

Geotechnical Engineering I

Dr. Naser A. Al-Shayea

Professor, CE, KFUPM

Introduction

- Scope of the Course
- Definitions
- Soil Composition
- Soil Formation and Identification
- Clay Minerals
- Nature and Behavior of Soil Materials

Scope of the Course

- Definitions
- Examples

Definitions

- **Geotechnical Engineering** : application of CE technology to some aspect of the earth
 - young discipline
 - 1- **Soil mechanics** – Eng. Mechanics & prop. of soil materials.
 - 2- **Foundation Eng.**
 - Analysis & design of foundation (science)
 - soil mechanics
 - str. eng.
 - geology
 - Earth structures (art)

Definitions

- Soil is the relatively loose materials, extending from ground surface down to solid rock (bed rock)
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EXAPLES

- Frozen ground
- Soil erosion
- Diff. Set. (BH # 3 organic soil layer)
- Pavement
- Foundations

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Soil Materials

- Soil is the oldest building material
- Soil supports all structures
- Detailed knowledge of soils at a site
 - Physical properties
 - Mechanical
 - Hydrological
- Soil formation: by weathering & disintegration from solid rock.
 - Differ → parent materials
 - weathering processes
 - transportation agents
 - glaciers
 - water
 - wind
- Soil profile ⇒ land forms (topographic features)

Mechanical properties

- Geotechnical properties of soils are required for the analysis & design of:
 - Foundations
 - Earth Dams
 - Excavations
 - Retaining Structures
- Stability of soil masses
 - -slope stability, highways cuts
- Load transfer & bearing capacity
 - Structures
 - superstructures
 - substructures (**foundation**): interfaces with ground
 - transferring load from superstructure to soil
 - economical
 - safe

Hydrological properties

- Seepage: flow of water through soil
 - movement under influence of gravity
 - degree of saturation
 - groundwater table (GWT)
 - Permeability
 - Drainage, discharge (quantity)

Soil Formation

- Origin & Formation of Soils
 - soil minerals : derived from rocks through weathering
 - parent rocks
 - igneous
 - sedimentary (layers)
 - Metamorphic
 - [Table 1.1](#)
- Geological cycle
 - Weathering
 - Erosion Transportation
 - Deposition
 - Consolidation
- [Sketch](#)

Weathering processes

- Disintegration (physical)
 - temp. change
 - freezing & thawing
 - drying
- Decomposition (chemical)
 - oxidation
 - hydration
 - carbonation
 - chemical effects of plants
- Biological
- Parameters
 - climate
 - topography
 - time
 - geologic history
 - rock type
- [Table 1.2](#)

Deposition

Erosion/Transportation processes

- Water
- Wind
- Glaciers
- Gravity

Soil Deposits

- Geol. Origin → physical characteristics
- Residual Soils
- Transported soils

Residual Soil

- Formed in-place (Not transported) No erosion
- Type of parent rock
 - Igneous
 - Granites
 - sand
 - Silt
 - kaolinite clay & mica
 - Basalt
 - montmorillonite
 - Sedimentary rocks - limestone (CaCO_3)
 - dissolved & removed by groundwater + CO_2
 - cavities - caves
 - collapse - sink holes filled with debris
 - metamorphic rock - sand, silt, mica
gneiss & schist
marble – by solution
- Environmental conditions
- Thickness up to 20m
- Degree of weathering
 - @ surface feldspar, mica, ferromagnesium → clays
 - Joints, shear zones
- Depth of weathering
 - rock type
 - Permeability (porous, not impervious)
 - cementation

Transported Soil -1

- **Water-Transported Soils**
 - River deposits (alluvium, alluvial)
 - lake deposits (lacustrine)
 - sea deposits (marine)
- moving water
 - erode
 - transport
 - deposit
- Texture/shape rounded by abrasion
- Examples
 - alluvial fans: mountain streams enter flat country
 - natural levees: rapid deposition along the riverbanks
 - varved clay: uniform laminae of silt & clay
 - peat → marsh or bog
 - tidal lagoon
 - swamps

Transported Soil - 2

- **Wind–Transported Soils**
- dunes, ridges
- sorted – uniform size
- loose
- continual migration in the direction of the prevailing wind
- Loess : - high vertical porosity
- - hard (dry)
- - soft (wet)

Transported Soil - 3

- Soils of **Glacial** Origin
- continental glaciers North of 40th parallel
- ice sheets
 - excavated
 - mixed
 - Transported - loose rocks & soils
 - Deposited
- Till : soil materials deposited directly by ice
- glacial till ⇒ wide variation →
 - Texture
 - size: boulder – clay
- meltwater deposits → outwash
- varved clay
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- terminal or end moraines : accumulate ridge at face of the glacier
- remains of rivers flowed beneath or near the ice front
 - eskers : sinuous ridges
 - kames : conical hills

Special/problematic Soil

- Expansive soils: potential for great volume increase, when exposed to water
 - Ex. Montmorillonite clays & clay shales
- Collapsing soils: potential for great volume decrease, upon increasing moisture content, without any change in the external loads.
 - Ex. Loess, weakly cemented (soluble gypsum or halite) sand/silt.
 - Found in arid regions.
- Limestone & related materials: solubility & potential for cavity development (potential disasters)
- Quick clays: - great sensitivity to disturbance
 - significant strength reduction upon remolding
 - marine origin $S_t > 15$.
- Organic Soils: