



# Fire Protection Training

Procedures Handbook 4300

BUILDING CONSTRUCTION

**TOPIC:** Structural Design, Construction Characteristics, and Terminology

**TIME FRAME:** 3 Hours

**LEVEL OF INSTRUCTION:**

**BEHAVIORAL OBJECTIVE:**

*Condition:* A written quiz

*Behavior:* The student will identify those structural design and construction characteristics which may significantly affect firefighter safety.

*Standard:* With a minimum of 70% accuracy

**MATERIALS NEEDED:**

- Appropriate visual aids
- Audio visual equipment

**REFERENCES:**

- IFSTA, Building Construction Related To The Fire Service, 1st Edition, Chapters 1 and 3
- IFSTA, Essentials of Fire Fighting, 2nd Edition, Chapters 6, 7 and 11

**PREPARATION:** There are many factors which may effect the spread of fire in a building. Many of these factors are unknown and have to be dealt with as they arise. One such factor, is the affect of a building's structural features on fire spread. Understanding construction features and pre-planning target hazards will greatly improve your ability to fight fires in these occupancies.



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STRUCTURAL DESIGN, CONSTRUCTION  
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PRESENTATION	APPLICATION
<p><b>I. DESIGN CHARACTERISTICS IN GENERAL</b></p> <p>A. Architect's Dilemma</p> <ol style="list-style-type: none"><li>1. Gravity is a structure's constant opponent</li><li>2. Structural stability is the foremost design consideration</li></ol> <p>B. Types of Loads</p> <ol style="list-style-type: none"><li>1. Dead loads<ol style="list-style-type: none"><li>a. Weight of the structure and any permanently mounted equipment</li></ol></li><li>2. Live loads<ol style="list-style-type: none"><li>a. All moveable loads within a structure which are not a permanent part of the structure, includes furniture, people, etc.</li></ol></li><li>3. Static loads<ol style="list-style-type: none"><li>a. Loads that are applied gradually and remain nearly constant</li></ol></li></ol>	<p>If live load becomes concentrated in one area it may exceed design capabilities and cause failure</p>



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<ul style="list-style-type: none"><li>4. Impact Loads<ul style="list-style-type: none"><li>a. Loads that are applied rapidly with a striking or collision effect</li></ul></li><li>5. Repeated loads<ul style="list-style-type: none"><li>a. Loads that are applied intermittently</li></ul></li><li>6. Uniformly distributed loads<ul style="list-style-type: none"><li>a. Loads that are applied constantly over an area</li></ul></li><li>7. Concentrated loads<ul style="list-style-type: none"><li>a. Loads that are applied to a small surface or contact area</li></ul></li><li>8. Wind loads<ul style="list-style-type: none"><li>a. Load applied to a structure by the wind</li></ul></li><li>C. Direction from which Loads May be Applied to Structural Members<ul style="list-style-type: none"><li>1. Axial load<ul style="list-style-type: none"><li>a. Applied along the members axis. Generally applied to the center of the structural member and perpendicular to that member</li></ul></li><li>2. Eccentric load</li></ul></li></ul>	<p>Can produce high stresses and can be delivered from a direction that the designer did not anticipate with disastrous consequences</p>



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<ul style="list-style-type: none"><li>a. Applied off center from the members center or axis and perpendicular to that structural member</li><li>b. Structural member will have a tendency to bend</li></ul> <p>3. Torsional load</p> <ul style="list-style-type: none"><li>a. Applied off center from or at an angle to the structural member</li><li>b. Structural member will have a tendency to twist</li></ul> <p>D. Effects of External Loads on Structural Members May Exhibit Themselves as:</p> <ul style="list-style-type: none"><li>1. Compression force<ul style="list-style-type: none"><li>a. A force which crushes or pushes the mass of the structural member together</li></ul></li><li>2. Tension force<ul style="list-style-type: none"><li>a. A force which tends to pull the structural member apart</li></ul></li><li>3. Shear force<ul style="list-style-type: none"><li>a. A force that tends to cause adjacent layers in a structural member to slide past one another. An opposite but parallel sliding motion.</li></ul></li></ul> <p>E. Structural Abuse May Cause Structural Collapse</p> <ul style="list-style-type: none"><li>1. Firefighters must be alert for the presence of structural abuse such as:<ul style="list-style-type: none"><li>a. Loads which exceed design specifications (fire streams to ceilings or upper floors, cargo storage in attics, etc.</li></ul></li></ul>	



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<ul style="list-style-type: none"><li>b. Improper modifications of structural members</li><li>c. Normal deterioration of structural members</li><li>d. Abnormal deterioration of structural members due to wind, fire, flood, earthquakes, etc.</li></ul> <p><b>II. BUILDING CONSTRUCTION CLASSIFICATION SYSTEM</b></p> <p>A. Type I Construction (Fire Resistive)</p> <ul style="list-style-type: none"><li>1. Structural members are non-combustible and are fire protected</li><li>2. Fire resistive requirements<ul style="list-style-type: none"><li>a. Exterior wall - 3 or 4 hours</li><li>b. Structural frame - 3 or 4 hours</li><li>c. Floor - 2 or 3 hours</li></ul></li></ul> <p>B. Type II Construction (Noncombustible)</p> <ul style="list-style-type: none"><li>1. Structural members are noncombustible</li><li>2. Fire resistive requirements<ul style="list-style-type: none"><li>a. Exterior wall - 0 to 3 hours</li><li>b. Structural frame - 0 to 3 hours</li><li>c. Floor - 0 to 3 hours</li></ul></li></ul> <p>C. Type III Construction (Exterior Protected Combustible)</p>	<p>Information sheet #1</p>



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<ul style="list-style-type: none"><li>1. Interior structural elements may be combustible, but exterior walls must be noncombustible</li><li>2. Fire resistive requirements<ul style="list-style-type: none"><li>a. Exterior wall - 2 hours</li><li>b. Structural frame - 0 to 1 hour</li><li>c. Floor - 0 to 1 hour</li></ul></li><li>D. Type IV Construction (Heavy Timber)<ul style="list-style-type: none"><li>1. Structural members are large dimension unprotected wood</li><li>2. Fire resistive requirements<ul style="list-style-type: none"><li>a. Exterior wall - 2 hours</li><li>b. Structural frame - 4" x 6" minimum nominal size</li><li>c. Floor - 8" x 8" minimum nominal size</li></ul></li></ul></li><li>E. Type V Construction (Wood Frame)<ul style="list-style-type: none"><li>1. Structural members entirely of unprotected wood</li><li>2. Fire resistive requirements<ul style="list-style-type: none"><li>a. Exterior wall - 1 hour</li><li>b. Structural frame - 0 to 1 hour</li><li>c. Floor - 0 to 1 hour</li></ul></li></ul></li></ul>	



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<p><b>III. BASIC CONSTRUCTION STYLES</b></p> <p>A. Conventional Construction</p> <ol style="list-style-type: none"><li>1. Size = Strength</li><li>2. Mass = Strength</li><li>3. Structural parts and members are usually not interdependent i.e. (rafter-joist)</li></ol> <p>B. Lightweight Construction</p> <ol style="list-style-type: none"><li>1. Less than average size/weight i.e. (2"x 4" or 2"x 3")</li><li>2. Compression and tension = Strength</li><li>3. Framing members are interdependent on one another. (If one member fails, others may fail) i.e., truss, wooden "I" beam</li></ol> <p><b>IV. DESIGN CHARACTERISTICS OF WALLS</b></p> <p>A. Types of Walls</p> <ol style="list-style-type: none"><li>1. Non bearing walls - A wall that only supports its own weight</li><li>2. Bearing wall - A wall which supports a vertical load in addition to its own weight<ol style="list-style-type: none"><li>a. Much more likely to jeopardize firefighters if it collapses</li></ol></li></ol>	<p>What gives this construction its strength?</p> <p>Explain lightweight construction</p>



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<ol style="list-style-type: none"><li>3. Curtain wall - An exterior wall supported by the structural frame of the building</li><li>4. Enclosure wall - an interior wall which creates a vertical opening for a stairway, elevator, duct space, etc. and connects two or more floors<ol style="list-style-type: none"><li>a. May encourage/facilitate vertical fire extension</li></ol></li><li>5. Fire partition - an interior wall which restricts the spread of fire, but does not qualify as a fire wall</li><li>6. Fire wall - a wall of sufficient durability and stability to withstand the effects of the most severe anticipated fire. Openings within the walls must be protected.</li><li>7. Parapet wall - a portion of an exterior fire or party wall which extends above the roofline</li><li>8. Partition wall - an interior wall not more than one story in height that separates two areas in the same building, but is not intended to serve as a fire barrier</li><li>9. Party wall - a common wall separating two occupancies</li><li>10. Cavity wall - a wall of two parallel vertical brick walls with an airspace between them connected by metal ties.</li><li>11. Faced wall - a wall of two different masonry materials; one, a facing vertical wall the other a backup vertical wall bonded together as a single wall</li><li>12. Hollow wall - a wall consisting of two parallel vertical brick walls with an air space between them and no ties to hold the walls together</li></ol>	



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<p>13. Sandwich wall - a non-bearing wall whose outer faces enclose an insulating core material</p> <p>B. Interior Wall Finishes and Wall Coverings May Jeopardize Firefighter Safety by:</p> <ol style="list-style-type: none"><li>1. Reducing the time required to build to a flashover condition</li><li>2. Contribute to fire extension by flame spread over its surface</li><li>3. Add to the fire intensity by contributing additional fuel</li><li>4. Produce smoke and toxic gases during decomposition</li></ol> <p><b>V. DESIGN CHARACTERISTICS OF ROOF ASSEMBLIES</b></p> <p>A. Support Systems</p> <ol style="list-style-type: none"><li>1. May be conventional<ol style="list-style-type: none"><li>a. Full dimensional wood</li><li>b. Steel</li><li>c. Concrete</li></ol></li><li>2. May be lightweight<ol style="list-style-type: none"><li>a. Advantages of lightweight<ol style="list-style-type: none"><li>(1) Less weight</li><li>(2) Great strength under normal conditions</li><li>(3) Less costly materials</li><li>(4) Less labor intensive</li></ol></li><li>b. Disadvantages</li></ol></li></ol>	





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<ul style="list-style-type: none"><li>(1) Fails within 3 minutes 20 seconds of flame contact</li><li>2. A truss is a framed structural unit made of a group of triangles on a single plane</li><li>3. Truss components<ul style="list-style-type: none"><li>a. Top chord<ul style="list-style-type: none"><li>(1) Generally subjected to compression force</li></ul></li><li>b. Bottom chord<ul style="list-style-type: none"><li>(1) Generally subjected to tension force</li></ul></li><li>c. Web members (diagonals)<ul style="list-style-type: none"><li>(1) Join top and bottom chords to construct a triangle</li></ul></li><li>d. Joints may consist of:<ul style="list-style-type: none"><li>(1) Pin connections</li><li>(2) Welds</li><li>(3) Gusset plates</li><li>(4) Strap connectors</li></ul></li></ul></li><li>4. Trusses normally span distances of 22 to 70 feet</li><li>C. Classifications of Roof Coverings<ul style="list-style-type: none"><li>1. Class A coverings<ul style="list-style-type: none"><li>a. Effective against severe fire exposures</li><li>b. Are not readily flammable</li></ul></li></ul></li></ul>	



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<ul style="list-style-type: none"><li>c. Do not communicate or carry fire</li><li>d. Afford high degree of fire protection to the roof deck</li><li>e. Do not slip from position</li><li>f. Possess no flying brand hazard</li><li>g. Do not require frequent repair to maintain fire resistive properties</li></ul> <p>2. Class B roof coverings</p> <ul style="list-style-type: none"><li>a. Effective against moderate fire exposure</li><li>b. Not readily flammable</li><li>c. Do not readily communicate or carry fire</li><li>d. Afford moderate degree of fire protection to the roof deck</li><li>e. Do not slip from position</li><li>f. Possess no flying brand hazard</li><li>g. Require repairs to maintain fire retardant properties</li></ul> <p>3. Class C roof coverings</p> <ul style="list-style-type: none"><li>a. Effective against light fire exposure</li><li>b. Not readily flammable</li><li>c. Do not readily communicate or carry fire</li><li>d. Afford slight protection to roof decks</li><li>e. Do not slip from position</li><li>f. Possess no flying brand hazard</li></ul>	



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<p data-bbox="380 344 1036 415">g. Require repair or renewal to maintain fire retardant properties</p> <p data-bbox="151 449 841 483"><b>VI. DESIGN CHARACTERISTICS OF STAIRS</b></p> <p data-bbox="228 516 862 550">A. May be Classified as Interior or Exterior</p> <p data-bbox="228 583 574 617">B. Types of Stairways</p> <p data-bbox="305 651 631 684">1. Straight run stairs</p> <p data-bbox="380 718 980 789">a. Stairs aligned without curves or turns from floor to floor</p> <p data-bbox="380 823 967 894">b. May have intermediate platform, but direction of travel is constant</p> <p data-bbox="305 928 561 961">2. Return stairs</p> <p data-bbox="380 995 1010 1066">a. Designed with an intermediate platform between levels</p> <p data-bbox="380 1100 919 1134">b. Reverse direction at the platform</p> <p data-bbox="305 1167 571 1201">3. Scissor stairs</p> <p data-bbox="380 1234 1026 1306">a. Two sets of straight run stairs in a single stairwell</p> <p data-bbox="380 1339 958 1411">b. Stairs crisscross to opposite side of stairwell at each floor</p> <p data-bbox="380 1444 990 1558">c. One stair commonly designated for upward traffic and other for downward traffic</p> <p data-bbox="305 1591 581 1625">4. Winding stairs</p> <p data-bbox="380 1659 1019 1772">a. Also called spiral stairs since they spiral around a single column between two floors</p> <p data-bbox="305 1801 558 1835">5. Partial stairs</p>	



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<ul style="list-style-type: none"><li>a. Interior stairs which serve a grouping of floors within a building, but not all floors (e.g. floors 1-5 in a 15 story building)</li><li>6. Escalators<ul style="list-style-type: none"><li>a. Electrically powered steps which move continuously in one direction</li></ul></li><li>7. Fire escapes<ul style="list-style-type: none"><li>a. A series of steel platforms and stairs mounted on the exterior of the building for emergency escape</li></ul></li><li>8. Smokeproof towers<ul style="list-style-type: none"><li>a. Stairways in multi-story structures which either:<ul style="list-style-type: none"><li>(1) Have open air balcony at each floor or</li><li>(2) Have a smoke shaft constructed in the stairway</li></ul></li><li>b. Purpose of vestibule or shaft is to exhaust smoke from building at each floor level</li></ul></li></ul>	<p>Information sheet #5</p>



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## **SUMMARY:**

Firefighters face many dangers in the line of duty. Not the least among them is the unknown structural stability of buildings they must enter under fire conditions. Posthumous tributes to fallen firefighters are filled with entries bearing the sad legend, "building collapse."

## **EVALUATION:**

A written quiz.

## **ASSIGNMENT:**

To be determined by instructor(s).