Geotechnical Engineering Basics For Non-Geotechnical Engineers

An Online Continuing Education Course for Engineers

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1.0 INTRODUCTION

Geotechnical engineering is an interesting subject. Unlike many engineering disciplines, it is not a pure science but rather it is an art form that requires both judgment and experience to arrive at a satisfactory solution. Unlike steel or concrete for instance, soil is quite different. Geotechnical engineers can arrive at different but equally satisfactory recommendations for design values even when given the same set of information.

Acceptable solutions are dependent upon many soil variables, methods used to predict the results and the practitioner's experience.

The purpose of this text is to acquaint the non-geotechnical engineer with basic information related to geotechnical engineering to enhance his or her understanding of the subject. The topics discussed herein have been simplified and do not provide an exhaustive review of the subject matter. The information has been drawn from reference sources as well as the author's experience. This publication is subject to the Disclaimers stated in Appendix B.

Topics have been selected for a wide range audience, but all topics have not been included. The interested reader is encouraged to consult one of the many textbooks and other publications for more information on the topics discussed herein as well as those that have not been discussed.

Photograph 1.1 - Foundations for a Medieval Era Cathedral

2.0 EXPLORATIONS

2.1 Introduction

Civil engineering projects such as buildings, bridges, earthen dams, and roadways require detailed subsurface information as part of the design process. The ground below us ultimately supports all structures and to be successful, the ground must not fail under the applied structural load.

The geotechnical engineer's task is to explore the subsurface conditions at a project site, determine the capacity of the soil to carry the load without collapsing or experiencing intolerable movement and to recommend appropriate foundation alternatives. The task might also expand to provide recommendations in other related areas such as groundwater and earthwork. The scope of the soil exploration program including the number of explorations, equipment and testing is usually determined by a registered design professional such as geotechnical engineer.

Explorations are used to obtain samples of the soil for classification and testing purposes. Common types of exploration methods include.

- Soil test borings with standard penetration testing
- Cone penetrometer soundings with cone penetration testing
- Test pit excavations

More discussion on these topics is provided in section 2.3 to 2.5.

Testing can be conducted in the laboratory with special samples retrieved for testing purposes. These tests might include methods for measuring the soil's shear strength, compressibility or permeability.

Tests are also conducted as part of the exploration program. These tests include methods such as the Standard Penetration Test (SPT) or the Cone Penetration Test (CPT) which are taken in soil test borings and cone penetrometer soundings respectively. The information obtained from these tests is used in the process of developing foundation design recommendations.

There is a wealth of published information correlating the test results obtained from the SPT or CPT to certain applicable engineering properties and soil values. The results of field testing and laboratory testing, coupled with the geotechnical engineer's assessment of subsurface conditions, engineering studies and experience is usually sufficient to provide satisfactory recommendations for a successful project.

An example of one correlation is shown in Figure 2.1. In this example, the results of the SPT are used to predict the internal friction angle of the tested soil. There is caution however in using correlations. Published correlations for the same set of values may vary. Therefore, correlations should be used for guidance and by experienced engineers.

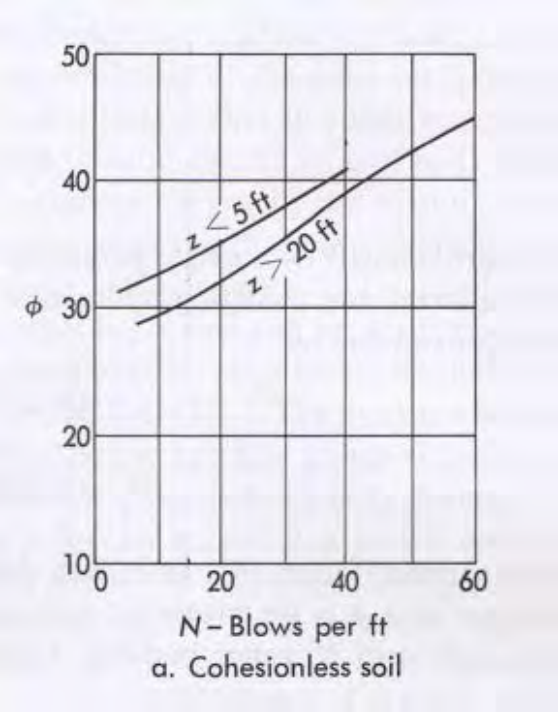

Figure 2.1
[Ref: Sowers and Sowers]

The geotechnical engineer is interested primarily in two pieces of information derived from the exploration program. This information can be used to develop appropriate recommendations for the engineer's task and includes:

- Characteristics ofthe material encountered, including groundwater
- Engineering properties of the materialand calculated values

The type of material encountered is important because it provides an indication of how the soil will react under load and whether the material is even sufficient to support foundations. For instance, clay reacts quite differently from sand. Peat and loose fill lying below a proposed structure are not suitable for supporting the structure. The poor material must be removed or stabilized, or the foundations must be supported in firm material lying below the layer(s) of poor material.

Engineering properties of the soil are also important because they provide information on the shear strength of the soil and the ability of the soil to carry the load as well as the settlement characteristics of the soil. Much of the information that the engineer uses is based on published values, results of past testing, empirical relationships and if necessary, the results of project specifictesting.

2.2 Geologic Profile

When explorations are conducted, the information is recorded on a log. By reviewing all the logs from a site, the geotechnical engineer can formulate a three-dimensional picture of the subsurface conditions. Of course, this is based on taking individual explorations at specific locations at the site and then interpreting the soil conditions in between the explorations. This is sometimes difficult because it involves interpreting subsurface conditions that have not been explored between the exploration locations.

In short, the purpose of the exploration program is to provide sufficient site-specific information to enable the engineer to develop a picture of the subsurface environment and select appropriate soil values applicable to the soils encountered. Often, the subsurface conditions are presented in a graphical geologic profile, which shows information from the log, soil strata and soil description. A typical profile is presented in Figure 2.2.

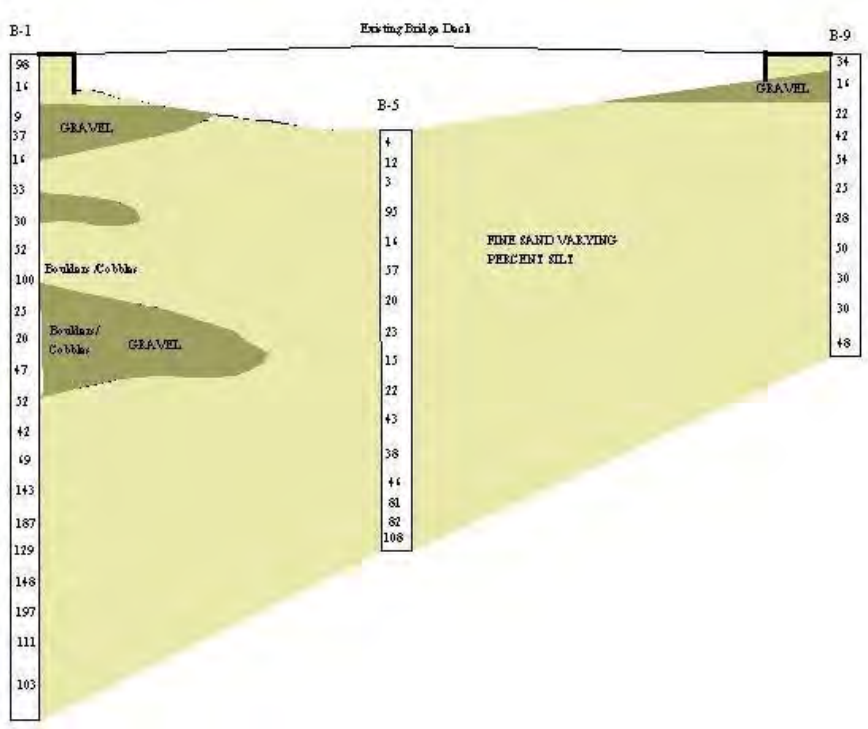

Figure 2.2 - Geologic Profile

2.3 Test Pits

Test pit excavations are useful for viewing large open areas to assess soil type and stratification, but they also have drawbacks. Test pits are limited to the depth that the machine can extend,

they are impractical to use for explorations below the groundwater level and they produce a large disturbed area, often within the proposed building footprint. Most importantly, they do not provide penetration test results like the SPT and CPT, which are often used as the basis for making bearing capacity recommendations.

Photograph 2.1 – Test Pit Excavation

Often a subsurface exploration program is taken at locations around the perimeter of a proposed building footprint as well as within the footprint. U... ...e exploration program is conducted well before column lines and f... ...n the field. A well-intentioned program ... ...ons within or very close to the actual footing l... ...ompacted fill suitable for supporting foundatio... ...ed directly over a test pit location.

Undoubtedly there are ... ...e means of subsurface exploration. Test pits of... ...". Because the size of the excavation is relativ... ...neer can get a first-hand look at the soil stra... ...rface materials becomes clear. Test pits ... ...surface explorations, but usually as a suppleme...
Test pits provide adequat... ...vays provide adequate data for assessi... ...material. For instance, a material descri... ...using a small, rubber-tired backhoe, may be clas... ...when using a much larger piece of equipment. An assessment o... ...well the soil is compact, therefore, is highly subjective and