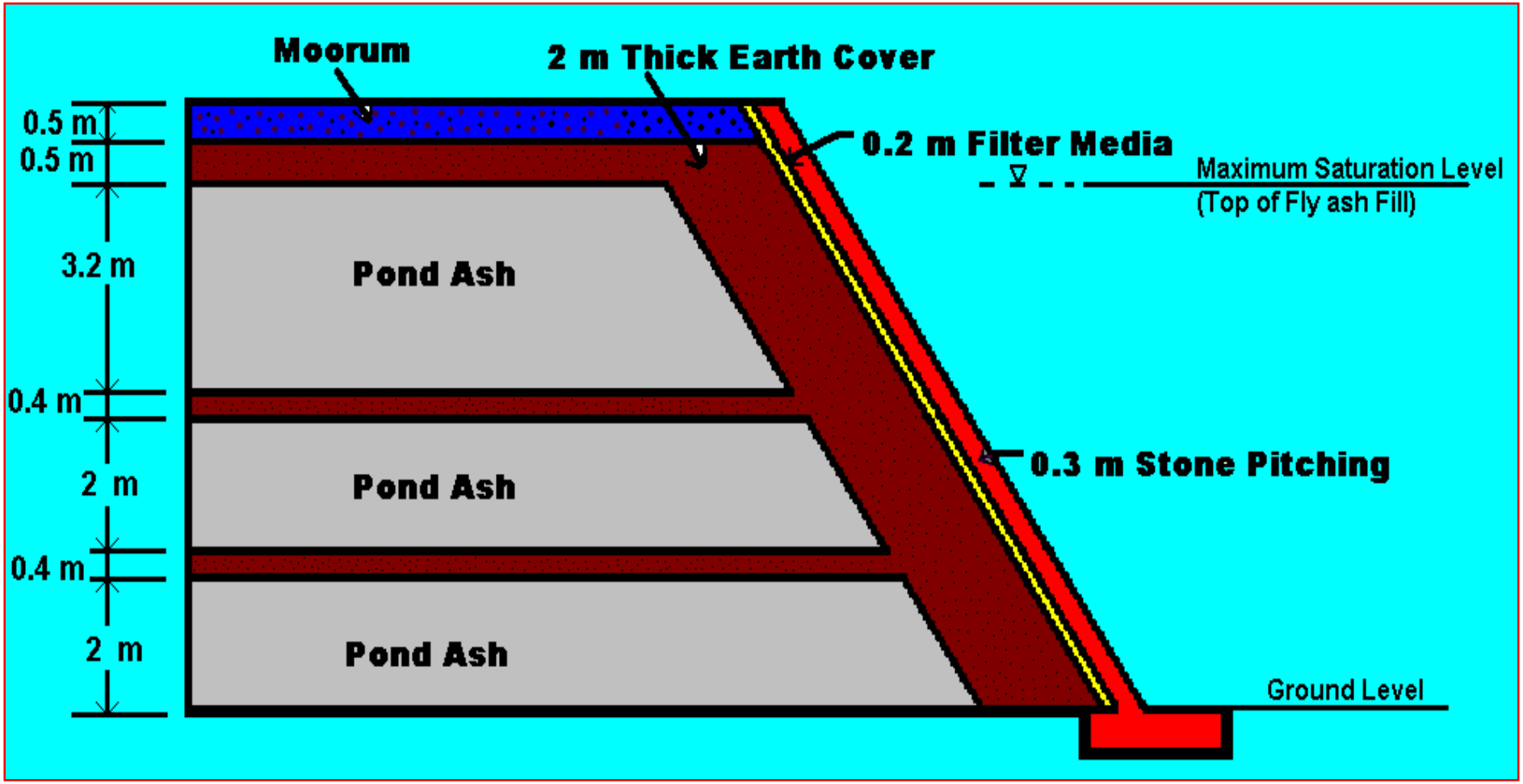
Wall Facing Elements

- **Steel**
- **Aluminum**
- **Plastic**
- **Fibre**
- **Glass**
- **Reinforced Concrete**
- **Used Rubber**

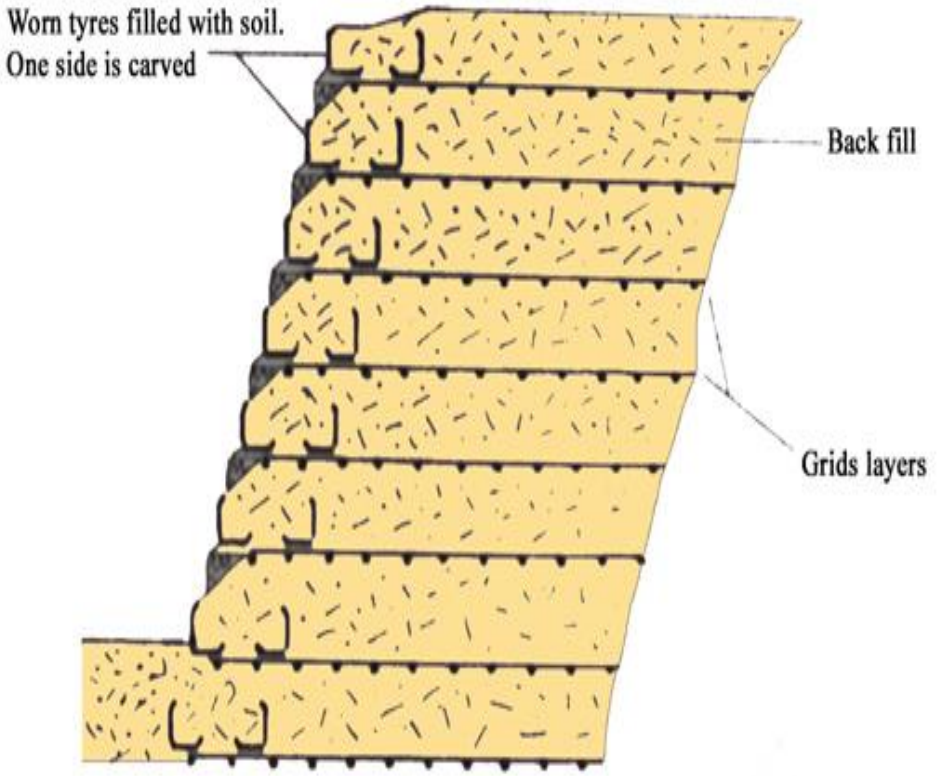
Reinforcing Elements

- Rods of galvanized steel
- Strips/rods Stainless steel/Aluminum
- Fibre glass strips
- Galvanzed iron grids
- Glass-fibre Reinforced plastics (GRP)
- Bamboos
- Geo-synthetic reinforcement like Geo-textiles, Geo-grids Geo-strips, Geo-fabrics

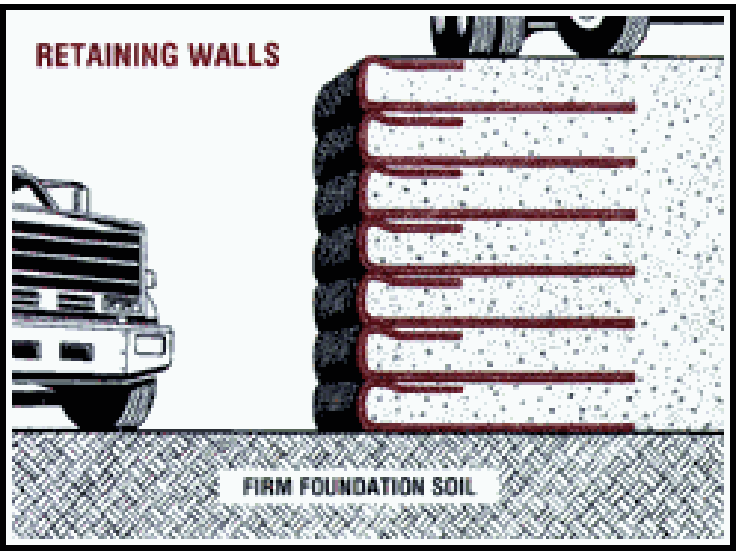
Approach embankment for second Nizamuddin bridge at Delhi



Worn out Tyres with soil as facing Element in an reinforced Earth fill



Okhla flyover approach embankment



Facing panels

medium

Geogrids

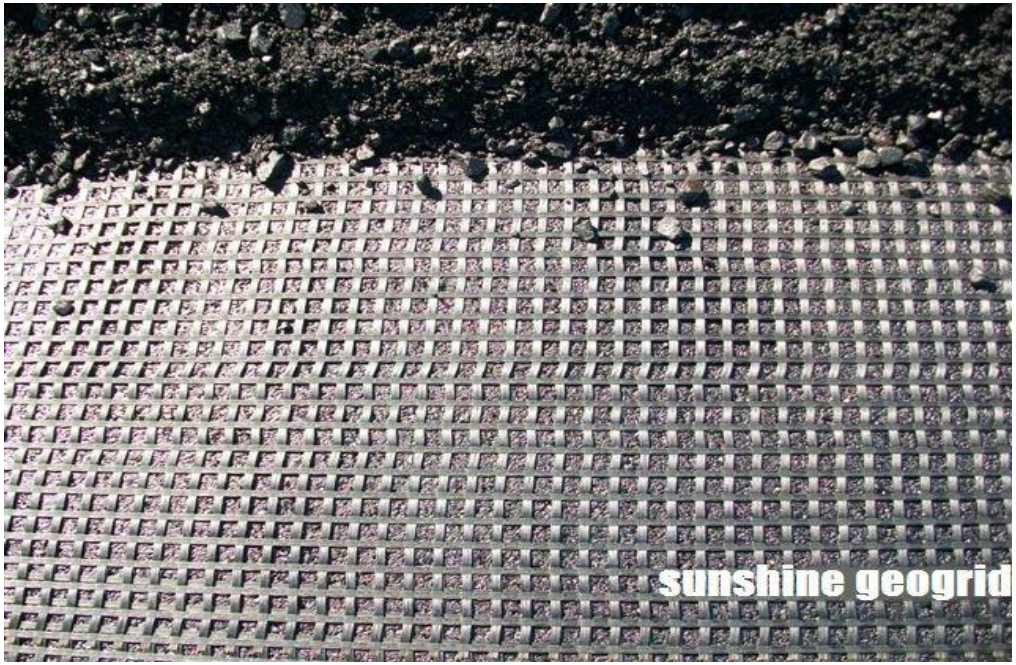
Pond Ash Fill

7.8 to 5.9 m

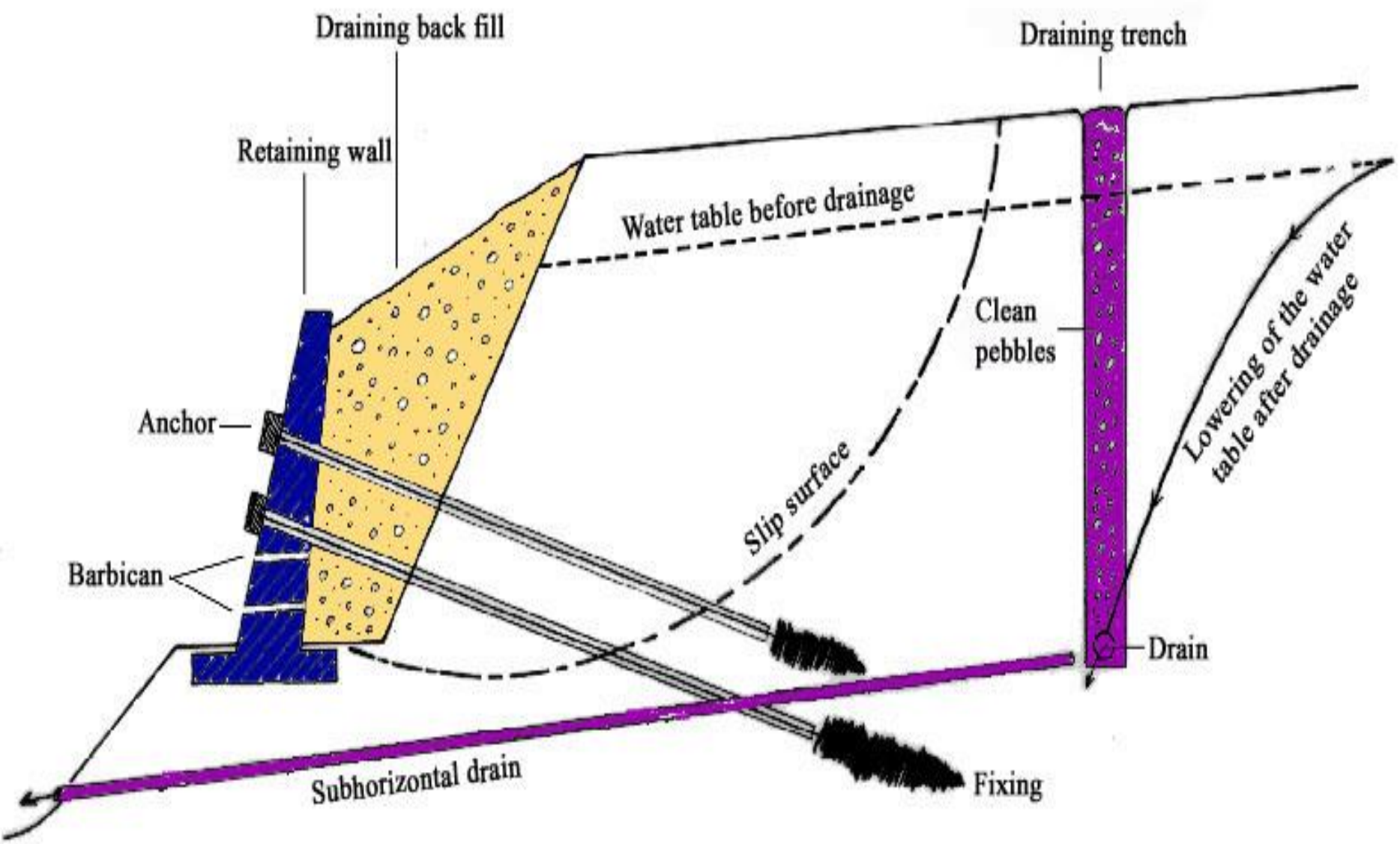
Reinforced foundation mattress of bottom ash

Steel Trip Reinforcement

Galvanized Iron Geo-grid



Combination Drainage and Earth Reinforcement Techniques for Ground Improvement



Requisite Properties

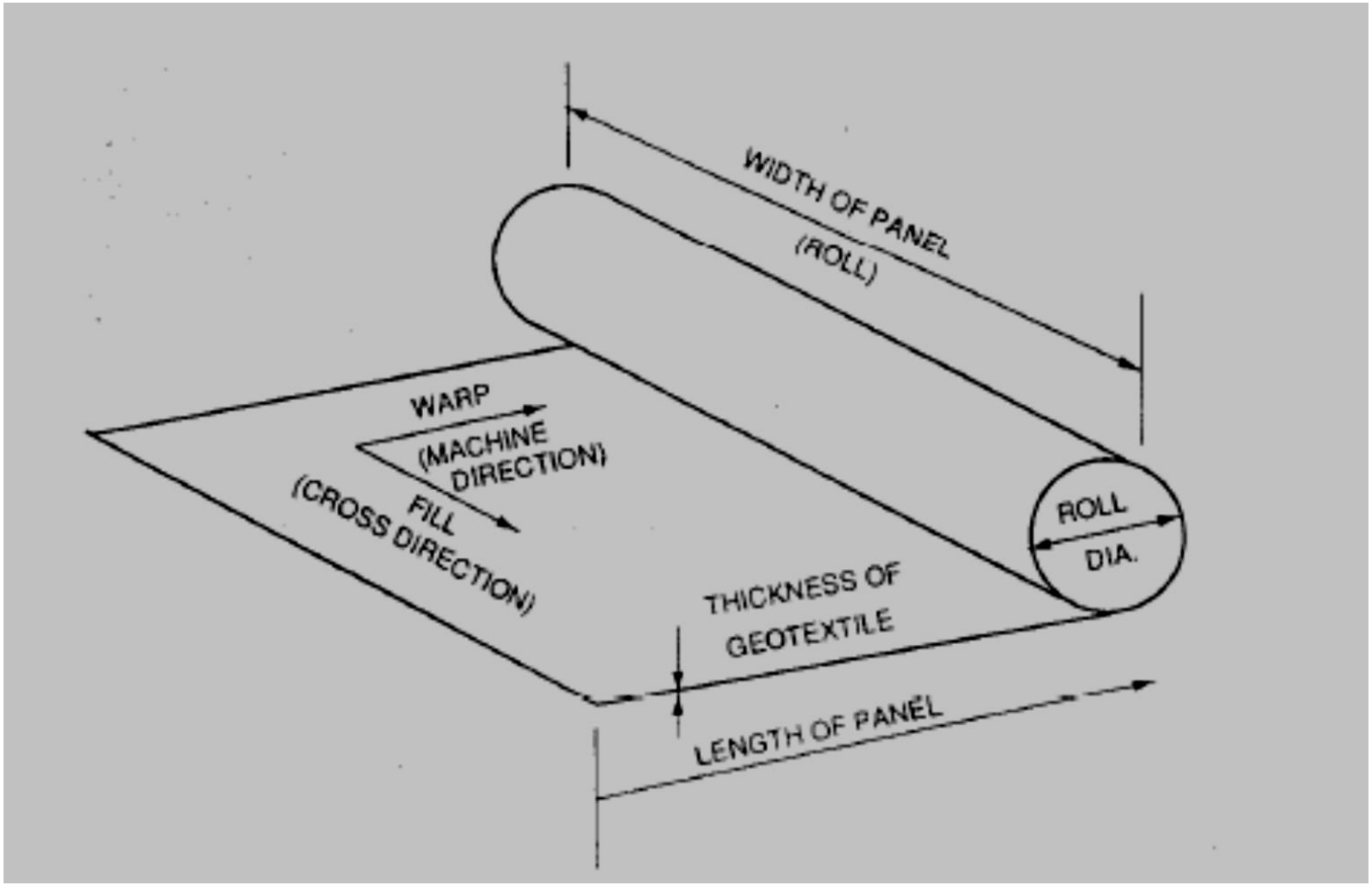
- It must be tough enough to withstand rigorous placement during installation process –tensile strength, shear strength, resistance to ultra violet light

- It must be strong and tough enough to withstand static & dynamic loads burst strength, puncture strength, abrasion resistance, elongation at failures

- It must be resistant to excessive clogging or blending permeability.

- It must be resistant to rot. Insects and rodents and to chemicals & diesel fuel.

Dimensions and Directions of Woven Textile



Wall reinforced material fiberglass mesh to be used in soil for Geo-reinforcement

Exposure to sunlight degrades the physical properties of polymers. The rate of degradation is reduced by the addition of carbon black but not eliminated.

Geo-fabrics and Geo-synthetics

used for reinforcement, separation, filtration and drainage in roads, retaining walls, embankments…

Geo-fabrics and Geo-synthetics used on Pacific Highway

Use of Geo-textile for Filtration

The use of Geotextiles in filter applications is probably the oldest. In this application, the Geotextile is placed in contact with and down gradient of soil to be drained. Geotextile filter must allow water (or gas) to pass without significant build-up of hydrostatic pressure.

1. **The plane of the Geotextile is normal to the expected direction of water flow. The capacity for flow of water normal to the plane of the Geotextile is referred to as permittivity.**

2. **Water and any particles suspended in the water which are smaller than a given size, flow or pass through the Geotextile. Those soil particles larger than that size are stopped and prevented from being carried away.**

3. **The geotextiles substitute serve the same function as the traditional granular filter.**

4, **A geotextile-lined drainage trench along the edge of a road pavement is an example using a geotextile as a filter.**

5. **Slit film Geotextiles are not preferred because opening sizes are unpredictable. Long term clogging is a concern when used for filtration.**

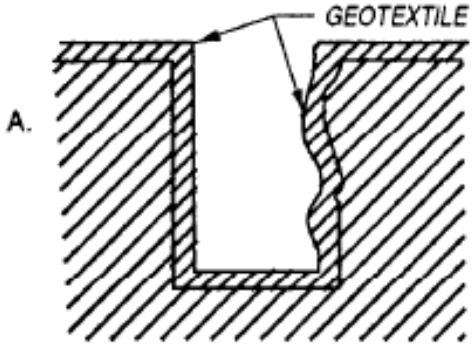
Use of Geo-textile for Drainage

- When functioning as a drain, a Geotextile acts as a conduit for the movement of liquids or gases in the plane of the Geotextile.

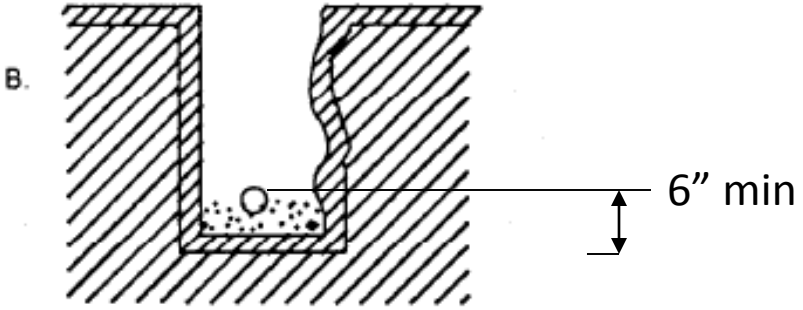
- Examples are Geotextile used as wick drains and blanket drains. The relatively thick non-woven Geo-textiles are the products most commonly used.

- Selection should be based on transmissivity, which is the capacity for in-plane flow.

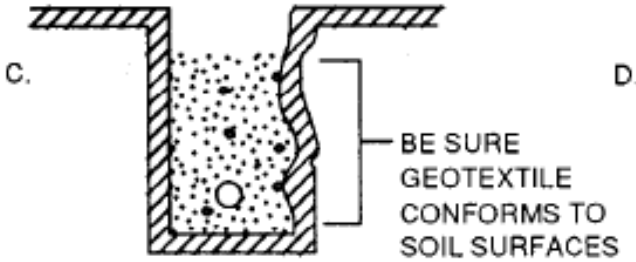
Fig. Trench Drain Construction with Geotextile



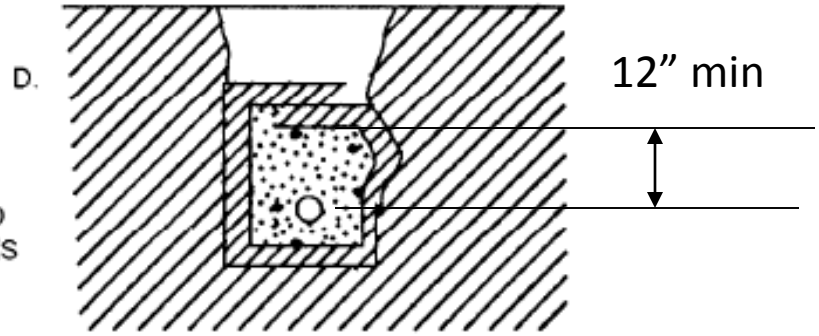
TRENCH EXCAVATED AND GEOTEXTILE PLACED TO INSURE INTIMATE CONTACT WITH SOIL SURFACES AND THAT PROPER OVERLAP WILL BE AVAILABLE AFTER BACK-FILLING



BEDDING (USUALLY 6-INCH MINIMUM) AND COLLECTOR PIPE PLACED (IF PIPE IS REQUIRED)

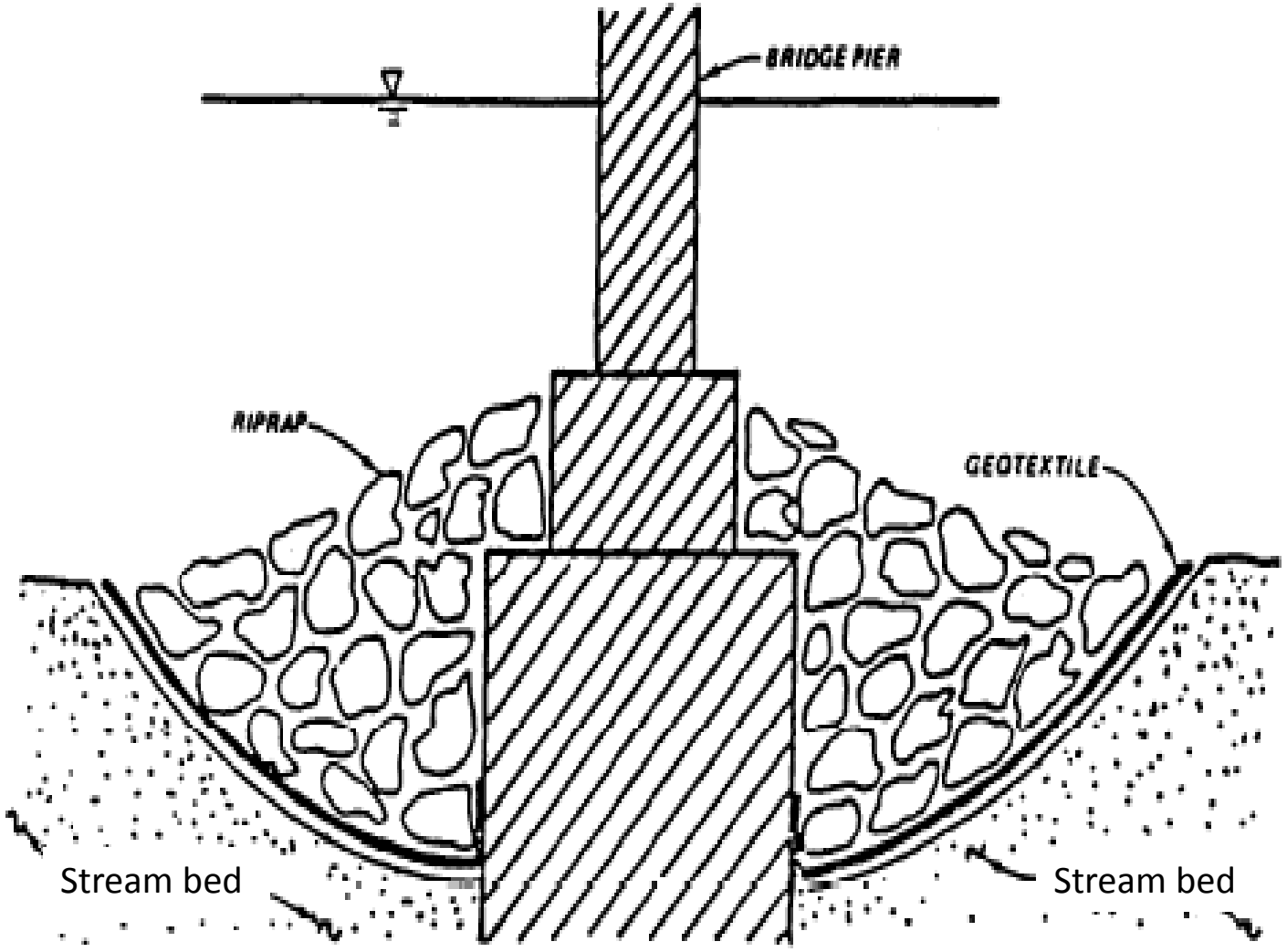


REMAINDER OF BACKFILL PLACED AND COMPACTED AS REQUIRED TO PRODUCE COM-PATIBLE STRENGTH AND CONSOLIDATION WITH SUR-ROUNDING SOIL AND STRUCTURES



GEOTEXTILE SECURELY OVER-LAPPED (USUALLY 12-INCH MINIMUM) ABOVE BACKFILL SO SOIL INFILTRATION IS PREVENTED. COVER MATE-RIAL PLACED AND COMPACTED

Fig. Geotextile Scour Protection for Bridge Pier



SCOUR PROTECTION FOR BRIDGE PIER

Use of Geo-textile for Separation

- **Separation is the process of preventing two dissimilar materials from mixing. In this function, a Geotextile is most often required to prevent the undesirable mixing of fill and natural soils or two different types of fills.**

- **A Geotextile can be placed between a railroad sub-grade and track ballast to prevent contamination and resulting strength loss of the ballast by intrusion of the sub-grade soil.**

- **In construction of roads over soft soil, a Geotextile can be placed over the soft sub-grade, and then gravel or crushed stone placed on the Geotextile. The Geotextile prevents mixing of the two materials.**

Use of Geo-textile for Pavement Applications

- **Geotextile for asphalt concrete (AC) overlays on roads and airfields and the separation and reinforcement of materials in new construction.**

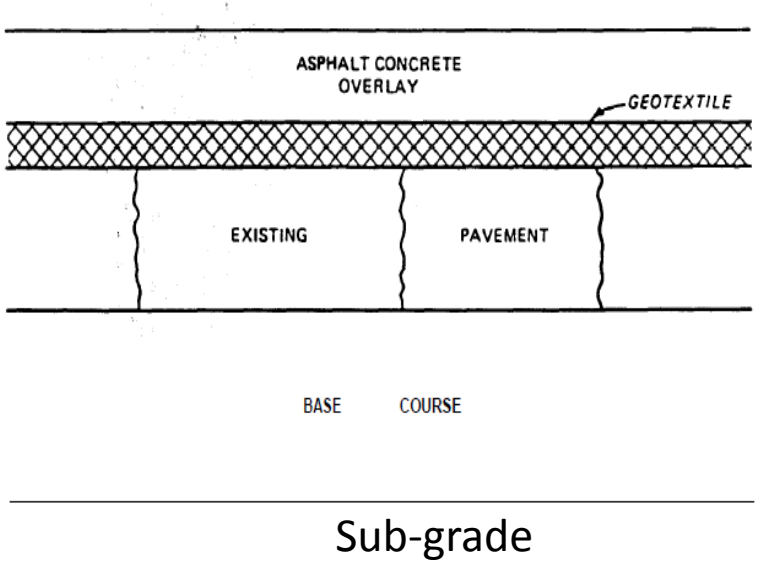


Fig. Geotextile in AC Overlays

ROCK BOLTS

Soil Nailing

- The fundamental concept of soil nailing consists of reinforcing the ground by passive inclusions, closely spaced, to create in-situ a coherent gravity structure and thereby to increase the overall shear strength of the in-situ soil and restrain its displacements.