ANKARA UNIVERSITY
DEPARTMENT of GEOLOGICAL ENGINEERING

GEO206 STRENGTH OF MATERIALS

LECTURE NOTES

Dr. KORAY ULAMIŞ

ANKARA, 2018

WHAT IS “MATERIAL”?

The term “*Material*” has a broad definition in the engineering world. Anything might refer to this term if concluded to serve the community as a tool. Engineering of material science includes chemistry, physics, geology, metallurgy, etc. Any particular natural or engineered compounds might act as a material. In addition, the materials must meet some standards and criteria to be used for engineering practice. Based on the relevant subject, the choice of choosing the significant material is another topic of interest. Maintenance, economy, serviceability and sustainability of materials are also other parameters to be addressed. Some common materials used in engineering are:

Ferrous and non-ferrous metals

Plastics, polymers, petroleum products

Wood

Building stones

Clay (Bricks, as main compound for porcelain, etc.)

Synthetic earthen materials

Mortar, gypsum, lime and chemical plasters

Pozzolans, Cement

Aggregates

Concrete

PROPERTIES OF MATERIALS

Physical : Color, dimensions, texture and shape
Density, specific gravity, Moisture content, absorption (weight and/or volume) Porosity, void ratio

Chemical : Compound composition, acidity, alkalinity, oxidation, resistance to corrosion, acids

Physico-Chemical : Water absorption/repellence; shrinkage, swelling (Mostly for soil material)

Others : Thermal conductivity, expansion, electrical conductivity and galvanic behavior, acoustic and optical properties

MECHANICAL PROPERTIES

Strength : Compression, tension, shearing, bending, flexural, fatigue

Elasticity, modulus of elasticity (Young modulus)

Stress-Strain (i.e. plane stress, plane strain)

Plasticity and flow (occasionally creep)

Ductility, brittleness, rigidity, hardness

MATERIALS IN GEOLOGICAL ENGINEERING

I. Crystalline Texture

	Examples
A. Soluble carbonates and salts	Limestone, dolomite, marble, rock salt, trona, gypsum
B. Mica or other planar minerals in continuous bands	Mica schist, chlorite schist, graphite schist
C. Banded silicate minerals without continuous mica sheets	Gneiss
D. Randomly oriented and distributed silicate minerals of uniform grain size	Granite, diorite, gabbro, syenite
E. Randomly oriented and distributed silicate minerals in a background of very fine grain and with vugs	Basalt, rhyolite, other volcanic rocks
F. Highly sheared rocks	Serpentinite, mylonite

II. Clastic Texture

	Examples
A. Stably cemented	Silica-cemented sandstone and limonite sandstones
B. With slightly soluble cement	Calcite-cemented sandstone and conglomerate
C. With highly soluble cement	Gypsum-cemented sandstones and conglomerates
D. Incompletely or weakly cemented	Friable sandstones, tuff
E. Uncemented	Clay-bound sandstones

III. Very Fine-Grained Rocks

	Examples
A. Isotropic, hard rocks	Hornfels, some basalts
B. Anisotropic on a macro scale but microscopically isotropic hard rocks	Cemented shales, flagstones
C. Microscopically anisotropic hard rocks	Slate, phyllite
D. Soft, soil-like rocks	Compaction shale, chalk, marl

IV. Organic Rocks

	Examples
A. Soft coal	Lignite and bituminous coal
B. Hard coal	
C. "Oil shale"	
D. Bituminous shale	
E. Tar sand	

Types of rock materials based on behavior (Goodman, 1989)

COMMON TYPES OF SOIL MATERIAL

Alluvial soil: Fine sediments eroded from rocks, transported by water, settled on river and stream beds

Calcareous soil: Contains calcium carbonate and effervesces when treated with hydrochloric acid

Caliche: Consists of gravel, sand and clay cemented together by calcium carbonate

Colluvial soil: Slope materials, eroded by combination of water and gravity

Eolian soil: Sand-sized particles deposited by wind

Expansive soil: Clays that undergo large volume change from wetting-drying cycles

Gypsum: Calcium sulphate formed under heat under pressure from sediments in ocean brine

Lacustrine soil: Mostly silt and clay deposited in glacial lake water

Lateritic soil: Residual soils cemented with iron oxides found in tropical regions

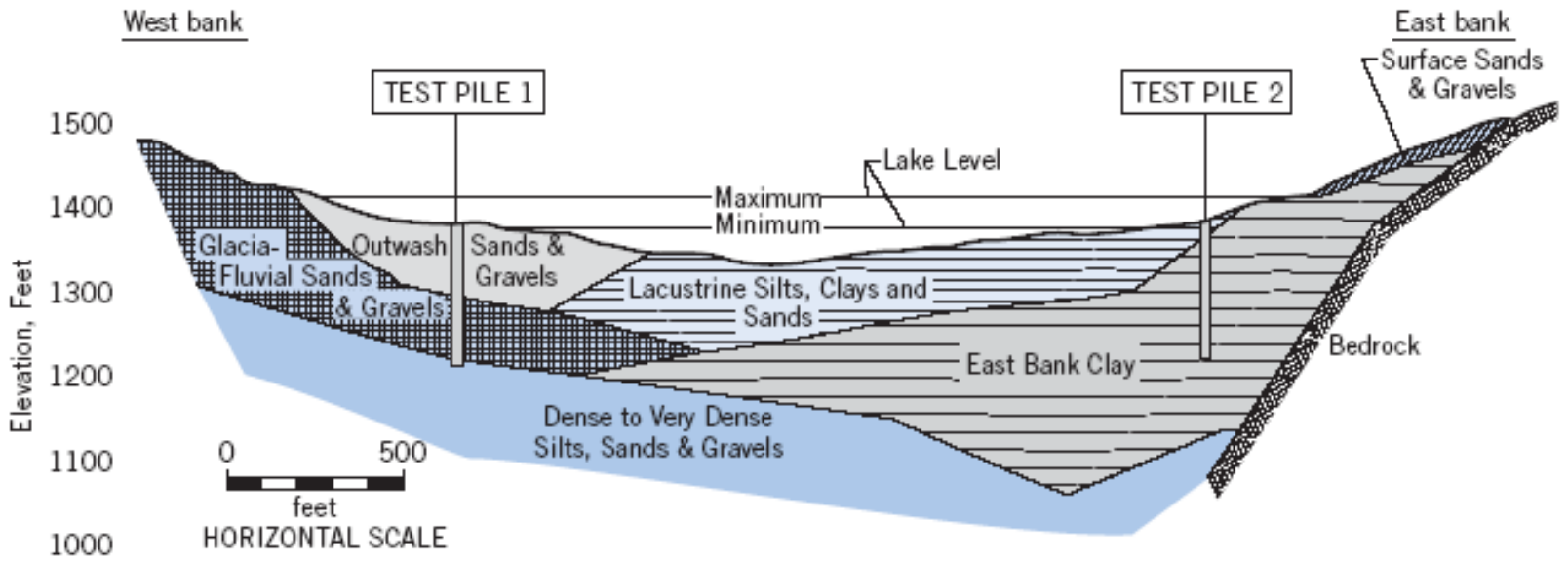
Loam: Mixture of sand, silt and clay that may contain organic material

Loess: Wind-blown, uniform fine grained soil

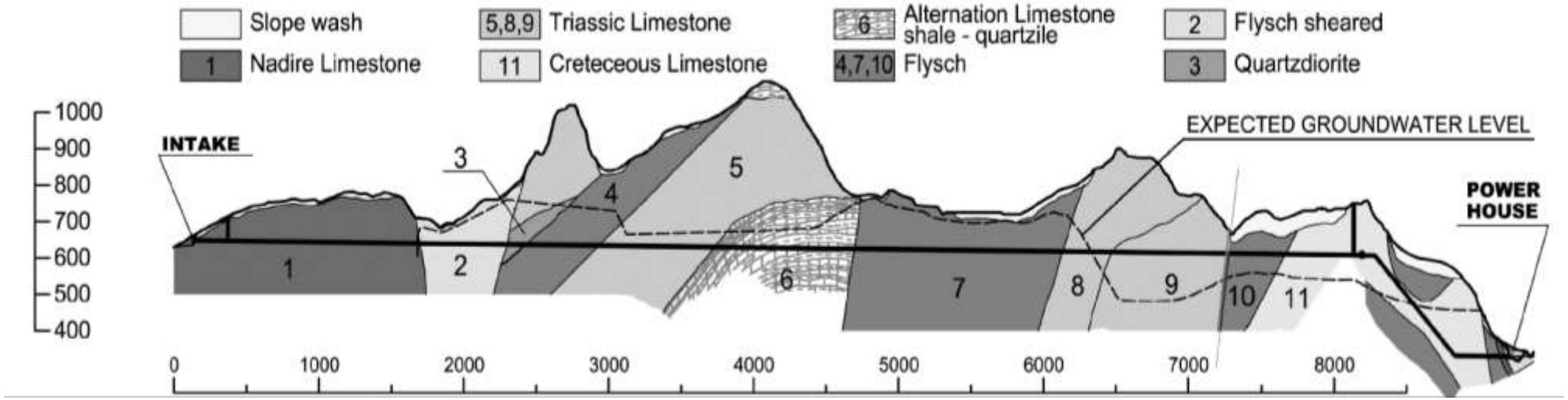
Marine soil: Sand, silt and clay deposited in salt of brackish water

Mud: Clay and silt mixed with water into a viscous fluid

Glacial till/clay: Soils, deposited in ancient lakes and subsequently frozen regions. Soil profiles with stratified silt and clay (varved clay)



(Use of geological material within a geotechnical project (Budhu, 2007; McGammon&Golder, 1970)



Rock material to be excavated in an (Ermenek Dam/Konya) (Marence&Oberladstatter, 2005)

Rock-cores in the same borehole. Please check out the intact and altered parts of the same rock. This rock unit is a foundation material. Location : Akpınar District, Dikmen (Ankara) (Photo courtesy of Kılıç&Ulamış, 2016)

Field instrumentation of soil material at Çorum-İskilip Reservoir/dam site (Photo courtesy of Alter, 2014)

Remediation of rock material due to rockfall and instability with the use of compacted soil material. The project consists of rock material (dacite) , reddish soil and steel fence materials (Selçuklu District, Keçiören,Ankara. Photo courtesy of Kılıç, 2014)

A closer view of the rock-bolt and wire mesh materials to prevent rock fall damage

Definition of “Force”

DEFINITION IV.

An impressed force is an action exerted upon a body, in order to change its state, either of rest, or of moving uniformly forward in a right line.

This force consists in the action only; and remains no longer in the body, when the action is over. For a body maintains every new state it acquires, by its *vis inertiæ* only. Impressed forces are of different origins: as from percussion, from pressure, from centripetal force.

DEFINITION V.

A centripetal force is that by which bodies are drawn or impelled, or any way tend, towards a point as to a centre.

DEFINITION VI.

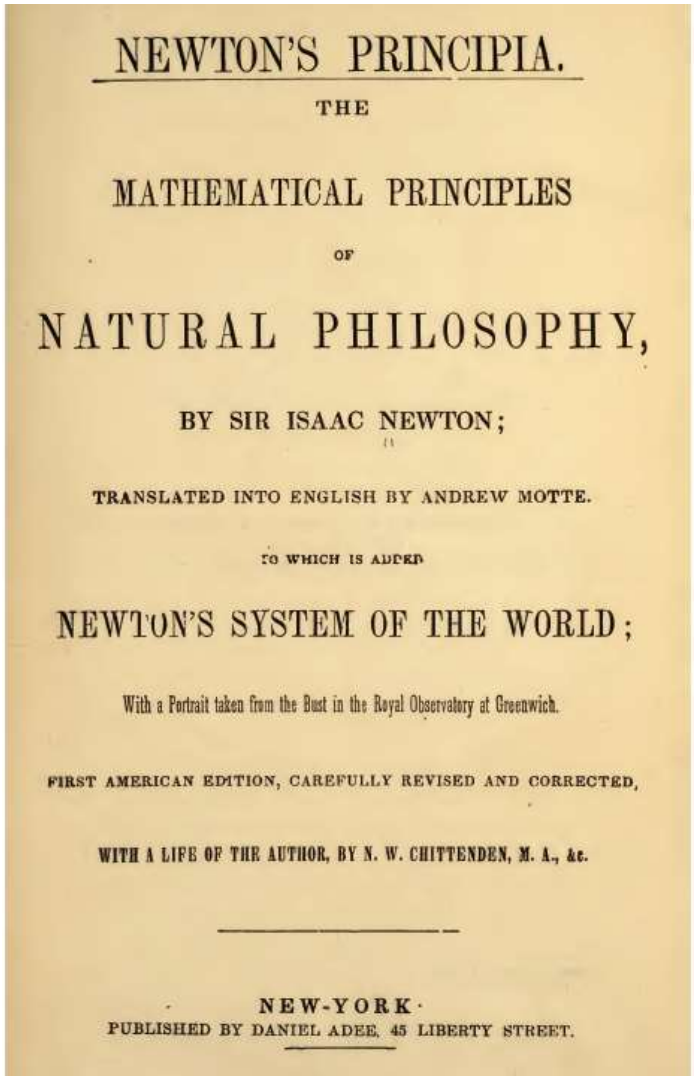
The absolute quantity of a centripetal force is the measure of the same proportional to the efficacy of the cause that propagates it from the centre, through the spaces round about.

DEFINITION VII.

The accelerative quantity of a centripetal force is the measure of the same, proportional to the velocity which it generates in a given time.

DEFINITION VIII.

The motive quantity of a centripetal force, is the measure of the same, proportional to the motion which it generates in a given time.



NEWTON'S PRINCIPIA.

THE

MATHEMATICAL PRINCIPLES

OF

NATURAL PHILOSOPHY,

BY SIR ISAAC NEWTON;

TRANSLATED INTO ENGLISH BY ANDREW MOTTE.

TO WHICH IS ADDED

NEWTON'S SYSTEM OF THE WORLD;

With a Portrait taken from the Bust in the Royal Observatory at Greenwich.

FIRST AMERICAN EDITION, CAREFULLY REVISED AND CORRECTED,

WITH A LIFE OF THE AUTHOR, BY N. W. CHITTENDEN, M. A., &c.

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Common Units for Engineering and Essentials of SI Units

Quantity	Base symbol	Symbol
Length	**metre**	**m**
Mass	**kilogram**	**kg**
Time	**second**	**s**
Electric current	ampere	A
Thermodynamic temperature	Kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd
Area	**Square metre**	**m^2**
Volume	**Cubic metre**	**m^3**
Speed, velocity	metre per second	m/s
Acceleration	**metre per square second**	**m^2/s**
Density	**kilogram per cubic metre**	**kg/m^3**
Frequency	hertz	1/s
Force	**Newton (N)**	**$kg.m/s^2$**
Pressure/Stress	**Pascal (Pa)**	**$kg/m.s^2 = N/m^2$**

1 Newton: The force required to accelerate a mass of 1.0 kg at 1.0 m/s2

Note: 1 kg ~9.80665002864 N
In practice, 9.81 N

Prefixes	Value	Standard form	Symbol
Tera	1 000 000 000 000	10^{12}	T
Giga	1 000 000 000	10^{9}	G
Mega	1 000 000	10^{6}	M
Kilo	1 000	10^{3}	k
deci	0.1	10^{-1}	d
centi	0.01	10^{-2}	c
milli	0.001	10^{-3}	m
micro	0.000 001	10^{-6}	μ
nano	0.000 000 001	10^{-9}	n
pico	0.000 000 000 001	10^{-12}	p

Also, check out

https://www.digitaldutch.com/unitconverter/length.htm

SUMMARY

✓Material is an kind of substance that can be engineered

✓Material science is a kind of junction of basic sciences and engineering

✓Both natural and man-made substances could be used as materials

✓Main geological materials are any kind of rocks and soils

✓Basic unit system to be used from here after is the “SI”