Title: Building Construction for the Fire Service

Time: 3 hours

Teaching Materials:

- **White board**
- **Building Construction for the Fire Service (PDF)**

Motivation: With the evolution of newer building construction types and materials, it is important for the firefighter to be able to recognize the type of construction, and identify the potential risks involved with each type. This training will provide a basic understanding of the process involved in constructing a residential structure and Basic terms for identification of critical parts of the structure.

Student Performance Objective: The student will be able to identify the type of construction used and then make informed decisions as to how to make the safest and effective fire attack.

Enabling Objectives:

- The student will be able to understand why codes and inspections are an important part of the construction process.
- The student will be able to identify different types of residential construction
- The student will become more familiar with construction terminology
- The student will be able to understand different styles of building systems
- The student will be able to evaluate risk versus safety with each type of construction
- The student will be able to determine when a defensive attack is the best option

Overview:

- Codes and inspections
- Types of construction
- Construction terminology
- Styles of building construction
- Risk versus safety
- Defensive attack

1. **The history of residential framing – Slide 3**
    a. Residential construction can be divided into two distinctive categories: Heavy frame, or conventional construction or light frame, engineered construction.
        i. Both have had their importance throughout history.
        ii. Heavy frame was the predominate type of construction until the mid-1990s when engineered materials made an appearance and became increasingly accepted by the building codes.

1. The engineered materials came into existence due to the cost and availability of true dimensional lumber.
2. The housing boom put a strain on the supply of these materials and the costs rose sharply.
3. Builders needed new equivalent materials that were just as strong, but readily available, and friendlier to the environment.

iii. Lightweight building materials became to emerge and have made a significant impact on the building industry.

2. Building Codes – Slide 4

a. COMAR has adopted building codes that regulate how structures are built, and dictate the basic instructions that contractors use when building a structure.
   i. Maryland Performance Building Standard is the culmination of all the codes that pertain to residential construction. The following codes are all under the MPBS
      1. International Building Code (IBC)
      2. International Residential Code (IRC)
      3. International Energy Conservation Code (IECC)
      4. Others
         a. National Electrical Code (NFPA 70)
         b. National Fire Sprinkler Code (NFPA 13D)

3. Building Codes – Slide 5

a. Codes are the "instructions" that designers and contractors are bound by to construct a safe and effective structure for the occupants.
   i. Different geographical locations will require the structure to perform differently.
   ii. For example, structures near the ocean can be prone to hurricanes, and need to be able to stand up to excessive winds, where structures in Western Maryland need to be able to withstand a loading of snow on their roof.

b. Most codes in Maryland are enforced by each individual county or a private inspection company approved by the county.

c. Codes exist to be the basic footprint and accepted practice to ensure the occupant has a reasonable expectation of safety, and minimize impact to the surrounding areas adjoining the structure.

4. Building Codes – Slide 6

a. The International Building Code (IBC) consists of 35 chapters that specify all aspects of construction, from height versus size requirements, to the basic materials that are allowable for construction.

5. Building Codes – Slide 7

a. Each county has the jurisdiction to administer the approved code as they see fit.

b. Most counties will have code enforcement personnel that will enforce the codes.

c. From submission of building plans to the final occupancy permit, the county will have a process in place to ensure that all new structures meet the current code and are safe to occupy.
d. Required inspections usually consist of the following:
    i. Initial building plan review – in the office, reviewing loads, zoning, and correct area zones.
    ii. Footing inspection – on site, prior to placement of the concrete footing or walls
    iii. Construction inspection - on-site prior to closing-in of walls by finished wall surface materials with a priority on structural components of the building.
    iv. Mechanical inspection- on-site prior to closing-in of walls by finished wall surface materials with a priority on electrical, plumbing, and HVAC requirements of the structure.
    v. Sprinkler inspection – on-site conducted when all sprinkler pipe is exposed. Usually pressurized during this test.
    vi. Final inspection – on-site culmination of all inspections and must be successfully completed prior to occupant move-in.

6. Building Codes – Slide 8

a. Code enforcement is a critical part of the construction process to ensure that the structure that is being built is of acceptable construction type for the geographic area, contains proven materials and construction methods to be safe for the occupants.

7. Framing Terms – Slide 9

a. Basically cover the terms as they are shown on this slide, as crucial ones will be described in detail in this section.
b. The following slides will demonstrate conventional framing also known as “stick built” homes.

8. Framing Anatomy – Sill Plate - Slide 10

a. The sill plate is a wood member that is attached to the foundation of the structure.
    i. This horizontal wood member will commonly be a 2” by 6” piece of lumber.
    ii. This plate will be permanently attached to the foundation by bolts or straps, and serves as the bottom structural member of the common wall section.
    iii. The wall studs will be attached to this along with the interior and exterior finish material.

9. Framing Anatomy – Wall Framing – Slide 11

a. Wall studs are vertical wood or metal members that extend from the sill plate to the ceiling-level of the structure.
    i. Studs will commonly be placed at 16” or 24” on center to each other.
    ii. All exterior and interior walls will be constructed in this manner.
    iii. Studs are the structural member that supports the entire wall load of the structure.
    iv. If studs are present, the firefighter can determine that the structure is not of panelized construction.

10. Framing Anatomy – Headers – Slide 12

a. A header is a horizontal structural member that is used above a window, door, or opening to support the load from above.
    i. These can be constructed of dimensional or engineered lumber.
    ii. Burn times are roughly the same between the different types as long as the engineered beam is dimensional (true to size).

11. Framing Anatomy – Roof System – Slide 13

a. The roof system can be constructed from dimensional lumber, truss system, or combination of both.
b. Point out the terminology, as the truss system will be shown later.

12. Platform Framing – Slide 14

a. Platform framing consists when wall studs extend from the floor to the underside of the second floor.
    i. They will not extend beyond one floor (roughly 8' – 10') in length.
    ii. Fire will only travel within one stud cavity vertically with this type of construction.

13. Panelized Construction – Slide 15

a. This type of construction is where wall sections are constructed in a factory and delivered to the site via truck and assembled with a crane.
b. These differ from modular construction as each wall will be a separate component.
c. Modular would be an entire house section or room in one part.
d. This is the lightest-weight construction as the interior finish, foam insulation, and exterior finish are all one component bonded by the foam insulation.
e. Structural members will only be found on the perimeter of the panels, or at openings.
f. Once a section of the wall is heated by a fire, it will begin to fail reasonably quickly as the foam interior softens.

14. Beams used for Construction – Slide 16

a. This slide shows the different common lightweight wooden beams that are used for construction.
    i. Explain the difference between laminated beams and TGI's.
        1. These are commonly used for floor systems, but the laminated style can be used as headers or main support beams as well.

15. The difference between engineered beams – Slide 17

a. The ultimate difference comes down to sheer mass of the beam.
b. The thicker it is the longer burn it will sustain, the lighter it is, the sooner it will fail.
c. The lightweight variety are more popular for floor systems, while the dimensional type will be found as headers or main support beams.
d. These engineered members can span further and are structurally stronger than the previous method of stick framing. But due to the minimal size, will fail early in a fire.
e. The floor is considered a "system" due to all structural members working in conjunction with each other, once one fails, and adjoining joists will cause a cascade failure.

16. Beams and Trusses – Slide 18

a. Trusses are engineered structural components that are made from smaller parts that combine to make a floor or roof system.
b. These serve as "ribs" to support the structure, and are stronger that conventional construction during normal environmental wind or snow load.
c. This type of component will commonly fail without warning and once one truss or beam has failed, adjoining members will fail just due to the additional load placed on them.
d. Once a single failure is observed, the firefighter should consider a catastrophic failure is imminent.

17. Trusses – Slide 19

a. Show that trusses can be constructed to meet almost any configuration, and are designed by an engineer for use as part as a system.
b. Modification of trusses on site will require a re-certification by the engineer.

18. Gusset Plates – Slide 20

a. Gusset plates are constructed of stamped metal and used to hold trusses, or engineered materials together.
b. They differ in size and are pressed into the wood to connect the individual parts together.
c. The teeth of the truss only penetrate the wood by an average of 3/8 of an inch.
d. In the event of a fire, the wood is burned, reducing the dimensional size.
    i. Under normal conditions, an exposed truss exposed to a normal fire load can fail within 15 minutes.
    ii. This is due to the minimal contact of the lumber with the truss, with conventional framing, a rule of thumb is one nail for every 2 inches of board.
    iii. A 2" by 6" would have 3 nails in it that penetrate through one component into the other an additional 2 inches.
    iv. A gusset plate has more contact surface, but less penetration, so in the event of a fire, will fail much sooner, and usually with cascading effect.

19. Truss Problems – Slide 21

a. Trusses, if designed, delivered, and installed properly are ideal for residential construction.
b. The only disadvantage to the firefighter is their inherent potential to fail quickly during normal fire loading conditions.
c. Issues that can drastically change this is modifications to this system.
d. Changing anything with them on-site can drastically change their strength and will cause early failure, not only during fire conditions, but wind or snow load, resulting in collapse.

20. Other Concerns – Slide 22

a. This slide show when the contractor or homeowner has done significant damage to an engineered beam system.
b. This extent of damage is almost impossible to repair.

c. The structure will normally remain standing, but will fail early during adverse weather or fire conditions due to the amount of material removed.
d. The engineered beams will have specifications as to how much material can be removed for pipe chases, or HVAC duct.
    i. Many will have pre-punched holes to be used as access. Modification beyond that will require permission from the manufacturer or structural engineer.

21. Burn Time – Slide 23

a. The time it takes a structural member to receive enough flame impingement to cause a failure cannot be given a specific time.
b. The average is seven minutes.
c. This is varied by direct flame contact, amount of fire load, wind currents, and if the structural member has been modified in any way.

22. Hazard Identification – Slide 24

a. Assume all newer residential structures built from 1990 through current are constructed with lightweight building materials until proven otherwise.
b. Under significant fire conditions the engineered systems could fail within 15 minutes.
c. The only true way to see what type of construction is present is to expose the framing members.
d. If the firefighter observes failure of one truss or engineered system, it is safe to assume that the whole roof or floor system has been jeopardized, and should consider evacuation and a defensive attack only.

23. Review- Slide 25

- Codes and inspections
- Types of construction
- Construction terminology
- Styles of building construction
- Risk versus safety
- Defensive attack