Geotechnical Engineering–I

BSc Civil Engineering – 4th Semester

Lecture # 1

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by

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Lecture Handouts: https://groups.google.com/d/forum/geotec-1

Evaluation

- Mid-Term Exam (30%)
- End Term Exam (60%)
- Class Participation (10%)
  - Quizzes
  - Assignment
  - Viva voce
  - Attendance

Suggested Reference Books

1- Principles of Geotechnical Engineering

(Braja M. Das)

2- Geotechnical Engineering: Principles & Practices

(Donald P. Coduto)

3- Fundamentals of Soil Mechanics

(M.S. Qureshi & Aziz Akbar)

INTRODUCTION

Soil

ASTM D 653 defines soils as "(earth), sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter."

Each soil, like human fingerprints, is unique.

INTRODUCTION

Soil Mechanics

Soil mechanics is a branch of Civil Engineering concerned with the study of soil and its behavior under different types of loads using the principles of engineering mechanics, fluid mechanics, mechanics of dynamics, thermal dynamics, etc.

Geotechnical Engineering

Geotechnical engineering deals with the application of soil mechanics to civil engineering field problems.

Soil mechanics is a science, but its application is an art.

(Karl Terzaghi)

Homework Assignment

1. What are the typical soil related problems that Civil Engineers have to deal with? (at least 3 unique)

2. What are the typical soil failures; i.e. failures caused to civil structures due to failure of soil?

Soil Formation

Soil is formed due to the *weathering* of rocks.

Weathering

Weathering is a process whereby an intact rock mass is decomposed or broken into a loose material by the action of various atmospheric agents.

Types of Weathering

1. Mechanical/Physical Weathering
2. Chemical Weathering

Mechanical Weathering

Mechanical weathering agents;

1. Temperature changes
2. Freezing & Thawing
3. Erosion/Abrasion due to flowing of water/wind
4. Natural disasters (landsides, earthquakes, etc)
5. Activities by plants, animals, humans, etc.

- Soils formed by mechanical weathering have the same composition as that of the parent rock.
- Soils formed by mechanical weathering retains the minerals and material fibers as that of the parent rock.
- Coarse grained soils (gravels, sands and their mixtures) are the examples of mechanical weathering.

Chemical Weathering

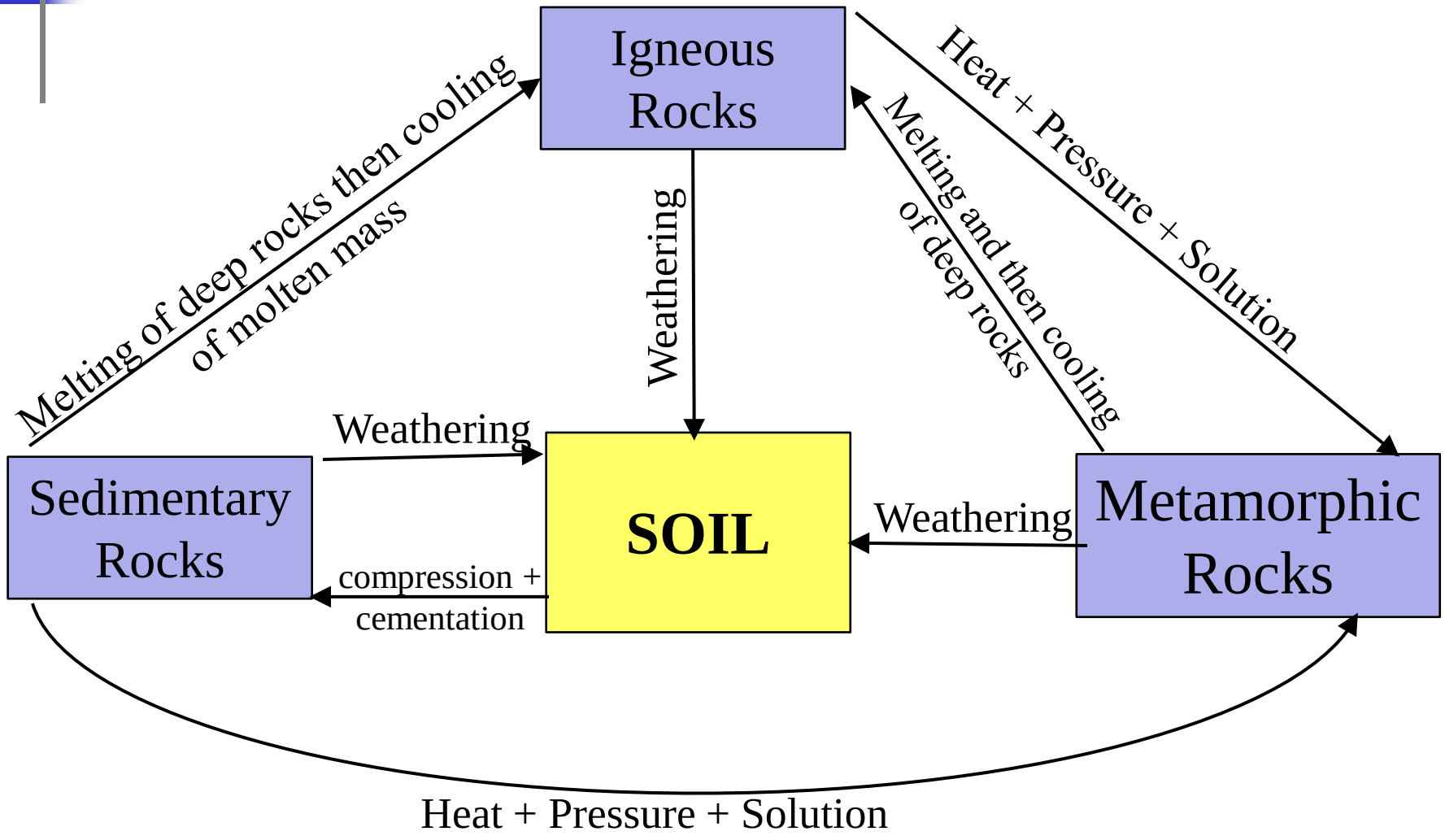
- Weathering caused by decomposition of rock mineral by different chemical processes such as oxidation, hydration, carbonation, leaching, solution, etc is known as chemical weathering.
- Different types of clays and organic soils are the common soils formed by chemical weathering.

Chemical weathering processes;

1. Oxidation
2. Carbonation
3. Hydration
4. Leaching
5. Solution

(Search for single line definition of the these + major problems associated with them)

Rock-Soil Cycle



Soil Deposits

1. Residual soil deposits
    i. Coarse grained
    ii. Fine grained
2. Transported soil deposits
    i. Alluvial deposits
    ii. Aolean deposits
    iii. Colluvial deposits
    iv. Glacial deposits
    v. Lucastrine deposits
    vi. Marine deposits
    vii. Pyroclastic deposits
3. Organic soil deposits
    i. Peat (partially decomposed organic matter)
    ii. Muck (completely decomposed organic matter)

Residual vs Transported Soils

Residual soils

Deposited at the place of decomposition.

- Properties of *coarse grained soils* generally depend upon size of particles.
- Properties of *fine-grained soils* are greatly influenced by mineral content, moisture content, etc.
- The knowledge of "classical" geotechnical engineering is mostly based on behavior of transported soils. The understanding of residual soils is insufficient in general.

Transported soils

Moved and deposited at other places.

- Particle size generally depends on mode of transportation
- The transported soils can be categorize based on the mode of transportation and deposition.

Transported Soils

1. **Glacial soils**: formed by transportation and deposition of glaciers.
2. **Alluvial soils**: transported by running water and deposited along streams.
3. **Lacustrine soils**: formed by deposition in quiet lakes.
4. **Marine soils**: formed by deposition in the seas.
5. **Aeolian soils**: transported and deposited by the wind.
6. **Colluvial soils**: formed by movement of soil from its original place by gravity, such as during landslide.
7. **Pyroclastic soils**: materials ejected from volcanoes, and transported through gravity and wind, etc.

Soil Texture & Soil Structure

Soil Texture

1. Coarse textured soils (sands, gravels, etc)
2. Fine textured soils (silts, clays)

Inter-Particle Forces

1. Weight of soil particles, F_g
2. Particle surface forces, F_s

$F_g \; \alpha \; (Dia)^3$

$F_s \; \alpha \; (Dia)^2$

$F_g / F_s \; \alpha \; Dia$

- In case of coarse textured soils F_g is dominating.
- In case of fine textured soils F_s dominates.

Soil Fabric: geometric arrangement of soil particles.

Soil Structure: geometric arrangement + inter-particle forces

Types of Soil Structures

1. Single grained structure
2. Honey-combed structure
3. Flocculent structure

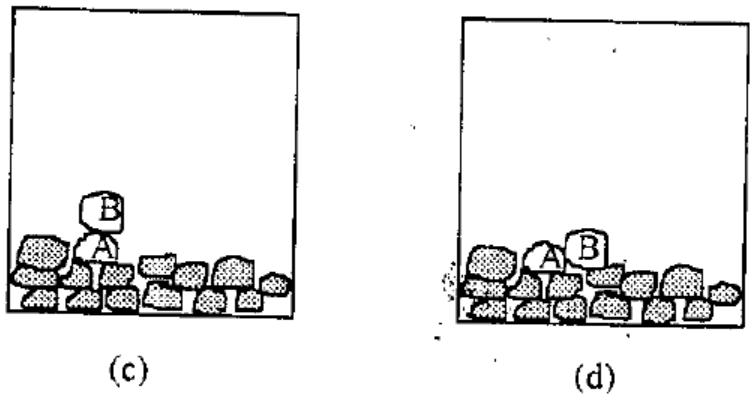


Figure 2.1 Single-grained soil structures.

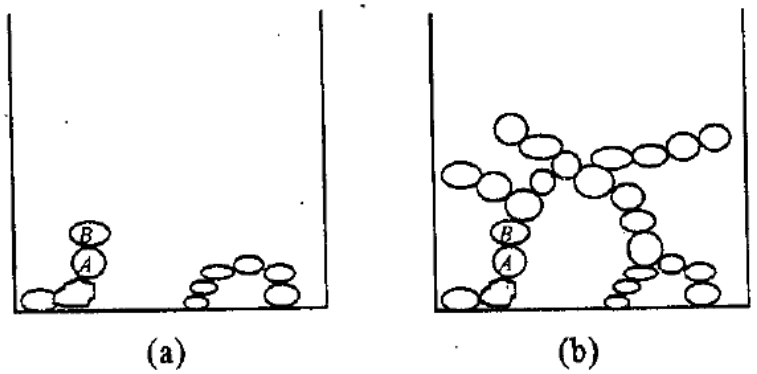


Figure 2.2 Honey-combed structure

Types of Soil Structures (contd…)

Single Grained Structure

- Formed by the suspension of coarse-grained particles in a soil-fluid suspension.
- Generally formed by cohesionless particles (e.g. sands)
- In loose form soils may be weak and unstable but quality can be improved by compaction.

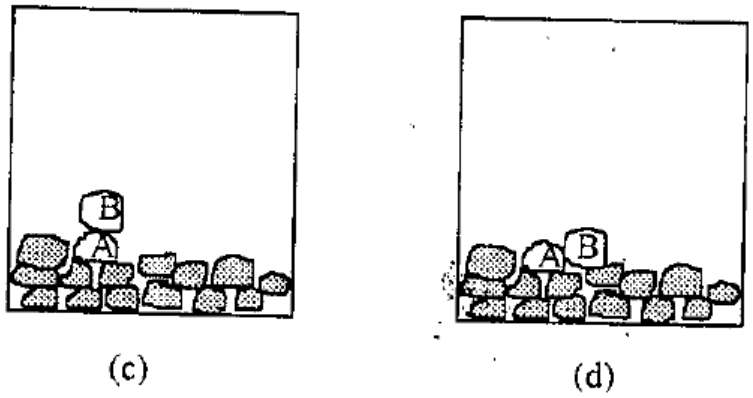


Figure 2.1 Single-grained soil structures.

Types of Soil Structures (contd…)

Honey Combed/Cellular Structure

- Formed by the particles having inter-particular attraction (cohesion) greater than their weight.
- Structure having large voids inside.
- Meta-stable structure.
- May be stable under static loads but can fail upon vibrations or dynamic load application.

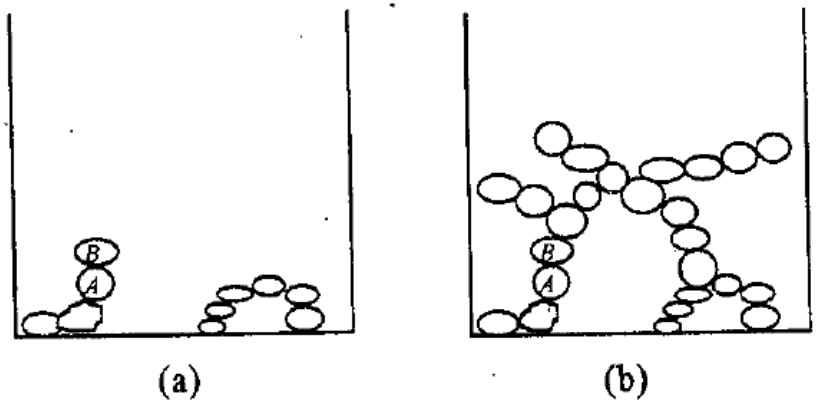


Figure 2.2 Honey-combed structure

Types of Soil Structures (contd…)

Flocculent Structure

- Formed by very small sized particles (< $5x10^{-4}$cm)
- Soil particles floating at the surface join together and form *flocs*. Settling down of *flocs* give rise to flocculent structure.
- Double-honey combed structure.

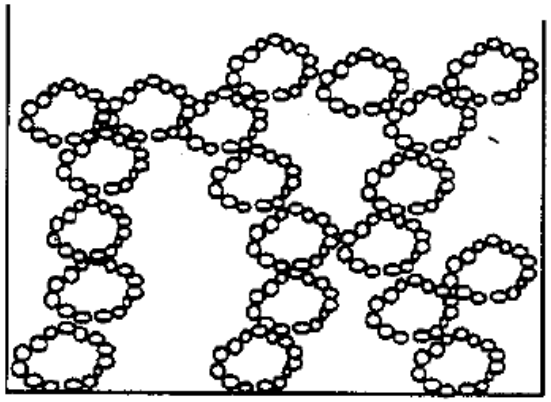


Figure 2.3 Flocculent structure

Common Clay Minerals

1. Kaolinite
2. Illite
3. Montmorillonite

(details from *Fundamentals of Soil Mechanics* by *Qureshi & Akbar*)

CONCLUDED