

Chapter One

1. Definition:

The term soil mechanics was coined by Dr. Karl Terzaghi and is the application of laws of mechanics and hydraulics to engineering problems dealing with sediments and other unconsolidated accumulations of soil particles produced by the mechanical and chemical disintegration of rocks regardless whether or not they contain an admixture of organic constituents; and therefore soil mechanics is branch mechanics which deal with the action of forces on soil and with flow of water in soil.

Soil engineering is not an exact science because of the nature and the variability of soils; sweeping assumptions are in the derivation of equations.

1.1 Coulomb's Contribution

Coulomb (1773) is credited as the first person to use mechanics to solve soil problems. He was a member of the French Royal engineers, who were interested in protecting old fortresses that fell easily from cannon fire. To protect the fortresses from artillery attack, sloping masses of soil were placed in front of them (Fig. 1.1). The enemy had to tunnel below the soil mass and the fortress to attack. Of course, the enemy then became an easy target.

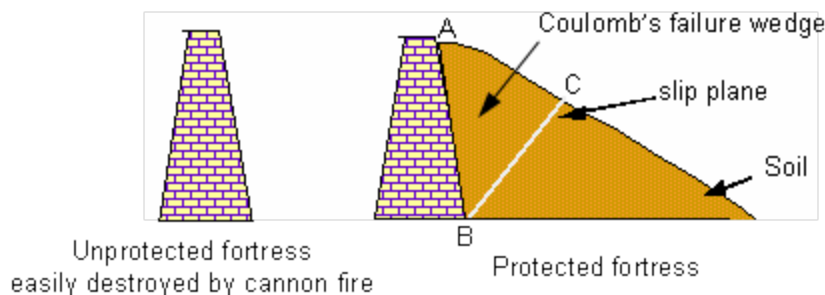


Figure 1.1: Unprotected and protected fortress.

The soil mass applies a lateral force to the fortress that could cause it to topple over or slide away from the soil mass. Coulomb attempted to determine the lateral force so that he could evaluate the stability of the fortress. He postulated that a wedge of soil ABC (Fig. 1.1) would fail along a slip plane BC and this wedge would push the wall out or over topple it as it moves down the slip plane.

Movement of the wedge along the slip plane would occur only if the soil resistance along the wedge were overcome. Coulomb assumed that the soil resistance is provided by friction between the soil particles and the

Problem now becomes one of a wedge sliding on a rough (frictional) plane, which you may have analyzed in your Physics or Mechanics course. Coulomb has tacitly defined a failure criterion for soils. Today, Coulomb's failure criterion and method of analysis still prevail.

1.2 Birth of Soil Mechanics

From the early 20th century, the rapid growth of cities, industry and commerce required numerous building systems. For example, skyscrapers, large public buildings, dams for electric power generation and reservoirs for water supply and irrigation, tunnels, roads and railroads, port and harbor facilities, bridges, airports and runways, mining activities, hospitals, sanitation systems, drainage systems, towers for communication systems, etc. These building systems require stable and economic foundations and new questions about soils were asked. For example,

- ◆ *what is the state of stress in a soil mass,*
- ◆ *how to design safe and economic foundations,*
- ◆ *how much would a building settle and*
- ◆ *What is the stability of structures founded on or within soil?*

We continue to ask these questions and to try to find answers as new issues have confronted us. Some of these new issues include removing toxic compounds from soil and water, designing foundations and earth structures to mitigate damage from earthquakes and other natural hazards, and designing systems to protect the environment.

To answer these questions, we need the help of some rational method and, consequently, soil mechanics was born. **Karl Terzaghi (1883-1963)** is the undisputed father of soil mechanics. The publication of his book "Erdbaumechanik" in 1925 laid the foundation for soil mechanics and brought recognition to the importance of soils in engineering activities.

1.3 Soil Mechanics and its application to foundations

Soil mechanics also called geotechnique or geotechnics or geomechanics, is the application of engineering mechanics to the solution of problems dealing with soils as a foundation and a construction material. Engineering mechanics is used to understand and interpret the properties, behavior, and performance of soils. Soil mechanics is a subset of geotechnical engineering, which involves the application of soil mechanics, geology and hydraulics to the analysis and design of geotechnical systems such as dams, embankments, tunnels, canals and waterways, foundations for bridges, roads, buildings, etc. Every application of soil mechanics involves uncertainty because of the variability of soils and their compositions. Thus, engineering mechanics can provide only partial solutions to soil problems. Experience and approximate calculations are essential for the successful application of soil mechanics to practical problems. Many of the calculations that you will learn in this course are approximations.

1.4 Geotechnical lessons from past failures

All structures that are founded on earth rely on our ability to design safe and economic foundations. Structural failures do occur due to different reasons. Some failures have been catastrophic and caused severe damage to lives and properties. Failures occur because of inadequate site and soil investigations; unforeseen soil and water conditions; natural hazards; poor engineering analysis, design, construction, and quality control; post-construction activities; and usage outside the design conditions. When failures are investigated thoroughly, we obtain lessons and information that will guide us to prevent similar types of failures in the future.

