Course Learning Outcomes for Unit VI

Upon completion of this unit, students should be able to:

3. Analyze the hazards and tactical considerations associated with the various types of building construction.
   3.1 Identify the different types of steel and concrete building components and their characteristics.
   3.2 Explain the hazards of fire loads in noncombustible and fire resistive construction and ways to improve the situation.
   3.3 Describe how steel and concrete structural elements react to fire.
   3.4 Describe the hazards associated with building types.
   3.5 Analyze the development and application to building codes in relation to each occupancy type.

Reading Assignment

Chapter 10: Noncombustible Construction

Chapter 11: Fire-Resistive Construction

Unit Lesson

Welcome to Unit VI where we will be discussing non-combustible and fire resistive construction.

These two terms sound very similar, and in many ways they are, as each uses materials that will not support combustion (e.g., steel and concrete). However, there are distinct differences that you will find throughout this unit—specifically, the level of fire resistance assigned to the structural frame, walls, floor, and roof. Non-combustible construction has little or no fire resistance for its structural members while fire resistive has moderate to heavy fire resistance (Brannigan, 2015, p. 282). Although it sounds like there is little difference because both are made of noncombustible materials, each has its own unique characteristics and hazards that firefighters must be aware of.

In addition, the height restrictions of these building are also varied. Since noncombustible construction relies heavily on the use of steel, the buildings are limited to twelve stories, but are generally only one to three stories. Fire resistive structures, however, can be of unlimited height. Fire resistive construction also relies heavily on the use of steel but will incorporate high levels of fire protection for structural members. Due to the nature of the construction of the buildings, there will be a heavy emphasis on understanding steel, its properties, characteristics, and safety considerations.

Steel is the most important metal used in building construction. It is generally available and relatively inexpensive in the United States. Without it, construction would be limited to massive all-masonry buildings with arched floors, or masonry wall-bearing buildings with wooden floors. Steel's modulus of elasticity (a term which measures its ability to distort and restore) is about 29 million pounds per square inch—far more than any other material. Steel's compressive strength is equal to its tensile strength. This great strength enables steel members of relatively small mass to carry heavy loads, particularly when used in trusses. Fire resistance, however, is a function of mass. Such strong but lightweight members have little inherent fire resistance.

As you can see, steel is tremendously strong; however, it will elongate at ordinary fire temperatures, about 1000 degrees Fahrenheit, leading to disruption of other structural members, and at 1300 degrees Fahrenheit steel will completely fail. Cold drawn steel, used as steel tendons, will fail at only 800 degrees Fahrenheit. It is also important to remember that steel is a great conductor of heat. This is especially hazardous for firefighters because heat can be conducted through walls to combustible materials on the other side. Many
Concrete is a cementitious material produced by a chemical reaction of Portland cement and water to which inert materials, called aggregates, are added. Shortly after it is mixed, concrete sets into a solid mass, but it continues to cure indefinitely. Construction specifications set the date by which concrete must reach its required compression strength. For instance, concrete required to reach design strength in 28 days is sometimes referred to as 28-day concrete. High early strength concrete achieves full compression strength in a shorter time. While curing, concrete generates heat of hydration. During its initial curing, concrete must be protected from freezing. Low temperatures retard the curing of concrete, and freezing is harmful to the material. Good concrete results from proper handling of carefully controlled materials. Because there are so many possibilities for a poor concrete product, high factors of safety are used in concrete design.
has a very weak tensile strength and poor shear resistance. Its compressive strength is good, particularly when compared to the cost of steel to resist the same load. Be careful about the terms cement and concrete; they are not the same thing.

Firefighters may still experience problems with concrete construction. These problems can be divided into three areas: collapse during construction with no fire; fire during construction; and fire in completed, occupied buildings. Each has its definitive dangers that firefighters must be prepared for during response. Once again, firefighters can have a false sense of confidence when it comes to fires in Type I buildings. When thinking about buildings under construction, there are numerous ignition sources present, from cutting torches to heaters—each utilizes fuel that can burn rapidly and at very high heat.

Even in fire resistive construction, fires do occur. Whether it is during construction or once the building is completed, the potential for fires does exist, and the false confidence that comes from working in a structure made of concrete is often unwarranted. Knowing that fires can occur, firefighters must be aware of the warning signs that accompany collapse in these buildings. A warning sign (e.g., smoke seeping through a brick wall) in ordinary construction may not be as evident in fire resistive construction. It is often difficult to observe spalling concrete during a fire, so it is important to anticipate collapse based upon other conditions present, problematic existing buildings, dangerous loads, cutting tensioned cables, and heavy fire conditions over an extended period of time. As you can see, some preparation requires preplanning, preplanning, and more preplanning. Other preparation requires situational awareness and good decision-making during an incident. Remembering that even the most veteran incident commanders can become occupied with the tasks at hand, it is important for everyone on scene to be aware of these factors and communicate any signs of collapse that may present themselves throughout the incident.

Ben Franklin stated that “Experience keeps a dear school, but fools will learn in no other” (as cited in Corbett & Brannigan, 2015, p. 341). The collapse potential in post-tensioned, fire resistive buildings is credible and real; lessons can be learned from the past to ensure that history does not repeat itself.

There is a lot of information regarding non-combustible and fire resistive construction that we did not cover in this lecture. It is imperative for this course and for your future that you understand and be able to apply this within your community. In the next unit, we will discuss the firefighting concerns of green structures as well as specific occupancy-related construction hazards.

Reference

Learning Activities (Nongraded)

Nongraded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions contact your instructor for further guidance and information.

For further review of the concepts discussed in Unit VI, review and respond to the Challenging Questions listed on pages 314 and 348 of your textbook.

Key Terms

1. Aluminum
2. Asphalt asbestos protected metal
3. Cast-in-place concrete
4. Composite construction
5. Masonry walls
6. Modulus of elasticity
7. Monolithic construction
8. Mushroom cap
9. Precast prestressed concrete panels
10. Prestressing
11. Pretensioning and post-tensioning
12. Reinforced concrete
13. Steel expansion joints
14. Stressing and tendons
15. Triage