

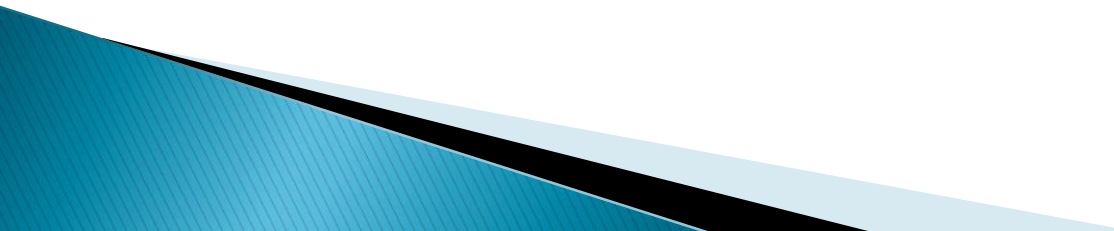
# PAVEMENT MATERIALS

## Lecture 2

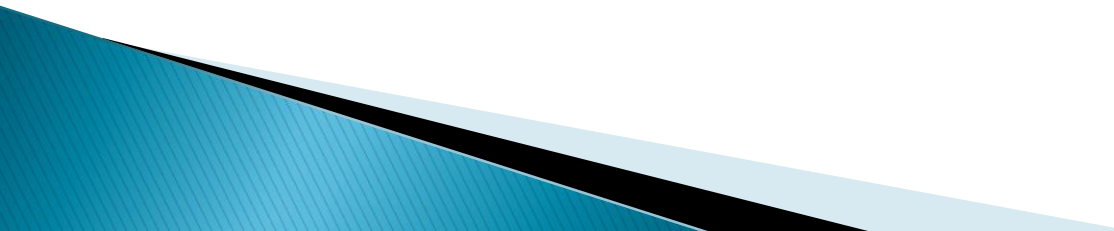
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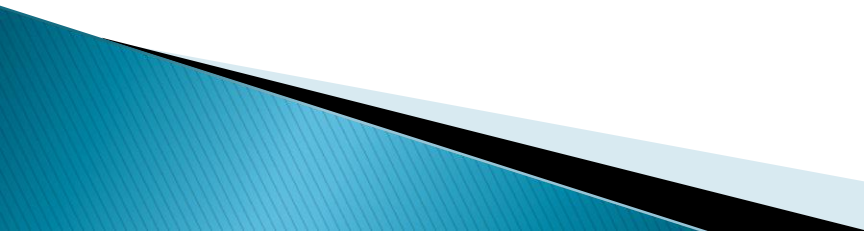
# Course Heads

- ▶ Subgrade
    - Natural
    - Stabilized
  - ▶ Subbase
  - ▶ Base Course
    - Unbound
    - Bound
  - ▶ Surface Courses
- 

# Course Agenda

- ▶ Material Identification
  - ▶ Material Evaluation
  - ▶ Material Selection
  - ▶ Material Compaction/Construction
  - ▶ Quality Evaluation During Construction
  - ▶ Quality Evaluation After Construction
- 

# Sequence

- ▶ SUBGRADE
  - ▶ Investigation
  - ▶ Material Classification/Identification
  - ▶ Material Evaluation
  - ▶ Material Selection
  - ▶ Construction of Subgrade
  - ▶ QA/QC
  - ▶ Post Construction Investigation
- 

# Subgrade Investigations

- ▶ Soil Investigations ?
- ▶ A complete picture of Subsurface Conditions
  - as far as possible
- ▶ Subsurface Conditions
- ▶ Soil/Rock Strata (Type, Layers, Thickness, Extent)
  - To Depth of Significance
- ▶ Water Table
- ▶ Engineering Properties
  - Strength, Density, Moisture, Compressibility, Stability (Frost, Expansion), Permeability, Capilarity

# Subsurface Conditions can be entirely different from what is visible on surface





# Subsurface Conditions can be entirely different from what is visible on surface



A complex landscape sculptured by water

*What if we do not correctly evaluate  
soil properties or understand  
subsurface condition ???*





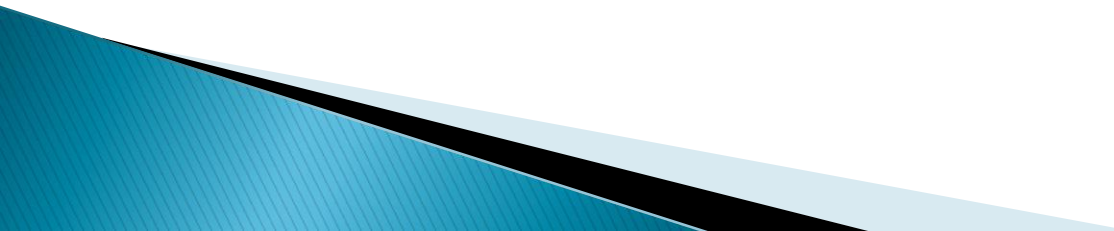
# INCOMPLETE / INACCURATE SITE INVESTIGATIONS

- ▶ Leaning Tower of Pisa in Italy
- ▶ 185-foot tower, whose top lies 15 feet south of the base (~ 5 degrees tilt)
- ▶ A weak foundation of silty alluvial soil (formed by water).



# Objectives of Investigations

## ▶ To determine

- The geologic, seismologic, hydrological and other subsurface conditions that influence selection of the project site
  - The characteristics of the foundation soils and rocks
  - Geotechnical conditions which influence project safety, design, and construction
  - Sources of construction materials
- 

# General Procedure

## Desk Study

- All possible info about all candidate sites are gathered

## Site Reconnaissance

- Site is visited to gather / confirm initial data

## Preliminary Investigations

- Include prelim BHs and prelim tests

## Main Investigations

- Detailed investigations: insitu tests, sampling, and Lab Test

## Geotechnical Report

- All findings are Presented
- Recommendations are made

# Subgrade Investigations

## ▶ GENERAL STEPS

### ▶ 1. Collection of Preliminary Data

- General Geology of the Site
- History of the Site (Existing Reports...)
- Pavement Details

### ▶ 2. Reconnaissance

- Site Visit
- General Topography
- General Ground Slope
  - Plain, Rolling, Hilly.....
- Property in Proposed ROW
- Presence of Water Courses
- Soil Stratification from Deep Cuts
- Prospect Material Sources
- Any Local Problems (Floods, Cracks, Subsidence.....)

# Subgrade Investigations

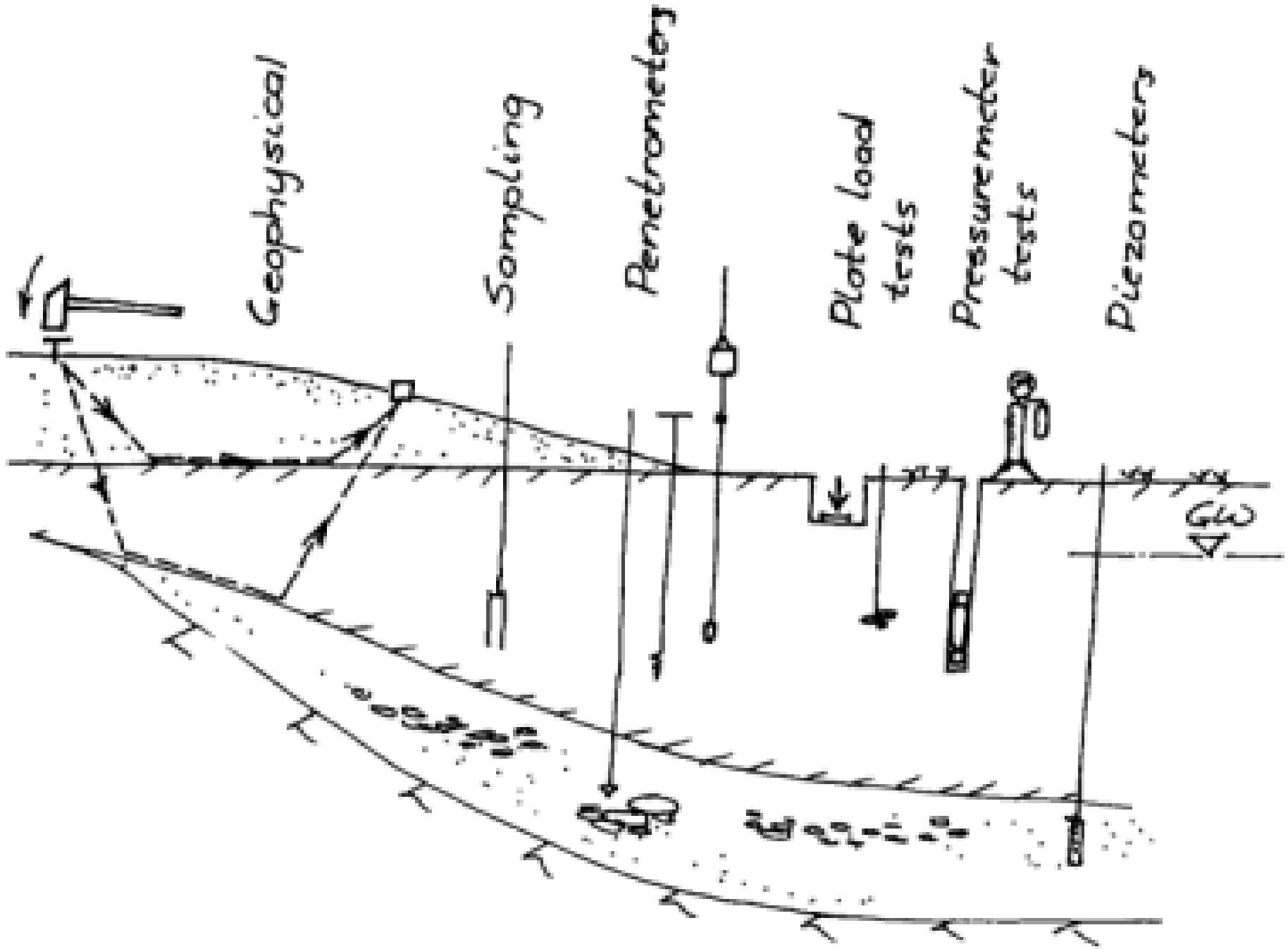
## ▶ 3. SITE WORKS

- Test Pits
- Boring/Drilling
- Sampling
- In-situ Density/Moisture
- Testing ( SPT, CPT,.....)

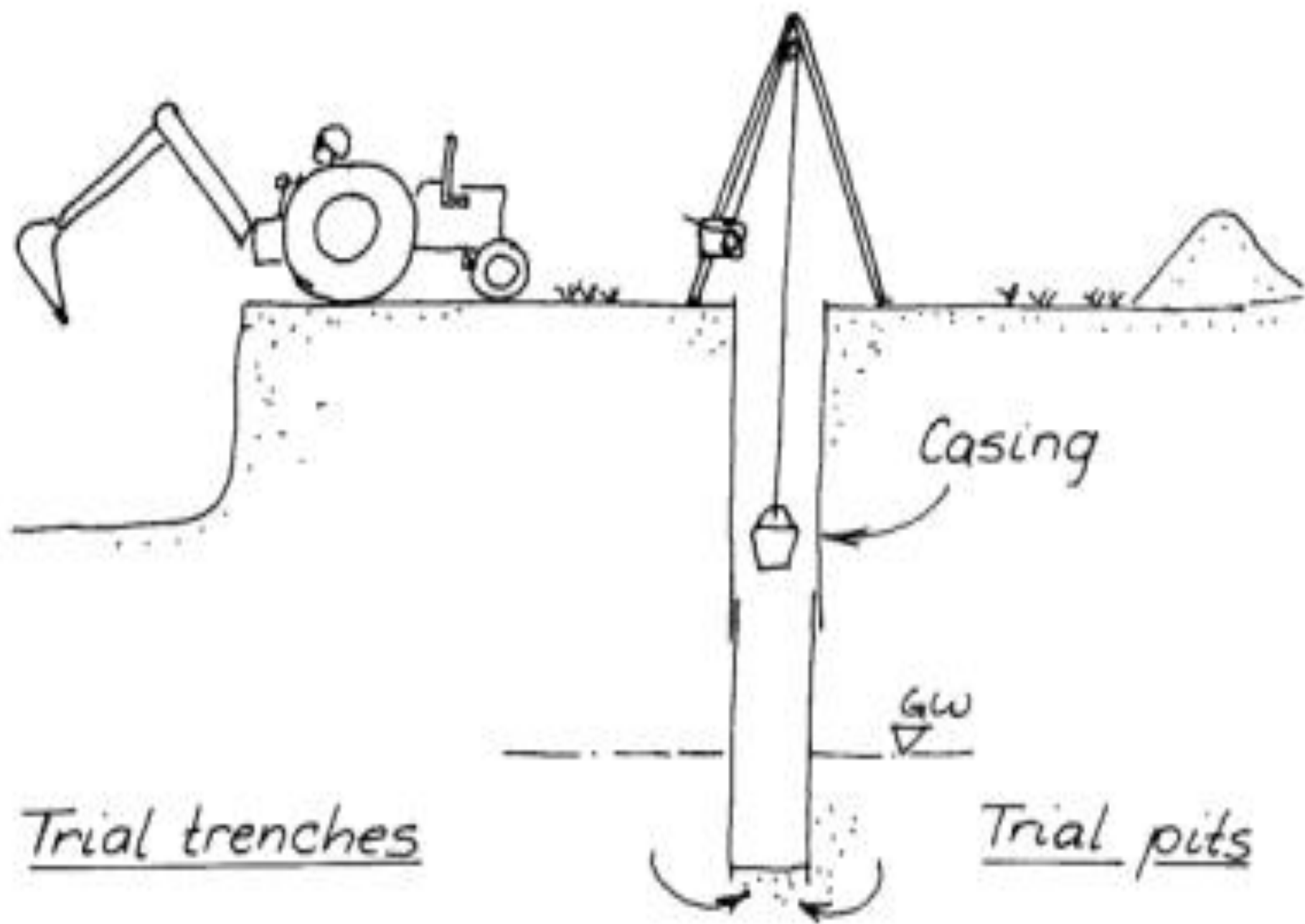
## ▶ 4. LABORATORY

- Classification Tests (Sieve Analysis, Atterberg Limits)
- Strength
- Consolidation/Settlement/Expansion
- Resilient Modulus
- Permeability
- Chemical Testing

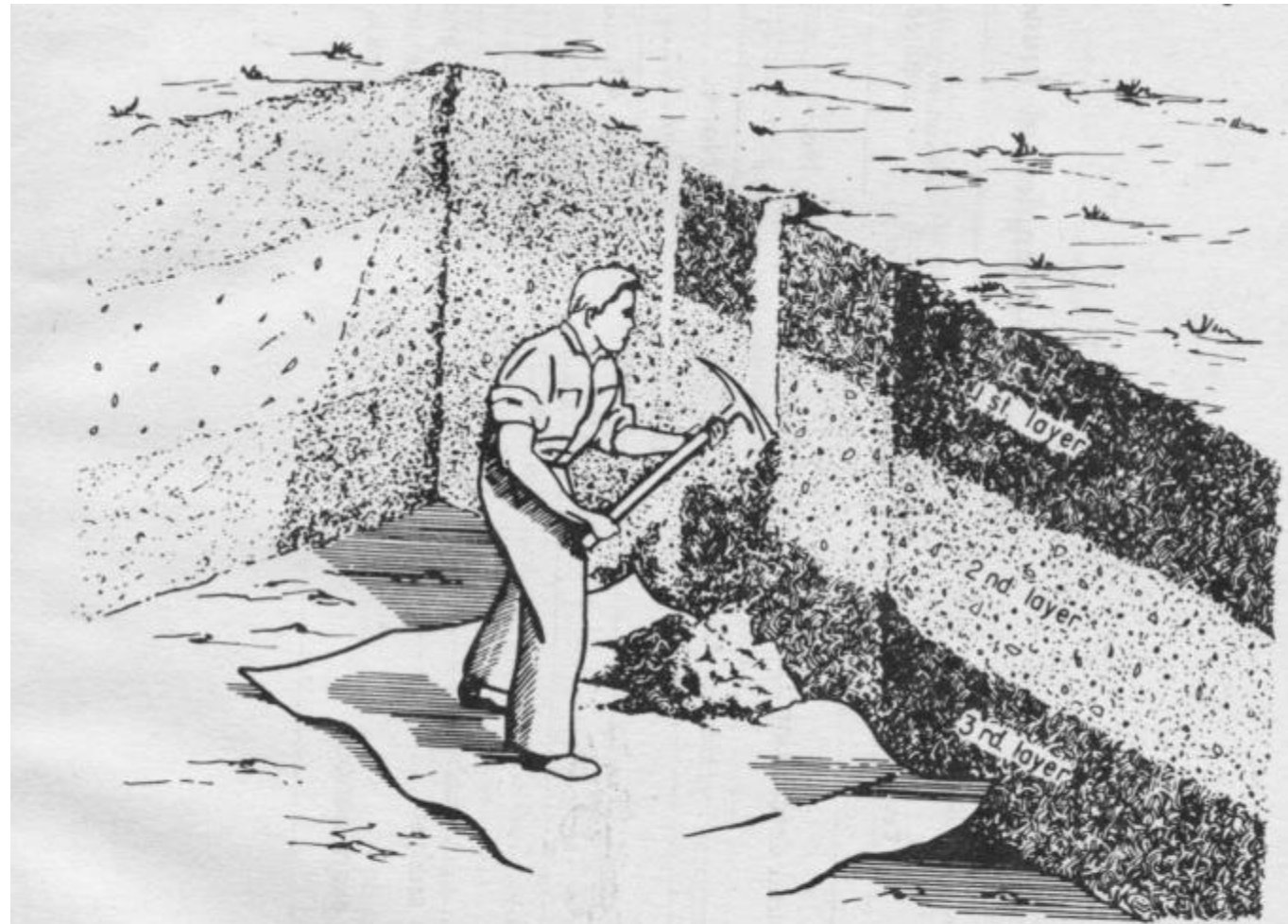
## ▶ 5. REPORT







# Trial Pits



Individual samples are taken from each layer of soil.  
Composite samples are taken from two or more layers of soil.

**Figure 1-1.—Sampling trench. PX-D-4784.**

# Subgrade Investigations

- ▶ Spacing ?
- ▶ Depth ? (*very important*) 1 m to 10m?
- ▶ *No General Binding Rule*
- ▶ Depends on
  - Nature of Road
    - Primary, Secondary, Low Volume.....
  - Amount of Uniformity of Soil Strata
    - Laterally and Vertically

# Subgrade Investigations

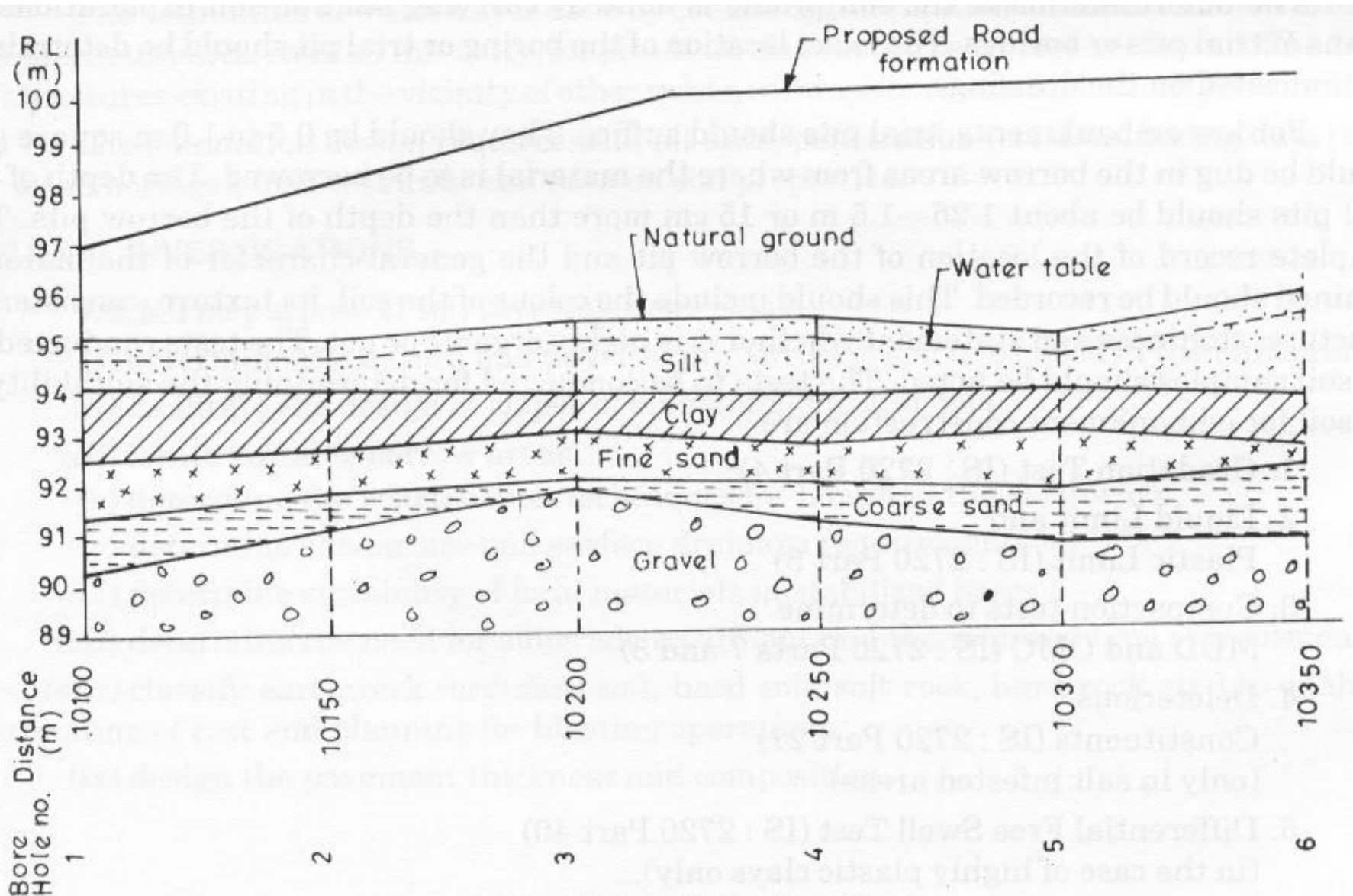


Fig. 7.2. A typical soil profile.

# Subgrade Investigations

Type of Job	Type of Soil in Horizontal Dir.			Min. Number of Boreholes	Depth (m)	Samples
	Uniform	Average	Erratic			
One/Two Storey Building	50	25	10-15	3	C1,C2,C3,C4	*
Multistorey Build.	30	15	8-10	5	C1,C2,C3,C4	UD for first 3m & *
Abutment & Bridge Pier	-	20	10	1 to 2 for ea. Fdn.	C1,C2,C3,C4	Continuous UD
Highways and Roads	300-500	150	100	Lane Dependent (75-150m)	2-3m	UD and D
Airports/Airfields	300-500	150	100 (pre)	30m grid (runway), 60-75m (other)	6m	UD and D
Dams (Main Embankment)	Grid to define complete strata			-	C1,C2,C3,C4	Continuous UD
Dams (Abutments)	Define complete strata (150-300m)			-	C1,C2,C3,C4	Continuous UD
Dams (Power Plant, Spillways etc.)	30	15	8-10	-	C1,C2,C3,C4	Continuous UD
* 0.15, 0.75, 1.5, 2.25, 3.0, 3.75, 4.5, and at 1.5m intervals thereafter						

**For Borrow Areas, a grid of Boreholes is to be performed to access the type, nature, and extent of material present.**

# Subgrade Investigations

## ▶ Depth of Significance

### ▶ Minimum Exploration Depth

- 2m for natural (in-situ) subgrades
- 3Xtimes the average width of embankment
- 2Xtimes the width of Foundations of Structures
- 2Xtimes the width of pile below the proposed pile length
- Practical Depth for Borrow Areas

### ▶ Penetrate all layers which are

- loose/soft
- having variation of water table
- frost susceptible
- liquifiable under dynamic loading



# Field Evaluations

## ▶ Methods of Explorations

### ▶ Excavations

- Drilling
- Test Pits

### ▶ Sampling

### ▶ Testing in the field

### ▶ Geophysical Testing

- Surface Seismic
- Electrical Resistivity



**THANK YOU**