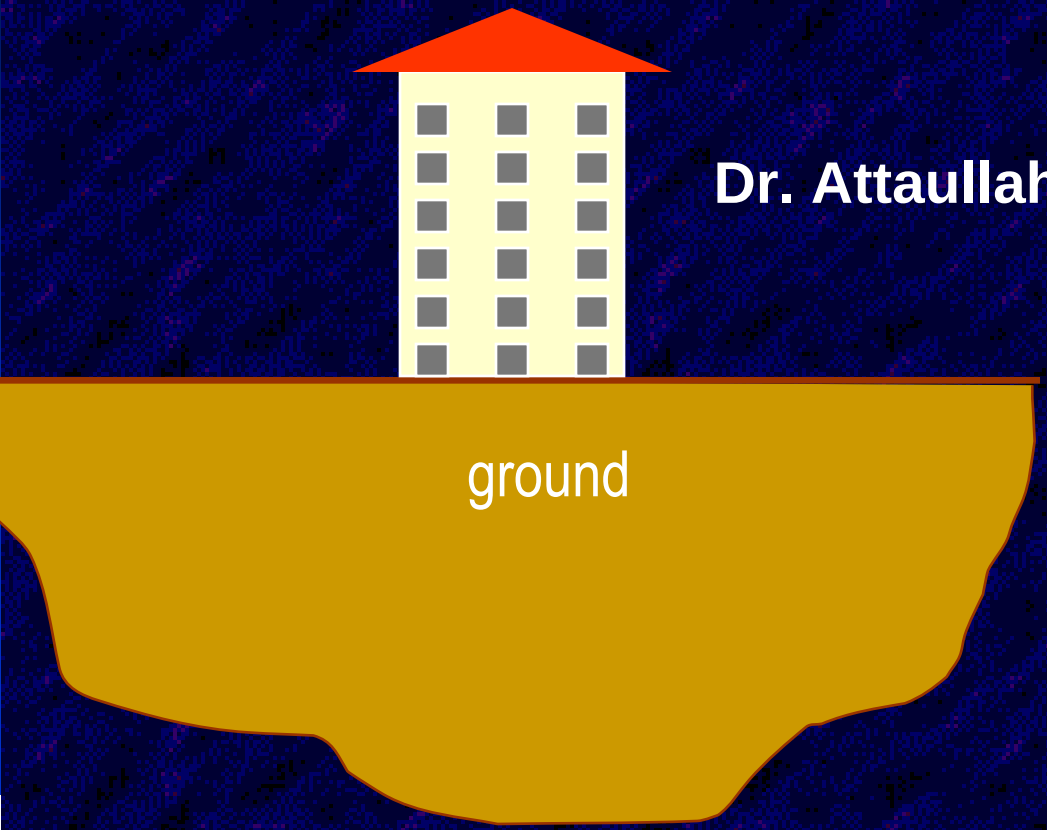
Introduction to Soil Mechanics Geotechnical Engineering



Dr. Attaullah Shah

Soil Mechanics= Soil+Mechanics

- Branch of Science dealing with the structure, Engineering properties and reactions (behavior) of soils under loading and weathering.
- Which studies theoretically and practically soils for building of structures over it.
- Knowledge of physics, mechanics, and hydraulics applied to study the behavior of soils.
- Also called Geo-Technique (Geo-Tech Engineering)
- Studies the mutual interaction of soils and structure.
- The practice of Engineering which applies the principles of soil mechanics to the design of engineering structures is called soil mechanics Engineering or Geo-technical Engineering.

Objectives of Soil Mechanics

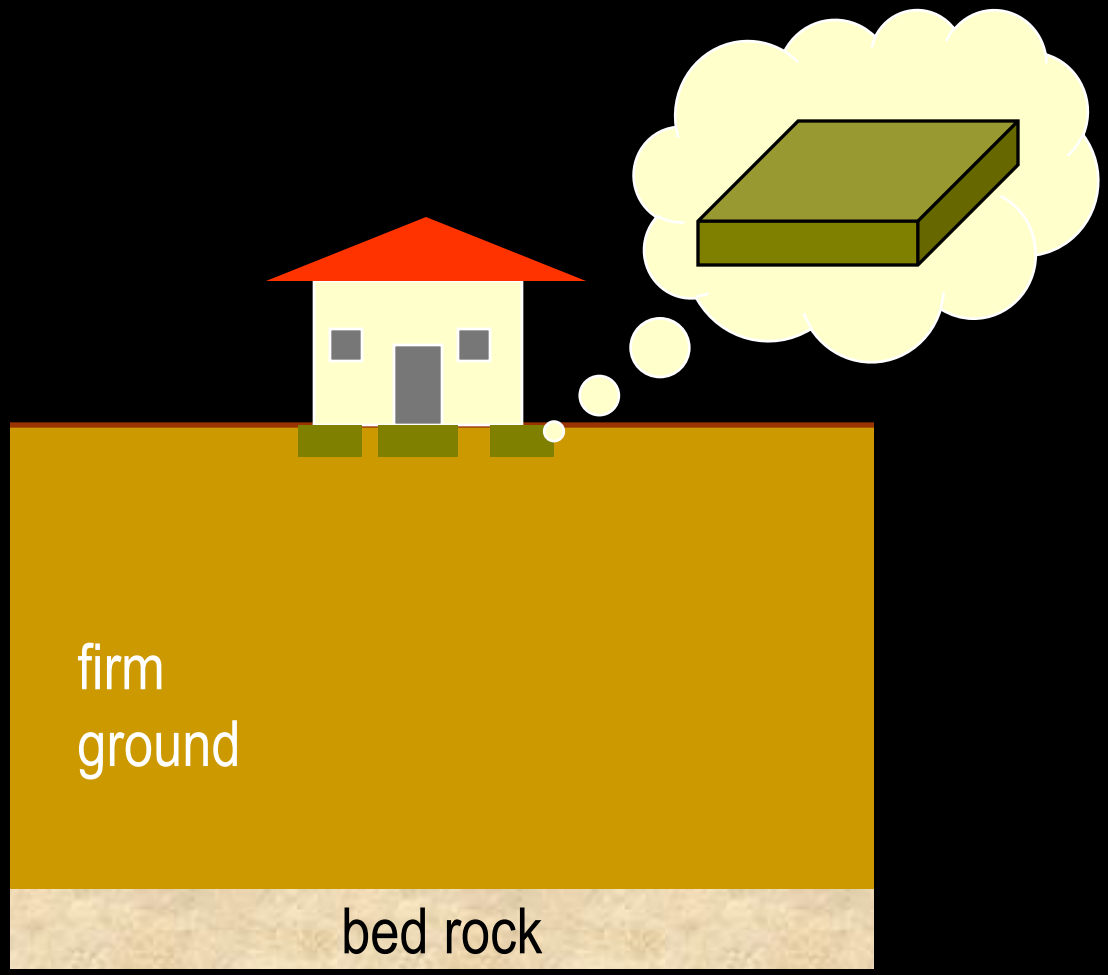
- To perform the Engineering soil surveys.
- To develop rational soil sampling devices and soil sampling methods.
- To develop suitable soil testing devices and soil testing methods.
- To collect and classify soils and their physical properties on the basis of fundamental knowledge of soil mechanics.
- To investigate the physical properties of soil and determine the coefficients to characterize these properties.
- To evaluate the soil test results and other applications as a construction material.
- To understand various factors such as static and dynamic loads, water and temperature.

Geotechnical Applications

Shallow Foundations

~ for transferring building loads to underlying ground

~ mostly for firm soils or light loads

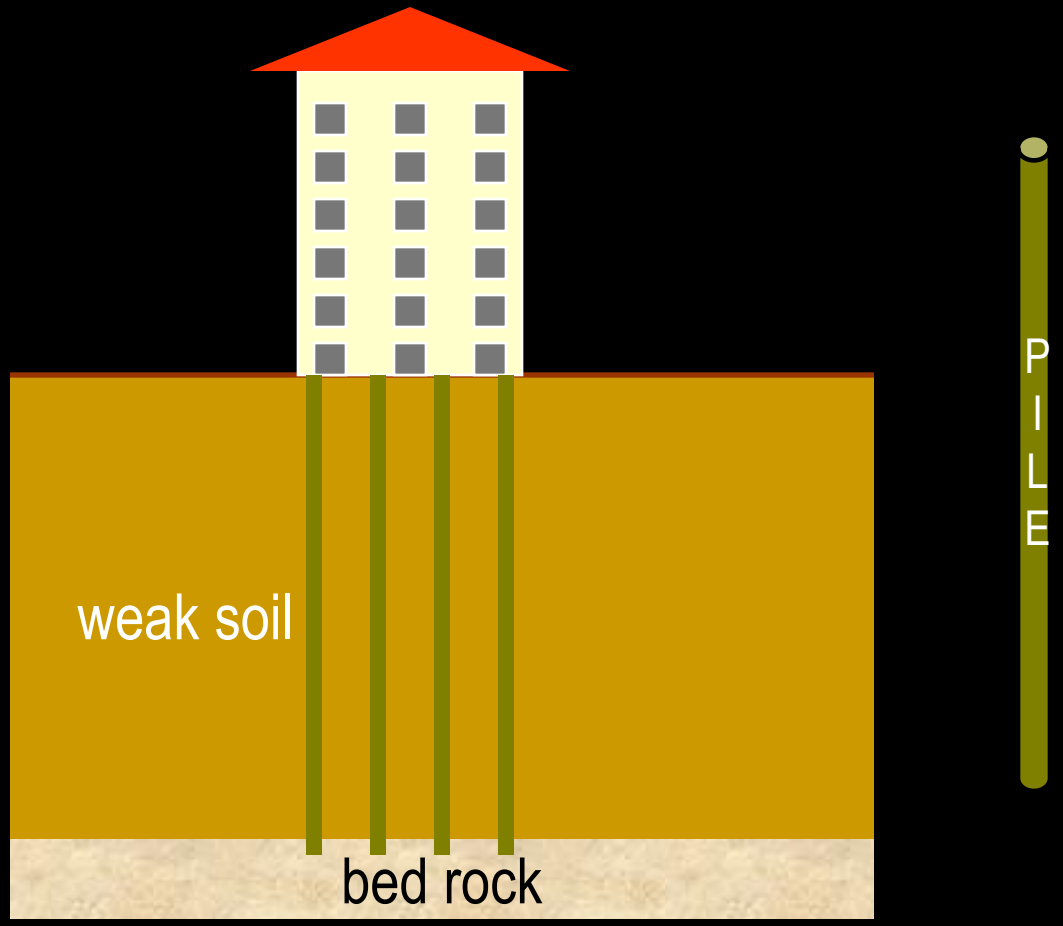


Shallow Foundations

Deep Foundations

~ for transferring building loads to underlying ground

~ mostly for weak soils or heavy loads

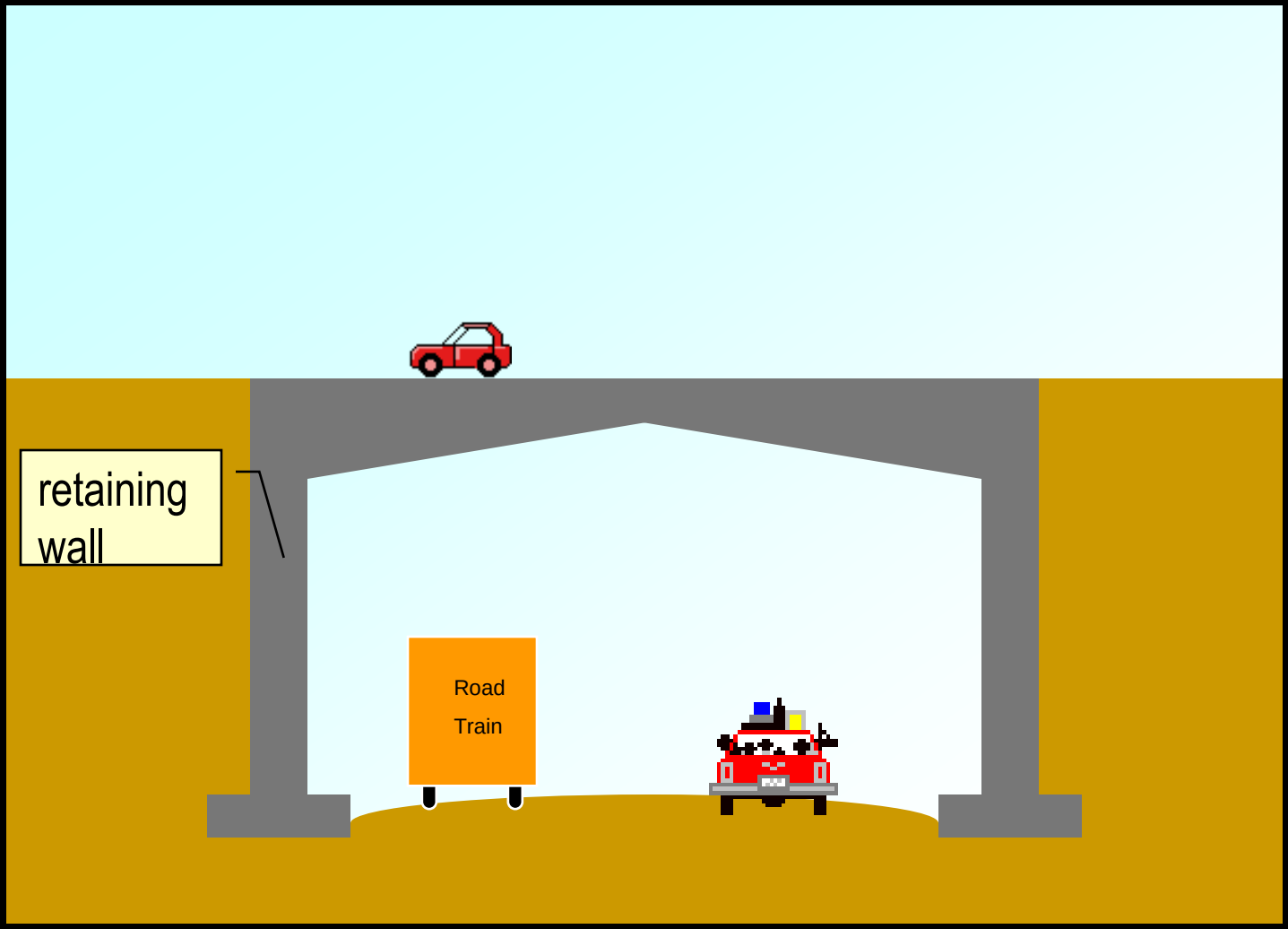


Deep Foundations

Driven timber piles, Pacific Highway

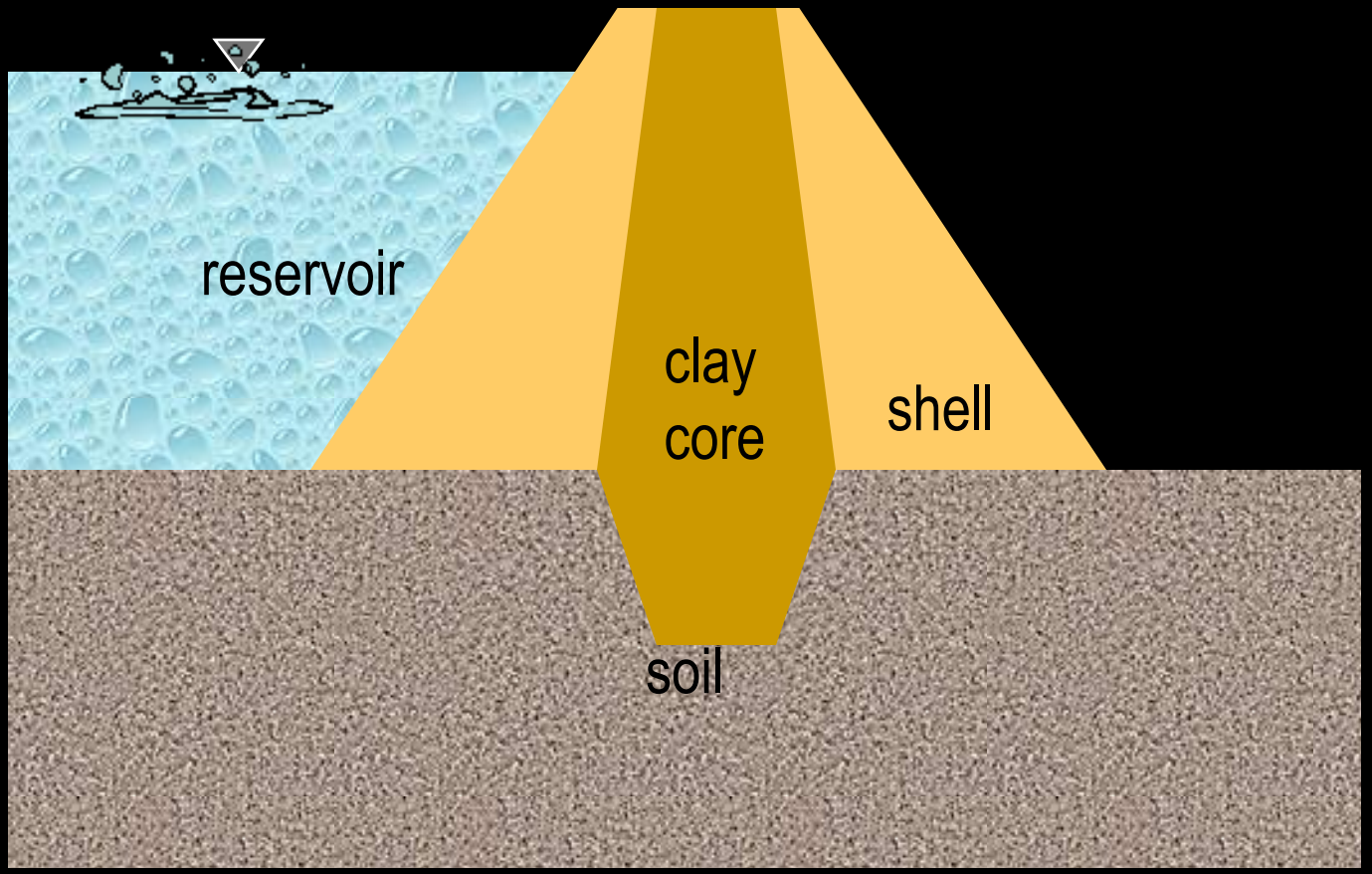
Retaining Walls

~ for retaining soils from spreading laterally

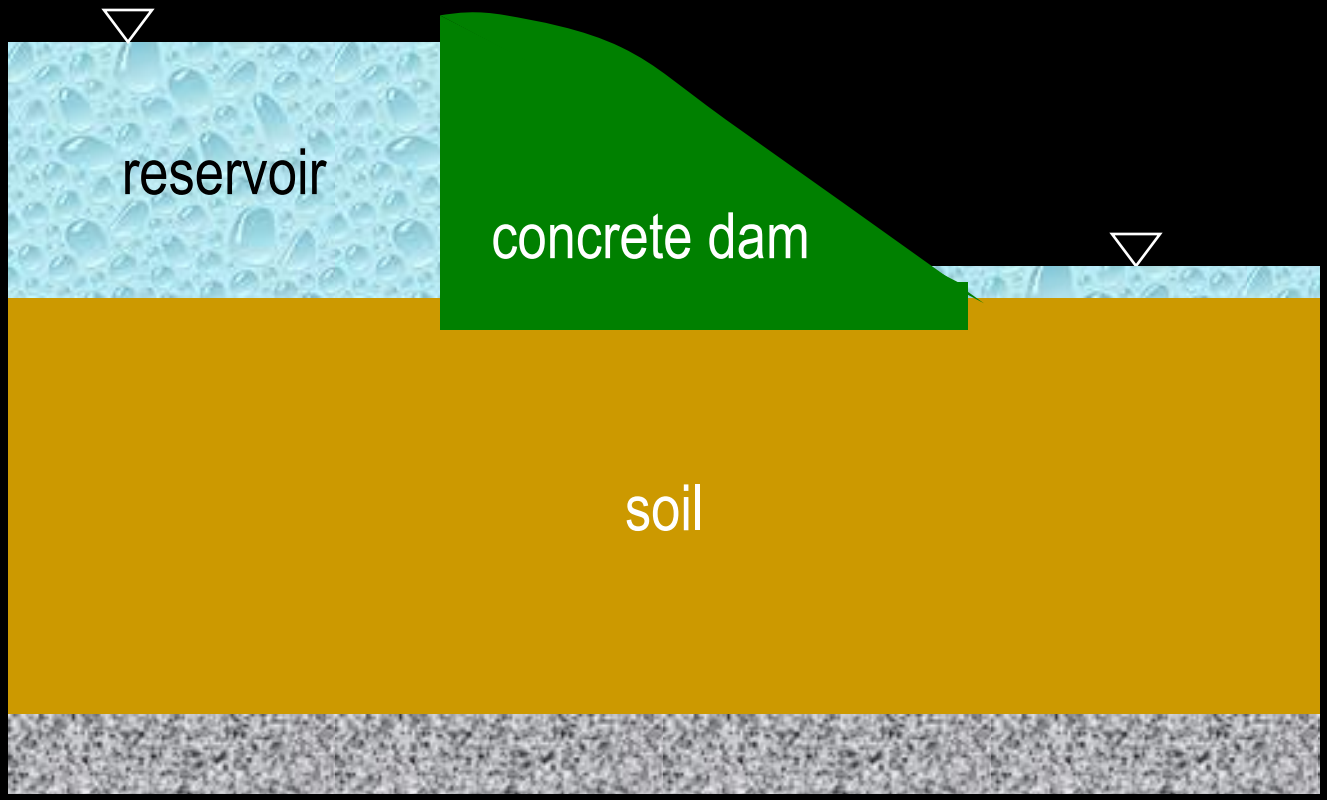


Earth Dams

~ for impounding water



Concrete Dams



Concrete Dams

Three Gorges Dam, Hong Kong

Concrete Dams

Earthworks

~ preparing the ground prior to construction

Roadwork, Pacific Highway

Construction hazard

~ an unwelcome visitor at an earthwork site.

What does it have to do with Geo?#!

A dead Anaconda python (courtesy: J. Brunskill)

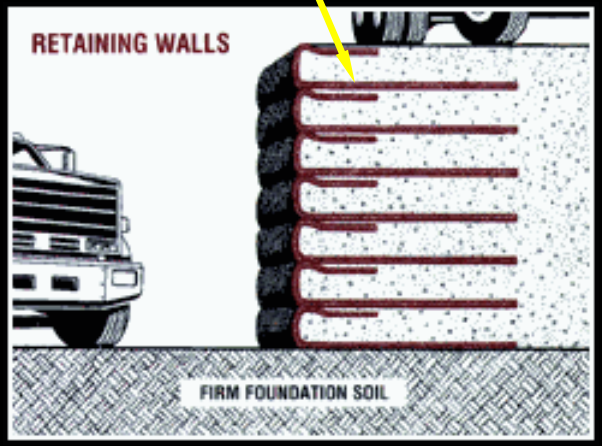
Geofabrics

~ used for reinforcement, separation, filtration and drainage in roads, retaining walls, embankments…

Geofabrics used on Pacific Highway

Reinforced Earth Walls

~ using geofabrics to strengthen the soil

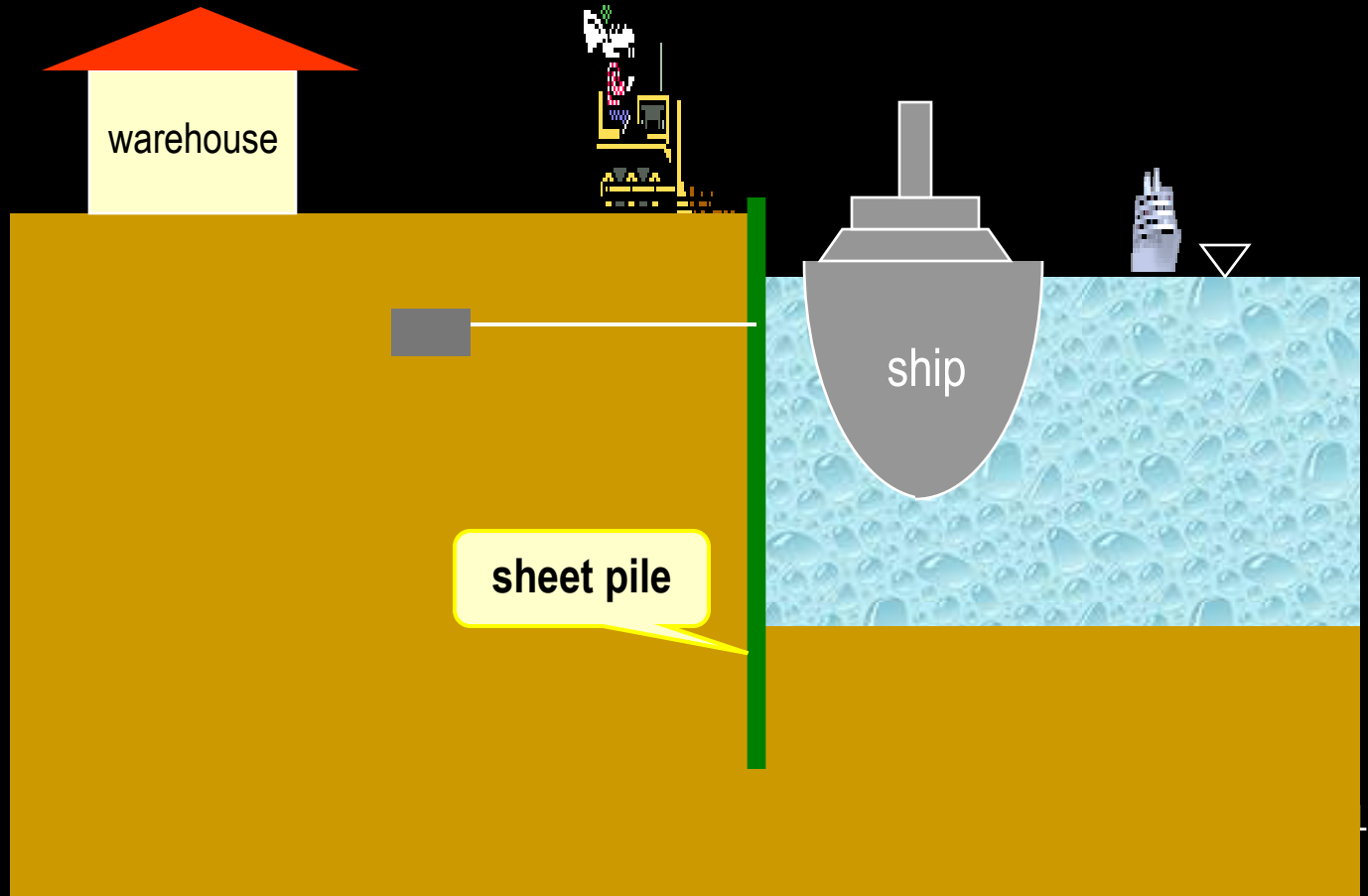


Soil Nailing

~ steel rods placed into holes drilled into the walls and grouted

Sheet Piles

~ sheets of interlockingsteel or timber driven into the ground, forming a continuous sheet



Sheet Piles

~ resist lateral earth pressures

~ used in excavations, waterfront structures, ..

Sheet Piles

~ used in temporary works

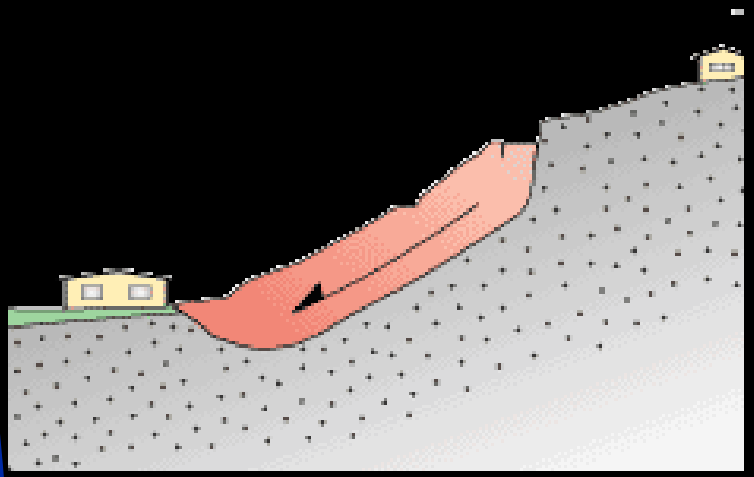
Sheet Piles

~ interlocking sections

Cofferdam

~ sheet pile walls enclosing an area, to prevent water seeping in

Landslides



Shoring

propping and supporting the exposed walls to resist lateral earth pressures

Tunneling

Blasting

For ore recovery in mines

Ground Improvement

Impact Roller to Compact the Ground

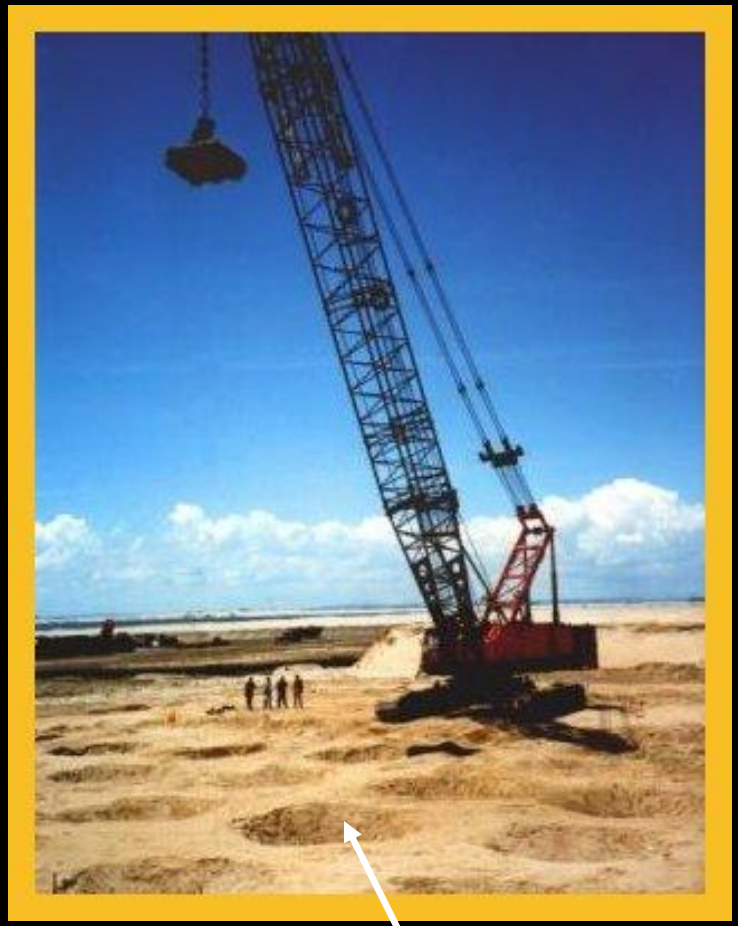
Ground Improvement

Sheep foot Roller to Compact Clay Soils

Ground Improvement

Smooth-wheeled Roller

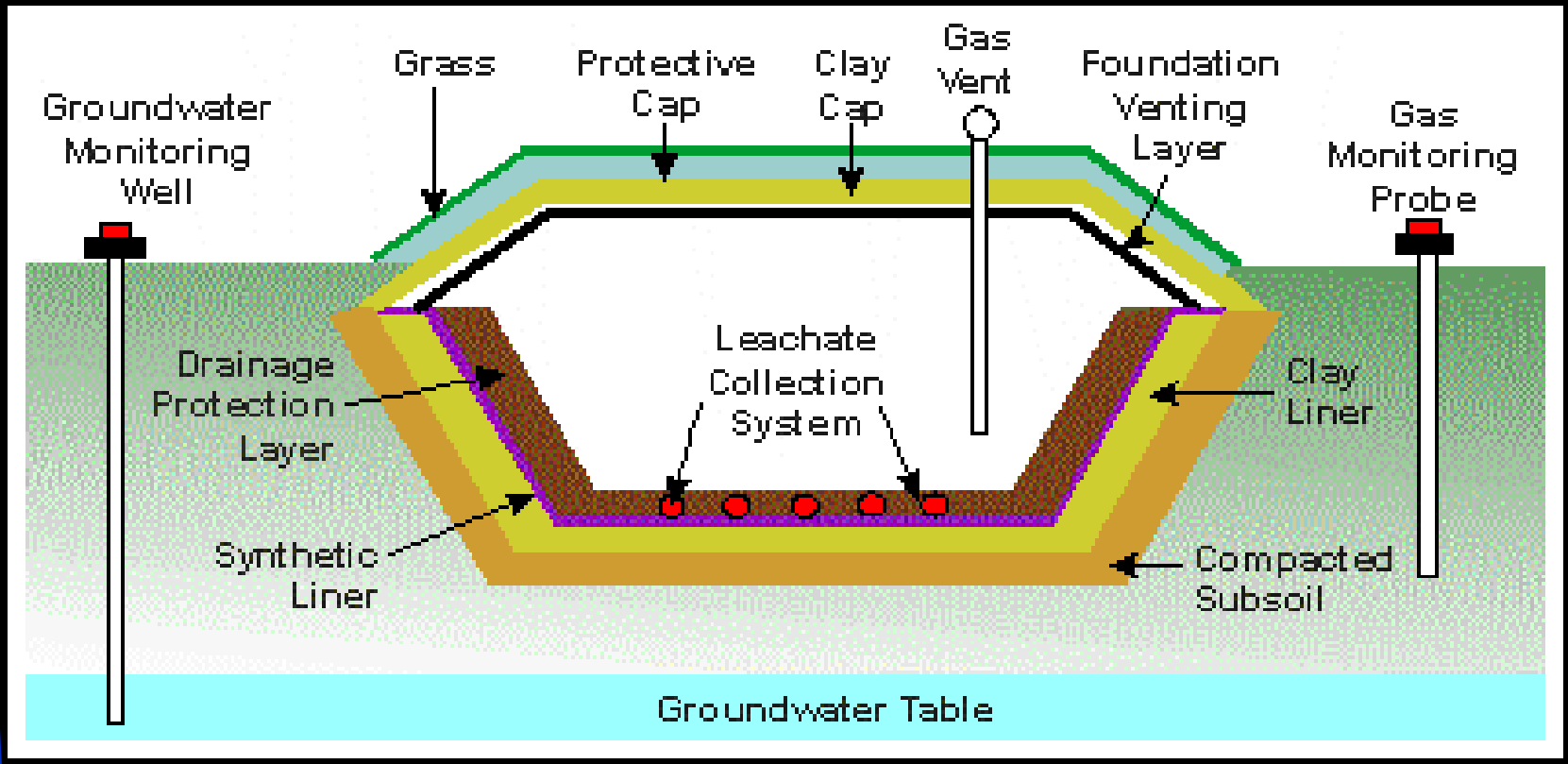
Ground Improvement



Big weights dropped from 25 m, compacting the ground.

Craters formed in compaction

Environmental Geomechanics



Waste Disposal in Landfills

Instrumentation

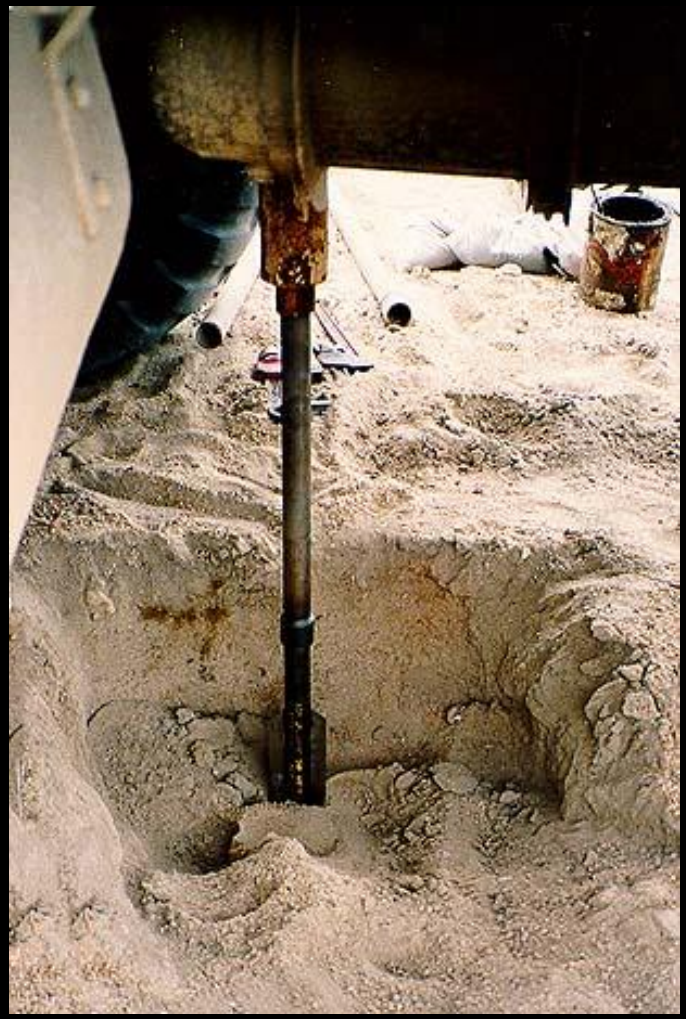
~ to monitor the performances of earth and earth supported structures

~ to measure loads, pressures, deformations, strains,…

Soil Testing

Cone Penetration Test Truck – Lavarach Barracks, Townsville

Soil Testing



Vane Shear Test

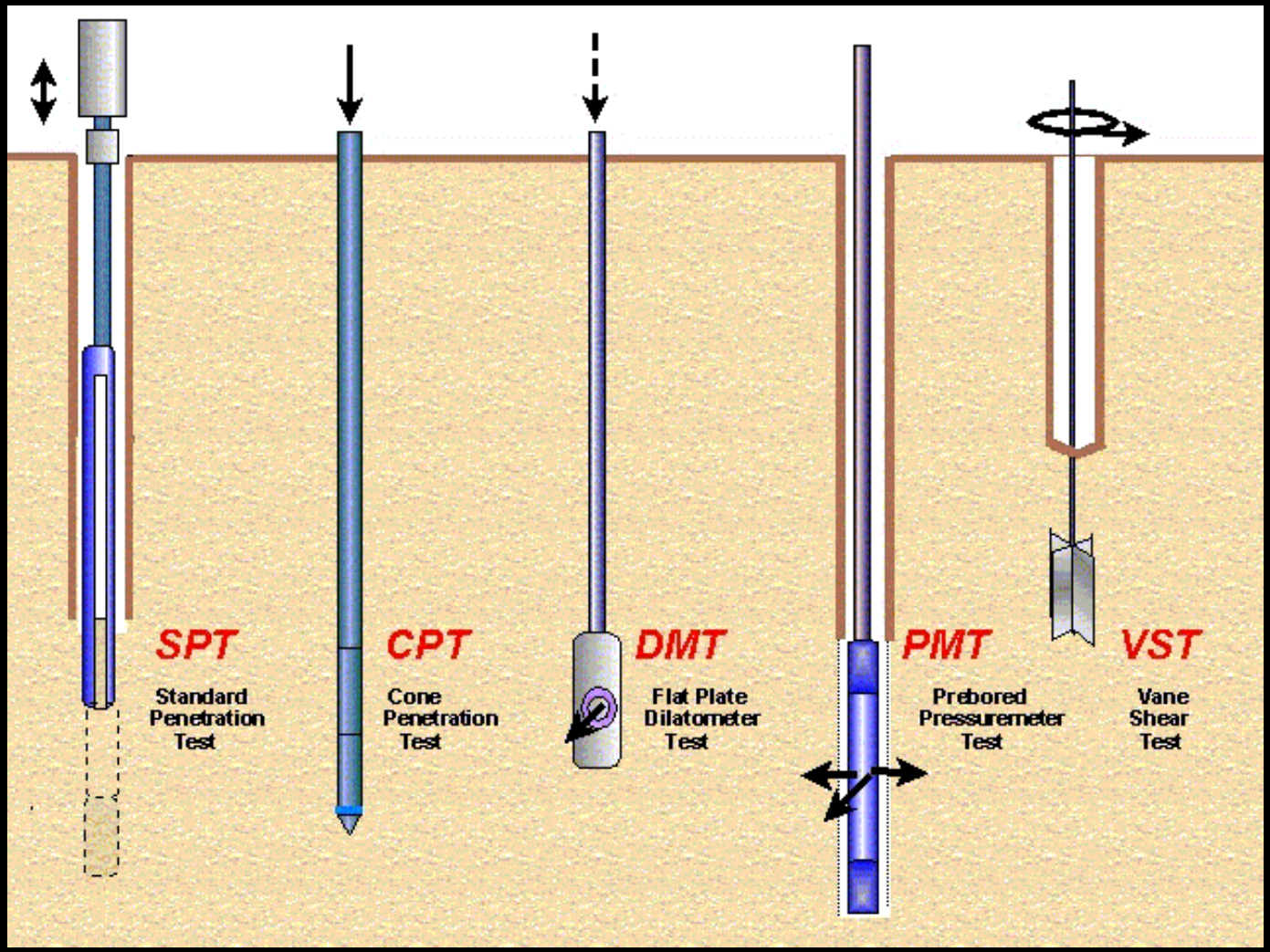
Standard Penetration Test

More Field Tests

Soil Testing

Tri-axial Test on Soil Sample in Laboratory

Soil Testing



Variety of Field Testing Devices

Typical Safety Factors

Type of Design	Safety Factor	Probability of Failure
Earthworks	1.3-1.5	1/500
Retaining structures	1.5-2.0	1/1500
Foundations	2.0-3.0	1/5000

Hall of Fame

Great Contributors to the Developments in Geotechnical Engineering

Karl Terzaghi
1883-1963

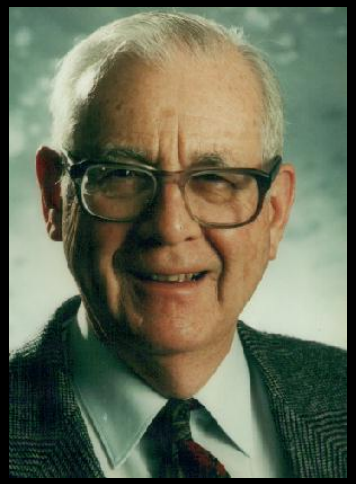
C.A.Coulomb
1736-1806

WJM Rankine
1820-1872

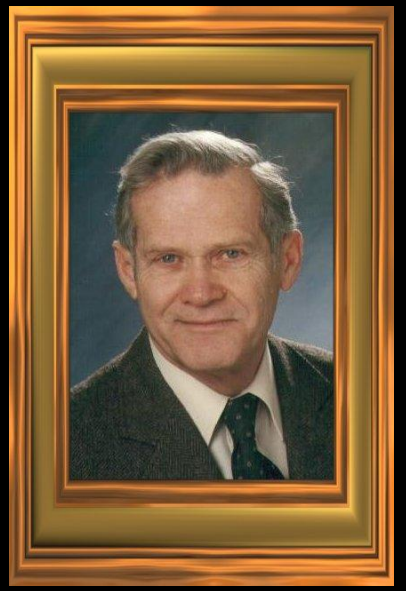
A.Casagrande
1902-1981

L. Bjerrum
1918-1973

A.W.Skempton
1914-



G.F.Sowers
1921-1996



G.A. Leonards
1921-1997

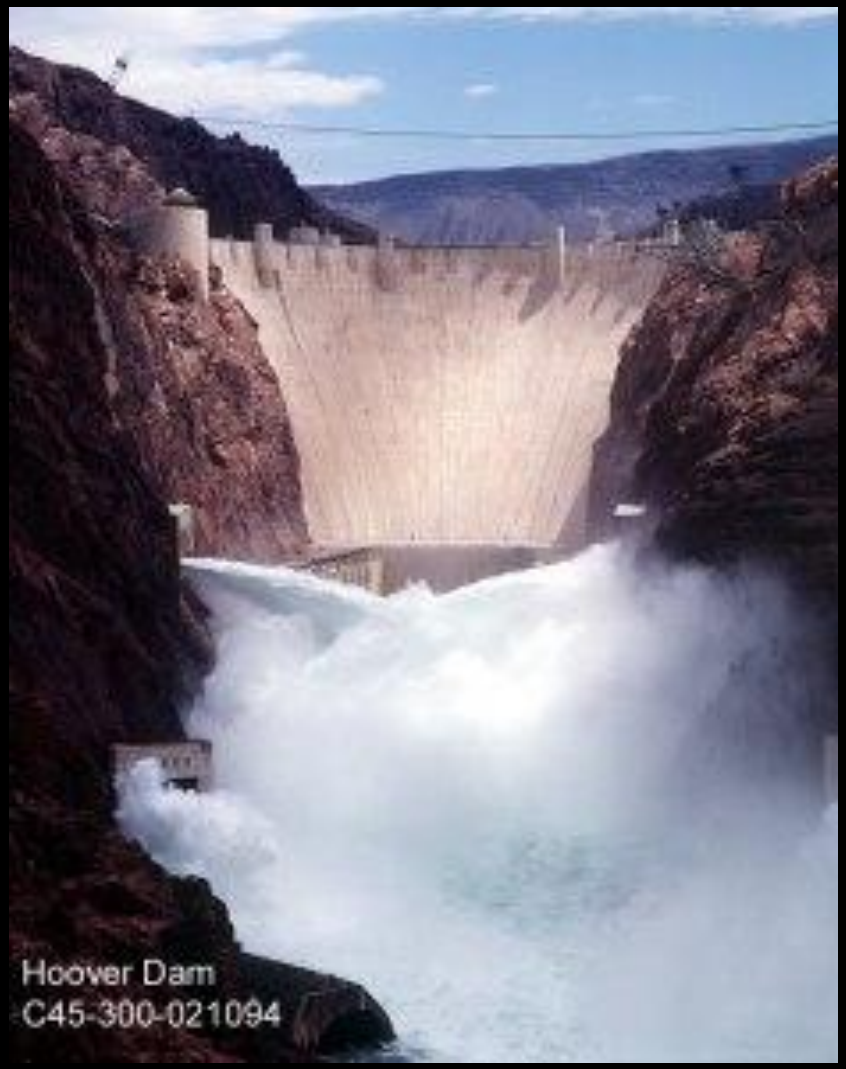
Challenges

Geotechnical Engineering Landmarks

Leaning Tower of Pisa

Our blunders become monuments!

Hoover Dam, USA



Tallest (221 m) concrete dam

Tallest buildings in the world

Petronas Tower, Malaysia

Monuments

Some Suggestions

Attend the lectures.

It takes longer to understand from the lecture notes

Develop a good feel for the subject.

It is practical, interesting and makes lot of sense.

Course Plan

Teaching Week	Topics to be covered	Follow up
One	- Introduction to the subject. - **Soil and its constituents**: Weathering of rocks and types of soil, Physical properties, e.g., water content, void-ratio, porosity, degree of saturation, specific gravity, and unit weight and their determination, Mass Volume relationships.	**Assignment#1.** Write a note on the importance of the subject of Soil Mechanics for Civil Engineering
Two	**Soil Classification**: Importance of soil classification, Atterberg limits, grain size distribution, sieve analysis.	
Three	**Soil Classification** Hydrometric analysis, Unified and AASHTO classification and description of their subgroups	**Assignment#2**
Four	**Soil Exploration:** Purpose of soil exploration, soil exploration methods, probing test, trenches and pits,	
Five	**1st Quiz** **-** Auger boring, Wash boring, Rotary drilling, Soil samples, Distributed and undistributed samples.	
Six	**Permeability and capillarity:** Definition, Darcy's law, Factors affecting permeability, Laboratories and field determination of permeability	**Assignment#3**
Seven	Capillarity and effects, bulking of sand, slabing of clay, frost heave and its prevention, Theory of flow nets.	**Assignment#4**

Eight	**Mid Term Test**	
Nine	**Compaction:** Definition, Compaction fundamentals, Moisture density relationship, Compaction standard.	**Assignement#5**
Ten	Factors affecting compaction, Field control and measurements of in-situ density, Effect of compaction on properties of soil	
Eleven	**2nd Quiz** **Shear Strength:** Concept, Shear strength parameters, Coulomb's law, shear strength of cohesive and non-cohesive soils,	
Twelve	Simple laboratory and field tests for determination of shear strength of soils.	**Assignement#6**
Thirteen	**Consolidation:** Mechanics of consolidation, Theory of one dimensional consolidation, assumptions and Validity.	
Fourteen	Oedometer test and graphical presentation of data, Compression index, Coefficient of compressibility.	**Assignement#7**
Fifteen	**3rd Quiz** Time factor, Co-efficient of volume change and degree of consolidation,	
Sixteen	Primary and secondary consolidation	**Assignment#8**
Seventeen	Primary and secondary consolidation	
Eighteen	Revision	**Comprehensive Assignment**

Distribution of Marks:

- **Sessional Marks: 60, as per following details:**
- **Assignments: 10**
- **Quiz: 10**
- **Mid Semester Exam: 20**
- **Practical/Viva voce Exam: 20**
- **Final End Semester Exam: 40**

Some Suggestions

Work in groups.

Some Suggestions

Thou shall not wait till the last minute.

Exams

"Exam is like a box of chocolates; you never know what you are gonna get"