EWCE 341

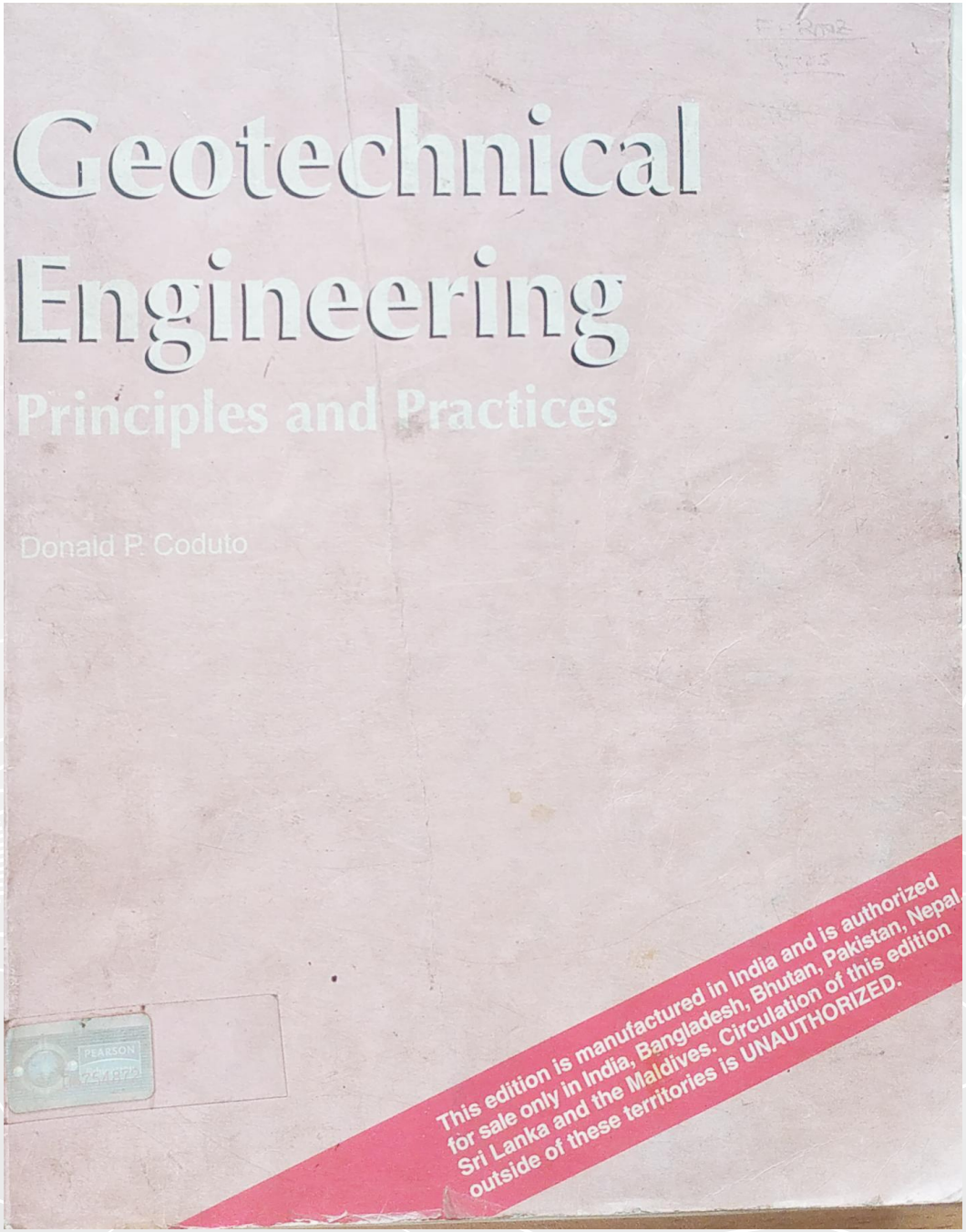
Principles of Soil Mechanics

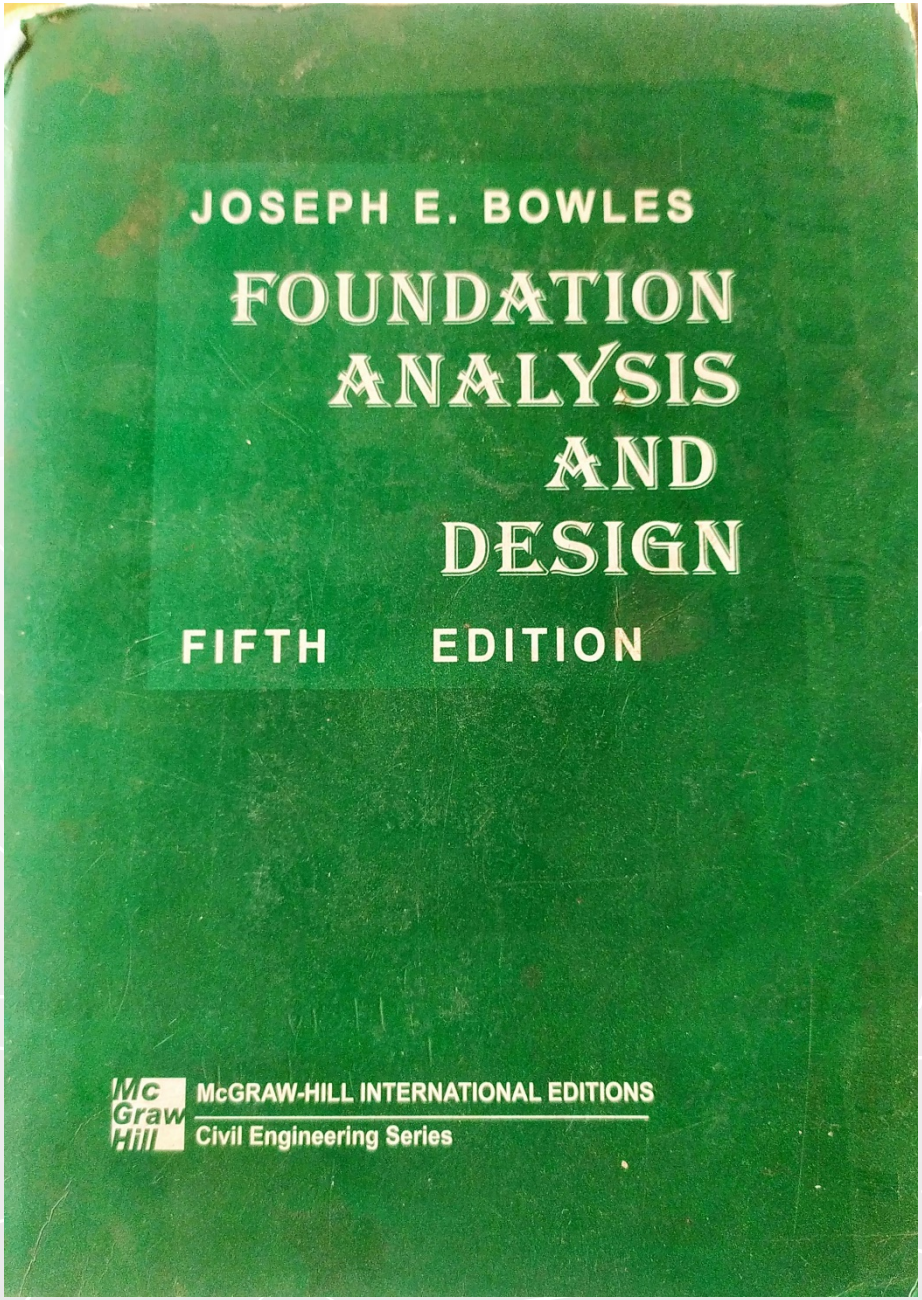
Syllabus

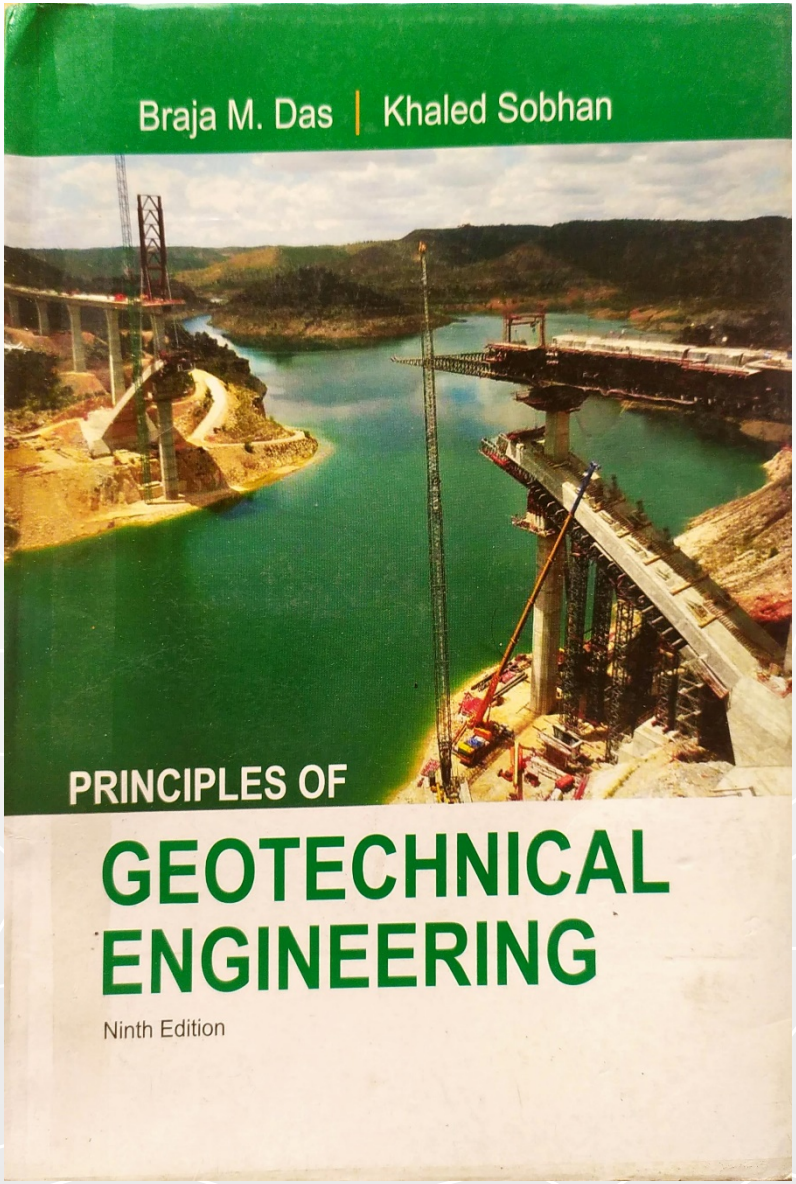
- **Scope** of Geotechnical Engineering
- Soil Mechanics and Foundation Engineering
- Soil Composition
- Soil **Compaction**
- Principles of total and effective **stresses**
- **Permeability** and **Seepage**
- **Compressibility** and **settlement** behavior of soil.

Reference Books

- Geotechnical Engineering, Principles and Practices, by **Donald P. Coduto**.
- Principles of Geotechnical Engineering, by **Braja M. Das, Khaled Sobhan.**
- Introduction to Soil Mechanics, by Brajs M Das.
- Advanced Soil Mechanics, by B M Das
- Physical and Geotechnical properties of Soils, 2nd Edition by **Joseph E. Vowels**
- A Text Book of Soil Mechanics & Foundation Engineering, 4th Edition, by VNS Murthy.
- Soil Mechanics and Foundation Engineering, by KR Arora.


Geotechnical Engineering
Principles and Practices
Donald P. Coduto
PEARSON
This edition is manufactured in India and is authorized for sale only in India, Bangladesh, Bhutan, Pakistan, Nepal, Sri Lanka and the Maldives. Circulation of this edition outside of these territories is UNAUTHORIZED.


JOSEPH E. BOWLES
FOUNDATION ANALYSIS AND DESIGN
FIFTH EDITION
McGRAW-HILL INTERNATIONAL EDITIONS
Civil Engineering Series


Braja M. Das | Khaled Sobhan
PRINCIPLES OF
GEOTECHNICAL
ENGINEERING
Ninth Edition

What we are going to discuss?

- **Soil & Rock and Soil as materials.**
- Soil Mechanics and its **need to study**.
- **Foundation Engineering and its scope**.
- Geotechnical Engineering, its **importance** and **concerned issues**.
- **Differences** between Soils & Rocks and other Civil Engineering Materials.
- Soil and Rock sizes.

What is soil?

What is Soil?

Soils are **aggregates of minerals/solid particles** and together with **air** and /or **water** in the void spaces, they form of **Three-Phase** system.

Aggregates- granular particles

Minerals- a solid element or compound that occurs naturally.



Soil as Materials and Rocks

Soil as materials-

Geologist:

- **Loose surface of the earth** produced by the gradual weathering of rock to produce sediments as distinguished from solid bedrock.

Agriculturist:

- **A** dynamic **natural body** on the surface of the earth in which **plants grow**, composed of **mineral** and **organic materials** and living forms.

Engineers:

- **Un-cemented aggregate** of mineral grains (**solid particles**) and **decayed organic matters** with **liquid and gas** in the empty spaces between the solid particles.
- **Support the foundation**.

Rocks: A rock is any **naturally occurring solid mass** or **consolidated aggregates of minerals or mineraloid.**

Mineraloids - A mineraloid is a naturally occurring mineral -like substance that **does not demonstrate crystallinity**.

Crystallinity - refers to the **degree of structural order** in a solid.



Soil Mechanics

Soil Mechanics

Definition:

Branch of Geotechnical Engineering that deals with the **engineering properties** of soils and its **behavior** under stress and strains.

Engineering Properties of soils comprises of:

- **Physical properties** (color, texture, structure etc.)
- **Index properties** (Sp. Gr, water content, particle size distribution etc.)
- **Shear strength parameters** (cohesion, angle of internal friction, vertical normal stress)
- **Permeability characteristics** (ability of soil to allow water to pass through it)
- **Consolidation** parameters.

Why do you need to Study Soil Mechanics?



Why do you need to study Soil Mechanics?

- Easily available **construction materials**.

  -Embankments, dams, road way and other similar structures.

- Safely **carry the loads** of any civil engineering structure.

Foundation Engineering

Foundation Engineering

Definition:

Branch of geotechnical engineering which **applies soil mechanics, structural engineering,** and **project serviceability requirements for design, construction, and maintenance** of foundations.





Scope of Foundation Engineering



Scope of Foundation Engineering:

- **Obtaining information** about the **superstructure** involved and the **loads** acting there on.
- **Collecting subsurface soil**.
- **Investigating** the **engineering properties** of the soil.
- Determine the **geotechnical input** for foundation design.
- **Studying the types of foundations required** in relation to the **load or structure**, **subsurface soil condition**.
- **Design** the foundation

Geotechnical Engineering

Geotechnical Engineering

Definition:

- Branch of **civil engineering** that deals with **soils**, **rocks** and **underground water**; and **their relation** to design, construction and operations of engineering projects.

Importance of studying of Geotechnical Engineering

- Almost all of the **civil engineering project** must be **supported by the ground**, hence all of us require at **least some knowledge** on geotechnical engineering.

Issues to be Addressed by Geotechnical Engineers

Issues to be addressed by the Geotechnical Engineers: (**SSG –IEFR-TEC**)

- What are the **soils and rocks** in the **subsurface** at the construction site?
- Can the soils and rocks beneath the construction site **can safely support** the projects?
- What **groundwater conditions** currently exist, how might they **change** in the future, and what **impact** do they have on the projects?
- What will be the **impact of any planned excavation**, **grading** and **filling**.
- Are the **natural or proposed earth slopes** are stable? If not, what must to be done to stabilize.

Issues to be addressed (cont..)

- What **kinds of foundations are necessary** to support the planned structures, and how **should to design them**?
- If the **project requires retaining walls**, what **kind** would be best and how to **design** them?
- If the project **requires a tunnel** or **underground opening**, how should it be excavated?
- How will the **site respond to potential earthquake**?
- Has the **ground become contaminated** with chemical or biological materials? Do they these materials represent **health or safety hazard**? If so, what must be done to rectify them?

Issues to be addressed by Geotechnical Engineers (summary): (SSG –IEFR-TEC)

- **Subsurface** conditions
- **Safely support** the project
- **Groundwater** conditions
- **Impact** planned soil disturbance
- **Earth slopes** stable
- **Foundation** Type
- **Retaining wall**
- **Tunnel** or opening in the ground
- **Earthquake**
- **Contaminated** ground

How Soil Mechanics help to Design Foundations

How does soil mechanics help to design the Foundation of Structures/Buildings?

All structures/buildings have to **be built on soils**.

- **Soil mechanics lays down certain principles, theories and procedures** for the design of a safe and sound substructure.

- **Foundation engineering deals with the design of various types of substructures/foundations** under different soil and environmental condition.

- **During design**, designer has to make use of the **properties of soils**, **theories pertaining to the design** and **his own practical experience** to **adjust** the design to suit the field condition.

- **Designer** has to **deal with the natural soil deposits**, which perform the engineering function of supporting the foundation and the superstructure above it.

- Soil deposits in nature are **available in an extremely erratic manner**, **producing** thereby, an **infinite variety** of possible combination which would **affect the choice and design of foundation.**

- Foundation engineer must have the ability to **interpret the principles of soil mechanics** to suit the field conditions.

Difference between Soil & Rocks and Other Engineering Materials

Differences in composition between Soils & rocks and other civil engineering materials:

- Soils and rocks are **natural materials**, **not manufactured** ones; most of the others are **manufactured** materials.

- Soils & rocks specially soils are **particulate materials** that consists of individual particles; most of the others are **continuous mass**.

- Soils & rocks can contain all the **three phases of matter (ie solid, liquid and gas) simultaneously** and can be present in varying proportion, where other materials are **solid mass**.

- Soil and rocks are **natural materials**, **not manufactured** ones;

most of the other civil engineering materials are manufactured materials.

-**Engineering properties** **of soil vary from place to place** even across a single building site.

-we cannot **sort out soils and rocks** but **must accommodate** what is present on site.

- Soil is a **particulate materials** that consists of individual particles.

-It is **not a continuous mass**.

- Some **rock strata** specially sedimentary rocks can also be treated as particulates.

-Even rock that appear to be continuous mass virtually **always contain cracks and fissures** that divide it into blocks.

- Soil can contain all the **three phases of matter** **(ie Solid, Liquid and Gas) simultaneously** and can be present in varying proportion.

-Rocks can also contain all three phases, although the liquid and gas phases **may be confined to the fissures**.

Soils as Particulate materials - Explanation

- **Most of the engineering materials** consists of:

  -**Continuous mass** held together with molecular bond, and

  -**Mechanical properties** of such materials depend on their **chemical make up** and the **nature of these bond**.

Example: Reinforcement bar

-**Shear strength of steel** depend on the strength of their molecular bond,

-their **shear failure** requires breaking them off.



Soil is a particulate material that consists of individual particles assembled together.

Its **engineering properties** depend on:

-**largely on interaction** between these particles.

-only **secondarily** on their **internal properties**.

Example: Gravel, sand, silts

- When **soils fail in shear**, they do:

-because of the **particles begin to roll and slide past each others**.

-**not because of the particles beak**, **breakage of individual particles** is typically minimal.

- **Shear strength of soil** depend on the following factors:

  -**coefficient of friction** between particles and

  -**tightness** of the of packing ie **compaction**.

  -Cohesion

- **Clays also have particulate structure** but the **nature of the particles is quite different.**

  -**much more interaction** between the particles and the pore water.

  -**behavior is more complex** than that of other.

Particle Sizes

Soil Particle Size

Name of the Organization	Grain Size (mm)			
	Gravel	Sand	Silt	Clay
Massachusetts Institute of Technology (MIT)	> 2	2 to 0.06	0.06 to 0.002	<0.002
US Department of Agriculture (USDA)	> 2	2 to 0.05	0.05 to 0.002	<0.002
American Association of State Highway and Transportation Officials (AASHTO)	76.2 to 2	2 to 0.075	0.075 to 0.002	<0.002
Unified Soil Classification System (USCS) (US Army Corps of Engineers, US Bureau of Reclamation, and American Society for Testing and Materials (ASTM))	**76.2 to 4.75**	**4.75 to 0.075**	**Fines (i.e. silts and clay) <0.075**	

Sieve opening of US **Sieve No. 4 is 4.75mm**. Sieve No. 10, 2mm and **Sieve No. 200**, is 0.075mm







Boulder > 256mm

Cobbles **76.2-256mm**

Gravel 76.2 to 4.75mm

Rock Fragments



Sand 4.75 to 0.075mm



Fines <0.075mm

(0.075m -0.002mm & < 0.002mm)

Thanks