*Unit 4:*

*Building construction types*

*objectives*

*The students will:*

*1. List ways to collect data and manage information.*

*2. List and describe the five types of building construction.*

*3. Identify the strengths, weaknesses, characteristics, and collapse potential for each of the five methods of building construction.*

*4. Identify special safety concerns.*

*5. Given a scenario, identify strengths and weaknesses in different building construction types.*

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INTRODUCTION

An awareness of the different classifications of building construction improves the ability of responders to control and effectively extinguish a structure fire. Many facts and factors must be considered. Knowledge of building construction means more than combustible or non-combustible features. In order to improve the safety record of firefighters, it is essential that information be collected on burn time, construction types, and structural integrity. These are critical to emergency scene decision making.

MANAGEMENT OF INFORMATION

Code enforcement inspections, regular preincident planning, and ongoing scene sizeup are essential to successfully confining a structural fire or searching a structure after a natural disaster. Knowing the basic types of building construction is vital. Each type of structure reacts differently during response and recovery efforts. How buildings are constructed and maintained is the basis for ordering resources, selection of strategy, implementation of tactics, positioning of apparatus, and use of special equipment. Each type of construction has positive and negative features that can affect all-risk/all-hazards operations. Understanding the "weaknesses" in a building reduces the likelihood of operational mistakes that result in serious or fatal injuries.

In reality, renovations take place after a structure is occupied. Buildings become a hybrid of materials. After a few decades, most buildings will result in a mixture of structural framing and finishes to meet the tenant's needs. These buildings create a dangerous environment with special safety concerns for first responders.

Once on the fireground, the initial action by all responders is the identification of potential problems. An accurate sizeup of structural characteristics will greatly assist in this endeavor. During the sizeup phase, structural integrity, paths for fire spread, and energy-efficient features are a few of the primary factors to be considered. It is often stated that the degree of compartmentation in a structure will determine the appropriate course of action in relation to a responder's risk. The success of an Incident Commander (IC), Incident Safety Officer (ISO), and Division/Group Supervisor hinges on making quick operational decisions. Architectural designs, building materials, and construction methods are critical components in selecting the proper mode of operation.

Just like a military commander knows how to use every part of a battlefield to the best advantage, so too must the code enforcement officials and field commanders possess an understanding of each "standard" type of building construction. Structural stability is the cornerstone foundation for effective and safe use of resources. A working knowledge by the first-arriving fire officer of the old and new concepts in building construction can save precious time and lives at the incident scene.

TYPES OF CONSTRUCTION

The fire service has different ways of classifying buildings. In North America, the most popular method is by general construction categories. The National Fire Protection Association (NFPA) system can be used to predict how a building will most likely react during a fire. By having an awareness of the various types of building construction, first responders can gain a better understanding of strengths, weaknesses, characteristics, hazards, collapse potential, and overall risks.

NFPA 220, *Standard on Types of Building Construction*, addresses building construction and firefighting. History has shown that the type of building construction has a significant influence on fire suppression, ventilation, and search activities. The most commonly used model building codes subdivide construction into five basic types:

1. Type I--Fire-Resistive Construction.

2. Type II--Noncombustible/Limited Combustible Construction.

3. Type III--Ordinary Construction.

4. Type IV--Heavy Timber/Mill Construction.

5. Type V--Wood-Frame Construction.

type I--Fire-Resistive construction

Type I--Fire-Resistive Construction has protected structural elements. It is the most fire-resistive category of all building constructions. Noncombustible fire-rated materials are coated or encased with protection against normal fire conditions. Key structural elements are commonly encased in concrete or fire-rated drywall, or sprayed with a fire-rated material so that the framing materials are not immediately exposed to any direct flame impingement. The protective materials used in this category will not ignite, burn, support combustion, or release flammable vapors when subject to predictable heat conditions. Data collected from concrete or steel skeleton-framed buildings with properly applied fire-resistive materials have shown that Type I structures can withstand complete devastation of the contents and still remain structurally sound. The weakness of Type I construction is that smoke and flames may spread from floor to floor. Central air-conditioning may penetrate all parts of these buildings. Toxic gases can be circulated by the heating, ventilating, and air conditioning (HVAC) system or travel in ducts without properly maintained self-closing dampers.

A common method of fire spread is autoexposure caused by fire lapping out the windows and up the side of the structure and entering the floors above through windows. Also, fire can extend to the floors above through the perimeter where the outer wall of the building attaches to the floor. Newer Type I buildings are designed with curtain walls that create a space between the steel frame and the outer prefabricated wall. This space that is created is called a safing gap. In the older Type I constructed buildings, this space was often filled with loose insulation that, over time, failed to properly seal this area to prevent fire extension. Today's codes are quite specific on the proper method and materials required to protect this space. This opening still may be compromised during repairs and renovations occurring after occupancy of the building.

Other operational challenges for firefighters in Type I construction might include large open floors, poke-through construction that negates firestops, and the generation of high-heat levels with limited ventilation points.

type ii--noncombustible/limited combustible construction

Type II--Noncombustible/Limited Combustible Construction has building materials that will not directly contribute to the development of fire or any flame spread. This type of building offers little fire-resistive qualities susceptible to early failure, yet is very popular in industrial and commercial facilities because of the reduced construction costs. The height of exterior bearing walls which is normally only one or two stories is of a noncombustible or limited combustible material. The structural framework is made of steel that is bolted, riveted, or welded in place and can be configured into many shapes. Typically, walls are made from metal or concrete block. Large area, single-story prefabricated metal clad buildings are becoming more popular.

The metal deck roof can be flat or peaked. The flat roof is often constructed and supported with steel bar joists. A peaked roof is often supported on a metal-framed truss consisting of small-dimensional angle iron and a roof surface of corrugated metal. The Type II building can be seriously negated by the use of combustible material during the construction or renovation phase. This includes the installation of wood paneling in an office area or decorative flammable wall covering. Automatic sprinklers should be used to protect combustible or valuable contents. The strength of this construction is the load-carrying capacity and the ability to span long areas with or without columns. However, the unprotected steel will expand and begin to lose strength at 1,100 °F (593 °C). At 1,500 °F (816 °C), steel will not even support its own weight. As steel warms up during a fire, it has the capacity to twist and distort. This movement can drop structural members being supported or push a wall to the point of collapse.

Although the structural elements do not add fuel to the fire, they are unprotected under fire conditions and likely to fail. Responders must be concerned with the potential for early collapse dangers and clearly establish collapse zones based on the height of the structure.

type iii--ordinary construction

Type III--Ordinary Construction has a combination of combustible and noncombustible features. Because of its popularity, this architectural style has been termed Main Street USA. The exterior walls are protected by a noncombustible material and the fire resistance of the interior depends on the age of the building. It is common to have parapet walls between adjoining properties, decorative cornices, and even a marquee in business districts. Type III buildings can be divided into older and newer construction features. Combustible walls and ceilings are protected with plaster, plasterboard, or drywall. These materials will assist in containing a fire for a reasonable period of time. Once flames or high heat enter the interconnecting combustible voids behind a partition, it will necessitate companies and crews to open walls and ceilings to ensure complete extinguishment. The use of thermal imaging cameras (TICs) can assist firefighters in finding areas of hidden fire that will need to be opened to ensure complete extinguishment.

The structural floor and roof members, in older construction, have solid joists and rafters that can be 3-inches wide and 10-inches deep. At times, columns were added to provide additional support. The size of rooms is limited by the span of the supporting element.

Floor joists are commonly fire cut on each end. The fire cut is an approximately 30°-cut on each end of the solid beam. The longer end of the cut is placed downward and rests in the bearing wall. The fire cut allows the floor to collapse down into the building without pushing the masonry wall outward. The danger of a fire cut is the increased risk of a collapse to fire companies and crews operating on the interior of the building.

Older buildings have combustible floors that can consist of tongue-and-groove boards while the flooring in newer construction can consist of plywood, oriented stand board (OSB), laminated veneer lumber (LVL) and parallel stand lumber (PSL), lightweight wooden trusses, and wooden "I" beams.

In Type III construction, the roof assembly can be viewed by older and newer techniques. Commonly in an older building, 1- to 1-1/4-inch thick wooden planks are used as roofing material. Contemporary construction techniques will use lightweight materials and evolving methods. Roof coverings such as tar and gravel, asphalt shingles, rolled asphalts, and rubber covering are likely to be found with this type of construction. Peaked roof structures commonly have an accessible area of various dimensions called an attic. In a flat roof building, there is a smaller void that is not accessible and normally free of storage. This concealed space is referred to as a cockloft and is open path for fire and smoke spread.

A drawback of Type III construction is that the structural elements will burn, while the exterior load bearing and nonload bearing walls will be of a fire-resistive material. Firefighters must be trained to carefully recognize and fully evaluate the presence of void spaces that are very typical in this category of construction. Experience has shown that through the decades, these buildings have had extensive modernization. Often, interior walls are altered to create an open contemporary appearance. Suspended ceilings are added. Channels for new HVAC equipment and shafts for plumbing fixtures can rapidly spread the fire. Numerous voids and open spaces can be found anywhere in the structure creating a "deadly ambush" for unsuspecting firefighters.

type iv--heavy timber/mill construction

Type IV--Heavy Timber Construction is also called Mill Construction because of the substantial size of the wooden structural elements. These buildings can be found in many parts of the Nation. This type of structure, when properly maintained, is not prone to early collapse. The large cross-sectional lumber used in walls, ceilings, floors, and roof assemblies makes it very sturdy. The masonry exterior walls can range up to 60 to 80 feet. Depending on the height of the structure, the extra thick walls can be 36 inches at the foundation. Often, the large interior is divided by firewalls and a self-closing fire door. The firewall is distinguishable by its thickness. It is wider than an ordinary wall and does not bear the weight of the building. The large open floors, constructed of solid wood planks, were built to handle heavy loads, and was accomplished by the installation of, at a minimum, 8-inch thick columns or solid timber trusses. Interior modifications to these structures can change some of the inherent qualities of the original construction. In Type IV construction, the interior walls and ceilings are not finished. This leaves masonry walls exposed and relatively few concealed spaces. Recently, factories and warehouse occupancies have been converted into retail or wholesale outlets. Other heavy timber buildings have been converted into energy-efficient, multiuse occupancies such as restaurants, small shops, galleries, vertical malls, apartments, and condominiums.

Historically, fires that get beyond the incipient stage generate the potential for a tremendous amount of radiant heat and will require several operational periods to contain and control. First-arriving responders must anticipate rapid fire spread and recognize hazards created by the many original openings for freight elevators, stairs, beltways, and utility shafts. Key strategic considerations will be needed for the proper placement of apparatus and the quick identification of all available water supplies with reliable pressure for the use of many master streams. The ability of a fire department to dispatch and deploy a sufficient amount of resources can mean the difference between containment and conflagration.

type v--wood-frame construction

Type V--Wood-Frame Construction has a support system that consists of wood or a similar material. This is the most prevalent type of construction used today. Model building codes are frequently being adjusted and energy-efficiency techniques are always being evaluated for residential and commercial properties. These changes can greatly assist or seriously impair responders in their quest to contain and control a small fire. To prevent weather-related damage, the wooden exterior framing system is commonly covered. In older construction, wood siding, hard asbestos shingles, or flexible asphalt wrapping are common. In newer construction, combustible coverings like aluminum and vinyl are used and will add to the fuel load. Stone, stucco, and brick veneer are noncombustible materials that can be used to protect the structural components without adding any fire load.

The structural elements will vary. The older wood-frame construction was assembled from solid lumber with nail connectors, while newer construction relies on predetermined engineered lumber and lightweight fasteners. Since the bearing walls are made out of combustibles, as they burn, there is a significant loss in the load-carrying capacity.

Different Eras Resulted in Different Styles of Wood-Frame Construction

Balloon frame was very popular until the mid-1900s when long structural materials were readily available from nearby lumber mills. This framing system has exterior walls assembled with wood studs that are a continuous inner cavity from the basement into the roof area. Compartmentation was lacking and the adequate firestopping was an operational concern. This open flue created the potential for rapid fire extension.

Platform frame is an open style of construction that has been popular since the late 1940s. The sidewalls are erected on the floor deck. After the wall studs are in place, the floor joists and flooring for the next level are set onto the studs or sill plate. This construction method reduces the path for fire that can extend to upper levels because of the amount of extensive materials that must burn.

Post-and-beam frame is another framing system that uses posts as the vertical supporting member and beams as the horizontal members. This technique has joists that are used to tightly connect the building. A modern version of post-and-beam frame can be found where large pressure-treated poles are firmly set into the ground and the framework of the structure is hung from the supporting elements.

Log frame is another framing system where wooden logs are interlocked by notching each end. In this style of construction, the exterior walls will supply an abundant amount of fuel to a fire. This log cabin design can be found in several regions of the country.

what are the firefighting SAFETY CONCERNS?

In this era of significant changes in the building industry, progressive fire departments have a unique opportunity to have input. In reality, the only reasonable way a firefighter can become familiar with the types of construction that exist in the community is to get out of the fire station and see what is occurring in his/her local district. Tours of new and existing buildings will provide an opportunity to see construction changes, examine modern materials, share ideas on "new wave" building methods, and review the training tips from an all-hazards perspective. Technology has, and will continue, to change many aspects of emergency response. Economically-driven trends in the use of lightweight construction materials such as laminated long-span composition lumber (e.g., "I" beams made of saw dust and glue), cold formed steel (C-joist) on aluminum hangers all have made interior firefighting, search, and rescue operations more dangerous than ever. Fortunately, new equipment, like the thermal imaging camera (TIC), will assist responders in the identification of building features that may be invisible in heavy smoke conditions.

what is the Brief Initial Report?

The Brief Initial Report (BIR), often called the Status Report, is critical information that is transmitted by the first-arriving unit at an incident. Simply stating **"working fire"** or **"fully involved"** is insufficient. The BIR should be a concise sizeup report of the fireground conditions.

Giving effective information in a standard format increases the ability of later-arriving companies and chiefs to be mentally prepared to assist the first-arriving unit quickly.

Initial Report

The initial report is to be given immediately upon arrival on location. The first-arriving officer should state the exact location and conditions as observed.

* Nothing showing.
* Size of structure--stories and dimensions--type of construction--occupied or vacant.
* Smoke/Fire--location and density.
* Status of occupants, if known.
* Exposures--Sides A, B, C, D or other.
* Engine \_\_\_ is establishing \_\_\_ Street Command.

The recommended format:

* Engine \_\_\_ arrived location Side \_\_\_ (state Side of the facility) of (describe the facility briefly).
* (Describe the situation specifically and the mode of operation.)
* Engine \_\_\_ crew is (describe what your crew has been assigned to do and where).
* Captain Engine \_\_\_ is Command on Side \_\_\_ (state Side).

Subsequent Report

The subsequent report will contain information not immediately reported and/or information developed upon investigation.

The subsequent report is to be given as soon as possible or within 5 minutes.

Progress Reports

Progress reports are to be given by the IC every 10 minutes until fire is under control.

this is a plan review of the size up report

Example Sizeup Report

* On location at 128 B Street, one-story strip store.
* Type III--Ordinary Construction, 20'x45', occupied as a furniture store.
* Heavy fire and smoke, Side A.
* All occupants have been removed.
* Exposures B-1 and D-1 similar type stores, medium smoke showing.

SUMMARY

Ensuring strict compliance with building codes, creating meaningful preincident plans, and performing ongoing sizeup steps at the scene will affect the lives of many present and future first responders. Conducting inspections gives local responders a perfect opportunity to not only gather the support of the people in the community, but to learn what hazardous conditions are waiting to injure or kill firefighters.

There are five major types of building construction. Each has distinguishing characteristics. Building modification can create special safety concerns. Familiarity with the various types of construction in one's response district along with training is critical to understanding the strengths, weaknesses, and potential for fire spread and collapse of each type of building construction. When leaders in the fire service encourage inspections and planning, Command Officers are able to project and deploy resources in an effective manner.

ICs must act decisively in the selection of an operating mode based on the type of building construction. Incident Safety Officers (ISOs) must monitor burn time and Company Officers (COs) must have a practical plan of action (POA) for an emergency evacuation. All responders must follow a risk-versus-benefit approach from response to termination. First responders must never simply guess on structural integrity; lives depend on recognizing and evaluating various types of building construction.