LESSON 3

BUILDING CONSTRUCTION,

SESSION 1

Objectives

- The Student Shall:
  - Identify the characteristics of fire resistive construction
  - List 7 fire spread concerns associated with fire resistive construction
  - State 2 structural concerns inherent in fire resistive construction

Objectives

- The Student Shall:
  - Identify the characteristics of non combustible construction
  - List 6 fire spread concerns associated with non combustible construction
  - State 3 structural concerns inherent in non combustible construction

Objectives

- The Student Shall:
  - Identify the characteristics of ordinary construction
  - List 5 fire spread concerns associated with ordinary construction
  - State 4 structural concerns inherent in ordinary construction

Building Construction and Fire Spread

- More important to know the building on fire than to know the fire that is in the building
  - Building features influence fire spread
    - Paths of least resistance
    - Collapse characteristics
  - This knowledge allows effective fire control strategies to be developed

Building Classifications

- Class I: Fire resistive
- Class II: Non-Combustible / Limited Combustible
- Class III: Ordinary
- Class IV: Heavy Timber
- Class V: Wood Frame

Building Construction

Fire-Resistive Construction

- NFPA Class I
- Walls, columns, beams, floors, and roof constructed of non combustible or limited combustible materials
  - Do not add to the fire load
  - Designed to allow fire to burn without causing massive structural failure

Building Construction

Fire-Resistive Construction

- Principle intention:
  - Limit fire spread outside of compartment of origin
  - Expedite occupant escape
- Reinforced concrete
- Structural steel – must be protected
  - Encasement
    - Concrete
    - Fire-rated sheetrock
    - Fire-resistive Coating

Building Construction

Fire-Resistive Construction

- Includes:
  - High Rise Office Buildings
  - High Rise Residences
  - Schools
  - Fire Resistive Low Rise Multiple Dwellings

Building Construction

Fire-Resistive: Fire Spread Concerns

- HVAC System
  - Defeat principle of compartmentation
  - Allow products of combustion to spread beyond area of origin
  - System must be shut down
    - Consult w/ Bldg. engineers
    - May be utilized for fire control or vent ops if properly coordinated

Building Construction

Fire-Resistive: Fire Spread Concerns

- False Floors
  - Found in commercial occupancies
  - Computer wiring
    - Ignition source
    - Debris problem
  - Protected by clean agent extinguishing system
    - CO_2
    - Halon

Building Construction

Fire-Resistive: Fire Spread Concerns

- Drop Ceilings
  - Create cockloft on each floor
  - Must be intact to be fire barrier
  - House HVAC system, electric, fire detection/suppression systems
    - Ignition sources
  - Collapse hazard
    - Unprotected steel wire supports
    - Entanglement hazard

Building Construction

Fire-Resistive: Fire Spread Concerns

- Elevators and Elevator Shafts
  - Can spread fire via shaft openings
  - Can cause confusing smoke conditions
  - Susceptible to water and fire damage
    - Can trap occupants and firefighters
  - Must be utilized properly during a fire
    - Must be Phase II for FF use
    - SOP and Training a must

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Building Construction

Fire-Resistive: Fire Spread Concerns

- Compactor / Incinerator Shafts
  - Smoke spread to upper floors
  - Sprinkler systems and smoke dampers that trigger automatic shutdown
  - Can cause fire extension via improperly designed or maintained shafts
  - Recon of all floors required
    - Personnel intensive
    - Utilize Bldg. Maintenance personnel

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Building Construction

Fire-Resistive: Fire Spread Concerns

- Access Stairs
  - Open stairs that connect 2 floors rented out to a single occupant
  - Should be protected by sprinklers
  - Extending fire can trap firefighters searching floor above fire
  - Preplanning and bldg. familiarization required

Building Construction

Fire-Resistive: Fire Spread Concerns

- Occupant Indifference
  - Lack of proper public awareness and fire safety education
    - What to do in the event of a fire
  - Alterations to fire containment features:
    - Self-closing door devices removed
    - Blocked open fire doors

Building Construction

Fire-Resistive: Structural Concerns

- Spalling of Concrete
  - Due to expansion of moisture trapped in concrete
  - Direct flame contact
  - FD weapon = reach of hose stream to reduce ceiling temperatures

Building Construction

Fire-Resistive: Structural Concerns

- Buildings under Construction
  - Least stable in terms of structural integrity
  - Most vulnerable in regard to fire ignition and spread
  - Most inundated with hazards in and around the building
  - Difficult access to both site and upper floors

Building Construction

Fire-Resistive: Structural Concerns

- Buildings under Construction
  - Pre cast
    - Connections vulnerable
    - Unprotected steel
  - Cast in Place
    - Formwork fire
    - Inadequate fire protection
    - Site debris / access problems
    - Catastrophic collapse

Building Construction

Non-Combustible Construction

- NFPA Class II
- Walls, floors, and roof support system constructed of non combustible material
  - Unprotected steel
  - Does not add to the fire load
  - Truss construction
  - Roof covering is combustible
  - Contents are major fire load problem

Building Construction

Non-Combustible Construction

- Includes:
  - Warehouses
  - Storage Occupancies
  - Strip Malls
  - Supermarkets
  - Fast Food Establishments

Building Construction

Non-Combustible: Fire Spread Concerns

- Large, Open Floor Areas
  - Indicative of truss construction
  - Few partitions
  - Consider lifelines
    - Disorientation hazard
  - Consider reach of stream
    - 2-1/2" lines w/ solid bore nozzles

Building Construction

Non-Combustible: Fire Spread Concerns

- Metal Deck Roof Fire
  - Corrugated steel decking over lightweight steel bar joist
  - Joists as much as 8' on center
    - Combustible felt and insulation
    - Hot-mopped tar
    - Gravel
    - Rubber or neoprene covering
    - PVC Covering

Building Construction

Non-Combustible: Fire Spread Concerns

- Metal Deck Roof Fire
  - Susceptible to ignition, spread, and failure
    - Contents fire heats up combustible roofing material
    - Roof becomes involved
    - Fire also spreads below roof deck
    - Tar or combustible glue drips between seams ahead of main fire, igniting secondary fires below

Building Construction

Non-Combustible: Fire Spread Concerns

- Drop Ceilings / Cockloft
  - (a.k.a. Hanging Ceiling Space)
    - Wire highway above ceiling (ignition source)
    - Often open over entire row of stores
    - Insufficient fire-stopping
      - Utility and building service penetrations
    - Cockloft backdraft
    - Personnel intensive

Building Construction

Non-Combustible: Fire Spread Concerns

- HVAC System
  - Can spread smoke and fire throughout area
  - Can be source of smoke
    - Burning fan motor belt
    - Dump smoke throughout building
  - Must be shut down
  - Individual units are best
  - Concentrated roof load

Building Construction

Non-Combustible: Fire Spread Concerns

- Facades / Mansards
  - Open across whole front and / or side of building
    - Defeats interior fire stopping features
    - May contain ignition sources
    - May have combustible covering
    - Avenue for fire spread to cockloft

Building Construction

Non-Combustible: Structural Concerns

- Least stable of ALL construction types in regard to collapse susceptibility
  - Unprotected steel structural members
  - Fire from contents below causes steel to fail in as little as 5 minutes
    - Sags prior to failing

Building Construction

Non-Combustible: Structural Concerns

- Unprotected Steel and FIRE
  - 400°-- begins to lose strength
  - 1000 ° -- Can be expected to fail
  - 1200 °-- 60% of strength lost
    - Will elongate when heated
      - 100' beam heated to 1000 ° will expand 9-1/2"
      - May push out walls or drop floors
- Collapse depends on steel temps, not fire temps

Building Construction

Non-Combustible: Structural Concerns

- Unprotected Steel and FIRE
  - Failure rate depends on variables
    - Size of steel
      - Lightweight steel fails quicker than I-Beam
    - Load steel is subject to
      - Roof Loads
      - Suspended loads
    - Temperature & distance to fire
      - Higher temps + close to fire = earlier failure

Building Construction

Non-Combustible: Structural Concerns

- Unprotected Steel and FIRE
  - Extent of failure may depend on:
    - Restrained or unrestrained
      - Restr = May pull walls in and drop roof
      - Unres = Earlier roof collapse, walls intact
    - Attached or unattached buildings
      - Att = No room to expand, pull walls in
      - Unatt = Push walls out

NO ONE CAN PREDICT HOW A COLLAPSE WILL OCCUR

Building Construction

Non-Combustible: Structural Concerns

- Lightweight Steel Bar Joist Truss
  - Can be spaced 8' apart
    - Use platform or roof ladder
  - Open web system = fire exposure on all sides
    - Best protection = sprinklers
    - Use reach of stream to cool overhead

Building Construction

Non-Combustible: Structural Concerns

- Heavy Roof Loads
  - Concentrated Load
  - HVAC units
  - Signs
- Require Roof Division recon / report
- Expect earlier failure in load area

Building Construction

Ordinary Construction

- NFPA Class III
- Exterior walls of non-combustible material
  - Brick / Masonry
  - Intended to limit exterior fire extension
- Side walls usually bearing
- Front and rear usually non-bearing

Building Construction

Ordinary Construction

- Interior members constructed of wood
  - No designed fire resistance
  - Many concealed spaces
  - Plaster on lathe walls
  - Plaster on wire mesh walls
  - Sheetrock

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Building Construction

Ordinary Construction

- Combustible roof
  - 2" x 10" – 3" x 12"
  - Wood plank roof boards
  - Roofing paper/Tar/Tin sheeting
  - May be many layers
- Standard
  - Roof boards nailed directly to roof joists
- Inverted
  - Small framework built above roof deck to allow for drainage

Building Construction

Ordinary Construction

- Includes
  - Apartment Buildings
  - Row Houses
  - Schools
  - Old High Rises
  - Taxpayers

Building Construction

Ordinary Construction: Fire Spread Concerns

- Concealed Spaces
  - Major fire spread problem
  - Allow uninhibited fire spread
  - Spread fire vertically and horizontally
    - Window Voids
    - Door Voids
    - Utility Pokethroughs
    - Soffits

Building Construction

Ordinary Construction: Fire Spread Concerns

- Unenclosed Stairways
  - Major vertical artery
  - Primary escape route for occupants
    - Fire apt. doors left open complicate the issue and may trap occupants on upper floors
    - Natural vent point at top of stairs
  - Primary attack route for FD
  - Whoever controls the stairs (Fire or FD) usually wins battle for the building

Building Construction

Ordinary Construction: Fire Spread Concerns

- Other vertical Shafts
  - Pipe Chases
    - Stacked kitchens and bathrooms
    - Path of least resistance on apt. interior
    - Terminate as natural roof openings
      - Soil pipes
      - Ventilators
    - Require commitment to floors above
    - Check at roof level

Building Construction

Ordinary Construction: Fire Spread Concerns

- Other vertical Shafts
  - Channel Rails
    - Buildings over 25' wide
    - Steel I-beams support floors
    - Boxed-in by sheetrock and wall studs
    - Difficult to identify

Building Construction

Ordinary Construction: Fire Spread Concerns

- Other vertical Shafts
  - Dumbwaiter Shafts
    - May be sealed closed
    - May be used to run utilities
  - Elevators
    - Usually not fire-service mode capable
  - Compactor and incinerator Chutes
    - May ignite nearby combustibles
    - Spread smoke and fire

Building Construction

Ordinary Construction: Fire Spread Concerns

- Light and Air Shafts
  - Spread fire to upper floors and adjoining buildings
  - Require recon
    - Fire
    - Victims
    - Exposure involvement

Building Construction

Ordinary Construction: Fire Spread Concerns

- Combustible Cockloft
  - Space between ceiling of top floor and roof boards
  - May be open over a row of bldgs
    - Intensive exposure operations
  - Backdraft potential
    - Require interior / roof coordination
  - Vent directly above fire to slow horizontal spread below roof

Building Construction

Ordinary Construction: Structural Concerns

- More susceptible to burn-through than collapse
  - Parapet Walls
  - Decorative Metal Cornice
  - Previous Fires
  - Renovations

Building Construction

Ordinary Construction: Structural Concerns

- Parapet Walls
  - Free-standing wall
  - Collapse hazards:
    - Fire Exposure
    - Uneven expansion due to ice / heat
    - Master Streams
    - Struck by aerial device
    - Eccentric Loads
  - Often fails during overhaul

Building Construction

Ordinary Construction: Structural Concerns

- Parapet Walls
  - When in danger of collapse:
    - Clear for distance equal to the entire height of the wall on which the parapet rests (full bldg. height)
    - Clear for entire width of the wall
      - May have lateral steel reinforcement
      - Weakened section may pull entire wall down

Building Construction

Ordinary Construction: Structural Concerns

- Parapet Walls
  - Coping Stones
    - Can weigh as much as 50 lbs
    - May be held by gravity only
    - Easily knocked off:
      - Master stream
      - Hoisting / lowering equipment
      - Leaning over roof edge

Building Construction

Ordinary Construction: Structural Concerns

- Parapet Walls
  - May be more than 6' drop to roof
  - Height recognition can be determined by:
    - Prior knowledge
    - Check the sides
    - Downspouts
    - Scuppers

Building Construction

Ordinary Construction: Structural Concerns

- Decorative Metal Cornices
  - Unsupported extended roof edge
  - Lateral fire spread danger
  - Indicators:
    - Raised or depressed lip at roof edge
    - Offset chimney
  - Preplanning is the key
  - Size up roof from ground level

Building Construction

Ordinary Construction: Structural Concerns

- Previous Fires
  - Open to elements
  - Vagrants
  - Reduced stability
  - Firefighter hazards
    - Holes in floors
    - Open roofs
    - Missing stairs
    - Dangerous fire escapes
- Use of Building Marking System

Building Construction

Ordinary Construction: Structural Concerns

- Renovations
  - Rarely strengthen building
    - Rain Roof
    - Lightweight Truss
  - Illegal living areas with insufficient exits
  - Confusing, maze-like conditions
  - Complicate search and attack operations

Building Construction

Summary

- Fire-Resistive Construction
- Non-Combustible / Limited Combustible Construction
- Ordinary Construction
  - Fire Spread Concerns
  - Structural Concerns

Building Construction

Conclusion

- Knowledge of building construction is critical to rational and safe fireground decision-making.
- Inherent building weaknesses set the parameters by which the battle will be fought.
- To be aware is to be alive.

Next Lesson

- **Lesson 4:**
  Building Construction Session 2

- **Reading Assignment:**
  - **Fireground Strategies**
  - **Ch. 3, pp 111 – 128**