Introduction: Overview of Soil Mechanics

A. What is "soil"?

1) Not "dirt"!

2) Soil is unconsolidated earthen material comprised of discrete mineral grains and decayed organic matter, along with interstitial gases and liquids.

   −> If the grains are "permanently" bonded or cemented together, the material is called "rock" or "stone".

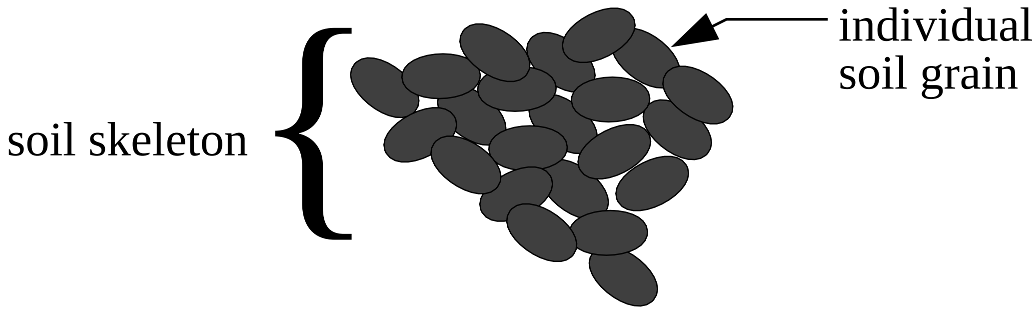
3) Soils tend to be fairly complex and heterogeneous materials which feature a wide range of mechanical behaviors.

   −> Understanding and describing the behavior of soils is the challenge being addressed in this course!

4) In general, 3 phases comprise soil:

   −> solid: the soil grains
   −> fluid: the pore fluid (typically water)
   −> gas : the pore gas (typically air)

a)When individual soil grains are loosely bonded together, they form a "structure" or "skeleton" which can transmit loads via contact between particles.



b) When loads are applied to the soil skeleton, deformations occur.

-> Typically, 95−100% of the total deformation is caused by relative motion, or sliding, of individual soil grains.

-> The remaining 0−5% of the overall soil deformation is typically caused by deformation of the individual soil grains.

5) There are many different types of soils, and the difference lies primarily in the size of the grains and the nature of the bonding between them. (See table on the following page)

-> We will learn how the difference between grain sizes and types of inter−grain bonding can explain many of the mechanical soil behaviors that we will observe.

Main Classes of Soils

Soil Type	Type of Grains	Predominant Size	Intergrain Bonding
Gravels	quartz, feldspars, rounded and/or angular	2mm < D < 76mm	Frictional
Sands	same as above	.075mm < D < 2mm	Frictional & chemical
Silts	primarily quartz flake-like grains	$2\mu m$ < D < 2mm	Frictional, chemical, electrical
Clays	micah, kaolinite, bentonite, etc. very small plate-like grains	D < $2\mu m$	Chemical & electrical

Note: D = grain size or diameter

B. What is "soil mechanics"?

-> Soil mechanics is the study of the both the solid and fluid mechanical characteristics of soils.

-> Solid Mechanics Issues:

- How much will soil deform when it is loaded?
- When loads are applied, on what time scale does soil deform?
- How much load can we apply to soil before it fails?
- How does soil "fail"?

-> Fluid Mechanics Issues:

- How does water flow through soil? (how fast?)
- How can fluid flow through soil cause it to fail?

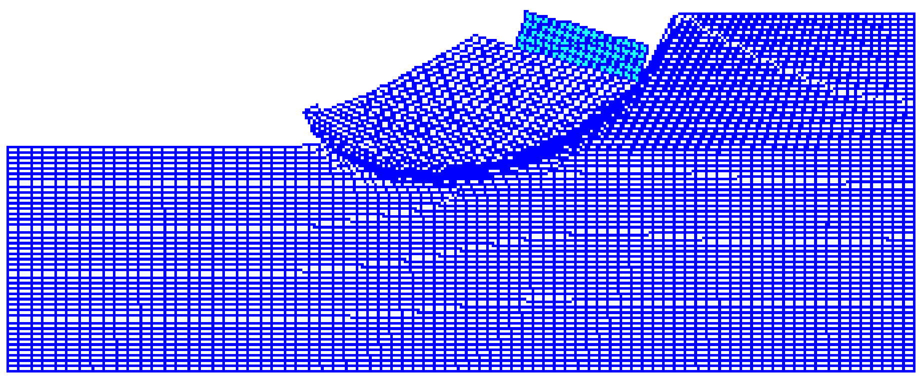
C. Why do we, as engineers, study "soil mechanics"?

In brief, because all branches of civil engineering require an understanding of soil and how it behaves.

1) Structural Engineering:

Virtually all CE type structures eventually come into contact with soil via their foundations. (i.e. bridges, office buildings, offshore drilling rigs, etc.)

Knowledge of soil mechanics is essential to assure that the structures are properly supported. This can preclude structural damage & failure, loss of life, financial ruin, etc.



2) Transportation Engineering:

Roadbeds are built of soil,and the roadways themselves can often pass through mountains,cuts, fills, etc.

Understanding soil mechanics can preclude problems with pavement potholing and cracking, as well embankment or slope failures that can wipe out entire roadways.

3) Environmental Engineering:

- Liquid toxins or pollutants are often spilled or dumped inadvertently onto soil.

- As a result, important questions that need to be answered are:

  −> Will the pollutants remain in place, or possibly be transported through the soil? If so, on what time scale?

  −> Can anything be done to clean up the pollution?

4) Hydraulic Engineering:

The design of earthen flow retention structures such as dams, levees, dikes, holding ponds, etc. requires a knowledge of how water is transported through soil.

It also requires that we know how water flowing through soil can cause failure by such mechanisms as heaving, erosion, piping, and scour.

D. Scope of this Course:

−> The focus of this course is basic engineering science course, and not engineering design. However, there will be some basic design examples.

−> While we will not necessarily address the issues mentioned above in detail, the fundamentals of soil mechanics will be stressed. Therefore, in later courses or in engineering practice, the basic competence and understanding will be in place.

E. Primary Course Objectives:

To facilitate learning about soil and its importance in civil engineering:

- −> What it is soil?
- −> How does it behave mechanically?
- −> Why does it behave that way?
- −> How to measure its properties?
- −> How to apply this understanding to solve some basic engineering problems.

Methods for achieving learning objectives:

- −> Reading/studying the materials
- −> Class periods and notes (questions during class are encouraged)
- −> Solving homework problems
- −> Laboratories, both performing the experiments and processing data for the writeups
- −> Studying for exams

F. Course Overview

Periods 1 − 6: Soil identification,characteristics,consistency
Periods 7 −14: Fluid flow in soil; fluid & solid stresses
Periods 15−18: Compressibility of soil
Periods 19−24: Shear strength of soil
Periods 25−28: Soil Compaction & Improvement