CHAPTER

6

Concrete Structures

The process of generating a solid substance by using a binder to adhere a mass of loose material is applied in various ways to produce filled plastics, asphalt pavements, particleboard, and plaster as well as what we call concrete. Although the term has broader generic meaning, we usually apply the word *concrete* to the material that is produced in rocklike form with a binder of water and portland cement and a loose filler consisting of sand and gravel.

Forms of concrete made with natural binders were used by ancient builders, but modern concrete, as we use it today, dates primarily from the development of calcined (burned) portland cement in the early nineteenth century. The potential for this highly improved material was first not fully recognized, and concrete continued to be used mostly in the old ways—for crude, filler functions in massive construction. Eventually, designers and builders began to experiment with the new material and to find ways to make better use of its refined quality. Basic systems and construction methods developed in a few decades in the late nineteenth and early twentieth centuries continue largely unchanged in form as major uses for building structures.

6.1 GENERAL CONCERNS FOR CONCRETE

Concrete is a somewhat complex material, and its use involves many concerns, such as those for mixing, forming, reinforcing, finishing, and curing of the cast material. This section deals with some of these critical concerns for the material and its production in forms for building structures. Considerations of its structural functions and the process of design must be built on some understanding of these general concerns. As compared to wood, steel, or masonry, concrete structures offer greater degree of freedom variability and require greater responsibility in terms of control of the finished product (see Figure 6.1).

Usage Considerations

Most of the concrete produced in the United States does not go into buildings but rather goes into pavements, bridges, dams, retaining walls, waterways, tunnels, and other types of structures. Indeed, most of the concrete used for buildings goes into foundations and grade-level pavements; almost every building has these elements, while only a relatively few have a structure above ground made of concrete (see Figure 6.2). This is said only so that it may be appreciated that the concrete industry is not oriented principally to the production of building structures.

On the other hand, concrete does lend itself to the possible production of all the basic structural components—foundations, roof and floor framing, walls, and columns—as well as a great range of various systems, including arches, domes, shells, and space frames. It is also generally the most inert and durable construction material, resisting aging, weather effects, rot, insects, fire, and most chemical change and decomposition. Given the right circumstances, it is a very usable material (see Figure 6.3).

Most concrete is produced by pouring the semifluid mixed material into a hole or a forming mold at the building site. For above-ground construction, forming costs often exceed that of the basic material itself. This has led to use of factory or on-site precasting of units that are then erected much like ordinary steel and wood elements.

Of course, a major early use of concrete was for precast masonry units: bricks and hollow-cored blocks. Today, most structural masonry is produced with concrete blocks—now called CMUs, for concrete masonry units.

A major structural limitation for concrete is its low resistance to tension. Compensation consists of using steel