2021 IBC Essentials

Based on the 2021 International Building Code® (IBC®)

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INTRODUCTIONS

Instructor Name

- About You Bullet 1
- About You Bullet 2
- About You Bullet 3
- About You Bullet 4
- About You Bullet 5
- About You Bullet 6
- Your email address

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COURSE OBJECTIVES

Goal

By the end of this learning you will be able to, apply the critical concepts and provisions of the 2021 *International Building Code®*



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DESCRIPTION

Why Does This Matter?

- This seminar focuses on 2021 IBC essential concepts
- Concepts provide a basis for correct code utilization
- Clear understanding of identified requirements allows code users to
  - Apply the IBC in specific situations
  - Build understanding of the code intent when asked to make code compliance judgments



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COURSE OBJECTIVES

To achieve this goal you can.

- Explain fundamental 2021 IBC provisions and intent
- Describe common provisions applicable to commercial building design
- Comprehend passive and active fire protection
- Identify how life safety and egress issues are addressed in design and construction
- Identify occupant health and safety safeguards with weather protection and interior environment controls



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Keys to a Successful Class

1. Slides contain some text and iconic images to help you learn
2. Text and commentary is in the handout
3. Follow along in the course handout
4. Ask Questions, ask questions, ASK QUESTIONS!!!!



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COURSE OUTLINE

- Administration
- Building Planning
- Fire Safety
- Life Safety
- Health Safety
- Structural Safety



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COURSE BASIS

Underlying Curriculum



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Code Administration and Enforcement

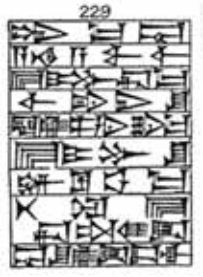


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COURSE BASIS

History of Building Codes

229. "If a builder has built a house for a man, and has not made his work sound, and the house he built has fallen, and caused the death of its owner, that builder shall be put to death."



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COURSE BASIS

History of Building Codes

Codes are minimum requirements to safeguard:

- Health & Safety
- Welfare of the Public
- Occupants
- Users of Spaces or Buildings



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U.S. Building Code History

Building Code Recommended by National Board of Fire Underwriters

- Published in 1905
- One of earliest U.S. model building codes



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U.S. Building Code History

By the end of the 20th century there were 3 model building code groups

- Building Officials & Code Administrators International (BOCA)
- International Conference of Building Officials (ICBO)
- Southern Building Code Congress International (SBCCI)

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U.S. Building Code History

In 1994, BOCA, ICBO and SBCCI agreed to develop one model code

- Together formed International Code Council (ICC)
- First *International Building Code* by ICC published in 2000



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Purpose of Building Codes

- Regulations adopted by governmental agencies to ensure that buildings are built in a safe manner
- People expect when entering a building to be safe from inherent dangers caused by natural or man-made disasters



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ICC Code Development

Family of "I" Codes revised and published every 3 years

- Updated with constantly evolving
  - Construction technology
  - Methods
  - Materials
  - Equipment
  - Processes



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ICC Code Development

Revised through open "Governmental Consensus Process" which provides for:

- Openness
- Transparency
- Balance of Interests
- Due Process
- Appeals Process
- Consensus



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ICC Code Development



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ICC Code Development



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ICC Code Development



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ICC Code Development



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ICC Code Development

- New code published every three years
- 12-month cycle
- Codes divided into 2 groups
  A. IBC, IPC, IMC, IFGC, IPSDC
  B. IRC, IFC, IEBC, IECC, IPMC, ISPSC, IWUIC, IZC, ICCPC, Admin.



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cdpACCESS

- Cloud-based system for code development process (cdp)
- Developed to increase participation
- On code change proposals & public comments users can
  - Create
  - Collaborate
  - Review
  - Submit
  - Vote (if eligible)



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Code Adoption

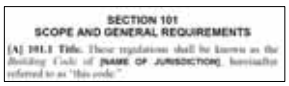
- IBC is a "model" code
  - Can be adopted by governmental agency and become law
  - Adopted by federal, state and local government agencies
  - Adopted through legislation or delegate to a board or state agency
  - Adopting legislation or ordinance is required to go through a public hearing process
  - Many jurisdictions develop amendments to model codes



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Code Adoption

- Sample adoption ordinance included in all I-codes
- Jurisdiction must adopt a specific code edition
- Any appendix must specifically be adopted
- Code official is responsible for assuring substantial compliance with the adopted code and any state laws dealing with construction issues



SECTION 101
SCOPE AND GENERAL REQUIREMENTS

[A] 101.1 Title. These regulations shall be known as the *Building Code* of [NAME OF JURISDICTION], hereinafter referred to as "this code."

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Code Adoption

U.S. Constitution creates
- States that have constitutions that create
  - Legislatures that pass laws signed by governors that create
    - Local governments that pass ordinances

10th Amendment to U.S. Constitution
- States granted authority to adopt laws to protect health, safety, morals and general welfare of its citizens
- Known as *"Police Powers"*



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International Building Code

Applies to every building, structure or appurtenance

- Construction
- Alteration
- Movement
- Enlargement
- Replacement
- Repair
- Equipment
- Use and Occupancy
- Location
- Maintenance
- Removal
- Demolition



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International Building Code

Minimum requirements for safety, health and general welfare

- Structural strength
- Means of egress facilities
- Stability
- Sanitation
- Light and ventilation
- Energy conservation
- Safety to life and property
  - Fire
  - Explosion
  - Other hazards



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International Building Code

Minimum requirements for safety, health and general welfare

- Applies to design, installation, maintenance, alteration and inspection of permanent mechanical systems installed within buildings
- Covers
  - Heating
  - Ventilation
  - A/C systems





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International Fuel Gas Code

Minimum requirements for safety, health and general welfare

- Regulates design, installation, maintenance, alteration and inspection of appliances that utilize natural gas and liquefied petroleum gas (LPG), gaseous hydrogen systems, and related accessories





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International Plumbing Code

Minimum requirements for safety, health and general welfare

- Provides regulations for design, installation, alteration and maintenance of plumbing systems
- Governs materials, sizing and installation of potable water supply and distribution plumbing fixtures, drain-waste-vent piping (DWV) and storm drainage systems





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International Energy Conservation Code

Regulates energy use in buildings

- Provides requirements for insulation R-values and door and window insulation requirements, as well as air infiltration limitations
- Applies to all buildings that are either heated or cooled



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International Fire Code

- Provides a reasonable level of life safety and property protection from hazards of fire, explosion or dangerous conditions in new and existing buildings and structures
- Provides regulations for safety of fire fighters and emergency responders during emergency operations



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International Property Maintenance Code

- Provides for maintenance of existing buildings and properties
- Provides minimum requirements for premises, structures, equipment, and facilities
- Addresses lighting, ventilation, space, heating, sanitation, life safety, and safety from fire and other hazards and for safe and sanitary maintenance



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International Residential Code

- Regulates construction of 1- and 2-family dwellings and townhouse structures
- Designed to be completely stand-alone code for residential construction
- Combines all regulations for building, energy, mechanical, fuel gas, plumbing and electrical into one document





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International Swimming Pool & Spa Code

- Comprehensive swimming pool code
- Developed with the Association of Pool & Spa Professionals (APSP)
- Coordinated with requirements in
  - International Codes
  - APSP standards
- Establishes minimum regulations for public and residential pools, spas, and hot tubs



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International Swimming Pool & Spa Code

- Intended to safeguard the environment, public health, safety and general welfare
- Establishes requirements to reduce negative potential impacts on the natural environment
- Works to conserve natural resources, materials and energy



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International Existing Building Code

- Covers alteration, addition, repair, relocation or change of use of an existing building
- 3 methods that an owner can choose to show compliance with the codes
- Address work done and how codes are applied to historic buildings without affecting historical significance and character



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Existing Buildings

- Existing buildings are permitted to continue without change if maintained in accordance with the code under which constructed



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Existing Buildings

- IBC requires work to existing buildings comply with IEBC





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Existing Buildings

- IEBC provides 3 compliance methods for owners
  1. Prescriptive
  2. Work area
  3. Performance
- Each addresses repairs, alterations, additions and change of occupancy



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Prescriptive vs. Performance

- *Prescriptive* Compliance
  - New work must comply with current code
  - Building official can
    - Require dangerous conditions corrected
    - Approve without current code compliance if new use is less hazardous than existing use
- *Performance* Compliance
  - Scoring system that evaluates
    - Fire safety
    - Means of egress
    - General Safety
  - Negative score in one category means non-compliance and additional upgrades needed



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Work Area Compliance

- Similar to prescriptive method
- Work area is that for which a building permit is obtained
- Maintain prior level of compliance
  - Fire protection systems
  - Means of egress
  - Accessibility



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Using the IBC



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Codes and Standards

- **"Codes"** are adopted by the legal authority in a jurisdiction
  - Establish minimum performance requirements to achieve life safety and property protection
  - Are written in "mandatory" language indicating *what* must be done
- **"Standards"** are referenced in the codes and indicate *how* to achieve what must be done



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Authority

- Local jurisdiction creates Department of Building Safety
- Building official appointed to
  - Manage the department
  - Review plans
  - Issue permits
  - Inspect work for compliance with codes and plans
  - Issue Certificates of Occupancy
  - Interpret code requirements



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Alternative Materials & Methods

- Designers can submit a request to meet code requirements with AM&M
- Building official reviews to determine compliance with purpose and intent of code
- Alternative must be at least equivalent in quality, strength, effectiveness, fire resistance, durability and safety
- ICC Evaluation Service (ICC-ES) reviews and provides reports



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Permits

Required for:

- New construction
- Remodeling
- Building an addition
- Change of occupancy



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Permits

- Exempt projects
  - Storage sheds less than 120 square feet
  - Fences not over 7 feet in height
  - Retaining walls not over 4 feet in height
  - Painting and wallpaper installation
  - Playground equipment accessory to 1- and 2-family dwellings
  - Other minor construction
- Permit exemption does not allow for nonconformance with code



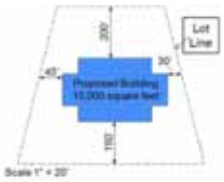
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Submittal Documents

Drawings
- Site plan
- Floor plans
- Elevations
- Details

Specifications
- Manufacturer installation instructions
- Minimum 2 sets submitted



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Plan Review

- Building department reviews plans for code compliance and other applicable jurisdiction laws
- If plans are compliant, a permit can be issued
- If plans have discrepancies, a plan review report is provided to the applicant
- Applicant makes corrections and resubmits plans for review
- Permit is issued when plans are approved



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Inspections

- Confirm compliance with plans and code
- Holder of permit requests inspection
- Work cannot be covered until inspection complete



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INSPECTIONS

Footing & Foundation

- Inspectors check forms and reinforcing steel to ensure correct size and proper location
- Concrete – inspection after forms are constructed and reinforcing steel installed
- Masonry – inspection for correct masonry, mortar, grout and reinforcing steel



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INSPECTIONS

Concrete Slab and Under-floor

Concrete slabs can contain

- Reinforcing steel
- Conduits
- Piping
- Other equipment

Inspection typically after

- Plumbing inspector checks plumbing installation
- Electrical inspector checks underground electrical equipment



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INSPECTIONS

Lowest Floor Elevation

- Where flooding is possible, buildings are to be elevated above 100-yr flood level
- Confirm lowest occupied floor elevated at or above design flood elevation



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INSPECTIONS

Frame

- Structure of the building inspected
- Confirm correct size and installation of building's structural members
- Frame inspection AFTER all plumbing, mechanical and electrical systems
  - Installed
  - Inspected
  - Approved





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INSPECTIONS

Connection Fire Protection

- Types IV-A, IV-B, IV-C
- Connection fire-resistance ratings by wood cover
- Inspect wood cover before other finishes installed





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INSPECTIONS

Lath and Gypsum

- Many buildings use gypsum board to provide fire protection or shear resistance
- Inspector confirms that materials are installed to provide
  - Level of specified fire protection
  - Shear resistance designed



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INSPECTIONS

Weather-exposed Balcony Waterproofing

- Inspection of moisture barrier required prior to membrane being concealed
- Balconies or other elevated walking surfaces exposed to water from direct blowing rain, snow or irrigation systems



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INSPECTIONS

Fire- and Smoke-resistant Penetrations

Penetrations (holes) in fire-rated components

- Protected with a material that fills them when piping or wiring melts out in a fire

Confirm installation per manufacturer's instructions



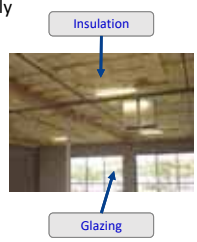
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INSPECTIONS

Energy Efficiency

Energy efficiency materials installed correctly

- Insulation values
- Sealing
- Equipment installation



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INSPECTIONS

Special Inspections

Certain portions of buildings may require 3rd party special inspections:

- Expertise in particular materials and designs
- Hired by building owner
- Report findings to building department

Third-party inspections required on materials such as:

- Structural concrete
- Structural steel
- Masonry
- Tall mass timber
- Helical piers
- Fire-resistant penetrations/joints



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INSPECTIONS

Final

- Confirm all work covered by permit is completed according to plans and applicable code
- When final inspection approved
  - Owner receives Certificate of Occupancy
  - Allows building use



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Board of Appeals

- Building official is responsible for code interpretation
- Designer or contractor may disagree with interpretation
  - Can request a hearing with board of appeals
- Board of appeals
  - Evaluates information against code intent
  - Renders a decision regarding code interpretation



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Definitions

- IBC includes definitions for specific terms
- Undefined terms
  - Other I-Code definitions apply
  - Normal use of a term as it applies to the code
- Defined terms are *italicized* in code text



SECTION 202
DEFINITIONS

[BC] 24-HOUR BASIS. The actual time that a person is an occupant within a facility for the purpose of receiving care. It shall not include a facility that is open for 24 hours and is capable of providing care to someone visiting the facility during any segment of the 24 hours.

[BS] AAC MASONRY. Masonry made of autoclaved aerated concrete (AAC) units, manufactured without internal reinforcement and bonded together using thin- or thick-bed mortar.

[BE] ACCESSIBLE. A site, building, facility or portion thereof that complies with Chapter 11.

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Poll Question

QUESTION & ANSWER

1. A building design can never stray from requirements found in the building code.
   A. True
   B. False



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Poll Question

QUESTION & ANSWER

2. Who is responsible to arrange for inspections of completed work?
   a. Registered design professional
   b. General contractor
   c. Owner
   d. Building permit holder



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QUESTION & ANSWER

Poll Question

3. How long must work remain open for inspection after it is requested?
   a. One week
   b. Two weeks
   c. One month
   d. Until work is inspected



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Discussion



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Building Planning



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Basic Occupancies

- 10 occupancy classifications
- Subdivisions lead to 26 classifications
- Based on use and function
- Most important part of plan review process



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Occupancy Classification

- Where a space is to be occupied for different purposes at different times, all requirements applicable to each use is considered
- Buildings with two or more distinct occupancy classifications must comply with **Section 508** for **mixed-occupancy buildings**



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OCCUPANCY CLASSIFICATIONS

Group A (assembly) – civic, social or religious

A-1	…usually fixed seating, intended for production and viewing of performing arts or motion pictures
A-2	…food and/or drink consumption
A-3	…worship, recreation, or amusement and other uses not classified elsewhere in Group A
A-4	…indoor sporting events and activities with spectator seating
A-5	…participation in or viewing outdoor activities



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OCCUPANCY CLASSIFICATIONS

Group B (business)

B	…office, professional, or service-type transactions, including storage of records and accounts



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OCCUPANCY CLASSIFICATIONS

Group E (educational)

E	…6+ persons at any one time for educational purposes through 12th grade and child-care facilities
Day Care	…5+ children older than 2½ who receive educational, supervision or personal care services < 24 hrs/day



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OCCUPANCY CLASSIFICATIONS

Group F (factory)

Group F (factory) – assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing not classified H (hazard) or S (storage)

F-1	…industrial uses not classified as F-2 Low Hazard
F-2	…industrial uses involving fabrication or manufacturing of noncombustible materials which during finishing, packing, or processing do not involve a significant fire hazard



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OCCUPANCY CLASSIFICATIONS

Group H (high hazard)

Group H (high hazard) – manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in control areas

H-1	…materials that pose a detonation hazard
H-2	…materials that pose a deflagration hazard or a hazard from accelerated burning
H-3	…materials that readily support combustion or that pose a physical hazard
H-4	…materials that are health hazards
H-5	Semiconductor fabrication facilities and comparable research and development areas in which hazardous production materials (HPM) are used



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OCCUPANCY CLASSIFICATIONS

Group I (institutional)

- Group I (institutional) – care/supervision for persons who
  - May not be capable of self-preservation without physical assistance
  - Are detained for penal/correctional purposes or liberty is restricted

I-1	…16+ persons, excluding staff, who reside on a 24-hr basis in a supervised environment and receive custodial care
I-2	…medical care on a 24-hr basis for 5+ persons who are incapable of self-preservation
I-3	…5+ persons who are under restraint or security…generally incapable of self-preservation due to security measures not under occupants' control
I-4	…persons of any age who receive custodial care for less than 24 hrs by individuals other than…relatives…in a place other than the home of the person cared for



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OCCUPANCY CLASSIFICATIONS

Group M (mercantile)

M	…display and sale of merchandise which involves stocks of goods, wares or merchandise incidental to such purposes and publicly accessible



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OCCUPANCY CLASSIFICATIONS

Occupancy Classifications

Group R (residential) – for sleeping purposes when NOT
- Classified as Institutional Group I
- Regulated by IRC

R-1	…sleeping units with primarily transient occupants
R-2	…sleeping units or 2+ dwelling units with primarily permanent occupants
R-3	…primarily permanent occupants not classified as Group R-1, R-2, R-4, or I
R-4	…5 to 16 persons, excluding staff, who reside on a 24-hr basis in a supervised residential environment and receive custodial care



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OCCUPANCY CLASSIFICATIONS

Group S (storage) – not classified as hazardous

S-1	…uses that are not classified as Group S-2
S-2	…noncombustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles, or film wrapping.



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OCCUPANCY CLASSIFICATIONS

Occupancy Classifications

Group U (utility)

U	…accessory and miscellaneous structures not classified in any specific occupancy shall conform to IBC commensurate with fire and life hazard incidental to their occupancy



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Types of Construction

Buildings' fire resistance based on

- Key building elements
  - Combustible or noncombustible
  - Protected by recognized level of fire resistance
- Permitted building size directly related to construction type



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Types of Construction (Continued)

- Buildings must be classified as single construction type
- Based on full compliance with minimum requirements for intended construction type
  - Unlike mixed-occupancy conditions where multiple uses occur



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Fire-Resistance Rating Requirements for Building Elements (hours)

Refer to Code Book

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Comparison of Construction Types

Type I-A—Fire-resistance-rated, noncombustible required			
Exterior Bearing Walls: 3 Hrs.	Structural Frame: 3 Hrs.	Floors: 2 Hrs.	Roofs: 1½ Hrs.
Type I-B—Fire-resistance-rated, noncombustible required			
Exterior Bearing Walls: 2 Hrs.	Structural Frame: 2 Hrs.	Floors: 2 Hrs.	Roofs: 1 Hr.
Type II-A—Fire-resistance-rated, noncombustible required			
Exterior Bearing Walls: 1 Hr.	Structural Frame: 1 Hr.	Floors: 1 Hr.	Roofs: 1 Hr.
Type II-B—Unrated, noncombustible required			
Noncombustible materials, but no fire-resistance required			
Type III-A—Fire-resistance-rated, combustible permitted, with fire-resistance-rated, noncombustible or FRTW exterior walls			
Exterior Bearing Walls: 2 Hrs.	Structural Frame: 1 Hr.	Floors: 1 Hr.	Roofs: 1 Hr.
Type III-B—Unrated, combustible permitted, with fire-resistance-rated, noncombustible or FRTW exterior walls			
Exterior Bearing Walls: 2 Hrs.	Structural Frame: None	Floors: None	Roofs: None

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Comparison of Construction Types (Continued)

Type IV-A—Fire-resistance-rated, protected mass timber			
Exterior Bearing Walls: 3 Hrs.	Structural Frame: 3 Hrs.	Floors: 2 Hrs.	Roofs: 1½ Hrs.
Type IV-B—Fire-resistance-rated, protected mass timber with limited unprotected elements			
Exterior Bearing Walls: 2 Hrs.	Structural Frame: 2 Hrs.	Floors: 2 Hrs.	Roofs: 1 Hr.
Type IV-C—Fire-resistance-rated, exposed mass timber with limited protected elements			
Exterior Bearing Walls: 2 Hrs.	Structural Frame: 2 Hrs.	Floors: 2 Hrs.	Roofs: 1 Hr.
Type IV-HT—Heavy Timber			
Exterior Bearing Walls: 2 Hrs.	Structural Frame: Heavy Timber or 1 Hr.	Floors: Heavy Timber	Roofs: Heavy Timber
Type V-A—Fire-resistance-rated, combustible permitted			
Exterior Bearing Walls: 1 Hr.	Structural Frame: 1 Hr.	Floors: 1 Hr.	Roofs: 1 Hr.
Type V-B—Unrated, combustible permitted			
Combustible materials permitted, but no fire-resistance required			

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Automatic Fire Sprinkler Systems

- NFPA 13
  - Sprinklers required in all rooms of a building
  - Also provided in concealed spaces
- NFPA 13R
  - Limited to residential uses ≤4 stories and ≤60 feet
  - Sprinklers can be omitted from concealed combustible spaces and small closets and restrooms
- NFPA 13D
  - Limited to 1- and 2-family dwellings



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Allowable Height (feet)

OCCUPANCY CLASSIFICATION	See Footnotes	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A, B, E, F, M, S, U	NS	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	86	75	270	180	85	85	70	60
R	NS	UL	160	65	55	65	55	65	65	65	65	50	40
	S13D	60	60	60	60	60	60	60	60	60	60	50	40
	S13R	60	60	60	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	270	180	85	85	70	60

[Ref. Table 504.3]

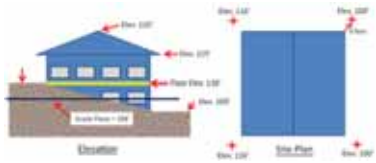
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Building Height

Determine Average Grade Plane
100 + 100 + 116 + 116 = 432
432 ÷ 4 = **108'**

Determine Average Roof Height
125 + 135 = 260
260 ÷ 2 = 130

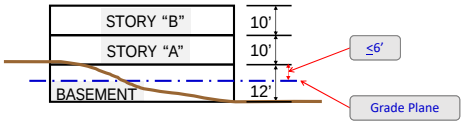
Determine Building Height
130 - 108 = **22'**



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Stories Above Grade Plane

- Determine Grade Plane
- Determine if bottom story is basement



The bottom story is a basement because the floor of Story "A" is ≤6' above grade plane

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Allowable Number of Stories

OCCUPANCY CLASSIFICATION	See Footnotes	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV			Type V		
		A	B	A	B	A	B	A	B	C	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	10	12	6	4	3	2
B	NS	UL	11	5	3	5	3	5	5	5	5	3	2
	S	UL	12	6	4	6	4	10	12	9	6	4	3
M	NS	UL	11	4	2	4	2	4	4	4	4	2	1
	S	UL	12	5	3	5	3	12	8	6	5	4	2
R-2	NS	UL	11	4	4	4	4	4	4	4	4	3	2
	S13R	4	4									4	3
	S	UL	12	5	3	5	3	10	12	8	5	4	3

(Ref. Table 504.4)

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Height and Area Limitations

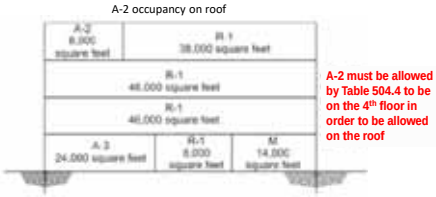
- Occupied roof occupancy based on Table 504.4 for story immediately below
- Roof area not added to building area regulated by §506



95

Height and Area Limitations

A-2 occupancy on roof



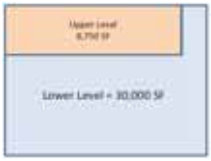
A-2 must be allowed by Table 504.4 to be on the 4th floor in order to be allowed on the roof

96

Mezzanines

Do not count as a story when evaluating building area or number of stories

- ≤ 1/3 floor area below
- ≤ 2/3 area for special industrial Type I or II
- ≤ 1/2 area in Type I and II
  - Sprinklered
  - EV/AC system



If area below upper level is not enclosed 8,750/30,000 = 0.29 upper level considered mezzanine

If area below upper level is enclosed 8,750/21,250 = 0.41 upper level considered second story

97

Allowable Building Area Factor (SF)



98

Allowable Area Determination

$A_a = A_t + (NS \times I_f)$ (Eq 5-1)

where:

A_a = Allowable building area per story (ft²)
A_t = Allowable area factor per Table 506.2
NS = Allowable area factor per Table 506.2 for nonsprinklered building
I_f = Area increase factor due to frontage per §506.3

Refer to Code Book

99

Area Increase for Frontage (I_f)

- ≥25% of perimeter on public way or open space

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (ft)			
	0 to less than 10	10 to less than 15	15 to less than 20	20 or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

[Ref. Table 506.3.3]

100

Area Increase for Frontage (I_f)

Interpolation permitted

- Lowest value in "Open Space" range
- Highest value in "% Building Perimeter" range

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (ft)			
	0 to less than 10	10 to less than 15	15 to less than 20	20 or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

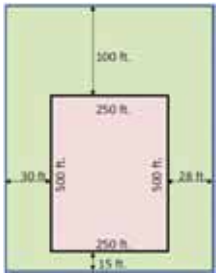
[Ref. Table 506.3.3]

OR use $I_f = [F/P - 0.25] W/30$
based on 2018 IBC Eq. 5-5

101

Minimum Frontage Distance (*W*)

- Right angle to building
- *W* ≥ 20 feet
  - Closest lot line
  - Width of public way
  - Exterior of adjacent building



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FOR EXAMPLE

Area Increase for Frontage

Building perimeter = 1500'

- *W* ≥ 20 feet
  - 500
  - 500
  - 250
  - } = 1250'
- W < 20 feet
  - 250

1250/1500 = **83%**



103

FOR EXAMPLE

Area Increase for Frontage (I_f)

- 83% of building perimeter with ≥30' open space

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (ft)			
	0 to less than 10	10 to less than 15	15 to less than 20	20 or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

[Ref. Table 506.3.3]

$I_f = 0.75$

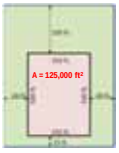
104

FOR EXAMPLE

Allowable Area for Frontage

Given

- Type IIA Business occupancy
- With sprinklers
- Single story with single occupancy
  - A_t = S1 = 150,000



$A_a = A_t + (NS \times I_f)$

$A_a = 150,000 + (37,500 \times 0.75)$

$A_a = 150,000 + 28,125$

$A_a = 178,125 > 125,000$ OK

OCCUPANCY CLASSIFICATION	See foot notes	Type I		Type II	
		A	B	A	B
A-B	NS	UL	UL	112500	75000
	S1	UL	UL	150000	100000
	SM	UL	UL	168750	112500
E	NS	UL	UL	67500	45000
	S1	UL	UL	150000	100000
	SM	UL	UL	172500	115000

105

Single Occupancy – Multi-story

$A_a = [A_t + (NS \times I_f)] \times S_a$ (Eq 5-2)

where terms defined earlier except:

S_a = Actual number of stories above grade plane ≤ 3

For buildings with NFPA 13R sprinkler system, $S_a \leq 4$

Refer to Code Book

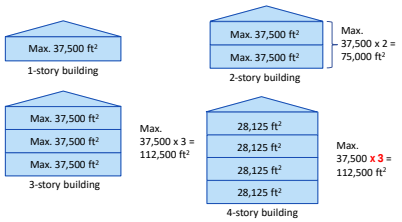
106

FOR EXAMPLE

Floor Area in Multi-story Building

Type IIA Group B Office – Nonsprinklered

Table 506.2: NS = 37,500 ft²



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Interior Dimensions

- Habitable rooms
  - Room width ≥ 7'
    - Exception for kitchens with ≥ 3' clear passageway
  - Ceiling height ≥ 7'-6"
  - Barrier required to protect occupants from objects protruding into clear height
- Egress path
  - Ceiling height ≥ 7'-6"
  - Door height ≥ 80"
  - Door width ≥ 32"



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Mixed-use and Occupancy

TABLE 508.4 Required Separation of Occupancies (Hours)

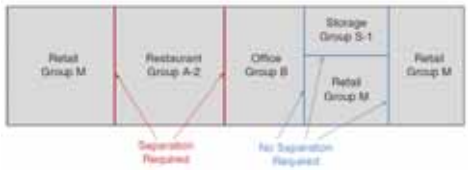
Occupancy	A, E	I-1, I-3, I-4	I-2	R	F-2, S-2, U	R, F-1, M, S-1	H-1	H-2	H-3, H-4	H-5
	S NS	S NS	S NS	S NS	S NS	S NS	S NS	S NS	S NS	S NS
A, E	N N	1 2	2 NP	1 2	N 1	1 2	NP NP	1 4	2 4	1 NP
I-1, I-3, I-4	1 2	N N	2 NP	1 NP	1 2	1 2	NP NP	1 NP	2 NP	1 NP
I-2	2 NP	2 NP	N N	2 NP	2 NP	2 NP	NP NP	1 NP	2 NP	2 NP
R	1 2	1 NP	2 NP	N N	1 2	1 2	NP NP	1 NP	2 NP	1 NP
F-2, S-2, U	N 1	1 2	2 NP	1 2	N N	1 2	NP NP	1 4	2 3	1 NP
R, F-1, M, S-1	1 2	1 2	2 NP	1 2	1 2	N N	NP NP	1 3	1 2	1 NP
H-1	NP NP	NP NP	NP NP	NP NP	NP NP	NP NP	N NP	NP NP	NP NP	NP NP
H-2	1 4	1 NP	1 NP	1 4	1 2	1 2	NP NP	N NP	1 NP	1 NP
H-3, H-4	1 3	1 NP	2 NP	1 3	1 2	1 2	NP NP	1 NP	1 NP	1 NP
H-5	1 NP	1 NP	2 NP	1 3	1 2	1 2	NP NP	1 NP	1 NP	N NP

Footnotes and clauses

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Mixed Use – Separated Occupancies

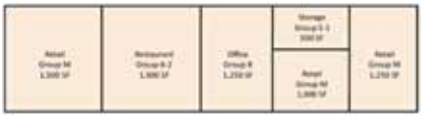
- Designer's option
- Separation based on Table 508.4
- Ratio calculation to determine allowable area



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Mixed Use – Separated Occupancies

FOR EXAMPLE



Given:
Mixed occupancy building shown
One Story
Type VB Construction
No Fire Sprinklers
No Frontage Increase
Allowable Areas
Group A-2 = 6,000 SF
Group B = 9,000 SF
Group M = 9,000 SF
Group S-1 = 9,000 SF

Evaluate Allowable Area:
Ratio Calculations

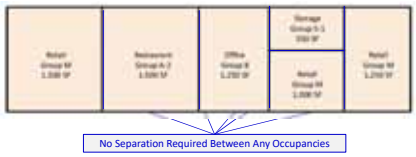
Group A-2	1,500/6,000 = 0.25
Group B	1,250/9,000 = 0.14
Group M	3,750/9,000 = 0.42
Group S-1	500/9,000 = 0.06
	Total Ratio = 0.87 < 1.0 OK

111

Mixed Use – Nonseparated Occupancies

Most restrictive requirement of each occupancy applied to entire building

- Height
- Area
- Chapter 9 requirements



112

Mixed Use – Accessory Occupancies

- **Subsidiary** occupancy to main use of building
- **Aggregate area** accessory occupancy ≤10% of floor area/story
- Not exceed **nonsprinklered tabular area** for accessory occupancy
- **Allowable height & stories** cannot exceed Table 504
- Accessory occupancy **individually classified**



113

Live/Work Units

- Classified as R-2
- Floor area ≤ 3,000 square feet
- Non-residential portion ≤ 50 percent of floor area
- Commercial portion on 1st floor
- ≤ 5 workers or employees



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Mixed Use – Incidental Uses

- Ancillary functions
- Higher hazards
- Protection per Table 509.1
  - Fire-rated construction, or
  - Fire sprinklers
    - Room constructed to resist smoke passage



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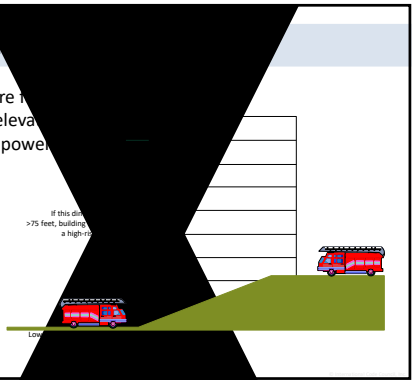
Mixed Use – Incidental Uses

Room or Area	Separation (hours) and/or Sprinkler Protection (S)
Furnace >400,000 Btu/hour input	1 or S
Boilers >15 psi and 10 HP	1 or S
Refrigerant machinery room	1 or S
Incinerator rooms	2 and S
Paint shops	2 or (1 and S)
Group E laboratories and vocational shops	1 or S
Group I-2 laboratories	1 or S
Group I-2 laundry rooms over 100 SF	1
Group I-3 cells and Group I-2 patient rooms with padded surfaces	1
Group I-2 physical plant maintenance shops	1

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High-rise Bui

- Smokeproof enclosure
- Smoke detection in eleva
- Standby/emergency powe
- Fire alarm
- Sprinklers
- Standpipes



117

High-rise Buildings

- Additional stairway required in high-rise > 420’
  - Other than Group R-2
- Fire service access elevator when floor level >120’ above LLFDVA
- Smoke removal
  - Operable windows, OR
  - Mechanical system
- Egress path marking



118

Atriums

- Fire sprinklers required throughout building
- Smoke-control system to provide safe path of egress
- Areas adjacent to atrium protected with minimum 1-hr fire-resistance-rated walls



119

Garages

- Private garages
- Parking garages
  - Enclosed
    - Mechanical ventilation
    - Fire sprinklers required
  - Open
    - Natural ventilation
    - Type I, II or IV construction



Image courtesy of SRG Partnership

Group U
≤1,000 ft²
Serving residential units

Group S-2
Serving public or private parking use

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Repair Garages

- Definition
  - A building, structure, or portion thereof used for servicing or repairing motor vehicles
- Solvents
- Vehicle fluids
- Vehicle fuel

  Must stay below exempt amounts or classified Group H
  - Gasoline, diesel
  - Liquified natural gas
  - Hydrogen, electric
- Mechanical ventilation



121

Hazardous Materials

- Maximum Allowable Quantity (MAQ) per Control Area of Hazardous Materials Posing a Physical Hazard

Material	Class	Storage		
		Cubic feet	Liquid gallons (pounds)	Gas (cubic feet @ NTP)
Combustible liquid	II IIIA IIIB	N/A	120 330 13,200	N/A
Combustible fiber	Loose Baled	100 1,000	N/A	N/A
Flammable gas	Gaseous Liquefied	N/A	N/A (150)	1,000 N/A

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Hazardous Materials – Footnotes

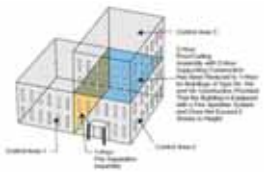
- b – Aggregate quantity shall not exceed storage
- d – Increase 100% for automatic sprinkler system
- e – Increase 100% if stored in approved storage cabinets, day boxes, gas cabinets, gas rooms or exhausted
- f – Not limited in automatic sprinkler buildings
- g – Allowed only in buildings equipped throughout with an automatic sprinkler system

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Hazardous Materials – Control Areas

- Control Areas are NOT considered an H occupancy
- Up to MAQ in each control area
- Number of control areas limited



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Hazardous Materials – Control Areas

STORY		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA[a]	NUMBER OF CONTROL AREAS PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS[b]
Above grade plane	Higher than 9	5	1	2
	7–9	5	2	2
	6	10.5	2	2
	5	10.5	2	2
	4	10.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
Below grade plane	1	75	3	1
	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

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Hazardous Materials

FOR EXAMPLE

- Given: One-story building used for storage of acetic acid, (Class II combustible liquid)
- Sprinklered building with one exhausted control area
- Determine MAQ

		Storage	
Material	Class	Cubic feet	Liquid gallons (pounds)
Combustible liquid	II IIIA IIIB	N/A	120 330 13,200

Tabular MAQ = 120
Footnote d = 100% increase
120 x 2 = 240 gallons/control area
Footnote e = 100% increase
240 x 2 = 480 gallons/control area

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Healthcare Occupancies

Classified as Group I occupancies

- Code official needs to know
  - Amount of time people are receiving care
  - Level of care people are receiving
  - Are people capable of responding to emergency situations on their own



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Healthcare Occupancies

- Group I-1: >16 persons living 24/7
  - Assisted living facilities, halfway houses, alcohol and drug centers, group homes and congregate care facilities



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Healthcare Occupancies

- Group I-2: medical care 24/7 for >5 people
  - Condition 1 – nursing and medical care
  - Condition 2 – emergency care, surgery, obstetrics or in-patient stabilization units for psychiatric or detoxification



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Ambulatory Health Care Facilities

- Medical, surgical, psychiatric, nursing or similar care <24-hour basis
- ≥4 individuals not capable of self-preservation
- Classified as Group B
- Fire sprinklers required
- Smoke compartments
  - When one story >10,000 ft²



130

Storm Shelters

- ICC 500 standard
  - Tornado and hurricane
- Dedicated – Group A-3
- Emergency shelters
  - Table 1604.5
  - Risk Category IV structures



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Storm Shelters



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QUESTION & ANSWER

Poll Question

4. Which of the following is classified as a Group I-2 occupancy?
   a. High School
   b. Hospital
   c. Office in a high-rise
   d. Warehouse storing plastic cups



133

QUESTION & ANSWER

Poll Question

5. In Type IIA construction what is the minimum fire-resistance rating for interior walls?
   a. 0 hours
   b. 1 hour
   c. 2 hours
   d. 3 hours



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QUESTION & ANSWER

Poll Question

6. The maximum height of a building is controlled by type of construction type, occupancy classification, and the installation of fire sprinklers.
   a. True
   b. False



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QUESTION & ANSWER

Poll Question

7. What is the allowable area for a non-sprinklered Type IIIB Group M occupancy without any frontage increase?
   a. 12,500
   b. 18,500
   c. 37,500
   d. 50,000



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QUESTION & ANSWER

Poll Question

8. A building with multiple occupancies can be designed using which of the following methods?
   a. Accessory occupancies
   b. Non-separated mixed-use occupancies
   c. Separated mixed use occupancies
   d. A combination of all of the above



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QUESTION & ANSWER

Poll Question

9. Hazardous materials are only allowed in Group H occupancies?
   a. True
   b. False



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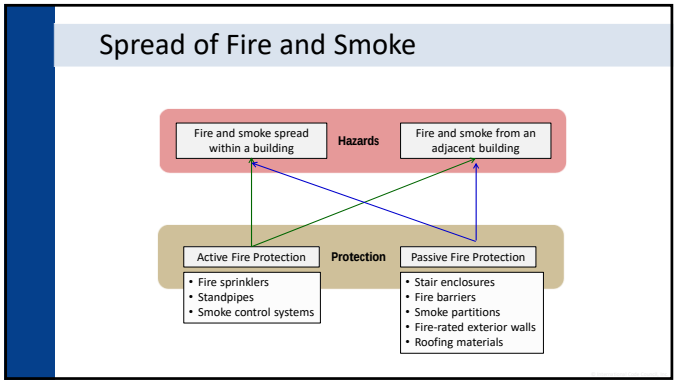
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Discussion

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Fire Safety

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Spread of Fire and Smoke
Fire and smoke spread within a building
Hazards
Fire and smoke from an adjacent building
Active Fire Protection
Protection
Passive Fire Protection
• Fire sprinklers
• Standpipes
• Smoke control systems
• Stair enclosures
• Fire barriers
• Smoke partitions
• Fire-rated exterior walls
• Roofing materials

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Determining Fire Resistance

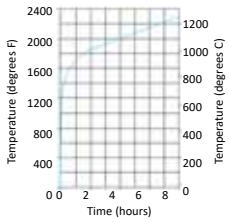
- Fire testing of assemblies and materials
- Prescriptive details
- Calculation based on specific materials



142

Fire Testing

- Relative comparison between different construction methods and materials
- Standard Time-Temperature Curve
  - UL 263
  - ASTM E119



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Prescriptive Details



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Calculated Fire Resistance – Mass Timber

Table 722.7.1(1). Protection Required from Noncombustible Covering Material

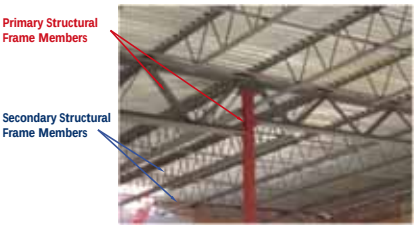
Required Fire-Resistance Rating of Building Element per Tables 601 and 705.5 (hours)	Minimum Protection Required from Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

Table 722.7.1(2). Protection Provided by Noncombustible Covering Material

Noncombustible Protection	Protection Contribution (minutes)
5/8-inch Type X gypsum board	25
5/8-inch Type X gypsum board	40

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Protection of the Structure



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Protection of Structural Frame

- Masonry and concrete walls encase rebar and provide protection
- When required to provide a fire-resistance rating, exposed steel must be protected

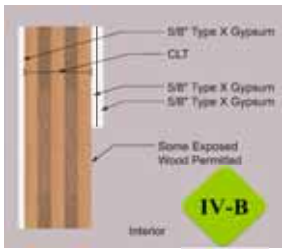


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Protection of Structural Frame

Mass Timber

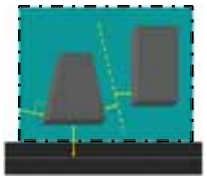
- Types IV-A, IV-B & IV-C
- $FRR_{Tot} = FRR_{MT} + FRR_{NC}$
- Exposed MT permitted in IV-B & IV-C



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Exterior Wall Protection

- Fire separation distance
  - Measured at right angles to walls
- Table 601 – based on construction type
- Table 705.5 – based on distance to property line



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Interior Fire-rated Walls

Fire Wall	Fire Barrier	Fire Partition
Building separation	Shafts & occupancy separation	Dwelling unit separation & corridors
Openings protected & limited	Openings protected & limited	Openings protected
Continuous from foundation through roof & exterior walls	Continuous from floor through concealed space at each level	Can terminate at fire-rated horizontal assembly
Structural stability		

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Fire Walls

- Structure on each side considered separate building for determining
  - Height and area
  - Construction type
- From foundation to ≥30" above roof (alternatives)
- Extends ≥18" beyond exterior walls (alternatives)
- Structural stability
  - Structure on either side can collapse but fire wall must remain for fire rating duration



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Fire Wall and Opening Ratings (hrs)

- Opening limits
  - Individual size ≤156 ft²
  - Aggregate width ≤25% of fire wall length

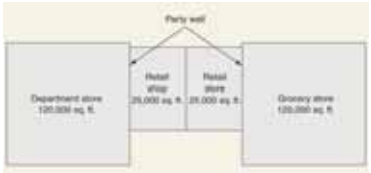
Group	Fire-resistance rating	Opening rating
A, B, E, H-4, I, R-1, R-2, U	3[a]	3
F-1, H-3[b], H-5, M, S-1	3	3[c]
H-1, H-2	4[a]	3
F-2, S-2, R-3, R-4	2	1½

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Party Walls

Required on lot lines dividing building ownership

- Constructed as fire wall

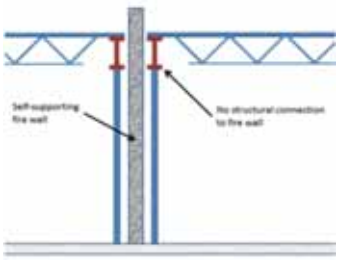


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FOR EXAMPLE

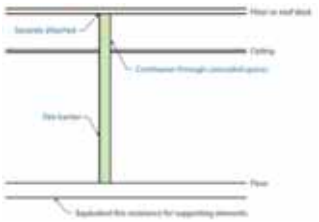
Fire Wall Example



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Fire Barriers

- Examples
  - Shaft enclosures
  - Separation of fire areas
  - Separated occupancy
  - Incidental use
  - Control areas
- Supporting construction and structure requires fire-resistance rating equal to or better than fire barrier



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Fire Barrier Opening Ratings (hrs)

FIRE BARRIER RATING	FIRE DOOR/SHUTTER RATING
4	3
3	3
2	1½
1	¾

[Ref. Table 716.1(2)]

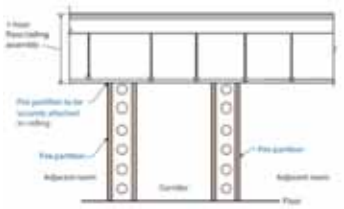
a. Openings in shafts, interior exit stairways and exit passageway walls are required to have a 1-hour fire rating.

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Fire Partitions

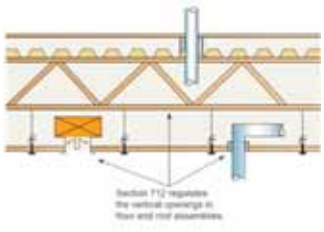
- Separate
  - Dwelling/sleeping units
  - Mall tenant spaces
  - Rated corridor walls
  - Elevator lobbies
  - Egress balconies



157

Horizontal Assemblies

- Floor/ceiling assembly
- Roof/ceiling assembly
- Uses
  - Dwelling separation
  - Exit enclosure
  - Fire area separation
  - Mixed-use separation
  - Control area enclosure
  - Smoke barrier enclosure



158

Vertical Openings

- Shaft enclosures
- Escalators
- Penetrations
- Joints
- Ducts
- Atriums
- Chimneys
- Mezzanines
- Skylights



159

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Shaft Enclosures

- Fire-resistance rating
  - 1-hr if connecting > 2 stories
  - 2-hr if connecting ≥ 4 stories
- Fire barrier construction
  - Continuity
- Openings and penetrations protected



160

Penetrations

- Pipes, tubing, conduit, and cables passing through fire assemblies
- Through penetrations
  - Entire assembly
- Membrane penetrations
  - One surface
- Listed penetration firestop system installed per manufacturers' instructions



161

Opening Protection

- Doors and windows installed in fire-resistance-rated assemblies require fire protection rating
- Fire door assemblies include door, frame and all associated hardware





162

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Interior Finish Requirements

- Flame spread is the propagation of flame over a surface

Group	Sprinklered			Nonsprinklered		
	Exit enclosures/ passageways	Corridors	Rooms & enclosed space	Exit enclosures/ passageways	Corridors	Rooms & enclosed space
A-1 & A-2	B	B	C	A	A	B
A-3, A-4, A-5	B	B	C	A	A	C
B, E, M, R-1	B	C	C	A	B	C
R-4	B	C	C	A	B	B
F	C	C	C	B	C	C
H	B	B	C	A	A	B
I-1	B	C	C	A	B	B
I-2 & I-4	B	B	B	A	A	B
I-3	A	A	C	A	A	B
R-3	C	C	C	C	C	C
R-2 & S	C	C	C	B	B	C
U	No restrictions			No restrictions		

163

Interior Finish Requirements

Class	Flamespread Index
A	0-25
B	26-75
C	76-200

MATERIAL	FLAME SPREAD
Red or White Oak	100
Douglas-fir	90
Western Red Cedar	69
Plywood paneling (untreated)	75 to 275
Plywood paneling (treated)	100
Gypsum board	10 to 55
Concrete or brick	0
Carpeting	10 to 600

164

Fireblocking

- Cuts off
  - Concealed openings
  - Openings between walls and floors or attics
  - Floor levels
  - Top floor and attic
- Required in wall spaces
  - Vertically at ceiling and floor
  - Horizontally at intervals ≤10'



165

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Draftstops

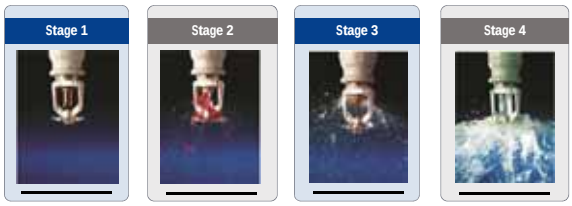
- Large concealed floor spaces and attics with combustible construction (≤1,000 ft²)
- Attics, mansards and concealed roof spaces subdivided into maximum 3,000 ft²
  - Fire sprinklers in these spaces eliminate requirement
- Group R exceptions



166

Automatic Fire Sprinklers

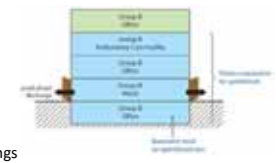
- React to heat
- Apply water directly to fire area
- Normally operate independently



167

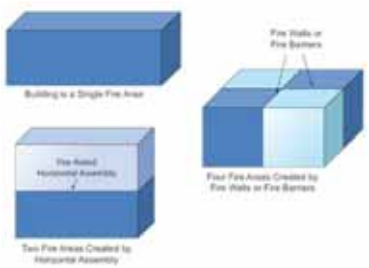
Automatic Fire Sprinklers

- Required based on
  - Occupancy classification
  - Use or materials handled
  - Number of occupants
  - Fire areas
  - Floor level in building
- Also required in
  - Buildings with no exterior wall openings
  - Rubbish/linen chutes



168

Fire Areas



169

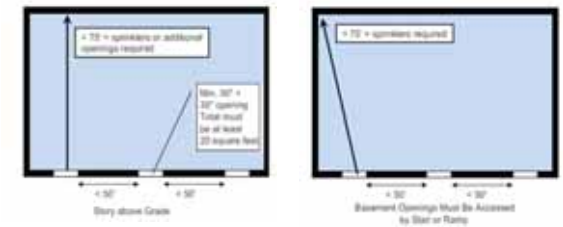
Fire Areas

- Created with ≥1-hr fire-resistance-rated construction
- Single occupancies separated into smaller fire areas eliminate sprinklers

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1
[Ref. Table 707.3.10]	

170

Automatic Fire Sprinklers – Stories without Openings



171

Automatic Fire Sprinkler Credits

- Credit and modifications allowed for added protection sprinkler systems provide
- Standards
  - NFPA 13
  - NFPA 13R
  - NFPA 13D



172

Standpipes

- Classes
  - Class I – 2½" connection for FD
  - Class II – 1½" connection with hose
  - Class III – combination of both I & II
- Types
  - Wet standpipe
  - Dry standpipe
- Must comply with NFPA 14



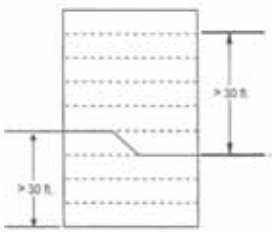


173

Standpipes

- In buildings with a floor level
  - >30 feet above LLFDVA
  - >30 feet below HLFDVA
- Covered malls
- Stages





174

Fire Alarm Systems

- Activation
  - Manual
  - Automatic
- Required based on
  - Occupancy classification
  - Occupant load
  - Floor level
  - Operations conducted
  - Materials handled
- Must comply with NFPA 72



175

Fire Alarm Systems

- Occupant notification
  - Audible
    - 15 dBA above ambient
    - 5 dBA above max 60 second sound level
    - Maximum 110 dBA
  - Visual
    - Public and common areas
  - Emergency voice/alarm communication system
    - Provide voice instructions



176

Smoke Alarms

- Per UL 217 & NFPA 72
- Multiple units interconnected so when one device senses smoke all devices sound-off
- Required in
  - R-1 – sleeping areas, egress path and each floor
  - R-2, R-3, R-4, I-1 – sleeping rooms, common area outside of sleeping rooms and each floor



177

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Smoke Control Systems

- Smoke barriers
  - Restrict passage of smoke
  - 1-hr fire-resistance rated
- Smoke-protected assembly seating
- Smoke control system
  - Mall or atrium with 3 levels
  - Underground buildings
  - Large arenas

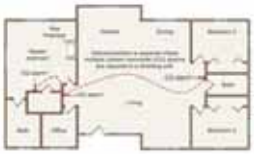


Cross-corridor doors with magnetic hold-open device released by smoke detectors or fire alarm

178

Carbon Monoxide Alarms

- Group E, I-1, I-2, I-4 and R occupancies with
  - Fuel-burning appliance
  - Attached garage
- Installed
  - Immediate vicinity of bedrooms
  - Every occupied level
    - Including basements
    - Excluding attics & crawl spaces



179

QUESTION & ANSWER

Poll Question

10. A 3-hr fire-resistance-rated fire wall is required to separate two Group M occupancies.
    a. True
    b. False



180

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QUESTION & ANSWER

Poll Question

11. A door in a 2-hr fire-resistance-rated fire barrier must have a minimum fire-resistance rating of _____ hours.
    a. ¾
    b. 1
    c. 1½
    d. 2



181

QUESTION & ANSWER

Poll Question

12. The flame spread index of interior finishes placed into the corridor of a sprinklered Group A-2 restaurant must be at least Class _____ .
    a. A
    b. B
    c. C
    d. No restriction



182

QUESTION & ANSWER

Poll Question

13. Fire area, rather than building area, is used to determine the size of occupancies when fire sprinklers are required.
    a. True
    b. False



183

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QUESTION & ANSWER

Poll Question

14. Fire sprinklers may be required based on which of the following criteria?
    a. Occupancy classification
    b. Use or materials handled
    c. Number of occupants
    d. Size of fire areas
    e. Floor level in the building
    f. Any of the above



184

QUESTION & ANSWER

Poll Question

15. A Group I-1 Assisted Living Facility with an attached garage must be equipped with both smoke alarms and carbon monoxide alarms?
    a. True
    b. False



185

Discussion



186

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Life Safety



187

Egress System Design

Areas without fixed seating

- Occupant load = Area/OLF
- Gross
- Entire floor area excluding vent shafts and courts
- Net
- Actual occupied area

Occupant Load Factor (OLF)

FUNCTION OF SPACE	FLOOR AREA IN SQ. FT. PER OCCUPANT
Assembly without fixed seats	
Concentrated (chairs only—not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Business areas	150 gross
Parking, commercial	200 gross
Storage	300 gross
Mercantile	60 gross
Storage, stock, shipping areas	300 gross
Assembly	100 gross
Washrooms	120 gross

188

Egress System Design

- Areas with fixed seating
  - Occupant load based on number of fixed seats
  - Benches
    - Pews = 18”/person
    - Dining = 24”/person

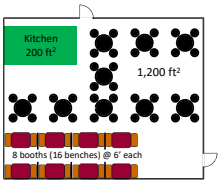


189

FOR EXAMPLE

Occupant Load Calculation

- Restaurant with 1,200 ft^2 of chairs and booths
- 8 booths (16 benches) – 6’ wide each
- 200 ft^2 kitchen
  - Kitchen 200/200 = 1
  - Dining Area 1,200/15 = 80
  - Booths 6'/24" = 3/bench = 48
  - Total 1 + 80 + 48 = 129



190

Exits from Spaces

- Each room or space is evaluated
- Exit access is 1st portion of egress system
- Minimum of 2 exits required
  - Limited occupancy allows one exit

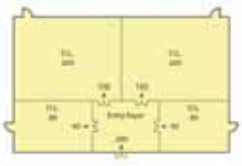
Spaces with One Exit or Exit Access Doorway

OCCUPANCY	MAXIMUM OCCUPANT LOAD
A, B, E, F, M, U	49
H-1, H-2, H-3	3
H-4, H-5, I, R-1	10
R-2, R-3, R-4	20
S	29

191

Number of Exits

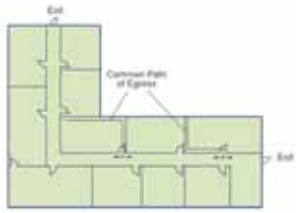
- Additional exits required if occupant load
  - 501-1,000 requires ≥3 exits
  - >1,000 requires ≥4 exits
- Also evaluated
  - Each floor
  - Entire building
  - Each use



192

Common Path of Egress Travel

Multiple exits based on travel distance



193

Common Path of Egress Travel

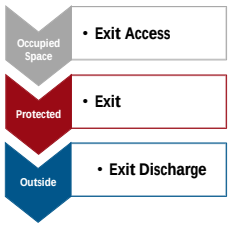
OCCUPANCY	WITHOUT SPRINKLER SYSTEM (FEET)		WITH SPRINKLER SYSTEM (FEET)
	Occupant load		
	OL ≤ 30	OL > 30	
A, E, M	75	75	75
B	100	75	100
I-1, I-2, I-4	NP	NP	75
R-2	NP	NP	125
S	100	75	100

[Ref. Table 1006.2.1]

OL = Occupant load; NP = Not permitted

194

Means of Egress (MOE) Systems



195

Exit

Occupants either
- Leave the building
- Enter protected egress path
  - Stair enclosure
  - Exit passageway
  - Horizontal exit



196

Exit Discharge

- From exit to public way
- At grade or direct access to grade
- Access public way without obstructions



197

Making it Wide Enough

- Egress doors/corridors/paths
  - Occupant Load x 0.2”
- Stairs
  - Occupant Load x 0.3”
- If one path lost total width >½
- Maintained to public way
- Reductions for
  - Sprinklers
  - EV/AC



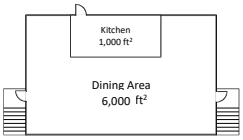
198

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FOR EXAMPLE

Exit Width Calculation

- 6,000 ft^2 dining area
- Determine Dining Occupant Load
  - 6,000 ft^2 ÷ 15 ft^2/occupant = 400 occupants
- Determine exit path width
  - 400 x 0.2"/occupant = 80"
  - Minimum 2 exits required
  - 3'-0" doors installed
  - 3 doors = 108"
- Determine stair width
  - 400 x 0.3"/occupant = 120"
  - 2 stairs ≥ 60" each

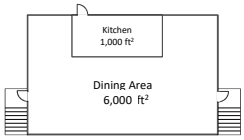


199

FOR EXAMPLE

Exit Width Calculation

- Add Sprinklers and EV/AC
  - Exit path width
    - 400 x 0.15"/occupant = 60"
    - Minimum 2 exits required
    - Clear door width ≥ 32"
    - 2 doors = 64"
  - Stair width
    - 400 x 0.2"/occupant = 80"
    - 2 stairs ≥ 44" width = 88"



200

Horizontal Travel

When >2 exits required
- Separated by ½ longest diagonal

With sprinklers
- Separation reduced to 1/3



201

Horizontal Travel

Exit access travel distance

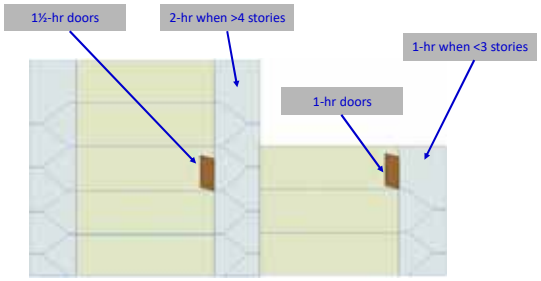
OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200	250
I-1	Not permitted	250
B	200	300
F-2, S-2, U	300	400
H-1	Not permitted	75
H-2	Not permitted	100
H-3	Not permitted	150
H-4	Not permitted	175
H-5	Not permitted	200
I-2, I-3	Not permitted	200
I-4	150	200

(Ref. Table 1017.2)



202

Vertical Travel



203

Exit Access Stairs and Ramps

- Open stairways and ramps used as part of MOE
- Travel distance measured to an exit
- Limited use



204

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Egress Path Identification

Exit signs required if >2 exits
- Additional floor-level exit signs in R-1
- Illuminated from internal or external light source

Egress path must be illuminated
- Emergency lighting required if > 2 exits

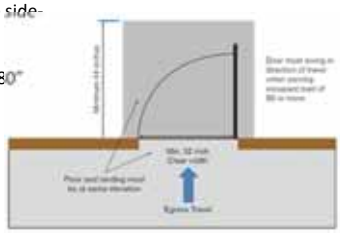


205

Doors

All egress doors must be side-hinged swinging
- Some exceptions

Minimum clear height >80"



206

Door Hardware

- Readily openable without a key or special knowledge or effort
- Forces required consistent with accessibility standards





207

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Panic Hardware

Required on doors in
- Group H
- Group A & E >50 occupants

Fire exit hardware = panic hardware listed for fire door assemblies

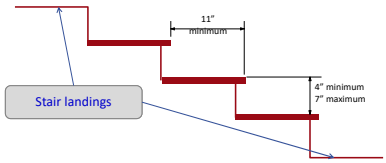
Installation
- Fire exit hardware
  - UL 10C and UL 305
- Panic Hardware
  - UL 305



208

Stairways

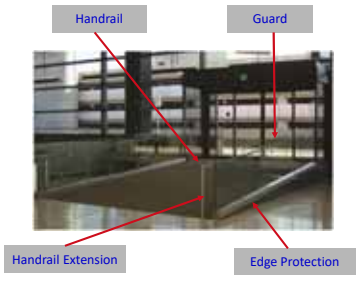
Minimum width
- 36" for < 50 OL
- 44" for > 50 OL
- 0.3" x OL for > 146 OL
- With sprinklers and EV/AC
  - 0.2" x OL for > 220 OL



209

Ramps

- Slopes < 1:12
- Ramps not part of MOE < 1:8
- Width
  - 36" minimum
  - 0.2" x OL
  - 0.15" x OL
    - With sprinklers and EV/AC



210

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Accessibility

IBC requirements similar to
- ADA Accessibility Guidelines
- Federal Fair Housing Act

Referenced standard
- ICC A117.1 – Accessible and Usable Buildings and Facilities

Areas not requiring accessibility
- Construction sites
- Detached 1- & 2-family dwellings
- Spaces containing equipment
- Coolers and freezers



211

Accessible Path Into a Building

Accessible path from points where people arrive
- Public transportation stops
- Parking spaces
- Passenger loading zones
- Public streets or sidewalks

60% of public entrances must be accessible



212

Accessible Path Through a Building

- Accessible route throughout from accessible entrance
- Route to other floors
  - Ramps
    - Slope < 1:12
  - Elevators
    - Cars sufficient for wheelchair and one extra person
    - Controls reachable from a wheelchair



213

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Accessible Toilet Facilities

Toilet rooms
- All accessible
- Family or assisted-use toilet room in Groups A and M

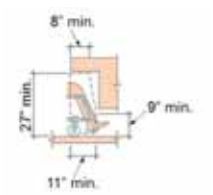
Water closets
- >1 water closet wheelchair accessible



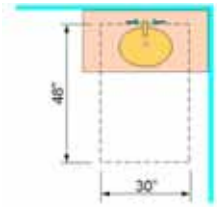
214

Accessible Lavatories and Sinks

>5% of lavatories accessible
- >1 in each toilet facility



Knee and Toe Clearance

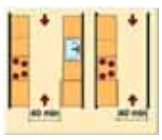


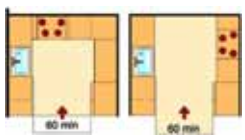
Clear Floor Space at Lavatory

215

Accessible Kitchens

- Commercial kitchen route
  - Approach, enter and exit
- In break room type areas throughout


Pass -Through Kitchens



U-Shaped Kitchens

216

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Accessible Seating Areas

Dining
- Total area for seating, interior/exterior, with some exceptions
- 5% dining surfaces

Other than dining
- Dispersed throughout



CAPACITY OF SEATING IN ASSEMBLY AREAS	MINIMUM REQUIRED NUMBER OF WHEELCHAIR SPACES
4-25	1
26-50	2
51-100	4
101-300	5
301-500	6
501-5,000	6, plus 1 for each 150, or fraction thereof, between 301 through 5,000
5,001 and over	36 plus 1 for each 200, or fraction thereof, over 5,000

[Ref. IBC Table 1108.2.2.1]

217

R-1 Accessible Dwelling/Sleeping Units

TOTAL NUMBER OF UNITS PROVIDED	MINIMUM REQUIRED NUMBER OF ACCESSIBLE UNITS WITHOUT ROLL-IN SHOWERS	MINIMUM REQUIRED NUMBER OF ACCESSIBLE UNITS WITH ROLL-IN SHOWERS	TOTAL NUMBER OF REQUIRED ACCESSIBLE UNITS
1 to 25	1	0	1
26 to 50	2	0	2
51 to 75	3	1	4
76 to 100	4	1	5
101 to 150	5	2	7
151 to 200	6	2	8
201 to 300	7	3	10

[Ref. Table 1108.6.1.1]

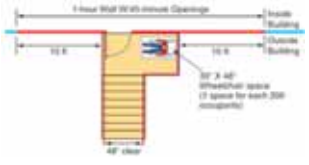
218

Accessible Means of Egress

Non Sprinklered buildings requiring
- One exit needs 1 accessible MOE
- > 2 exits needs 2 accessible MOE

>4 stories
- Elevator as 1 accessible MOE

Accessible MOE must continue to public way or Area of Assisted Rescue



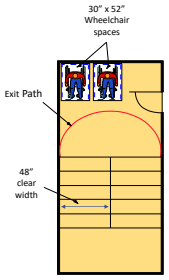
219

Accessible Areas of Refuge

One wheelchair space for every 200 occupants
- Not required in sprinklered buildings

Location
- Stairway enclosure
- Elevator lobby

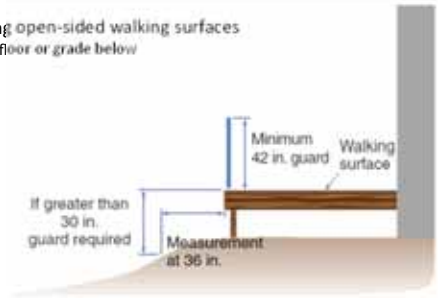
2-way communication required



220

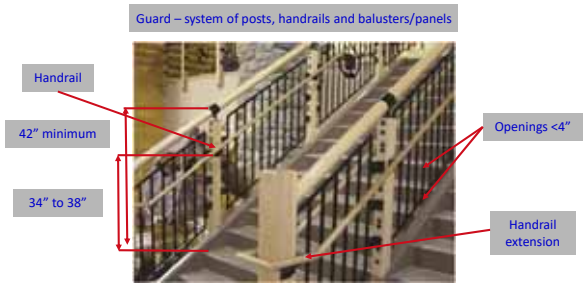
Guards

- Required along open-sided walking surfaces
  - >30" above floor or grade below



221

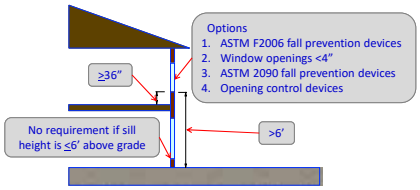
Stairway Guards and Handrails



222

Window-sill Height

Regulated in R-2 and R-3 residential

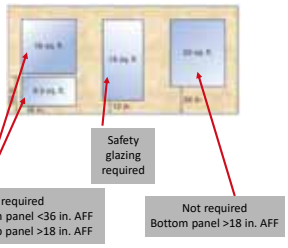


223

Safety Glazing

- Laminated glass
- Tempered glass
- Must be labeled
- Required locations
  - Doors
  - Within 24" of doors
  - Along walking areas with size thresholds





224

Safety Glazing

- Tub or shower enclosures
- <60" of pool or spa
- Stairway guard or railing
- <36" of stairway or landing
- <60" of walking surface







225

Swimming Pools

International Swimming Pool and Spa Code

- Any structure intended for swimming
- Water depth > 24”
- In-ground, above-ground and on-ground pools
- Hot tubs and spas
- Fixed-in-place wading pools



226

Poll Question

16. In a Group A-2 restaurant with tables and chairs, the occupant load is determined based on a factor of _____ per person.
    a. 5 net
    b. 7 net
    c. 15 net
    d. 150 gross



227

Poll Question

17. In a Group A-2 restaurant, 2 exit doors are required when the occupant load is _____ or more.
    a. 11
    b. 21
    c. 30
    d. 50



228

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Poll Question

18. In a non-sprinklered Group B office building with an occupant load of 95, the common path of egress travel is limited to _____ feet.
    a. 25
    b. 75
    c. 100
    d. NP



229

Poll Question

19. Exit access travel distance is limited to _____ feet in a Group M occupancy equipped with a fire sprinkler system.
    a. 75
    b. 200
    c. 250
    d. 300



230

Poll Question

20. Doors must swing in the direction of egress when the occupant load is _____ or more.
    a. 25
    b. 50
    c. 75
    d. 100



231

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Poll Question

21. In buildings with more than 1 required means of egress, at least _____ of the means of egress must be accessible.
   a. 1
   b. 2
   c. 3
   d. All



232

Discussion



233

Health Safety

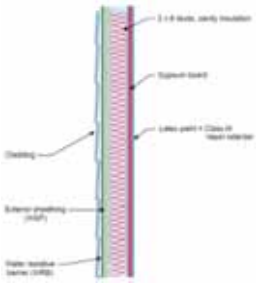


234

Keeping Water Out

Weather-resistant exterior wall envelope

- Water-resistive barrier (WRB)
- Flashing



235

Vapor Retarders

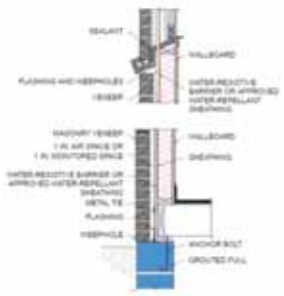


236

Siding

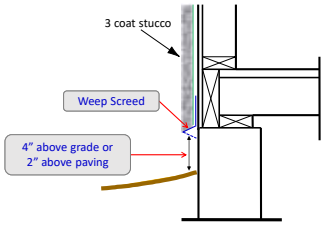
Many materials available

IBC Table 1404.2 specifies minimum thickness



237

Siding



238

Roofing

- Roof coverings must meet
  - Chapter 15
  - Manufacturer's instructions
  - Code prevails if conflicts arise
- Minimum slope dependent on roof covering chosen
- Roof drains or scuppers required if water cannot drain off roof edge



239

Flashing

Installed at
- Wall and roof intersections
- Gutters
- Change in roof slope or direction
- Around roof openings

Parapets coped with weatherproof materials
- FRR parapet coping materials
- Weatherproof
- Maintain required FRR



240

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Low-slope Roofs

Slope can be as low as ¼:12

Roof covering systems

- Built-up
  - Asphalt
  - Coal tar pitch
- Modified bitumen
- Thermoset single-ply roof covering (EPDM)
- Thermoplastic single-ply roof covering (PVC, TPO, CSPE)



241

Steep Roofs

Slopes > 3:12

Common roof covering materials

- Asphalt shingles
- Wood shakes
- Wood shingles
- Clay tiles
- Concrete tiles
- Metal roof panels

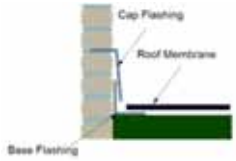


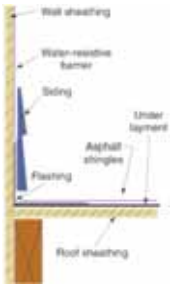
242

Flashing

Required at

- Roof and wall intersections
- Valleys
- Drip edge





243

Clay and Concrete Tiles

Installed over solid sheathing or spaced sheathing
Minimum slope of 2½:12
- Double underlayment <4:12
- Single underlayment >4:12



244

Light and Ventilation

Lighting
- Natural
- Artificial

Ventilation
- Natural
- Mechanical
  - Installed per IMC
- Ventilation of attics and crawl spaces also required



245

Natural and Artificial Lighting

Natural lighting
- Openings/windows in exterior walls that allow sunshine in

Artificial lighting
- Electrical-powered

If natural light inadequate
- Artificial light installed
- Must provide >10 foot-candles at 30" height

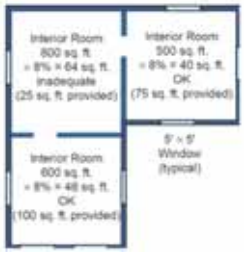


246

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Natural Lighting

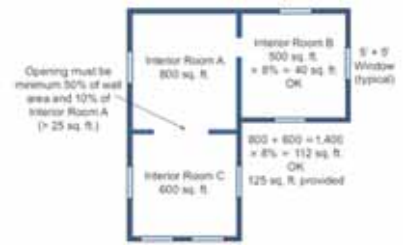
Openings >8% of floor area



247

Natural Lighting

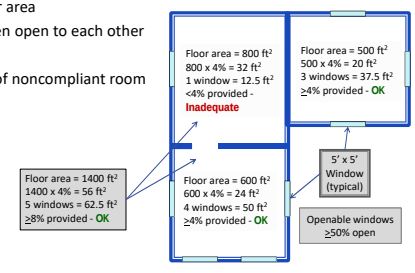
Rooms combined when open to each other



248

Natural Ventilation

- Openings **≥4%** of floor area
- Rooms combined when open to each other
- Opening must be
  - **≥8%** of floor area of noncompliant room
  - **≥25** ft²



249

Exhaust Systems

Moisture created inside buildings removed
- Bathrooms with bathtubs, spas, etc.

Contaminants removed
- Contaminants in naturally ventilated spaces
- Flammable and combustible hazards
- Per IMC and IFC



250

Temperature

Interior space for human occupancy
- Requires heating system
  - Active or passive
- Min indoor temperature
  - 68°F at 3' above floor

Design temperature
- Outdoor temperature
  - Used for design
- IPC Appendix D

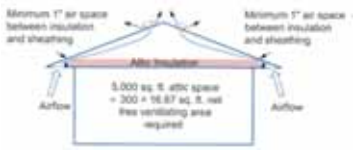
LOCATION	WINTER DESIGN TEMPERATURE (degrees F)
Minneapolis, MN	-12
Chicago, IL (O'Hare)	-4
Buffalo, NY	6
Kansas City, MO	6
Dallas, TX	33
San Diego, CA	44

(Ref. IPC Table D101)

251

Moisture Control in Attics

- Net free area of attic vents
  - >1/150 attic area
  - >1/300 when
    - 40–50% of openings in top 3' of attic
    - Remainder at eave or cornice vents
  - >1/300 with Class I or II vapor barrier

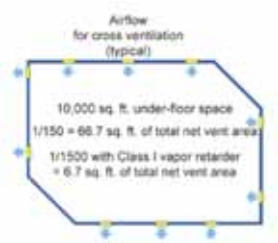


252

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Under-floor Ventilation

- Ratio of 1 ft2 of opening for 150 ft2 of under-floor space
- Class I vapor retarder
  - Ratio of 1 ft2 of opening for 1,500 ft2 of under-floor space



253

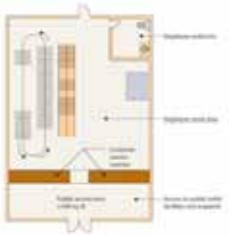
Plumbing Facilities

Classification	Occupancy	Description	Water closets		Lavatories		Bathtubs/ showers	Drinking fountains	Other
			Male	Female	Male	Female			
	A-2	Restaurant, banquet halls and food courts	1 per 75	1 per 75	1 per 200			1 per 500	1 service sink
Assembly	A-3	Auditoriums without permanent seating, art galleries, exhibition halls, museums, lecture halls, libraries, arcades and gymnasiums	1 per 125	1 per 65	1 per 200			1 per 500	1 service sink
Business	B	Buildings for the transaction of business, professional services	1 per 25 for the first 50 and 1 per 50 for the remainder exceeding 50		1 per 40 for the first 80 and 1 per 80 for the remainder exceeding 80			1 per 100	1 service sink
Educational	E	Educational facilities	1 per 50		1 per 50			1 per 100	1 service sink

254

Location of Toilet Facilities

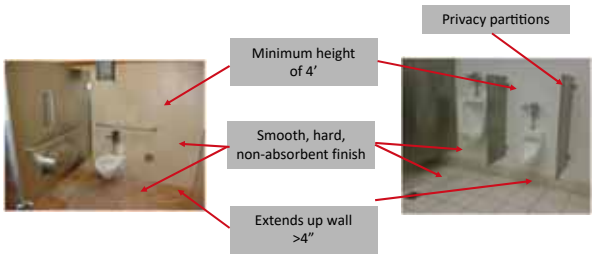
- Toilet facilities provided for
  - Employees
  - Public – if public building
- Public access
  - Accessible
  - Cannot pass through kitchens, storage rooms, or closets
- Distance <500'
  - Longer distances for factory, storage and industrial
  - Building official approval



255

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Toilet/Bathing Room Finishes



256

QUESTION & ANSWER

Poll Question

22. Buildings must be designed with a water-resistant barrier in the exterior wall envelope behind the exterior veneer.
   a. True
   b. False

257

QUESTION & ANSWER

Poll Question

23. Minimum roof slope must be _____ :12
   a. 0
   b. ¼
   c. 2½
   d. 3

258

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QUESTION & ANSWER

Poll Question

24. Either natural light or artificial light can be utilized to meet the minimum lighting requirements.
   a. True
   b. False



259

QUESTION & ANSWER

Poll Question

25. Attics and under-floor areas must be provided with ventilation at a ratio of 1 ft2 of vent area for every ____ ft2 of area.
   a. 150
   b. 300
   c. 500
   d. 1500



260

QUESTION & ANSWER

Poll Question

26. A Group A-3 gymnasium with an occupant load of 625 requires _____ water closets for male use.
   a. 3
   b. 4
   c. 5
   d. 6



261

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QUESTION & ANSWER

Poll Question

27. Except in mall buildings, the maximum travel distance to a water closet cannot exceed _____ feet.
    a. 200
    b. 300
    c. 400
    d. 500



262

Discussion



263

Structural Safety



264

Structural Design

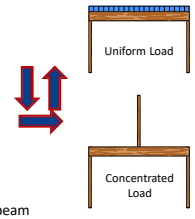
- Loads determined per ASCE 7
- Risk categories based on building use
  - Category I
    - Agricultural and minor storage
  - Category II
    - Most common classification
  - Category III
    - Assemblies with occupant load >300 and hospitals without emergency treatment
  - Category IV
    - Hospitals with emergency treatment



265

Basic Loads

- Gravity loads
  - Applied vertically down through a structure
- Uplift loads
  - Applied vertically up through a structure
- Lateral loads
  - Applied horizontally to a building
- Uniform loading
  - Applied equally across a structural member
- Concentrated load
  - Applied in a single location of a member
    - Example: column bearing in the middle of a beam



266

Live Loads

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
Dining rooms and restaurants	100	-
Office spaces	50	2,000
Residential 1- and 2-family dwellings Habitable attics and sleeping areas Other areas	30 40	- -
Retail First floor Upper floors	100 75	1,000 1,000
Stairs and exits 1- and 2-family dwellings All others	40 100	300
Storage warehouses Heavy Light (must be designed for heavier loads if required for anticipated loads)	250 125	
Roofs Roof surfaces subject to maintenance workers Ordinary flat, pitched and curved roofs Occupiable roofs	20 100	300

(Ref. Table 1607.1)

267

Dead Loads

- Actual weight of construction materials
- Considered permanent loads

COMPONENT	LOAD (psf)
Double wood floor supported on 2 x 12 joists 16 inches on center	7
Hardwood flooring, ½-inch	4
Linoleum tile ¼-inch	1
Wood stud walls with ½-inch gypsum board each side	8
½-inch gypsum board ceiling	3
Asphalt shingles	2

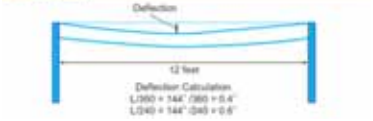
[Ref. Table C3.1-1a of ASCE 7]

268

Deflection

CONSTRUCTION	MAXIMUM DEFLECTION UNDER		
	Live Load	Wind or Snow Load	Dead + Live
Roof members			
Supporting plaster or stucco ceiling	l/360	l/360	l/240
Supporting nonplaster ceiling	l/240	l/240	l/180
Not supporting ceiling	l/180	l/180	l/120
Floor members	l/360	–	l/240
Exterior walls			
With stucco or plaster finishes	–	l/360	
With brittle finishes	–	l/240	–
With flexible finishes	–	l/120	–

[Ref. Table 1604.3]



269

Snow Loads

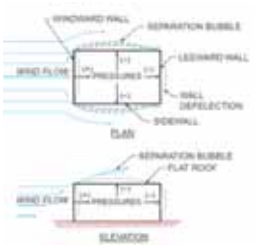
- Ground snow loads
- 'CS' = case study
- Elevation influence
- State-specific tables
- Drifts and sliding must be considered



270

Wind Loads

- Typically lateral and uplift loads
- Positive and negative pressures
- Based on wind speed
- Affected by surface roughness and exposure



271

Earthquake Loads

- Based on severity of site's design earthquake ground motion
- Seismic design categories
  - A , B, C, D, E, F

    Low → High
- Design per ASCE 7



272

Flood Loads

- Methods to determine flood hazard areas
  - >1% chance of flooding annually (100-yr flood plain)
  - Designated on community flood hazard map
- FEMA Flood Insurance Rate Map (FIRM)



273

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Soils

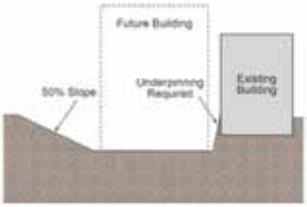
- Unified soil classification
- Building official can require a geotechnical investigation
  - Drilling into the ground and taking samples
  - Digging test pits
  - Evaluate
    - Soil strength
    - Bearing capacity
    - Effects of moisture
    - Compressibility
    - Liquefaction
    - Expansiveness



274

Excavation

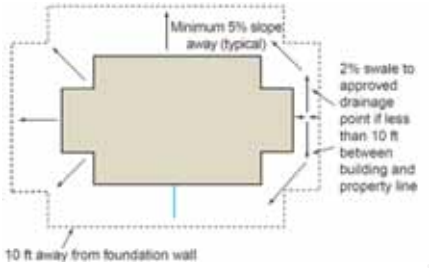
- Proximity to existing structures may require underpinning
- Excavation slope controlled so dirt does not fall into the hole
  - 1:2 (50% slope)



275

Grading

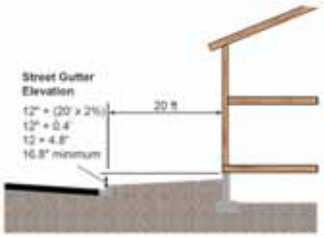
Positive drainage away from buildings



276

Grading

Foundation must be 12” + 2% above street gutter



277

Concrete Construction

- Concrete is a mixture of cement, aggregate, and water
- American Concrete Institute’s (ACI) Standard 318 Building Code Requirements for Structural Concrete
  - Code-referenced standard
- IBC Chapter 19 contains additional requirements and amendments to ACI 318



278

Concrete Durability

Exposure categories

- F – Moisture and freezing/thawing and deicer chemicals
- S – Sulfates in water or soil
- W – Water where concrete is intended to have low permeability
- C – Moisture and chlorides from (or spray from these sources)
  - Deicing chemicals
  - Salt
  - Brackish water
  - Seawater

Moisture and Freeze/Thaw Exposure Category	Structural Concrete ACI 318-19 Table 19.3.2.1	Nonstructural Concrete IBC 1904
F0	2,500	2,500
F1	3,500	3,000
F2	4,500	3,500
F3	5,000[a]	3,500

[a]Plain concrete minimum compressive strength is 4,500 psi.

279

Concrete Foundation Walls

- Prescriptive or engineering
- Seismic Design Categories C, D, E and F
  - Typically require RDP
- Wall thickness and steel reinforcement based on lateral loads
- High lateral loads require engineering



280

Concrete Formwork

- Designed, fabricated, erected and removed in accordance with ACI 318
- Substantially tight to prevent leakage of concrete
- Properly braced
- Remain in place until cured or shored



281

Concrete Steel Reinforcement

- Resists tension, or pulling apart, when concrete is subjected to loads
- Vertical and/or horizontal rebar may be required



282

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Concrete Special Inspection

- Quality has direct relationship to strength
- Inspection by special inspection agency – with some exceptions
- Continuous inspections
  - Full-time observation of work
- Periodic inspections
  - Part-time or intermittent observation of work
- ASTM Standard C172 Practice for Sampling Freshly Mixed Concrete



283

Masonry Construction

TMS 402/602 Building Code Requirements and Specification for Masonry Structures



284

Masonry Foundation Walls

- Thickness determined by lateral loads
- Steel reinforcement typically required
- Cells of hollow or solid masonry units often grouted



285

Masonry Materials

- Concrete, clay or shale, stone, AAC, and glass
- Bonded with mortar
- Grout
  - Fine
  - Course
- Steel reinforcing per TMS 602



286

Masonry Special Inspections

- Level I, II or III quality assurance
  - Risk Category
  - Designed or prescriptive
- Testing
  - Unit strength
  - Prism



287

Steel Construction

- American Institute of Steel Construction (AISC)
  - ANSI/AISC 360 Specification for Structural Steel Buildings
  - ANSI/AISC 341 Seismic Provisions for Structural Steel Buildings



288

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Protection of Steel

- Approved coating to protect from corrosion
- If scratched or chipped during erection
  - Approved paint or primer
  - SFRM
    - Bare steel
    - Approved primer
    - Often unprimed for better adhesion of fireproofing



289

Steel Connections

- Welding or bolting
  - Both require special inspections
- Bolted joints
  - Snug-tight
  - Twist-off
  - Slip-critical
    - Resist movement by friction
- Pretensioned
  - High-strength bolts tightened to specified minimum



290

Steel Special Inspections

- Connections
- Steel frame
  - Verify bracing, stiffening, member locations, and joint details at each connection
- Steel joists and girders
  - Inspection at fabrication facility
  - Approved fabricator



291

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Wood Construction

National Design Specification® (NDS®) for Wood Construction



Special Design Provisions for Wind and Seismic



292

Wood Construction

- Conventional light-frame
  - Primary structural elements created by repetitive wood framing members
- Mass timber
  - Large-dimensioned wood members as structural elements





293

Protection of Wood

Protection from moisture and insects
- Naturally durable wood
- Preservative-treated wood



Wood post on metal pedestal 1" above concrete



Preservative-treated wood or >8" above grade

294

Grade Marks

- Required for
  - Lumber
  - Wood structural panels
  - Engineered wood products
  - Treated products



Lumber Grade Mark

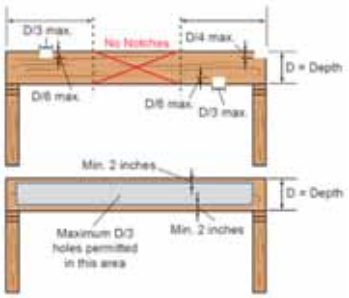


Wood Structural Panel Mark

295

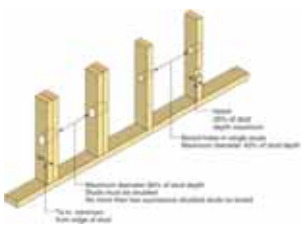
Notching and Boring

- Joists and rafters
  - Notches
  - Holes

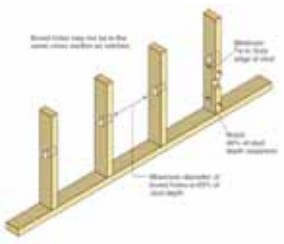


296

Notching and Boring



Bearing Wall



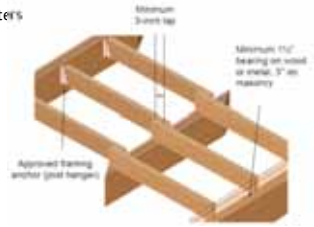
Non-bearing Wall

297

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Floor Construction

- Joist span tables for common wood species
- Other species
  - Span Tables for Joists and Rafters



298

Allowable Floor Joist Spans

FOR EXAMPLE

Determine minimum joist size: Hem-Fir #2, 16" o.c., 15' span, 30 psf live load, 10 psf dead load

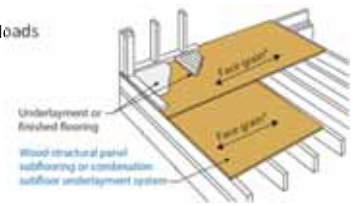
JOIST SPACING (inches)	SPECIES AND GRADE	LIVE LOAD = 30 psf DEAD LOAD = 10 psf			
		2 × 8	2 × 10	2 × 12	
		Maximum Floor Joist Spans (ft-in)			
16	Douglas fir #2	10-9	14-1	17-2	19-11
	Hem fir #2	10-0	13-2	16-10	19-6
	Southern pine #2	10-3	13-3	15-8	18-6
	Spruce-pine-fir #2	10-3	13-6	17-2	19-11

For Example

299

Floor Sheathing

- Designed for expected loads
- Most common
  - Wood structural panels
- Example
  - ¾" WSP, 48/24 rated



Roof sheathing span | Floor sheathing span

300

Walls

- Studs
  - Widest dimension perpendicular to wall
  - Continuous from bottom to top plates
  - Minimum 3 studs each exterior wall corner
- Top plates
  - Doubled in exterior and bearing walls
  - Overlapped at corners and partition intersections

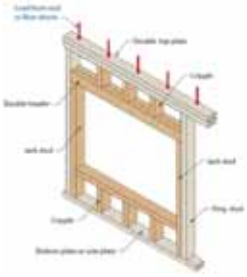
STUD SIZE (inches)	BEARING WALLS				NONBEARING WALLS	
	Stud Height (feet)[a]	Supporting Roof and Ceiling Only	Supporting One Floor, Roof and Ceiling	Supporting Two Floors, Roof and Ceiling	Stud Height (feet)[a]	Spacing (inches)
		Spacing (inches)				
2 × 4	10	24	16	16[b]	14	24
2 × 6	10	24	24	16	20	24

[Ref. Table R602.3.1]

301

Wall Framing

- Bearing wall openings require headers to support loads
  - Single-ply to 4-ply tabulated
  - Equivalent single solid members permitted



302

Wall Bracing Methods

METHODS/ MATERIALS	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA	
			Fasteners	Spacing
WSP Wood Structural Panel	7/16" in accordance with Table 2308.6.3(2) or 2308.6.3(3)		Table 2304.10.1	6" edges, 12" field
GB Gypsum Board (Double Sided)	1/2" or 5/8" by a minimum of 4' wide to studs at maximum of 24" o.c.		Section 2506.2 for exterior and interior sheathing. 5d annular ringed cooler nails (1 5/8" x 0.086") or 1 1/4" screws (Type W or S) for 1/2" gypsum board or 1 5/8" screws (Type W or S) for 5/8" gypsum board	For all braced wall panel locations, 7" o.c. along panel edges (including top and bottom plates) and 7" o.c. in the field

[Ref. Table 2308.6.3(1)]

303

FOR EXAMPLE

Ceiling and Roof Framing

Determine minimum rafter size: Douglas Fir-Larch #2; 16" o.c.; 14' span; ceiling attached; 30 psf ground snow load; 10 psf dead load

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum Rafter Spans (ft-in)				
16	Douglas fir	#2	7-10	11-11	15-1	19-5	23-5
	Hem fir	#2	7-3	11-5	14-11	18-2	23-1
	Southern pine	#2	7-6	11-8	14-8	18-10	23-10
	Spruce-pine-fir	#2	7-6	11-8	15-1	18-5	23-5

304

Crawl Space and Attic Access

- Crawl spaces
  - Minimum 18" x 24" opening
- Attics with clear height >30"
  - Minimum 20" x 30" opening
- Clear headroom >30" above access opening
- Large enough to remove largest appliance



305

Engineered Wood Products

- Prefabricated Wood I-joists
- Glued-Laminated Timber
- Cross-Laminated Timber
- Structural Composite Lumber
  - Laminated Veneer Lumber (LVL)
  - Parallel Strand Lumber (PSL)
  - Laminated Strand Lumber (LSL)
  - Oriented Strand Lumber (OSL)



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Trusses

- Floor and roof framing members
  - 2x4 up to 2x12
  - Typically fabricated with metal connector plates
- Installed per
  - Submitted truss drawings
  - TPI National Design Standard for Metal-Plate-Connected Wood Truss Construction



307

Gypsum Board

- Provides a smooth finished surface
- Can provide passive fire protection
- Can provide lateral resistance
- Various types
  - Type X
  - Type C
  - Water-resistant



308

Foam Plastics

Foam plastic insulation
- Flame-spread index <75
- Smoke developed index <450
- ASTM E84 and UL 723

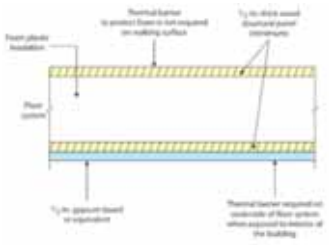


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Interior Foam Plastics

Separated by thermal barrier
- Single layer of ½" gypsum wallboard or equivalent
- Must remain in place for 15 minutes



310

Interior Foam Plastic Trim

- Density >20 pcf
- Thickness <½"
- Width <8"
- <10% of wall or ceiling area
- Flame-spread index <75



311

QUESTION & ANSWER

Poll Question

28. The 1st floor in a Group M retail store must be designed to carry a uniform live load of _____ psf.
    a. 50
    b. 75
    c. 100
    d. 125



312

QUESTION & ANSWER

Poll Question

29. When designing a building, each of the following loads are specific to the area where the building will be constructed except:
   a. Ground snow load
   b. Live loads
   c. Wind speeds
   d. Seismic loads



313

QUESTION & ANSWER

Poll Question

30. The ground must have a minimum slope of _____ percent for a minimum of 10 feet perpendicularly away from a building.
   a. 1
   b. 2
   c. 3
   d. 5



314

QUESTION & ANSWER

Poll Question

31. The exterior foundation of a building must be elevated to a point at least 2% plus _____inches above the point of discharge.
   a. 6
   b. 12
   c. 15
   d. 18



315

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QUESTION & ANSWER

Poll Question

32. Absolutely no holes or notches can be made in a 2 x 12 wood floor joist.
   a. True
   b. False



316

QUESTION & ANSWER

Poll Question

33. Foam plastic materials are prohibited as trim on the interior of a building.
   a. True
   b. False



317

Discussion



318

Final Reflection

What? What was observed?

So what? What did you learn?

Now what? How will you do things differently on the job?



319

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