SOIL IMPROVEMENT

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Introduction

The existing soil at a construction site may not always be totally suitable for supporting structures. Various techniques for improving soil are used to:

- Reduce the settlement of structures
- Improve the shear strength of soil and thus increase the bearing capacity of shallow foundations
- Increase the factor of safety against possible slope failure of embankments and earth dams
- Reduce the shrinkage and swelling of soils

Introduction

Compaction

Field Compaction: Ordinary compaction in the field is done by rollers.

Types:

- Smooth wheel rollers (or smooth drum rollers)
- Pneumatic rubber-tired rollers
- Sheepsfoot rollers
- Vibratory rollers

Soil compaction characteristics & recommended compaction equipment

General Soil Description	Unified Soil Classification	Compaction Characteristics	Recommended Compaction Equipment
Sand and sand–gravel mixtures (no silt or clay)	SW, SP, GW, GP	Good	Vibratory drum roller, vibratory rubber tire, or pneumatic tire equipment
Sand or sand–gravel with silt	SM, GM	Good	Vibratory drum roller, vibratory rubber tire, or pneumatic tire equipment
Sand or sand–gravel with clay	SC, GC	Good to fair	Pneumatic tire, vibratory rubber tire, or vibratory sheep's-foot equipment
Silt	ML	Good to poor	Pneumatic tire, vibratory rubber tire, or vibratory sheep's-foot equipment
	MH	Fair to poor	Pneumatic tire, vibratory rubber tire, or vibratory sheep's-foot, sheep's-foot-type equipment
Clay	CL	Good to fair	Pneumatic tire, sheep's-foot, vibratory rubber tire, or vibratory sheep's-foot equipment
Organic soil	CH	Fair to poor	
	OL, OH, PT	Not recommended for structural earth fill	

Vibroflotation

The process involves the use of a vibroflot (called the vibrating unit), which is about 2m in length. Compaction process:

- The jet at the bottom of the vibroflot is turned on and the vibroflot is lowered into the ground.
- The water jet creates a quick condition in the soil, which allows the vibrating unit to sink.
- Granular material is poured into the top of the hole. The water from the lower jet is transferred to the jet at the top of the vibrating unit. This water carries the granular material down the hole.
- The vibrating unit is gradually raised in about 0.3m lifts and held vibrating for about 30 seconds at a time. This process compacts the soil to the desired unit weight.

Precompression

When highly compressible, normally consolidated clayey soil layers lie at a limited depth and large consolidation settlements are expected as a result of the construction, precompression of soil may be used to minimise post-construction settlement.

Sand Drains

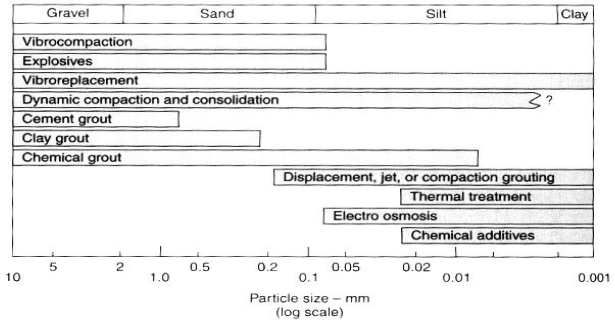
- The use of sand drains is another way to accelerate the consolidation settlement of soft, normally consolidated clay layers and achieve precompression before foundation construction.
- Sand drains are constructed by drilling holes through the clay layers in the field at regular intervals. The holes are then backfilled with highly permeable sand.
- After backfilling the drill holes with sand, a surcharge is applied at the ground surface.
- This surcharge will increase the pore water pressure in the clay.
- The excess pore water pressure in the clay will be dissipated by drainage, both vertically and radially to the sand drains which accelerates settlement of the clay layer.

Soil Stabilisation by Admixtures

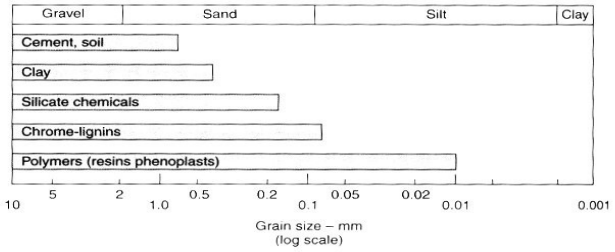
- Admixtures are used to stabilise soils in the field especially fine-grained soils. The most common admixtures are lime, cement and lime-fly ash. The main purposes of soil stabilisation are to
  - a) modify the soil,
  - b) accelerate construction and
  - c) improve the strength and durability of the soil.
- Lime Stabilisation
- Cement Stabilisation
- Fly Ash Stabilisation

- *Stone Columns*
  - To increase the load-bearing capacity of shallow foundations on soft clay layers, stone columns are used.
- *Foundations on Granular Trenches*
  - When the width of a foundation is relatively small and is constructed over soft clay soil, to prevent it from undergoing undesirable settlement and to increase its allowable bearing capacity, it can be constructed over granular (sand) trenches made in the soft clay.

- *Dynamic Compaction*
  - This process involves dropping a heavy weight repeatedly on the ground at regular intervals. The degree of compaction achieved depends on the
    - weight of the hammer
    - height of hammer drop
    - spacing of locations at which the hammer is dropped



(a) Methods and particle-size range for in-place treatment of soils

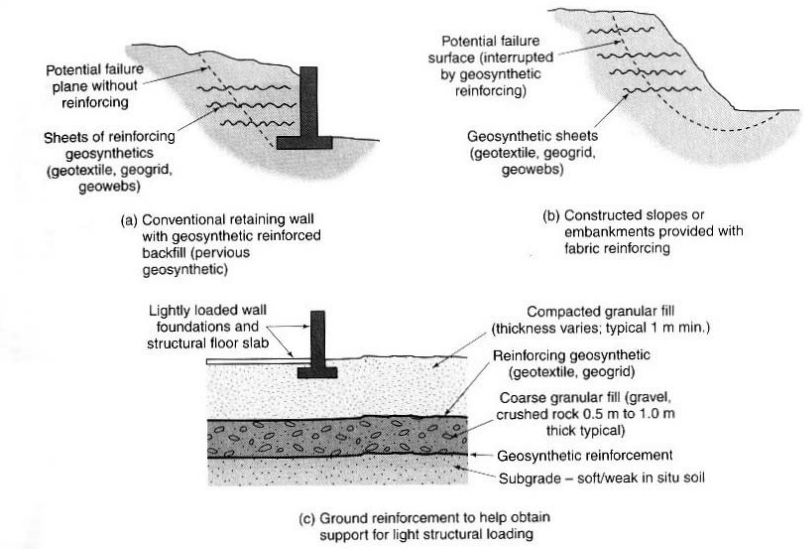


(b) Particle size ranges to which different grout materials apply

Geosynthetics

- Are:
  - Geotextiles
  - Geomembranes
  - Geogrids
  - Geonets
  - Geocomposites
- Major Functions:
  - Separation
  - Reinforcement
  - Filtration
  - Drainage
  - Moisture barrier

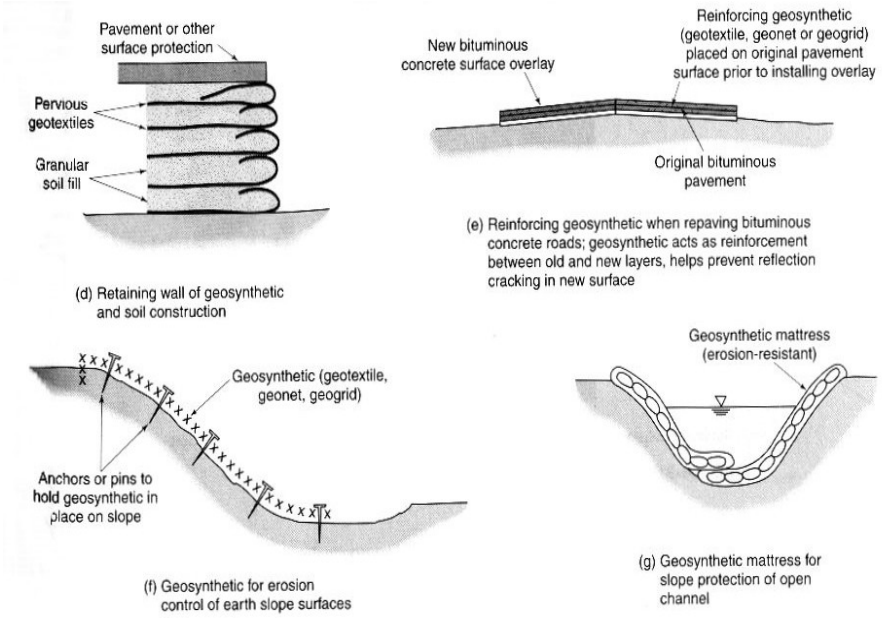
Use of geosynthetics



(a) Conventional retaining wall with geosynthetic reinforced backfill (pervious geosynthetic)

(b) Constructed slopes or embankments provided with fabric reinforcing

(c) Ground reinforcement to help obtain support for light structural loading



(d) Retaining wall of geosynthetic and soil construction

(e) Reinforcing geosynthetic when repaving bituminous concrete roads; geosynthetic acts as reinforcement between old and new layers, helps prevent reflection cracking in new surface

(f) Geosynthetic for erosion control of earth slope surfaces

(g) Geosynthetic mattress for slope protection of open channel