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Soil Improvement

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Preamble

Since the dawn of construction, soil has always been a crucial element in the success of civil engineering projects. Long considered a mere support, it is now recognized as a material in its own right, whose characteristics determine the safety, durability, and cost-effectiveness of projects. However, natural soils very often exhibit insufficient or unsuitable properties to meet the increasing demands of modern infrastructure.

Furthermore, the soils that form the fundamental basis of all civil engineering infrastructure do not always possess the necessary mechanical and hydraulic characteristics to ensure the stability, durability, and safety of structures. The natural variability of soils, their heterogeneity, and the influence of environmental conditions often necessitate the use of specific techniques aimed at improving their performance.

Soil improvement encompasses all methods used to modify the physical, mechanical, and sometimes chemical properties of soils to make them suitable for supporting structures such as roads, buildings, dams, or industrial platforms. These techniques can aim to increase bearing capacity, reduce settlement, improve stability, control permeability, or decrease water sensitivity. These constantly evolving methods optimize the use of existing soils, limit excavation, and reduce the economic and environmental impacts of projects.

This book aims to present the fundamental principles of soil improvement in a clear and progressive manner. The various techniques, whether mechanical, hydraulic, chemical, or innovative, are discussed, highlighting their areas of application, limitations, and selection criteria.

Intended for students, teachers, engineers, and civil engineering practitioners, this book serves as both a teaching aid and a reference tool. It aims to present the fundamental principles of soil improvement, the mechanisms involved, and the main techniques used in practice, whether mechanical, hydraulic, chemical, or a combination of both. It will also provide the necessary knowledge to understand soil improvement mechanisms and to design solutions adapted to the technical, economic, and environmental constraints of contemporary projects. It will also emphasize the criteria for selecting improvement methods based on soil type, project constraints, and economic and environmental requirements.

Through this book, students and engineers will be able to understand the problems associated with poor soils, identify appropriate improvement solutions, and integrate these techniques into the design and construction of civil engineering projects.

1 Soil improvement and geotechnics

1.1 General information on Soil Improvement

Soil improvement is a branch of geotechnical engineering that aims to modify the mechanical, hydraulic, or physicochemical properties of soil *in situ* to improve its performance for construction or development projects. This approach is essential when the soil's natural properties do not meet the stability, load-bearing capacity, durability, or deformability requirements of the structures to be built.

1.2 Geotechnical Soil Definition

We will represent soils as being composed of three phases: a solid phase, a liquid phase, and a gaseous phase. The solid phase consists of mineral particles and organic matter. The liquid phase includes water in different forms, such as free water and pore water. The solid phase is the only component that can withstand significant stresses.

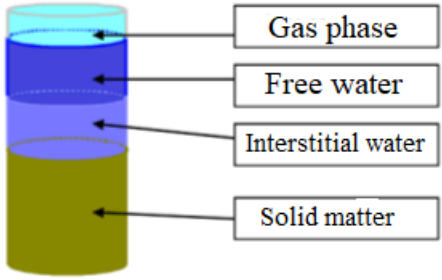

Figure 1. Soil Characteristics

1.3 Soil improvement techniques

Soil improvement techniques can be classified into two main categories: