

Soil Stabilisation



What is Soil Stabilisation

Soil stabilisation is the process of improving the physical properties of soil to enhance its strength, load-bearing capacity, durability, and overall performance for construction and engineering purposes.



What is Soil Stabilisation

This is achieved by altering the soil's structure, composition, or moisture content through **mechanical**, **chemical**, or **biological** methods.



What is Soil Stabilisation

The primary goal of soil stabilisation is to create a stable, firm base that can support buildings, roads, embankments, and other structures with reduced risk of settlement, erosion, or deformation over time.



Why do we need to stabilise soil?

Inadequate soil strength

- The bearing capacity of a soil is dependent upon its physical characteristics – mineral composition; particle size, shape, and distribution; water content; and the confinement pressure.



Why do we need to stabilise soil?

Excessive soil settlement

- Soil will deform and compress under load at the surface, the effect of this is settlement.
- The soil type, arrangement of particles and the degree of saturation will determine the amount of settlement.



Mechanical Soil Stabilisation

- Involves manipulating the soil particles through physical means.
- Mechanical stabilisation is commonly used in road construction, foundation work, and other infrastructure projects where strong soil support is essential.



Compaction

- **Purpose:** Compaction reduces the voids between soil particles, which increases the soil's density and stability.



Compaction

- **Process:** Heavy machinery like rollers, compactors, or vibratory plates is used to compress soil layers to a desired density.



Compaction

- **Application:** Often used in road construction, embankments, and foundations to create a stable and firm base layer.



Soil Mixing

- **Purpose:** Mixing different soil types can help balance properties like particle size, cohesion, and permeability.



Soil Mixing

- **Process:** Engineers may combine coarse-grained soils (like sand and gravel) with fine-grained soils (like clay or silt) to optimise stability.



Soil Mixing

- **Application:** Useful in situations where the native soil alone lacks the right properties for construction, such as areas with loose sandy soils or high-clay content soils.



Dynamic Compaction

- **Purpose:** This technique involves using large weights dropped repeatedly on the soil to compact it, increasing density at deeper soil levels



Dynamic Compaction

- **Process:** Weights (often as heavy as several tons) are dropped from a height to transfer energy into deeper soil layers, compacting them.



Dynamic Compaction

- **Application:** Primarily used for stabilising loose, granular soils where standard surface compaction might not reach the necessary depth.



Vibro-Compaction

- **Purpose:** Vibro-compaction uses vibration to rearrange soil particles, particularly effective in granular soils.



Vibro-Compaction

- **Process:** Specialised equipment like vibro-compactors or vibro-floats penetrate the soil and emit vibrations that reduce air gaps, increasing stability.



Vibro-Compaction

- **Application:** Commonly used in sandy soils or loose, granular materials where traditional compaction might be insufficient.



Mechanical Soil Stabilisation - Advantages



Mechanical Soil Stabilisation - Advantages

- **Cost-Effective**
- **Environmentally Friendly**
- **Increased Load-Bearing Capacity**
- **Versatile**



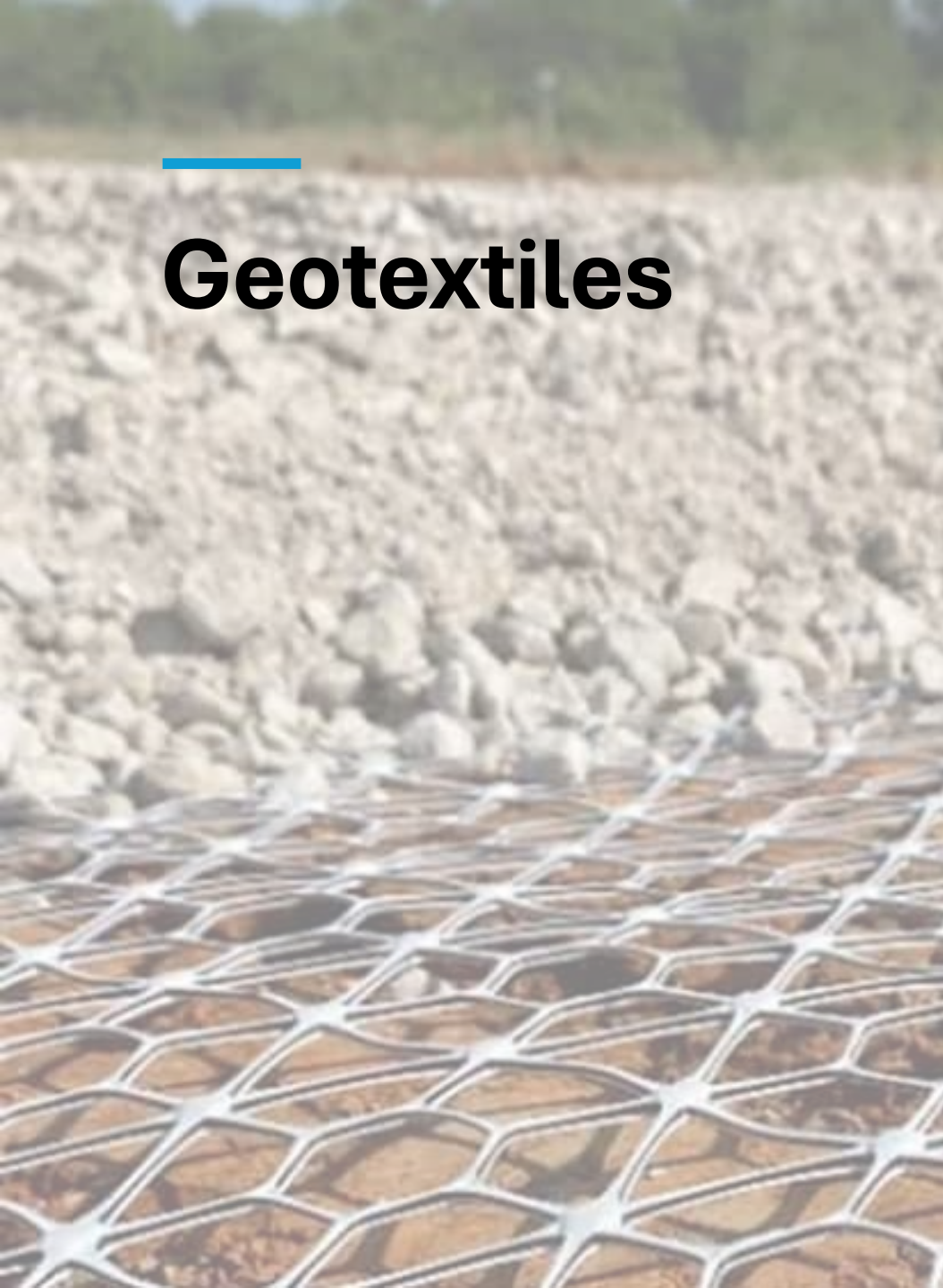
Mechanical Soil Stabilisation - Disadvantages



Mechanical Soil Stabilisation - Disadvantages

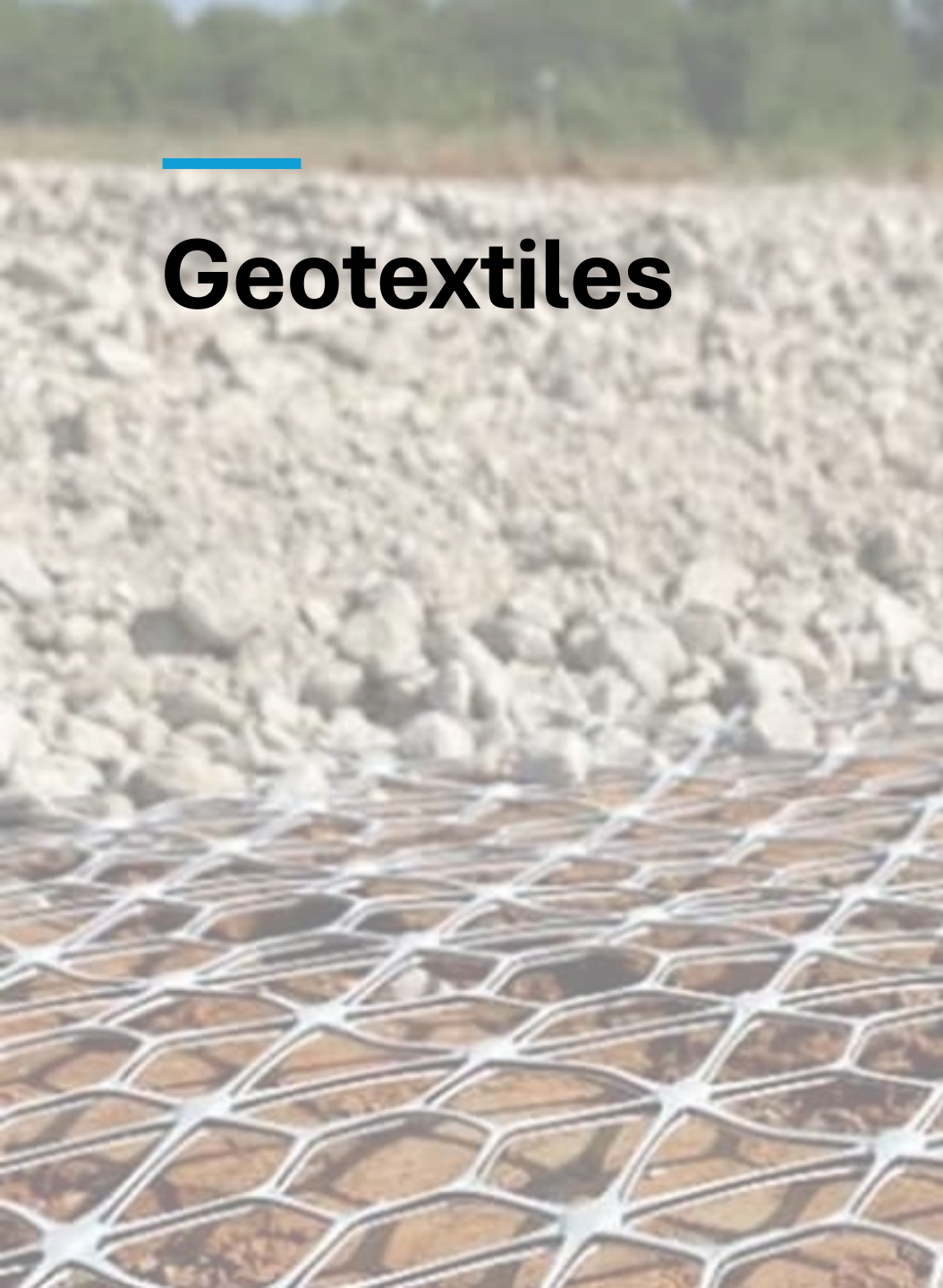
- **Limited to Certain Soil Types**
- **Heavy Equipment Requirements**
- **Depth Limitation**





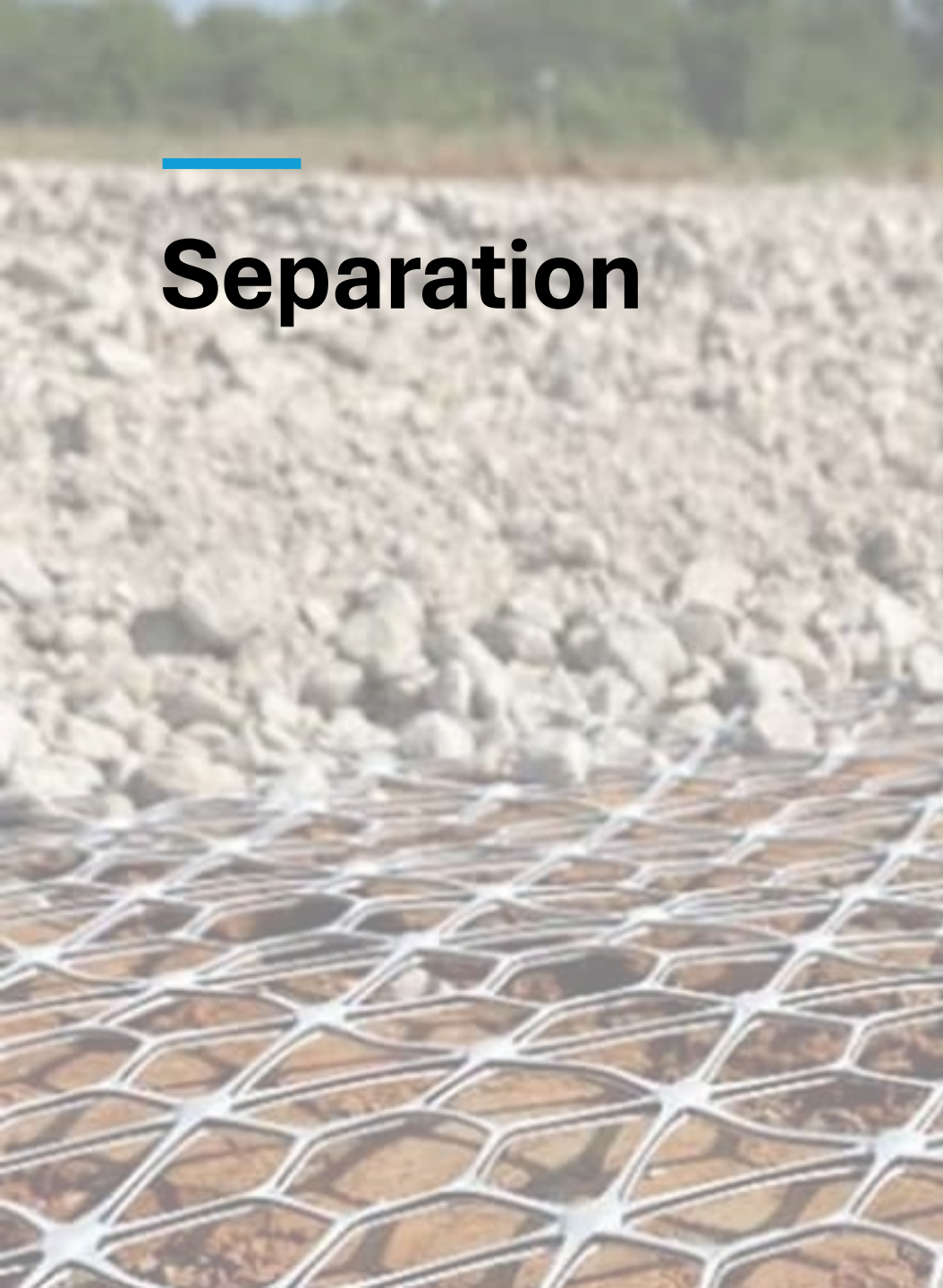
Geotextiles

- Soil stabilisation using geotextiles is a technique where synthetic fabrics, called geotextiles, are integrated into the soil

The background image shows a close-up of a geotextile mesh, which is a white, diamond-shaped grid. This mesh is used to separate a layer of light-colored gravel on top from a layer of brown soil or sand underneath. The gravel is piled up, and the mesh is visible as a distinct boundary between the two materials.

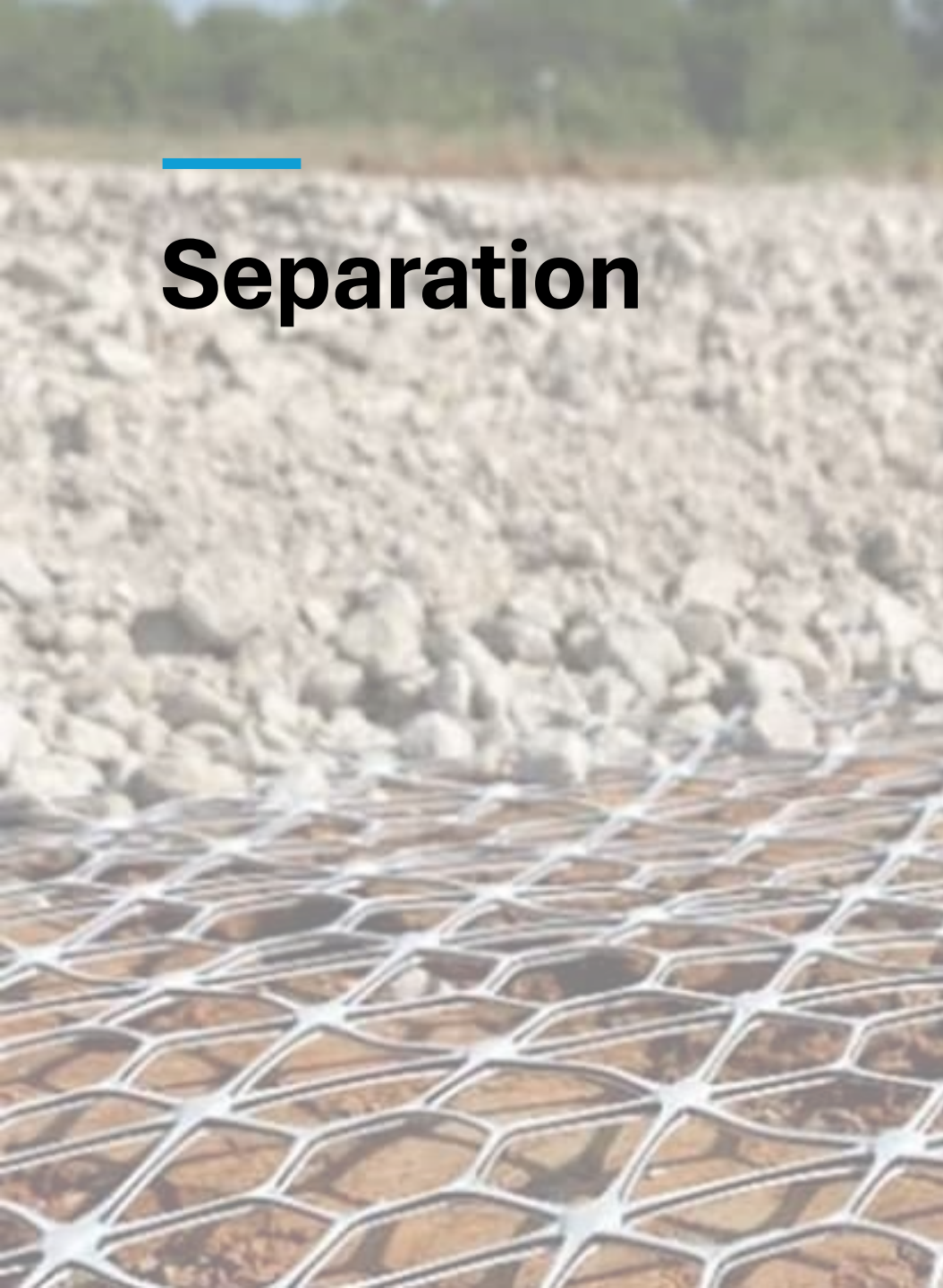
Geotextiles

- These geotextiles are made from permeable materials, such as polypropylene or polyester, which provide separation, reinforcement, filtration, and drainage functions, improving soil performance under loads.



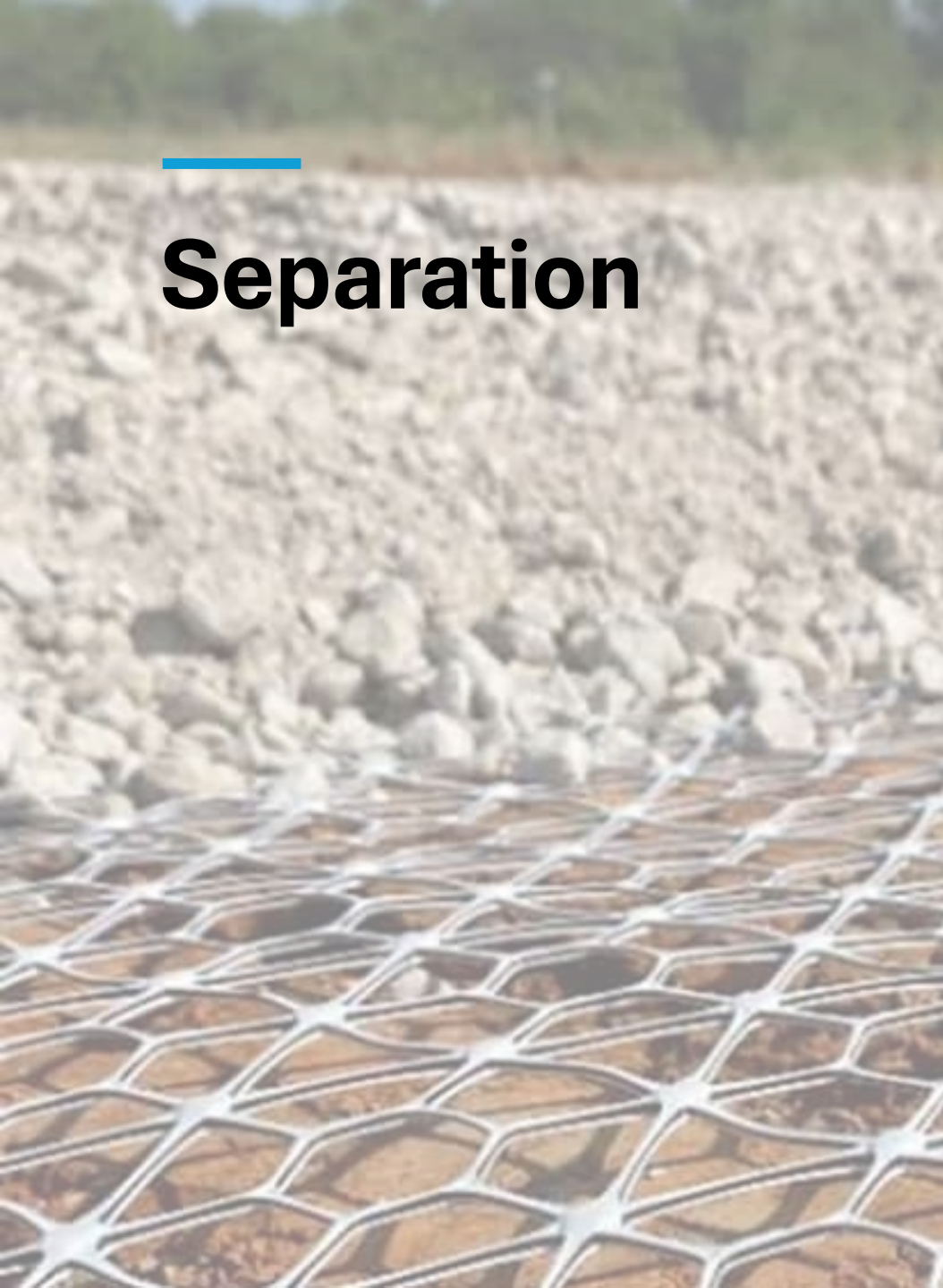
Separation

- **Purpose:** Geotextiles act as a barrier, preventing the mixing of different soil layers, such as subgrade and base materials.



Separation

- **Function:** This separation maintains the integrity of each layer, preventing weak soils from contaminating stronger base layers and vice versa.



Separation

- **Application:** Commonly used in road construction to separate subgrade from the aggregate base layer, preserving the road structure and preventing rutting and deformation.



Reinforcement

- **Purpose:** Geotextiles add tensile strength to the soil, helping it withstand greater loads and reducing deformation.



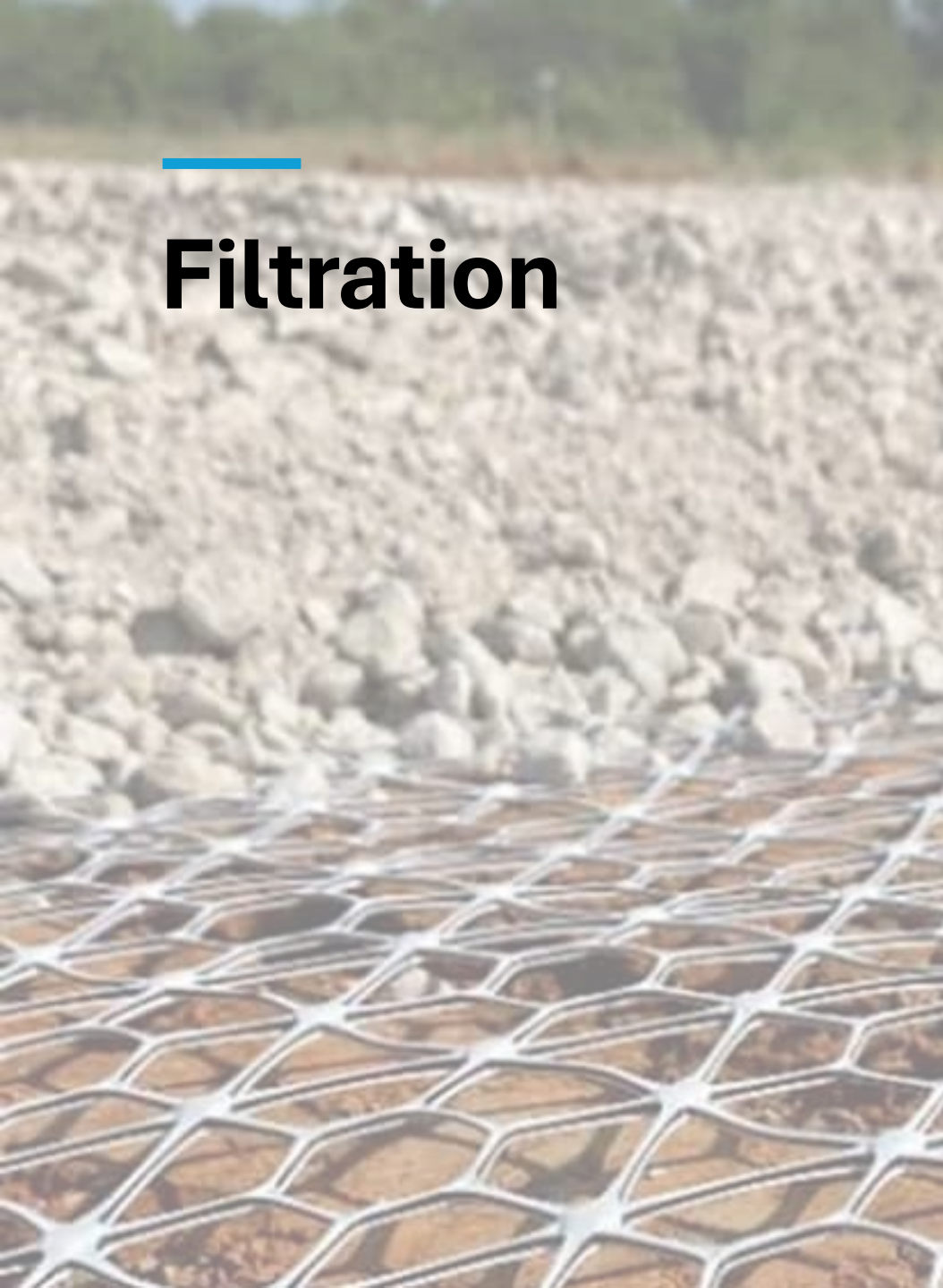
Reinforcement

- **Function:** When soil is loaded, the geotextile acts as a reinforcement layer, distributing the load across a wider area and reducing settlement.

The background image shows a close-up of a stone wall or embankment. A white, diamond-shaped geotextile mesh is overlaid on the lower portion of the image, illustrating its application in reinforcement. The mesh is made of a woven material, likely polypropylene, and is designed to hold soil in place while allowing water to drain. The stones are light-colored and irregularly shaped. The overall scene is outdoors, with some greenery visible in the background.

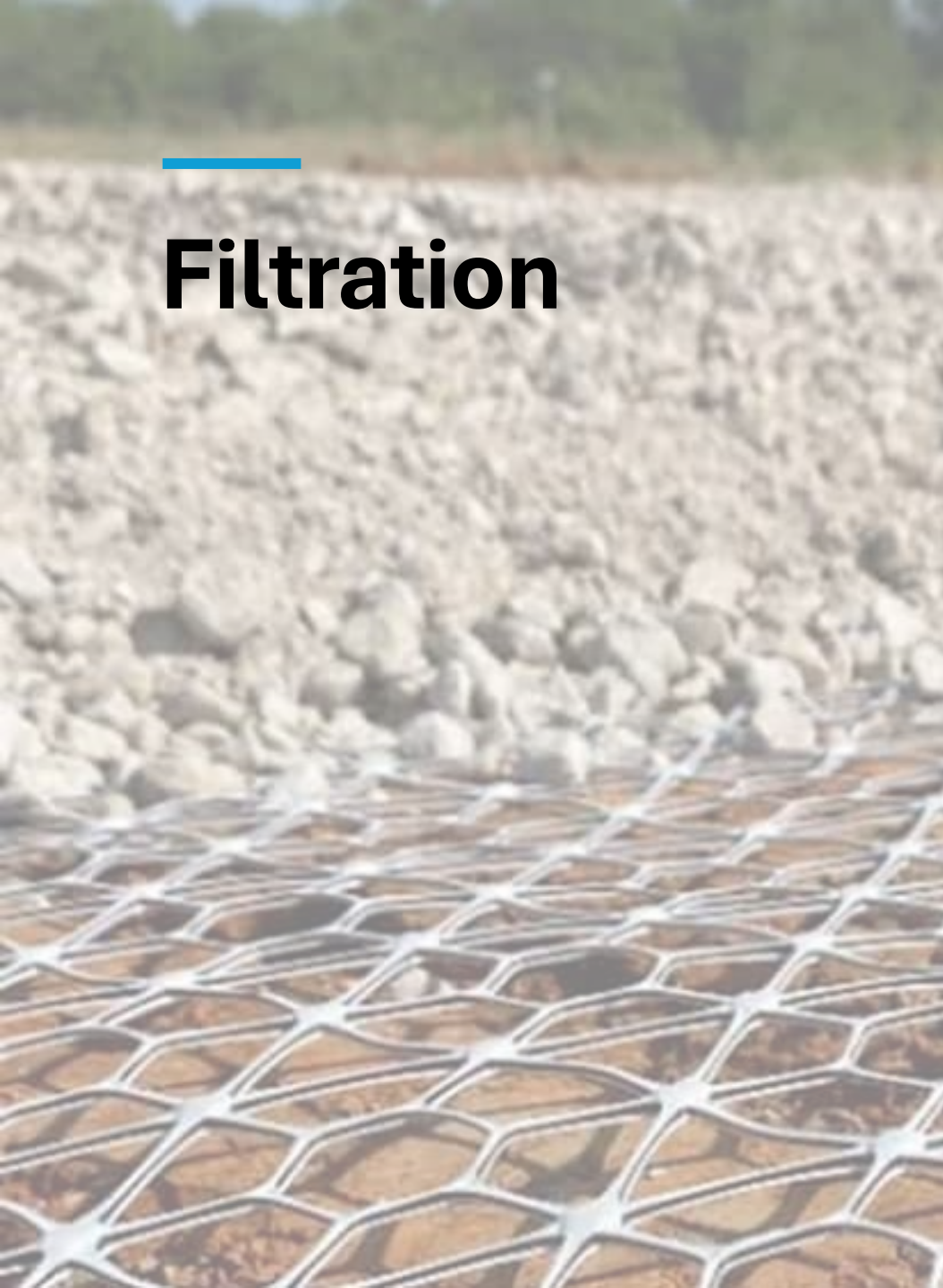
Reinforcement

- **Application:** Used in slopes, embankments, retaining walls, and load-bearing foundations, where geotextiles help to improve stability and load distribution.

The background image shows a cross-section of a drainage system. In the foreground, there is a white, diamond-shaped geotextile filter fabric. Above this fabric is a layer of brown soil. Above the soil is a thick layer of light-colored, irregularly shaped stones or gravel. The top of the image shows a blurred green landscape.

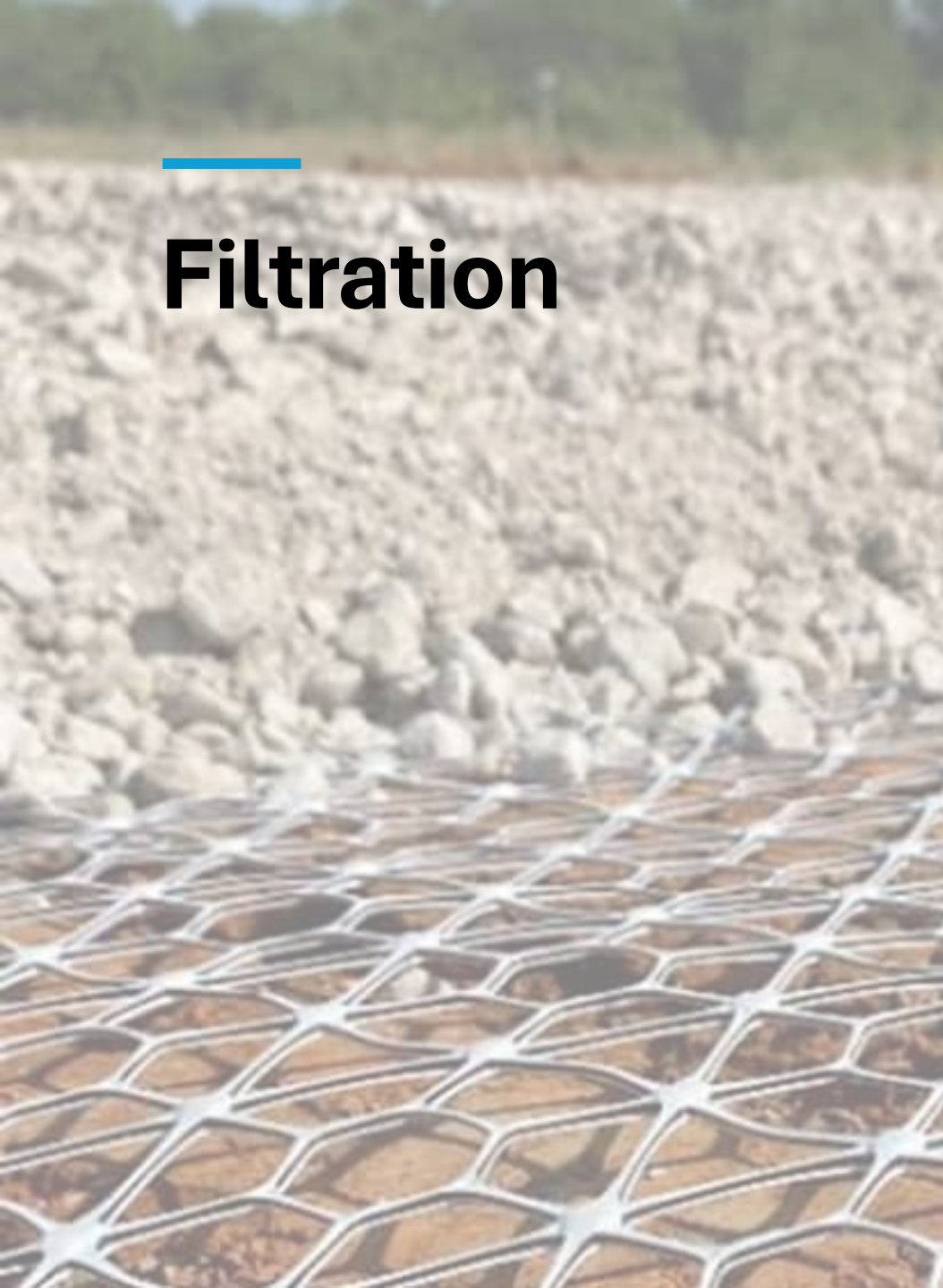
Filtration

- **Purpose:** Geotextiles allow water to pass through while preventing soil particles from migrating, preserving soil structure and preventing erosion.



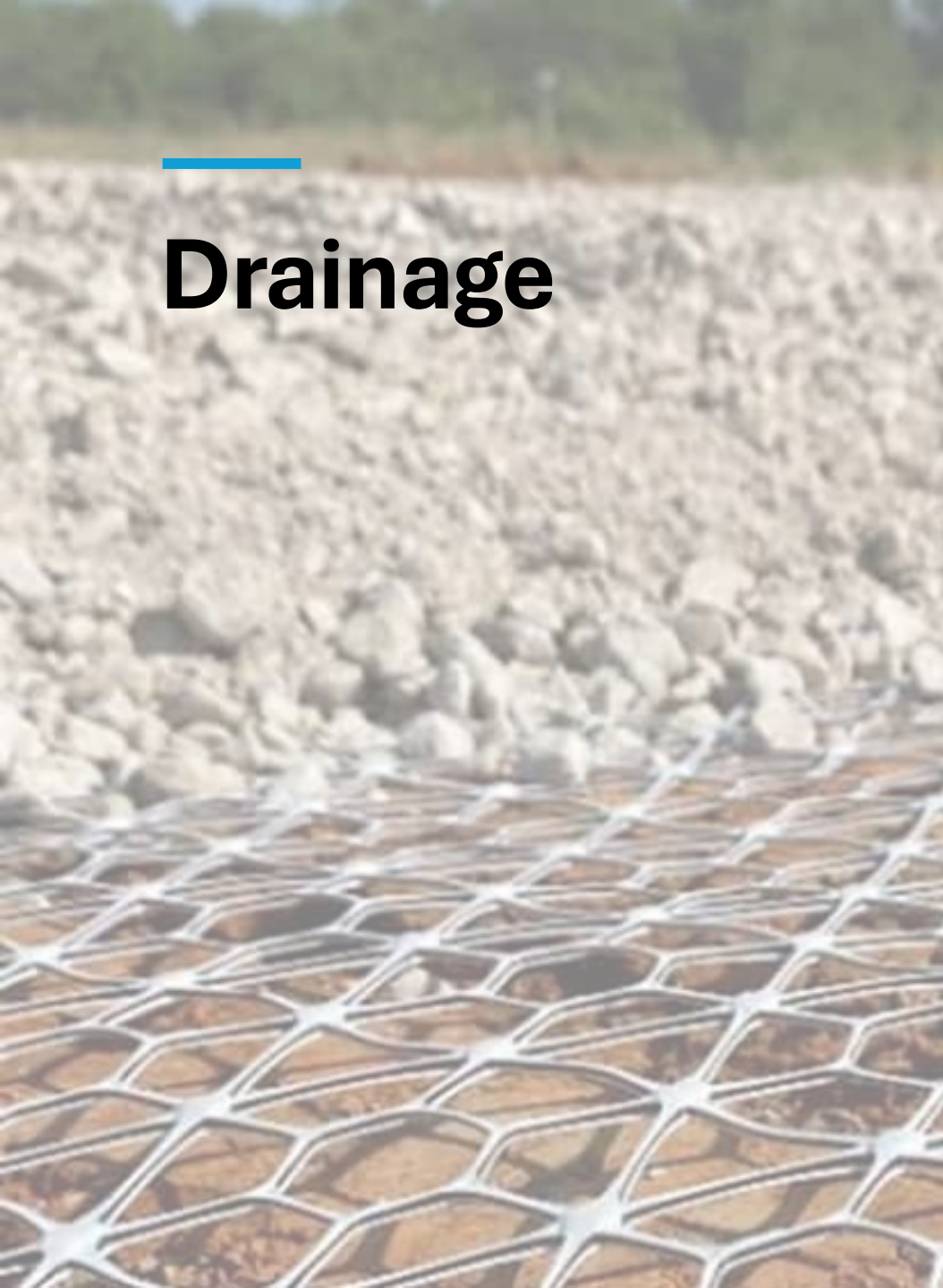
Filtration

- **Function:** By acting as a filter, geotextiles stop soil erosion and maintain soil compaction, which is essential for drainage systems and slopes.



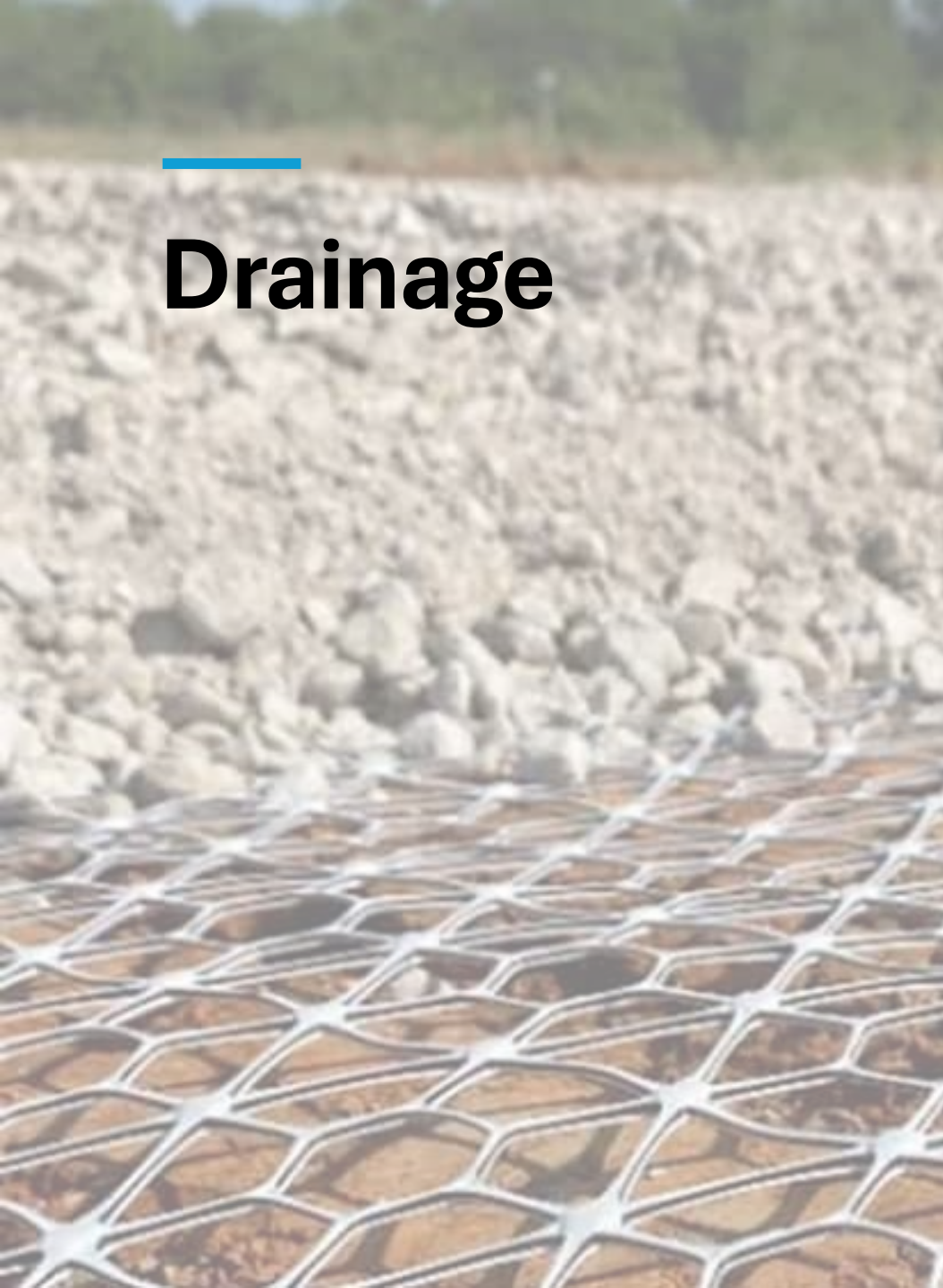
Filtration

- **Application:** Often used in drainage layers, around drainage pipes, or on slopes to control surface and subsurface water flow without allowing soil to wash away.



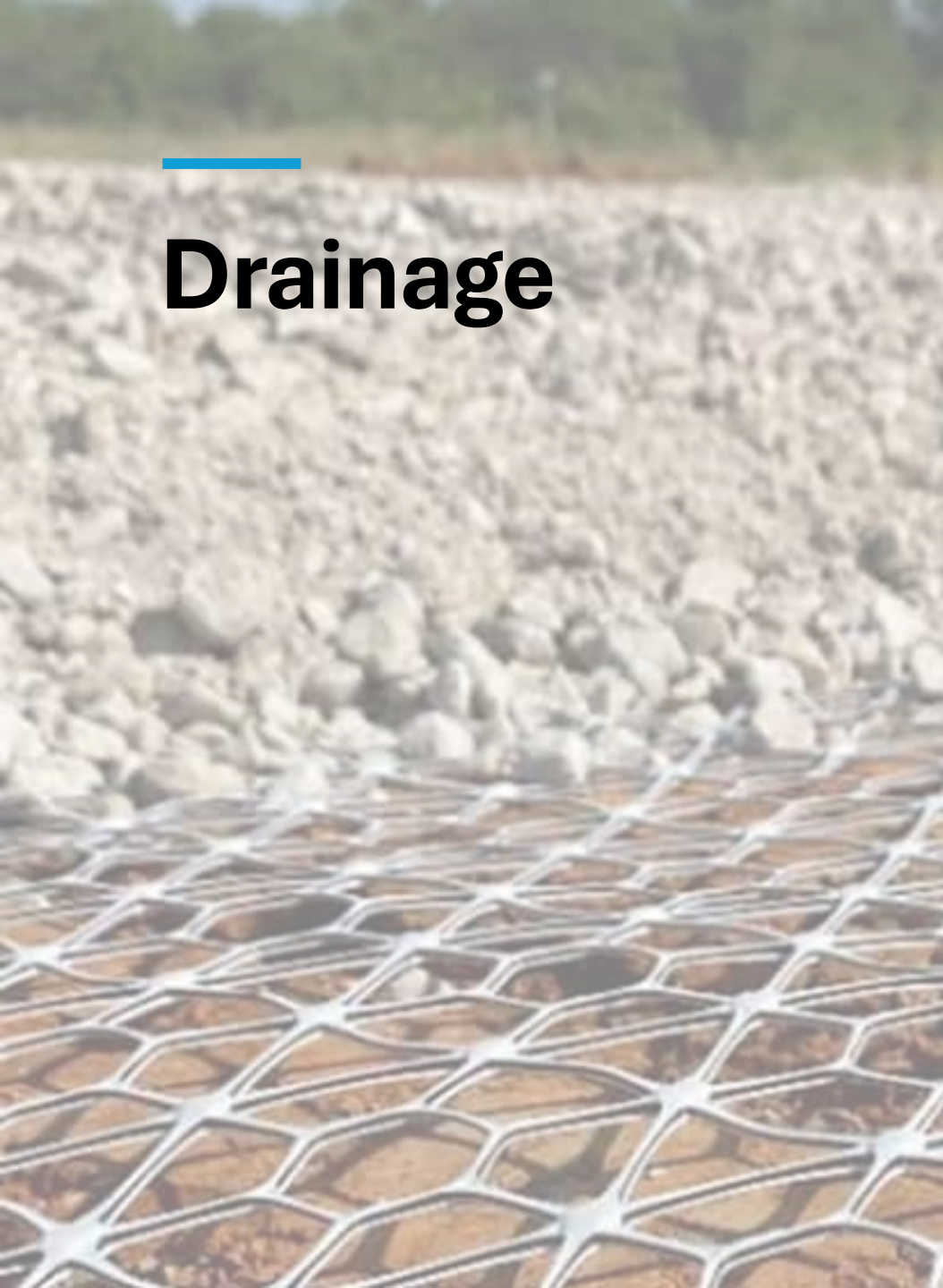
Drainage

- **Purpose:** Geotextiles facilitate drainage by providing a channel for water flow within or across soil layers.



Drainage

- **Function:** With a high permeability, geotextiles help manage water movement, reducing the hydrostatic pressure that can destabilise structures like retaining walls or road bases.



Drainage

- **Application:** Widely used in applications that require efficient water removal, such as under highways, around building foundations, and in green roofs.



Woven

- Made by weaving fibres together, they are strong and durable, providing excellent reinforcement.
- **Application:** Best suited for applications that need high tensile strength, such as roadways, retaining walls, and embankments.



Non Woven

- Made by bonding fibres together (usually via heat or needle-punching), they are softer and offer good filtration and drainage.
- **Application:** Often used in applications where filtration and separation are key, such as drainage systems and erosion control.



Knitted

- Made by interlocking loops of yarn, they offer flexibility and resilience.
- **Application:** Suitable for applications that need flexibility, often used in slope stabilisation and where soil movement is expected.



Geotextiles - Advantages



Geotextiles - Advantages

- **Enhanced Load Distribution**
- **Reduced Soil Erosion**
- **Increased Longevity**
- **Environmental Adaptability**
- **Easy Installation:**

The background of the slide is a photograph of a geotextile mesh installed on a slope. The mesh is a white, diamond-shaped grid that covers the lower portion of the slope, which is covered in brown soil. Above the mesh, the slope is covered in light-colored, irregularly shaped rocks. The top of the image shows a blurred green landscape under a clear sky.

Geotextiles - Disadvantages



Geotextiles - Disadvantages

- **Susceptibility to damage**
- **Limited effectiveness in certain soil types**
- **Degradation due to UV exposure**
- **High Cost**
- **Susceptible to chemical or biological degradation**

Chemical Soil Stabilisation

- Chemical soil stabilisation is a process in which chemical additives are mixed into soil to improve its properties, making it more suitable for construction and increasing its strength, stability, and durability.
- This technique is especially useful for soils with high clay content or expansive soils, which can swell or shrink with moisture changes.





Lime Stabilisation

- **Purpose:** Lime is widely used to stabilise soils with high clay content by reducing plasticity and swelling potential.



Lime Stabilisation

- **Process:** Lime is spread over the soil surface and then mixed in thoroughly, often using a rotary mixer. The calcium in lime reacts with clay particles, binding them together.



Lime Stabilisation

- **Application:** Frequently used in road construction and foundations where expansive soils are present.



Cement Stabilisation

- **Purpose:** Cement improves the compressive strength of soil by acting as a binder, which solidifies the soil matrix.



Cement Stabilisation

- **Process:** Cement is mixed into the soil, creating a hardened layer as it hydrates. The mixture forms cementitious bonds that enhance stability.



Cement Stabilisation

- **Application:** Used in constructing bases for roads, runways, and embankments, particularly effective in granular and fine-grained soils.



Fly Ash Stabilisation

- **Purpose:** Fly ash, a byproduct of coal combustion, is used to reduce plasticity and improve load-bearing capacity.



Fly Ash Stabilisation

- **Process:** Class C fly ash (which contains more calcium) is commonly used. When mixed with soil and water, it reacts with soil particles to form a solid matrix.



Fly Ash Stabilisation

- **Application:** Used in soft or expansive soils, often in combination with other binders like lime or cement for enhanced effects.



Bitumen Stabilisation

- **Purpose:** Bitumen is an asphalt-based additive that improves soil waterproofing, reducing water permeability.



Bitumen Stabilisation

- **Process:** Bitumen is applied to soil particles, either as an emulsion or mixed in hot liquid form, creating a coating that binds particles together.



Bitumen Stabilisation

- **Application:** Commonly used in road construction for creating water-resistant layers, especially in areas prone to moisture.



Chemical Polymers and Synthetic Additives

- **Purpose:** Synthetic polymers and resins act as binding agents to improve soil strength, flexibility, and water resistance.



Chemical Polymers and Synthetic Additives

- **Process:** Polymers are typically applied as a liquid solution, mixed into the soil, and allowed to cure, forming a bonded soil matrix.



Chemical Polymers and Synthetic Additives

- **Application:** Used in infrastructure projects needing specific durability characteristics, such as roads, embankments, and sports fields.

Chemical Soil Stabilisation - Advantages



Chemical Soil Stabilisation - Advantages

- **Long-Term Stability**
- **Enhanced Load-Bearing Capacity**
- **Moisture and Frost Resistance**
- **Adaptability to Various Soil Types**



Chemical Soil Stabilisation - Disadvantages



Chemical Soil Stabilisation - Disadvantages

- **Cost**
- **Environmental Concerns**
- **Special Handling Requirements**
- **Long Curing Time**



Biological Soil Stabilisation

- Biological soil stabilisation is a technique that uses living organisms, like plants, microbes, or their by-products, to enhance soil strength, reduce erosion, and improve soil structure.



Biological Soil Stabilisation

- This environmentally friendly method leverages natural processes to bind soil particles, increase organic matter, and improve soil cohesion, making it particularly suitable for areas prone to erosion, like slopes, riverbanks, and construction sites.



Vegetation

- **Purpose:** Plant roots naturally stabilise soil by creating a dense network that binds soil particles and reduces erosion.



Vegetation

- **Process:** When plants grow, their roots extend into the soil, interlocking with particles and improving soil structure and cohesion. Above-ground vegetation, like grasses and shrubs, shields the soil from rain impact and wind erosion.



Vegetation

- **Application:** Often used for stabilising slopes, riverbanks, coastal areas, and areas prone to desertification. Grasses, trees, and shrubs are frequently planted for erosion control in these settings.



Extracellular Polymeric Substances

- **Purpose:** EPS bind soil particles, enhancing soil structure and moisture retention while being environmentally friendly.



Extracellular Polymeric Substances

- **Process:** EPS are produced by microorganisms such as bacteria, fungi, and algae, forming a sticky matrix around soil particles. This matrix creates a biofilm that encases soil particles, helping to hold them together and retain moisture.



Extracellular Polymeric Substances

- **Application:** Can be used for stabilising slopes, agricultural land, coastal and wetland areas.



Biological Soil Stabilisation - Advantages



Biological Soil Stabilisation - Advantages

- **Environmental Benefits**
- **Erosion Control**
- **Soil Health Improvement**
- **Cost-Effective:**



Biological Soil Stabilisation - Disadvantages



Biological Soil Stabilisation - Disadvantages

- **Time-Consuming**
- **Environmental Constraints**
- **Maintenance Requirements**
- **Limited Load-Bearing Capacity**

