WELCOME

TO
FOUNDATION ENGINEERING(66465)

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CHAPTER-2

Understand the soil stabilization.

- 2.1 State the meaning of soil stabilization.
- 2.2 Mention the various methods of soil stabilization.
- 2.3 Describe the process of addition and removal of soil particles for soil stabilization.
- 2.4 Describe the soil stabilization by drainage.
- 2.5 Describe the process of sand piling.
- 2.6 Describe the process of soil cement stabilization.

SOIL STABILISATION

SOIL STABILIZATION

- The improvement process under the situation when the influence zone is limited to less than 1m (roads etc.) is called **surface stabilization.**

- Geo-Technical process of improving the engineering properties of the soil (density, shear strength, C&O factors are improved while compressibility, settlement and permeability reduced) and making it more stable and durable is called **ground improvement.**

- Stabilising a soil implies the modification of the properties of a soil – water – air system in order to obtain lasting properties, which are compatible with a particular application. The parameters involved are:

- Properties of the soil to be stabilised
- Planned improvements
- Project economies
- Construction techniques
- Maintenance of the project
- **OBJECTIVES**
- Reducing the volume of voids = reducing the porosity.
- Filling the voids that cannot be eliminated = reducing the permeability.
- Increasing the bonding between grains = increasing the mechanical strength.
- **PROCEDURES**
- Mechanical – by compaction to reduce the porosity and increase the compressibility.
- Physical – by acting on its texture (e.g. the controlled mixing of different grain fractions).
- Chemical – by adding other materials or chemicals to modify its properties.

1.0 SURFACE STABILISATION

1. **MECHANICAL STABILIZATION**
2. **PHYSICAL STABILIZATION**
3. **CHEMICAL STABILIZATION**
4. **PHYSIO CHEMICAL STABILIZATION**

MECHANICAL STABILIZATION

- **In this technique mechanical energy is used (rollers, plate compactors, tampers etc. By choice or nature of soil) to improve the soil properties by compaction.**
- **Preferably for construction of embankment for roads, railways etc.**
- Mechanical stability depends upon the degree of compaction. Normally, the compaction is done at optimum water content.

Uses–

- Simplest method of soil stabilization.
- To improve the sub-grades of low bearing capacity.
- Extensively used for construction of bases, sub-bases and surfacing of roads.

Mechanical Stabilization Cont.

Factors Affecting the Mechanical Stabilization

The mechanical stability of the mixed soil depends upon the following factors.

(1) **Mechanical Strength of the Aggregate—** The mixed soil is stable if the aggregates used have high strength. However, if the mixture is properly designed and compacted, even the aggregates of relatively low strength can provide good mechanical stability.

(2) **Mineral Composition—** the mechanical stability of the mixed soil depends upon the composition of the minerals. The minerals should be weather resistant.

(3) **Gradation—** the gradation of the mixed soil should be such that the voids of the coarser particles are filled with finer particles to obtain a high density.

Mechanical Stabilization Cont.

(4) Plasticity Characteristics—

- For mud roads surfacing, highly plastic soils are used as binders. They posses greater cohesion, moisture retention capacity and provide seal against downward movement of surface water.
- For base courses, the soils should have low plasticity to avoid excessive accumulation of water and the resulting loss of strength.
- The soil available at site may seldom meet both the requirements. It is necessary to mix soils from different sources to obtain desired mix.

PHYSICAL STABILISATION

- IN THIS TECHNIQUE MORE THAN TWO OR THREE SOILS ARE BLENDED TO IMPROVE THE PHYSICAL PROPERTIES OF WEAK SOIL.

- QUITE OFTEN SOME ADDITIVES MAY ALSO BE ADDED FOR THE PURPOSE.

1. **CEMENT STABILISATION**
2. **LIME STABILISATION**
3. **BITUMEN STABILISATION**
4. **CHEMICAL STABILISATION**
5. **RESIN STABILISATION**

CEMENT STABILISATION

1. MOST COMMONLY USED FOR ROAD CONSTRUCTION.
2. HEAVY CLAYS ARE DIFFICULT TO PULVIRIZE AND NOT SUITABLE.
3. WELL GRADED SAND AND GRAVEL MIXTURES WITH UPTO 10% FINE BINDER MATERIAL (PASSING#200SIEVE).
4. QUANTITY OF CEMENT TO BE DETERMINED ON TRIAL BASIS IN LAB. (MINIMUM STRENGTH REQUIRED 3.5N/mm2—7 DAYS CUBE STRENGTH.
5. Compaction to be completed within two hours after laying mixing with water.

a. **CENTRAL PLANT METHOD**: Faster construction, expansive, dry mix and then wet thoroughly, spreading and compaction.

b. **MIX IN PLACE METHOD:** Similar to agriculture rotary cultivator, firstly soil is pulverized then dry cement is spread over, then water sprinkled in layers, again remixed and shaped to camber., compacted using rollers.

Cement Stabilization Cont.

(1)Normal Soil-Cement—

- It consists of 5 to 14% of cement by volume.
- Cement is sufficient to produce a hard and durable material.
- Sufficient water be used for hydration requirement & workability
- It is weather resistant and strong and used for stabilizing sandy and other low plasticity soils.

(2) Plastic Soil-Cement—

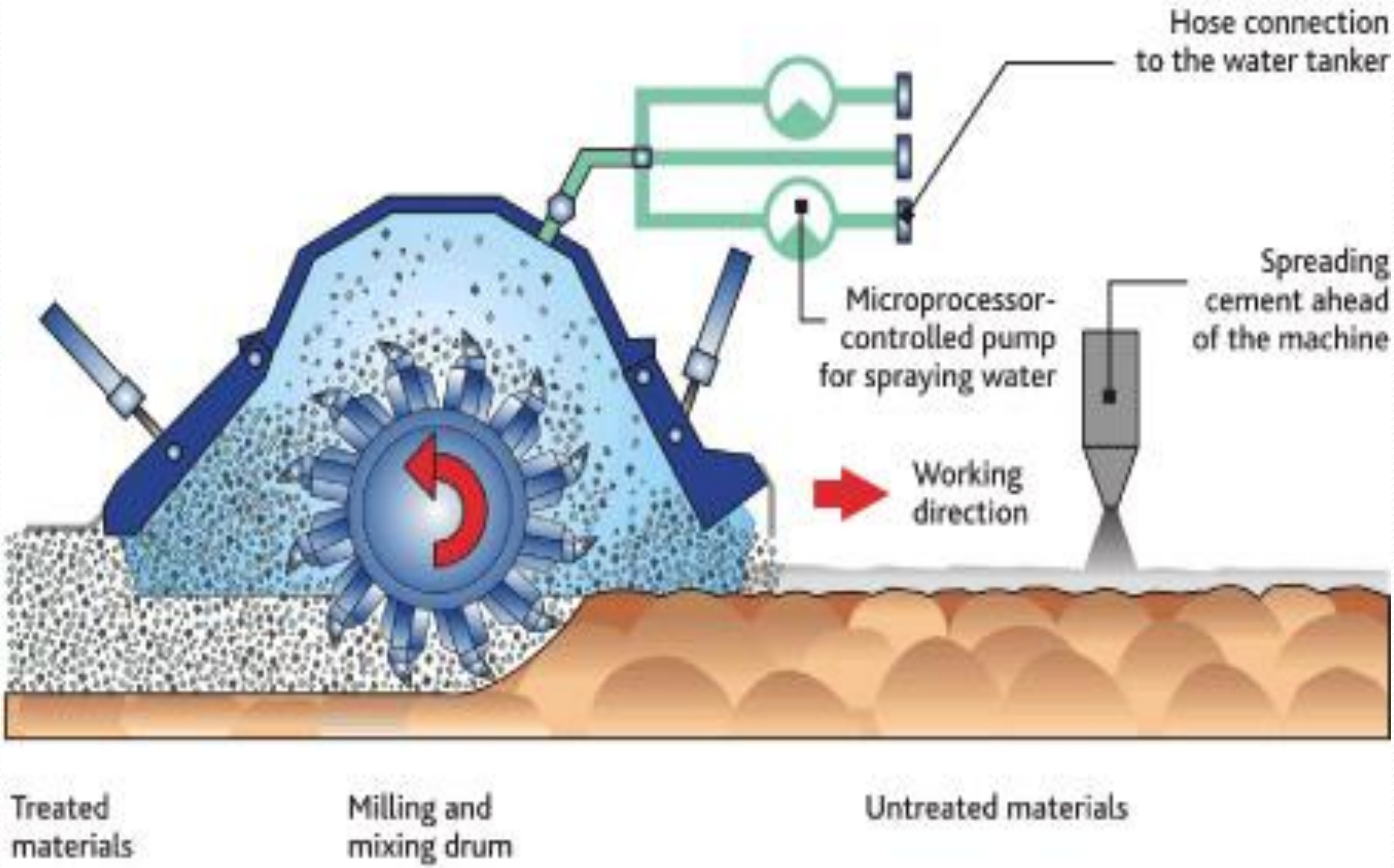
★ It consists of 5 to 14% of cement by volume,

★ It has more water to have wet consistency similar to that of plastering mortar at the time of placement.

★ Used for water proof lining of canals and reservoirs

★ Used for protection of steep slopes against water erosion.

Spreading cement ahead of the machine and metered injection of water




Soil stabilisation cement-GLORIT Step 2


D. GUTZWILLER
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Soil stabilisation cement-GLORIT Step 3

LIME STABILIZATION

There are basically five types of lime:

- High Calcium, quick lime (CaO)
- Hydrated, high calcium lime [$Ca(OH)_2$]
- Dolomite lime ($CaO+MgO$)
- Normal, hydrated dolomitic lime [$Ca(OH)_2+MgO$]
- Pressure, hydrated dolomitic lime [$Ca(OH)_2+Mg(OH)_2$]

—The quick lime is more effective than the hydrated lime, but the latter is more safe and convenient to handle. Generally, hydrated-lime is used. It is also known as slaked lime.

—The higher the magnesium content of the lime, the less is the affinity for water and the less is the heat generated during mixing.

—The amount of lime required varies between 2 to 10% of the soil.

Lime Stabilization

Lime stabilization is done by adding lime to soil. It is useful for the stabilization of clayey soil.

- When lime reacts with soil there is exchange of cations in the absorbed water layer and a decrease in the plasticity of the soil occurs.
- The resulting material is more friable than the original clay, and is, therefore more suitable as sub-grade.

Types of Lime

Lime is produced by burning of lime stone in kilns. The quality of lime obtained depends upon the parent material and the production process.

Lime Stabilization

The following amount may be used as a rough guide:

1. 2 to 5% for clay gravel material having less than 50% of silt-clay fraction
2. 5 to 10% for soils with more than 50% of silt clay fraction
3. About 10% for heavy clays used as bases and sub-bases
4. For soils having particle size intermediate between (1) and (2) above, the quantity of lime required is between 3 to 7%.

—Lime stabilization is not effective for sandy soils.

Lime Stabilization Cont.

Construction Method— Construction methods used in lime stabilization are similar to those used in cement stabilization. However, the following points should be carefully noted.

- The reaction in the case of lime is slow, there is no maximum time limit between the addition of lime to the soil and the completion of compaction.
- Lime may be added in the form of slurry instead of dry powder.
- A rest period of 1 to 4 days is generally required after spreading lime over a heavy clay before final mixing is done.
- The soil-lime is compacted to the required maximum dry density.
- After compaction, the surface is kept moist for 7 days and then covered with a suitable wearing coat.

Lime Stabilization Cont.

Chemical & Physical Changes in Lime Stabilization

- Lime reacts with wet soil and alters the nature of absorbed layer as calcium ions replace the sodium or hydrogen ions, the double layer is depressed due to increase in cation concentration but sometimes expand due to high PH value of lime.
- Lime reacts chemically with silica and alumina in soils and forms natural cement composed of calcium-alumino-silicate.
- In Lime stabilization, liquid limit decreases, plastic limit increases, plasticity index decreases. Soil becomes more friable and workable. The strength of the soil is improved. Unconfined compressive strength is increased up to 60% and the modulus of elasticity of soil increases.
- Lime causes decrease in tendency of attraction of water.

Lime Stabilization **Cont.**

- Soil resistance to water absorption, capillary rise and volume changes on wetting or drying is increased.
- Lime stabilized bases and sub-bases form a water resistant barrier which stops penetration of rain water.
- Optimum water content is increased and maximum dry unit weight is decreased.
- In swampy areas where water content is above the optimum, it helps in drying of the soil.

Fly ash is a pozzolanic material, i.e. it reacts with lime and is therefore almost always used in combination with lime in soils that have little or no plastic fines. It has often been found desirable to use a small amount of portland cement with lime and fly ash for added strength. This combination of lime-cement-flyash (LCF) has been used successfully in base course stabilization. Asphalt or bituminous materials both are used for waterproofing and for strength gain. Generally, soils suitable for asphalt stabilization are the silty sandy and granular materials since it is desired to thoroughly coat all the soil particles.


Before Lime
After Lime


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CATERPILLAR

Bituminous Stabilization Cont.

- Any inorganic soil which can be mixed with asphalt is suitable for bituminous stabilization.
- In cohesionless soils, asphalts binds the soil particles together and serves as a binding agent.
- In cohesive soils, asphalts protects the soil by plugging its voids and water proofing it. It helps to maintains low moisture content and to increase in bearing capacity.

The amount of bitumen required varies between 4 to 7% by weight.

Bituminous Stabilization Cont.

(1) Soil-bitumen (proper)– It is a water proof, cohesive soil system. The best results are obtained if the soil satisfies the following criteria.

- Passing No. 4 (4.76 mm) Sieve 50%
- Passing No. 40 (0.425 mm) Sieve 35-100%
- Passing No. 200 (0.074 mm) Sieve 10-50%
- Plastic Limit Less than 18%
- Liquid Limit less than 40%
- The maximum size of the particle should not be greater than one-third the compacted thickness of the soil bitumen.

The quantity of bitumen required varies from 4 -7% of the dry weight.

Bituminous Stabilization

Certain granular soils may be stabilized by adding bitumen such as

—**Bitumen Emulsion**

—**Cut Back Bitumen**

—**Asphaltic Bitumen**.

The bitumen seals the pores of soil thus reducing its permeability and may also increase the shearing strengthby providing cohesion between the particles.

Bituminous Stabilization Cont.

- Soils of three different gradations are recommended.
- For the three gradations, the percentage passing No. 200 sieve varies between:
  - 8 to 12
  - 10 to 16
  - 13 to 30

(4) Oiled Earth—

- A soil surface consisting of silt-clay is water proofed by spraying bitumen in two or three applications.
- Slow or medium curing bitumen or emulsion are used.
- The bitumen penetrates only a short depth into the soil.
- The bitumen required is about 5 Lit per square meter of soil surface.

Bituminous Stabilization Cont.

(2) Sand-bitumen–

- This is a bitumen stabilized cohesionless soil system.
- The sand should be free from vegetable matter or clay lumps.
- The sand require filler for mechanical stability.
- It should not contain more than 25% passing No. 200 sieve material for dune sands and not more than 12% in case of other types of sand.
- The amount of bitumen required varies from 4 to 10%.

(3) Water-Proof Clay Concrete–

- Soil of good gradation is water proofed by uniform distribution of 1 to 3% of bitumen in this system.

Bituminous Stabilization Cont.

Amount of Asphalt–

- The quality of stabilized soil improves with the amount of asphalt up to certain limit.
- Excessive asphalt results in highly fluid mixture that cannot be compacted.

Mixing–

- The quality of the product improves with more thorough mixing.

Compaction–

- The dry-unit-weight of bitumen soil depends on the amount and type of compaction and the volatile content.
- In modified AASHTO test, max. dry unit weight occurs at volatile content of about 8%.

Bituminous Stabilization Cont.

Construction Methods–

The following points should be noted.

- The opt. volatile content for compaction is greater than that for stability. The requirement for thorough mixing may be even greater i.e., for clayey soils. It is necessary to aerate the mix between mixing and compaction and between compaction and application.
- For high stability, the layer method of construction is preferred. Each layer is about 5 cm thick. When lower layer is dried up, subsequent layer is laid. The total thickness for bases is between 10 to 20 cm.
- In the mix-in-place method, the bitumen is sprayed in several passes. Each layer is partially mixed before the next pass. This method prevents the saturation of the surface of the sub-grade.
- Climatic conditions influence the amount of bitumen applied.

Bituminous Stabilization Cont.

Factors Affecting Bitumen Stabilization–

- Type of soil
- Amount of asphalt
- Mixing
- Compaction

Type of Soil–

- It is effective in stabilizing sandy soils having little or no fines.
- Cohesive soil with P.L<20% and L.L<40% can be stabilized.
- Plastic clays cannot be properly treated because of mixing problems and large quantity of asphalt is required.
- Fine grained soils having high PH value and dissolved salts do not respond well.

Chemical Stabilization

Soils are stabilized by adding different chemicals. Its main advantage is that the setting and curing time can be controlled.

The following chemicals have been successfully used:

- Calcium Chloride
- Sodium Chloride
- Sodium Silicate
- Polymers
- Chrome Lignin
- Other chemicals

Chemical Stabilization Cont.

- It lowers the optimum water content.
- Causes a small decrease in the strength of soil.
- However if the compacted soil is put to water imbibitions, water pick up is reduced and the strength of the soil increases.
- The benefits of the stabilization require the presence of the chemical in the pore fluid. As the chemical is leached out, the benefits are lost.
- Its performance depends on the ground water movement.
- The construction methods are similar to those used for lime stabilization
- Its quantity required is about ½% of the weight of the soil.

Sodium Chloride—

- Its tendency for attraction of moisture is somewhat lesser than of calcium chloride.

Chemical Stabilization Cont.

Calcium Chloride—

- It causes colloidal reaction & alters the *characteristics* of the soil.
- It is deliquescent and hygroscopic and reduces the loss of moisture.
- It reduces the chances of frost heave, as the freezing point of water is lowered.
- Effective as dust calming,
- Effective for silty and clayey soils which loose strength with an increase in water content.
- It causes a slight increase in maximum dry unit weight.

Chemical Stabilization Cont.

- It forms crystallization in the pores of the soil and finally a dense hard mat with the stabilized surface. The pores in the soil filled up and retard further evaporation of water.
- It also checks the tendency for the formation of shrinkage cracks.
- It is mixed with the soil either by mix-in-place or by plant-mix method and should be applied directly to the surface.
- The quantity required is about 1% of the soil weight.

Sodium Silicate—

- It is used as solution in water, known as water glass.
- It is directly injected into the soil.
- It increases the strength of the soil and makes it impervious.

Chemical Stabilization Cont.

- Acts as a dispersing agent.
- It increases the maximum compacted unit weight of the soil.
- The chemical required varies between 0.1 to 0.2% of the weight of the soil.
- The method is relatively inexpensive but long-term stability is doubtful. The treated soil may lose strength when exposed to air or ground water.

Polymers—

- Polymers are long-chained molecules formed by polymerizing of certain organic chemicals called monomers.
- They may be natural or synthetic.
- Resins are natural polymers and calcium acrylate is synthetic.

Chemical Stabilization Cont.

- When added to the soil reaction takes place.
- Sometimes catalyst is added with the monomers to the soil. In that case polymerization occurs along with the reaction.

Chrome Lignin—

- Lignin is obtained as a by product during the manufacture of paper.
- Chrome lignin is formed from black liquor in sulphite paper manufacture.
- Sodium bicarbonate or potassium bicarbonate is added to sulphite liquor to form chrome lignin. It slowly polymerizes into a brown gel.
- When added to the soil, it slowly reacts to cause binding of particles.
- The quantity required varies from 5 to 20% by weight.
- As lignin is soluble in water, its stabilizing effect is not permanent.

Chemical Stabilization Cont.

Other Chemicals—

- Water proofers such as alkyl chloro silanes, siliconates amines and quaternary ammonium salts, have been used for soil water proofing.
- Coagulating chemicals such as calcium chloride and ferric chloride have been used to increase the electrical attraction and to form flocculated structure in order to improve the permeability of soil.
- Dispersant such as sodium hexa-metaphosphate are used to increase the electric repulsion and to cause dispersed structure. The compacted density of the soil is increased.
- Phosphoric acid combined with a wetting agent can be used for cohesive soils. It reacts with clay minerals and forms an insoluble aluminum phosphate.


argus
green
UNIKLEEN
ALL PURPOSE CLEANER / DEGREASER

A truck applies chemical stabilizers to reduce soil erosion where vegetation can not be planted (Source: Terra Firma Industries, 1999)

2. GROUND IMPROVEMENT

ANY OF THE FOLLOWING METHOD USING ONE OR IN COMBINATION MAY BE EMPLOYED TO IMPROVE IN SITU SOIL PROPERTIES TO SUPPORT STRUCTURAL FOUNDATIONS;

a) **DEEP COMPACTION**
b) **SOIL REPLACEMENT**
c) **PRE LOADING**
d) **DRAINAGE AND GWT CONTROLL**
e) **INJECTION GROUTING**
f) **SOIL FREEZING**
g) **USE OF GEOTEXTILES**

a. DEEP COMPACTION

- **DYNAMIC COMPACTION OR CONSOLIDATION;**
- 10-20 TONNE FREE FALING WEIGHT DROPPED FROM A HEIGHT OF 30M OR LESS. SHOCK WAVES GENERATED TRAVELL TO CONSIDERABLE DEPTH, REARRANGING THE SOIL FORMATION TO A DENSER AND MORE COMPACT STATE. GREATER DEPTHS UPTO 15M MAY BE TREATED USING SPECIAL HEAVY MACHINES.

i. Low cost, rapid treatment, suitable for large variety of soils.
ii. But may harm to adjacent structures, installations, utilities, environmental issues like noise pollution.
iii. Following Control tests may be employed to monitor compaction improvement; SPT, PLT (plate), VST (vane shear),DT (Density).

- Soil improvement depth depends on; tamper weight and its height of fall, surface area and its shape, impact spacing and grid pattern.

- **VIBROCOMPACTION**
- **COMPACTION PILES**

- **D**

b. SOIL REPALCEMENT

- In this method weak/soft/organic soil is removed and replaced with compacted engineered soil.
- This is the most reliable, economical and controlled method, if the replaced soils are available near the site.

c. PRE-LOADING

- In this method preloading of 1.2 to 1.3 times of designed load is applied in advance to allow desired settlement and accelerate consolidation.
- Specifically for alluvial soils having high moisture content, high compressibility and low shearing strength by lowering water table by any means.
- Process can be accelerated by introducing sand piles in the periphery.
- Best suited for air fields, storage tanks, flood control structures etc.
- Undesired initial investment, disposal of use of preloaded soil, unexpected time delay may be considered.

d. DRAINAGE AND GWT

- In this method ground water conditions are attained by drains and by lowering GWT.
- Blanket drains and vertical sand drains are sometimes employed to accelerate the consolidation process.
- Effect of lowering GWT to the adjacent structures must be monitored and considered before applying this method.

e. INJECTION GROUTING

- Various fluid grouts are injected in to the bore holes/weak soils by special pressure techniques or otherwise.

- Application of this technique is mainly for reduction of permeability, reduction of settlement, stiffening of soil, underpinning etc.
- **Grouts may be;**

A. **Cement grout,**
B. **Fly ash grout/clay grout**
C. **Chemical grouts**

Stabilization by Grouting

In this method stabilizers are introduced by injection into the soil.

- Grouting is always done under pressure.
- High viscosity stabilizers are suitable for high permeable soils.
- Not suitable for clays because of very low permeability.
- The method is costlier than other direct blending methods.
- Suitable for buried zones of relatively limited extent i.e., pervious stratum below a dam.
- Used to improve the soil that cannot be disturbed.
- An area closed to an existing building can be stabilized by this method.

Stabilization by Grouting

Depending upon the stabilizer used, grouting techniques can be classified as under:

- Cement Grouting
- Clay Grouting
- Chemical Grouting

Cement Grouting —

- A cement grout consists of a mixture of cement and water.
- If the hole drilled in the soil is smooth, the water-cement ratio is kept low.
- Chemicals are also added in the grout to increase its fluidity.
- Very effective for rocks with fissures, gravel and course sand.

Stabilization by Grouting

Clay Grouting —

- The grout used is composed of a very fine grained soil and water (bentonite clay). The bentonite clay readily absorbs water on its surface.
- The viscosity, strength and flow characteristics of the grout can be adjusted according to the site conditions.
- Clay grouting is suitable for stabilizing sandy soils.
- Some chemicals are also added to the clay grout.
  - Clay-cement-grout is a mixture of clay, bentonite and cement.
  - Clay-chemical-grout is a mixture of clay and sodium silicate.
- It is effective for medium and fine sands.

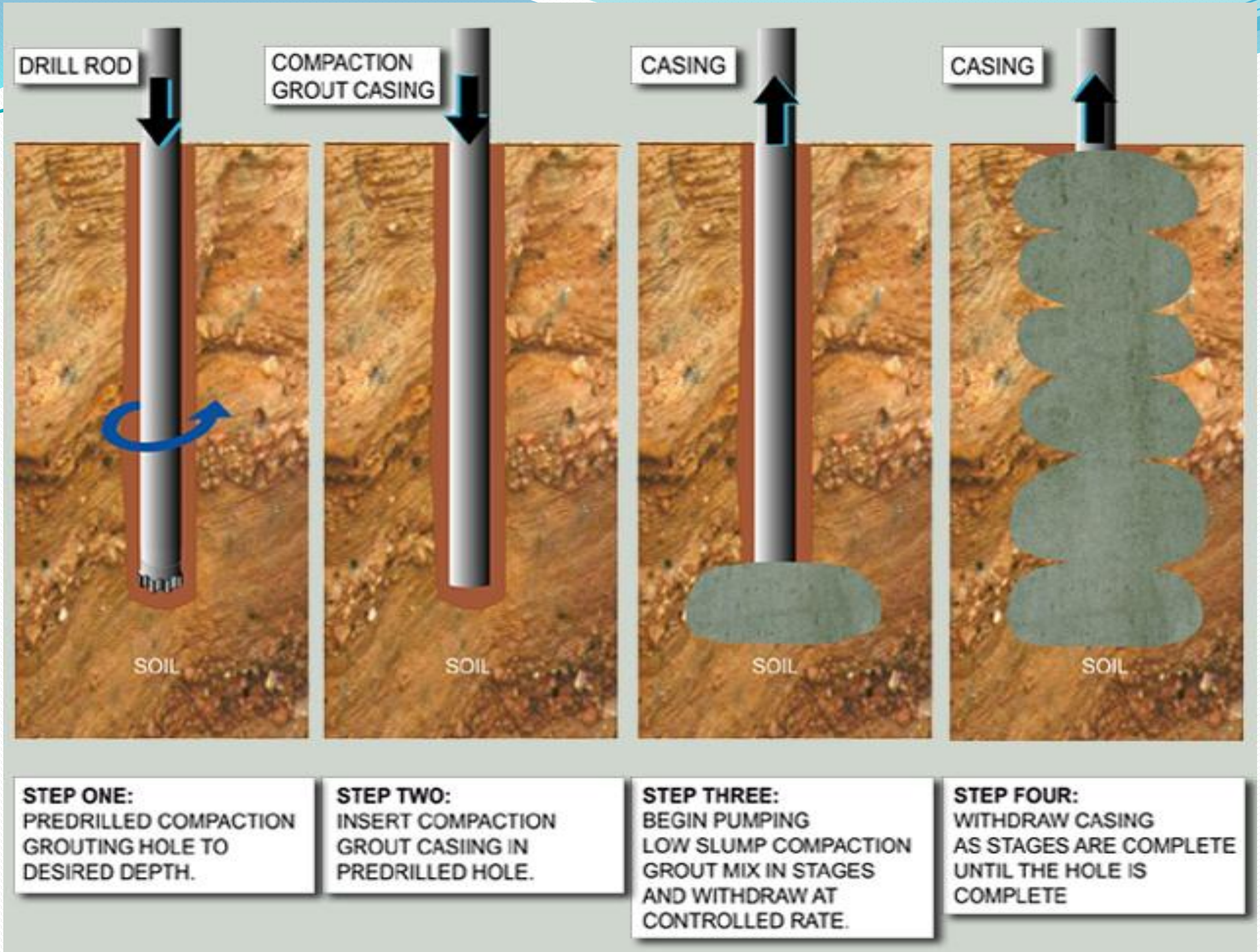
Stabilization by Grouting

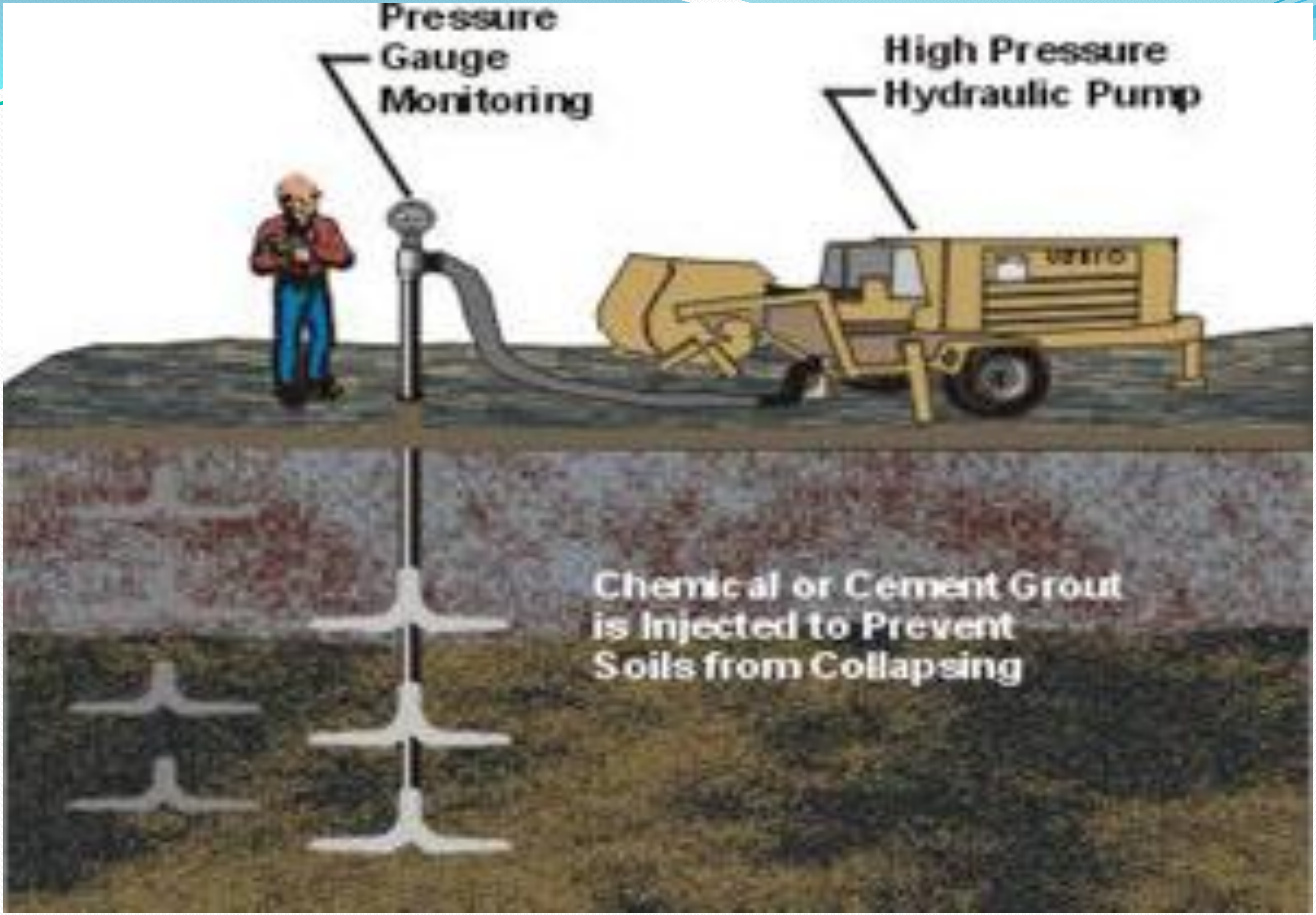
Chemical Grouting —

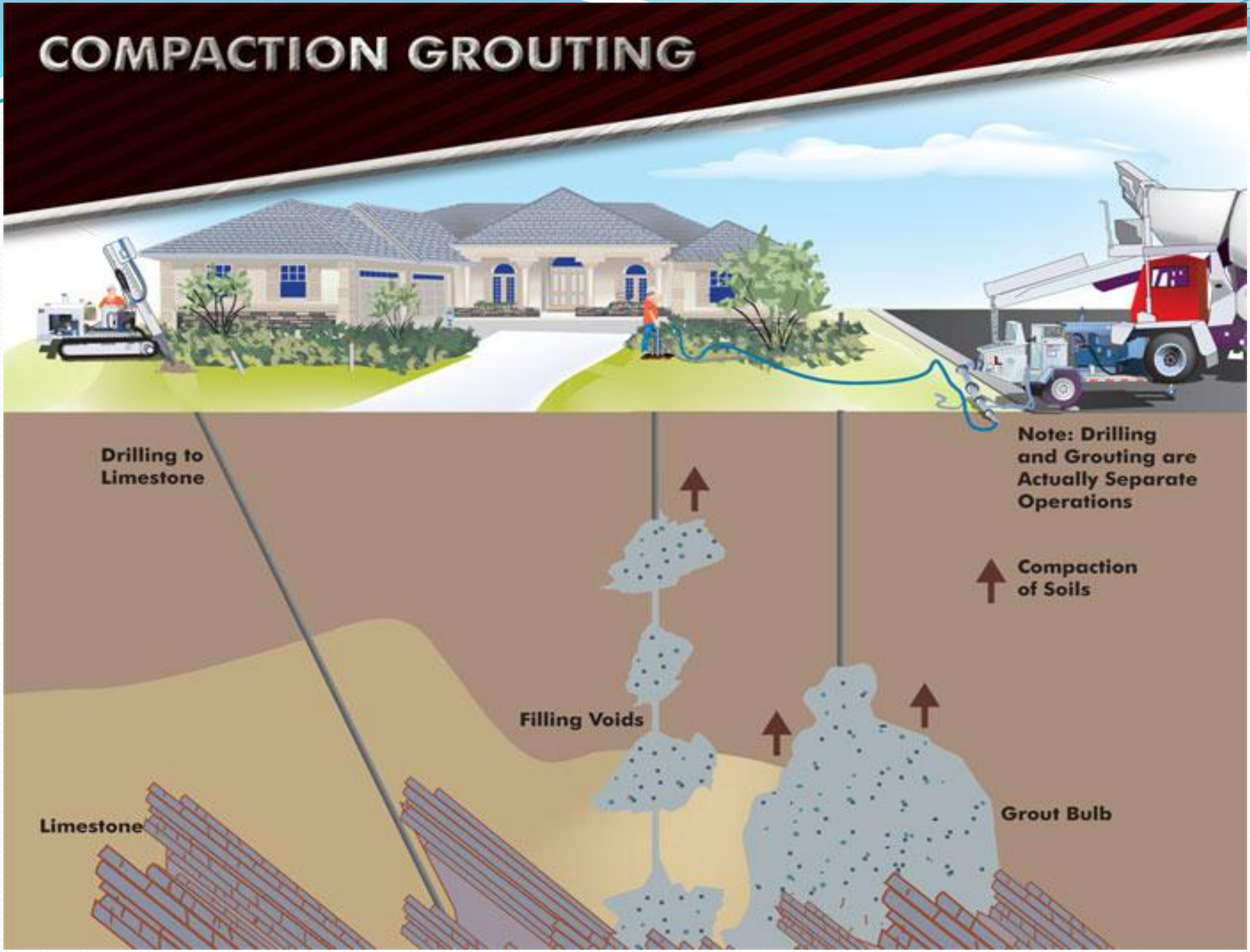
- The grout used consists of a solution of sodium silicate in water, known as water glass.
- The solution contains both free sodium hydroxide and colloidal silicic acid. An insoluble silica jell is formed.
- As the reaction is slow, calcium chloride is added to accelerate the reaction.
- The method is suitable for medium and fine sands.
- The effect of grouting is not permanent.

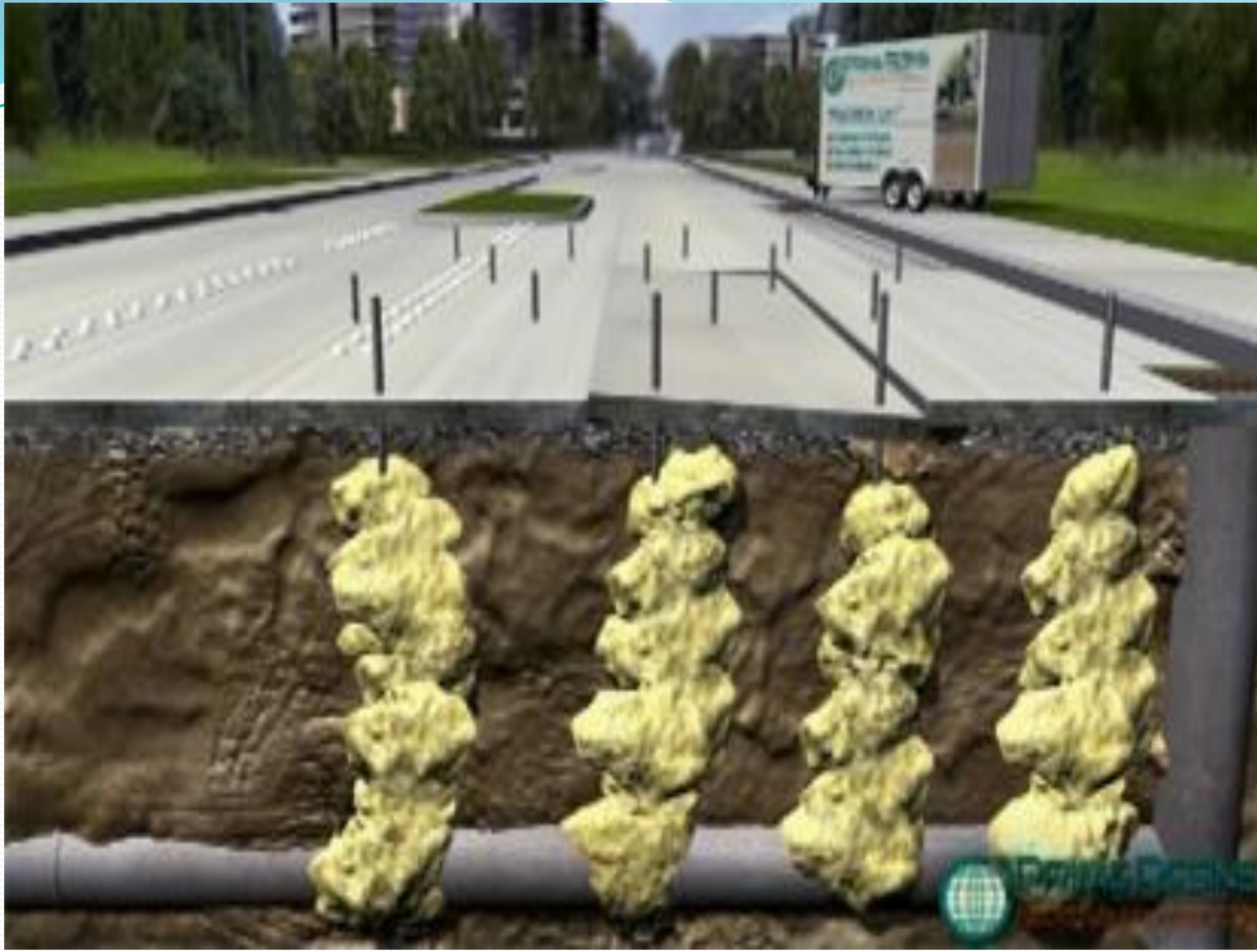
Chrome-lignin Grouting —

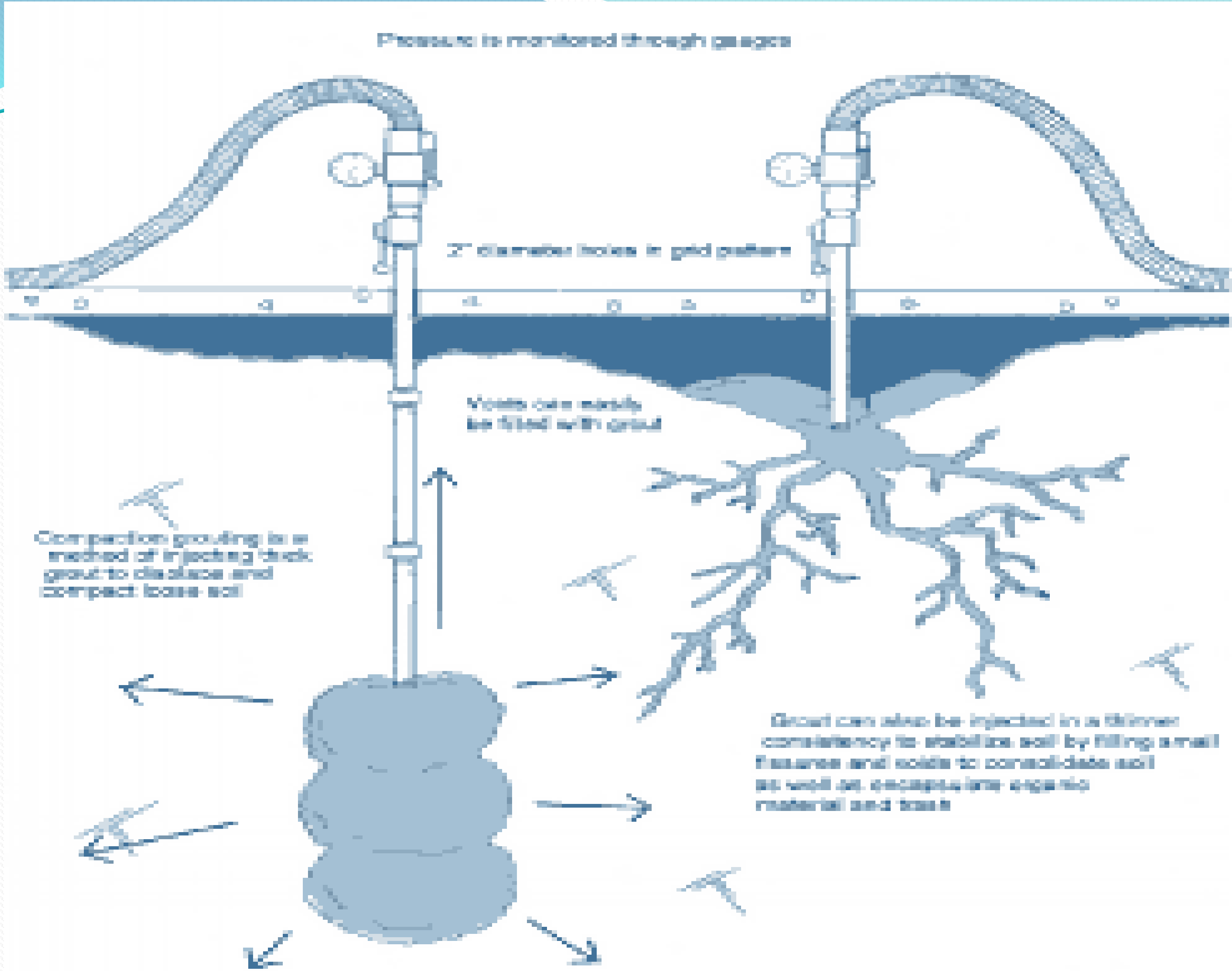
- The grout used is made of ligno-sulphates and a haxavalent chromium compound.
- When it is combined with an acid, ligno-sulphate is oxidized into a gel.

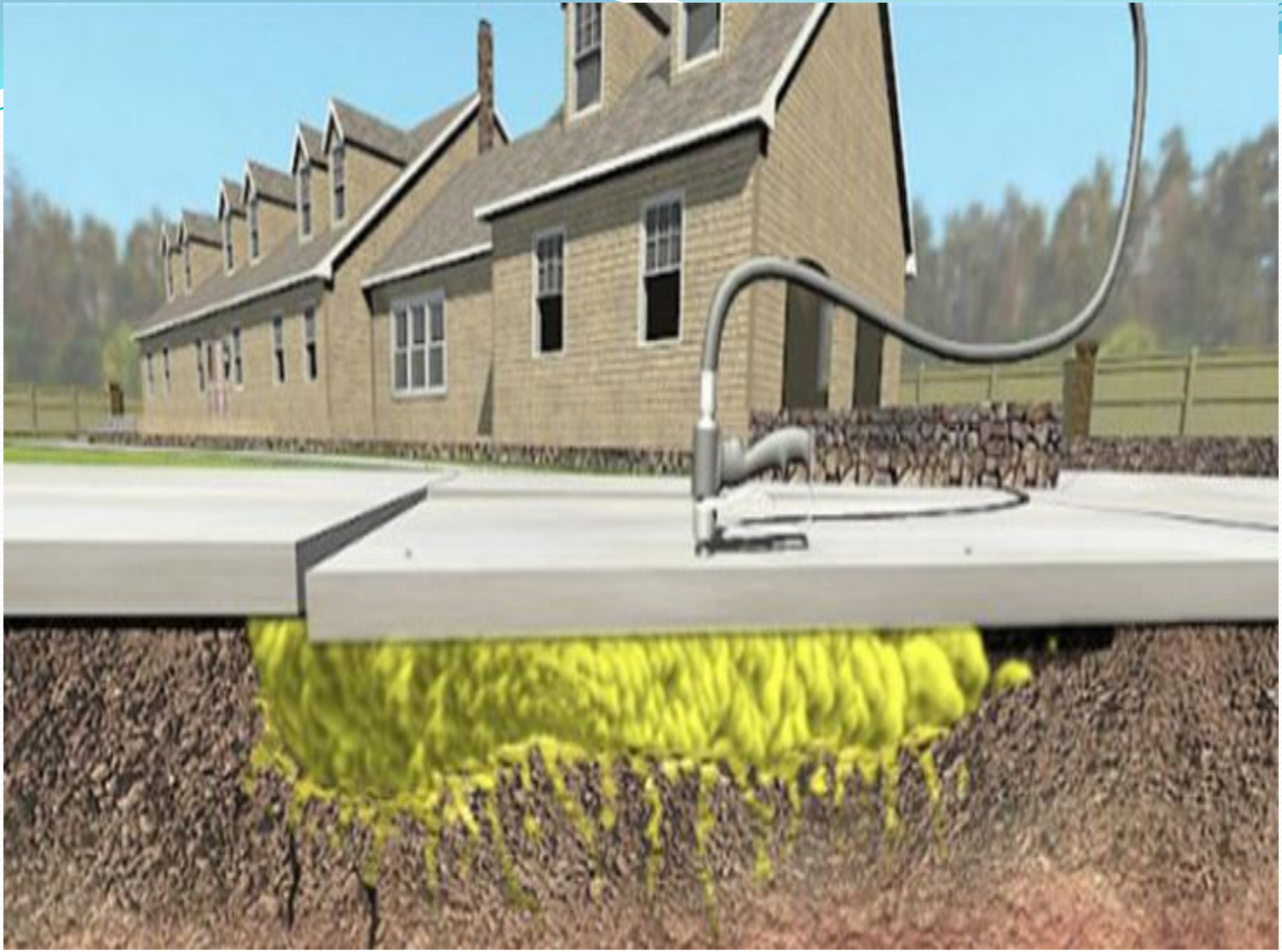

DRILL ROD
COMPACTION GROUT CASING
CASING
CASING
SOIL
SOIL
SOIL
SOIL
STEP ONE:
PREDRILLED COMPACTION GROUTING HOLE TO DESIRED DEPTH.
STEP TWO:
INSERT COMPACTION GROUT CASIING IN PREDRILLED HOLE.
STEP THREE:
BEGIN PUMPING LOW SLUMP COMPACTION GROUT MIX IN STAGES AND WITHDRAW AT CONTROLLED RATE.
STEP FOUR:
WITHDRAW CASING AS STAGES ARE COMPLETE UNTIL THE HOLE IS COMPLETE

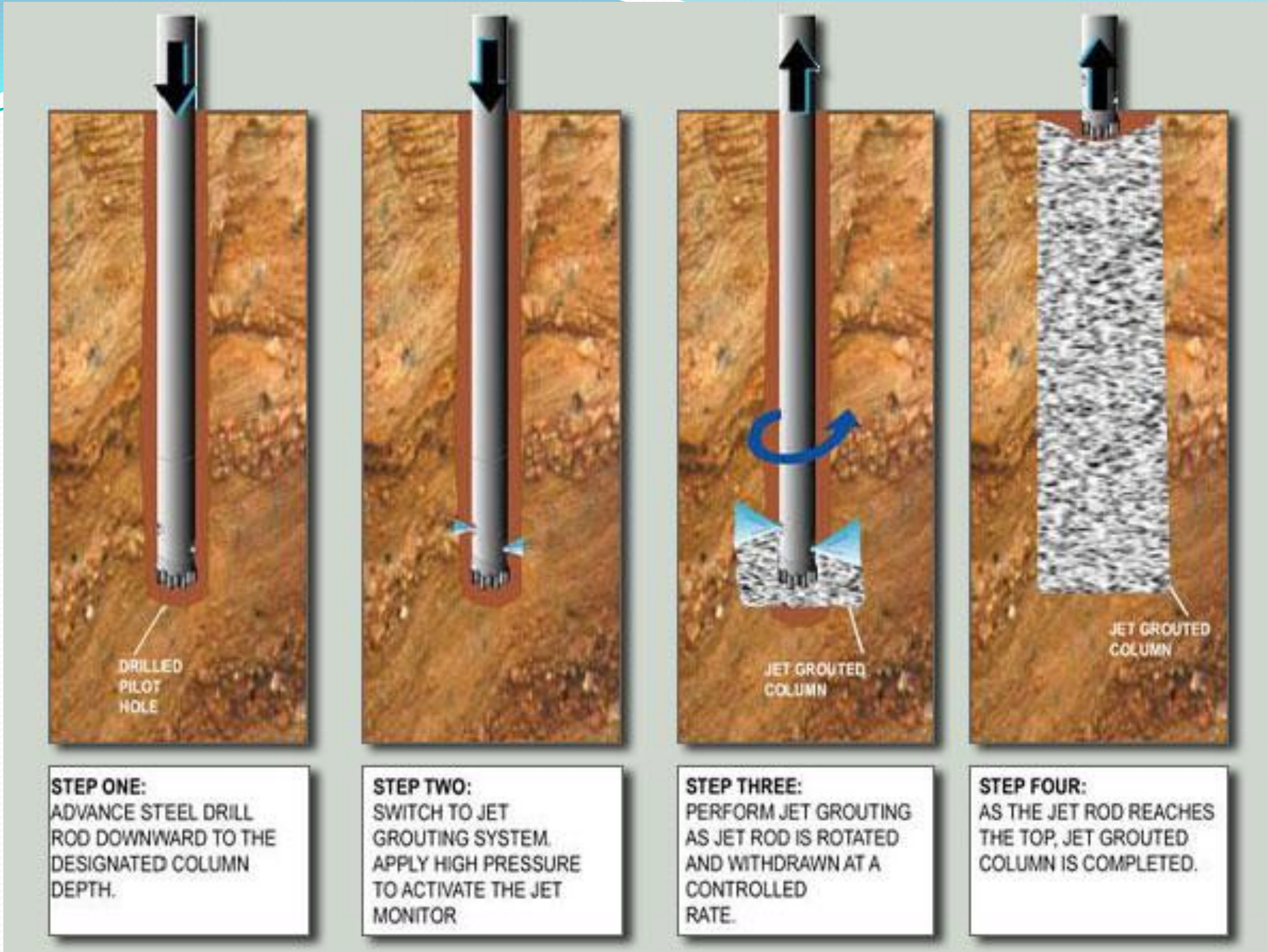

Pressure
Gauge
Monitoring
High Pressure
Hydraulic Pump
Chemical or Cement Grout
is Injected to Prevent
Soils from Collapsing

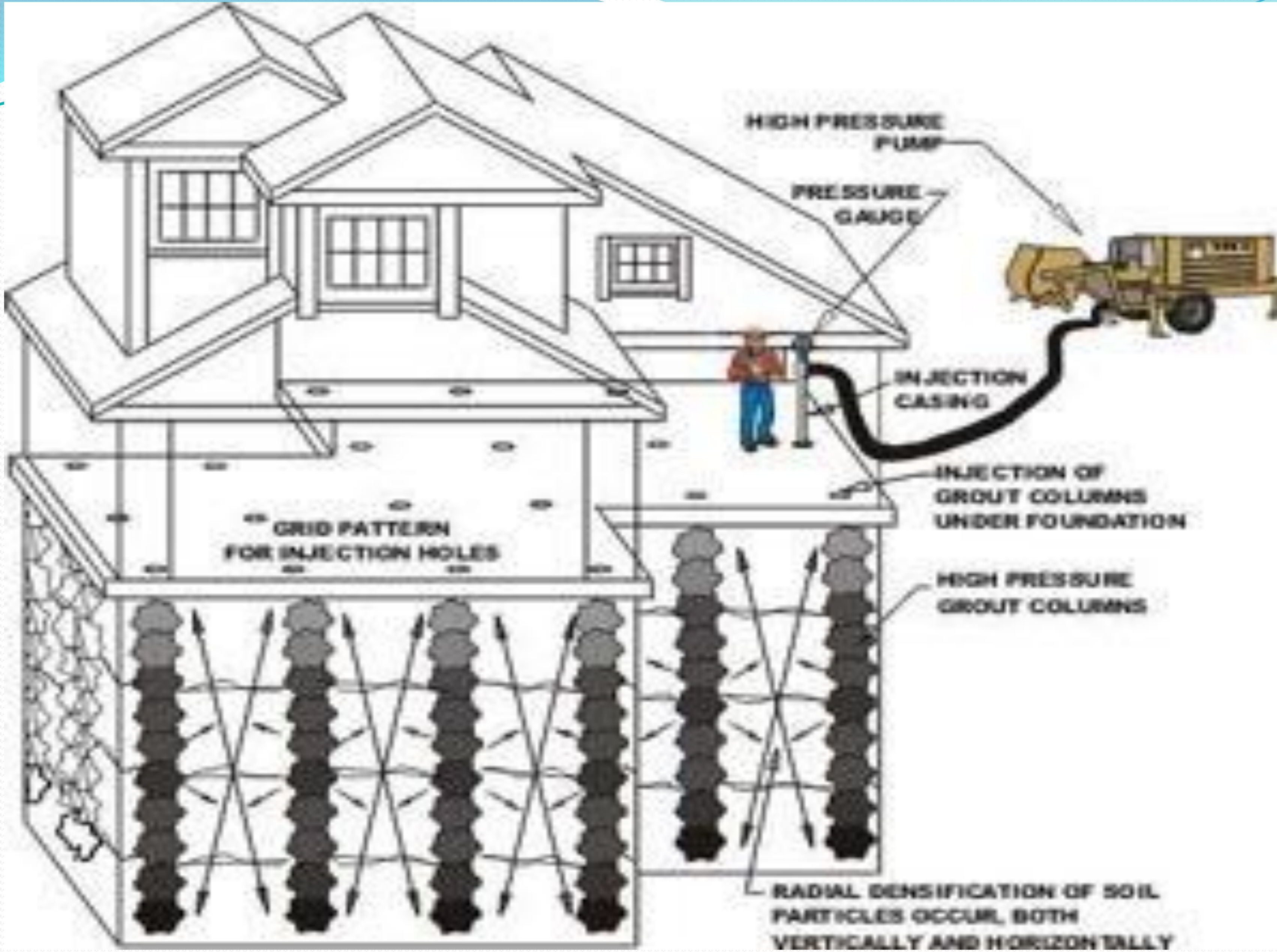

COMPACTION GROUTING
Drilling to Limestone
Note: Drilling and Grouting are Actually Separate Operations
Compaction of Soils
Filling Voids
Grout Bulb
Limestone




Pressure is monitored through gauges
2" diameter holes in grid pattern
Voids can easily be filled with grout
Compaction grouting is a method of injecting thick grout to displace and compact loose soil
Grout can also be injected in a thinner consistency to stabilize soil by filling small fissures and voids to consolidate soil as well as encapsulate organic material and trash




DRILLED PILOT HOLE
JET GROUTED COLUMN
JET GROUTED COLUMN
STEP ONE:
ADVANCE STEEL DRILL ROD DOWNWARD TO THE DESIGNATED COLUMN DEPTH.
STEP TWO:
SWITCH TO JET GROUTING SYSTEM. APPLY HIGH PRESSURE TO ACTIVATE THE JET MONITOR
STEP THREE:
PERFORM JET GROUTING AS JET ROD IS ROTATED AND WITHDRAWN AT A CONTROLLED RATE.
STEP FOUR:
AS THE JET ROD REACHES THE TOP, JET GROUTED COLUMN IS COMPLETED.


HIGH PRESSURE PUMP
PRESSURE GAUGE
INJECTION CASING
INJECTION OF GROUT COLUMNS UNDER FOUNDATION
GRID PATTERN FOR INJECTION HOLES
HIGH PRESSURE GROUT COLUMNS
RADIAL DENSIFICATION OF SOIL PARTICLES OCCUR, BOTH VERTICALLY AND HORIZONTALLY

f. Soil Freezing

- Soil freezing method is suitable for soils not too fine.
- This is slow, expansive and require circulation of ammonia gas.
- Used for stabilizing excavations, for sinking mine shafts, for recovering undisturbed soils from grannular strata and for preventing inflow in to the excavations.

STABILIZATION BY GEOTEXTILE AND FABRICS

In geotextile stabilization, a geotextile is properly embedded in the soil and contributes to its stability. A geotextile has high tensile strength.

- Geotextiles are porous fabrics made of synthetic materials, such as polyethylene, polyester, nylon, polyvinyl chloride.
- Geotextiles are manufactured as woven, non-woven or grid form.
- They are used in the construction of road over soft soils.
- Geotextile is laid over the soil and aggregate is placed directly over it. When the traffic passes over the road, it deforms and its strength is mobilized. The more a geotextile is deformed, the greater the load it can carry.

ASTM D4439 defined a geotextile as follows

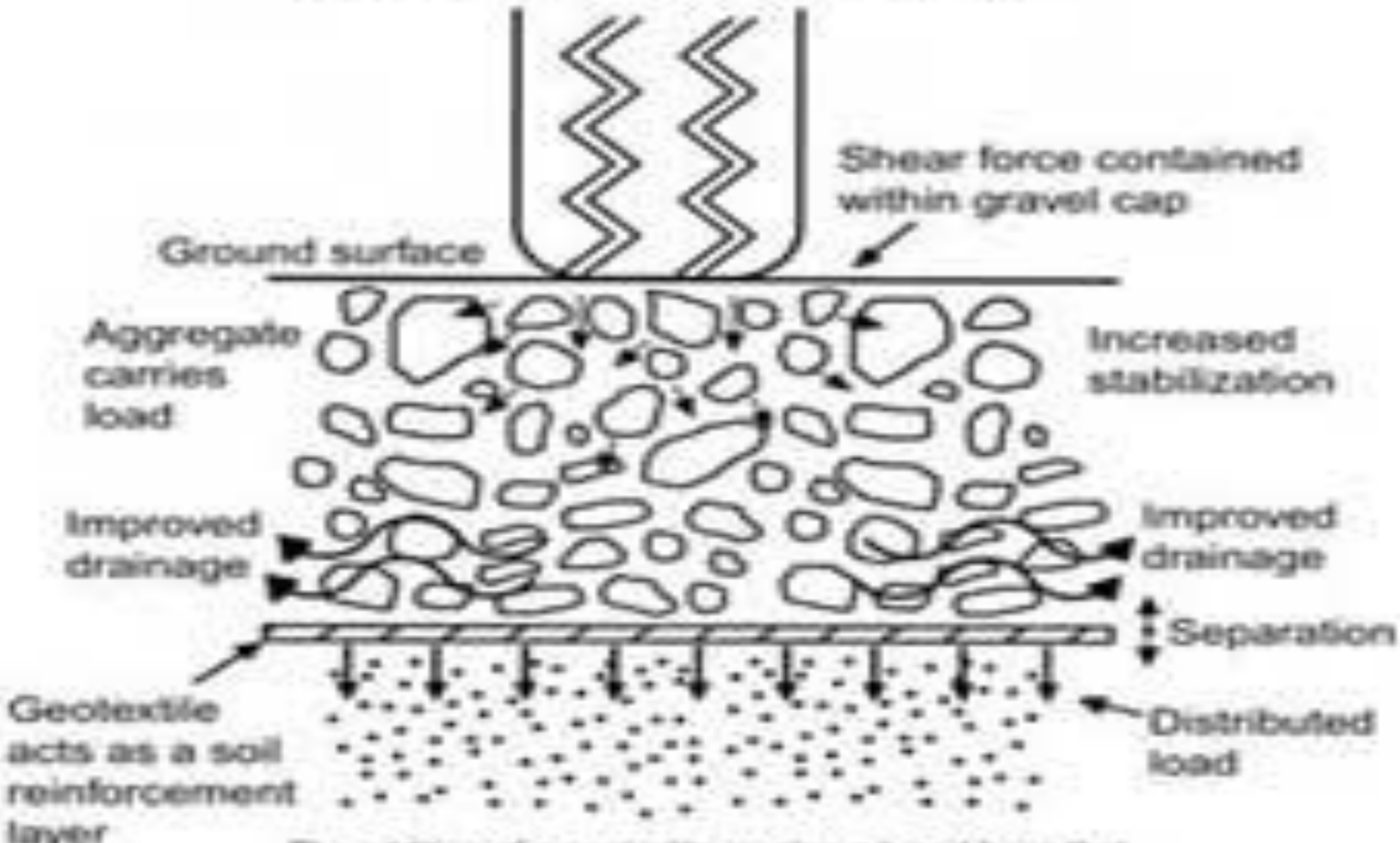
Geotextile : A permeable geosynthetic comprised solely of textiles. Geotextiles are used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made product structure, or system.

Due to the very wide range of applications and the tremendous variety of available textiles having widely different properties, the selection of a particular design method or design philosophy is a critical decision that must be made before the actual mechanics of the design process are initiated.

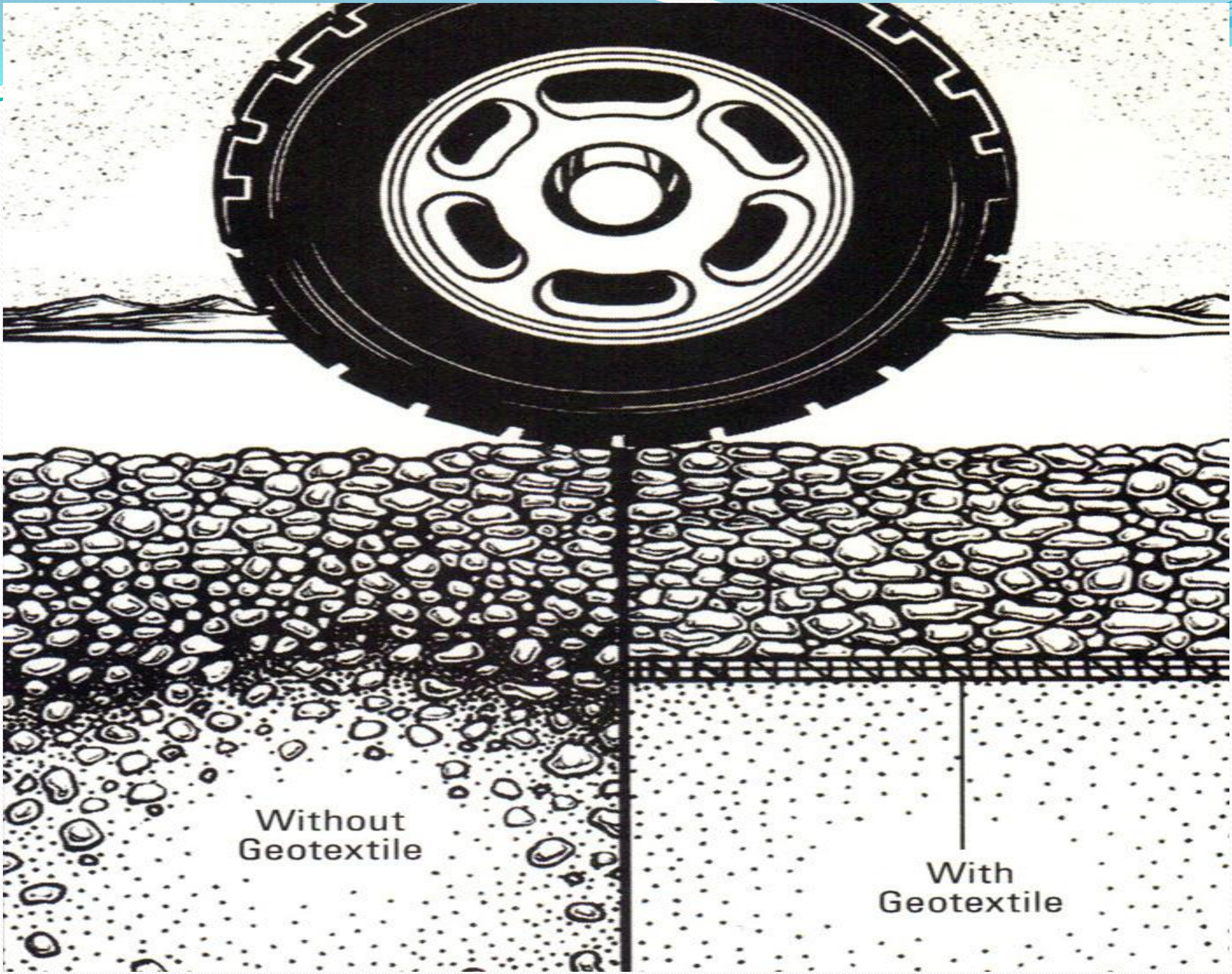
Stabilization by Geotextile and Fabrics

The soil can also be stabilized by introducing metallic strips into it and providing an anchor or tie back to restrain a facing skin element. The composite mixture is known as reinforced earth.

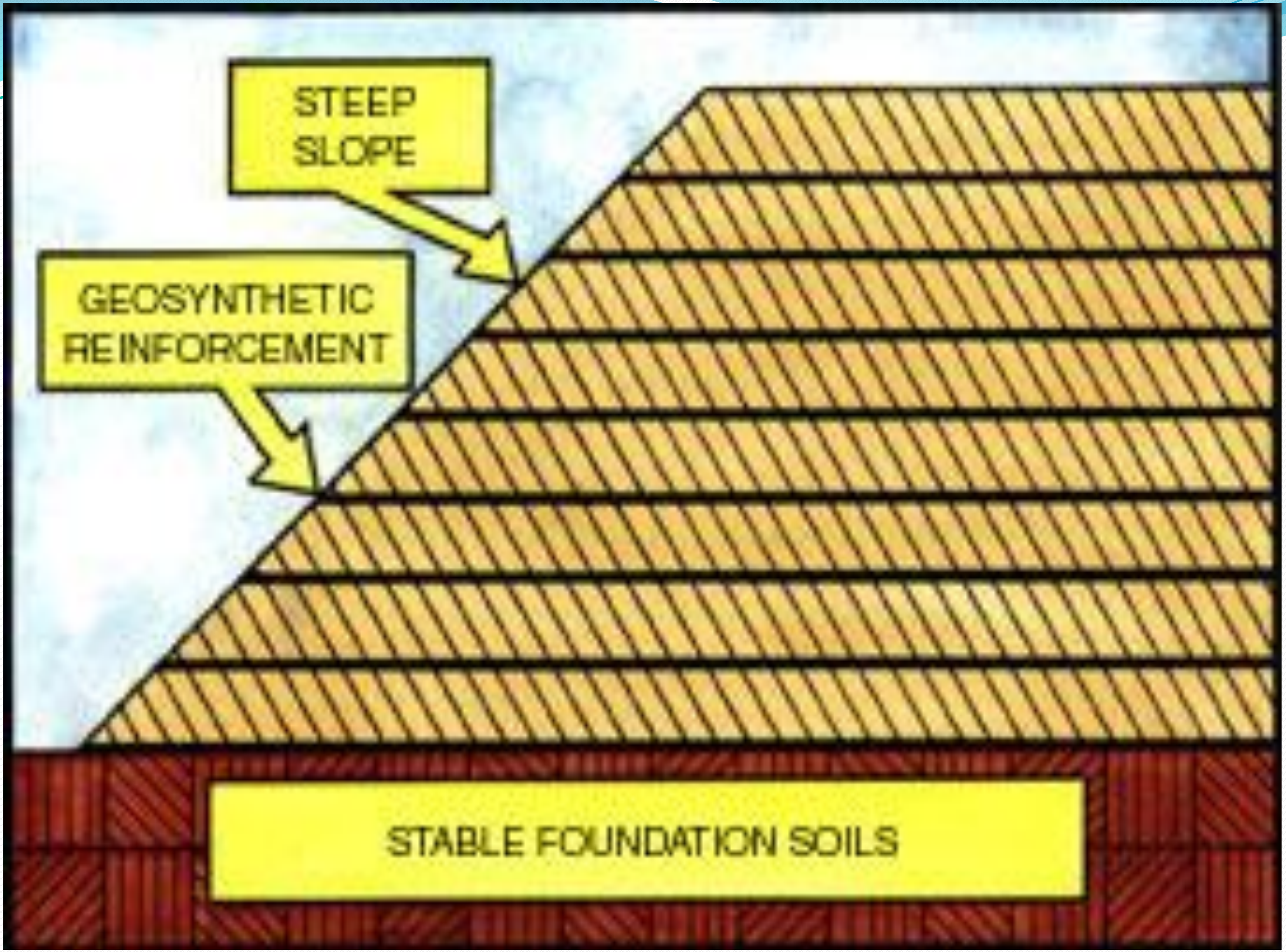
Gravel cap with geotextile



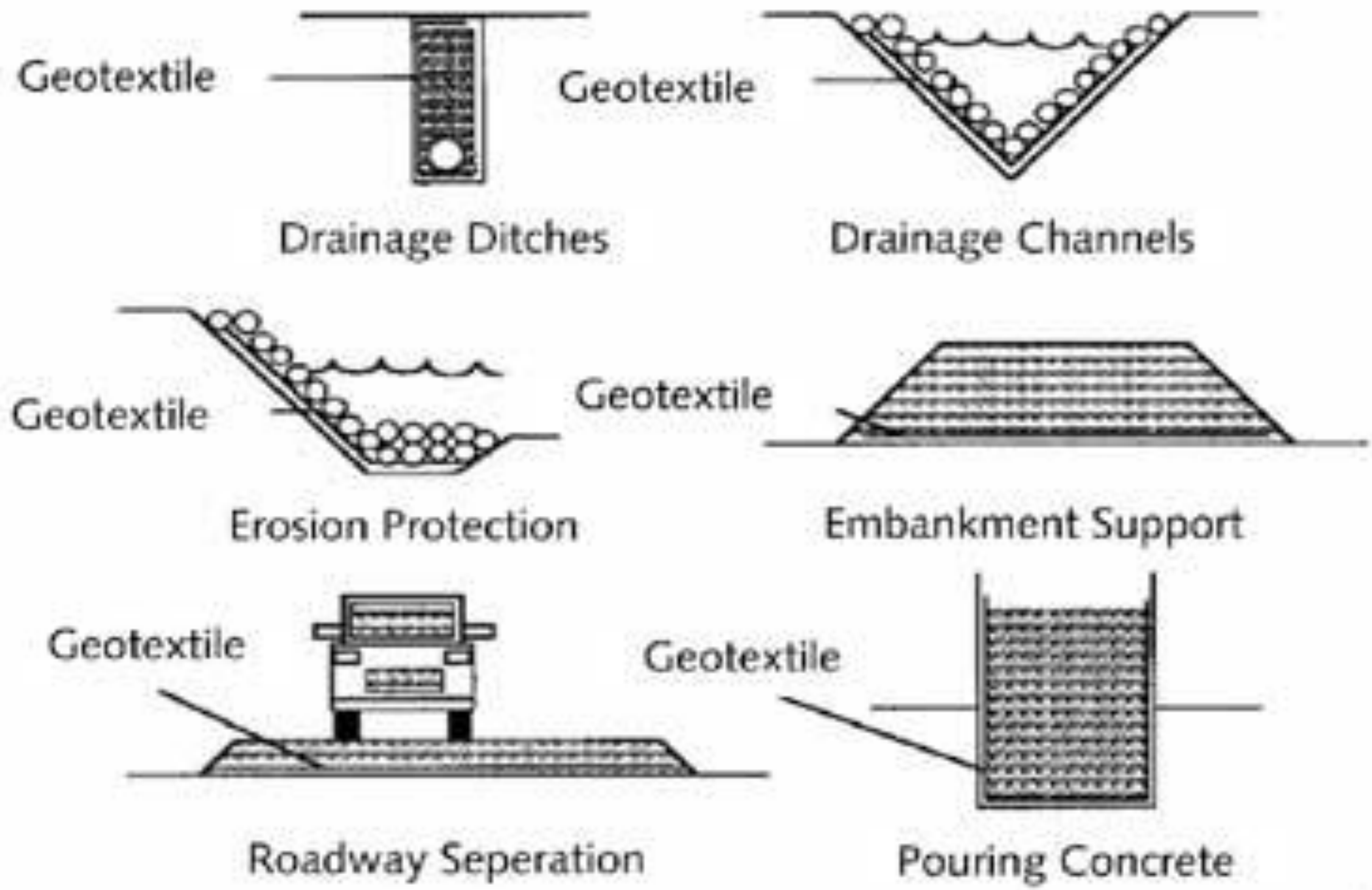
The addition of a geotextile creates a broad base that distributes the load, increasing bearing strength and reducing pumping action.



Without
Geotextile
With
Geotextile

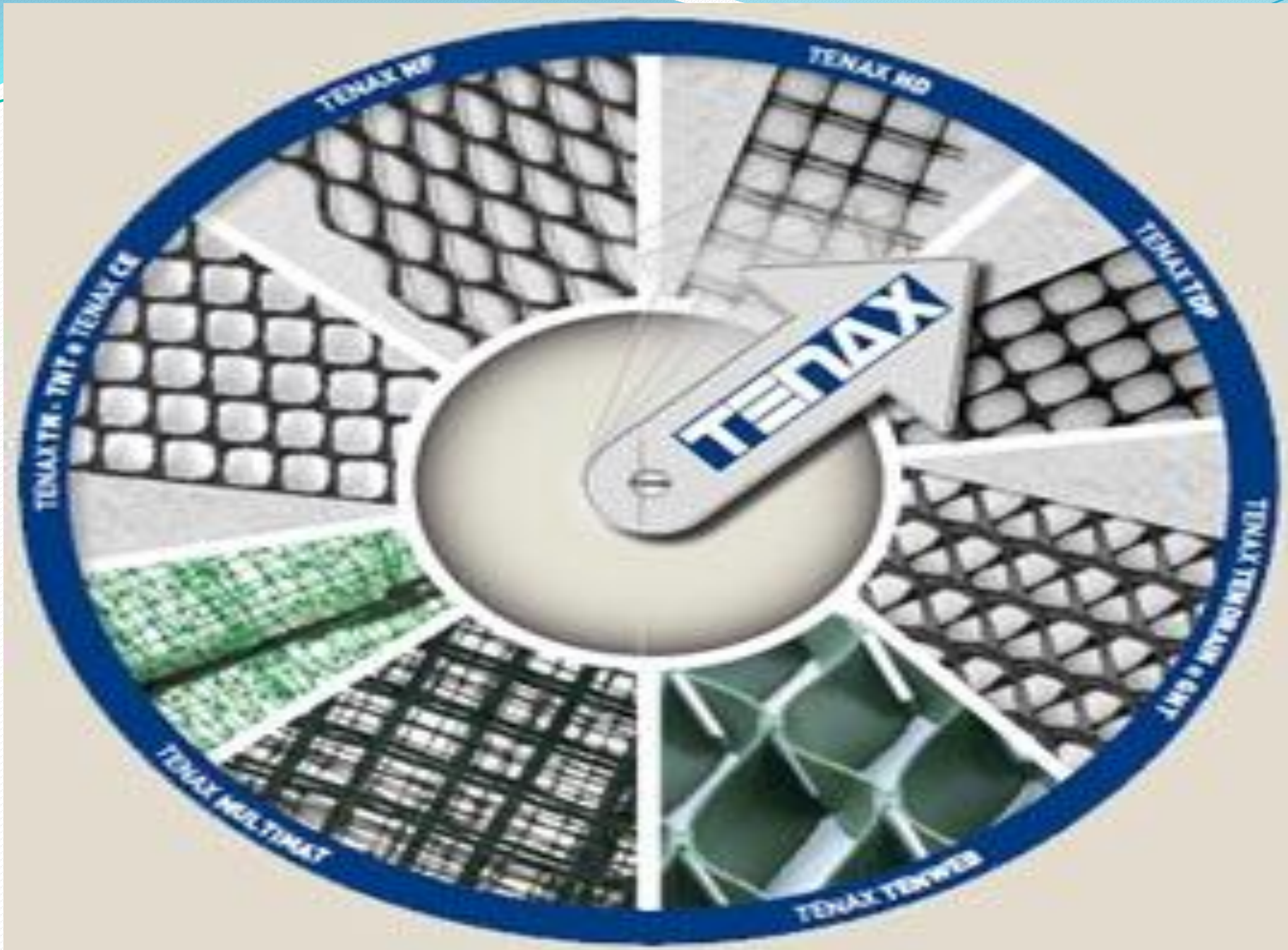

STEEP
SLOPE
GEOSYNTHETIC
REINFORCEMENT
STABLE FOUNDATION SOILS

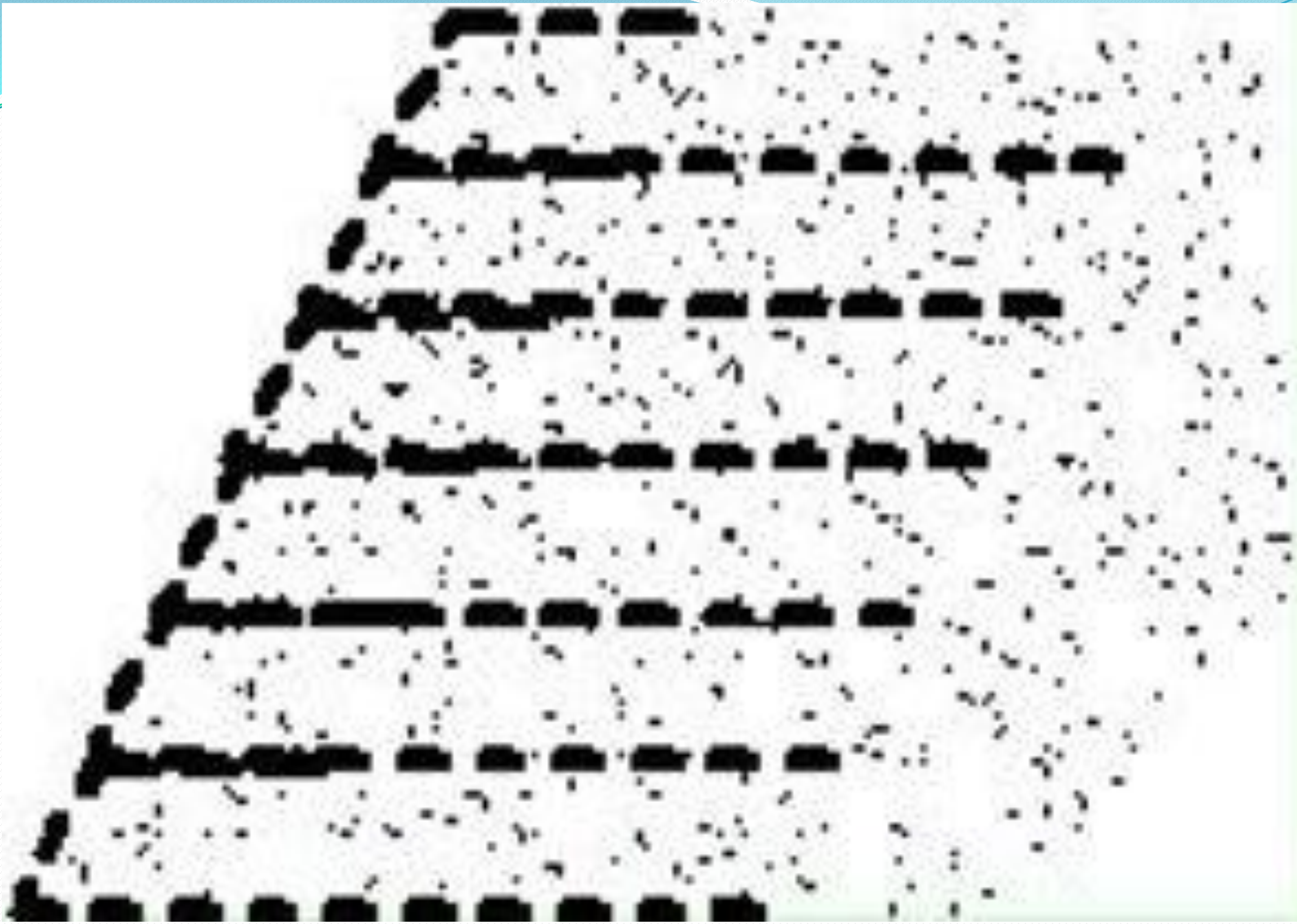
Industrial Sector	Application Area	Function
Transportation	Roads, Railways, Airports, & Tunnels.	Separation, Filtration, Drainage, Reinforcement, Protection.
Environment	Waste containment (Landfill) Land reclamation, Building site developments & General amenities, Ground drainage Slope erosion control; Ground & Slope reinforcement.	
Water resources	Dams, Reservoir, Ponds, Irrigation channels, Canal &. Water containment liners. River bank erosion control	
Costal defences	Costal erosion	

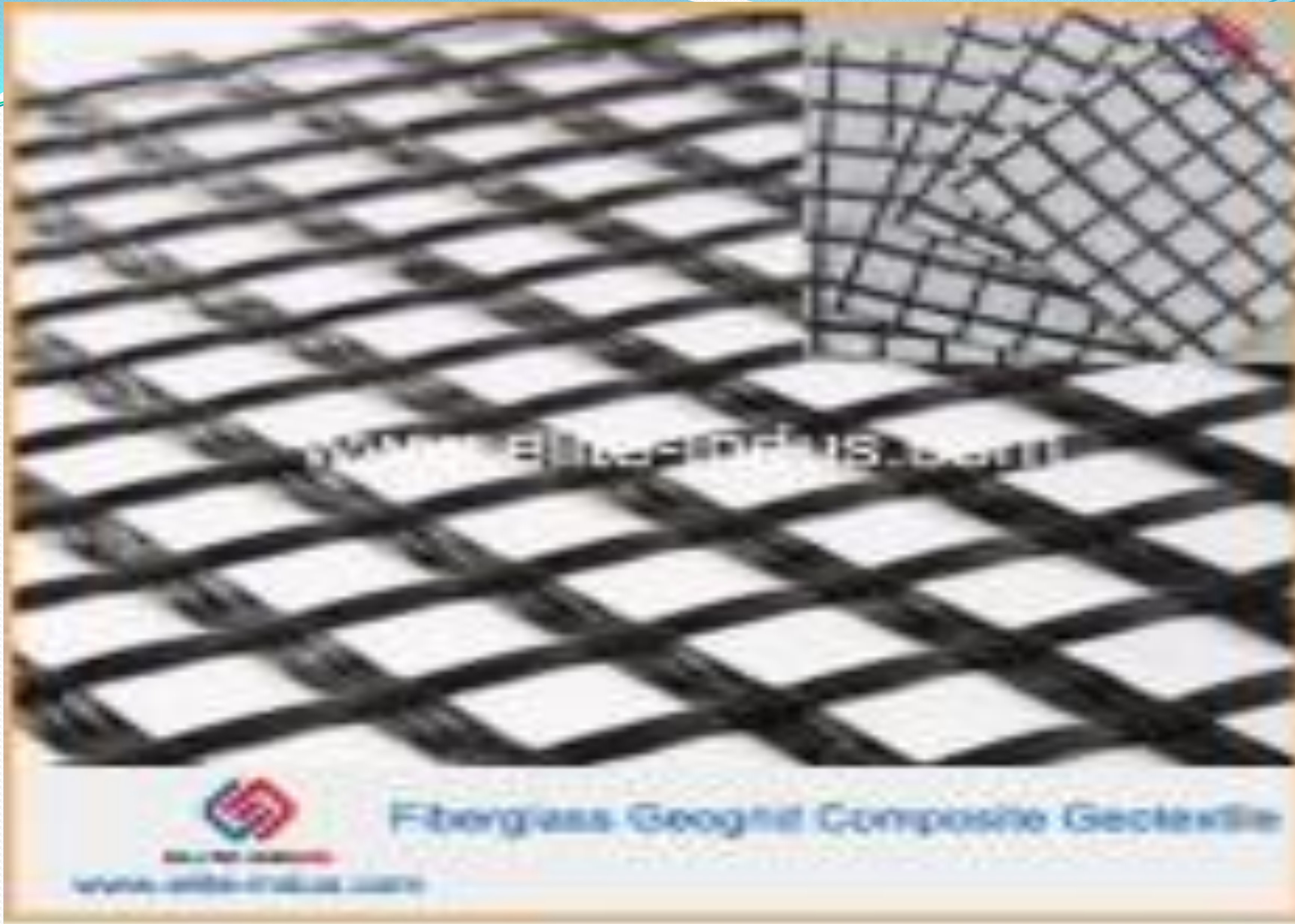


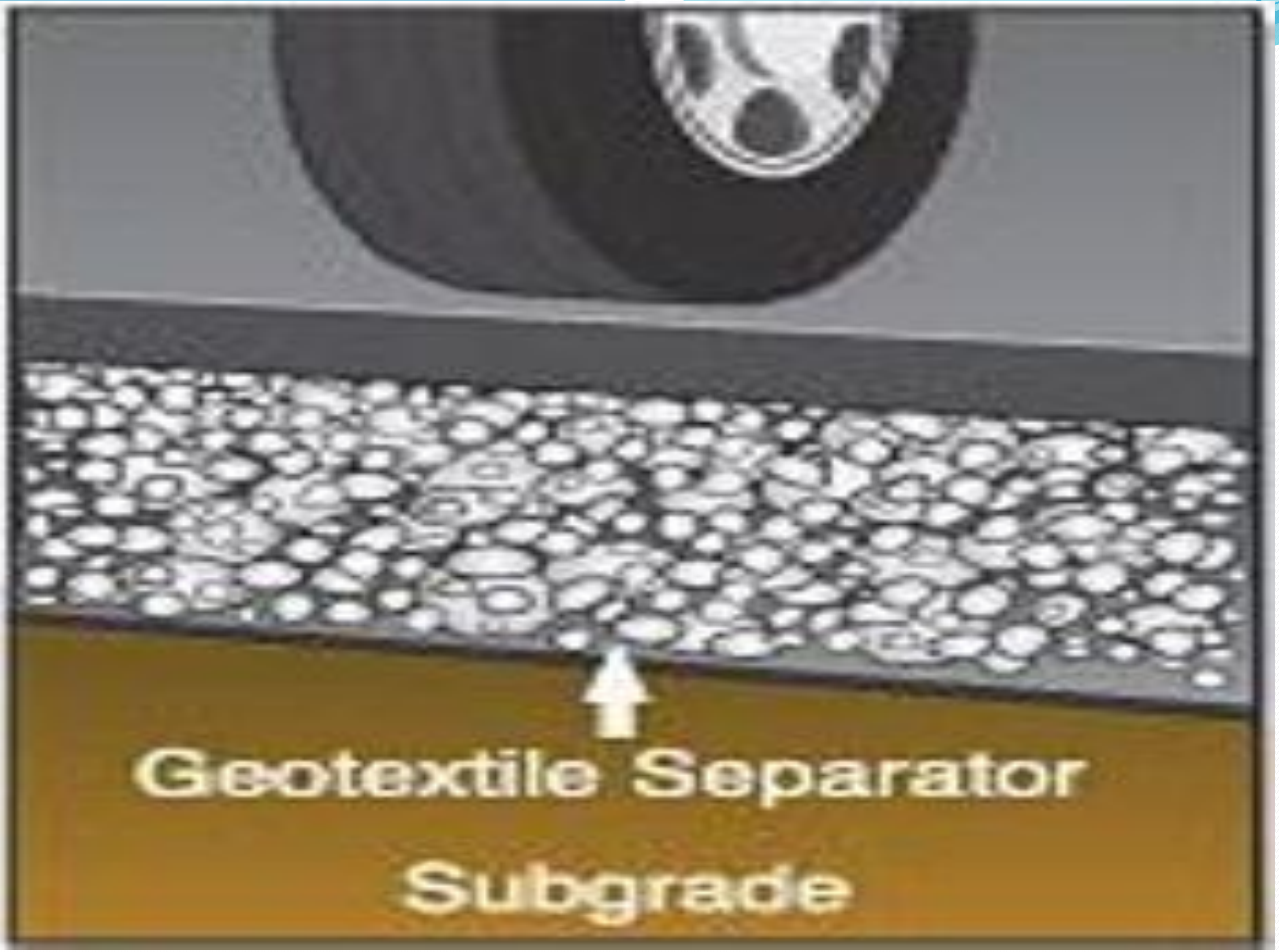
Source: A. Horrocks, S. Anand, "Handbook of Technical Textiles", Textile Institute Manchester, 367, 2000.


A Brief History of Geotextiles:
A 40-Year Update


TENAX
TENAX RF
TENAX RD
TENAX TDP
TENAX TENDRAIN • GMT
TENAX TENWEB
TENAX MULTIMAT
TENAX TR · TNT • TENAX CE




Fiberglass Geogrid Composite Geotextile


Geotextile Separator
Subgrade