INTRODUCTION

Every man-made structure on Earth rests on or in geological materials. Many of these structures also require connections to land-based infrastructure. The stability of these structures and infrastructure depends on the soil or rock characteristics and the potential for geological hazards. The suitability of geological materials for any construction activity, including ease and stability of excavation, adequate bearing strengths, and drainage conditions, is a major concern. In Illinois, important soil and geological hazard characteristics to identify, avoid, or design for are compressible peat and muck deposits, poorly drained soils, shallow groundwater or flooding conditions, unstable slopes, high susceptibility to freeze-thaw cycles, high shrinking and swelling properties, soil corrosiveness, and soil amplification of ground shaking from earthquake activity. This chapter examines the characteristics and use of earth materials and geological hazards as they relate to homes and other structures and to everyday activities.

GENERAL SITING ISSUES

The long-term, trouble-free stability of a structure depends on the ability of its foundation to withstand its geological setting. To determine whether a location is suitable for construction, the earth materials of the site must first be characterized to determine

- the materials’ bearing strength, that is, the ability to support the planned structure or excavation (e.g., cavern walls, tunnels, mined-out areas);
- the need for artificial support to contain weaker soil or rock;
- the depth of groundwater (water reduces strength of soil materials and enters excavations);
- the shrinking and swelling characteristics of the soil;
- the vulnerability of certain soils to erosion by moving water on or below the ground surface; and
- the direction and spacing of natural rock fractures that affect stability and groundwater flow and pressure.

Many of the very near-surface characteristics of Illinois soils, such as strength, shrinking and swelling, and moisture, can be found in county-based soil map publications of the U.S. Department of Agriculture, Natural Resources Conservation Service (formerly the Soil Conservation Service).

Shrinking and Swelling

The geological hazard that the largest segment of the population will experience is created by the actions of “reactive soils.” The national annual cost of structural damage from subsidence or heaving—estimated at $6 billion to $8 billion—is likely to exceed the combined annual cost of damage caused by earthquakes, tornados, hurricanes, and floods (Holtz 1983). Approximately half of the homes built in the United States today are constructed on reactive soils. When exposed to certain physical or geological conditions, these soils undergo changes in shape that can cause foundation and structural damage to buildings. Drying of reactive soil, as during a prolonged dry spell or drought, causes the soil to shrink, leading to settlement, or subsidence, of the ground surface. Addition of water to soil causes it to swell, which leads to heaving of the ground surface and horizontal pressures on basement and foundation walls.

The magnitude of settlement and heave is related to the amount of change in water content of the soil. In Illinois, most soils are not highly expansive, but nearly all contain varying amounts of clays, which are reactive to the reduction in or addition of water. Two major contributors to the removal of water from clayey soils are drought and transpiration by plants, especially trees.

As an example, Perpich et al. (1965) reviewed damages in the Chicago area from excessive drying of soils by trees. Investigations of more than 200 structures and foundations indicated that damage began as the moisture content of the soil was reduced to less than about 13 to 21%. Differential settlements of 1 to 4 inches (2.5 to 10.2 cm) were measured across the structures. Damage to buildings was typically associated with large trees having a trunk diameter of over 10 inches (25.4 cm); small trees and shrubs were not a problem. In no cases were evergreen trees involved. The depth of desiccation varied between 6 and 15 feet (1.8 and 4.6 m) from the ground surface and between 1 and 11 feet (0.3 and 3.3 m) from the bottom of the foundation. Generally the trees were located 10 to 25 feet (3.1 to 7.6 m) away from the foundation.