Soil Mechanics - Subsurface Exploration for Effective Foundation Design

An Online Continuing Education Course for Engineers

Course Number: G-6002

Credit: 6 Hours / 6 PDH / 6 CPD

© 2023 Decatur Professional Development, LLC. All rights reserved.

Soil Mechanics: Subsurface Exploration for Effective Foundation Design

To perform properly, a structure must interact favorably with the soil on which it rests. The modern geotechnical specialist, who often must build in areas that were considered too poor to build upon a few years ago, must be well versed in the fundamentals of soil mechanics. This knowledge will be used in the design of structural foundations and earthworks to answer the following questions. Will settlements be excessive? Can the structure tolerate settlements? Will the proposed foundation type perform better than another type? Can the foundation soils safely support the imposed embankment or footing loads? Will the proposed cut or fill slopes have adequate stability? Are the foundation and earthwork designs cost-effective?

The engineer should have adequate knowledge of the subsurface conditions at a site before attempting to answer these questions. A site- and project-specific subsurface model must be developed for the cost-effective engineering design of a facility. Figure 1 shows a flow chart that identifies a recommended process for developing a subsurface model for engineering design. The investment of a few tens of thousands of dollars in a systematic approach as outlined in Figure 1 could result in design and construction savings of hundreds of thousands of dollars by preventing costly failures or overly conservative designs.

The process shown in Figure 1 is logical and is generally followed on many projects. In many cases, however, old “rules-of-thumb” and “status quo” approaches can result in an unconscious “by-passing” of critical steps. In particular, selection of the correct tests to determine the relevant engineering properties, the interpretation of the results of those tests, and summarization of data are often poorly performed. Rigorous attention to the rational process in Figure 1 is required to assure efficient and thorough exploration and testing programs, especially since many projects are fragmented to the extent that drilling, testing, and design are performed by different parties. This course provides guidance on all the items presented in Figure 1. The three major steps in the flow chart in Figure 1 are as follows:

Step 1: Subsurface Exploration and Field Testing
Step 2: Laboratory Testing and Test Interpretation
Step 3: Engineering Design

Portions ©2013 Decatur Professional Development, LLC All rights reserved

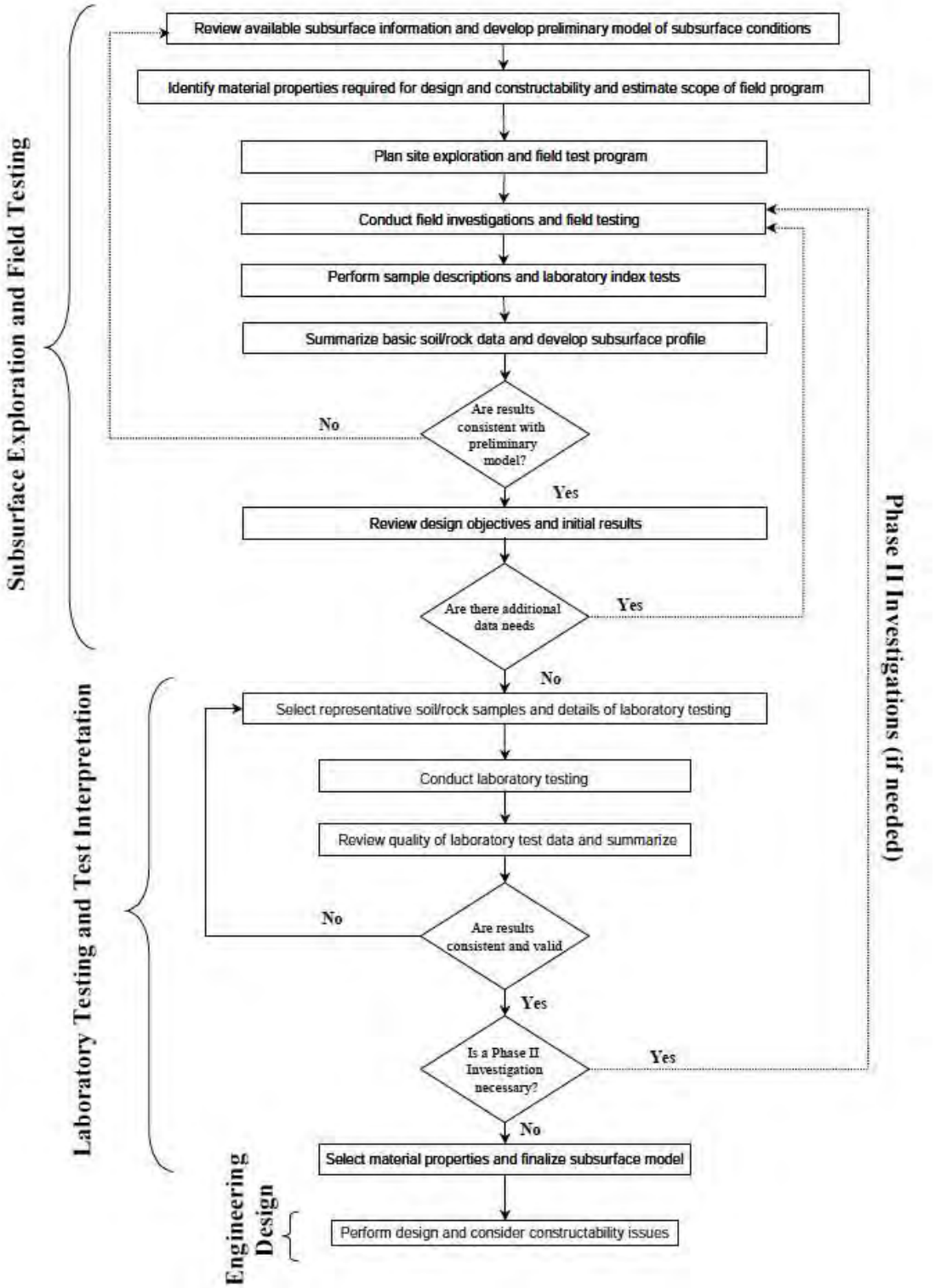

Figure 1. Recommended process for developing subsurface model for engineering design (FHWA, 2002a).

Portions ©2013 Decatur Professional Development, LLC All rights reserved

1 PREPARING FOR SUBSURFACE EXPLORATION

The initial step in any highway project must include consideration of the soil or rock on which the highway embankment and structures are to be supported. The extent of the site exploration will depend on many factors, not the least of which will be the project scheduling, general subsurface conditions, and the nature of the loads to be supported. In any event, certain basic steps should be followed before exploration equipment is mobilized to the project site. The first step in the exploration is to collect and analyze all existing data. A review of available information prior to the field reconnaissance will help establish what to look for at the site. In the Eighth Rankine Lecture, Glossop (1968) stated the following truism regarding site exploration: "**If you do not know what you should be looking for in a site investigation, you are not likely to find much of value.**" For a highway project, basic sources of geotechnical information should be reviewed to determine landform boundaries and to provide a basis for outlining the project subsurface exploration program. Those sources and functional uses are identified in Table 1.

Portions ©2013 Decatur Professional Development, LLC All rights reserved

Source	Functional Use	Location	Examples
Utility Maps	• Identifies buried utility locations • Identifies access restrictions • Prevents damage to utilities	Local agencies/utility companies	Power line identification prior to an intrusive exploration prevents extensive power outage, expensive repairs, and bodily harm
Aerial Photographs	• Identifies manmade structures • Identifies potential borrow source areas • Provides geologic and hydrological information which can be used as a basis for site reconnaissance • Track site changes over time	Local Soil Conservation Office, United States Geological Survey (USGS), local library, local & national aerial survey companies	Evaluating a series of aerial photographs may show an area on site which was filled during the time period reviewed
Topographic Maps	• Provides good index map of site area • Allows for estimation of site topography • Identifies physical features in the site area • Can be used to assess access restrictions	USGS, State Geological Survey	Engineer identifies access areas/restrictions, identifies areas of potential slope instability; and can estimate cut/fill capacity before visiting the site
Existing Subsurface Exploration Report	• May provide information on nearby soil/rock type; strength parameters; hydrogeological issues; foundation types previously used; environmental concerns	USGS, United States Environmental Protection Agency (USEPA), State/local agencies, developers, etc.	A five year old report for a nearby roadway widening project provides geologic, hydrogeologic, and geotechnical information for the area, reducing the scope of the exploration
Geologic Reports and Maps	• Provides information on nearby soil/rock type and characteristics; hydrogeological issues, environmental concerns	USGS and State Geological Survey	A twenty year old report on regional geology identifies earth fissure rock types (including fracture and orientation data) and groundwater flow patterns
Water/Brine Well Logs	• Provide stratigraphy of the site and/or regional area • Varied quality from state to state • Groundwater levels	State Geological Survey/Natural Resources, Department of water resources	A boring log of a water supply well two miles from the site area shows site stratigraphy facilitating evaluations of required depth of exploration

Table 1
Sources of historical site data (after FHWA, 2002a)

Portions ©2013 Decatur Professional Development, LLC All rights reserved

Source	Functional Use	
Flood Insurance Maps	• Identifies 10(near water bo • Caution again floodplain • Provide inform of scour potenti	ion, the flood map shows that the site odplain and the proposed structure is ocation
Soil Survey	• Identifies site sc • Permeability of s • Climatic and geo	y provides information on near- litate preliminary borrow source
Sanborn Fire Insurance Maps	• Useful in urban a • Maps for many ci for over 100 years. • Identifies building type • Identifies business t (e.g., chemical plant) • May highlight potent environmental proble site	o of St. Louis shows that a lead or 10 years. This information on in a contaminated area.

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

Close this window and click "Add to cart" on the product page.

Table 1 (Continued)
Sources of historical site data (after FHWA, 2002a)

Portions ©2013 Decatur Professional Development, LLC All rights reserved