Geotechnical Engineering I
CE 341

What do we learn in this course?

- Introduction to Geotechnical Engineering (1)
- Formation, Soil Composition, Type and Identification of Soils (2)
- Soil Structure and Fabric (1)
- Index (1)
- Properties of Soil (1)
- Engineering Classification of Soils (2)
- Compaction (3)
- Principles of Total and Effective Stresses (1)

What do we learn in this course?

- Permeability and Seepage (4)
- Stress-Strain-strength Characteristics of Soils (4)
- Compressibility and Settlement Behaviour of Soils (4)
- Lateral Earth Pressure (3)
- Stress Distribution (2)

Structural composition of Soil

- Influences engineering properties of soil, such as
  - Permeability
  - Compressibility
  - Shear strength

Structure of the Soil

- It is the property that produces a response to external changes in the enviroment

Soil Structure

- Soil structure may be defined as
  - the geometrical and skeletal arrangement of the particles
  - Interparticle forces that may act on them
- Soil structure includes
  - Gradation
  - Arrangement of particles
  - Void ratio
  - Bonding agents
  - Associated electrical forces

Common Soil Structures:

- Single grain structure
- Honeycomb structure

} CG

- Flocculated structure
- Dispersed structure
- Packet or ped

} FG

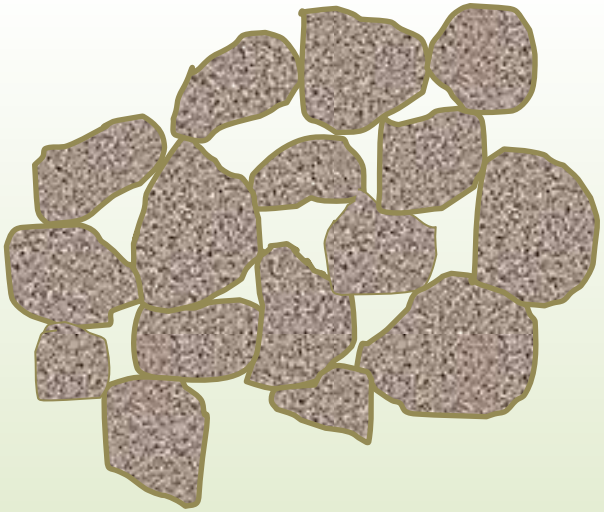
CG: Coarse grained; FG: Fine grained

Cohesionless/Cohesive

- Coarse grained soil: Cohessionless
- Fine grained soil: cohesive

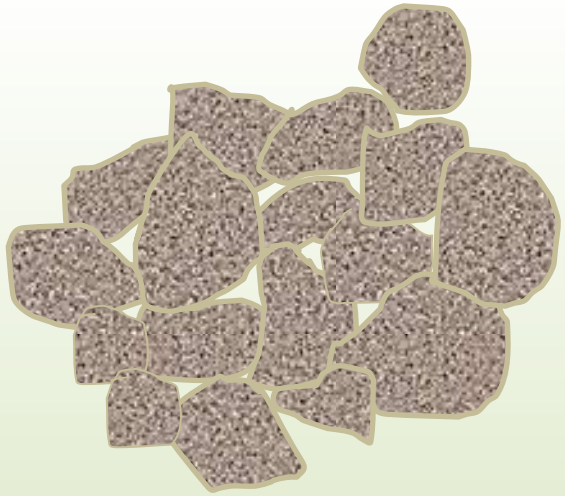
Soil Structure: Coarse Grained Soil (1)

Single grain structure: Primary structure of Coarse grained soil



(a) Loose

Typically formed in quiet water or may result when dense deposits are disturbed (e.g., landslides)



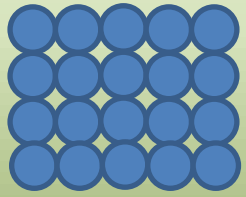
(b) Dense

Usually built in active water environment

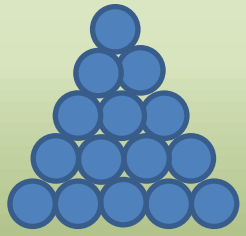
Stability of individual particles depends on their mode of deposition.

Single grain Structure

- In single grain structure,
  - Particles are in stable positions
  - Each particle are in contact with surrounding particles
  - Denseness of packing (void ratio) depends on
    - Shape and size of particles
    - relative position of the particles



Cubic Packing, void ratio = 0.91



Pyramidal Packing, void ratio = 0.35

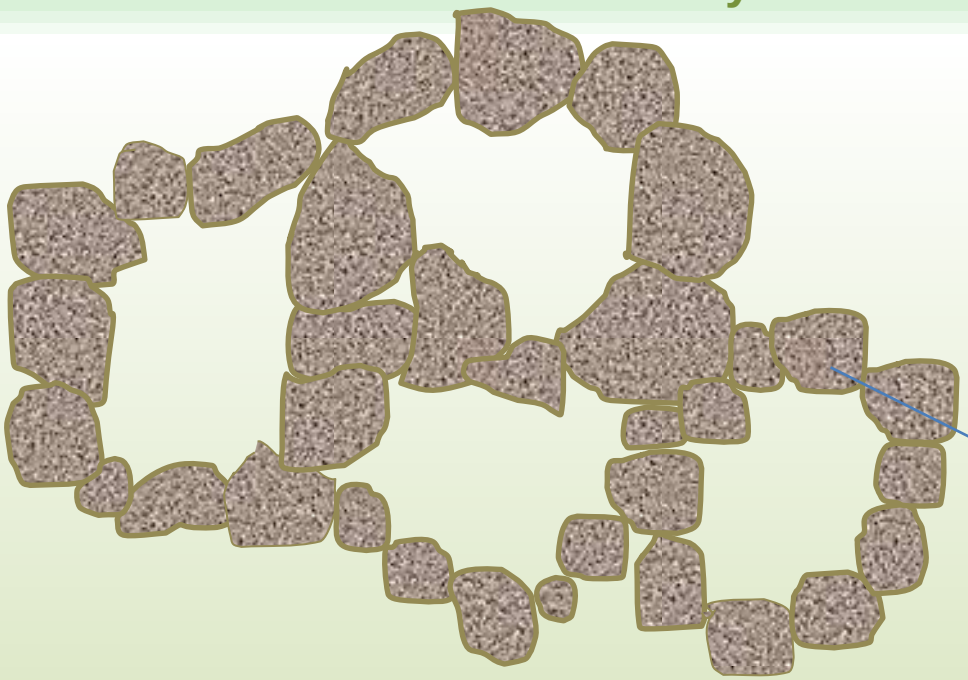
Single Grain Structure

- In real soil,
  - Particle shape: not sphere
  - Particle size: all particles are not of same size.

Real Soil	Equal Spheres	Remarks
Smaller particles occupy the spaces between the larger ones.	All particles are of same size and shape	Real soil has relatively low void ratio.
Irregular shape of particle		Real soil has increased void ratio than ideal sphere arrangement.

Soil Structure: Coarse Grained Soil (2)

Honeycomb structure



- Very open structure
- Very fine sand and silt may assume this configuration

Results during deposition of these materials: Gravitational forces < inter-particle attractive forces

The term ‘metastable’ is sometimes used to describe this configuration

Because of its inherent sensitivity to even the most minor disturbance

This configuration is often firm and strong, but unworkable during excavation, as the primary structure breaks down.

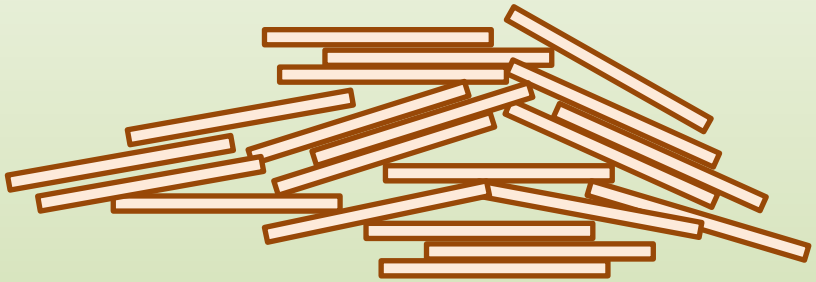
Honey-comb Structure

- Found in fine sand and silt deposits
- In honey-comb structure,
  - Large void ratio
  - Negative relative density

Type of load	Performance of honey-comb structure
Static load (ordinary)	Soil structure can carry the load.
Heavy load or shock loading	Soil structure breaks down, large settlement results.

Soil structure of cohesive soil

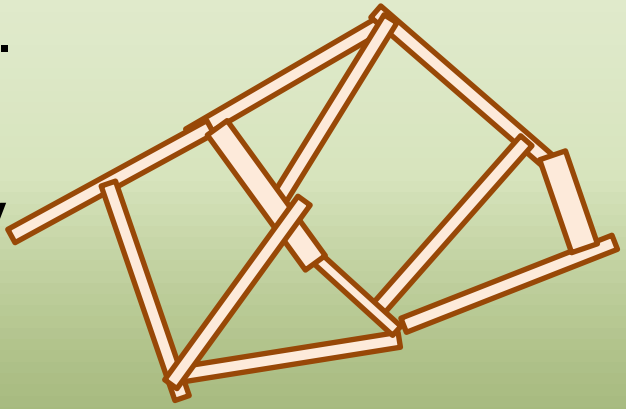
- Dispersed Structure
  - Formed by the settling of individual particles
  - Particle orientation: more or less parallel to each other



Soil structure of cohesive soil

- Flocculent Structure
  - Initially dispersed clay particles in water → come to close to each other during random motion in suspension
  - Then particles might tend to aggregate into visible flocs with edge-to-edge contact
  - Particles are held together by electrostatic attraction (+vely charged edge to –vely charged edge)
  - This condition is called flocculation.
  - Flocs become large,

  then they settle under force of gravity



Structure of cohesive soil

- Clays with flocculent structure
  - Lightweight
  - Possess high void ratio
  - If formed in the sea, highly flocculent

If sediment formed in freshwater, soil has an intermediate structure between dispersed and flocculent.

Index and Consistency of Soil