Calculation of Building Height & Area under the 2009 IBC

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512-795-2900

Consultant’s Motto

If you’re not a part of the solution, there’s good money to be made in prolonging the problem.
Discussion Topics

- Occupancy classification
Discussion Topics

- Occupancy classification
- Types of construction

Discussion Topics

- Occupancy classification
- Types of construction
- History of height & area limits
Discussion Topics

- Occupancy classification
- Types of construction
- History of height & area limits
- Height & area calcs.
  - Basic calculation examples with single occupancy buildings

Helpful Hints on Use of the IBC

1. Check definitions
   - Generally in Chapter 2, but often in the front of a chapter or section
   - Defined terms italicized

2. Careful reading
   - Watch for key phrases such as “firewall” vs. “fire barrier”

3. Use of tables
   - Check footnotes
   - Check text referencing the table
# IBC Key Chapters Related to Height & Area Calculations

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Subjects</th>
</tr>
</thead>
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<td>Use and occupancy classifications</td>
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<td>Special requirements for specific occupancies or elements</td>
</tr>
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<td>Height and area limitations based on type of construction</td>
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<td>Requirements for evacuation</td>
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<td>32</td>
<td>Encroachment outside of property lines</td>
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<td>33</td>
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<td>35</td>
<td>Referenced standards</td>
</tr>
<tr>
<td>Appendices A-K</td>
<td>Appendices</td>
</tr>
</tbody>
</table>

## A Simpler Approach

Hammurabi’s Code
Section 229 - If a builder has built a house for a man and his work is not strong, and if the house he has built falls in and kills the householder, that builder shall be slain.
Classifying the Building
Five Key Issues

- Occupancy classification
- Type of construction
- Location on property
- Height and number of stories
- Allowable floor area

Occupancy Classification Considerations

- Occupant risk
  - Number of occupants
  - Density of occupants
  - Age of occupants
  - Mobility of occupants
  - Awareness of occupants
- Contents risk
  - Quantity and types of contents
  - Environment/situation of contents
Low Fire Hazard Occupancies
(Fire Load: 0-10 psf)

Residential  Educational Business  Institutional Assembly Hazardous (health) Factory* Storage*

Medium Fire Hazard Occupancies
(Fire Load: 10-20 psf)

High Fire Hazard Occupancies
(Hazardous (Physical) High
Fire Hazard Occupancies
(Fire Load: Over 20 psf)

Classification of Occupancies by their Relative Fire Hazard

Occupancy Classification
Where are the Occupancy Requirements in the IBC?

• Scope (301)
• Classification (302)
  – Occupancy Groups (303-312)
  – Mixed occupancies (508)
    • Accessory occupancies (508.2)
      – Incidental accessory occupancies (508.2.5)
    • Nonseparated occupancies (508.3)
    • Separated occupancies (508.4)

TABLE 912.5
HEIGHTS AND AREAS HAZARD CATEGORIES

<table>
<thead>
<tr>
<th>RELATIVE HAZARD</th>
<th>OCCUPANCY CLASSIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Highest Hazard)</td>
<td>H</td>
</tr>
<tr>
<td>2</td>
<td>A-1, A-2, A-3, A-4, I, R-1, R-2, R-4</td>
</tr>
<tr>
<td>3</td>
<td>E, F-1, S-1, M</td>
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<tr>
<td>4 (Lowest Hazard)</td>
<td>B, F-2, S-2, A-5, R-3, U</td>
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</table>
**Occupancy Classifications**

<table>
<thead>
<tr>
<th>Group</th>
<th>Code Section</th>
<th>Occupancy Groups</th>
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<tr>
<td>B</td>
<td>Business</td>
<td>304 B</td>
</tr>
<tr>
<td>E</td>
<td>Educational</td>
<td>305 E</td>
</tr>
<tr>
<td>F</td>
<td>Factory and Industrial</td>
<td>306 F-1 and F-2</td>
</tr>
<tr>
<td>H</td>
<td>High Hazard</td>
<td>307 H-1, H-2, H-3, H-4 and H-5</td>
</tr>
<tr>
<td>I</td>
<td>Institutional</td>
<td>308 I-1, I-2, I-3 and I-4</td>
</tr>
<tr>
<td>M</td>
<td>Mercantile</td>
<td>309 M</td>
</tr>
<tr>
<td>R</td>
<td>Residential</td>
<td>310 R-1, R-2, R-3 and R-4</td>
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<tr>
<td>S</td>
<td>Storage</td>
<td>311 S-1 and S-2</td>
</tr>
<tr>
<td>U</td>
<td>Utility and Miscellaneous</td>
<td>312 U</td>
</tr>
</tbody>
</table>

**Classifying the Building**

**Five Key Issues**

- Occupancy classification
- **Type of construction**
- Location on property
- Height and number of stories
- Allowable floor area
Types of Construction
Sec. 602

- Type I - Noncombustible & fire resistive
- Type II - Noncombustible & may be fire resistive
- Type III - Noncombustible exterior walls with combustible floor and roof assemblies
- Type IV - Combustible heavy timber
- Type V - Any recognized material

Type I Construction

- Noncombustible and very fire resistive
- Typically concrete or insulated steel
- Types I-A and I-B
Type II Construction

- Noncombustible
- May or may not be fire resistive
- Typically concrete or steel
- Types II-A and II-B

Type III Construction

- Noncombustible exterior walls – FRT Exception
- Combustible floor and roof assemblies
- Types III-A and III-B
- Sometimes called “Ordinary Construction”
Type IV Construction

- Heavy timber members
- Fire resistance is provided by large mass of wooden members
- Sometimes called “mill construction” or “heavy timber construction”

Type V Construction

- Typically wood
- May include steel, masonry or concrete
- Types V-A and V-B
Type VI Construction

Summary of IBC Types of Construction (See Chapter 6)

• Noncombustible
  – Fire resistive
    • Types I-A and I-B
  – Protected
    • Type II-A
  – Unprotected
    • Type II-B

• Combustible
  – Protected
    • Types III-A, IV and V-A
  – Unprotected
    • Types III-B and V-B
## Fire Resistance Requirements Based on Type of Construction

**Table 601**

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
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<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A²</td>
<td>B</td>
<td>HT</td>
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<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3²</td>
<td>2²</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Bearing walls</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Exterior</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3²</td>
<td>2²</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Nonbearing walls and partitions</td>
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<tr>
<td>Exterior</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interior</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Floor construction and secondary members (see Section 202)</td>
<td>1²</td>
<td>1²</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Roof construction and secondary members (see Section 202)</td>
<td>1²</td>
<td>1²</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

Do not forget: There are important notes (a-g) to applying this Table!

## Classifying the Building

**Five Key Issues**

- Occupancy classification
- Type of construction
- Location on property
- Allowable floor area
- Height and number of stories
Location on Property
Sections 506, 507

• Where a building is provided with open space around the perimeter, the maximum allowable area can be increased in some cases

Classifying the Building
Five Key Issues

• Occupancy classification
• Type of construction
• Location on property
• Height and number of stories
• Allowable floor area
Height and Area Limit Steps

1. Determine the maximum height of a building
2. Determine the base tabular area of a building
3. Determine the area increases for a building
4. Do the maximum allowable area calculations correctly
Where did Table 503 Come From?

THE THREE LITTLE PIGS

Once upon a time there was a mother pig who had three little pigs.

The three little pigs grew so big that their mother said to them, "You are too big to live here any longer. You must go and build houses for yourselves. But take care that the wolf does not catch you."

Then the first little pig built himself a house of straw. He was very pleased with his house. He said, "Now the wolf won't catch me and eat me."

"I shall build a stronger house than yours," said the second little pig.

"I shall build a stronger house than yours, too," said the third little pig.
Where did Table 503 Come From?

Then the second little pig built himself a house of sticks. It was stronger than the house of straw.

The second little pig was very pleased with his house. He said, "Now the wolf won't catch me and eat me."

"I shall build a stronger house than yours," said the third little pig.

Then the third little pig built himself a house of bricks. It took him a long time to build it, for it was a very strong house.

The third little pig was very pleased with his house. He said, "Now the wolf won't catch me and eat me."
"No, no," said the little pig. "By the hair of my chinny chin chin, I will not let you come in."

"Then I'll huff and I'll puff and I'll blow your house in," said the wolf.

So he huffed and he puffed and he huffed and he puffed. The house of straw fell down and the wolf ate up the first little pig.

"No, no," said the little pig. "By the hair of my chinny chin chin, I will not let you come in."

"Then I'll huff and I'll puff and I'll blow your house in," said the wolf.

So he huffed and he puffed and he huffed and he puffed. The house of sticks fell down and the wolf ate up the second little pig.
Where did Table 503 Come From?

"No, no," said the little pig. "By the hair of my chinny chin chin, I will not let you come in."

"Then I'll huff and I'll puff and I'll blow your house in," said the wolf.

So he huffed and he puffed and he huffed and he puffed. But the house of bricks did not fall down.

Where did Table 503 Come From?

When the wolf heard this he was very, very, very angry indeed.

He said, "Little pig, I am going to eat you up. I am going to climb down your chimney to get you."

The little pig was very frightened, but he said nothing. He put a big pot of water on the fire, to boil.
Where did Table 503 Come From?

- The wolf climbed on the roof. Then he began to come down the chimney.
- The little pig took off the lid from the pot. Into the pot fell the wall, with a big splash. And that was the end of the wall.
- The third little pig was too clever for him.

- The End -

Where did Table 503 Come From?

- There must be a bit of truth in the fairy tales because Mommy and Daddy would not misguide us in our childhood?
- What “The Three Little Pigs” taught us:
  - Noncombustible material (brick) is better than combustible materials (straw/wood)
- True story of Table 503 is little different….
Height & Area Concept

• Primary objectives of height and area limits:
  – Safe egress
  – Structural longevity adequate for fire fighting
• No need to limit height or area if:
  – Construction is capable of resisting a complete burnout of the contents

Height & Area Limits

• Long and diverse history
• Legacy approaches
  – BOCA building code
  – SBC
  – UBC
  – American Insurance Association
  – Board for Coordination of Model Codes
BCMC Study: 1982-1986

- BCMC surveyed many parties as to the “relative risks of various building uses”
- Submitted code changes (1988-1990) to the three model code groups to adopt the BCMC Height & Area Table and mythology
  - Were rejected by all three code groups

The IBC

- In the late-1990s, the three model code groups needed a single single approach to height/area limits for the IBC
- BCMC approach was proposed by special interest groups but was again rejected
**IBC 1996 Occupancy Regulations Drafting Committee**

- Dan Chudy, Riverside, CA (Chair) (ICBO)
- Paul Myers, Cincinnati, OH (Vice Chair) (BOCA)
- Gregori Anderson, Chatham County, GA (SBCCI)
- Ron Estepp, Hillsborough Township, NJ (BOCA)
- Lon Fairless, Carrollton, TX (ICBO)
- Jeff Feid, Normal, IL (BOCA)
- Gerry George, Central City, CO (ICBO)
- Ken Greene, Birmingham, AL (SBCCI)
- Chris Sanidas, Orange County, FL (SBCCI)
- Staff Liaison: Dennis McCreary & Bill Wall (ICBO), John Battles (SBCCI), and Tom Frost (BOCA)

**1996 IBC Occupancy Committee**

- Question: Which of the model codes can show the best fire- and life-safety record based on allowable area of buildings?
  - Answer: Who knows? There is no empirical data to substantiate that one code is superior to the others in this aspect
- Fact: There has not been any identification of known problems with the H & A of existing buildings built to the legacy codes
Another perspective discussed:
- The allowable area provisions create artificial and unnecessary limitations on building size.
- The philosophy of this perspective is that the exiting, fire sprinkler and fire resistivity provisions found elsewhere in the code will satisfy the fire- and life-safety needs, regardless of the building size.

Note: Under the ICC Performance Code, there is no height and area table.
1996 IBC Occupancy Committee

• Solution:
  – Determined that the best approach was to compare all three model codes and identify the maximum allowable area for any given type of construction and occupancy, using that area as the basis for the IBC allowable area tables.

The 3 legacy codes were different in terms of how they addressed modifications to the base height and area in the codes
  – Solution: It was agreed to use the BCMC formulas
1996 IBC Occupancy Committee’s Conclusions

• When viewed objectively, all three of the model codes’ allowable area provisions are valid, defensible, rational and have a history of evidence that each has provided a safe built environment for the users of the buildings.
• The methodology minimized the negative impacts resulting from this new document as the United States move to a single national code.

Where are the Height & Area Requirements in the IBC?

• 501 General
• 502 Definitions
• 503 General Height & Area Limitations
• 504 Height Modifications
• 505 Mezzanines
• 506 Area Modifications
• 507 Unlimited Area Buildings
• 508 Mixed Use and Occupancy
• 509 Special Provisions
Exceptions
To Height and Area Calculations

• 503.1.1 Special industrial occupancies
• 503.1.3 Type I construction
• 509 Special Provisions
  – Mixed uses (above) w/Parking Garage (below)
    • Now called “Horizontal building separation allowance”
  – R-2 use buildings

507 Unlimited Area Buildings

• 507.2 Unsprinklered, one-story
• 507.3 Sprinklered, one-story
• 507.4 Two-story
• 507.6 One-story, sprinklered, Group A-3
• 507.7 One-story, sprinklered, Group A-3 of Types III & IV
• 507.8 Group H
• 507.9 Aircraft paint hangar, one-story
• 507.10 Group E buildings, one story
• 507.11 Motion picture theaters, one story
• 507.12 Malls
Understanding Table 503

- Layout
- Terminology

Ht. Limits shown as stories and feet above grade plane
Definition in Section 502.1 does not incl. thickness of exterior walls/firewalls
Occupancy vs. Construction Type
Table values based on combination of the 3 previous Model Building Codes – no case less than previous codes
502.1 AREA, BUILDING

The area included within surrounding exterior walls (or exterior walls and fire walls) exclusive of vent shafts and courts. Areas of the building not provided with surrounding walls shall be included in the building area if such areas are included within the horizontal projection of the roof or floor above.

HEIGHT, BUILDING (502.1). The vertical distance from grade plane to the average height of the highest roof surface.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPE OF CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TYPE I</td>
</tr>
<tr>
<td>A-2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td>A-4</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>B</td>
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</tbody>
</table>
Height, Building (502.1)

502.1 Definitions

- GRADE PLANE. A reference plane representing the average of finished ground level adjoining the building at exterior walls. Where the finished ground level slopes away from the exterior walls, the reference plane shall be established by the lowest points within the area between the building and the lot line or, where the lot line is more than 6 feet (1829 mm) from the building, between the building and a point 6 feet (1829 mm) from the building.
Grade Plane Calculation

EL = 104'

EL = 103'

EL = 105'

Grade Plane Calculation

EL = 103' *

EL = 101' *

EL = 100' *

EL of building slab = 100'

200'

100'

EL = 102'

EL = 101'

Street

Height, Building (502.1)

Measuring the grade plane

Ht. (start @ Grade Plane)

Grade Plane 102.38'

Finished ground level

Average Ht. Of Roof

Finished ground level

Low Pts. w/i 6'
Stories Above Grade Plane (202)

How do you now determine number of stories above grade?

Height (start @ Grade Plane)

Finished ground level

Low Pts. w/i 6'

Average Ht. Of Roof

STORY ABOVE GRADE PLANE (202).
Any story having its finished floor surface entirely above grade plane, except......

TABLE 503
ALLOWABLE HEIGHT AND BUILDING AREAS
Height Limitations shown as stories and feet above grade plane.
Area Limitations as determined by the definition of "Area, building", per floor.

<table>
<thead>
<tr>
<th>TYPE OF CONSTRUCTION</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
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<tbody>
<tr>
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<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
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<tr>
<td>GROUP:</td>
<td>UL</td>
<td>169</td>
<td>65</td>
<td>55</td>
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<tr>
<td>A-1</td>
<td>8</td>
<td>10</td>
<td>6.5</td>
<td>8.5</td>
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<td>10</td>
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<td>A-3</td>
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<td>10</td>
<td>6.5</td>
<td>8.5</td>
<td>10.00</td>
</tr>
</tbody>
</table>
502.1 & 202 Definitions

- Basement. That portion of a building that is partly or completely below grade plane. A story that is not a story above grade plane (see "Story above grade plane" in Section 202).
- Story above grade plane. Any story having its finished floor surface entirely above grade plane, or in which the finished surface of the floor next above is:
  1. More than 6 feet (1829 mm) above grade plane;
  2. More than 6 feet (1829 mm) above the finished ground level for more than 50 percent of the total building perimeter; or
  3. More than 12 feet (3658 mm) above the finished ground level at any point.

When a Basement Becomes a Story Above Grade: Condition #1
When a Basement Becomes a Story Above Grade: Condition #2

- Floor above is > 6 feet above grade plane
  - yes
  - no

- Floor above is > 6 feet above finished ground level for > 50% of total building perimeter
  - yes
  - no

- Floor above is > 12' above finished ground level at any point
  - yes
  - no

Basement becomes a story above grade

Basement NOT story above grade

Basement story above grade (502.1)?
Questions on Grade, or Height & Stories above Grade Calculations

Height & Area Modifications to Table 503

<table>
<thead>
<tr>
<th>GROUP</th>
<th>HT (FT)</th>
<th>UL</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>175</th>
<th>200</th>
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<td>A-1</td>
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<td>A</td>
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</table>

TABLE 503
ALLOWABLE HEIGHT AND BUILDING AREAS
Height Limitations shown as stories and feet above grade plane.
Area Limitations as determined by the definition of "Area, building", per floor.
### TABLE 503
ALLOWABLE HEIGHT AND BUILDING AREAS

- Height limitations shown as stories and feet above grade plane.
  - More restrictive will govern as discussed
- Exception:
  - SECTION 504 HEIGHT MODIFICATIONS

### SECTION 504
HEIGHT MODIFICATIONS

- **504.1** Exception on Height of one-story aircraft hangars
- **504.2** Automatic sprinkler increase
  - NFPA 13 vs. NFPA 13R
    - Extra story and 20’
      - Not for certain I-2 Construction Types
      - Not for H-1, H-2, H-3 or H-5
- **504.3** Roof structures
  - Towers, spires, steeples
SECTION 506
AREA MODIFICATIONS

1. Frontage increase (506.2).
   – Also called “open perimeter increase”
   – Is the separation of a structure:
     • From other structures on the same lot
     • From the property lines
   – Intent: Reduce the fire exposure/conflagration hazard to & from other structures

SECTION 506
AREA MODIFICATIONS – Cont.

2. Automatic sprinkler system increase (506.3)
   – Based on NFPA 13 System (Not for NFPA 13R)
   – 300% increase for one story
   – 200% increase for multi-stories
     • No sprinkler increase for H-1, H-2 or H-3
     • No sprinkler increase for H-2 or H-3 occupancies in mixed – use buildings
Area Modification to Table 503

\[ A_a = \left\{ A_t + A_t \times I_f \right\} \times A_t \times I_f \]  

(Equation 5.1)

where:
- \( A_a \) = Allowable area per story (square feet).
- \( A_t \) = Tabular area per story in accordance with Table 503 (square feet).
- \( I_f \) = Area increase factor due to frontage as calculated in accordance with Section 506.2.
- \( I_f \) = Area increase factor due to sprinkler protection as calculated in accordance with Section 506.3.

Given

Either 0, 200% or 300%

Up to 75%

506.2 Frontage increase \((I_f)\)

\[ I_f = \left[ \frac{F \times P - 0.25}{P} \right] \times W \times 30 \]  

(Equation 5.2)

where:
- \( I_f \) = Area increase due to frontage.
- \( F \) = Building perimeter that fronts on a public way or open space having 20 feet (6096 mm) open minimum width (feet).
- \( P \) = Perimeter of entire building (feet).
- \( W \) = Width of public way or open space (feet) in accordance with Section 506.2.1.

Will be based on \( W \geq 20'\)

Easy to scale from site plan

Will be based on weighted average \(20' \leq W \leq 30'\)
Example #1 on Frontage Increase

- $F = 500'$
- $P = 600'$
- $W = 30$

\[
I_f = \left( \frac{F}{P} - 0.25 \right) \frac{W}{30}
\]

\[
I_f = \left( \frac{500}{600} - 0.25 \right) \frac{30}{30} = 58\%
\]

Example #2 on Frontage Increase

- $F = 400$
- $P = 600'$
- $W = 30$

\[
I_f = \left( \frac{F}{P} - 0.25 \right) \frac{W}{30}
\]

\[
I_f = \left( \frac{400}{600} - 0.25 \right) \frac{30}{30} = 42\%
\]
Example #3 on Frontage Increase

\[ I_f = \left[ \frac{F}{P} - 0.25 \right] \frac{W}{30} \]

\[
\begin{align*}
F &= 600' \\
&P = 600' \\
W &= \frac{(200' \times 20') + (400' \times 30')}{600} = 26.67' \\
I_f &= \left[ 1 - 0.25 \right] \frac{26.67}{30} \\
I_f &= 67\% 
\end{align*}
\]

Example #4 on Frontage Increase

\[ I_f = \left[ \frac{F}{P} - 0.25 \right] \frac{W}{30} \]

\[
\begin{align*}
F &= 600' \\
P &= 600' \\
W &= \frac{(100' \times 20') + (500' \times 30')}{600} = 28.33' \\
I_f &= \left[ \frac{600}{600} - 0.25 \right] \frac{28.33}{30} \\
I_f &= 70.83\% 
\end{align*}
\]
Questions on Frontage Increase Calculations?

Exercises in applying the Area Modification to Table 503

Given

Either 0, 200% or 300%

\[ A_a = \{ A_t + [ A_t + I_f ] + [ A_t + I_s] \} \]

\[ A_a = A_t (1 + I_f + I_s) \]

(Equation 5-1)

where:

- \( A_a \) = Allowable area per floor
- \( A_t \) = Base Table 503 area per floor
- \( I_f \) = Frontage increase (506.2)
- \( I_s \) = Sprinkler increase (506.3)

We just reviewed 4 example calculations!
Use: A-3
IIIB Const.
Sprinklered
1 Story

Use: A-3
IIIB Const.
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1 Story

2009 IBC Ht. & Area Calculations Talk

Exercise #1: Allowable Area for Single Story Building

Use: A-3
IIIB Const.
Sprinklered
1 Story

2009 IBC Ht. & Area Calculations Talk

Exercise #1: Allowable Area for Single Story Building

506.4.1 Area determination for Single Occupancy Buildings.

The maximum area of a building with more than one story shall be determined by multiplying the allowable area of the first floor \( A_a \), as determined in Section 506.1, by the number of stories as listed below.

1. For two-story buildings, multiply by 2;
2. For three-story or higher buildings, multiply by 3; and,
3. No story shall exceed the allowable area per floor \( A_a \), as determined in Section 506.1 for the occupancies on that floor.
506.4.1 Area determination.

Exceptions

1. Unlimited area buildings in accordance with Section 507.
2. The maximum area of a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.2 (NFPA 13R) shall be determined by multiplying the allowable area per floor (Aa), as determined in Section 506.1 by the number of stories.

Exercise #2: Allowable Area for Multi-Story

Use: A-3 IIIB Const. Sprinklered 3 Story

Frontage Increase

$I_f = \frac{400}{600} - 0.25 = 0.30$

$I_f = 42\%$

$A_a = A_t \left(1 + I_f + I_s\right)$

$A_t = 9500$ sq. ft. (Table 503)

$F = 400$ P = 600’ W = 30’ $\Rightarrow I_f = 42\%$

$I_s = 200\%$ (Sec. 504.2)

$A_a = 9500 \times 3.42 = 32,490$ sq. ft./floor

$A_M = 32,490 \times 3 = 97,470$ sq. ft. for the Building

Table 503 Max is 3 Stories (AS) for A-3 of IIIB (or IIB)

What if the Building is 4 Stories?
Exercise #3: Allowable Area for Multi-Story

Use: B IIIA Const. Sprinklered 3 Stories

$A_a = A_L \left[1 + I_f + I_s \right]$  

$A_L = 28500$ sq. ft. (Table 503)  
$F = 600$ P = 600'  
$W = (200' \times 20') + (400' \times 30') = 26.67$  
$\Rightarrow I_f = 67\%$  
$I_s = 200\%$ (Sec.504.2)  
$\Rightarrow A_a = 28500 \times 3.67 = 104,595$ sq. ft./floor  
$\Rightarrow A_M = 104595 \times 3 = 313,785$ sq. ft. for the building

What if the Building is 6 Stories?

$\Rightarrow$ Max. of 104,595 sq. ft. per floor AND  
$\Rightarrow$ Max. of 313,785 sq. ft. aggregate area of ALL 6 floors

Exercise #4: Allowable Area for NFPA 13R

Use: R-2 VA Const. Sprinklered (13R) 3 Stories

$A_a = A_L \left[1 + I_f + I_s \right]$  

$A_L = 12000$ sq. ft. (Table 503)  
$F = 600$ P = 600' W = 30' $\Rightarrow I_f = 75\%$  
$I_s = 0\%$ (Sec.504.2: No increase for NFPA 13R)  
$\Rightarrow A_a = 12000 \times 1.75 = 21,000$ sq. ft./floor  
$\Rightarrow A_M = 21000 \times 3 = 63,000$ sq. ft. for the building

What if the Building is 4 Stories?

$\Rightarrow$ Max. of 21,000 sq. ft. per floor AND  
$\Rightarrow$ Max. of 84,000 sq. ft. aggregate area of ALL 4 floors
Summary

Why Allowable Building Height & Area Limits?
• Limitations on height & area are intended to limit the size of a fire that may develop. Concerns include:
  – Limiting property damage
  – Providing life safety
  – Providing firefighter safety by designing certain structures to stay in place for longer periods

Height and Number of Stories
Sec. 504
• Building height and number of stories are determined by the construction type and use group of the building
• A basic number is derived from Table 503 using the type of construction and the use group classification, and an increase may be applied in some cases based on sprinklers
  – Increases are 1-story, up to 20 additional feet for most uses
  – Group R uses protected by NFPA 13R sprinkler systems (up to 4 stories) receive a 1-story increase, but are limited to 60 feet total height
Allowable Floor Area

- The base tabular area listed in Table 503 may be a lot less than the actual allowable area permitted.
- The base tabular area increases may include:
  - Up to 75% for frontage on open space
  - 300% for NFPA 13 (NOT 13R) sprinklers in one story buildings
  - 200% for NFPA 13 (NOT 13R) sprinklers in multi-story buildings
- Total allowable area increases are cumulative up to 475% for sprinklered 1-story, and 375% for sprinklered multi-story.

Maximum Total Building Area
Table 503 & Sec. 506.4

- Sec. 506.4 limits the maximum total building area to 3 times the calculated area for buildings exceeding 3 stories in height.
  - Exception for NFPA 13R Buildings
    - NFPA 13R limited to max. 4 stories above grade
    - No area increase given for NFPA 13R under 504.2
Questions & Discussion
On Height & Area Calculations

Thank you for your time

Jeff Shapiro
&
Marshall Klein