UNIVERSITY OF ZAMBIA

# GG3051: ENGINEERING GEOLOGY

# LECTURE_1: INTRODUCTION & BASICS OF EG

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# 1.1. What is Engineering Geology?

1. The application of GEOLOGIC:

- ✓ Data
- ✓ Techniques, &
- ✓ Principles

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

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

# 1.2. Geology & Civil Engineering

- **Geology:** science dealing with physical nature & history of earth [i.e. rocks of which it is composed; and changes, which it has undergone / is undergoing].

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

# Geology & Civil Engineering cont'd

Difference between Geologist & Civil Engineer is philosophical:

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

# Geology & Civil Engineering cont'd

Engineering Geology has attempted to fill philosophical gap by:

- Evaluating geological phenomena, and
- Defining geological environments for the purpose of engineering works.

# Geology & Civil Engineering cont'd

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 cont'd

- 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:

✓ assure that geologic factors affecting location, design, construction operation, & maintenance of engineering works are recognized and adequately provided for……

# 1.3. Why Engineering Geology?

Geology is everywhere!

Therefore, its importance is because ALL engineering works:

- Are built on / in the ground
- Aare usually constructed from materials taken from ground
- Have potential to pollute natural resources.

# Why Engineering Geology? Cont'd

∴ Appropriate geological investigation [GI] of proposed sites & surrounding area:

✓Establishes interrelationships between engineering works & geologic environment

GI of a site is fundamental in determining its:

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

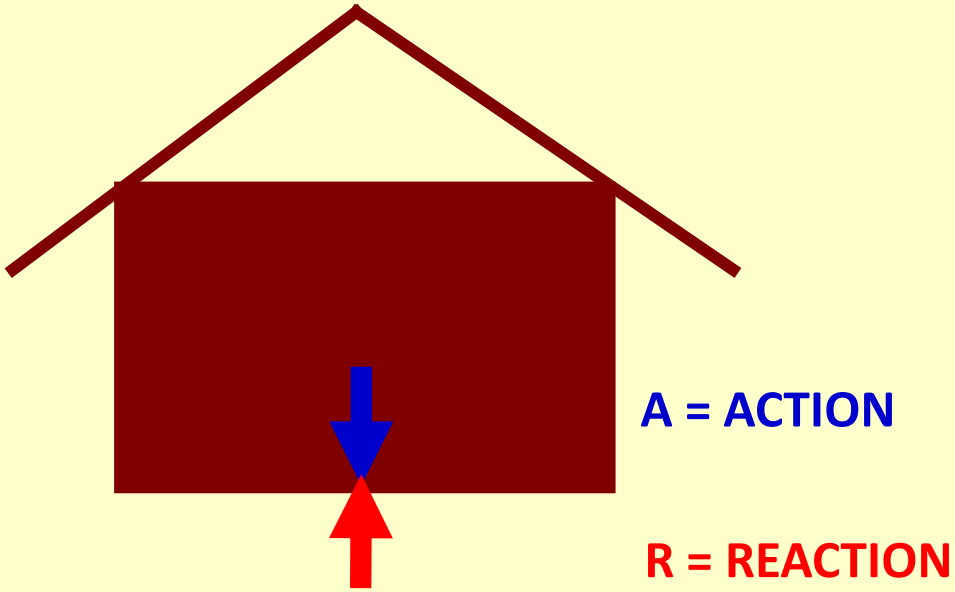
# 1.4. Principles of Engineering Geology

...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 cont'd

Civil/Engineering Geology works receive some *reaction* from ground, *equal in magnitude* to imposed action, & **COLLINEAR** to the action:



# Principles of Engineering Geology cont'd

Task of engineering geologist is to determine:

- ✓ Nature of **REACTION**
- ✓ **BEHAVIOUR** of completed works

# 1.5. Determination of Nature of REACTION

Starts with:

- Determination of ground properties of the site, accomplished by:

  Laboratory Tests

  ✓ Field Tests

# Determination of Nature of REACTION cont'd

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

- ✓ CLIMATE
- ✓ TIME
- ✓ NATURAL HAZARDS.

# Determination of REACTION cont'd

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

  ∴ Identical soil/rock mats / masses may behave differently under action of engineering process, depending on moisture content.

- 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…

# 1.6. Significance of Engineering Geology

1. **It provides a means for:**

- **Appreciation** & **identification** of geologic features that could have short- and long-term consequences on overall performance of civil engineering structures / projects.

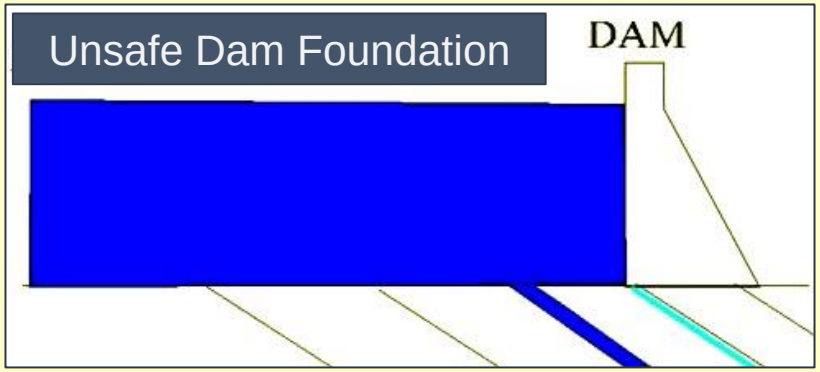
# Significance of Engineering Geology cont'd

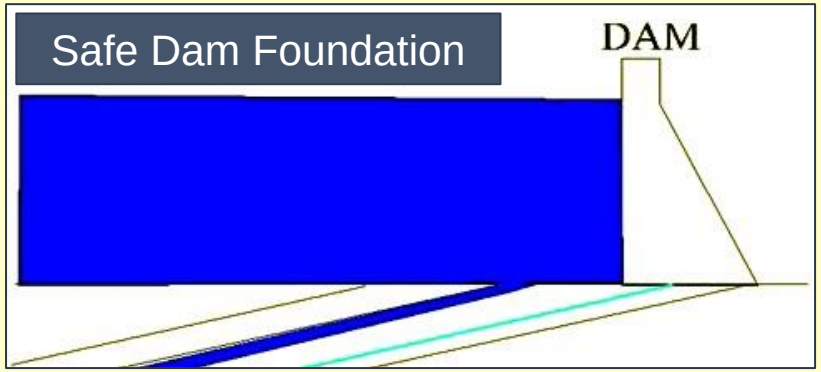
**2. Is useful in:**

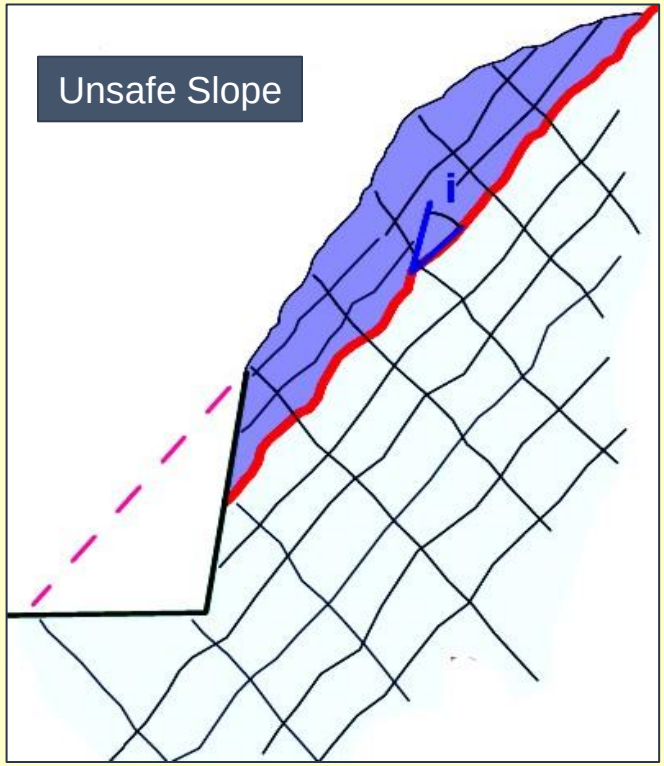
- Design of *foundations; stabilisation methods for hillsides, eroding shorelines; reservoir storage, dams, & tunnels etc*
- Evaluating & mitigating groundwater contamination
- Planning of highway routes & identify earthen construction material sources
- Mitigating natural hazards such as earthquakes

# Significance of Engineering Geology.....cont'd.

- Determining Effects of joints [orientation & location] on stability



# Significance of Engineering Geology.....cont'd


- 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.

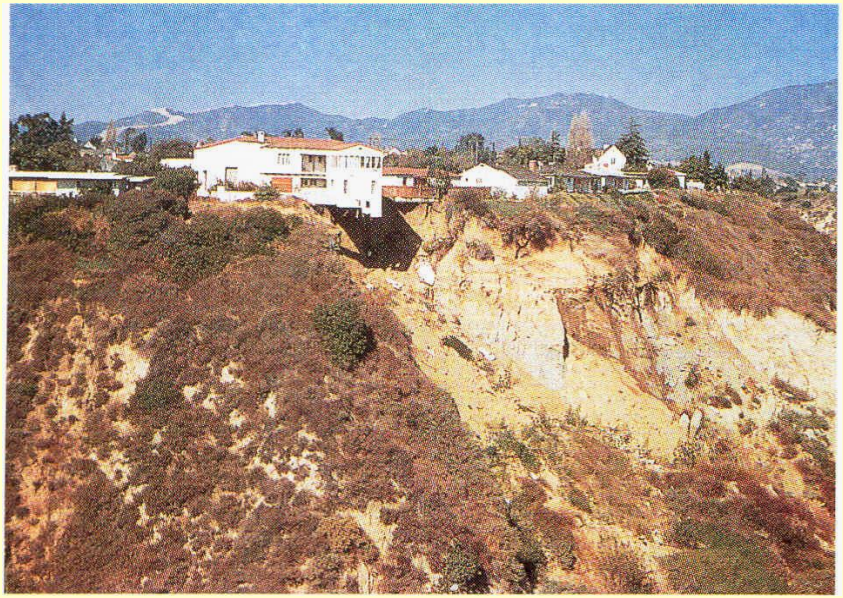
- **EX. 2:** Typical Problems of Slopes:

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

# Significance of Engineering Geology.....contd.

- **EX. 3: Typical Problems of Slopes:**

c) 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.

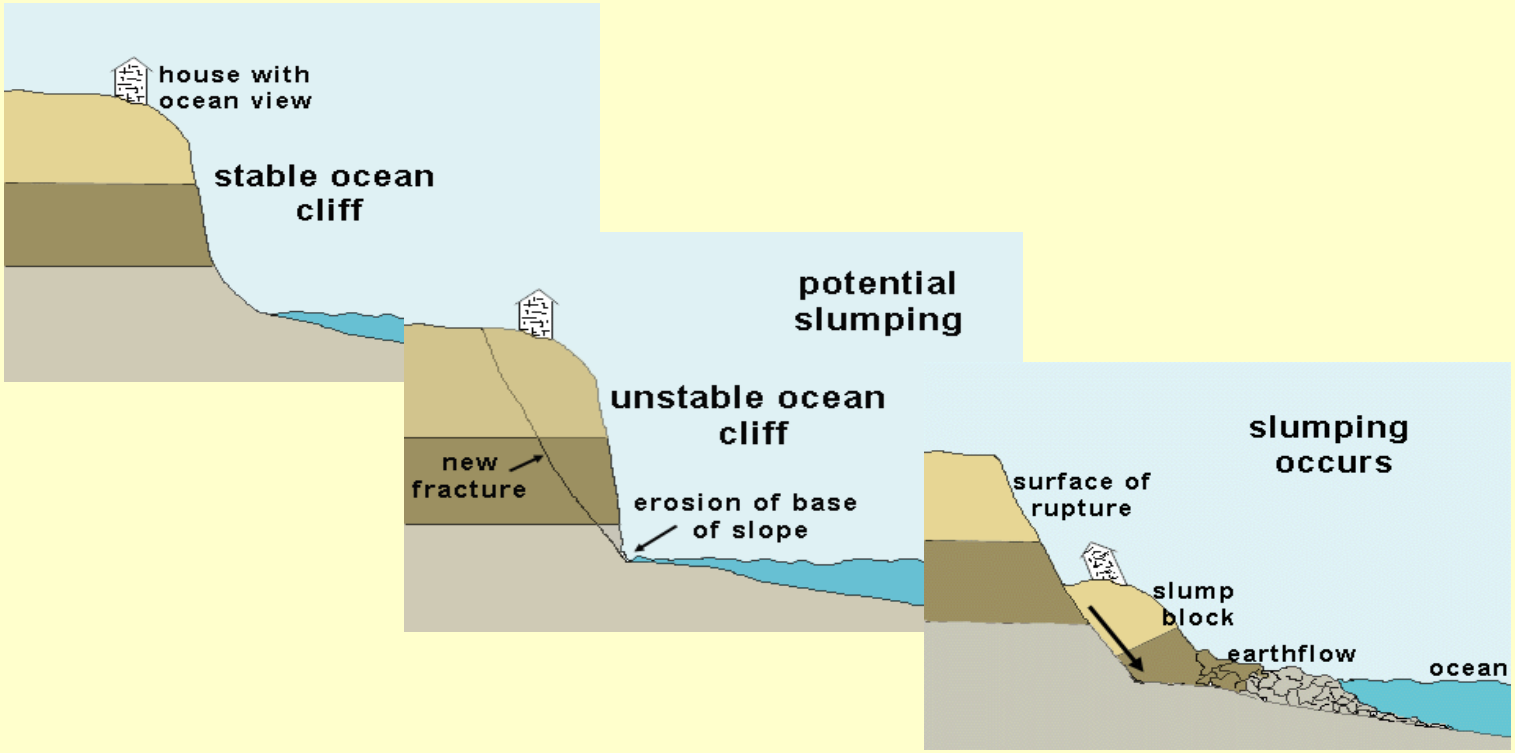
EX 4: Typical problems of slopes:

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

# Significance of Engineering Geology.....contd.

**EX 5: Erosion and undercutting**

e) Dangers posed by eroding shorelines on proposed project



# Significance of Engineering Geology.....contd.

**Ex. 6: Shrinking Soils**

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

# Significance of Engineering Geology.....contd.

**Ex. 7: Eroding Ground**

g) Dangers posed by erosion on proposed project

# Significance of Engineering Geology.....cont'd.

**EX 8: Typical problems of carbonate rocks [underlying geology]**

h) Danger posed by construction of project on 'dissolved' rock?

# Significance of Engineering Geology.....contd.

**EX Floods**

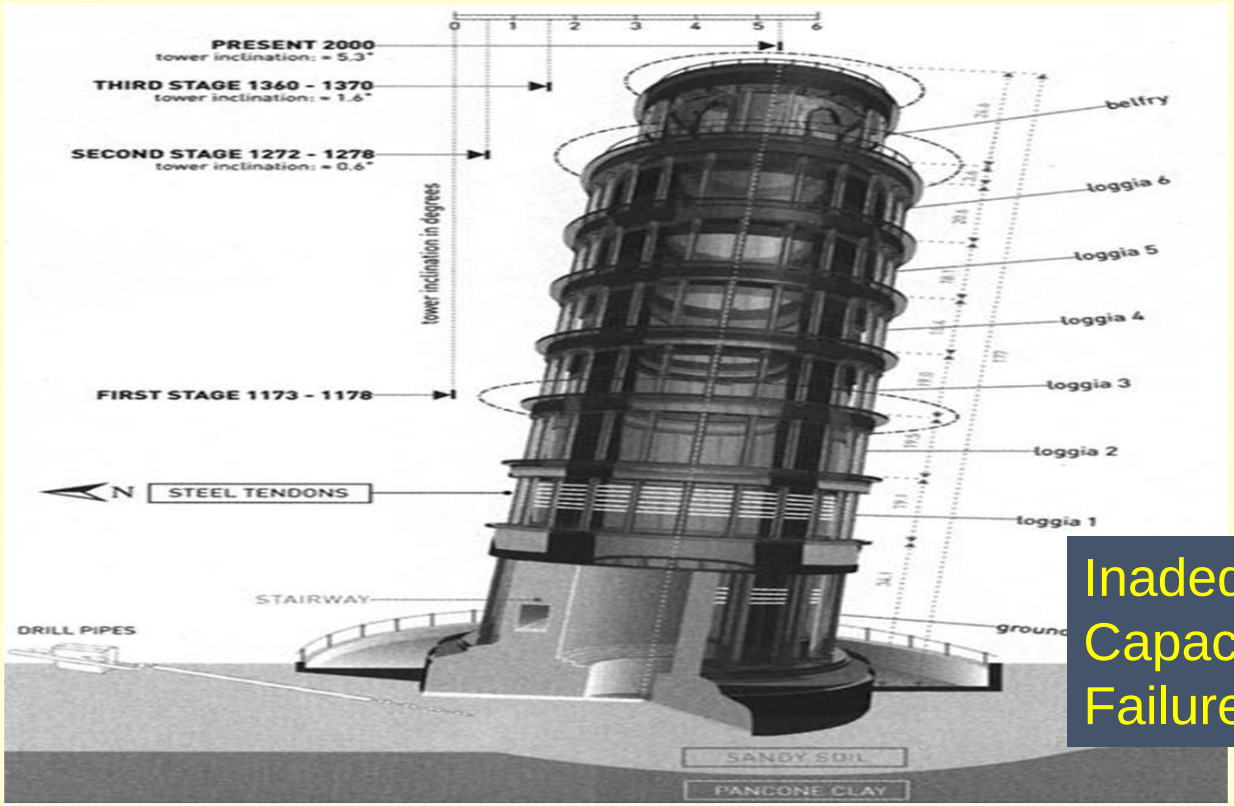
i) Dangers posed on proposed project by floods….

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

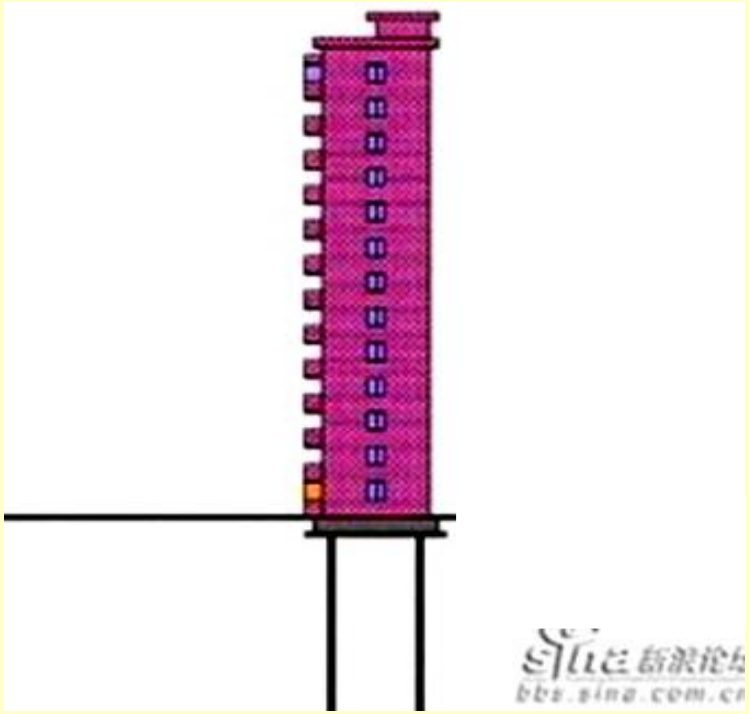
a) Poor Sub-surface Conditions

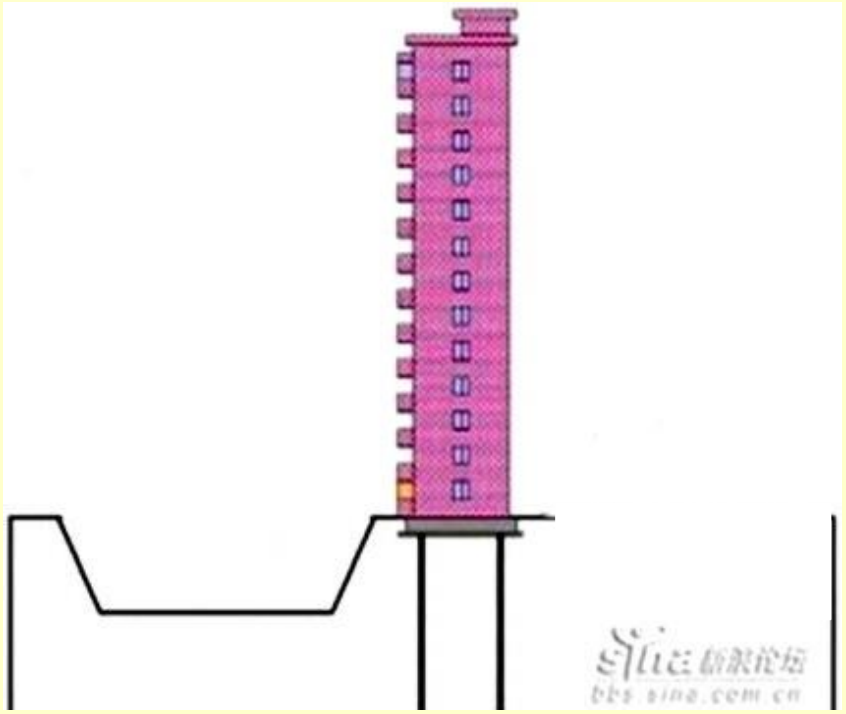



Inadequate Soil carrying Capacity, leading to Failure

# Why These Incidences Happened.....contd.

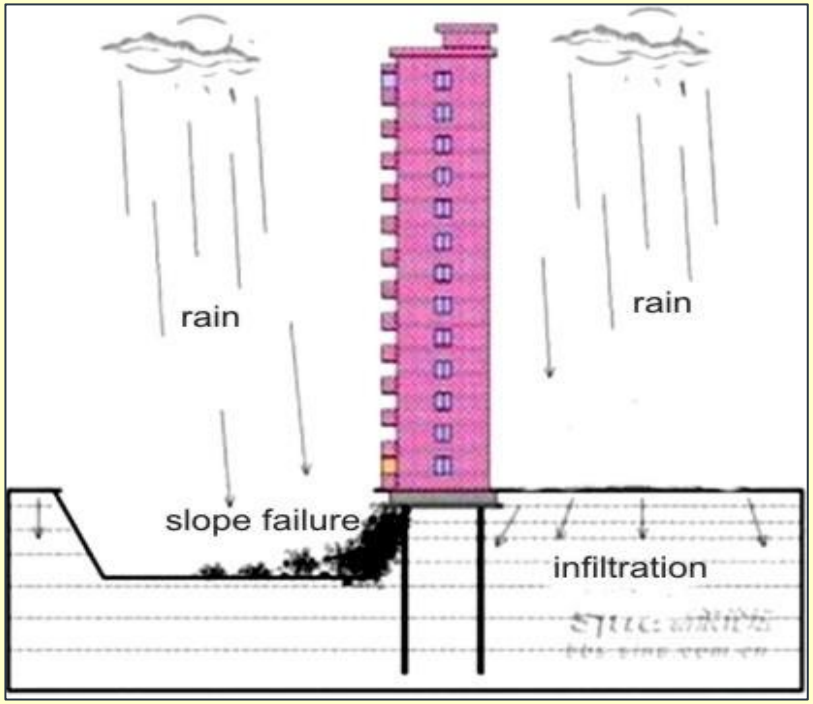
b) Structure constructed without proper study of Deformability of underlying ground.

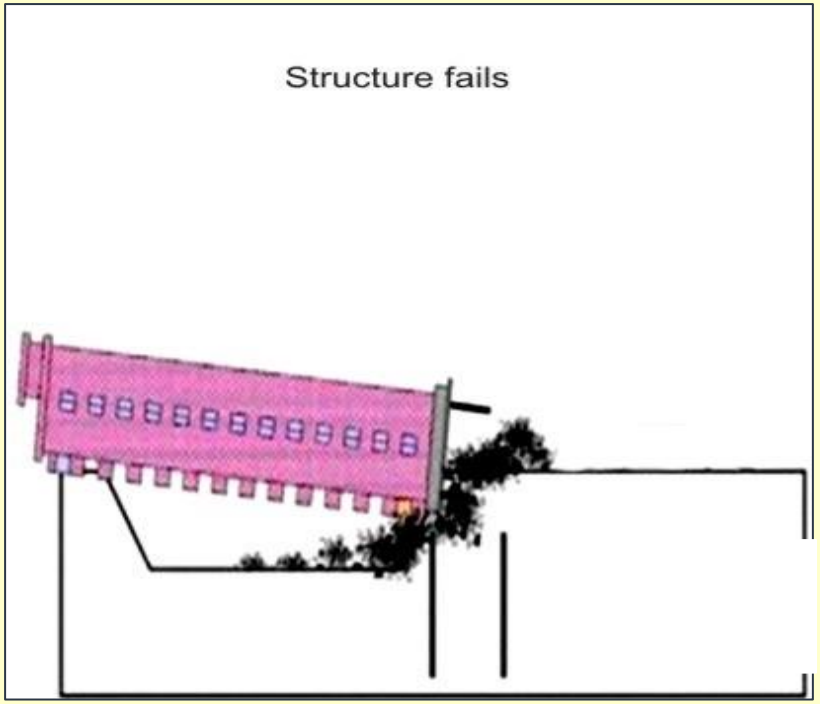




# Why These Incidences Happened.....contd.

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
- ✓ 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.*

**END OF LECTURE**