UNIVERISTY OF ZAMBIA
GEOLOGY DEPARTMENT

GGY3051: ENGINEERING GEOLOGY

GEOLOGY IN ENGINEERING: SITE INVESTIGATIONS

LECTURER: D.P.T. Zilifi

Introduction

Knowledge of fractures in rocks is important in Engineering Geology Practice because the fractures:

- ✓ Control transport & circulation of various fluids thru rocks.
- ✓ Determine movement & storage of grdwater as well as penetration of surface water into rocks.
  - ➢ *Well-jointed rocks, which are **otherwise impermeable**, may form important water reservoirs.*

Introduction.....contd.

Geologic features & info of importance to foundations on rock include:

- ✓ Faults, joints, shear zones, stratigraphy.
- ✓ Groundwater levels, springs, surface water or other evidence of gw regimes.
- ✓ Potential cavities due to karstic formations, mines, and tunnels.

Introduction.....contd.

Other important features include:

- Potential problem rocks subject to ***dissolving, swelling, shrinking, and/or erosion.***

Joints under foundations should be treated / sealed to prevent water circulation that may lead to erosion of rock leading to their enlargement into caverns.

Definining- Site Investigations(SI)

SI is a Process by which:

- Geologic
- Geotechnical &
- Other relevant surface & sub-surface data/information

which affect construction and/or performance of an engineering or building project – are acquired

Objectives - of Site Investigations

- ✓ To assess suitability of a site & its environs for proposed project
- ✓ To provide data for effects of proposed project on its environment → distress to neighbouring structures resulting from loss of ground &/or lowering of GW Table (which would lead to legal action).
- ✓ To explore & locate sources of construction materials.

Objectives - of Site Investigations…..contd.

- ✓ To observe & record any conditions that may have led to failure of existing or former structures
- ✓ Where alternatives exist, to advise on suitability of alternative sites

Organisation - of Site Investigations

For a site investigation to be successful, it must be:

- ✓ Well-planned / organised
- ✓ Undertaken in an orderly manner using appropriate & well-maintained field & lab equipment.

⇒ Investigations are carried out in **STAGES or PHASES**.

Stages outlined below → an expression of a principle, which can be separated or merged into each other.

1. Project Conception Stage

After decision to initiate project → need for desk study. This involves study of:

- ➢Geological, geotechnical & topographic data
  - ✓ All relevant topographic maps
  - ✓ Aerial photographs
  - ✓ Geologic & hydrogeologic maps of site
  - ✓ Site investigation & construction reports for adjacent engineering projects.

1. Project Conception Stage.....contd.

Main idea for this phase is:

- To produce sufficient evidence to allow for formation of hypothesis regarding
  - ✓ Geologic structure
  - ✓ Nature of sedimentary deposits, if any, @ site
  - ✓ Location & type of likely engineering problems that may arise as a result of prevailing ground conditions.

1. Project Conception Stage.....contd.

To achieve the above objective, the following need to be investigated:

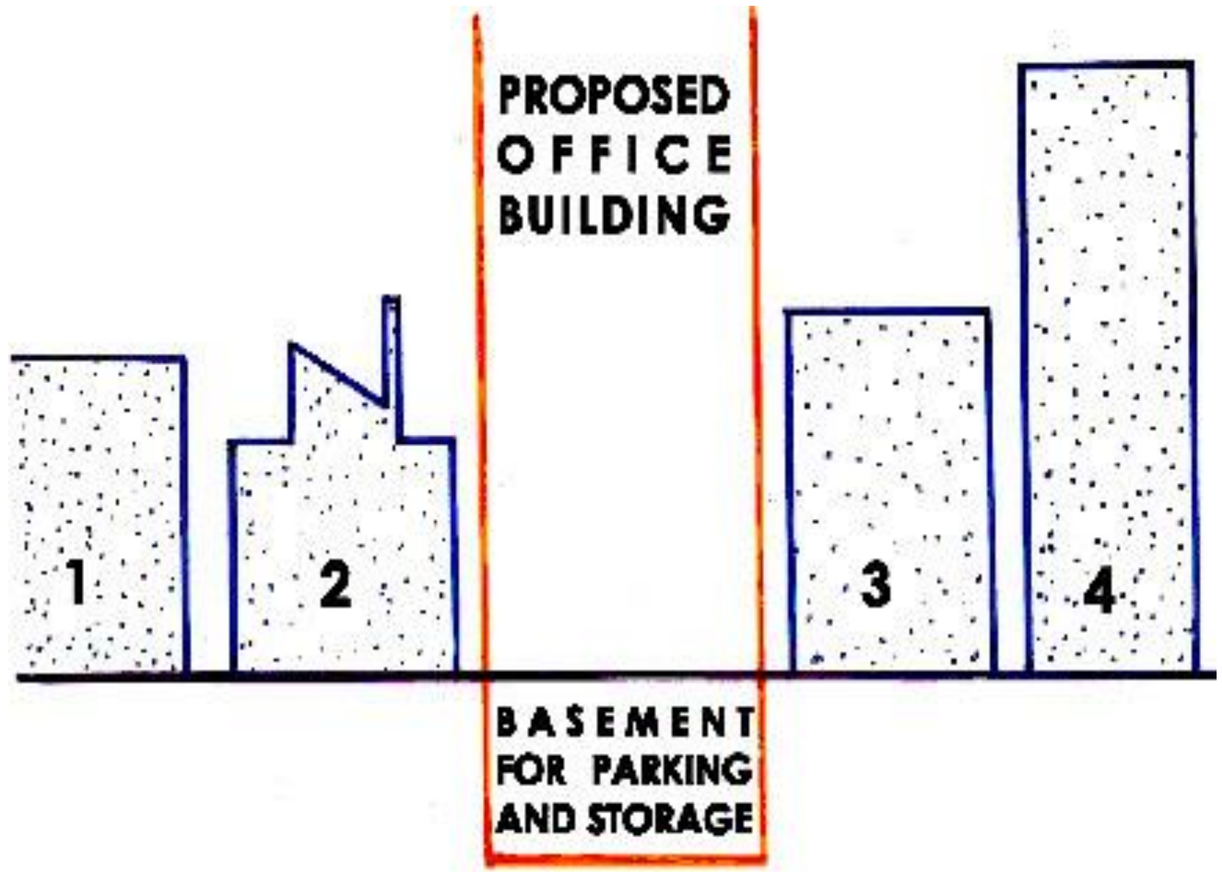
- ✓ History and previous use of site
- ✓ Any defects /failures of existing or former buildings attributable to foundation conditions
- ✓ Any special features – possibility of earthquakes, flooding, seasonal swelling & shrinkage of ground.

1. Project Conception Stage.....contd.

An Example

Tall office block in built-up area, incorporates basement for storage or car park

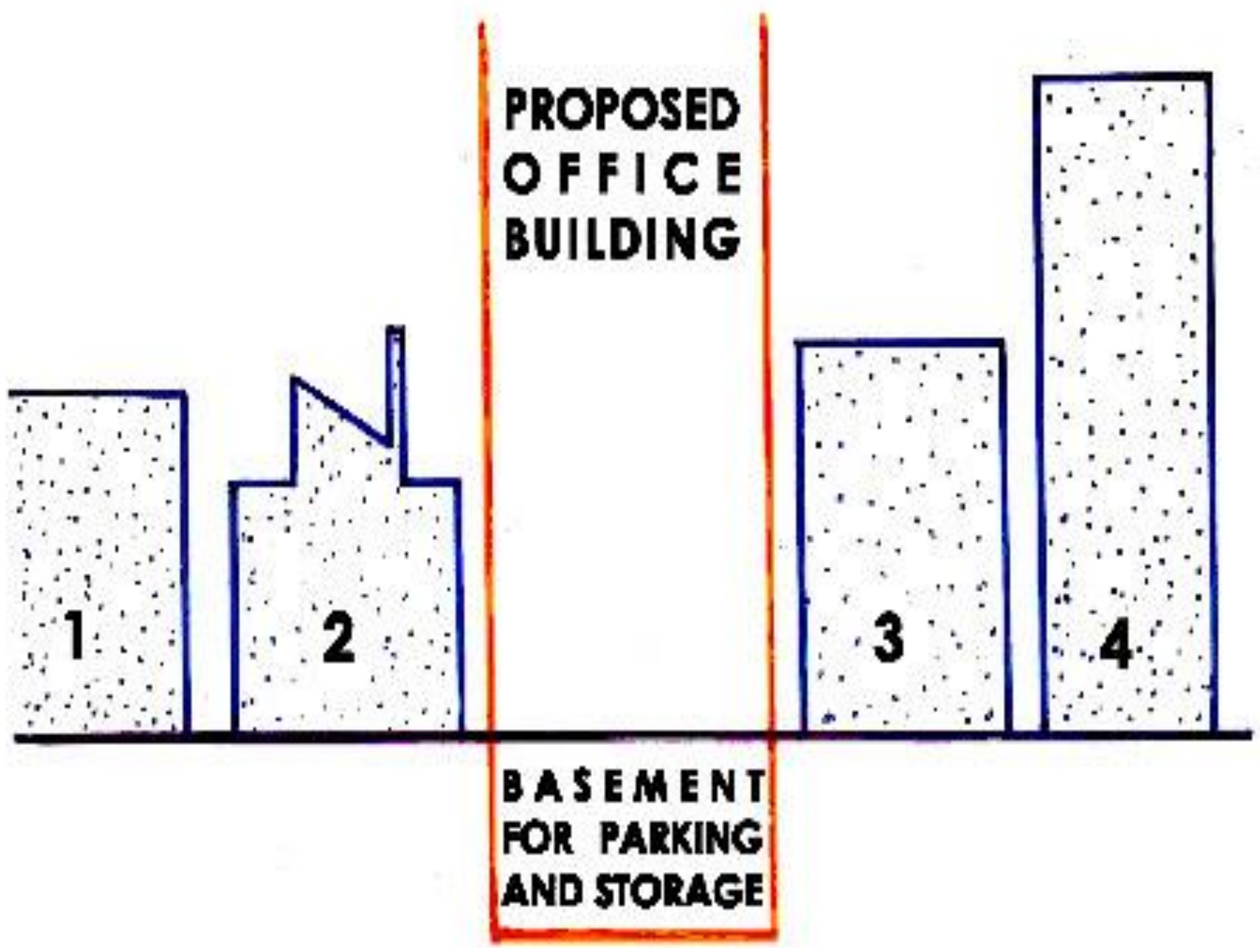
- Buildings on both sides are of varying age.
- Building 2 is very old and of antique design.
- Building 4 is modern, but relatively old
- Buildings 1 & 3 are modern and new.



1. Project Conception Stage.....contd.

In addition, the following is known:

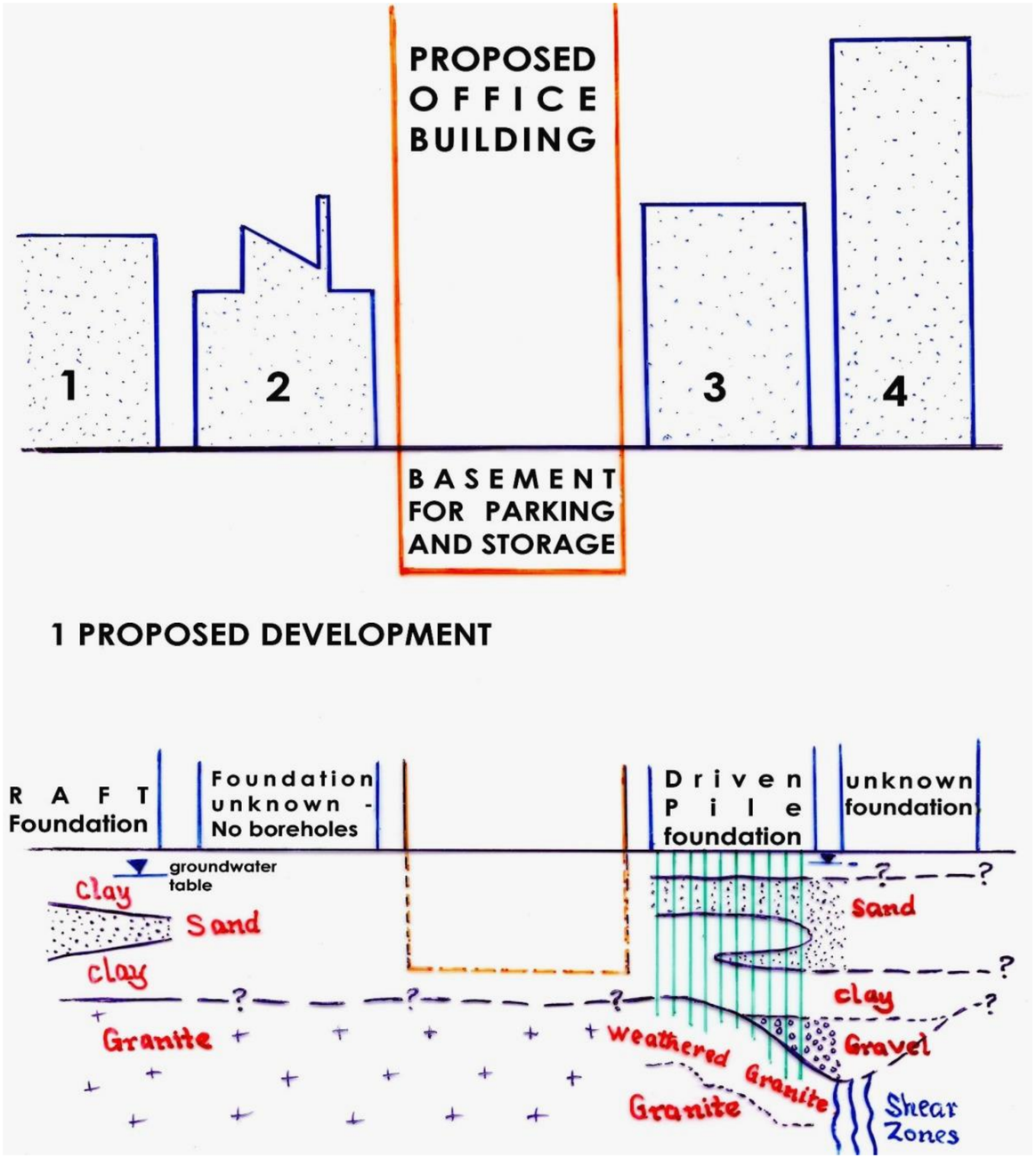
- ✓ Records of an old b/h @ 4
- ✓ Investigations records & foundation drawings @ 1& 3
- ✓ Some known geologic conditions @ 4



1. Project Conception Stage.....contd.

⇒ Site geology & hydrogeology can be deduced:

- ✓ Granite most probably underlies proposed block & would seem likely to be deeper than bottom of proposed basement.
- ✓ If work must go on, it should begin with excavation of b/m ⇒ <u>withdrawal of support</u> from surrounding ground



1. Project Conception Stage.....contd.

Consequence:

- Creates problems with stability of excavated slope

To determine this problem requires knowledge of geotechnical props of soil/rock mass in the slope.

Unfortunately, because of presence of adjacent blgs, slope must be **near vertical.**

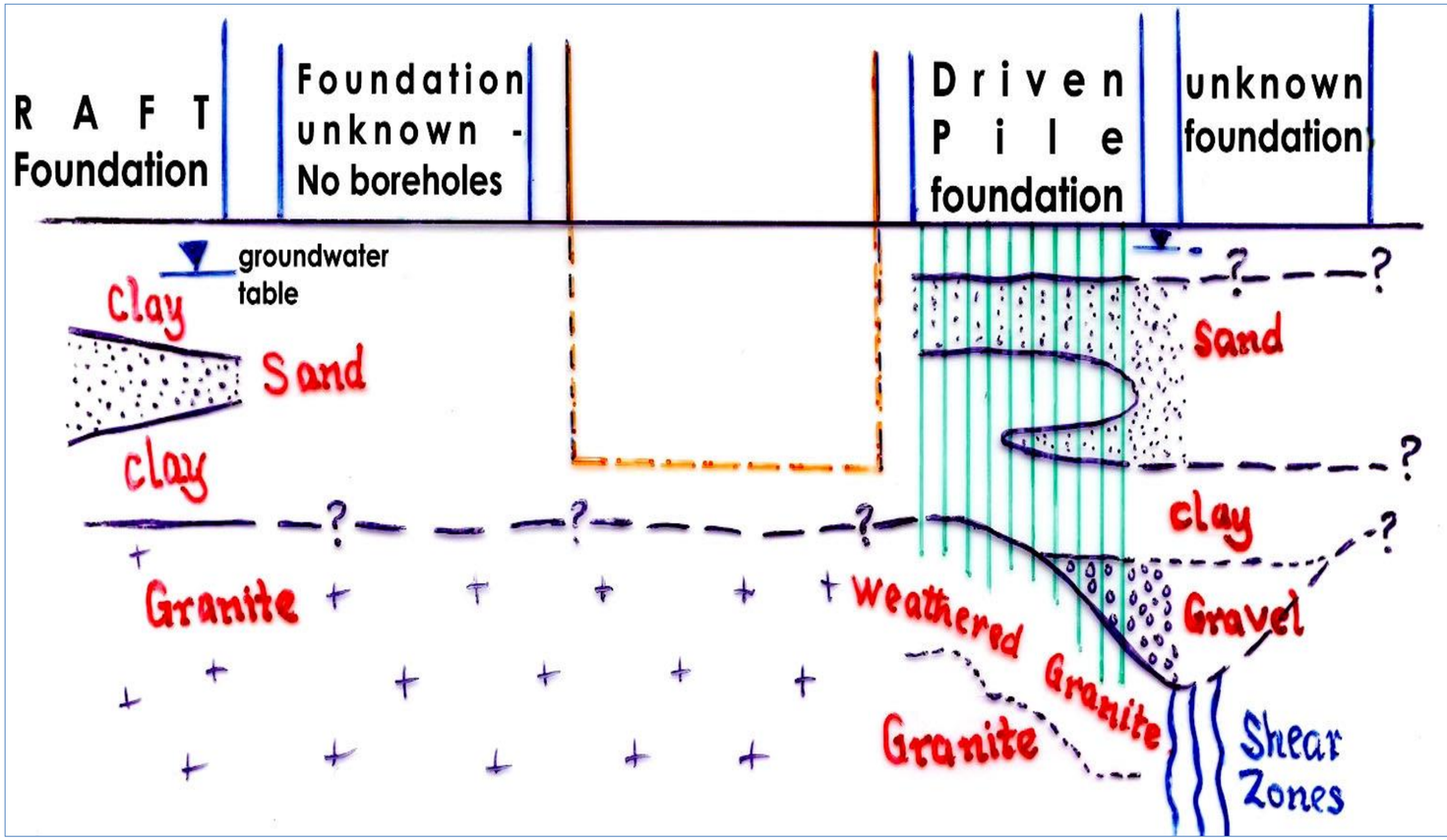
1. Project Conception Stage.....contd.

Slopes may subsequently need some support. To achieve this, will require knowledge of:

- ✓ Geotechnical props of ground.
- ✓ Foundation loads imposed by nearby buildings (including their types, depth & conditions).

1. Project Conception Stage.....contd.

Assuming foundation excavation can be made, depth to top of granite will need to be known.



If granite is deep, & alluvium too weak to support building load, foundation may need to extend below bottom of b/m to reach it.

1. Project Conception Stage.....contd.

Possible problems:

- ✓ Higher slope will be created ⇒ ***need for support***

- ✓ If wt is high in alluvium, water **will flow into excavation** & **influence stability of slope**…….

Having assessed some likely problems that'd affect project,

basic practicability of project should be established!

2. Preliminary Investigation Stage

The foregoing will reveal gaps in the basic knowledge of the site.

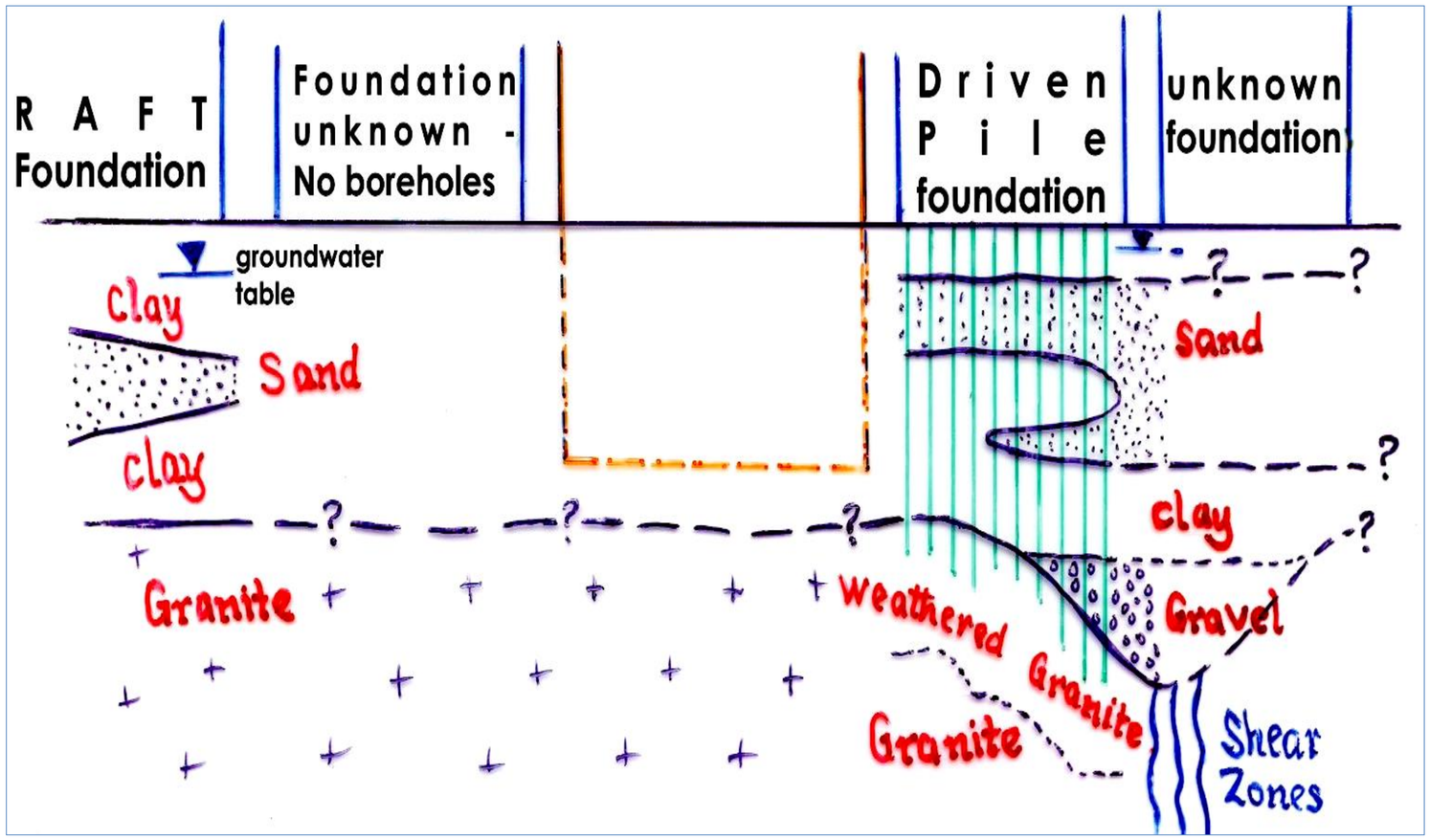
In this stage [stage 2], ltd exploration is carried out using relatively simple & inexpensive techniques to:

- ✓ Establish basic knowledge, and
- ✓ Define the main factors that'd influence feasibility, cost & safety of project.

2. Preliminary Investigation Stage.....contd.

If granite is too deep, the alluvium too weak, & adjacent foundations of uncertain nature & quality, design may need to be modified:

- Do without basement
- Move to alternative site, if available.



If from this stage

design seems possible → proceed to next stage [Stage 3]

3. Main Investigation Stage

Work done in this stage is to get detailed & appropriate parameters for foundation design:

- ✓ Geotech. props of ground mass thru extensive lab & in situ testing – permeability, shear strength,.. etc.
- ✓ Distribution of alluvium
- ✓ Ground conditions within zone affected by foundation pressures – geophysical surveys, etc.
- ✓ Groundwater levels in various strata

3. *Main Investigation Stage.....contd.*

- ✓ Nature, depth & conditions of foundations of adjacent buildings.
- ✓ Distribution/character of strata on/in under foundations
- ✓ Any environmental hazards & how they'd affect the determined parameters

3. Main Investigation Stage.....contd.

Subsequently:

✓ parameters appropriate to foundation design must be provided → ENGINEERING GEOLOGICAL SITUATION

✓ Behaviour of ground to proposed engg. work → determined by CALCULATION & JUDGEMENT

4. Construction Investigation Stage

Results of the Main Investigation are rarely absolutely correct. Construction of project often reveals DISCREPANCIES between forecast GROUND CONDITIONS & those encountered.

⇒ Sometimes this raises need for project re-design

All ground conditions encountered during construction must be monitored, recorded & assessed.

5. Post-Construction Investigation Stage

Intended to:

- Monitor behaviour of completed engg. work computed on basis of data acquired in earlier stages & comparing with predicted performance;
  - ✓ If behaviour of structure is not same as anticipated,… need for further investigations.
  - ✓ If there are anomalies, their cause must be established & remedial measures undertaken before severe damage/failure can occur.

5. Post-Construction Investigation Stage.....contd.

- ✓ Reveals discrepancies between forecast and actual conditions.
- ✓ Observes anomalies of project behaviour
- ✓ Establishes causes of these anomalies in order to undertake appropriate remedial measures before severe damage / failure occurs.

Summary

In most civil engg- and building-works worth of their name;

- The unexpected will always happen.
- To be prepared for such eventualities, and to forestall their effects, is the test of good construction practice.