GGY3051 – ENGINEERING GEOLOGY

Introductory Lecture

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What is Engineering geology?

1. The application of GEOLOGIC:

   - data
   - techniques, &
   - principles

   to the study of naturally occurring rock + soil materials or subsurface fluids.

What is Engineering geology?.....contd.

2. Field of study that describes how we:

   - are affected by geological phenomena, &
   - can affect environment & trigger geologic processes

3. Is a hybrid science consisting mainly of Geology & Civil Engineering.

   - Deals with *Soil Mechanics & Rock Mechanics*

Geology & Civil Engineering

- **GEOLOGY:** science dealing with *physical nature & history of earth* – rocks of which it is composed; and changes, which it has undergone / is undergoing.

- **ENGINEERING:** science concerned with construction of everything we see in the built environment – *bridges, roads, canals, hospitals, schools, airports, power stations, railways, pipelines, etc.*

Geology & Civil Engineering.....contd.

Difference between Geologist & Civil Engineer is philosophical:

- GEOLOGIST builds his/her conclusions on observations & intuitive reasoning.
- ENGINEER measures properties & applies mathematical relationships to reach his/her conclusions.

Geology & Civil Engineering.....contd.

∴EG has attempted to fill philosophical gap by:

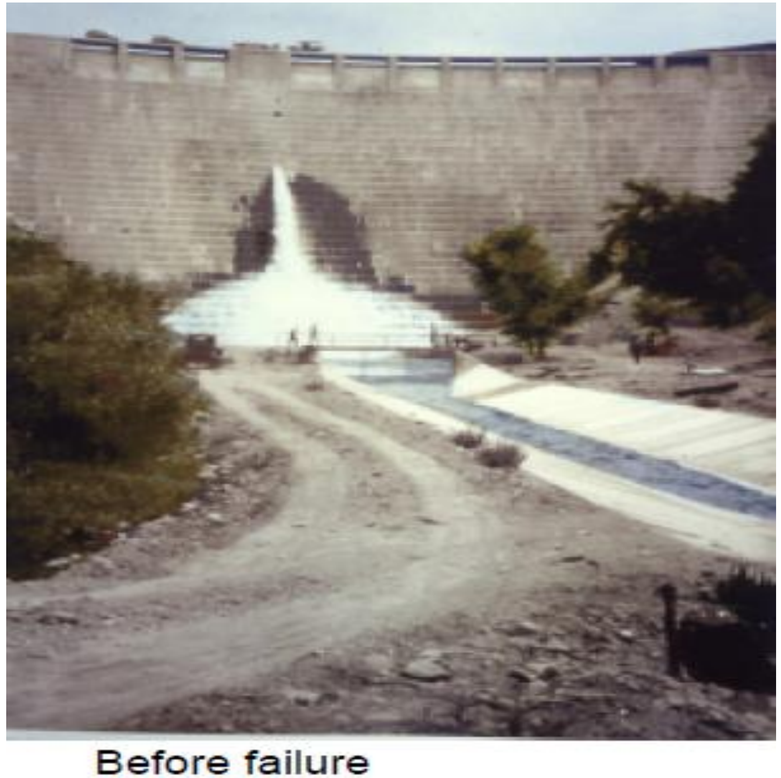
- evaluating geological phenomena, and
- defining geological environments

for the purpose of engineering works.

Geology & Civil Engineering.....contd.

- Need for geologist on engineering works gained world wide attention in 1928, March 12 with failure of St. Francis dam in CA & loss of 426 lives.

  Engineering community then realised the importance of geology in civil engineering



Before failure

After failure with the 'Tombstone' in the center

Geology & Civil Engineering.....contd.

- More engineering failures, which occurred in following years prompted requirement for engineering geologists to work on large engineering projects to:
  - apply geological knowledge to engineering practice, and:
    - assuring that geologic factors affecting location, design, construction operation, & maintenance of engineering works are recognized and adequately provided for……

Why Engineering geology?

Geology is everywhere!

Therefore, its importance is because **ALL** engg works:

- are built on / in the ground
- are usually constructed from materials taken from ground
- have potential to pollute natural resources.

Why Engineering geology?.....contd.

∴ Appropriate geological investigation of site & surrounding area:

- Establishes interrelationships between engineering work & geologic environment

Why Engineering geology?.....contd.

So, appropriate geological investigation of site is fundamental in determining its:

- Existing Environment
- Likely Significant Impact(s).
- Mitigation Measures.
- performance of completed structure / project

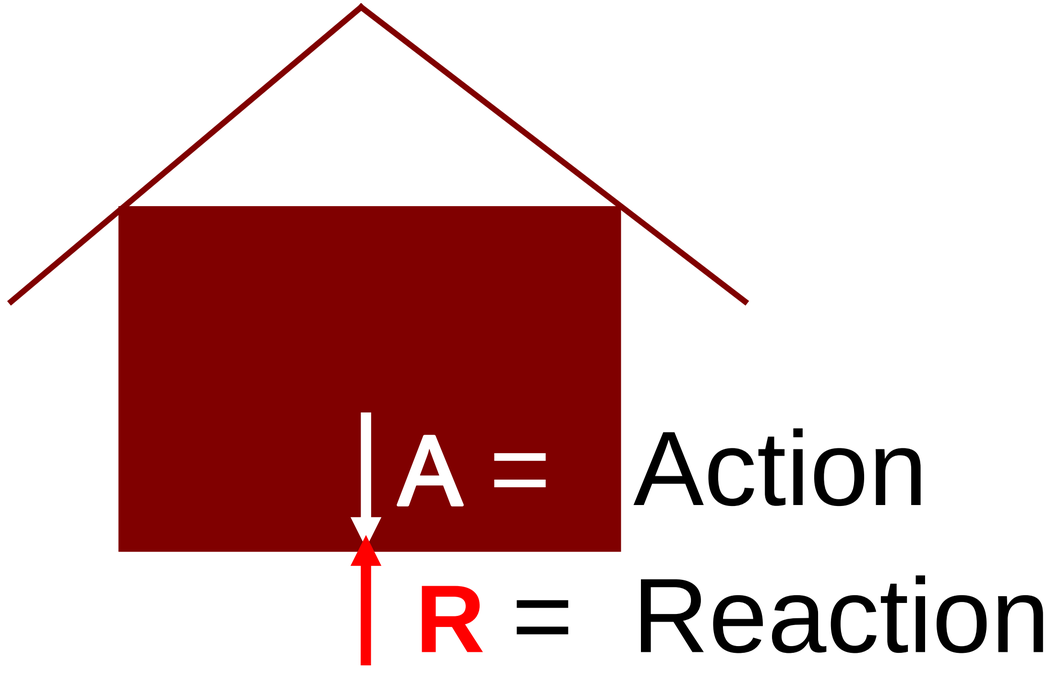
Principles of Engineering geology

...based on **Newton's 3rd Law**:

- Every **ACTION** produces a **REACTION**, which is
  - ✓ **EQUAL** in magnitude to the action
  - ✓ **OPPOSITE** in direction, and
  - ✓ **COLLINEAR** to the action

Principles of Engineering geology.....contd.

Engg works receive some *reaction* from ground *equal in magnitude* to imposed action, & **COLLINEAR** to the action.



Principles of Engineering geology.....contd.

Task of engineering geologist is to determine:

- Nature of **REACTION**
- **BEHAVIOUR** of completed work.

Determination of Reaction

Starts with:

- determination of ground properties of the site accomplished by testing in the;
  - laboratory
  - field.

Determination of Reaction.....contd.

However, even when properties of ground have been determined, they must be assessed against effects by:

- CLIMATE
- TIME
- NATURAL HAZARDS.

Determination of Reaction.....contd.

- In CLIMATE, rainfall is very important factor ....due to change in moisture content.

∴ Identical soil/rock mats / masses may behave differently under action of engineering process.

Determination of Reaction.....contd.

- TIME – All materials weather/decay with time....

  ∴ Changes in geotech props with time must be considered….

- NATURAL HAZARDS – *earthquakes, floods, etc.* – must be taken into account for any engg work…

Significance of Engineering Geology

1. It provides a means to:

- **appreciating** & **identifying** geologic features that could have
  - short- and long-term consequences on overall

    performance of engineering structures / projects.

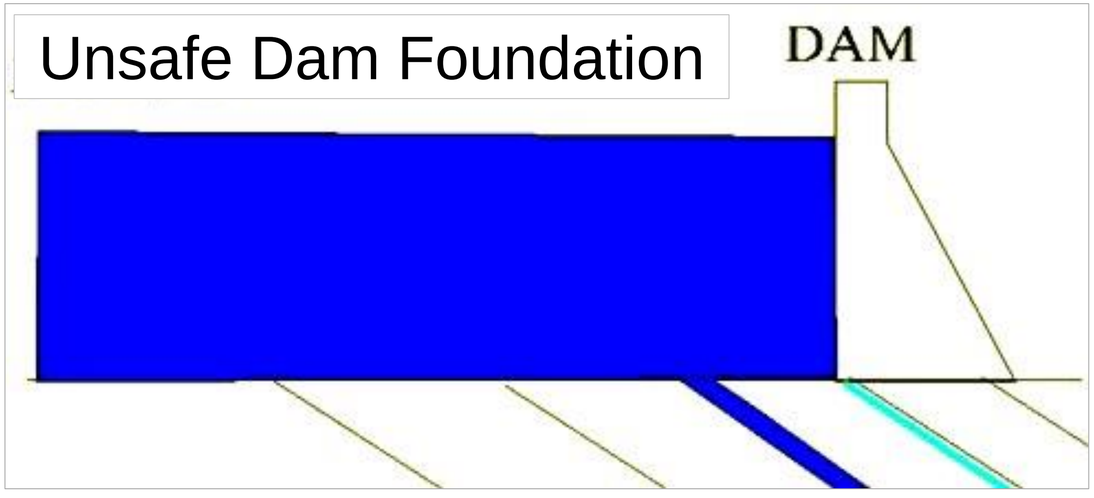
Significance of Engineering Geology.....contd.

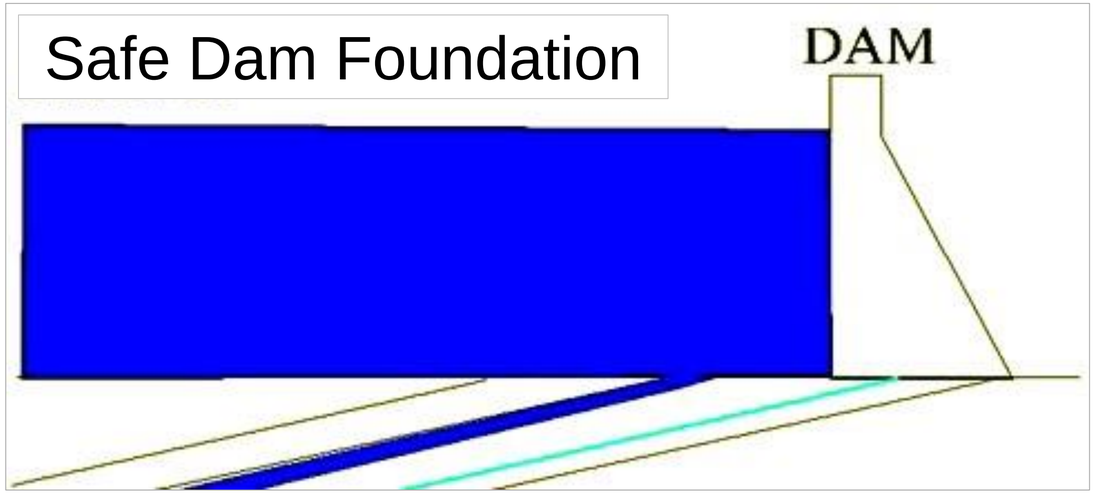
2. Is useful in:

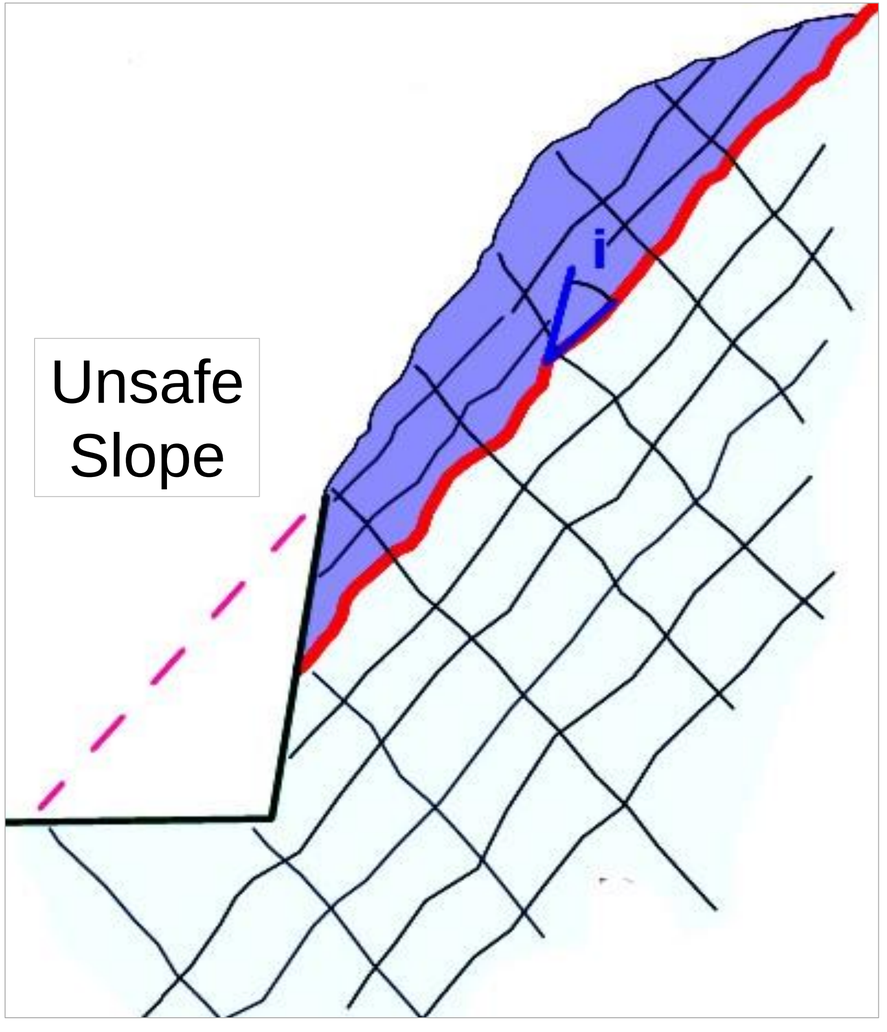
- Design of *foundations; stabilisation methods for hillsides, eroding shorelines; reservoir storage, dams, & tunnels*
- evaluating and mitigating groundwater contamination
- Planning of highway routes & identify earthen construction material sources
- mitigating natural hazards such as earthquakes

Significance of Engineering Geology.....contd.

Effects of joints on stability

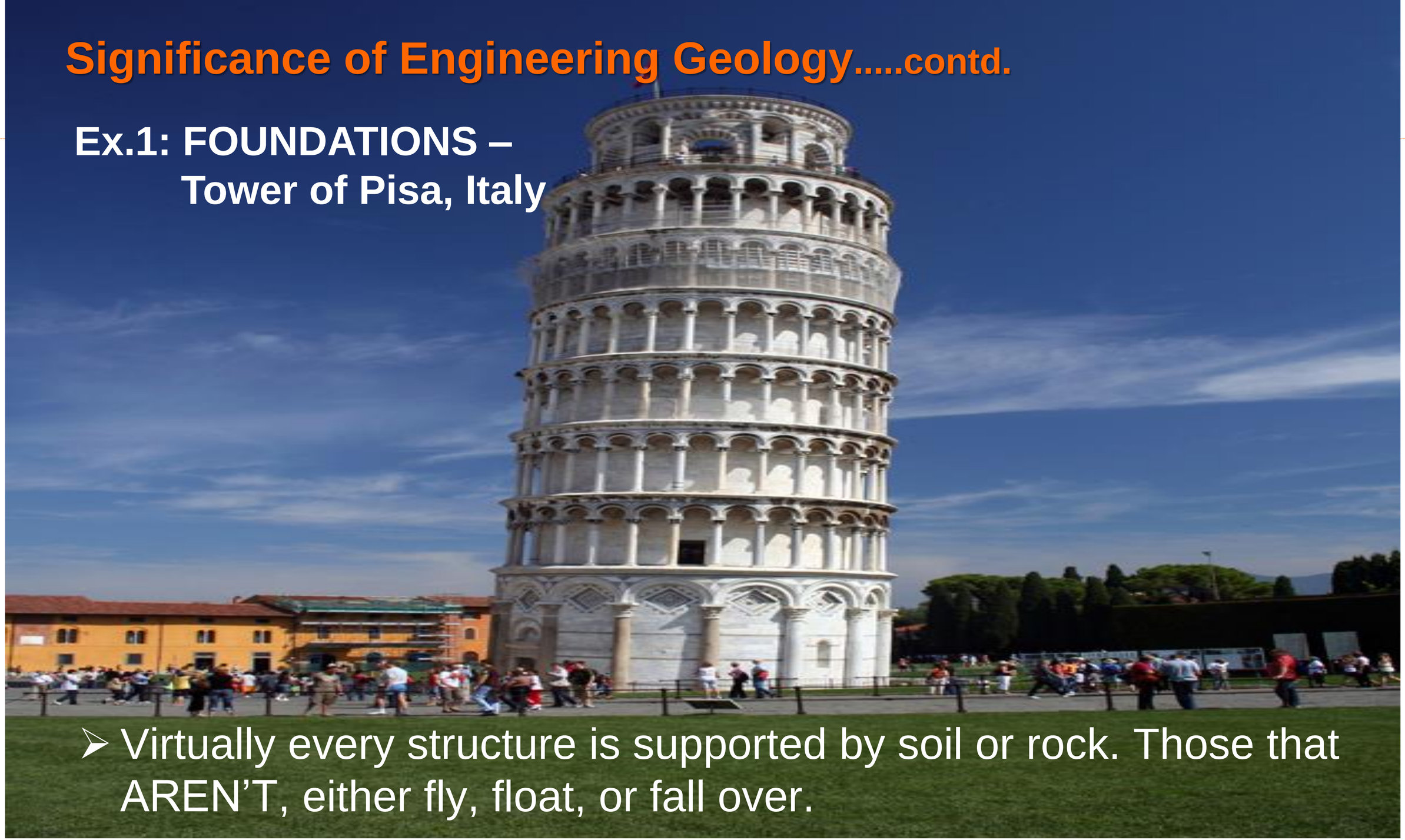






Significance of Engineering Geology.....contd.

Ex.1: FOUNDATIONS –
Tower of Pisa, Italy



- Virtually every structure is supported by soil or rock. Those that AREN'T, either fly, float, or fall over.

Significance of Engineering Geology.....contd.

Typical Problems for foundations:

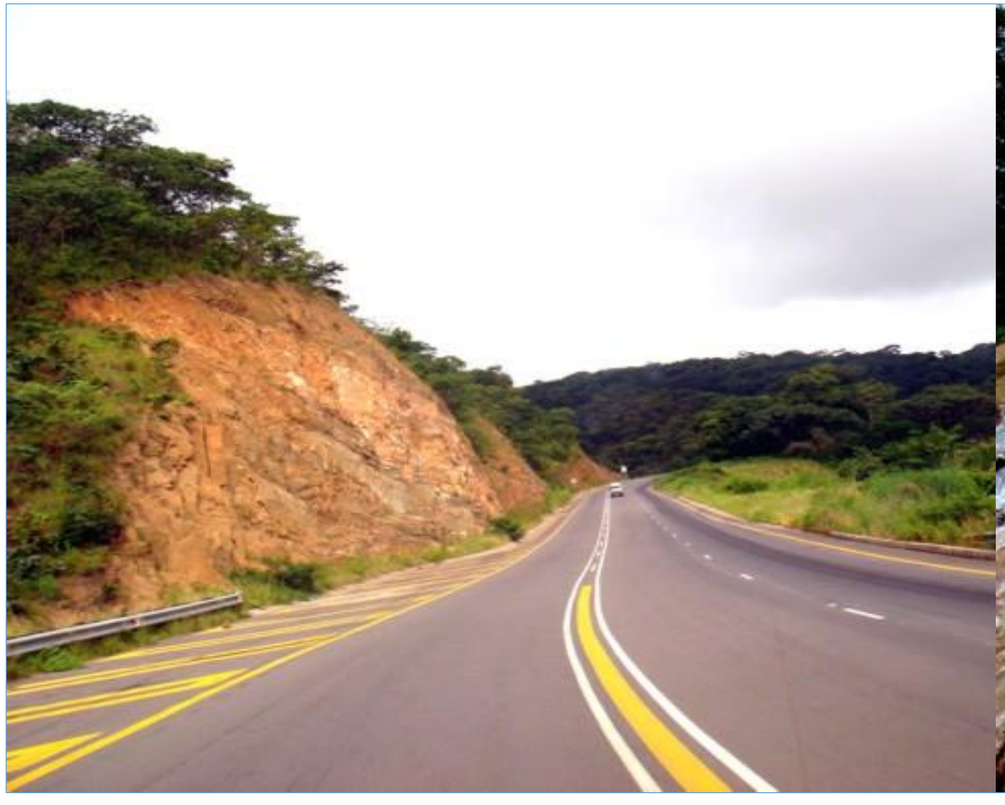
a) Is soil / rock beneath a construction site able to safely support proposed project?

The Tower was not originally intended to lean, but because it was built on **soft soils**, it gradually tilted to one side. Prior to restoration in 1990 to 2001, the Tower had a tilt of 5.5^{o}. Many people think that it will fall one day.

Significance of Engineering Geology.....contd.

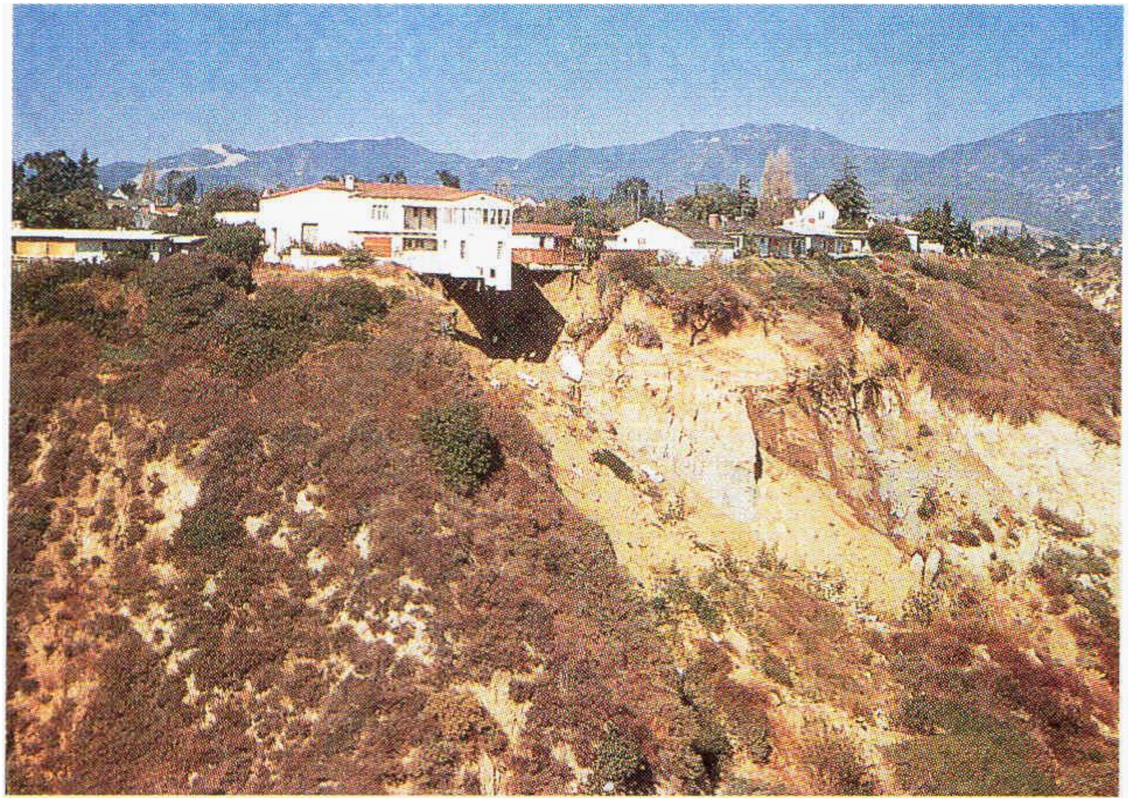
EX. 2: Typical Problems of Slopes:

a) Are cut-slopes and hillslopes stable and able to safely support proposed project?



Significance of Engineering Geology.....contd.

b) Are cut-slopes and hillslopes stable and able to safely support proposed project?



House fell few days after this photo was taken

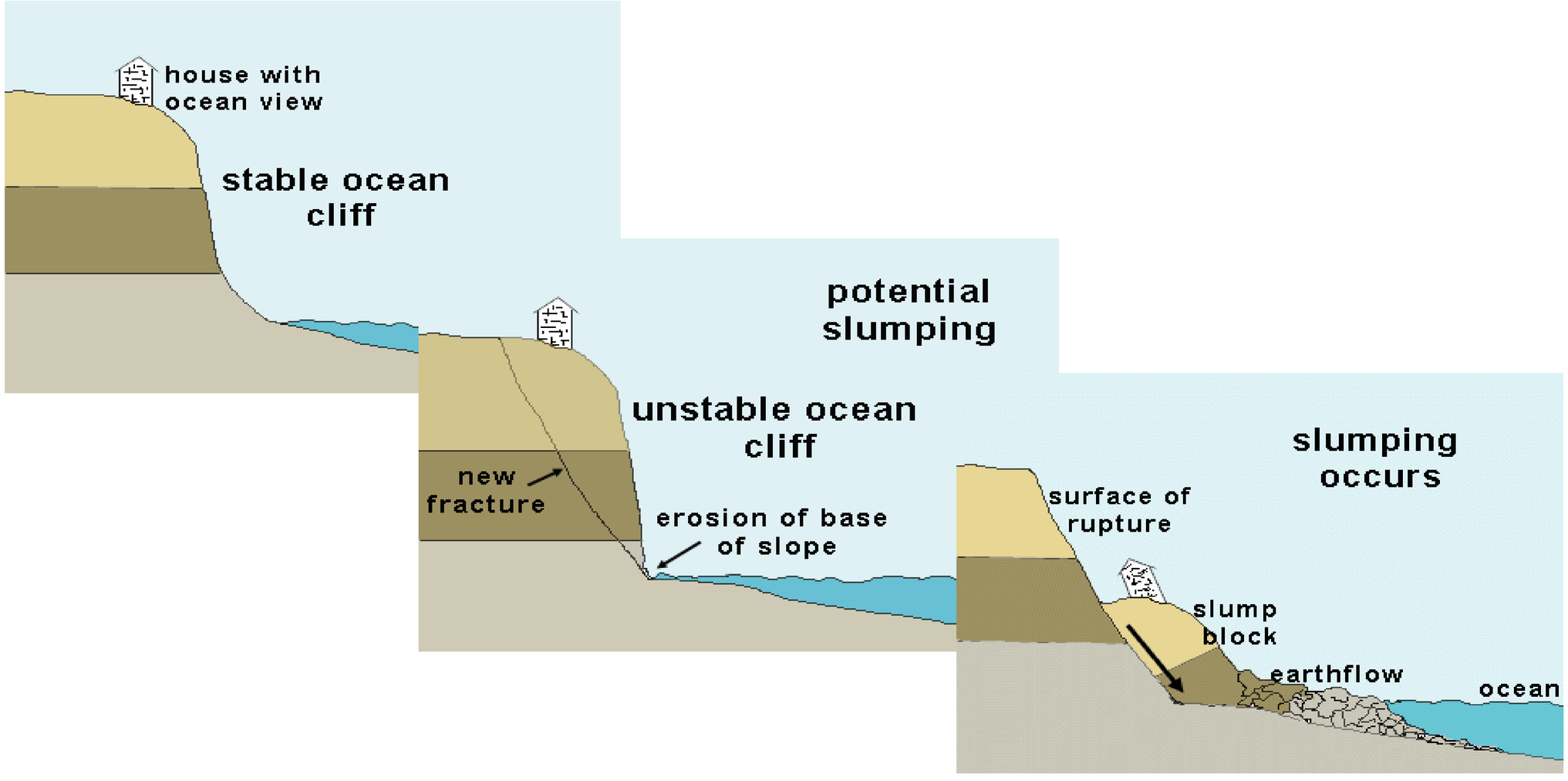
Excavation in hill slope

Significance of Engineering Geology.....contd.

c) Are cut-slopes and hillslopes stable and able to safely support proposed project?

Significance of Engineering Geology.....contd.

d) Dangers posed by eroding shorelines on proposed project



Significance of Engineering Geology.....contd.

Ex. 3: shrinking Soils

a) What danger is posed by shrinking subsoil on proposed project?

Significance of Engineering Geology.....contd.

Ex. 4: Eroding Ground – Dangers posed by erosion on proposed project

Significance of Engineering Geology.....contd.

Danger posed by construction of project on ‘dissolved’ rock?

Significance of Engineering Geology.....contd.

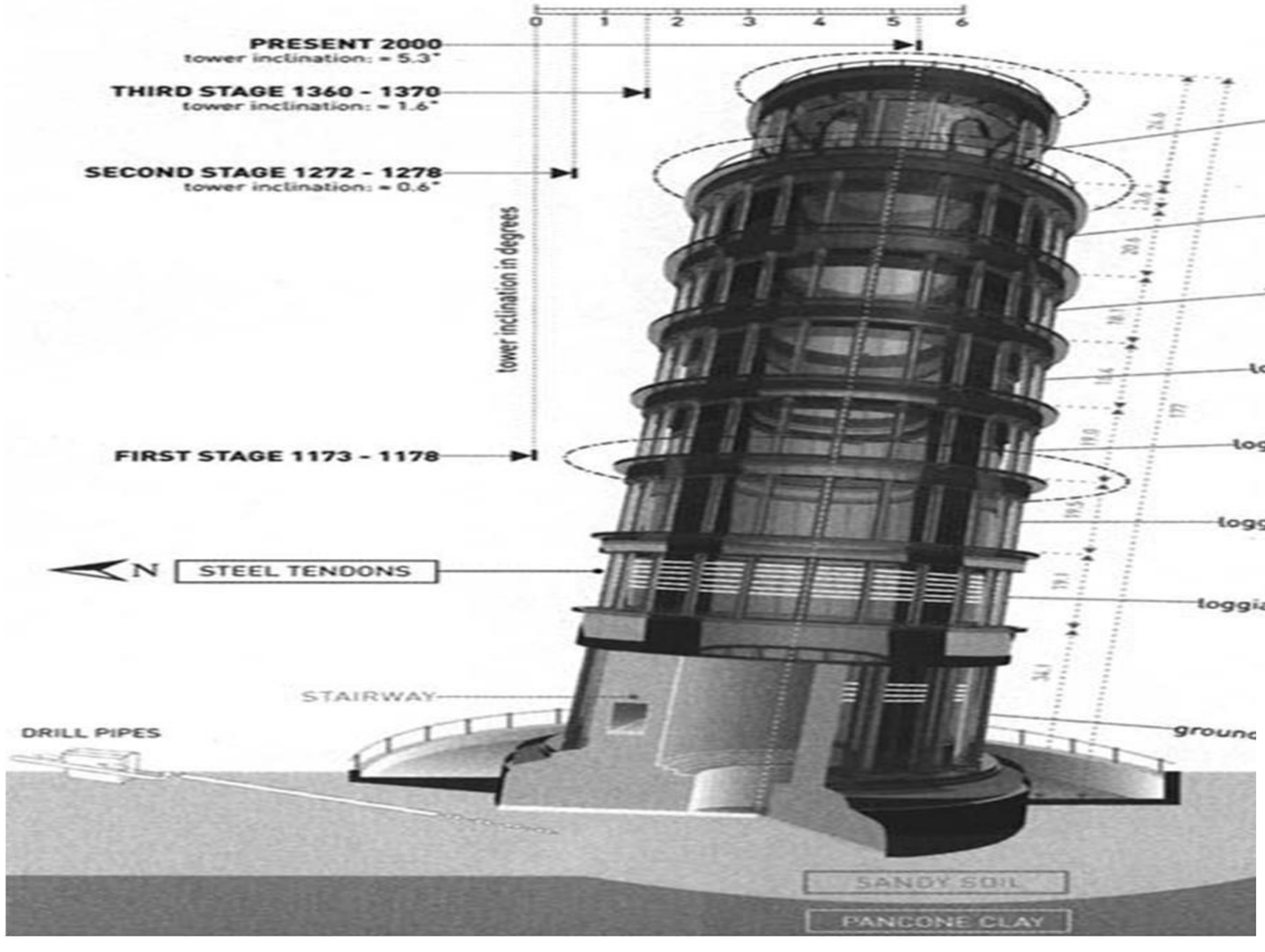
f) dangers posed on proposed project by floods….

Satellite image of Banda Aceh Shore, Indonesia, before the tsunami (June 23, 2004)

Satellite image of Banda Aceh Shore, Indonesia, after the tsunami (December 28, 2004)

Why These Incidences Happened

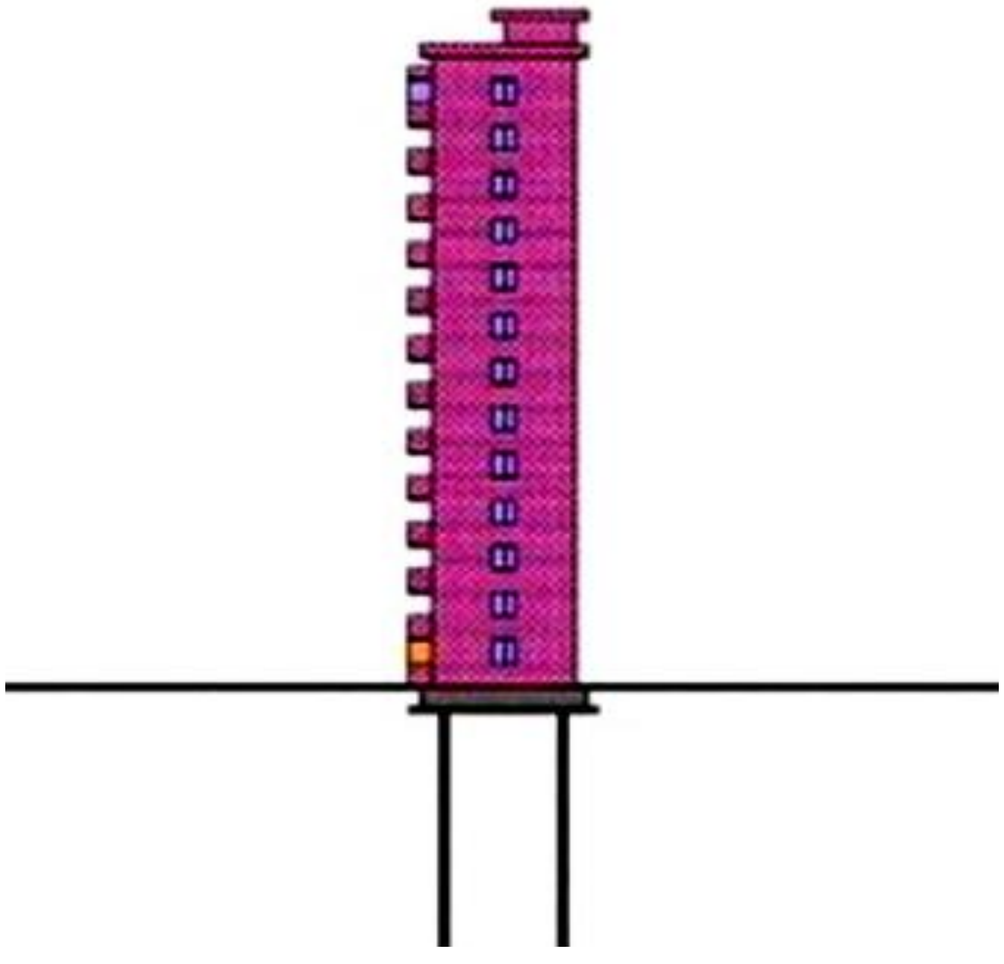
a) Poor Sub-surface Conditions

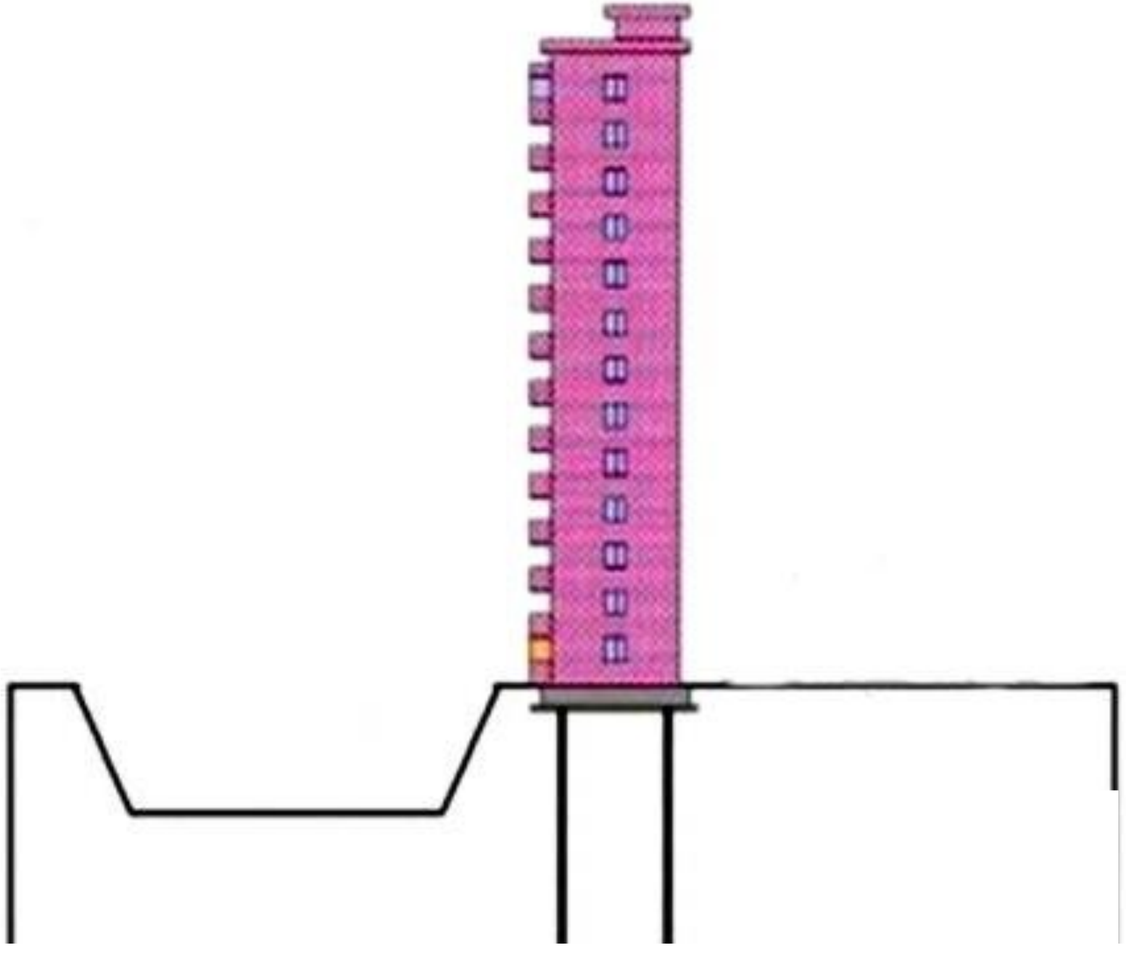


Inadequate Soil carrying Capacity, leading to Failure

Why These Incidences Happened.....contd.

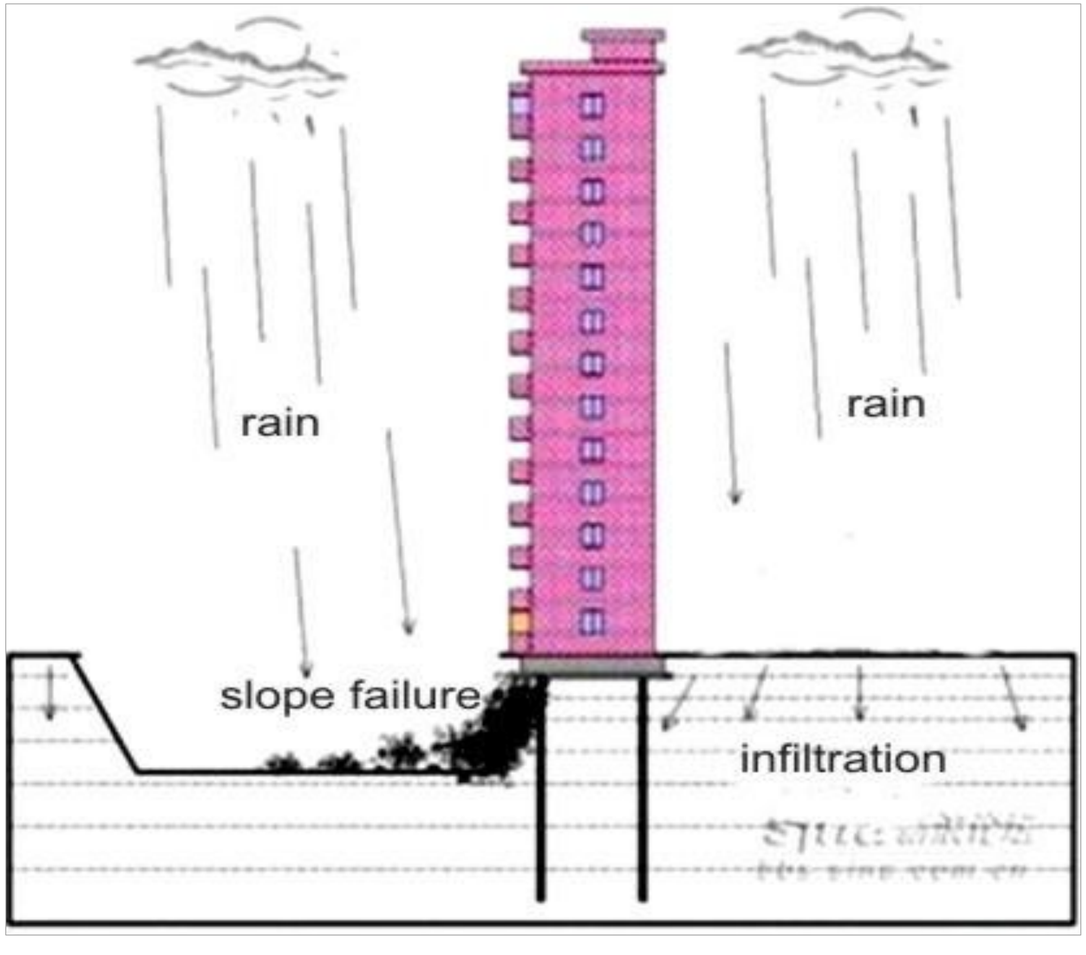
c) Structure constructed without proper study of Deformability of underlying ground.

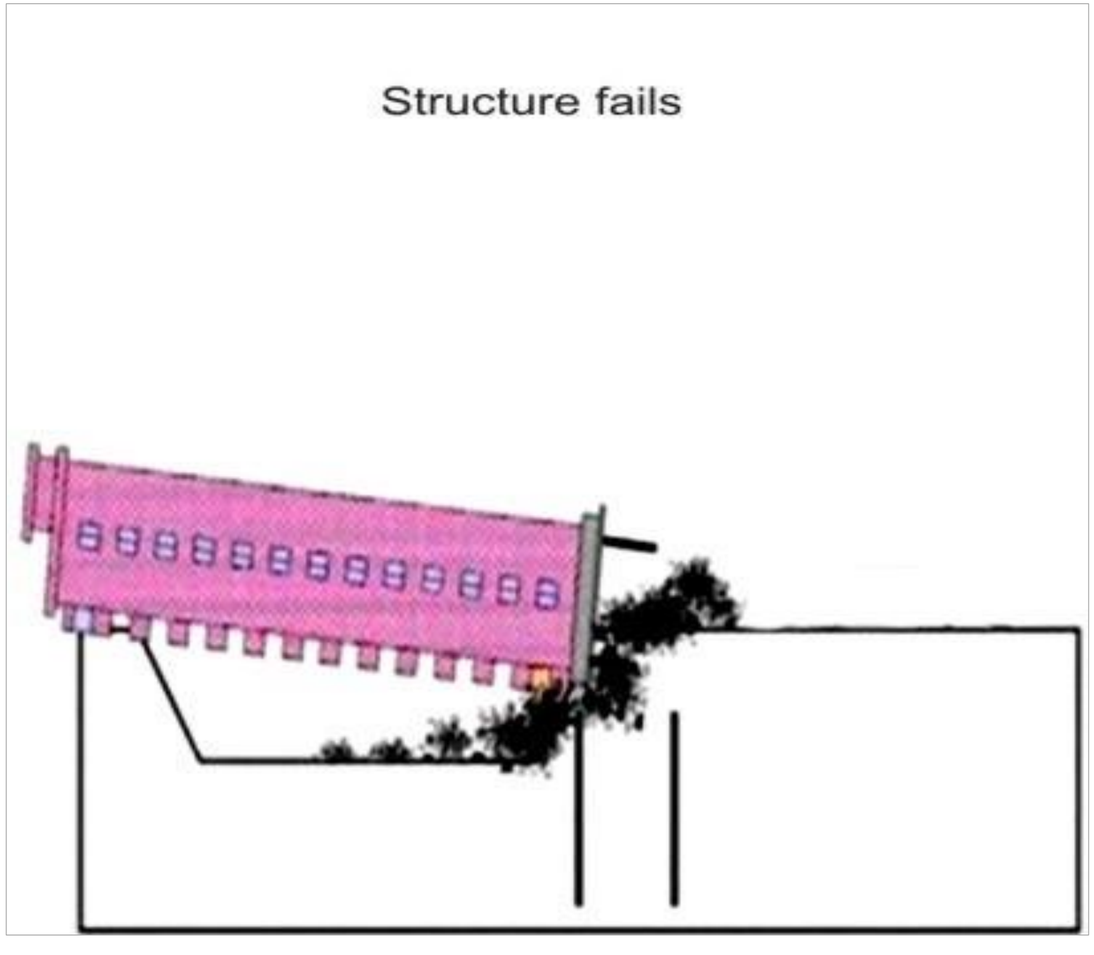




Why These Incidences Happened.....contd.

c) Structure constructed without proper study of Deformability of underlying ground…(2)





Concluding Remarks

Engineering geology is important in the selection of best sites for engineering purposes through:

- Recognition of potentially difficult ground prior to detailed design and construction.
- Identification of areas susceptible to failure due to geological hazards.

Concluding Remarks

- Selection of best engineering materials for construction.
- Identification of potential geologic/man-made hazards that may impact civil structures and human development – *earthquakes, landslides, flooding, surface subsidence, etc.*

Teaching Method

- Lectures – 4 hours per week
- Practical – 3 hours, once a week

Method of Assessment

Continuous assessment – 40 %

- Labs – 20 %
- Tests – 20 %

Final Examination – 60 %

Readers

PRESCRIBED

⇨ Introduction to Physical Geology. Thompson, G.R, & Turk, J.

SUPPLEMENTARY MATERIAL

⇨ A Geology for Engineers, Seventh Edition. Blyth, F.G.H. & de Freitas, M. H.

End of Lecture