

Fire Safety in Wood Construction

Paul D. Coats, PE, CBO
 In cooperation with the American Wood Council

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Four main approaches to fire safety in wood construction:

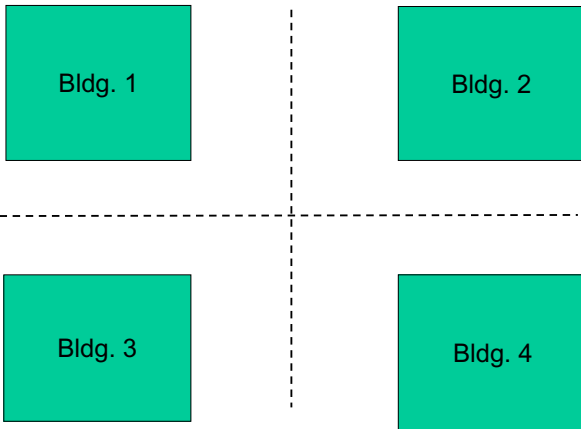
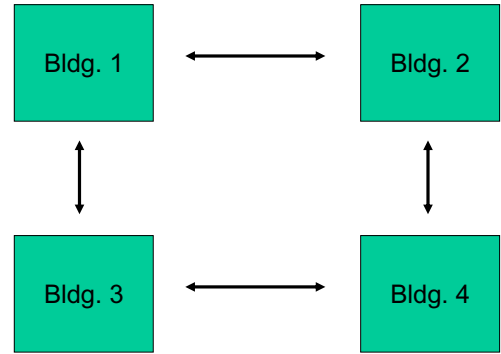
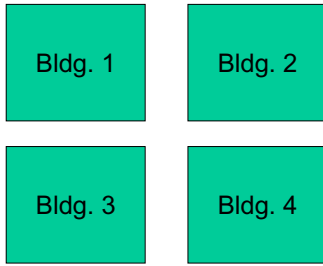
- restricting proximity of buildings
- restricting size of buildings
- protection with fire resistance
- active fire suppression systems

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Four main approaches to fire safety in wood construction:

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Equation 5-2 of the 2009 IBC:

$$I_f = [F/P - 0.25] W/30$$

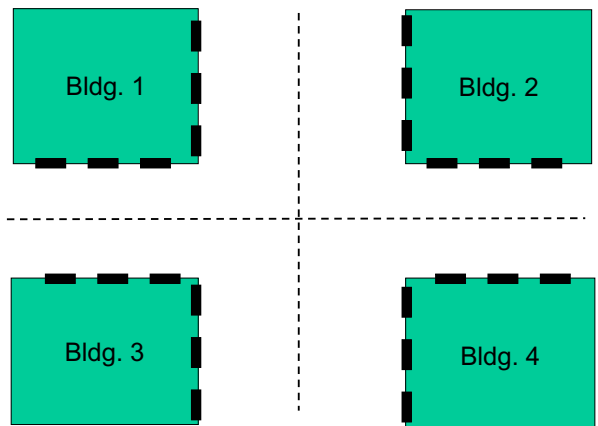
W = width of open space next to building

In general, W = 30 maximizes the available increase

Equation 5-2 of the 2009 IBC:

$$I_f = [F/P - 0.25] W/30$$

maximum increase =
 75% of tabular building area per story
 (e.g. 9,000 sq. ft. becomes 15,750 sq. ft.)



Exterior wall tables in the 2009 IBC:

Table 602

Exterior wall ratings
based on width of open space

Exterior wall tables in the 2009 IBC:

Table 705.8

Restrictions and protection
of openings
based on width of open space

Exterior wall tables in the 2009 IBC:

Table 602, Table 705.8

Generally, width of open space
= 10 feet precludes wall ratings;
= 30 feet precludes openings limits

restricting proximity of buildings:

$$I_f = [F/P - 0.25] W/30$$

Table 602, Table 705.8

In general, $W = 30$ maximizes
area increase and minimizes
exterior wall protection

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International Building Code TABLE 503

Allowable Building Heights and Areas

GROUP		NONCOMBUSTIBLE				MIXED		COMBUSTIBLE		
		TYPE I A	TYPE I B	TYPE II A	TYPE II B	TYPE III A	TYPE III B	TYPE IV HT	TYPE V A	TYPE V B
A2	HEIGHT SR	UL/UL	11'160	365	255	365	255	365	250	140
	AREA	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
B	HEIGHT SR	UL/UL	11'160	565	455	565	455	565	350	240
	AREA	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
M	HEIGHT SR	UL/UL	11'160	465	455	465	455	465	350	140
	AREA	UL	UL	21,500	12,500	18,500	12,500	20,500	14,000	9,000

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Allowable height and area in the IBC:

Table 503

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Allowable height and area in the IBC:

Table 503

-“Per story” areas

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Allowable height and area in the IBC:

Table 503

-“Per story” areas

-modified by open frontage

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Allowable height and area in the IBC:

Table 503

-“Per story” areas

-modified by open frontage

-modified by sprinklers

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Allowable height and area in the IBC:

Table 503

outdated approach?

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Four main approaches to fire safety in wood construction:

- restricting proximity of buildings
- restricting size of buildings
- **protection with fire resistance**
 - fire resistance rated construction
 - heavy timber construction
 - fire retardant treated wood
- active fire suppression systems

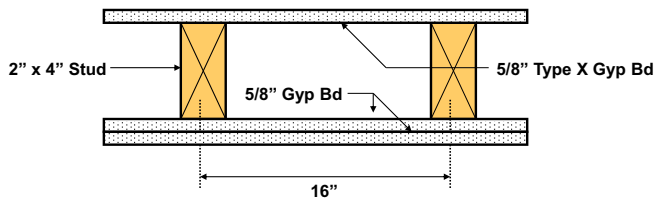
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fire resistance rated construction

- general fire resistance for larger building areas (Tables 601 and 503, fire walls to define buildings)
- protection from specific hazards (occupancy separations, control areas, shafts and atriums, dwelling unit separations)
- refuge during exiting (exit enclosures and horizontal exits, areas of refuge)

Interior Wall



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Testing



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fire resistance rated construction--testing

First testing done by various architects in late 1700s

First standardized tests by New York City

International Fire Prevention Congress, London (1903)/London Test Protocol/ASTM C19

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fire resistance rated construction--testing

-ASTM C19 becomes ASTM E119 in 1918

-proliferation of test standards, including tests for full-scale building features and individual features

-there are now several well-used fire tests reference in the IBC

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fire resistance rated construction--testing

-ASTM E119 (building construction and materials)

-ASTM E84 (surface burning of building materials)

-ASTM E136 ("noncombustibility" test)

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fire resistance rated construction--testing

-others standardized tests for elements of assemblies such as openings, penetrations, glazing, etc.; also for full scale features such as joints, exterior wall connections, etc.

-developed and promulgated by organizations such as ASTM, NFPA, UL, GA, and others

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fire resistance rated construction--testing

- methods derived from testing:
- prescriptive assembly tables in IBC section 720
- calculated fire resistance method in IBC section 721
- engineering analysis and alternative methods

fire resistance rated construction--testing

AF&PA's American Wood Council has sponsored testing and provides tools (see www.awc.org):

- involved in development of calculated fire resistance methods for assemblies and exposed timber
- involved in development of prescriptive assemblies in the code

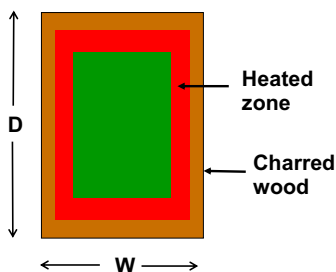
Four main approaches to fire safety in wood construction:

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 - protection with fire resistance
 - active fire suppression systems
- [fire resistance rated construction](#)
 → heavy timber construction
 → fire retardant treated wood

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Exposed Heavy Timber Members



International Building Code TABLE 503

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		TYPE I A	TYPE I B	TYPE II A	TYPE II B	TYPE III A	TYPE III B	TYPE IV HT	TYPE V A	TYPE V B
A2	HEIGHT	UL	11'10"	365	255	365	255	365	250	140
	AREA	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
B	HEIGHT	UL	11'10"	565	455	565	455	565	350	240
	AREA	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
M	HEIGHT	UL	11'10"	465	455	465	455	465	350	140
	AREA	UL	UL	21,500	12,500	18,500	12,500	20,500	14,000	9,000



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Fire Retardant Treated Wood (FRTW)



[fire retardant treated wood \(FRTW\)](#)

FRTW permitted:

- in nonbearing interior walls (< 2 hr.), nonbearing exterior walls (not required to be rated), and roof construction of most noncombustible buildings
- in exterior walls of Type III construction (< 2 hr.)
- many other specific applications in the code where noncombustible or rated construction is required

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Sprinkler protection = vastly larger wood buildings



Equation 5-1 of the 2009 IBC:

$$A_a = [A_t + (A_t \times I_f) + (A_t \times I_s)]$$

I_f = maximum 75% tabular area increase per story

Equation 5-1 of the 2009 IBC:

$$A_a = [A_t + (A_t \times I_f) + (A_t \times I_s)]$$

I_f = maximum 75% tabular area increase per story;
 I_s = maximum 300% tabular area increase per story

OCCUPANCY		NONCOMBUSTIBLE		MIXED		COMBUSTIBLE	
		TYPE II A	TYPE II B	TYPE III A	TYPE III B	TYPE V A	TYPE V B
A-2	HEIGHT S/Ft	3/65 4/85	2/55 3/75	3/65 4/85	2/55 3/75	2/50 3/70	1/40 2/60
	AREA	15,500 27,125 73,625	9,500 16,625 45,125	14,000 24,500 66,500	9,500 16,625 45,125	11,500 20,125 54,625	6,000 10,500 28,500
	HEIGHT S/Ft	5/65 6/85	4/55 5/75	5/65 6/85	4/55 5/75	3/50 4/70	2/40 3/60
B	AREA	37,500 65,625 178,025	23,000 40,250 109,250	28,500 49,875 135,375	19,000 33,250 90,250	18,000 31,500 85,500	9,000 15,750 42,750
	HEIGHT S/Ft	4/65 5/85	4/55 5/75	4/65 5/85	4,55 5/75	3/50 4/70	1/40 2/60
M	HEIGHT S/Ft	4/65 5/85	4/55 5/75	4/65 5/85	4,55 5/75	3/50 4/70	1/40 2/60
	AREA	21,500 37,625 102,125	12,500 21,875 59,375	18,500 32,375 87,875	12,500 21,875 59,375	14,000 24,500 66,500	9,000 15,750 42,750

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active fire suppression systems

Unlimited Area Buildings (507 of the IBC): With sprinklers and surrounded by 60 feet of public way or yards, use group B, F, M, and S buildings up to two stories are unlimited in area and have no construction type limitation--they may be wood structures.

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active fire suppression systems

Sprinkler systems are effective and reliable
see "U.S. Experience with Sprinklers" fact sheet at www.nfpa.org

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active fire suppression systems

Debates between materials industries and among code officials
-are sprinklers a "trade-off", or a "trade-up"?
-what are the assumptions behind this debate?

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History and Recent Developments in Materials Considerations in the Codes



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Recent developments in materials considerations

As the U.S. fire record continues to improve with the use of improved fire safety systems, structural frame materials considerations in the codes have evolved.

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How much does the structural frame impact the potential for a fire, injury and loss?



UNIFORM
BUILDING CODE

BOCA NATIONAL
BUILDING CODE

STANDARD
BUILDING CODE

**INTERNATIONAL
BUILDING CODE**

Recent developments in material considerations

The Drafting Committee in 1997 had to “create” a height and area table for the IBC.

Recent developments in material considerations

Committee: what is the basis for current model code restrictions on height and area?

Recent developments in material considerations

Committee: what is the basis for current model code restrictions on height and area?

Conclusion: original height and area limits were arbitrary, considered “reasonable” at the time.

New York City Department of Buildings

Department of Commerce Building Code Committee

American Standards Association (ASA) A51



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Recent developments in material considerations

During the development of ASA A51, it was acknowledged that assumed base areas were arbitrary and not based on any systematic fire science.

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Recent developments in material considerations

Committee: no compelling fire data to support limiting the height or area of a building beyond the natural limits imposed by the mechanical properties of the construction materials

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Recent developments in material considerations

Committee: more important were travel distance for egress, protection of exits, and fire detection and suppression systems.

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Recent developments in material considerations

Counter-arguments are based on the desire to preclude the increase of fire risk from any prevailing or previous height and area standard--but the U.S. fire record has continued to steadily improve

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Recent developments in material considerations

In the end, the 1997 Drafting Committee adopted the traditional approach:

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Recent developments in material considerations

Committee: allow buildings currently permitted under any one of the existing model building codes.



Recent developments in material considerations

Recent developments in material considerations

The Chapter 7 Task Group of NFPA 5000, a committee of materials representatives, code enforcers, fire protection engineers, and fire service representatives, studied the issue

Recent developments in material considerations

Among their conclusions: no compelling fire data to support the conventional height and area table approach

Recent developments in material considerations

Appendix D: Construction Types and Enhanced Fire Compartment Requirements

Recent developments in material considerations

The alternative approach in optional Appendix D establishes maximum area within boundaries of fire resistance rated construction regardless of type of construction (a compartmental approach without limit to number of compartments or area of building, regardless of construction type).

active fire suppression systems

Unlimited Area Buildings (507 of the IBC): With sprinklers and surrounded by 60 feet of public way or yards, use group B, F, M, and S buildings up to two stories are unlimited in area and have no construction type limitation--they may be wood structures.

New trend: focus on firefighter safety



New concern: firefighter safety

Are lightweight engineered wood products dangerous for firefighters?

QuickTime™ and a decompressor are needed to see this picture.

New concern: firefighter safety

1992: National Engineered Lightweight Construction Research Project (National Fire Protection Research Foundation)

More recent studies by UL and the National Research Council of Canada

New concern: firefighter safety

Elements of the debate:

- less wood mass can result in earlier loss of strength under fire conditions
- there are many variables in firefighter injury/death related to collapse
- comparable risks among all building materials

New concern: firefighter safety

Lightweight building components--of all materials types--are here to stay

New concern: firefighter safety

Lightweight building components--of all materials types--are here to stay

Some engineered wood products are “lean and green”; some perform like solid sawn

New concern: firefighter safety

AF&PA is working with the fire service on a national level to address concerns

QuickTime™ and a decompressor are needed to see this picture.

New concern: firefighter safety

QuickTime™ and a decompressor are needed to see this picture.

New concern: firefighter safety

IAFF, IAFC, NAHB, and AWC are co-proponents of a challenge to RB-87; 1/2” drywall on I-joist and truss floor assemblies (not required when sprinklered)

Thank you--questions?

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