LESSON 1

TOPIC 2

General Overview of Geotechnical Input to Highway Projects

GENERAL OVERVIEW OF GEOTECHNICAL INPUT TO HIGHWAY PROJECTS

Lesson 1 - Topic 2

Slide 1-2-1

Explain the purpose of this initial lecture is to familiarize students with the overall geotechnical process and with the method of teaching to be used in the remainder of the course. The instructor should use this lesson to generate interest in geotechnical engineering concepts. The use of case histories is important to convince students that geotechnical issues are important for highway design and construction.

GENERAL OVERVIEW OF GEOTECHNICAL INPUT

1. Recognize the Importance of Testing, Theory, and Experience

2. Recall Basic Geotechnical Phases

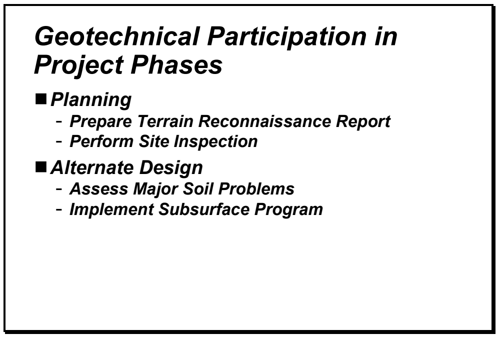
ACTIVITY: Question-Answer

Slide 1-2-2

Instructor explains the display of learning objectives at the beginning of each lesson and the use of question – answer to test learning.

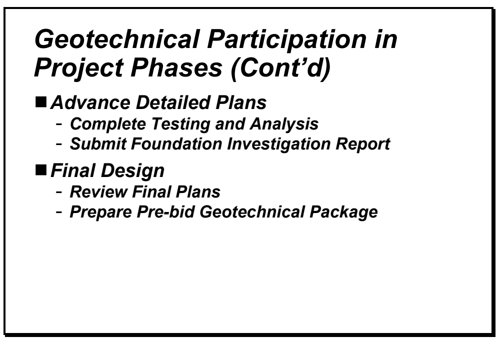
Slide 1-2-3

Ask what geotechnical items students see in this picture; answer is stable cut and fills slopes, stable pavement foundation, smooth riding highway with no differential across culvert.

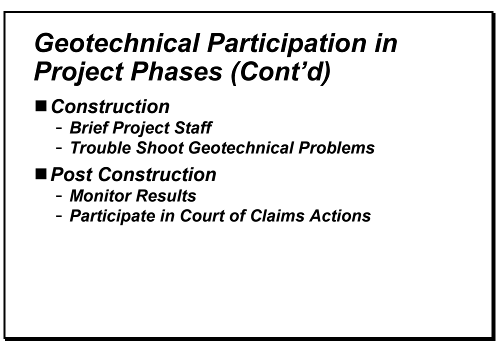


Slide 1-2-4

Next 3 slides show the geotechnical process by project phase. Note that the geotechnical units are involved in all project phases.

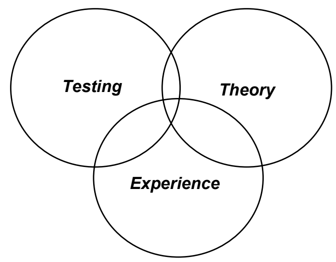


Slide 1-2-5



Slide 1-2-6

After explanation of process, mention that 50% of highway claims are geotechnically related. Ask the best way to avoid geotechnical claims; answer is to follow this process in order; i.e. Do not take borings after design is finished.



Slide 1-2-7

The proper approach to geotechnical problems involves the combined use of testing, basic theories, and experience. Over-reliance on any one of these aspects will not produce a satisfactory design. The sole use of theory (number-crunching) may produce a wonderful design which cannot be built. Similarly the sole use experience (foot-stomping) may produce a design that is at the best not cost-effective and at the worst, unsafe. Soil conditions at each site must be analyzed by obtaining and testing soil samples, applying basic theory to produce a preliminary result, and then tempering the result with previous experience to produce an optimal design.

Terrain Reconnaissance

Slide 1-2-8

Is Terrain Reconnaissance done in the field or the office?

Use the header slides for process steps, which follow to gage how much the audience understands about the overall process.

Slide 1-2-9

Show USDA County soil map as example of office review process. Briefly discuss how such documents can provide an overview of the general ground conditions at a project site.

Site Inspection

Slide 1-2-10

After showing header ask student what they see in the following project slides 11-12

Slide 1-2-11

How would testing, theory and experience be applied to the solution of this situation?

Example of slope instability. Experience tells us that the slope is unstable (tilted utility poles), testing will be needed to find soil strength, and stability analyses will be needed to find the safety factor and assess stabilization methods.

Slide 1-2-12

Example of karstic sinkhole. Instructor should mention that sinkholes can be deep and contain voids or soft soils. Sinkholes represent a major problem to highway construction and need to be identified early in design.

Slide 1-2-13

Funny Slide to show what happens if you do not find sinkhole until after construction begins and have to change alignment.

Subsurface Borings

Slide 1-2-14

Ask what type of borings the audience is familiar with?

Slide 1-2-15

Show optimal conditions to perform borings (warm, sunny, no precipitation, near road, easy move-in, etc.)

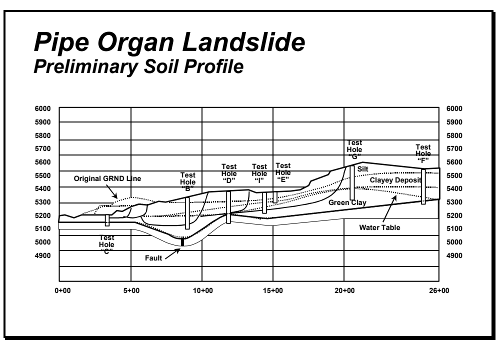
Slide 1-2-16

Show difficult site and working conditions. Stress that driller must be a dedicated professional to perform ASTM tests under difficult conditions. If they do a good job your designer will have a chance to do a good job. Spend as much time as necessary to insure audience understands how valuable these workers are!

Soil Profile

Slide 1-2-17

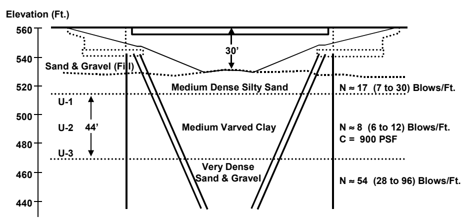
Ask who has developed a soil profile and what was the most important information which was used (answer will be boring info. so emphasize the importance again of the drillers)



Slide 1-2-18

This slide shows a rough generalized soil profile for a large landslide. Information from site inspections, geologic maps, aerial photos, and preliminary borings have been plotted on the profile. This profile will be used to make a preliminary assessment of the landslide problem and plan the detailed exploration and testing program.

Typical Final Soil Profile



Slide 1-2-19

A typical final soil profile will be used to make a preliminary assessment of the landslide problem and plan the detailed exploration and testing program.

Soil Testing

Slide 1-2-20

Why are soils more difficult to test than concrete or steel?

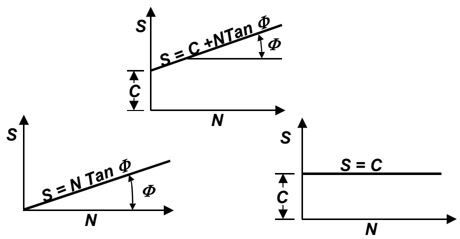
Answer to question is that soils are made of water, minerals and air, which have developed a structure from the pressures in the ground.

Slide 1-2-21

Explain that sample structure must be maintained to obtain structural soils properties for design.

Coulomb's Equation

S= C + (Normal Force) Tan Φ



Slide 1-2-22

Explain that different lab tests produce different strength results for the same soil sample depending on the test method selected.

Geotechnical Analysis

Slide 1-2-23

Ask what types of analysis the audience has performed.

Embankments
Major Design Considerations

- ***Stability***
- ***Settlement***
- ***Effects on Structure***

Slide 1-2-24

Show the main categories of analyses to be covered in the course.


Slide 1-2-25

Show stability case history (this one is a failure caused by drawdown).


Slide 1-2-26

Show settlement case history (this one is a simple approach embankment settlement). Ask if the previous stability or this settlement cost more to fix? (Answer is in life cycle cost…often the long term cost of settlement repair is much greater than stability repair)


Slide 1-2-27

Is this structure on a shallow foundation or deep foundation?

Answer is piles. But poor construction control caused piles to hang up in embankment just above 30’ thick soft clay deposit. Result was 30” settlement over a period of 10 years.

Design Solutions to Embankment Problems

- ***Change Alignment***
- ***Lower Grade***
- ***Counterberm***
- ***Excavate and Replace Weak soils***

Slide 1-2-28

Introduce problem solutions for embankments and stress the need to match the solution to the problem.

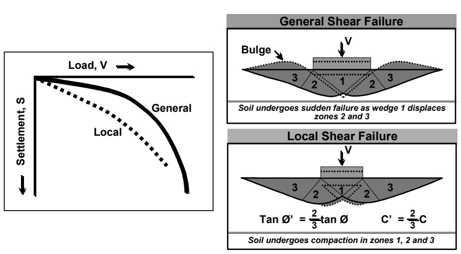
Structural Foundation Topics

- ***Shallow Foundations (Spread Footings)***
  - ***Bearing Capacity***
  - ***Settlement***
- ***Deep Foundations***
  - ***Load Capacity***
  - ***Settlement***
  - ***Negative Skin Friction***

Slide 1-2-29

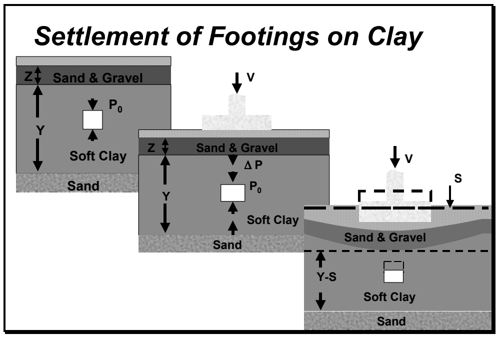
Structural topics only considered after the designer has evaluated stability and settlement of the embankment.

Shallow Foundation Failure Mode



Slide 1-2-30

Theoretical aspects of bearing capacity less important than the practical aspects (depth and extent of failure, etc,)



Slide 1-2-31

Settlement consists of both magnitude and time considerations; often maintenance is more concerned about time as this increases number of maintenance visits and the cost.

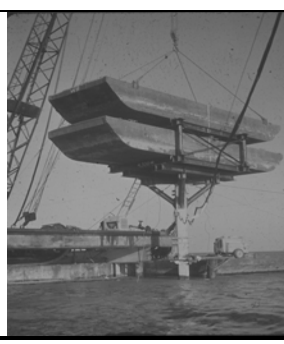
Individual Piles

Method of Estimating Load Capacity

- ***Load Test***
- ***Dynamic Formula***
- ***Static Analysis***

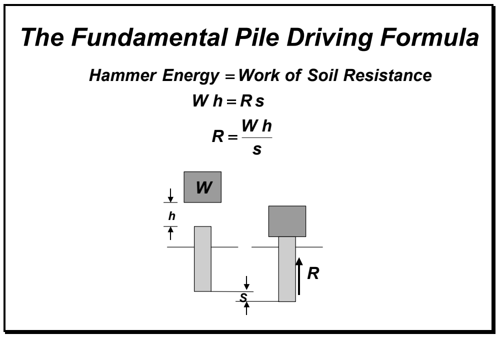
Slide 1-2-32

Deep foundation capacity can be found by 3 methods; what do the first 2 have in common, which the third does not have? (Done in the field not the office)



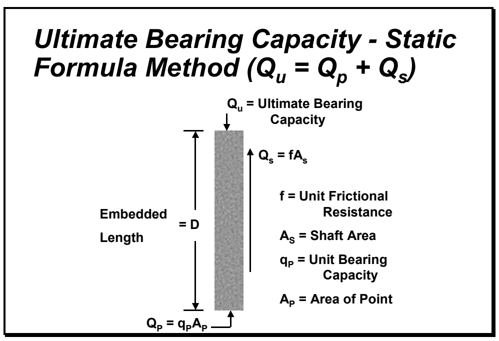
Slide 1-2-33

Explain costs and possible danger of load testing.



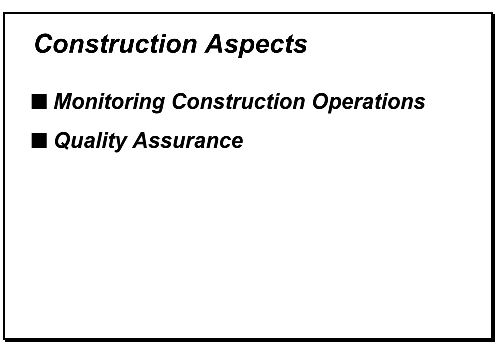
Slide 1-2-34

Explain basic assumption of a Newtonian impact for the dynamic formulas and how this is incorrect.



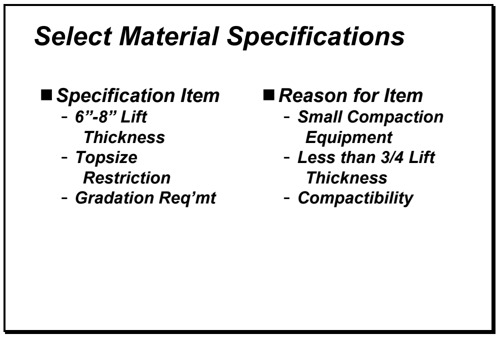
Slide 1-2-35

Explain how designers must rely on prediction of deep foundation capacity from soil data on the vast majority of highway projects.



Slide 1-2-36

Introduce construction monitoring and quality assurance for both embankments and foundations.

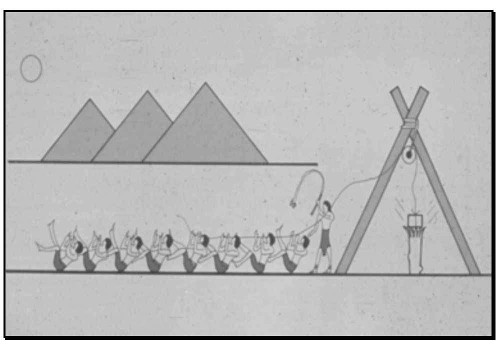


Slide 1-2-37

Show how specifications are the backbone of embankment control.

Slide 1-2-38

Show case history of poor embankment construction practice. (This one uses degradation shale with no top size in an interstate embankment, which failed after 5 years service.)



Slide 1-2-39

Humorous slide depicting the current state of pile construction monitoring in some highway agencies. After showing slide, ask the group what methods are used by their highway agency to monitor pile construction operations.

Slide 1-2-40

The number one priority in monitoring construction operations is the use of a trained inspector.

PROJECT SUCCESS

Cooperation Between
Design & Construction

Slide 1-2-41

Stress need for cooperation and communication.

GENERAL OVERVIEW OF GEOTECHNICAL INPUT

1. ***Recognize the Importance of Testing, Theory, and Experience***
2. ***Recall Basic Geotechnical Phases***

ACTIVITY: Question-Answer

Slide 1-2-42

End presentation with a review of the objectives. Then ask students to open reference manual to Chapter 1 and briefly review the chapter contents.