

---

Executive Certificate in Underground Construction

# Geotechnical Engineering for Underground Construction

---

Geotechnical engineering is a branch of civil engineering that deals with the behavior of soil and rock when subjected to forces, and the engineering properties of earth materials. In the context of underground construction, geotechnical engineers play a critical role in the design and construction of underground structures such as tunnels, shafts, and caverns. This explanation will cover key terms and vocabulary related to geotechnical engineering for underground construction.

## 1. Soil Mechanics:

Soil mechanics is the study of the behavior of soil under the action of external forces and the deformation and strength characteristics of soil materials. Soil is a three-phase system consisting of solid, liquid, and gas phases. The solid phase is composed of mineral and organic particles, the liquid phase is water, and the gas phase is air.

## 2. Soil Classification:

Soil classification is the grouping of soils based on their engineering properties. The most widely used soil classification system in geotechnical engineering is the Unified Soil Classification System (USCS). The USCS classifies soils into two major groups: coarse-grained soils and fine-grained soils. Coarse-grained soils consist of gravel and sand, while fine-grained soils consist of silt and clay.

## 3. Soil Properties:

Soil properties include index properties, physical properties, and engineering properties. Index properties are used to identify and classify soils, such as grain size distribution, liquid limit, and plastic limit. Physical properties include density, porosity, and water content. Engineering properties include shear strength, compressibility, and permeability.

## 4. Shear Strength:

Shear strength is the ability of a soil to resist shear forces, which are forces that tend to cause a material to deform or break along a plane. Shear strength is a critical factor in the design of underground structures, as it affects the stability of the soil and the ability of the structure to withstand external loads.

## 5. Compressibility:

Compressibility is the ability of a soil to decrease in volume when subjected to an external load. Compressibility is a critical factor in the design of underground structures, as it affects the settlement of the structure and the surrounding soil.

## 6. Permeability:

Permeability is the ability of a soil to allow the flow of water through its pores. Permeability is a critical factor in the design of underground structures, as it affects the drainage of water from the structure and the surrounding soil.

## 7. Groundwater:

Groundwater is water located in the saturated zone of soil, where all the pores are filled with water.

Groundwater is a critical factor in the design of underground structures, as it affects the stability of the soil and the ability of the structure to withstand external loads.

#### 8. Slope Stability:

Slope stability is the ability of a slope to resist sliding or collapsing under the action of external forces. Slope stability is a critical factor in the design of underground structures, as it affects the stability of the soil and the ability of the structure to withstand external loads.

#### 9. Tunnel Boring Machine (TBM):

A Tunnel Boring Machine (TBM) is a machine used to excavate tunnels. TBMs are designed to excavate soil and rock using a rotating cutterhead, which is mounted at the front of the machine. TBMs are used in the construction of underground structures, such as tunnels, shafts, and caverns.

#### 10. Shaft Sinking:

Shaft sinking is the process of excavating a vertical or near-vertical shaft. Shaft sinking is used in the construction of underground structures, such as tunnels, shafts, and caverns.

#### 11. Cavern Construction:

Cavern construction is the process of excavating large underground chambers. Cavern construction is used in the construction of underground structures, such as tunnels, shafts, and caverns.

#### 12. Ground Improvement:

Ground improvement is the modification of soil or rock to improve its engineering properties. Ground improvement is used in the construction of underground structures, such as tunnels, shafts, and caverns.

#### Example:

Consider the construction of a subway tunnel in a city. The geotechnical engineer would first conduct a site investigation to determine the soil and rock conditions at the proposed tunnel location. The engineer would then classify the soil and rock using the USCS and determine the soil properties such as shear strength, compressibility, and permeability. The engineer would also consider the groundwater conditions and slope stability.

Based on the site investigation and soil properties, the engineer would then design the tunnel using a TBM. The TBM would excavate the soil and rock while simultaneously constructing the tunnel lining. The engineer would also consider the ground improvement techniques to improve the soil and rock conditions, such as grouting or jet grouting.

#### Practical Application:

Geotechnical engineering for underground construction is used in various projects, such as subway systems, water and sewage tunnels, and underground storage facilities. In these projects, geotechnical engineers play a critical role in the design and construction of underground structures, ensuring their stability and safety.

#### Challenges:

Geotechnical engineering for underground construction presents several challenges, such as complex soil and rock conditions, high groundwater levels, and limited access to the construction site. Geotechnical

engineers must also consider the potential impact of underground construction on nearby structures and utilities.

**Conclusion:**

Geotechnical engineering for underground construction is a critical field that involves the study of soil and rock behavior and the design and construction of underground structures. Key terms and vocabulary related to geotechnical engineering for underground construction include soil mechanics, soil classification, soil properties, shear strength, compressibility, permeability, groundwater, slope stability, tunnel boring machine (TBM), shaft sinking, cavern construction, and ground improvement. Geotechnical engineers play a critical role in the design and construction of underground structures, ensuring their stability and safety. Despite the challenges, geotechnical engineering for underground construction is a rapidly evolving field with numerous practical applications.