LESSON 3
BUILDING CONSTRUCTION,
SESSION 1

Objectives

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

Objectives

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

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

Fire-Resistive Construction

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

Fire-Resistive: Fire Spread Concerns

• False Floors
  - Found in commercial occupancies
  - Computer wiring
    - Ignition source
    - Debris problem
  - Protected by clean agent extinguishing system
    - CO2
    - Halon

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

- **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

- **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
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

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

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**
  - Precast
    - Connections vulnerable
    - Unprotected steel
  - Cast in Place
    - Formwork fire
    - Inadequate fire protection
    - Site debris / access problems
    - Catastrophic collapse

**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

**Non-Combustible Construction**

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

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

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
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

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

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
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

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

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
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

- 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

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

### Ordinary Construction

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

### 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

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

• 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
Ordinary Construction: Fire Spread Concerns

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

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

Ordinary Construction: Structural Concerns

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

- **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

- **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

- **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

- **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

- **Use of Building Marking System**
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

Summary

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

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