



Opportunities for Wood Use in Low-Rise Commercial Buildings

February 13, 2024

Presented by
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WoodWorks



Apex Plaza / Courtesy William McDonough + Partner

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Course Description

This course is intended for designers who want to learn more about the use of wood-frame construction for low-rise retail, office and restaurant occupancies designed under the International Building Code.

Topics covered include common framing systems and details, paths to code compliance and tall wall design.

Learning Objectives

1. Review permitted applications of wood-frame construction in the International Building Code in low-rise commercial buildings, with an emphasis on retail, office and restaurant occupancies.
2. Consider detailing options for the framing of common features in low-rise commercial buildings, such as flat roofs, parapets and open front floor plans.
3. Examine code requirements pertaining to multi-occupancy buildings and different paths to compliance.
4. Evaluate opportunities for tall wall framing with wood construction and understand the design requirements for code compliance.

Outline

- » Introduction
- » Framing System Design and Details
 - » Structural Design Compliance
 - » Wall Framing
 - » Wall Bracing
 - » Roof Framing
- » Non-Structural Requirements and Design
 - » Allowable Heights and Areas
 - » Multi-Tenant and Multi-Occupancy Buildings
 - » Fire Resistance and Detailing
- » Large Retail Project Case Study

Outline

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Low-Rise Wood Construction

Retail



Restaurants



Warehouses



Storage Facilities

Offices

Medical Office Buildings

Schools

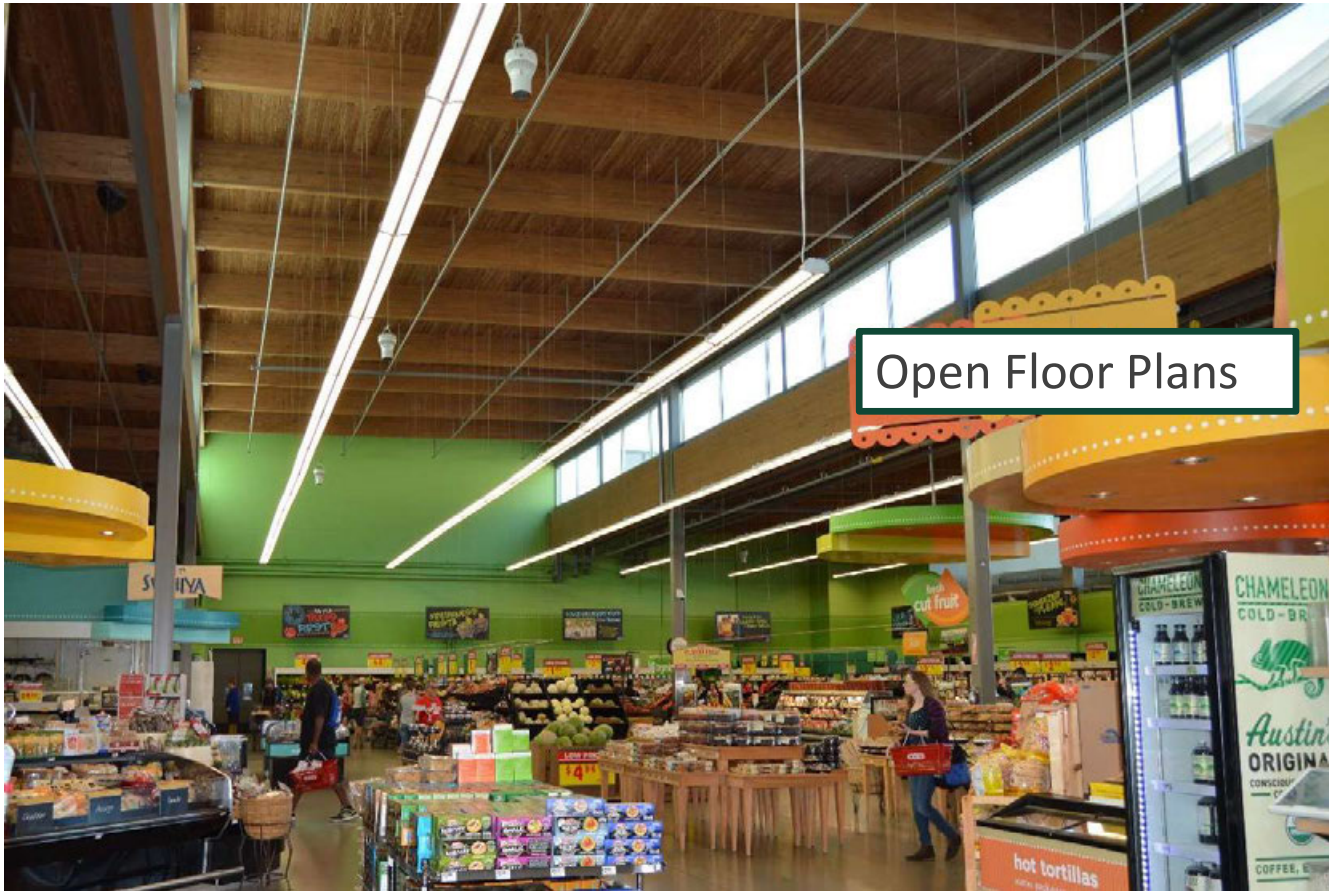
Wood Can Handle Common Features



Wood Can Handle Common Features



Wood Can Handle Common Features



Open Floor Plans

IBC Occupancy Groups

- » **Assembly** : Groups A-1, A-2, A-3, A-4 and A-5.
- » **Business**: Group B.
- » **Educational**: Group E.
- » **Factory and Industrial**: Groups F-1 and F-2.
- » **High Hazard**: Groups H-1, H-2, H-3, H-4 and H-5.
- » **Institutional**: Groups I-1, I-2, I-3 and I-4.
- » **Mercantile**: Group M.
- » **Residential**: Groups R-1, R-2, R-3 and R-4.
- » **Storage**: Groups S-1 and S-2.
- » **Utility and Miscellaneous**: Group U.

IBC Occupancy Groups

- » **Assembly : Groups A-2**
 - » Nightclubs, Restaurants, Taverns and bars
- » **Business: Group B**
 - » Banks, barber and beauty shops, dry cleaning and laundries, professional services, etc.
- » **Mercantile: Group M**
 - » Department stores
 - » Drug stores
 - » Markets
 - » Motor fuel-dispensing facilities
 - » Retail or wholesale stores
 - » Sales rooms

ICC Building Valuation Data

	Construction Type								
Occupancy Group	IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
A-2 Assembly	269	261	252	245	229	223	236	208	202
B Business	261	251	242	232	211	203	223	187	178
M Mercantile	201	193	185	177	162	156	168	141	135

Published \$ / Square Foot of Building Area

Structural Wood Framing
Allowed

Source February 2023, ICC Published National Building Valuation Data

<https://www.iccsafe.org/products-and-services/i-codes/code-development-process/building-valuation-data/>

ICC Building Valuation Data

Occupancy Group	Construction Type		
	IIA	IIIA	Difference
A-2 Assembly	252	229	\$23/sf
B Business	242	211	\$31/sf
M Mercantile	185	162	\$23/sf

Published \$ / Square Foot of Building Area

Type IIA and IIIA construction
have very similar allowable
heights and areas

Is this enough to matter to
you or your clients?

Source August 2023, ICC Published National Building Valuation Data

ICC Building Valuation Data

Occupancy Group	Construction Type		
	IIB	VA	Difference
A-2 Assembly	245	208	\$37/sf
B Business	232	187	\$45/sf
M Mercantile	177	141	\$36/sf

Published \$ / Square Foot of Building Area

Type IIB and VA construction have very similar allowable heights and areas.

An even larger difference than IIA and IIIA

Source February 2023, ICC Published National Building Valuation Data

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Paths to Structural Compliance

- » IBC Chapter 16 as the starting point for most structural requirements
- » IBC Chapter 23 for wood specific requirements and paths to compliance
- » ASCE 7 Minimum Design Loads for Buildings and Other Structures referenced from IBC Chapter 16 for Wind and Earthquake Loading

	Path to Compliance	Reference	Approach
1	Conventional Construction	IBC 2308	Prescriptive
2	AWC Wood Frame Construction Manual	IBC 2309	Prescriptive or Engineered
3	AWC National Design Specification for Wood Construction (NDS) AWC Special Design Provisions for Wind and Seismic (SPDWS)	IBC 2305 IBC 2306 (ASD) IBC 2307 (LRFD)	Engineered

Prescriptive Methods



IBC Conventional Construction



AWC Wood Frame Construction Manual

**Both Limited to 40 psf Live loads.
Possibly useful for 1 story Commercial Buildings**

Conventional Construction in IBC 2308

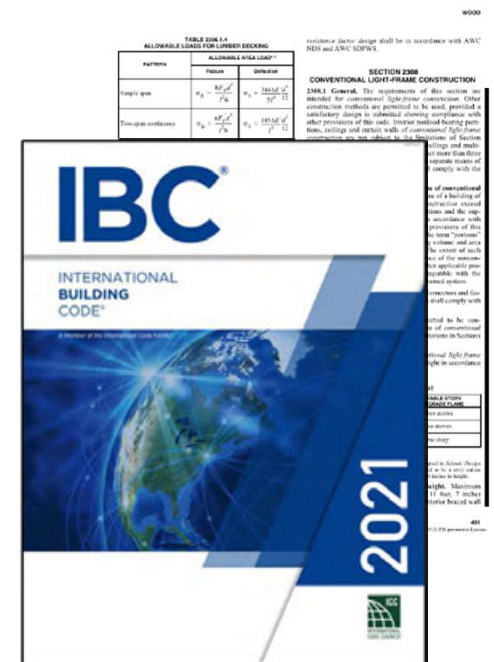
IBC Conventional Construction Scope of Application

- | | |
|----------------------------|---------------|
| » Max bearing wall height: | 10 ft |
| » Max Roof Dead Load | 15 psf |
| » Max Live Load | 40 psf |
| » Max Ground Snow Load | 50 psf |
| » Max Ultimate Wind Speed | 130 mph |
| » Max roof span | 40 ft |

Prescriptive Design

- » Similar to IRC provisions for conventional construction
- » When in scope, many details defined in the code.
- » Span Tables for headers, beams, joists and rafters
- » Braced Wall Panels not Engineered Shear Walls

Can be useful for 1 story Commercial Buildings



AWC Wood Frame Construction Manual

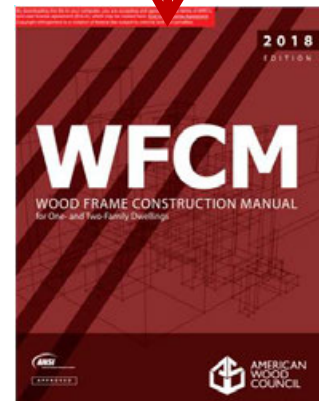
AWC WFCM Scope of Application:

- » Risk Category I or II Buildings (See IBC Table 1604.5)
- » Max stud height
 - » **10' load bearing**
 - » 20' non-load bearing
- » Max Roof and Ceiling Dead Load 25 psf
- » Max Live Load **40 psf**
- » Max Ground Snow Load 70 psf
- » Max Ultimate Wind Speed 195 mph
- » Mean Roof Height 33 ft
- » Max building length/width 80 ft

AWC WFCM Includes:

- » Engineered And Prescriptive Design Sections
- » Useful tables such as allowable wall stud spans including deflection criteria (*quick tall-wall checks*)

***Can be useful for 1 story Commercial Buildings.
Broader scope than IBC 2308***



Engineered Design via AWC NDS and SDPWS



*General Engineered Approach:
Not limited in scope as
Conventional Construction and WFCM*

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Wall Framing Options

Solid Sawn Lumber Sizes

- » 2x4 to 2x14
- » 4x, 6x and greater thickness available

Different Species Groups Available

- » “Southern Pine” is not a single species but a group of related species which are graded together
- » Other common species groups include: Doug-Fir Larch, Hem-Fir, Spruce-Pine-Fir

Different Grades

- » Visually Graded: #1, #2, etc
 - » Most Common
- » Machine Graded:
 - » Machine Stress Rated (MSR)
 - » Mechanical Evaluated Lumber (MEL)



Automatic Lumber Tester
Photo: Metriguard

Wall Framing Options

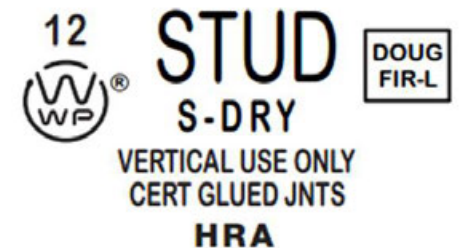
Finger-Jointed Dimensional Lumber:

- » Structural end-gluing of shorter members
- » Technically called “End-Jointed”
- » Can be used interchangeably with solid sawn lumber of same species and grade, where approved.
 - » See IBC 2303.1.1
- » Look for grading and grade stamp by



Variations of Finger Jointed Lumber

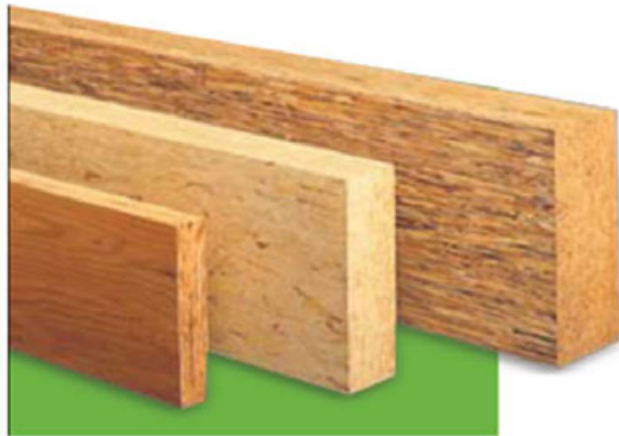
- » **HRA** (Heat Resistant Adhesive)
 - » Only use HRA FJ Lumber in fire rated assemblies
- » **Non-HRA** (or no HRA in stamp)
- » **Vertical Use Only** or **Stud Use Only**
 - » Bending or tension stresses only from short term loading



Wall Framing Options

Engineered Lumber Products

- » Laminated Strand Lumber (LSL)
- » Laminated Veneer Lumber (LVL)
- » Parallel Strand Lumber (PSL)
- » Glue Laminated Lumber (Glulam)



Tall Walls in Low Rise



Parameters for Engineered Stud Design

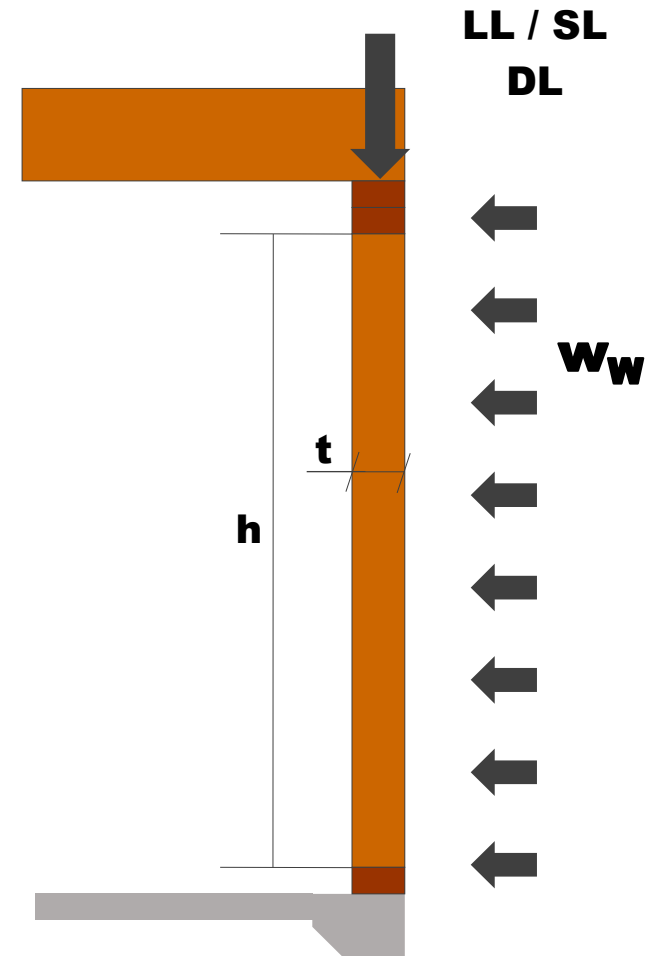
Structure Parameters

- Design height - **h**
- Stud spacing
- Wall thickness – **t**

Loading Parameters

- Dead Load - **DL**
- Live and Snow Load – **LL/SL**
- Wind Loads (C&C and MWFRS) – **w_w**
- Any eccentricity

Deflection Criteria based on Finishes



Exterior Wall Design Checks

- » Strength Check 1:

Gravity + Main Lateral Force Loads

- » Strength Check 2:

Full Components and Cladding Wind Loads

- » Deflection Check:

Reduced Components and Cladding Wind Loads

Strength Check 1 for Stud Design

Strength Check as a Vertical Load Supporting element:

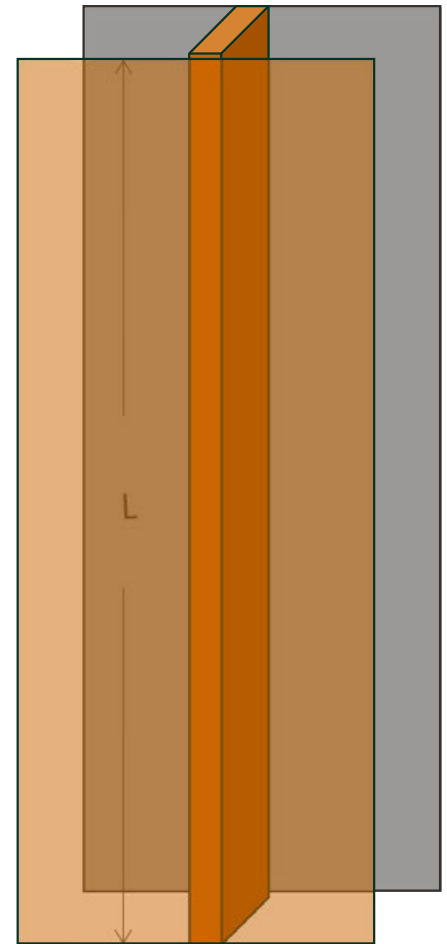
- » Apply Vertical Dead, Live, Roof and/or Snow Loads
- » Apply out-of-plane lateral loads
 - » MWFRS wind loads (ASCE 7-16 Chapter 27 or 28)
 - » Seismic wall forces (ASCE 7-16 12.11.1)
- » Apply vertical MWFRS wind or Seismic force (if any)
 - » For example: a hold-down post.
- » Combined Bending & Axial Load Check per AWC NDS
- » Use standard load combinations
 - » IBC Section 1605 or
 - » ASCE 7 Chapter 2

Design Tip: Bottom plate crushing may govern over Stud and Post Capacities

Wall Sheathing Provides Weak Axis Bracing

NDS Commentary:

“Experience has shown that any code allowed thickness of gypsum board, hardwood plywood, or other interior finish adequately fastened directly to studs will provide adequate lateral support of the stud across its thickness irrespective of the type or thickness of exterior sheathing and/or finish used.”



Design Considerations

Slenderness Limits (NDS 2018 3.7.1.4)

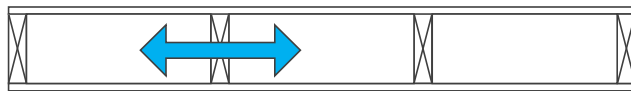
Max Effective Unbraced Length = $50d$, d = depth in inches

Max of $75d$ during construction

$1\frac{1}{2}$ " depth

6'-3" max unbraced length.

9'-4" during construction.

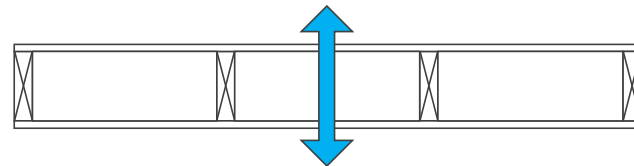


Stud or column can be braced against buckling in this direction by sheathing.

$3\frac{1}{2}$ " (2x4) Max Height: 14'-7"

$5\frac{1}{2}$ " (2x6) Max Height: 22'-11"

$7\frac{1}{4}$ " (2x8) Max Height: 30'-2"



Stud or column is **not** braced against buckling in this direction by sheathing.

Intermediate Wall Stud Blocking



Strength Checks on Stud Design 2

Strength Check for Components & Cladding Winds

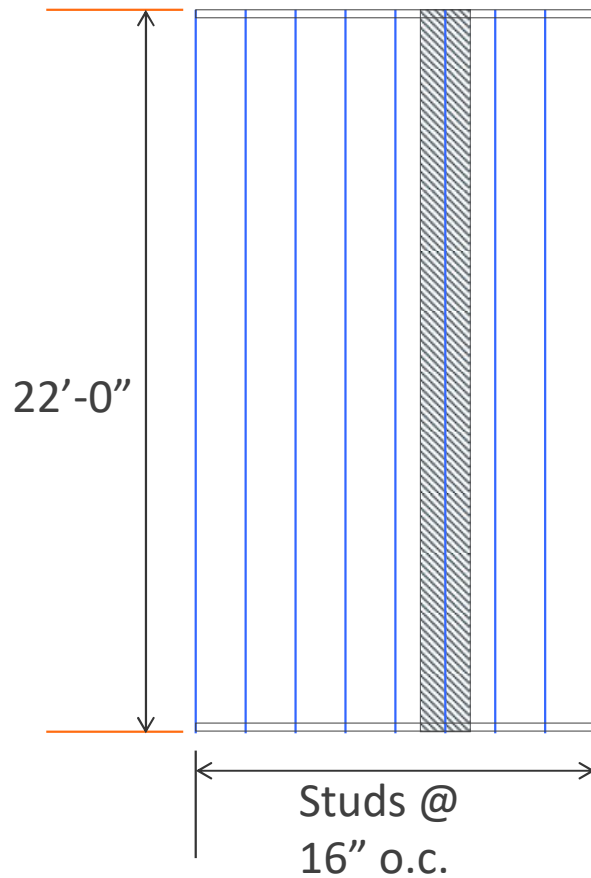
- » No axial loading
- » **C&C transverse Wind loads only**
- » Check stud for bending and shear

Design Tip: Be aware of ASCE 7 Definition of Effective Wind Area to decrease the required C&C wind load

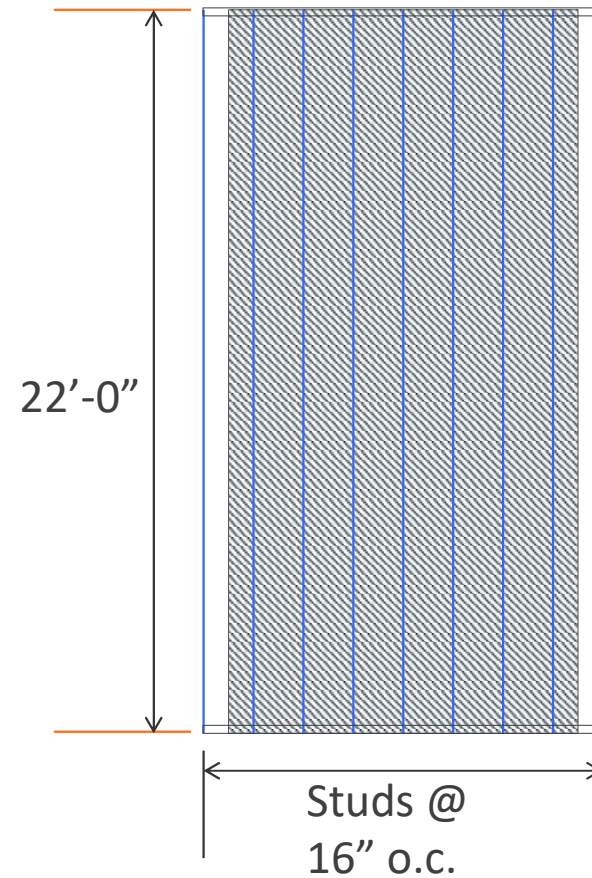
EFFECTIVE WIND AREA, A : The area used to determine (GC_p). For component and cladding elements, the effective wind area in Figs. 30.4-1 through 30.4-7, 30.5-1, 30.6-1, and 30.8-1 through 30.8-3 is the span length multiplied by an effective width that need not be less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.

Effective Wind Area Example

$$\text{Tributary Area} = (22)(1.33) = 29 \text{ ft}^2$$



$$\text{Effective Wind Area} = 22^2/3 = 161 \text{ ft}^2$$



Strength Checks on Stud Design 2

Strength Check for Components & Cladding Winds

- » No axial loading
- » C&C transverse Wind loads only
- » **Check stud bending** and shear.

Design Tip: For bending stress check, be aware of Repetitive Use factor C_r of NDS and Wall Stud Repetitive Member Factor of SDPWS 3.1.1

Table 3.1.1.1 Wall Stud Repetitive Member Factors	
Stud Size	System Factor
2x4	1.50
2x6	1.35
2x8	1.25
2x10	1.20
2x12	1.15

Strength Checks on Stud Design 2

Strength Check for Components & Cladding Winds

- » No axial loading
- » C&C transverse Wind loads only
- » **Check stud bending** and shear.

Design Tip: If using ASD for design, don't forget to take the allowed reduction in the wind load for the ASD load combinations.

** ASCE 7 Ultimate Wind Speed Loads*

$$D + (0.6W)$$
$$0.6D + 0.6W$$

Deflection Checks on Stud Design

Deflection Check for Components and Cladding Winds

- » No Axial Loading
- » C&C transverse Wind load only.
- » Check out-of-plane deflection to IBC Table 1604.3 or other more stringent requirements.

Note: This check often governs tall walls

Design Tip: ASCE 7 Definition of Effective Wind Area to decrease the required C&C wind load applies here.

Deflection Checks on Stud Design

Deflection Check for Components and Cladding Winds

- » No Axial Loading
- » C&C transverse Wind load only.
- » Check out-of-plane deflection to IBC Table 1604.3 or other more stringent requirements.

TABLE 1604.3
DEFLECTION LIMITS^{a, b, c, h, i}

CONSTRUCTION	<i>L</i>	<i>S</i> or <i>W</i> ⁱ
Exterior walls:		
With plaster or stucco finishes	—	//360
With other brittle finishes	—	//240
With flexible finishes	—	//120

Deflection Checks on Stud Design

Deflection Check for Components and Cladding Winds

- » No Axial Loading
- » C&C transverse Wind load only.
- » Check out-of-plane deflection to IBC Table 1604.3 or other more stringent requirements.

Design Tip: Read all the footnotes!

*Multiply calculated C&C Wind Loads by
0.42 when using V_{ULT} (ASCE 7-10 and later) OR
0.70 when using V_{ASD} (ASCE 7-05 and earlier)*

Deflection Checks on Stud Design

Deflection Check for Components and Cladding Winds

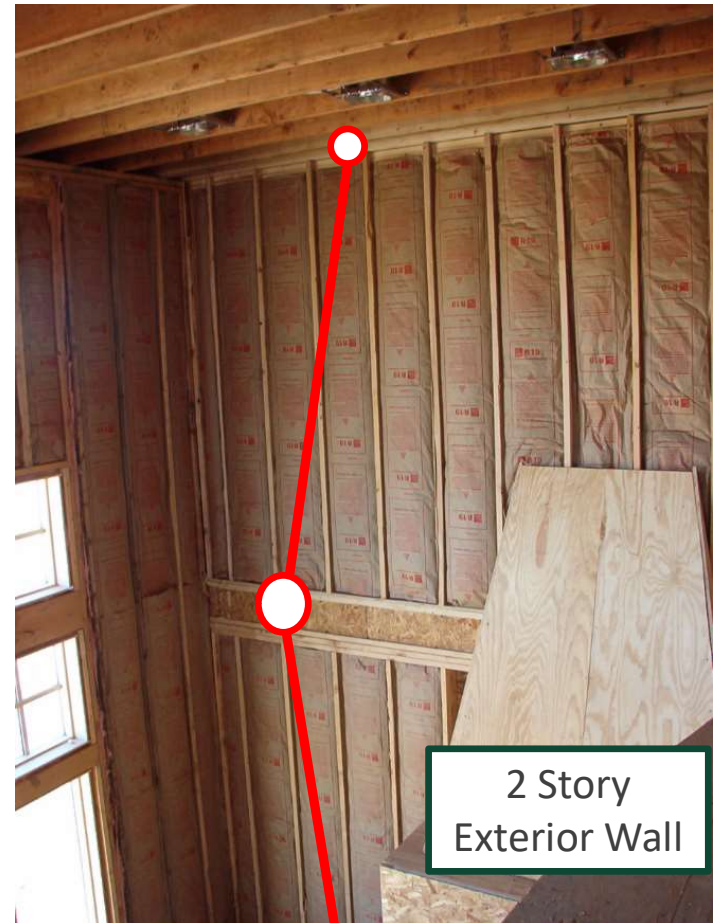
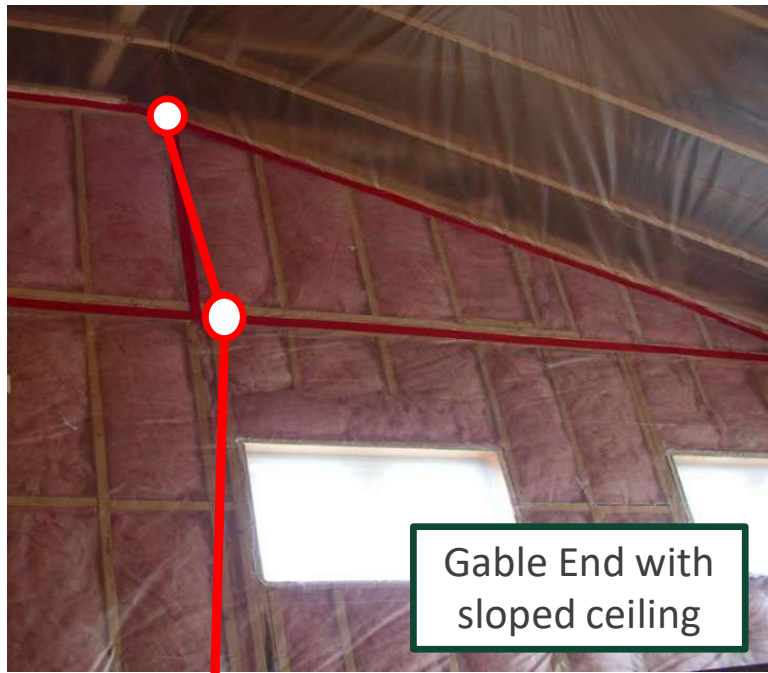
- » No Axial Loading
- » C&C transverse Wind load only.
- » Check out-of-plane deflection to IBC Table 1604.3 or other more stringent requirements.

Design Tip: Change in SDPWS 2015 referenced from IBC 2015 allows application of Wall Stud Repetitive Factor to Stud STIFFNESS. See SDPWS 3.1.1

Table 3.1.1.1 Wall Stud Repetitive Member Factors	
Stud Size	System Factor
2x4	1.50
2x6	1.35
2x8	1.25
2x10	1.20
2x12	1.15

Can this Exterior Wall Pass Deflection Check?

“Hinge Point” creates a structural weakness in the wall



Can this Exterior Wall Pass Deflection Check?

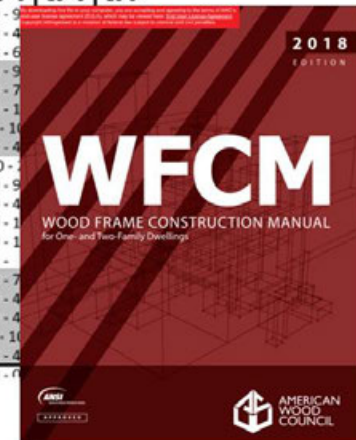
Solution = Continuous Studs



AWC WFCM Prescriptive Stud Tables

Table 3.20A2 Maximum Exterior Loadbearing¹ and Non-Loadbearing Stud Lengths for Common Lumber Species Resisting Interior Zone Wind Loads - Stud Deflection Limit = H/240 **Exposure B H/240**
(Fully Sheathed with a Minimum Sheathing Material)²

700-yr. Wind Speed 3-second gust (mph)			110			115			120			130			140		
Stud Spacing (in.)	Species	Grade	2x4	2x6	2x8	2x4	2x6	2x8	2x4	2x6	2x8	2x4	2x6	2x8	2x4	2x6	2x8
Maximum Allowable Stud Length (ft.-in.) ¹																	
16	DFL	SS	12 - 3	19 - 8	20-0†	11 - 11	19 - 1	20-0†	11 - 6	18 - 6	20-0†	10 - 11	17 - 6	20-0†	10 - 4	16 - 8	20-0†
	DFL	No.1	11 - 10	18 - 11	20-0†	11 - 5	18 - 4	20-0†	11 - 1	17 - 10	20-0†	10 - 6	16 - 10	20-0†	10 - 0	16 - 0	20-0†
	DFL	No.2	11 - 7	18 - 6	20-0†	11 - 2	18 - 0	20-0†	10 - 10	17 - 5	20-0†	10 - 3	16 - 6	20-0†	9 - 9	15 - 9	20-0†
	DFL	No.3/Stud	11 - 0	17 - 8	20-0†	10 - 8	17 - 2	20-0†	10 - 4	16 - 8	20-0†	9 - 10	15 - 9	20-0†	9 - 4	15 - 4	20-0†
	DFL	Standard	11 - 0	-	-	10 - 6	-	-	10 - 0	-	-	9 - 3	-	-	8 - 6	-	-
	HF	SS	11 - 7	18 - 6	20-0†	11 - 2	18 - 0	20-0†	10 - 10	17 - 5	20-0†	10 - 3	16 - 6	20-0†	9 - 9	15 - 9	20-0†
	HF	No.1	11 - 3	18 - 2	20-0†	10 - 11	17 - 7	20-0†	10 - 8	17 - 1	20-0†	10 - 1	16 - 2	20-0†	9 - 7	15 - 7	20-0†
	HF	No.2	10 - 9	17 - 3	20-0†	10 - 5	16 - 9	20-0†	10 - 1	16 - 3	20-0†	9 - 7	15 - 4	20-0†	9 - 1	15 - 1	20-0†
	HF	No.3/Stud	10 - 5	16 - 9	20-0†	10 - 2	16 - 3	20-0†	9 - 10	15 - 9	20-0†	9 - 4	14 - 11	19 - 11	8 - 10	14 - 10	20-0†
	HF	Standard	10 - 5	-	-	10 - 2	-	-	9 - 10	-	-	9 - 0	-	-	8 - 4	-	-
	SP	SS	12 - 0	19 - 4	20-0†	11 - 8	18 - 9	20-0†	11 - 4	18 - 2	20-0†	10 - 9	17 - 2	20-0†	10 - 2	16 - 6	20-0†
	SP	No.1	11 - 7	18 - 6	20-0†	11 - 2	18 - 0	20-0†	10 - 10	17 - 5	20-0†	10 - 3	16 - 6	20-0†	9 - 9	15 - 9	20-0†
	SP	No.2	11 - 0	17 - 8	20-0†	10 - 8	17 - 2	20-0†	10 - 4	16 - 8	20-0†	9 - 10	15 - 9	20-0†	9 - 4	15 - 4	20-0†
	SP	No.3	10 - 9	17 - 3	20-0†	10 - 5	16 - 9	20-0†	10 - 1	16 - 3	20-0†	9 - 7	15 - 0	19 - 2	9 - 1	15 - 1	20-0†
	SP	Stud	10 - 9	17 - 3	20-0†	10 - 5	16 - 9	20-0†	10 - 1	16 - 3	20-0†	9 - 7	15 - 0	19 - 2	9 - 1	15 - 1	20-0†
	SP	Standard	9 - 11	-	-	9 - 6	-	-	9 - 1	-	-	8 - 4	-	-	-	-	-
	SPF	SS	11 - 3	18 - 2	20-0†	10 - 11	17 - 7	20-0†	10 - 8	17 - 1	20-0†	10 - 1	16 - 2	20-0†	9 - 7	15 - 7	20-0†
	SPF	No.1	11 - 0	17 - 8	20-0†	10 - 8	17 - 2	20-0†	10 - 4	16 - 8	20-0†	9 - 10	15 - 9	20-0†	9 - 4	15 - 4	20-0†
	SPF	No.2	11 - 0	17 - 8	20-0†	10 - 8	17 - 2	20-0†	10 - 4	16 - 8	20-0†	9 - 10	15 - 9	20-0†	9 - 4	15 - 4	20-0†
	SPF	No.3/Stud	10 - 5	16 - 9	20-0†	10 - 2	16 - 3	20-0†	9 - 10	15 - 9	20-0†	9 - 4	14 - 11	19 - 11	8 - 10	14 - 10	20-0†
	SPF	Standard	10 - 5	-	-	10 - 2	-	-	9 - 10	-	-	9 - 0	-	-	8 - 4	-	-



If building within scope of AWC WFCM, it contains useful wall height tables

Tall Walls in Office

Atlanta, GA

2-Story, 12,000 sf office bldg.

≈20ft tall

2x6 SYP #2 at high entry



Tall Walls in Restaurant

Emeryville, CA

24'+ tall

2x8 Doug Fir



Tall Walls in Retail

Large Diamond Retailer
Murfreesboro, TN
22' tall 2x8 Pre-Fabricated



Small Retail Building – Northern CA



Small Retail Building – Northern CA

Flat Roof with:

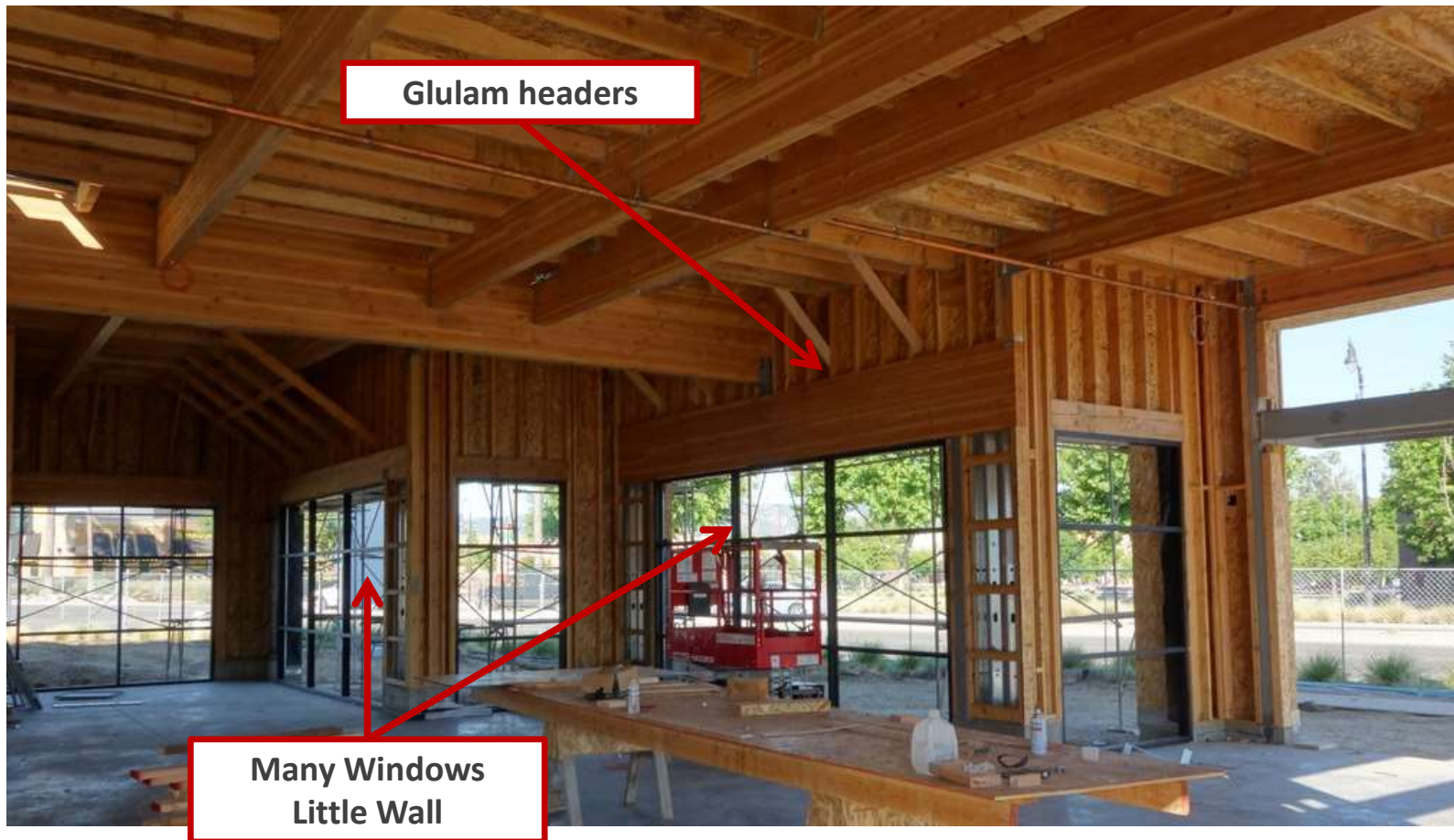
- » WSP Sheathing
- » 2x Sub-Purlins
- » Glulam Purlins
- » Glulam Beams

20 ft 2x6 DF walls

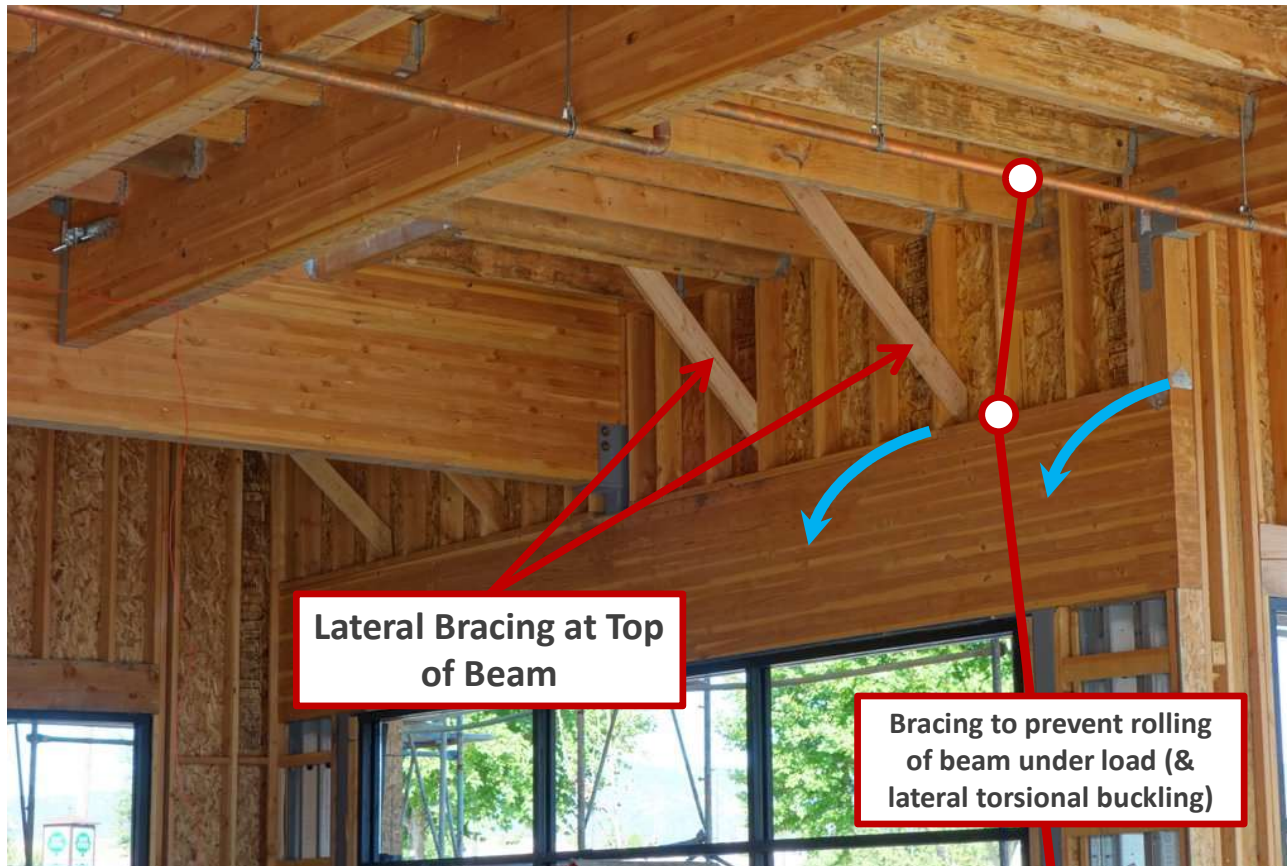
- » Interior
- » Exterior



Small Retail Building – Northern CA



Small Retail Building – Northern CA



Small Retail Building – Northern CA



Retail Building – Berlin Vermont

4,500 sf



Retail Building – Berlin Vermont

Roof Construction:

- » Metal Plate Connected Monoslope Wood Roof Trusses
- » 6' Deep at Front, 4.5' at Back, 50' Span, 24" o.c.
- » Wood Structural Panels
- » 2x6 @ 16" o.c. Bearing Walls & Shear Walls– 13' Tall
- » Structural Steel Open Front Frame



Retail Building – Berlin Vermont

Front Canopy and Façade



Retail Building – Berlin Vermont



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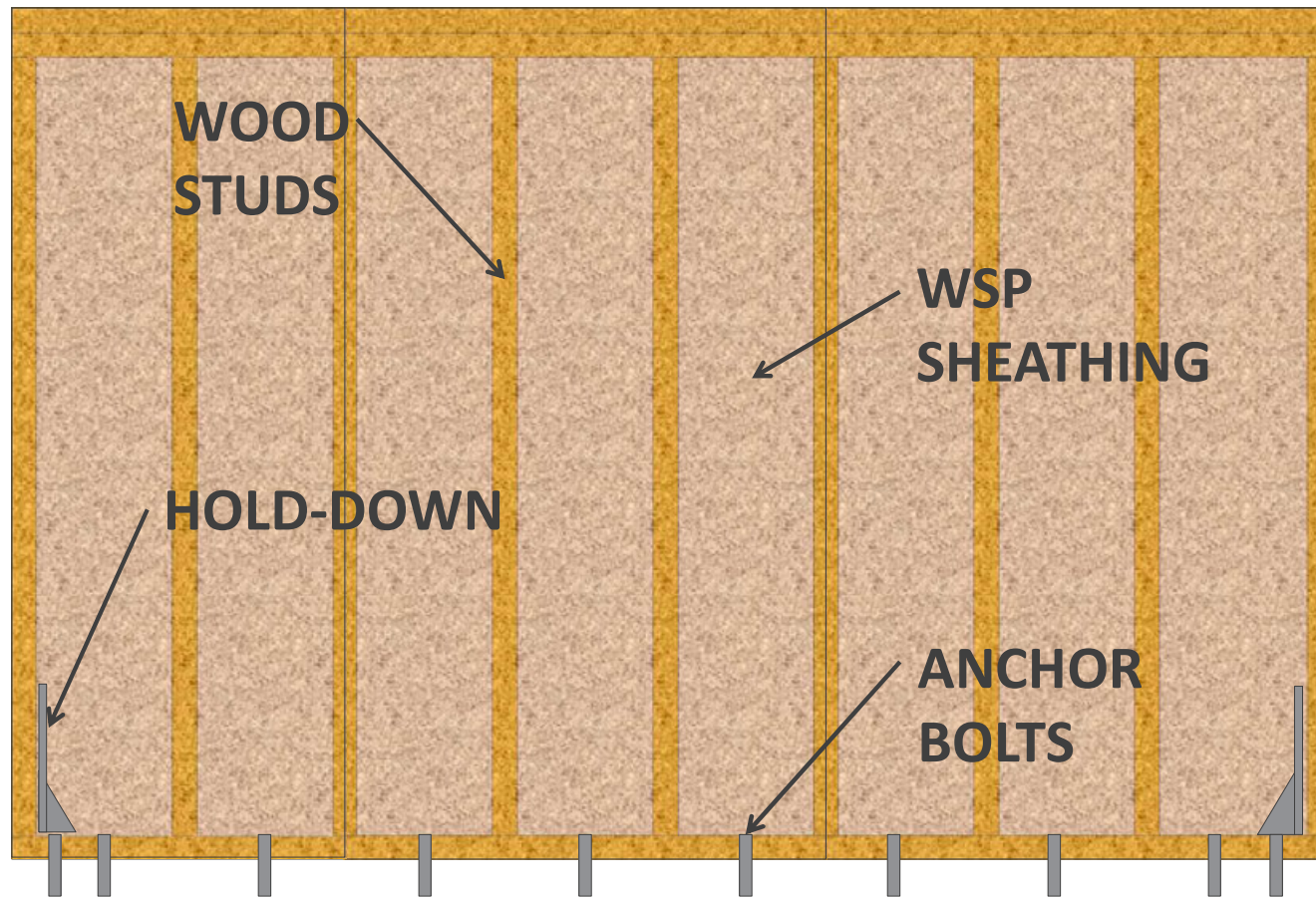
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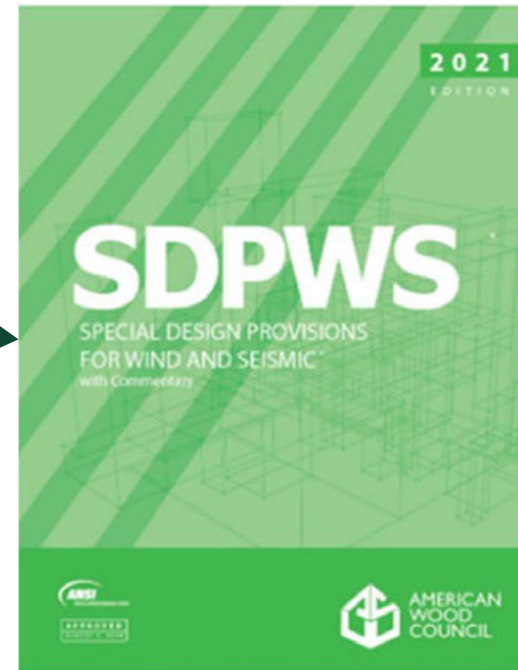
Anatomy of Wood Sheathed Shear Walls



Lateral Load Capacity

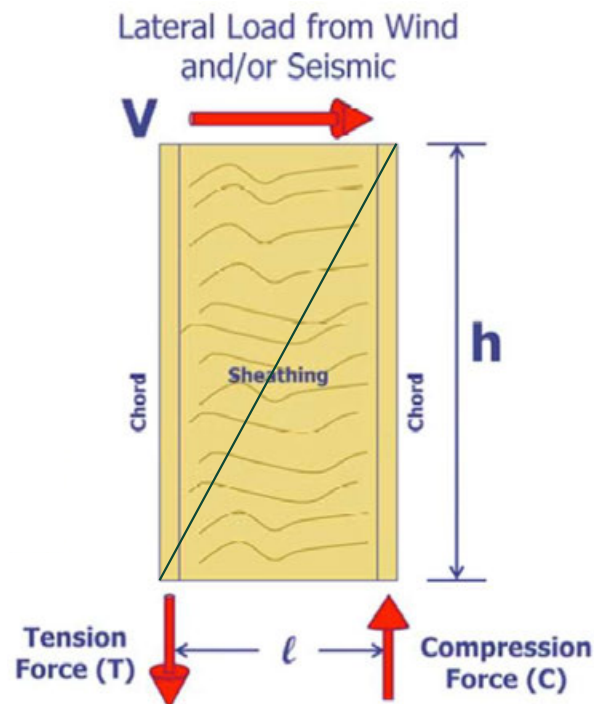


Tip: Nailed Wood Shear Wall Allowable Capacities in IBC 2009 and earlier versions. Not in IBC 2012+. Nominal capacity in SDPWS



AWC SDPWS
Provides details and capacities of these types of nailed wood shear walls

Shear Wall Requirements in AWC SDPWS



Wood Education Institute

Table 4.3.4 Maximum Shear Wall Aspect Ratios

Shear Wall Sheathing Type	Maximum h/b, Ratio
Wood structural panels, unblocked	2:1
Wood structural panels, blocked	3.5:1 ¹
Particleboard, blocked	2:1
Diagonal sheathing, conventional	2:1
Gypsum wallboard	2:1 ²
Portland cement plaster	2:1 ²
Structural Fiberboard	3.5:1 ³

3:5:1 max aspect ratio for blocked Wood Structural Panel Shear Wall.
Reduction in Capacity when greater than 2:1

Shear Wall Requirements in AWC SDPWS

Capacities in SDPWS are **Nominal** values. Not ASD

SDPWS 2015

Separate Seismic and Wind nominal values

Divide Nominal Values by 2.0 for ASD Capacity

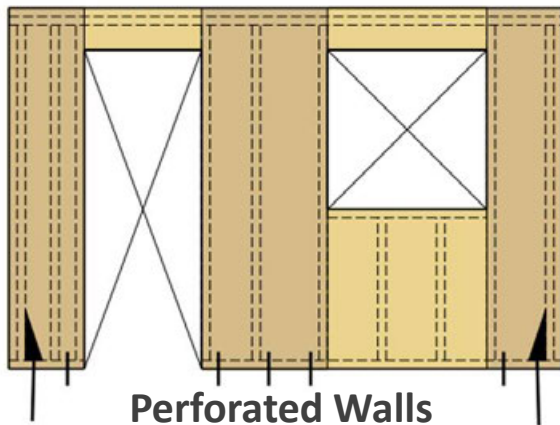
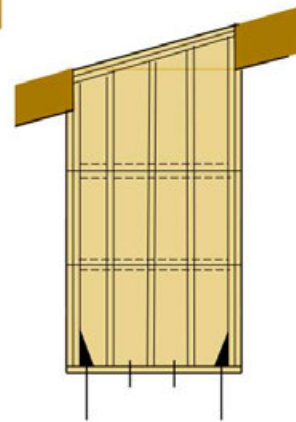
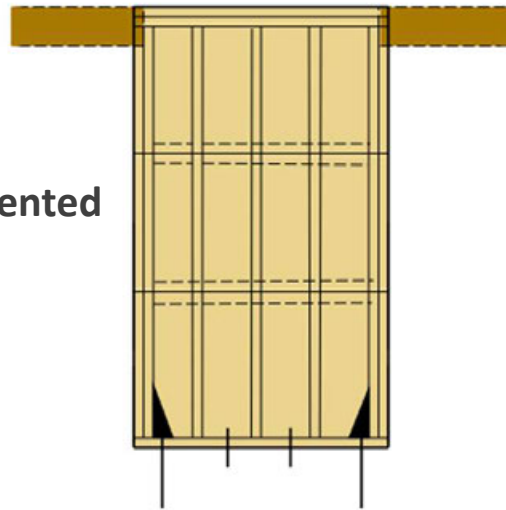
Multiply Nominal Values by 0.8 for LRFD Capacity

Table 4.3A Nominal Unit Shear Capacities for Wood-Frame Shear Walls^{1,3,6,7}

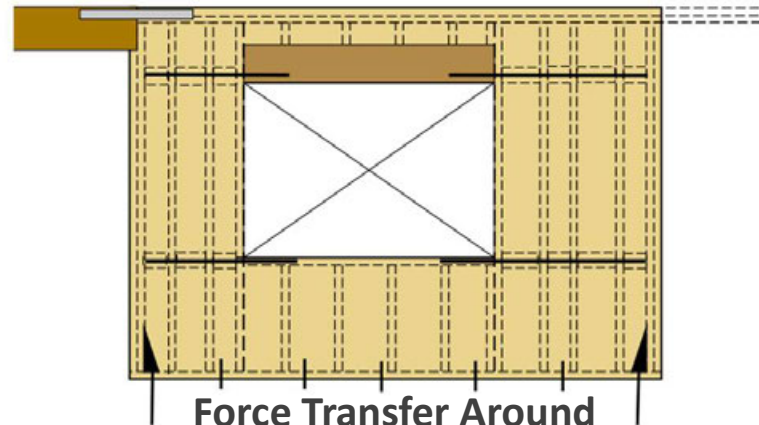
Wood-based Panels ⁴																			
Sheathing Material	Minimum Nominal Panel Thickness (in.)	Minimum Fastener Penetration in Framing Member or Blocking (in.)	Fastener Type & Size	A SEISMIC										B WIND					
				Panel Edge Fastener Spacing (in.)										Panel Edge Fastener Spacing (in.)					
				6			4			3		2		6	4	3	2		
				v _s (plf)	G _s (kips/in.)		v _s (plf)	G _s (kips/in.)		v _s (plf)	G _s (kips/in.)		v _s (plf)	G _s (kips/in.)		v _w (plf)	v _w (plf)	v _w (plf)	v _w (plf)
Wood Structural Panels - Structural I ^{4,5}	5/16	1-1/4	Nail (common or galvanized box) 6d	400	13	10	600	18	13	780	23	16	1020	35	22	560	840	1090	1430
	3/8 ²	1-3/8	8d	460	19	14	720	24	17	920	30	20	1220	43	24	645	1010	1290	1710
	7/16 ²			510	16	13	790	21	16	1010	27	19	1340	40	24	715	1105	1415	1875
	15/32			560	14	11	860	18	14	1100	24	17	1460	37	23	785	1205	1540	2045
	15/32	1-1/2	10d	680	22	16	1020	29	20	1330	36	22	1740	51	28	950	1430	1860	2435
Wood Structural Panels – Sheathing ^{4,5}	5/16	1-1/4	6d	360	13	9.5	540	18	12	700	24	14	900	37	18	505	755	980	1260
	3/8			400	11	8.5	600	15	11	780	20	13	1020	32	17	560	840	1090	1430
	3/8 ²			8d	440	17	12	640	25	15	820	31	17	1060	45	20	615	895	1150
	7/16 ²	480	15		11	700	22	14	900	28	17	1170	42	21	670	980	1260	1640	
	15/32	520	13		10	760	19	13	980	25	15	1280	39	20	730	1065	1370	1790	
	15/32	1-1/2	10d	620	22	14	920	30	17	1200	37	19	1540	52	23	870	1290	1680	2155
19/32	680			19	13	1020	26	16	1330	33	18	1740	48	22	950	1430	1860	2435	

Engineered Shear Wall Types

Solid or Segmented Walls



Perforated Walls



**Force Transfer Around
Openings Walls**

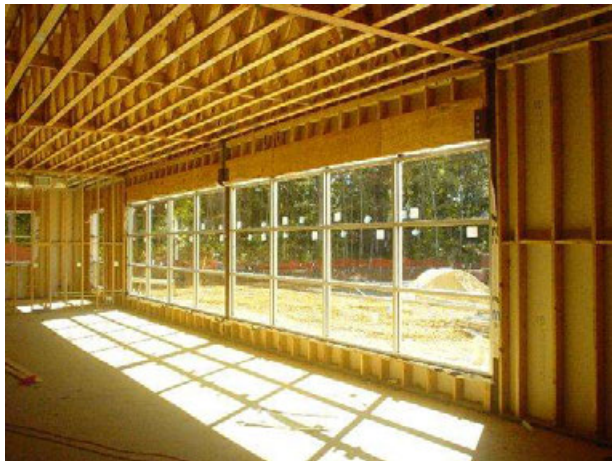
Why Use Force Transfer Around Openings?



Why Use Force Transfer Around Openings?



Open Front & Narrow Walls



Prefabricated Shear Wall Options

Proprietary Products with Evaluation Reports
Different Material Options



Metal Panel
Hardy Frame



Metal Panel
Simpson Strong-Tie



Wood Panels
Simpson Strong-Tie

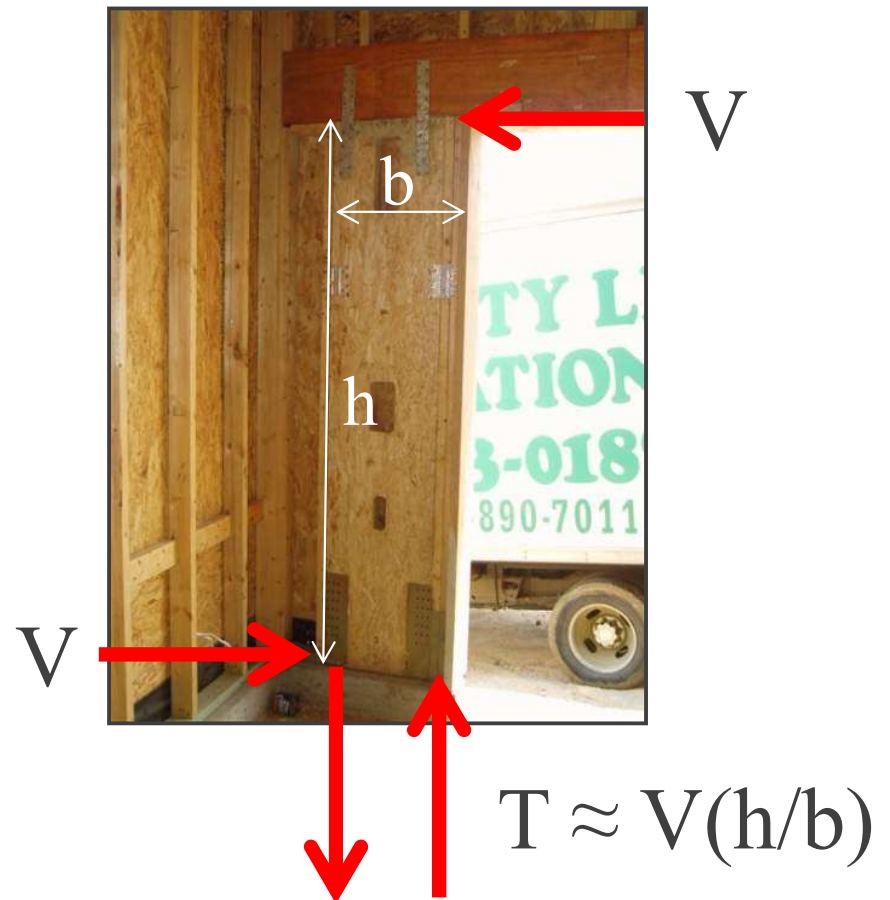
The primary benefit is to have lateral force resistance where a 3:5 to 1 aspect ratio shear wall does not fit.

Using Prefabricated Shear Walls

Considerations:

- » Drift compatibility with other walls sharing load
- » Large hold-down forces
- » Foundation Anchorage Coordination
- » Sizes range from 12"->24" wide to 6.5'->20' tall

*Tip: Cast-in-place anchorage to concrete needed.
Don't expect post-installed concrete anchors to work.*



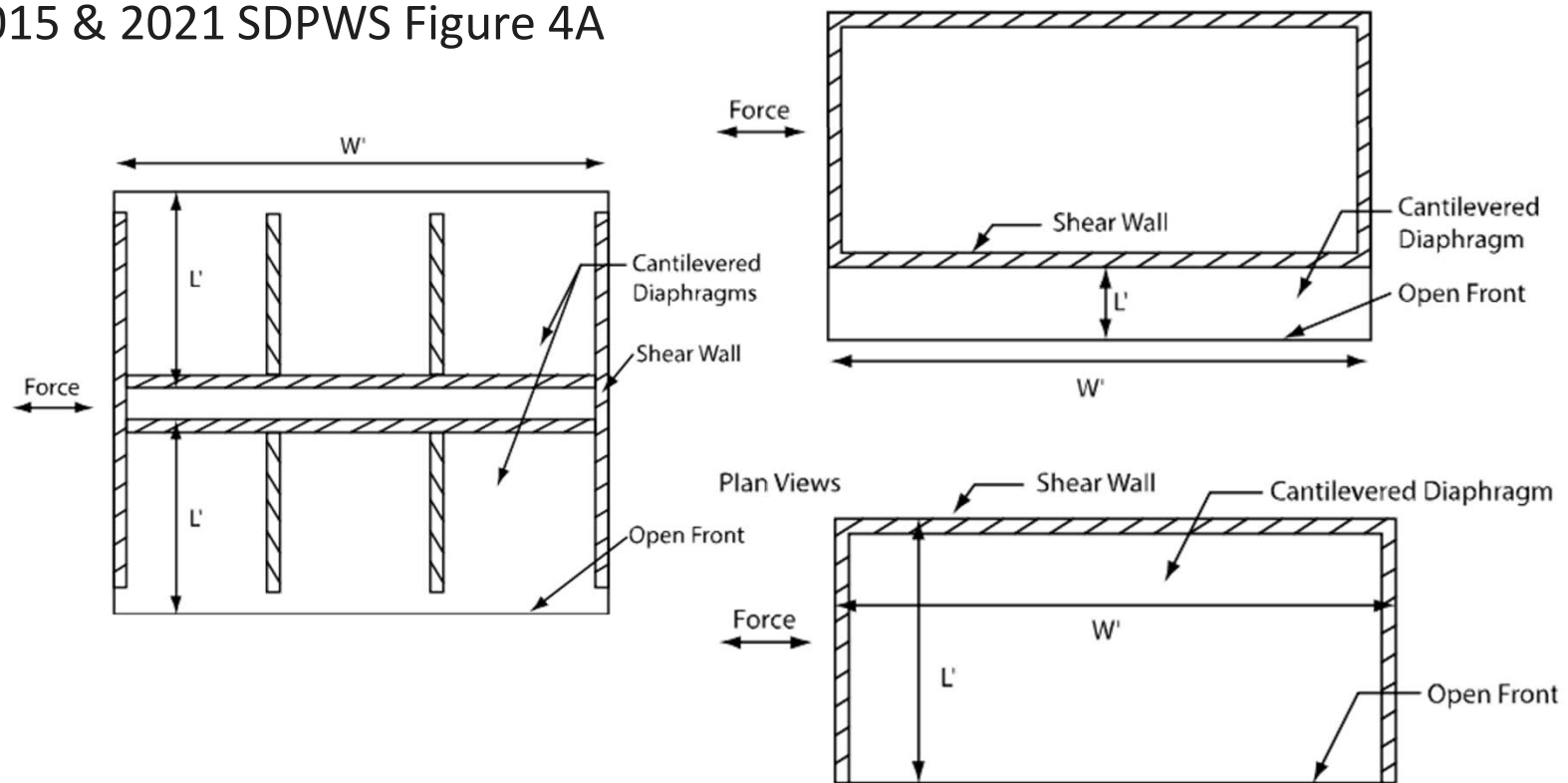
Small Retail Building – Northern CA



Open Front Structures

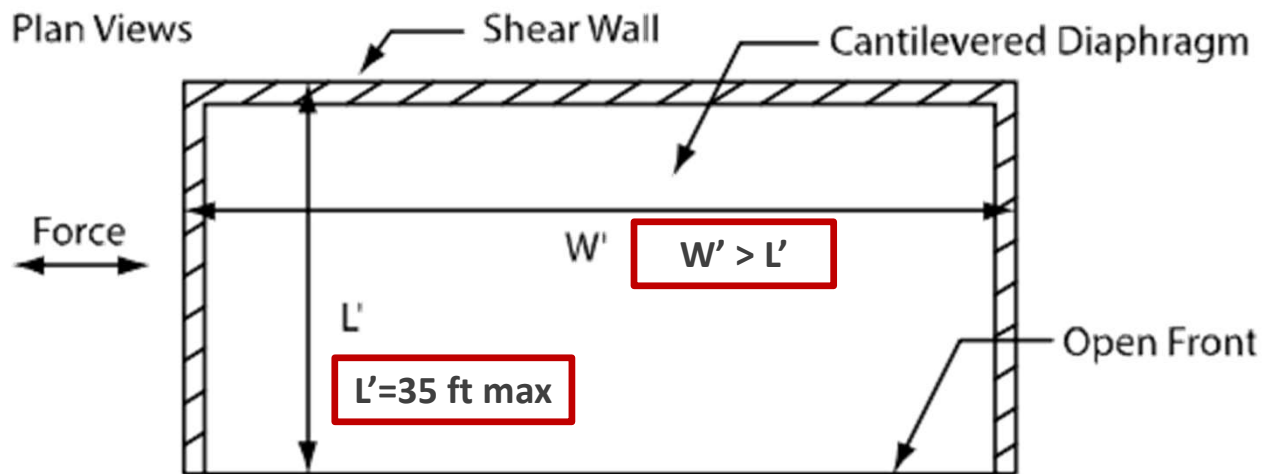
2015 SDPWS unifies Cantilever Diaphragms and Open Front Structures

2015 & 2021 SDPWS Figure 4A



Open Front Structures

SDPWS allow Open Front Structures... provide certain important requirements are met.



Possible **1-Story** Open-Front Structure in SDPWS 2015 & 2021

Outline

- » Introduction

- Framing System Design and Details

 - » Structural Design Compliance

 - » Wall Framing

 - » Wall Bracing

 - » Roof Framing

- » Non-Structural Requirements and Design

 - » Allowable Heights and Areas

 - » Multi-Tenant and Multi-Occupancy Buildings

 - » Fire Resistance and Detailing

- » Large Retail Project Case Study

Common Roof Framing Options



Metal Plated Wood Truss



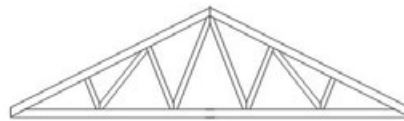
Metal Plated Wood Truss



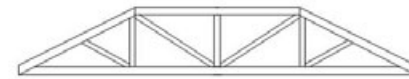
Truss Configurations



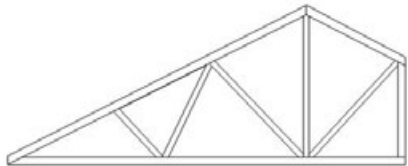
MONOPITCH



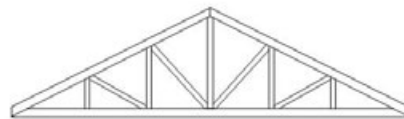
DOUBLE FINK



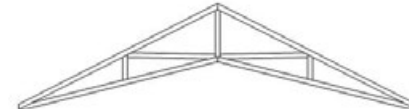
HIP



STUB



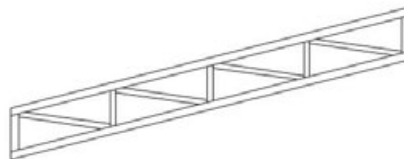
DOUBLE HOWE



SCISSORS



MONOPITCH



SLOPING FLAT



FLAT

Exposed Timber Trusses

T&G Deck over Timber
Trusses



Berlin Shopping Mall, Berlin VT

Exposed Timber Trusses

90ft Span Concealed
Connector Timber Truss



Exposed Timber Trusses

67' Span Glulam Trusses



Whole Foods Market, Atlanta, GA

Metal Plated Trusses over Exposed Timber Trusses



Shenandoah Social Center

Photo courtesy D. Remy & Co.

I-Joist Roof Framing

- » Flat or Sloped Roofs
- » Vaulted Ceiling Possibilities



Havens Elementary, Photo courtesy RedBuilt



Strip Mall Building

Large Flat Roof Systems



Creating Open Floor Space

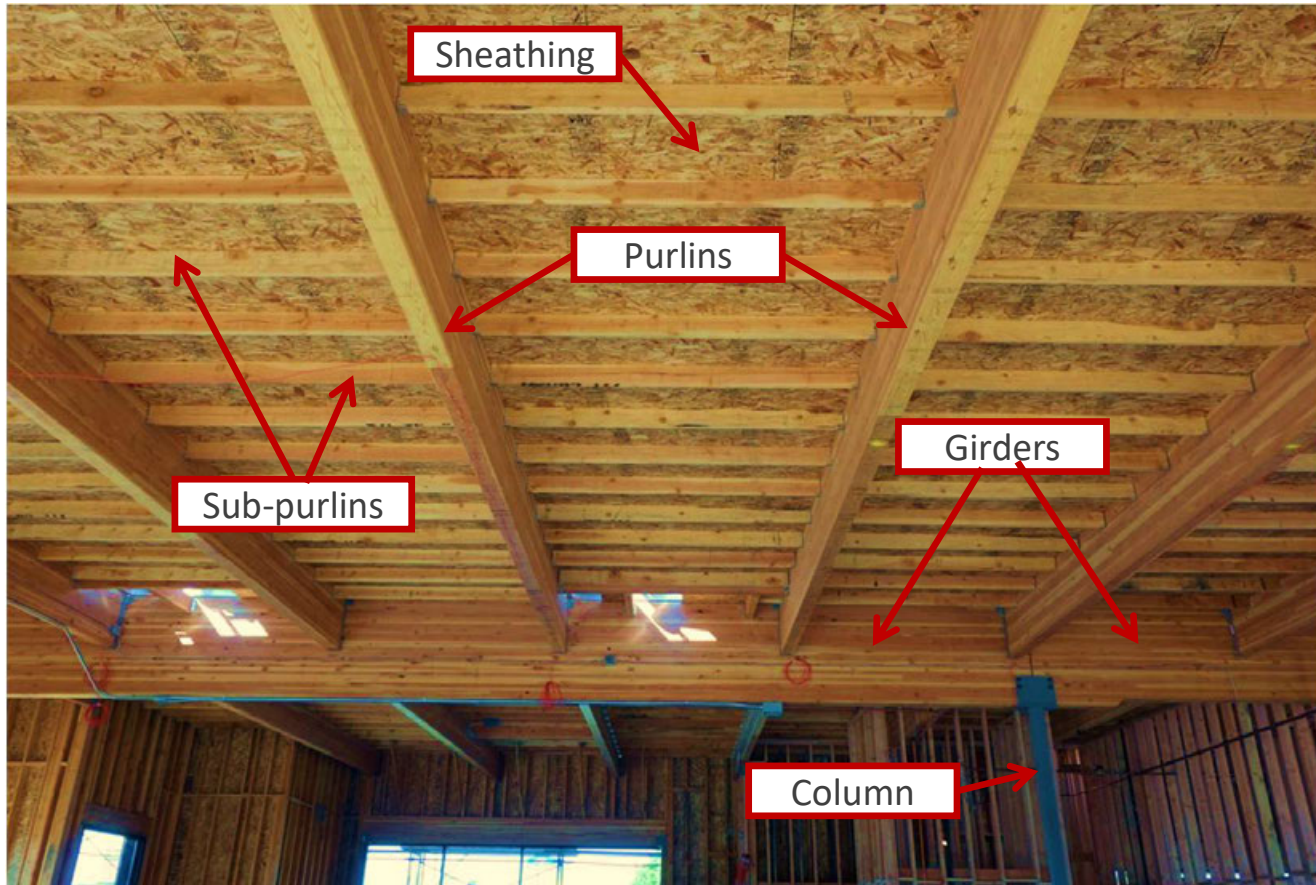
Grid dimensions in low rise commercial buildings are often a deciding factor when determining structural systems. Accommodation of large, open floor plans with a minimal number of columns is required

Common Grid Dimensions: 25'x30' to 45'x50' and larger



Photo: Myers-Company.com

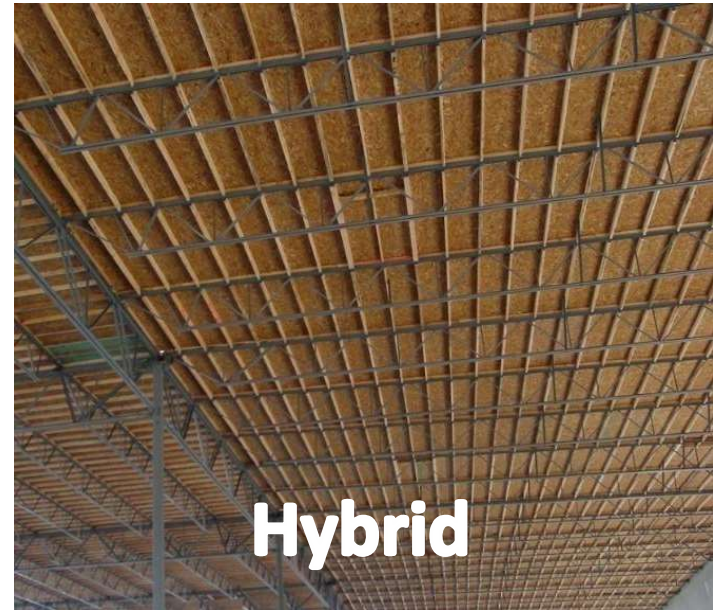
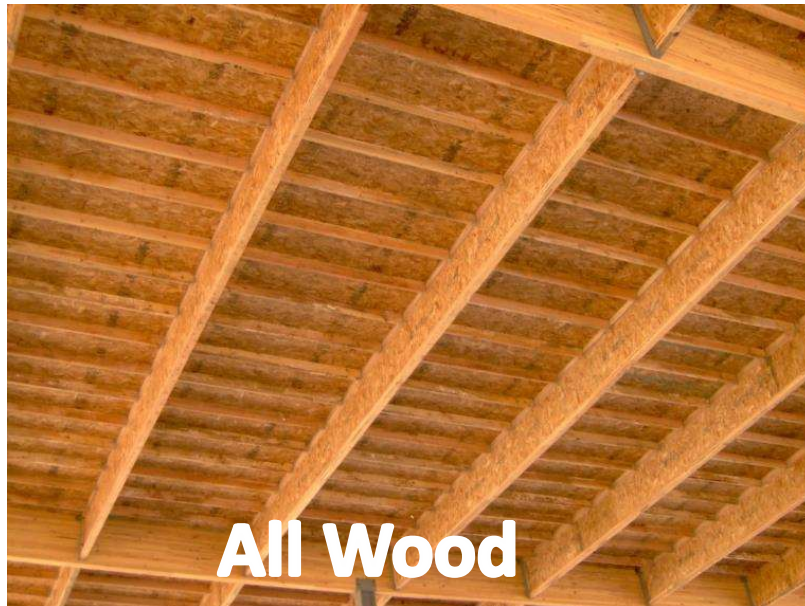
Anatomy of a Large Flat Roof



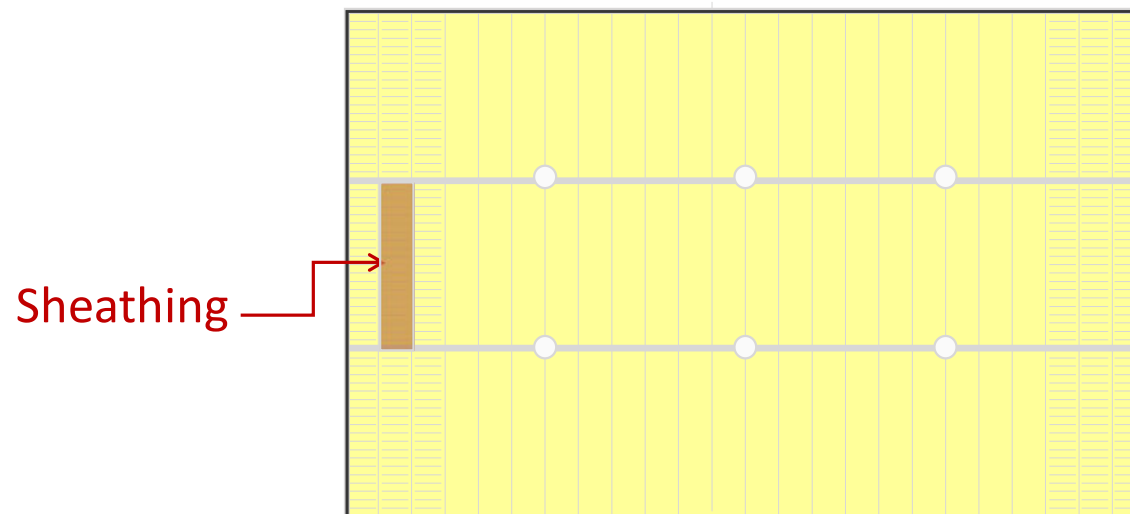
Commercial Flat Roof System

To common types

- » All wood
- » Hybrid



Anatomy of a Large Flat Roof

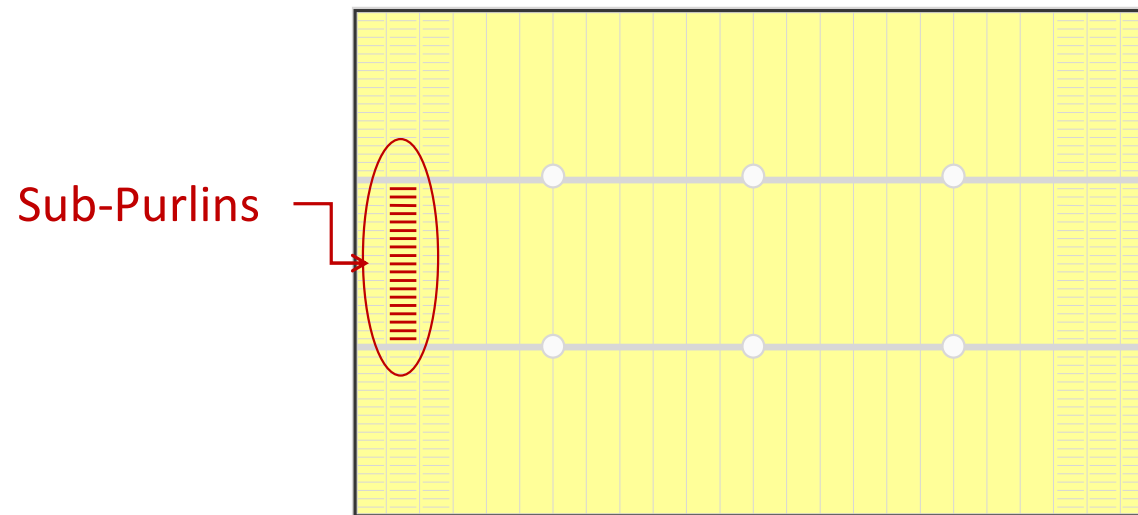


Sheathing

Wood Structural Panel Sheathing

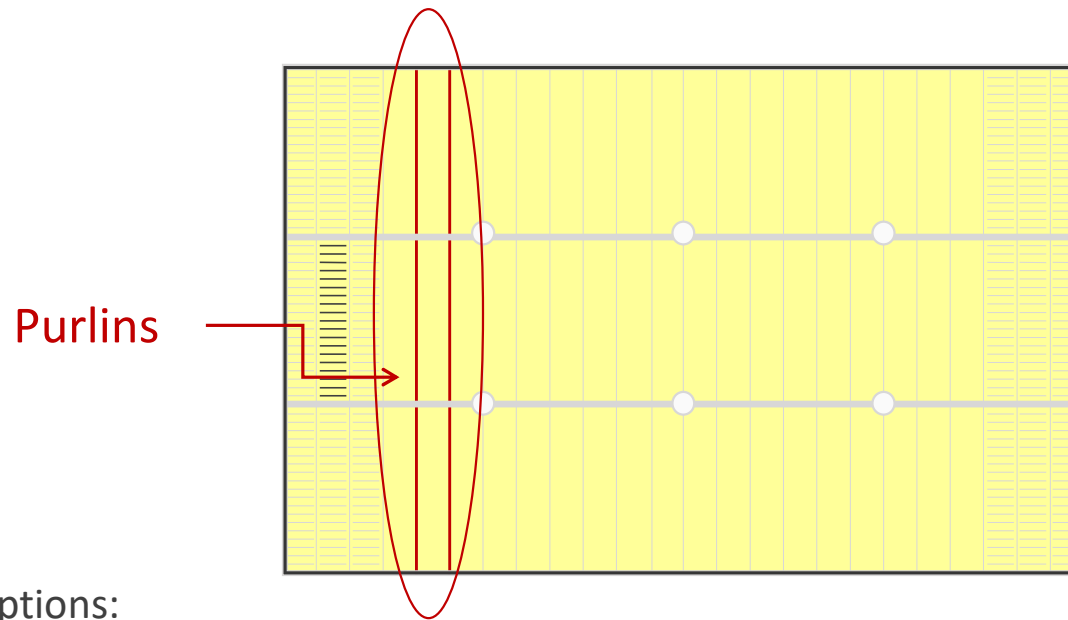
4x8, 4x10, 8x8 panels, spanning 24 or 48 inches

Anatomy of a Large Flat Roof



Solid Sawn Lumber @ 24 or 48 inches on center
Spanning 4 to 10 feet. 8ft most common

Anatomy of a Large Flat Roof

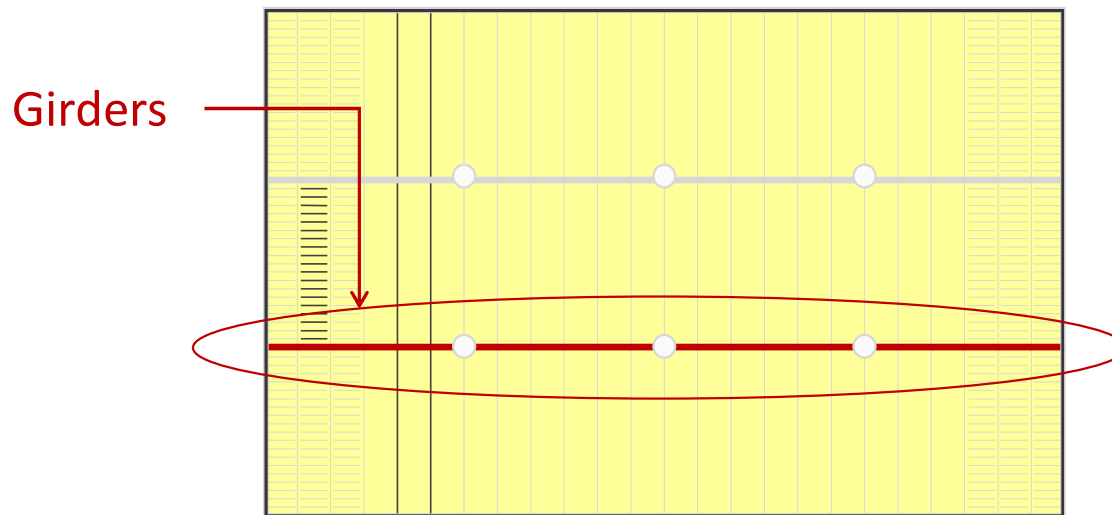


Many Options:

- » Glu-lam beams
- » I-Joists
- » Metal Plated Wood Trusses
- » Wood Flange Metal Web Trusses

Wood purlins can be viable to spans of 50 feet or more

Anatomy of a Large Flat Roof



Glulam beams most commonly used
Simply Supported or Cantilevers

*Glulam Girders can be
viable to spans of 40
feet or more*

Different Flat Roof Framing Systems

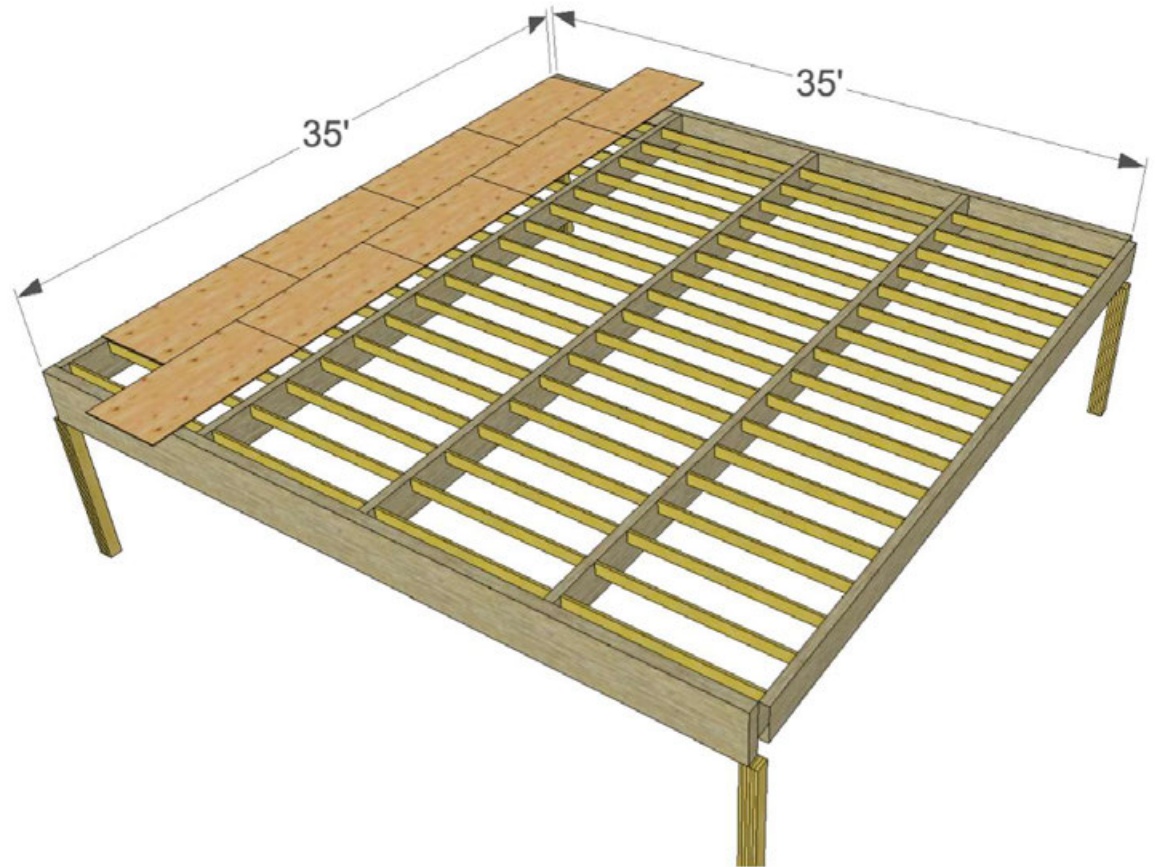
Girder	Purlin	Sub-Purlin	Sheathing
Glulam	Glulam @ 8' to 10' o.c.	2x	WSP
Glulam	Trusses @ 4' to 10' o.c.	2x	WSP
Glulam	Trusses @ 16" to 48" o.c.	None	WSP
Glulam	I-Joists @ 16" to 48" o.c.	None	WSP
Glulam	Glulam @ 4' to 10' o.c.	None	T&G Decking
Glulam	Glulam @ 8'+ o.c.	None	Mass Timber Panels: Cross-Laminated Timber Nail-Laminated Timber Etc.

Architectural Grade Exposed Wood Options

Example Roof Framing System

15 psf Roof DL

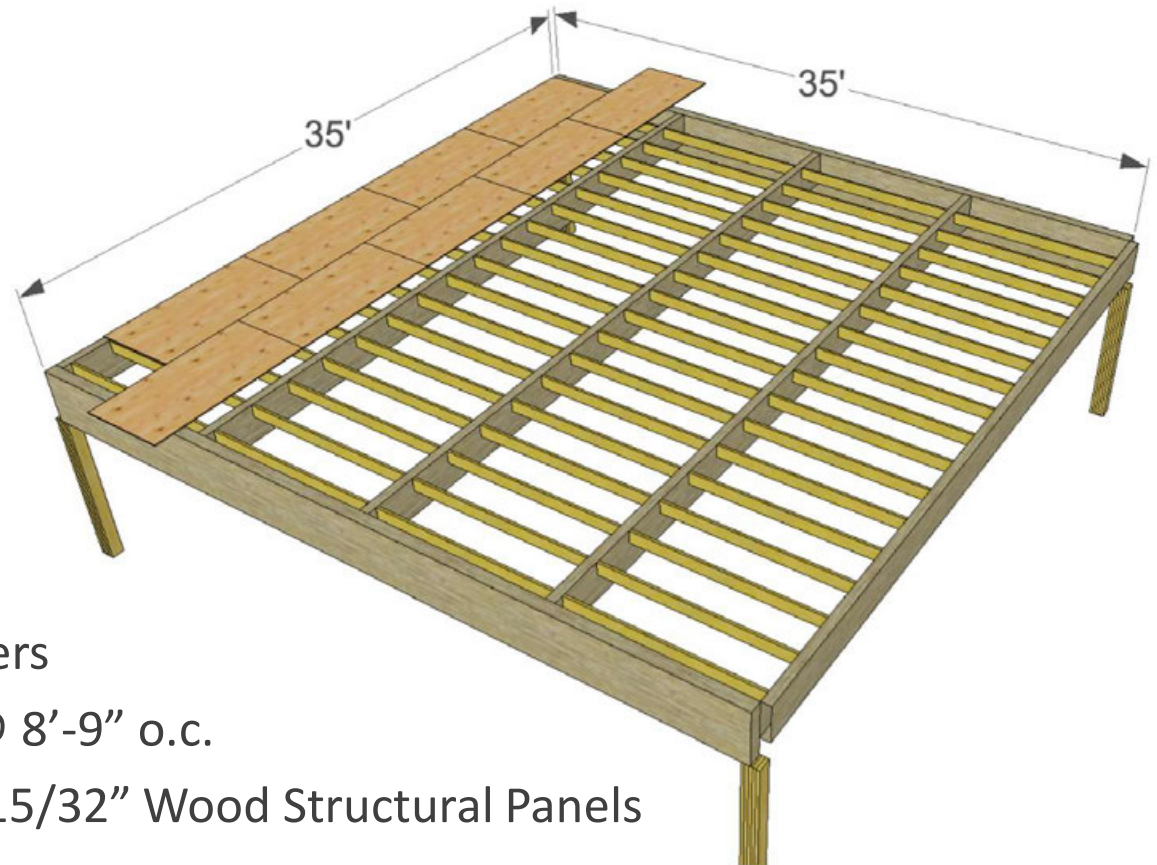
20 psf Roof Live Load



Example Roof Framing System

15 psf Roof DL

20 psf Roof Live Load



6-3/4"x31-1/2" Glulam Girders

5-1/8"x21" Glulam Purlins @ 8'-9" o.c.

2x8 @ 24" o.c. Sub-Purlins, 15/32" Wood Structural Panels

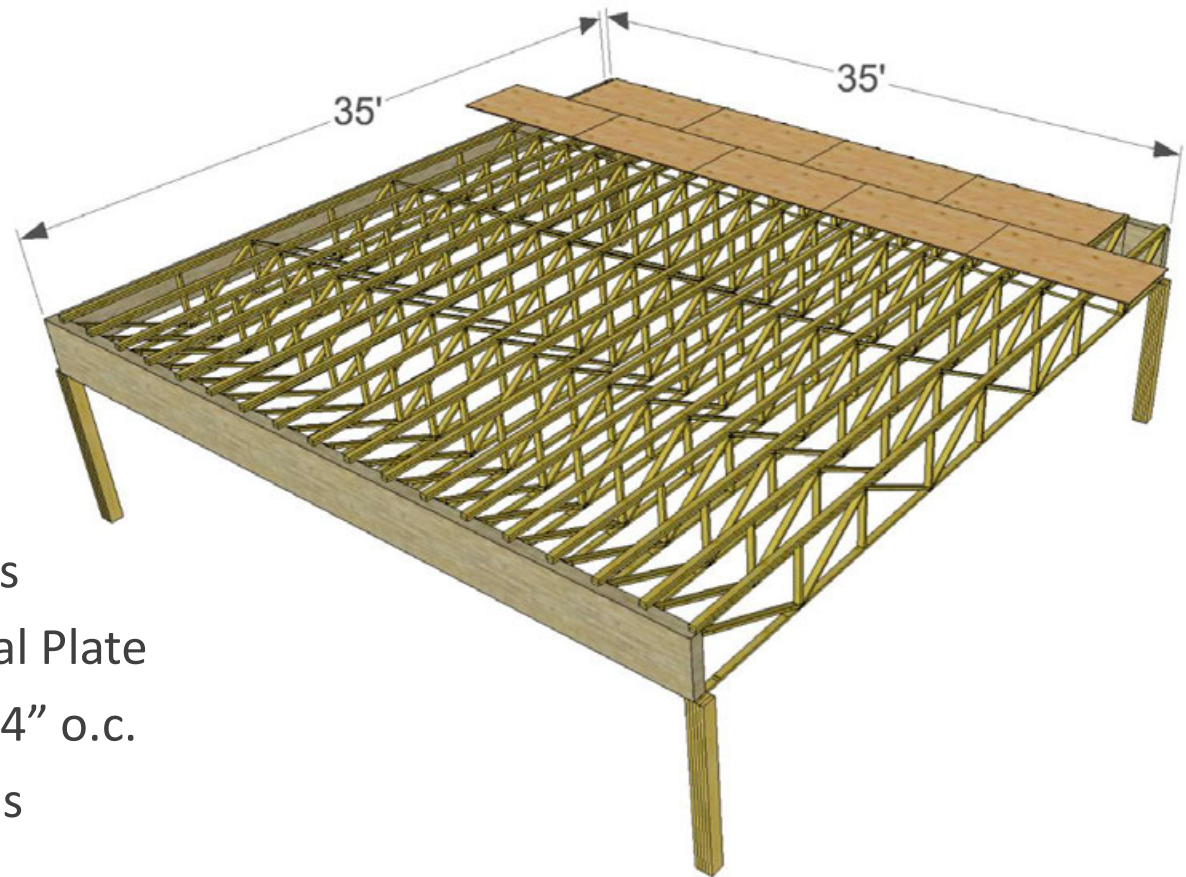
Example Roof Framing System



Example Roof Framing System

15 psf Roof DL

20 psf Roof Live Load



6-3/4"x31-1/2" Glulam Girders

3'-0" Deep Prefabricated Metal Plate

Connected Wood Trusses @ 24" o.c.

15/32" Wood Structural Panels

Example Roof Framing System

15 psf Roof DL

20 psf Roof Live Load



6-3/4"x31-1/2" Glulam Girders

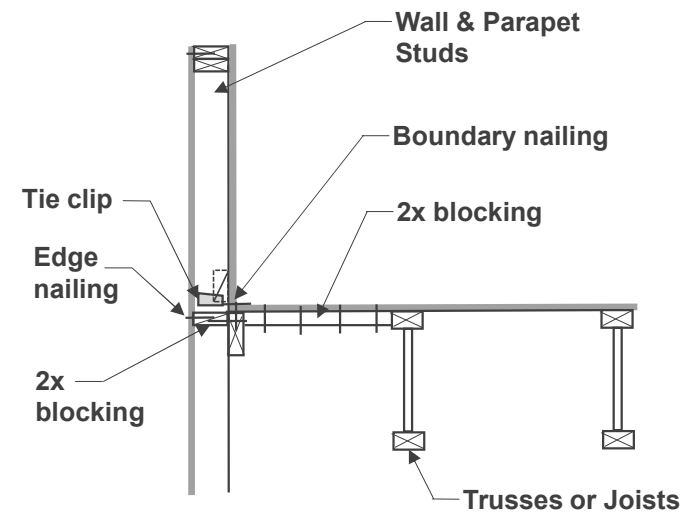
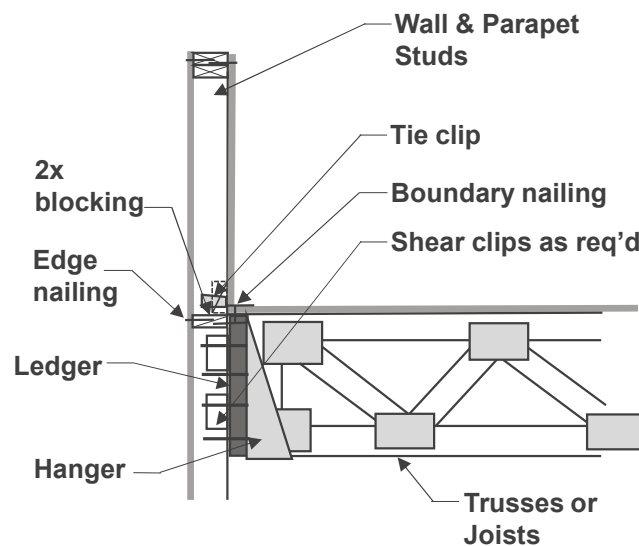
5-1/8"x21" Glulam Purlins @ 8'-9" o.c.

HT/Mass Timber Decking Options: NLT, CLT, GLT, 3x T&G

Example Roof Framing System



Parapet Framing Options



Tall Stud Parapet Style

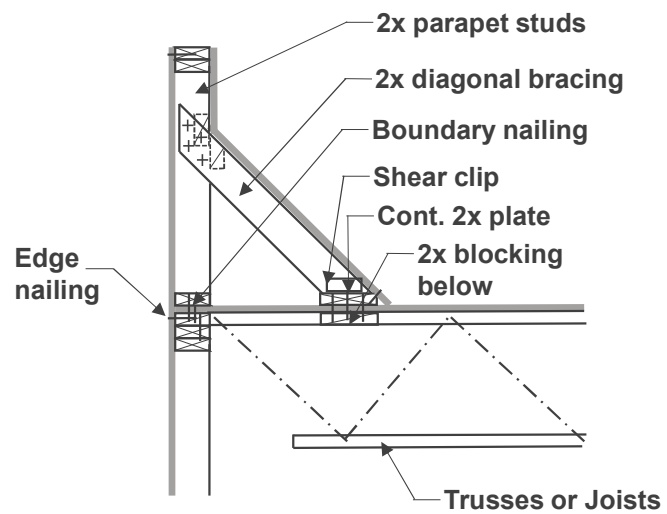
Parapet Wall Example

- » Sporting Good Retailer
- » Dinuba, CA
- » 17' to top of roof
- » 22' to top of parapet
- » 2x6 DF
- » Used with hybrid panelized roof

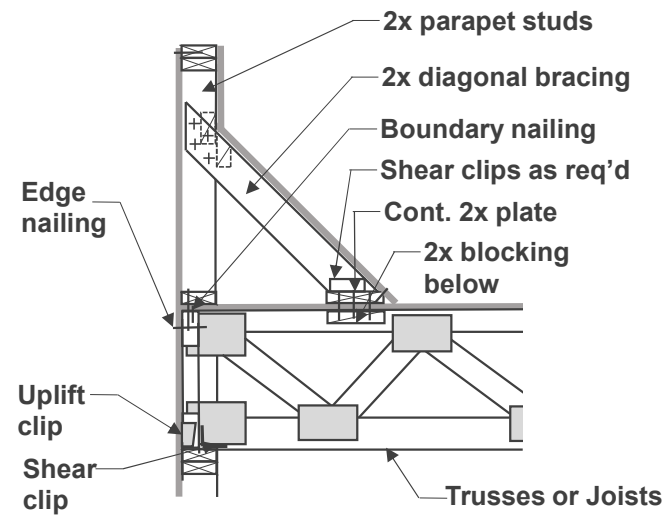


Pelton Engineering

Parapet Framing Options



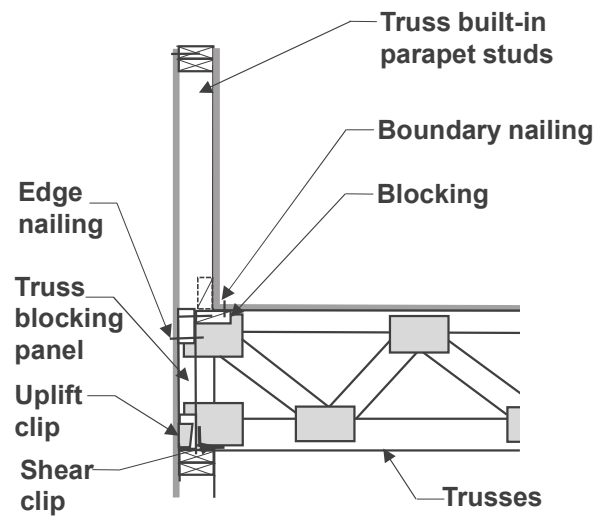
Top Flange Hanger Style



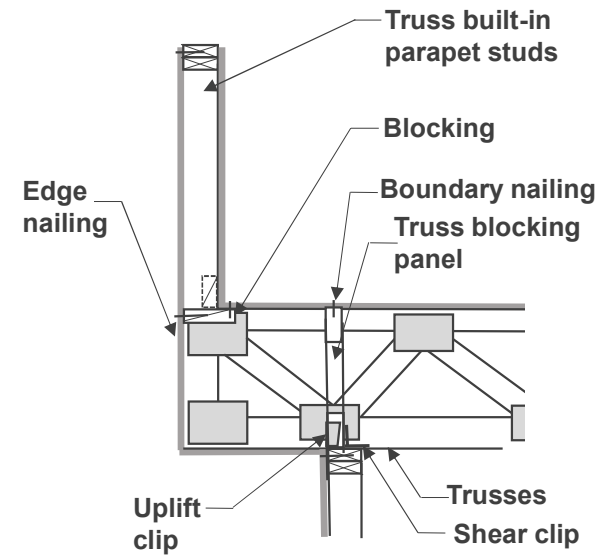
Platform Framing Style

Built-Up Parapet Style

Parapet Framing Options



Parapet Flush with Wall



Cantilevered Truss

Parapet in Truss Style

Example Projects

Layton Petro Mart, Greenfield, WI



Photos by Arquitectura

Commercial Wood Design Award 2009
Arquitectura Inc. – Milwaukee, WI

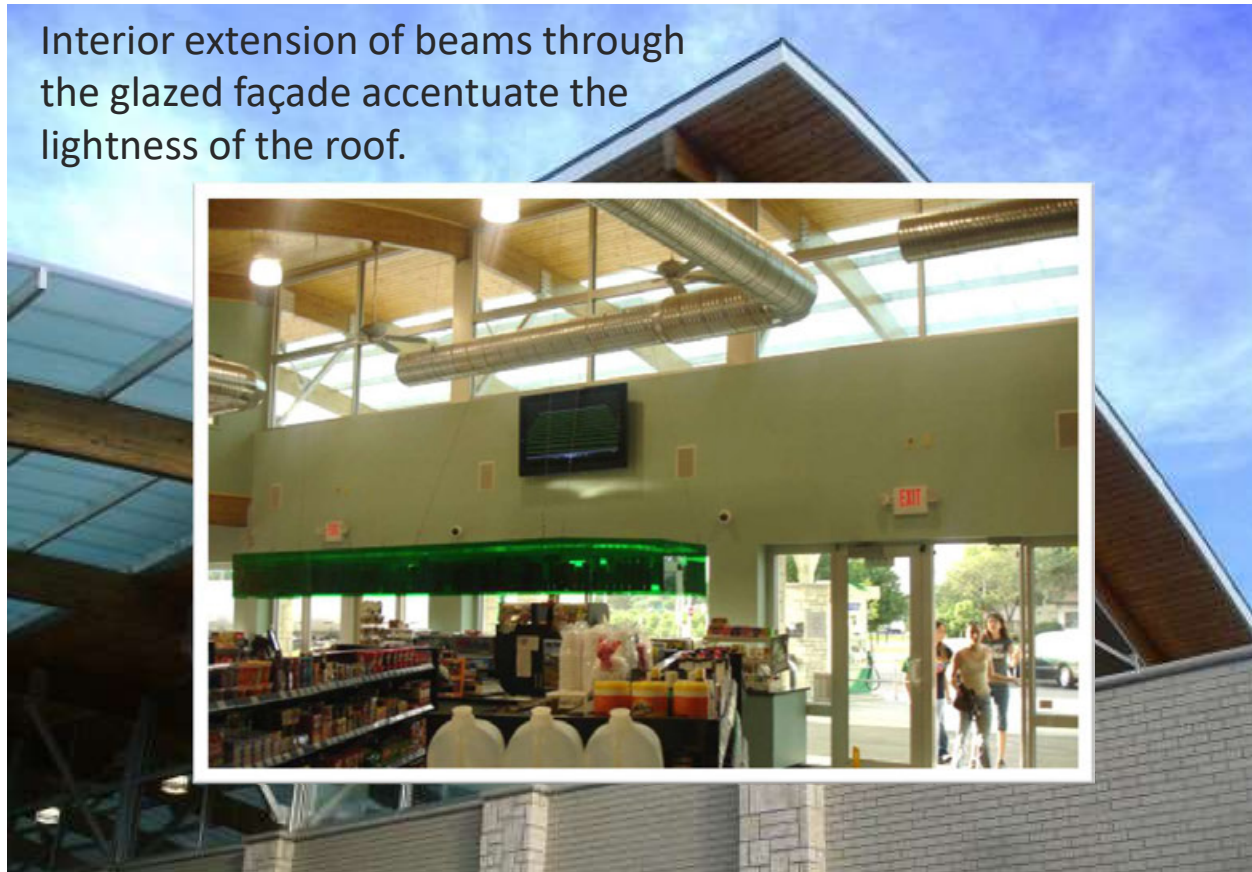
Layton Petro Mart, Greenfield, WI



Photo: Arquitectura, Inc.

Layton Petro Mart, Greenfield, WI

Interior extension of beams through the glazed façade accentuate the lightness of the roof.







Fast Food Restaurant

- » 2x6 wall studs
- » 10' tall walls + 3' Parapet
- » Brick and Stone Cladding



Fast Food Restaurant

Roof Construction:

- » Metal Plate Connected Wood Roof Trusses
- » 36" Deep, 34' Spans, 32" o.c.



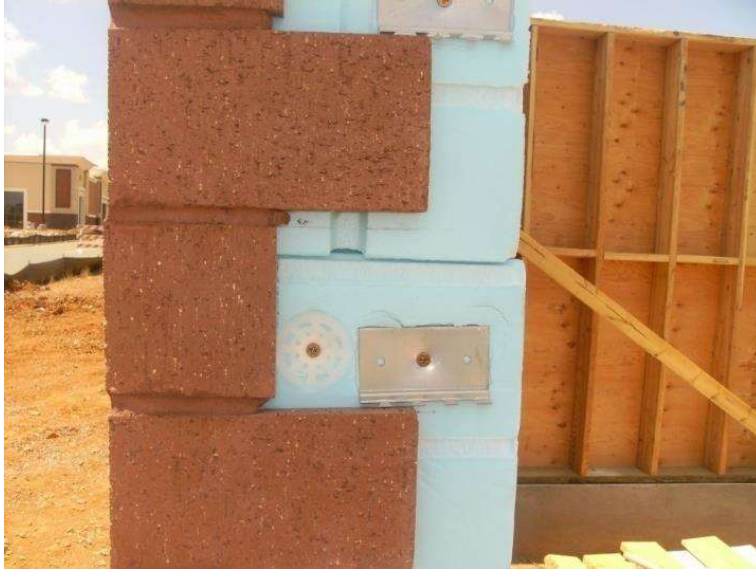
Wood in Retail Design

National Chain Jewelry Store



Retail – Jewelry Store

- » Murfreesboro, TN
- » 2x8 wall studs, 22' tall
- » Panelized walls
- » Exterior Finishes Applied



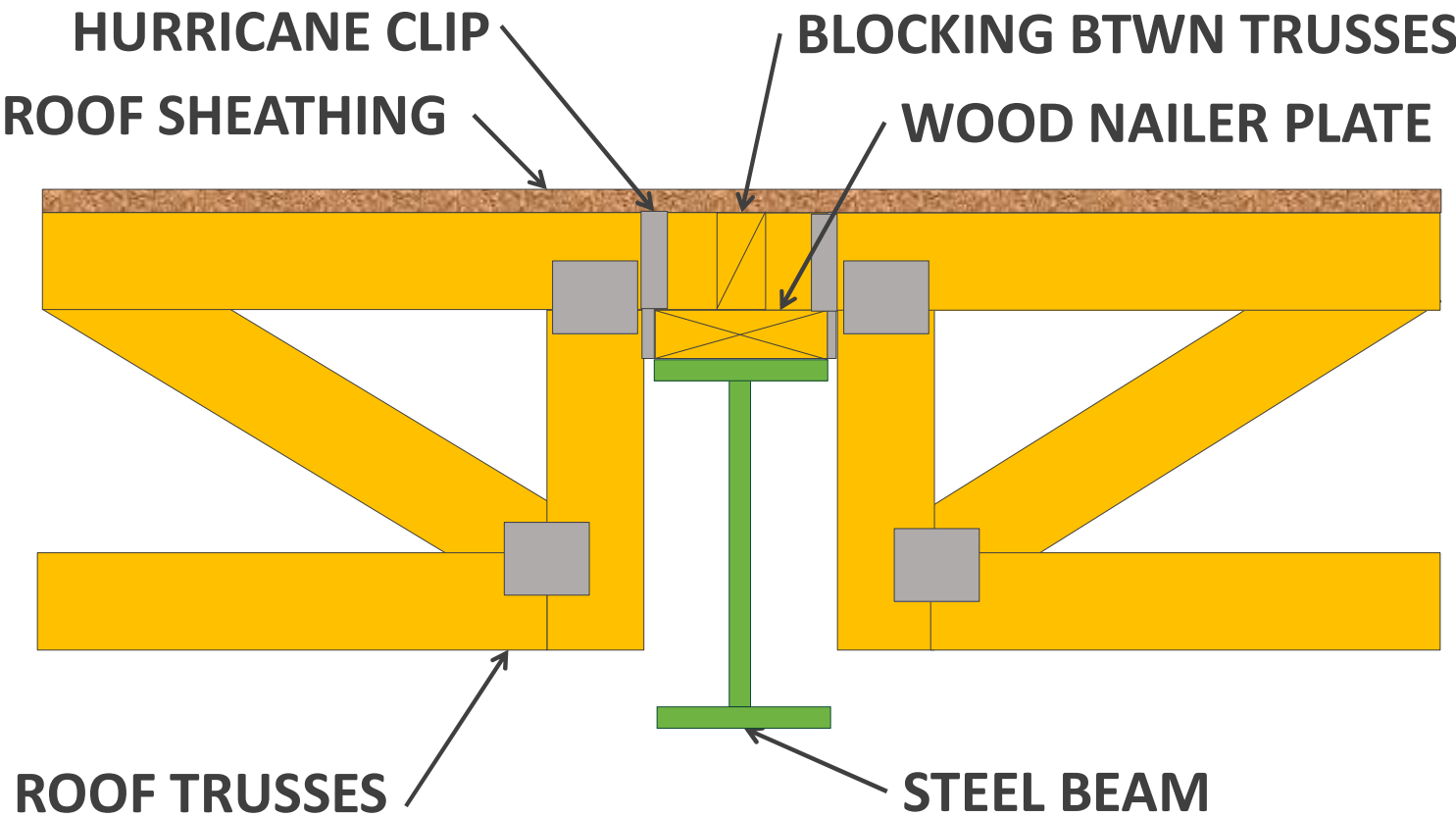
Retail – Jewelry Store

Roof Construction:

- » Metal Plate Connected Wood Roof Trusses, 25' Span
- » Steel beam utilized along center of building. 32' Spans



Roof Framing Detail



Wood in Retail Design

Restaurant

- » Murfreesboro, TN
- » Completed July, 2015



Restaurant – Brewery Chain

Roof Construction

- » Wood Structural Panels Sheathing
- » Composite Wood-Steel Open Web Trusses
- » Glulam Beams
- » 2x6 Bearing Walls

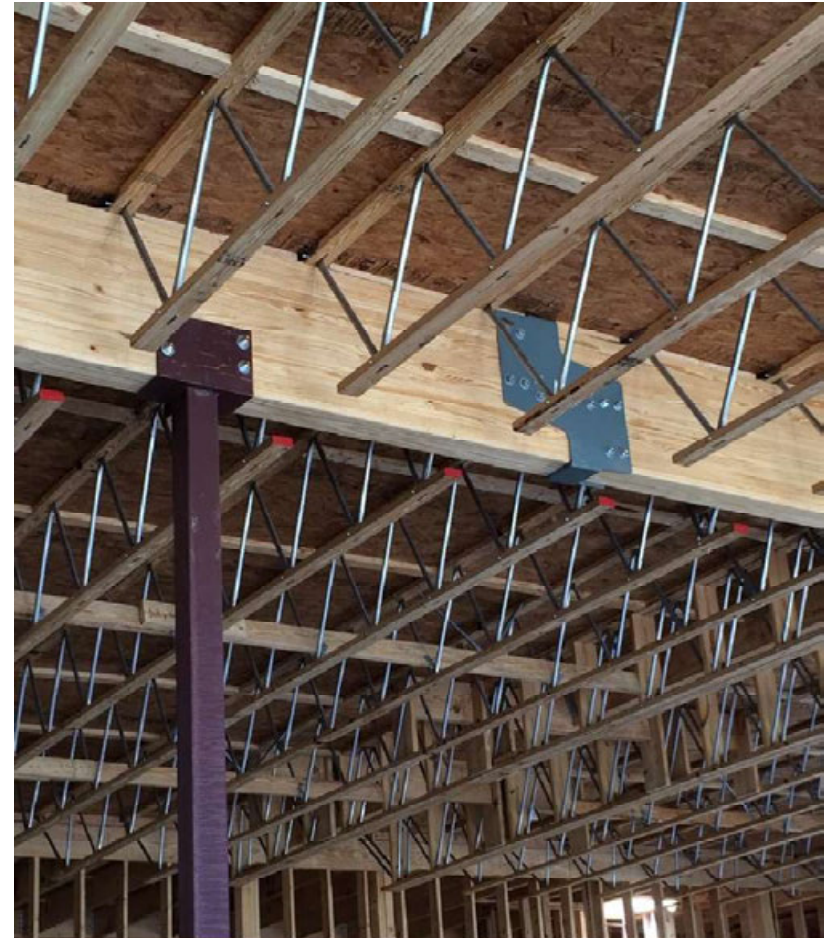


Wood in Retail Design



Restaurant – Brewery Chain

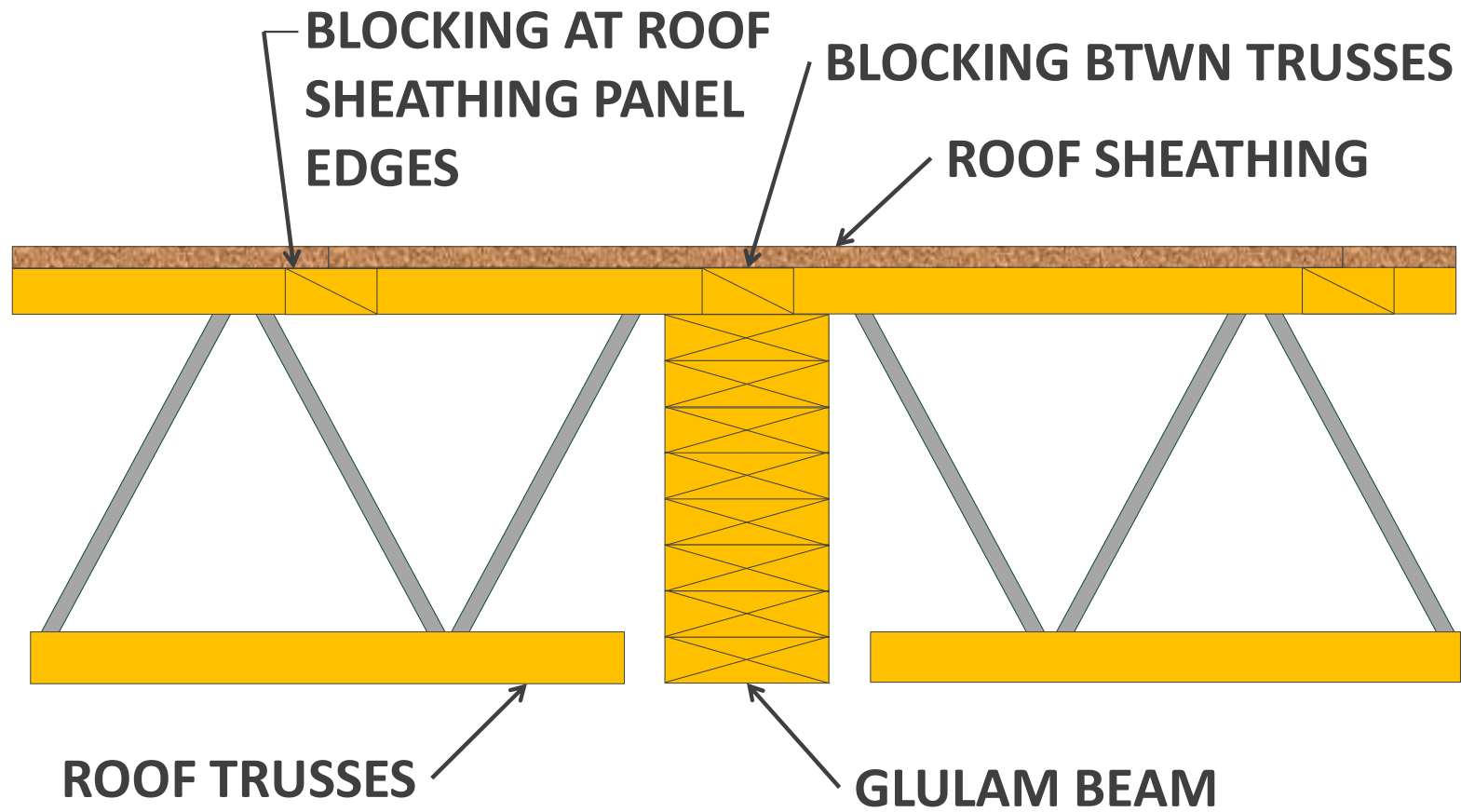
Blocked Roof Diaphragm for Higher Capacity



Wood in Retail Design



Roof Framing Detail



Wood in Retail Design

Fast Food Restaurant in Provo, UT



Fast Food Restaurant

Building Construction

- » Wood Structural Panels & T&G Decking Sheathing
- » Composite Wood-Steel Open Web Roof Trusses & Solid Sawn Rafters
- » Glulam Beams
- » PSL & Built-Up Solid Sawn Columns
- » 2x6 Bearing Walls & Shear Walls



Wood in Retail Design



Fast Food Restaurant



Fast Food Restaurant



Outline

- » Introduction
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 - » Allowable Heights and Areas
 - » Multi-Tenant and Multi-Occupancy Buildings
 - » Fire Resistance and Detailing
- » Large Retail Project Case Study

Height and Areas Code Analysis

Question:

For the building program, including its occupancies and size, what Construction Types are allowed by the Building Code?

Answer:

Determined by Heights and Areas Code analysis

Heights and Areas – IBC 2021 Table 504.4

TABLE 504.4
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE^{a, b}

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	3	3	3	2	1
	S	UL	6	4	3	4	3	9	6	4	4	3	2
A-2	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-3	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-4	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	NS	UL	11	5	3	5	3	5	5	5	5	3	2
	S	UL	12	6	4	6	4	18	12	9	6	4	3
M	NS	UL	11	4	2	4	2	4	4	4	4	3	1
	S	UL	12	5	3	5	3	12	8	6	5	4	2

*Normal Calculated Allowable Heights and Area
one route to an answer.
Don't overlook Unlimited Area Route*

Unlimited Area Buildings

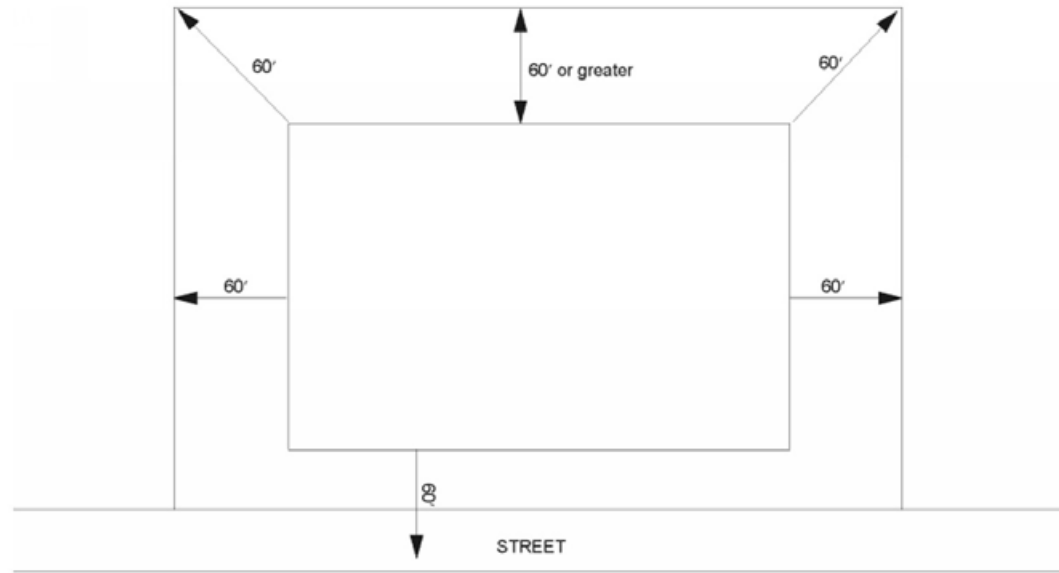
IBC Section 507 gives Unlimited Area Building routes for Type III, IV and/or V Construction for the following occupancies:

Assembly
Education
Business
Factory
Factory
Mercantile
Storage



Unlimited Area Buildings

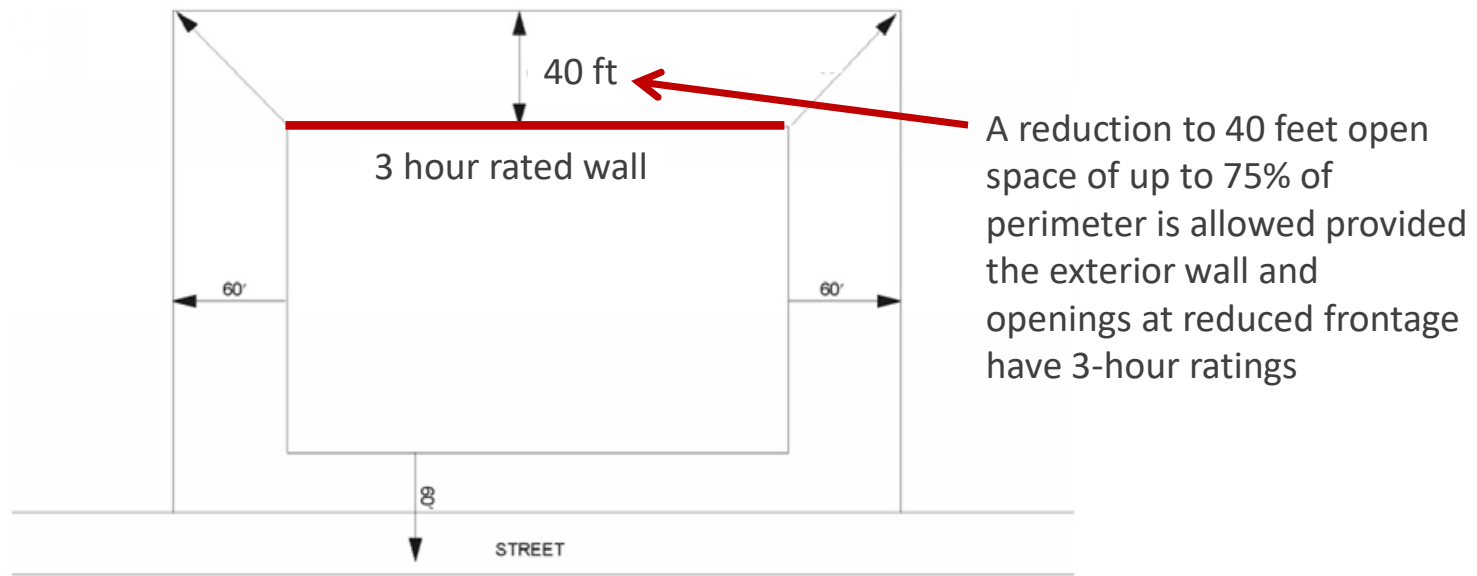
Provisions for unlimited area buildings rely on open space surrounding building (IBC 507)



REQUIRED SEPARATION FOR UNLIMITED AREA BUILDINGS

Unlimited Area Buildings

Provisions for unlimited area buildings rely on open space surrounding building (IBC 507)



REQUIRED SEPARATION FOR UNLIMITED AREA BUILDINGS

Unlimited Area Building Route 1

Business

Factory

Mercantile

Storage

Occupancies can have **unlimited area** for **any construction type** provided:

- » Two stories or less above grade plane
- » Equipped with automatic sprinklers
- » *See IBC 507.5 – Two-story buildings*



Photo Steve Fareham- Creative Commons

Unlimited Area Buildings

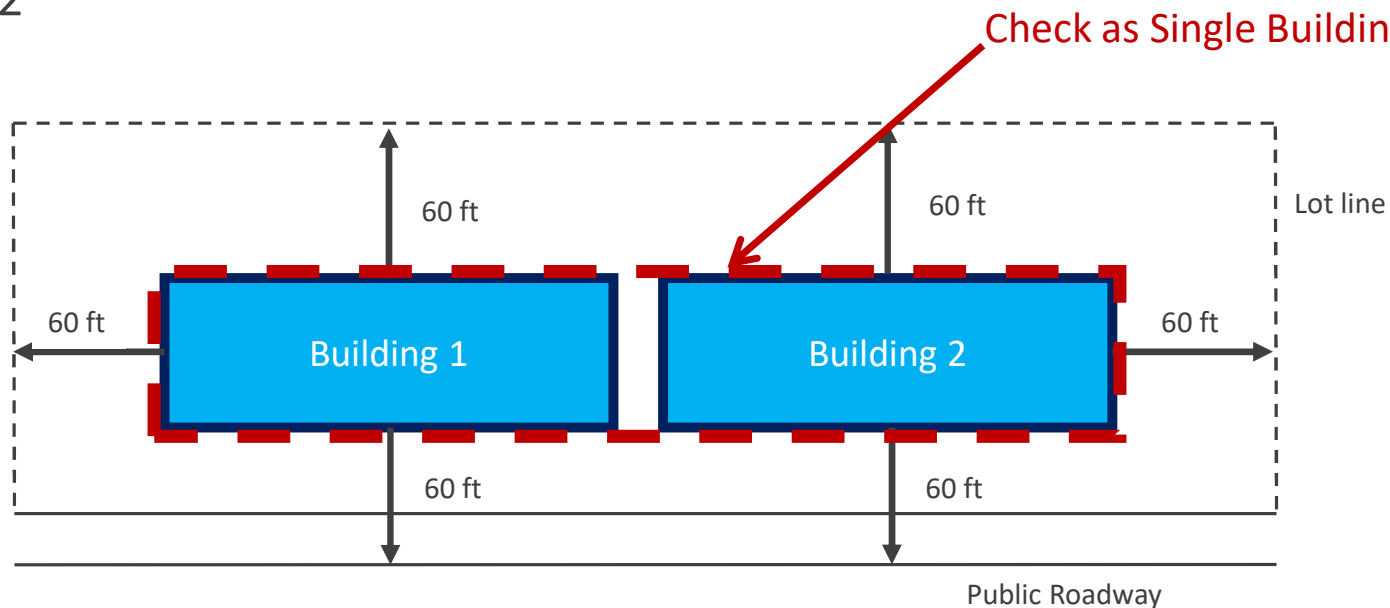
Can these buildings meet the open space provision to qualify for Unlimited Area?



Photo Steve Fareham- Creative Commons

Unlimited Area Building(s)?

IBC 507.2 Commentary: Two unlimited area buildings ***on the same lot*** must be separated by 60 feet [or 40 feet if Section 507.2.1 is used] unless they are treated as a single building under the provisions of Section 503.1.2



Other Unlimited Area Buildings Routes

- » 1-Story A-4 (Arenas, Skating Rinks, Tennis Courts & Swimming Pools)
 - » Sprinklered of Type III or IV
 - » See IBC 507.4
- » 1-Story A-3 (Libraries, Museums, Churches, Art Galleries...)
 - » Sprinklered of Type III or IV
 - » See IBC 507.7
- » 1-Story Group E Buildings
 - » Sprinklered of Type IIIA or IV
 - » See IBC 507.11

AWC Code Conforming Wood Design

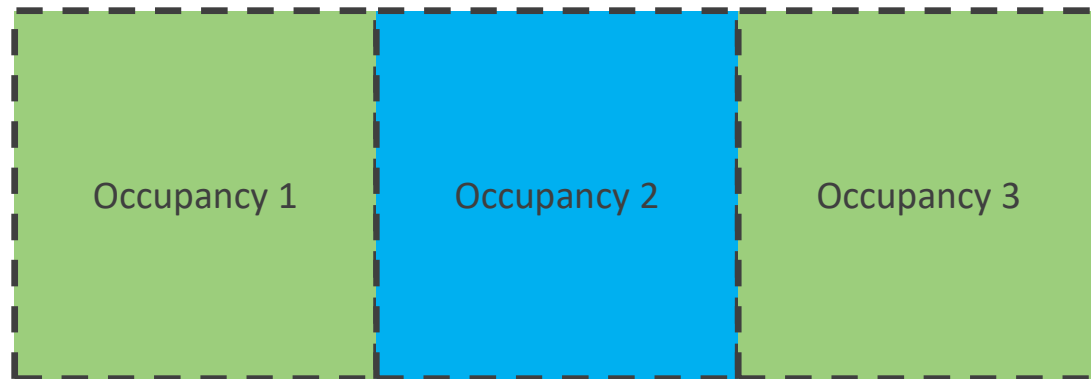


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Multi-Tenant Buildings

Lead to mixed occupancy buildings



Code Sections Related to Multiple Occupancies

- » Incidental Uses (509)
- » Accessory occupancies (508.2)
- » Non-Separated occupancies (508.3)
- » Separated Occupancies (508.4)
- » Separate Buildings (503.1)
- » Covered and Open Malls (402)



Outside scope of
presentation

Incidental Uses (IBC 509)

- » Ancillary function associated with an Occupancy
- » Pose GREATER risk than the Occupancy
- » Examples:
 - » Laundry room over 100 square feet.
 - » Refrigerant machinery room
 - » Incinerator room
 - » Furnace room
 - » Boiler room



Incidental Uses (IBC 509)

- » Not more than 10% of area of story
- » Have fire separation, smoke separation and/or sprinkler systems per Table 509 and Section 509.4
- » **NOT** classified as a different occupancy.
- » **Allowable Building Area and Height per main Occupancy**

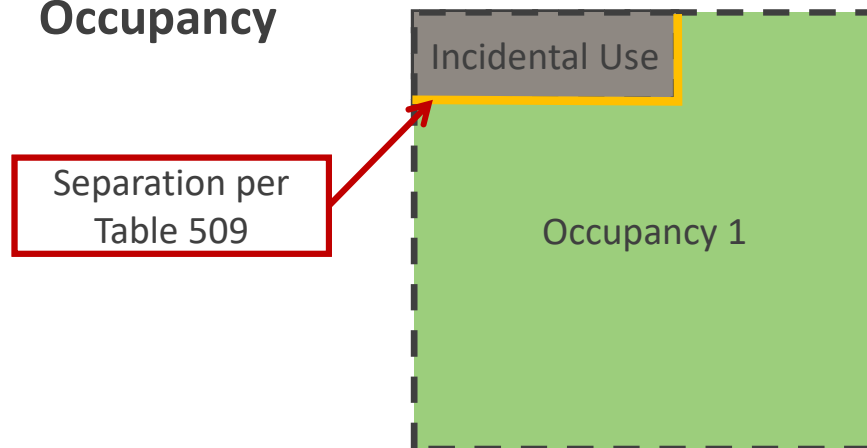


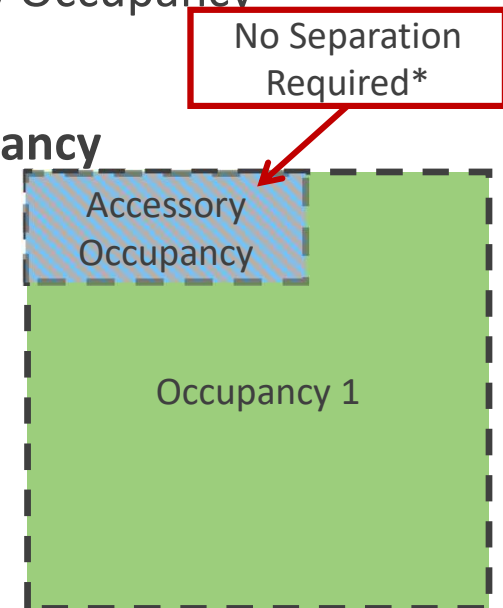
Photo Sean Hackbarth/Flickr

Accessory Occupancies (508.2)

- » Ancillary to the main Occupancy
- » Accessory Area not greater than:
 - » 10% of the main Occupancy on same floor
 - » IBC 506 “NS” Allowable Area limit of Accessory Occupancy
- » No separation between occupancies required*
- » **Allowable Building Area and Height per main Occupancy**

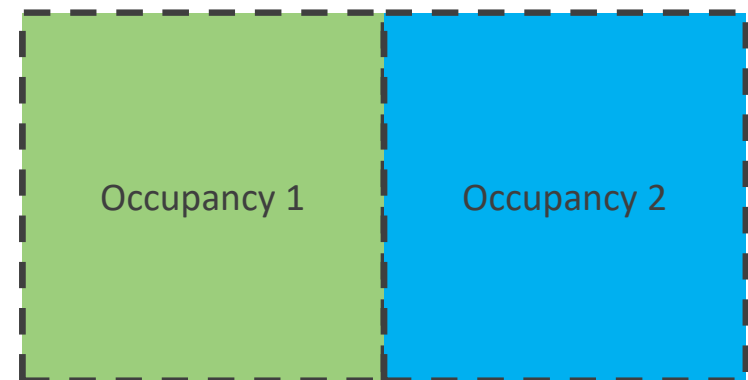
*Hazardous occupancies require separation

*Residential separations per Section 420 still apply



Non-Separated Occupancies (508.3)

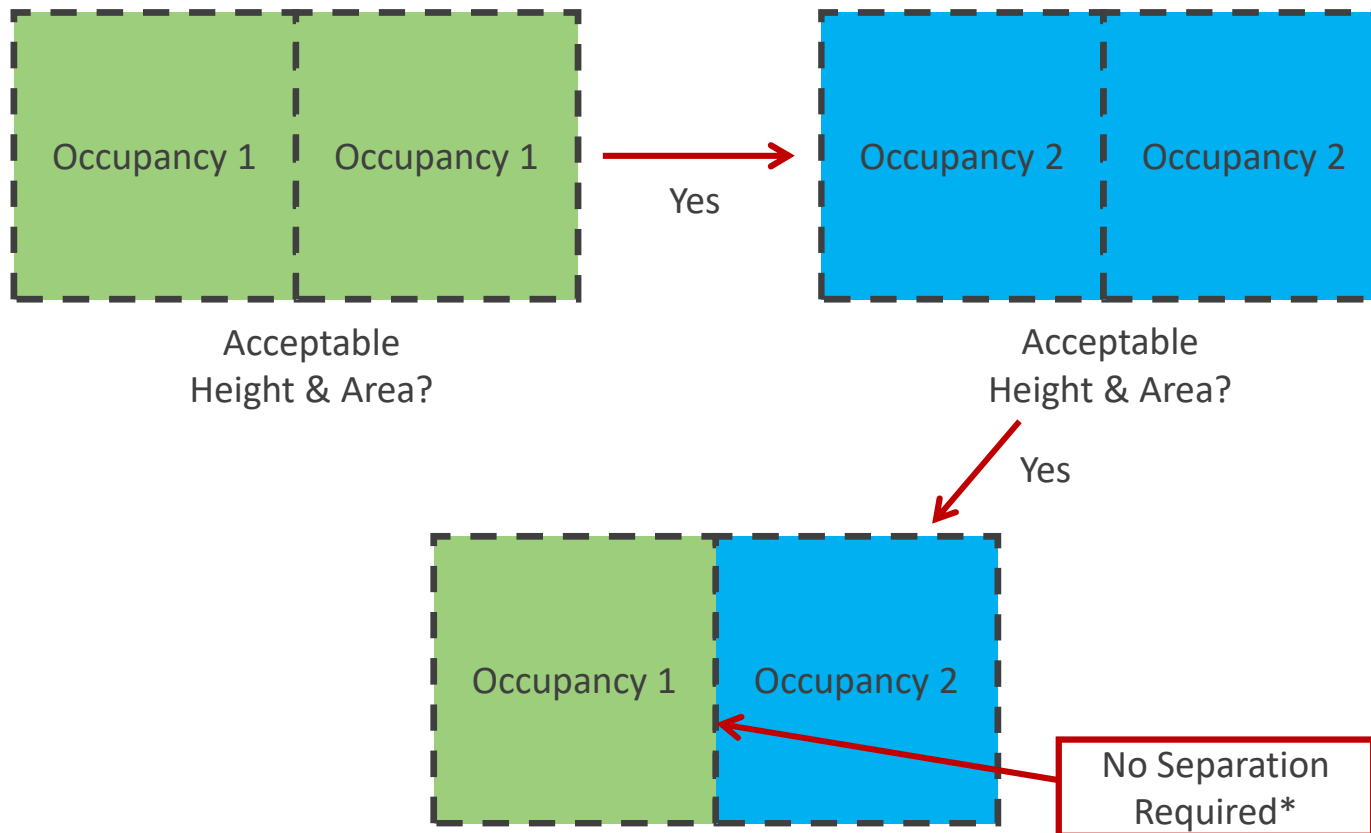
- » Most restrictive requirements of all occupancies apply for:
 - » Fire Protection Systems (Chapter 9)
 - » Allowable Height and Area
- » Other requirements for each portion based upon occupancy of that portion
- » No separation between occupancies required*



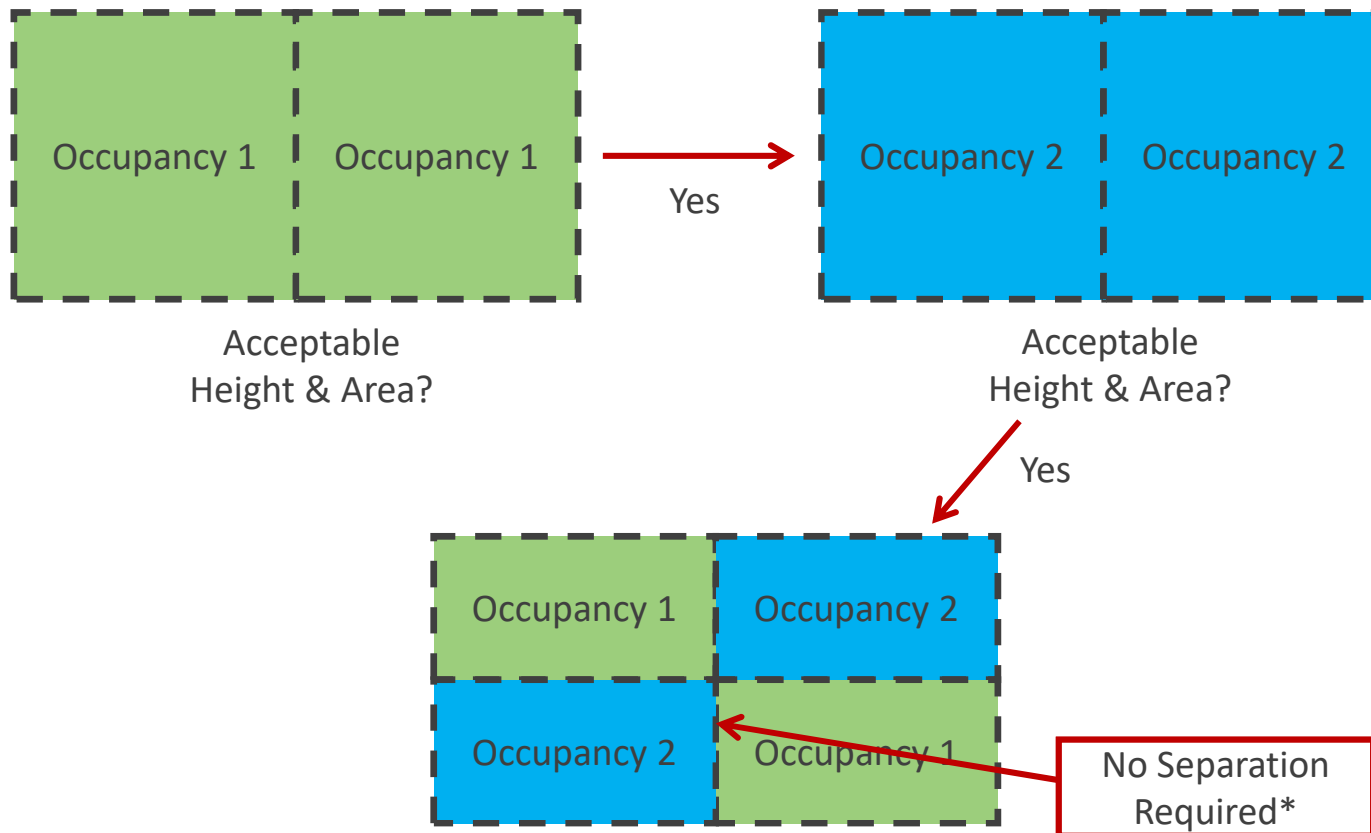
*Hazardous occupancies require separation.

*Residential separations per Section 420 still apply

Non-Separated Occupancies (508.3)



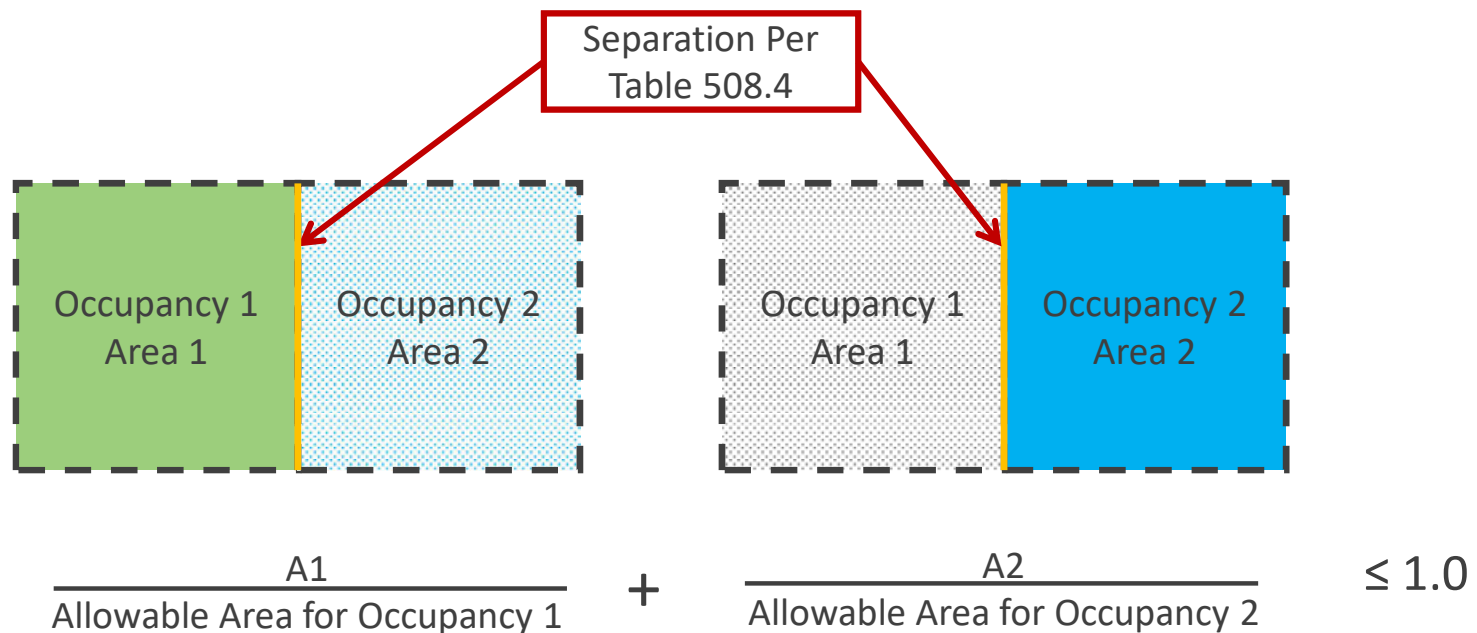
Non-Separated Occupancies (508.3)



Separated Occupancies (508.4)

- » Requirements of code for each portion based upon occupancy of that portion
- » Allowable Height of each occupancy based upon construction type and occupancy
- » Allowable Area of each story
 - » Sum of actual area over allowable area of each occupancy ≤ 1.0

Separated Occupancies (508.4)



Check Performed for each Story.
Separation by Fire Barriers and Horizontal Assemblies

Separated Occupancies (508)

Separation by *Fire Barriers* and *Horizontal Assemblies* required per Table 508.4

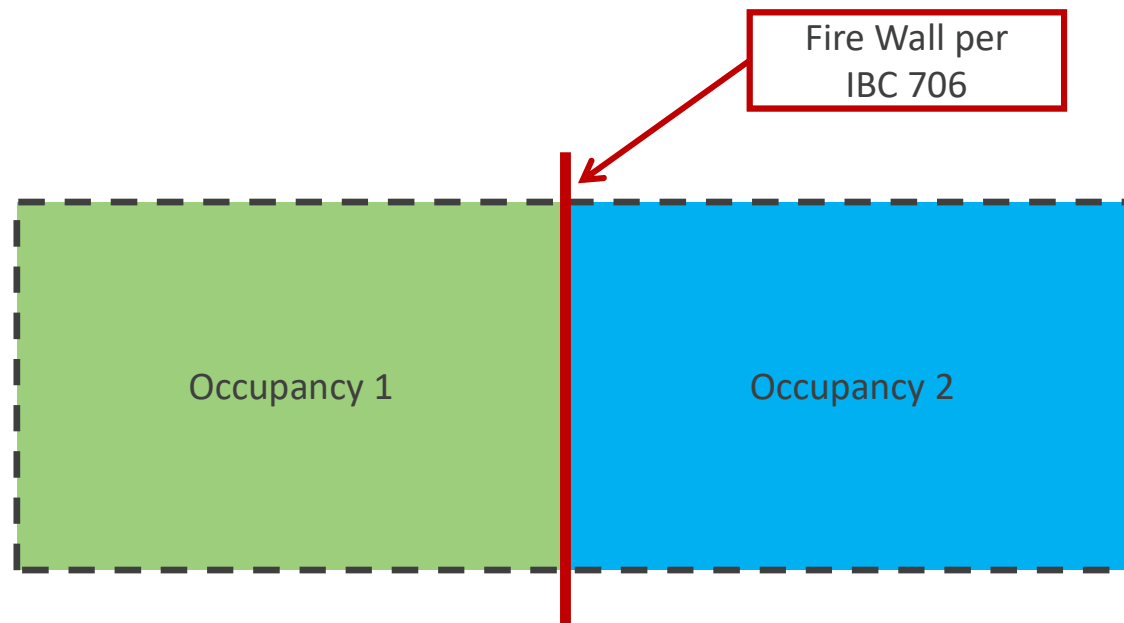
OCCUPANCY	A, E		I-1 ^a , I-3, I-4		I-2		R ^a		F-2, S-2 ^b , U		B ^c , F-1, M, S-1	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2
I-1 ^a , I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP
R ^a	—	—	—	—	—	—	N	N	1 ^c	2 ^c	1	2
F-2, S-2 ^b , U	—	—	—	—	—	—	—	—	N	N	1	2
B ^c , F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N
H-1	—	—	—	—	—	—	—	—	—	—	—	—
H-2	—	—	—	—	—	—	—	—	—	—	—	—
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—
H-5	—	—	—	—	—	—	—	—	—	—	—	—

Table 508.4 (Abbreviated)

NP = Not Permitted, N = No Separation Required

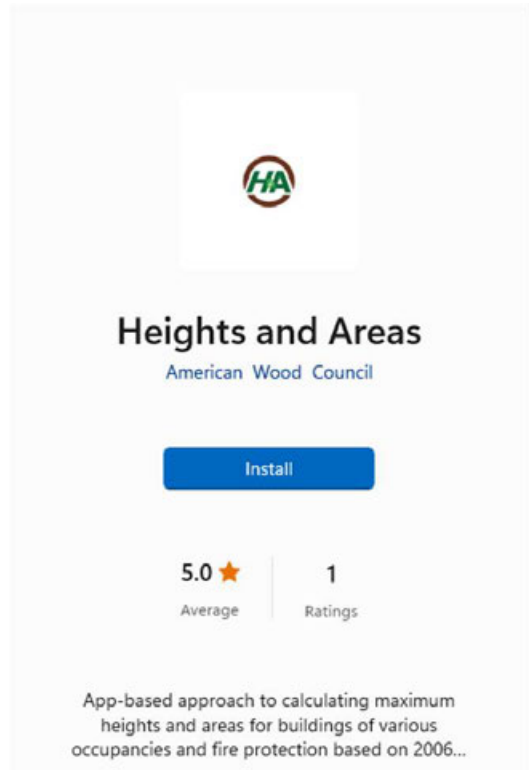
Separate Buildings

Each portion of a building separated by one or more ***fire walls*** shall be considered to be a separate building



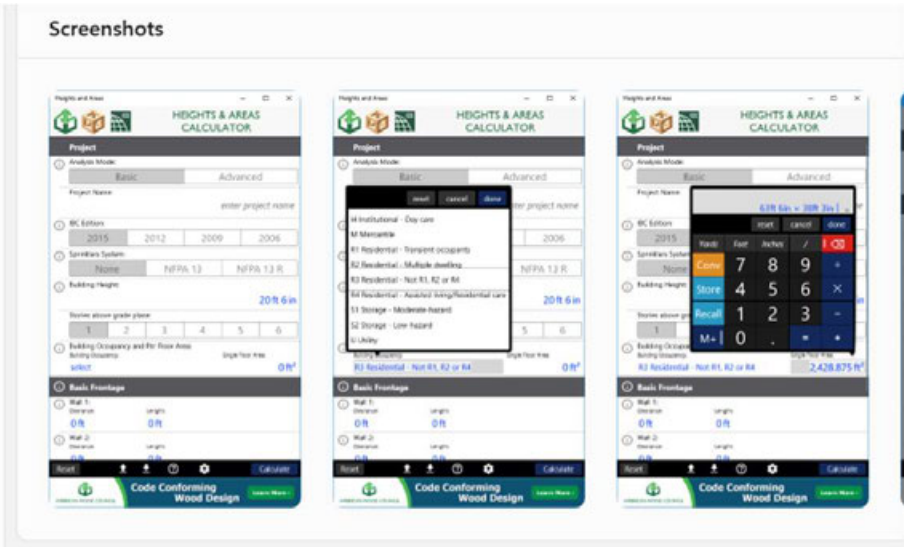
Heights and Areas Calculator

IBC H&A Calculator available from App Stores for Windows, iOS and Android



The app listing features the 'HA' logo, the title 'Heights and Areas' by the American Wood Council, and a blue 'Install' button. It shows a 5.0 star average rating and 1 rating. The description highlights the app-based approach to calculating maximum heights and areas for buildings of various occupancies and fire protection based on 2006 International Building Code (IBC) editions.

Screenshots



The screenshots show the app's interface across different devices. The first screenshot shows the 'Project' screen with fields for 'Project Name', 'IBC Edition' (2015, 2012, 2009, 2006), 'Sprinklers System' (None, NFPA 13, NFPA 13 R), 'Building Height' (20 ft 6 in), and 'Basic Frontage' (Wall 1: 0 ft, Wall 2: 0 ft). The second screenshot shows the 'Basic Frontage' screen with a list of building types (e.g., M Mercantile, R1 Residential - Transient occupants, R2 Residential - Multiple dwelling, R3 Residential - Not R1, R2 or R4, R4 Residential - Attached single residential care, S1 Storage - Moderate hazard, S2 Storage - Low hazard, U Utility) and a 'Calculate' button. The third screenshot shows the 'Calculate' screen with a calculator interface displaying '6.58 sq ft = 100 sq ft' and '2,428,875 sq ft'.

Description

Wood construction offers distinct design options typically not found in a single structural material. It is inexpensive, readily available, easy to work with, strong and adaptable. The economic, environmental and efficiency advantages account for more buildings being constructed of wood than any other structural material.

The Heights and Areas (H&A) Calculator is a joint effort of the American Wood Council, International Code

Outline

- » Introduction
- » Framing System Design and Details
 - » Structural Design Compliance
 - » Wall Framing
 - » Wall Bracing
 - » Roof Framing
- **Non-Structural Requirements and Design**
 - » Allowable Heights and Areas
 - » Multi-Tenant and Multi-Occupancy Buildings
 - » **Fire Resistance and Detailing**
- » Large Retail Project Case Study

Fire Resistance Ratings – IBC Table 601

Building Element	Type III		Type IV	Type V	
	A	B	HT	A	B
Primary Structural Frame	1	0	HT	1	0
Exterior Bearing Walls*	2	2	2	1	0
Interior Bearing Walls	1	0	1/HT	1	0
Exterior Nonbearing walls*	Varies per Fire Separation Distance – See IBC Table 602				
Interior Nonbearing walls	0	0	See IBC section 602.4.6	0	0
Floors	1	0	HT	1	0
Roofs	1	0	HT	1	0

* See IBC Table 602 for Exterior wall Fire Resistance Rating modifications due to Fire Separation Distance

Fire Resistance Rating – IBC Table 601

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A ^d	B	A ^d	B	HT	A ^d	B
Roof construction and secondary members (see Section 202)	1 ^{1/2} ^b	1 ^{b,c}	1 ^{b,c}	0 ^c	1 ^{b,c}	0	HT	1 ^{b,c}	0

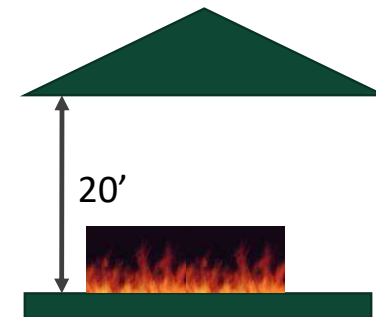
b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed for roof construction, including primary structural frame members, where a 1-hour or less fire-resistance rating is required.

Table 601 Footnote – “b”

Fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below.

Fire retardant-treated wood members shall be allowed to be used for such unprotected members.



Except in group F-1, H, M, and S-1 occupancies

Table 601 Footnotes – “c”

Heavy Timber roof can be used where fire rating is 1hr or less

- » Applies to any type of construction except Type IA



TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A ^d	B	A ^d	B	HT	A ^d	B
Roof construction and secondary members (see Section 202)	1 ^{1/2} ^b	1 ^{b,c}	1 ^{b,c}	0 ^c	1 ^{b,c}	0	HT	1 ^{b,c}	0

Whole Foods Market, Atlanta, GA

15,000 sf Type VA Structure
67' Span Glulam trusses @
14' o.c. & 2x6 T&G SP Deck
On glulam beams and 8x8
Columns @ 20 ft o.c.



Sources of Fire Rated Assemblies and Components

In the IBC:

- » Prescriptive designs of IBC Section 721 and Tables 721.1(2) [Walls] and 721.1(3) [Floors and Roofs].
- » Calculated designs of IBC Section 722.
 - » IBC Section 722.6 can be used for assemblies requiring 1-hour ratings or less.

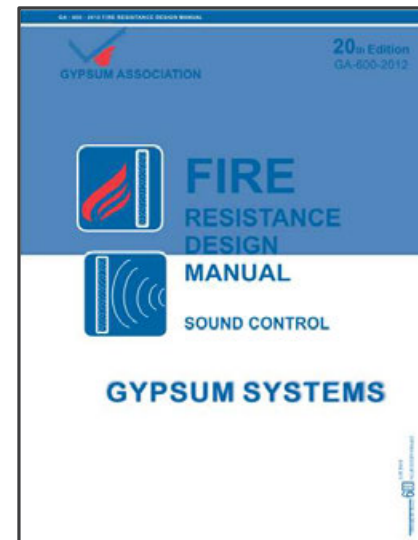
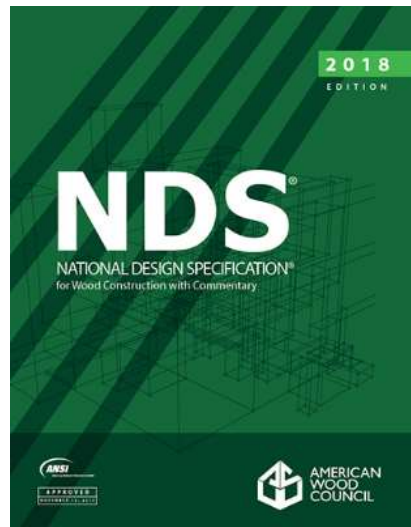
TABLE 721.1(2)—continued
RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS^{a, c, p}

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE ^b (inches)			
			4 hours	3 hours	2 hours	1 hour
	14-1.1 ^{h, m}	2" × 4" wood studs 16" on center with two layers of $\frac{3}{8}$ " regular gypsum wallboard ^e each side, 4d cooler ⁿ or wallboard ⁿ nails at 8" on center first layer, 5d cooler ⁿ or wallboard ⁿ nails at 8" on center second layer with laminating compound between layers, joints staggered. First layer applied full length vertically, second layer applied horizontally or vertically.	—	—	—	5
	14-1.2 ^{l, m}	2" × 4" wood studs 16" on center with two layers $\frac{1}{2}$ " regular gypsum wallboard ^e applied vertically or horizontally each side ^k , joints staggered. Nail base layer with 5d cooler ⁿ or wallboard ⁿ nails at 8" on center face layer with 8d cooler ⁿ or wallboard ⁿ nails at 8" on center.	—	—	—	5½

Sources of Fire Rated Assemblies and Components

Referenced from the IBC

- » NDS Chapter 16 can be used for exposed wood construction up to a 2-hour rating. Referenced from IBC 722.1
- » US Gypsum GA-600. Referenced from IBC Tables 721.1



Sources of Fire Rated Assemblies and Components

Commonly Approved Sources:

- » American Wood Council's DCA3: Fire-Rated Wood-Frame Wall and Floor/Ceiling Assemblies
- » APA's Document W305 – Fire-Rated Systems.
- » SBCA's Metal Plate Connected Wood Truss Handbook – Section 17 Fire Performance of Trusses
- » Underwriters Laboratory Fire Rated Listing

An “UL Assembly” listed by the Underwriters Laboratory is only ONE of MANY routes to compliance with fire ratings.

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Retail Store Design

- » 55,000 sf chain grocery store in northern CA
- » Originally designed and built with steel and masonry
- » WoodWorks commissioned structural re-design with wood framing
- » Comparing original to wood re-design, WoodWorks commissioned cost estimate & LCA studies



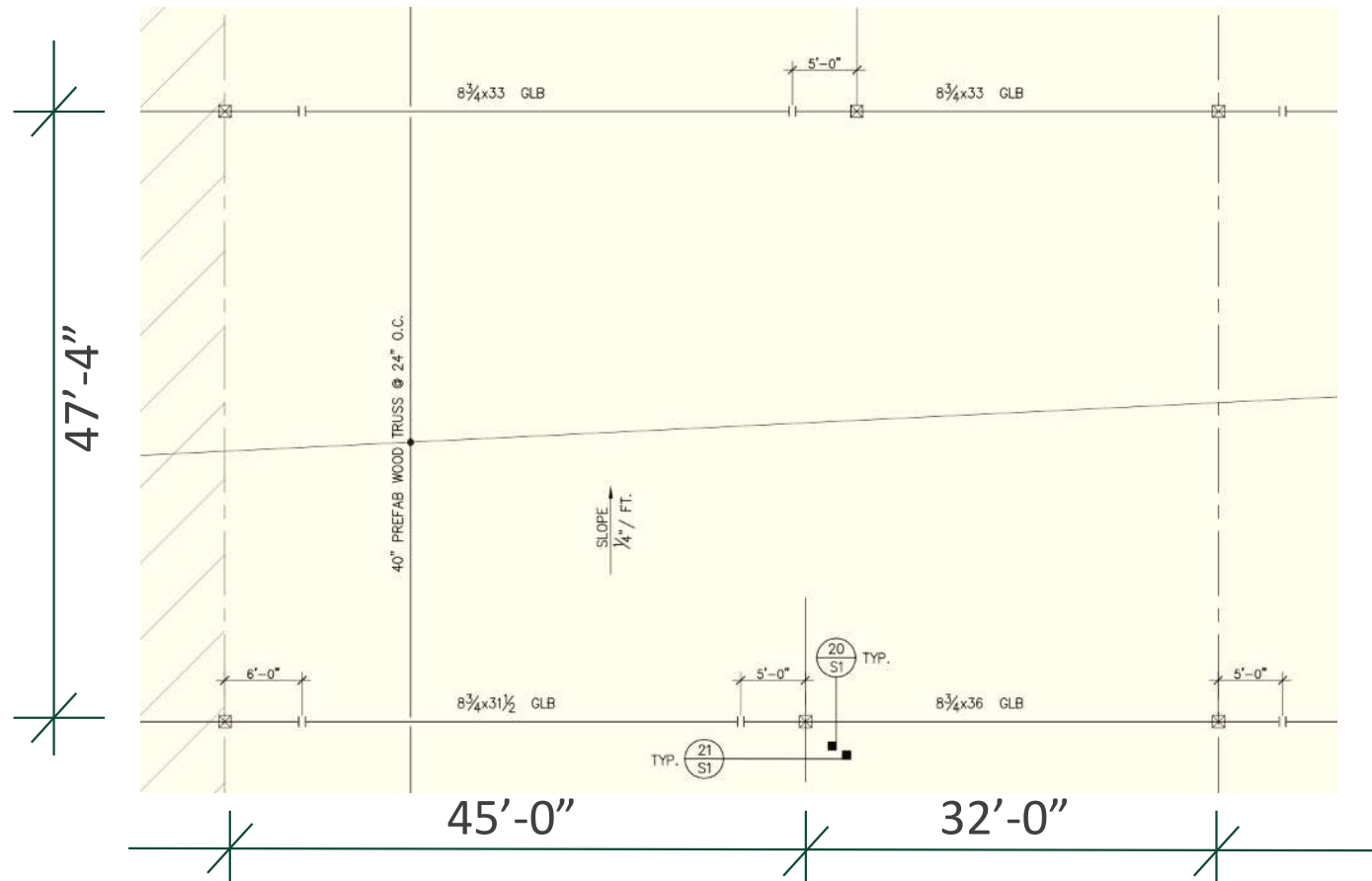
Big Cost Savings for Retail Store

- » Original Steel & Masonry Building: \$4.49 M
- » Wood Building: \$3.5 M
- » Nearly **\$1 M Savings** – 22% Savings - \$18/sf Savings

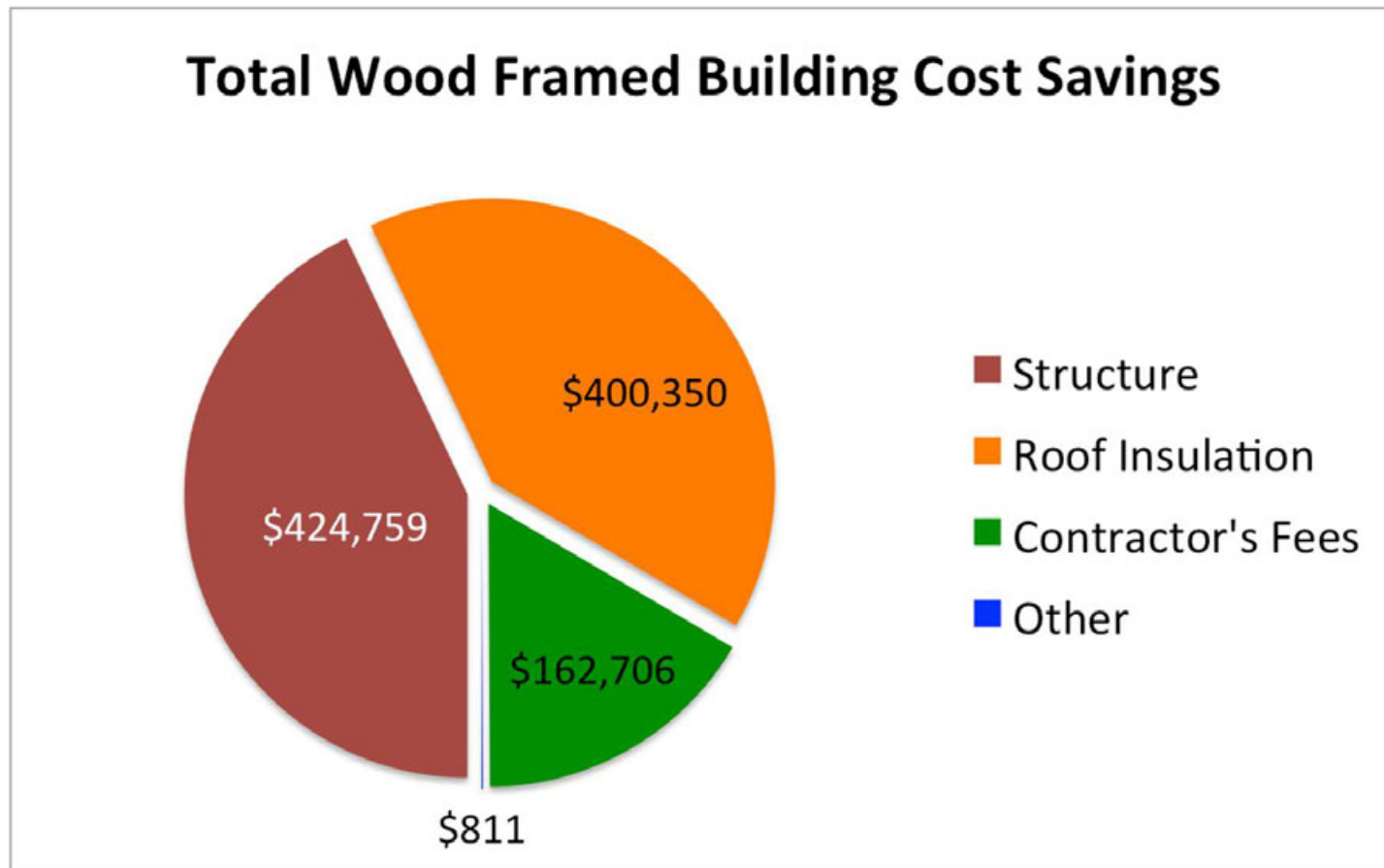


Retail Store: Gravity Framing System

Partial Roof Framing Plan



Cost Savings Factor: Structure



Cost Savings Factor: Roof Insulation

- » Original Steel & Masonry Building: 4.5" Extruded Polystyrene (XPS) Rigid Insulation on Top of Steel Roof Deck. R-22. Cost = \$783,000
- » Wood Building: 5.5" Fiberglass Batts Between Roof Trusses. R-22. Cost = \$383,000
- » Roof Insulation Savings of \$400,000



Source: Owens Corning



Source: Networkx

Cost Savings Factor: Structure



Source: Canadian Wood Council

Cost Savings Factor: Structure

Total Structure Cost Savings for Wood Building = \$425,000

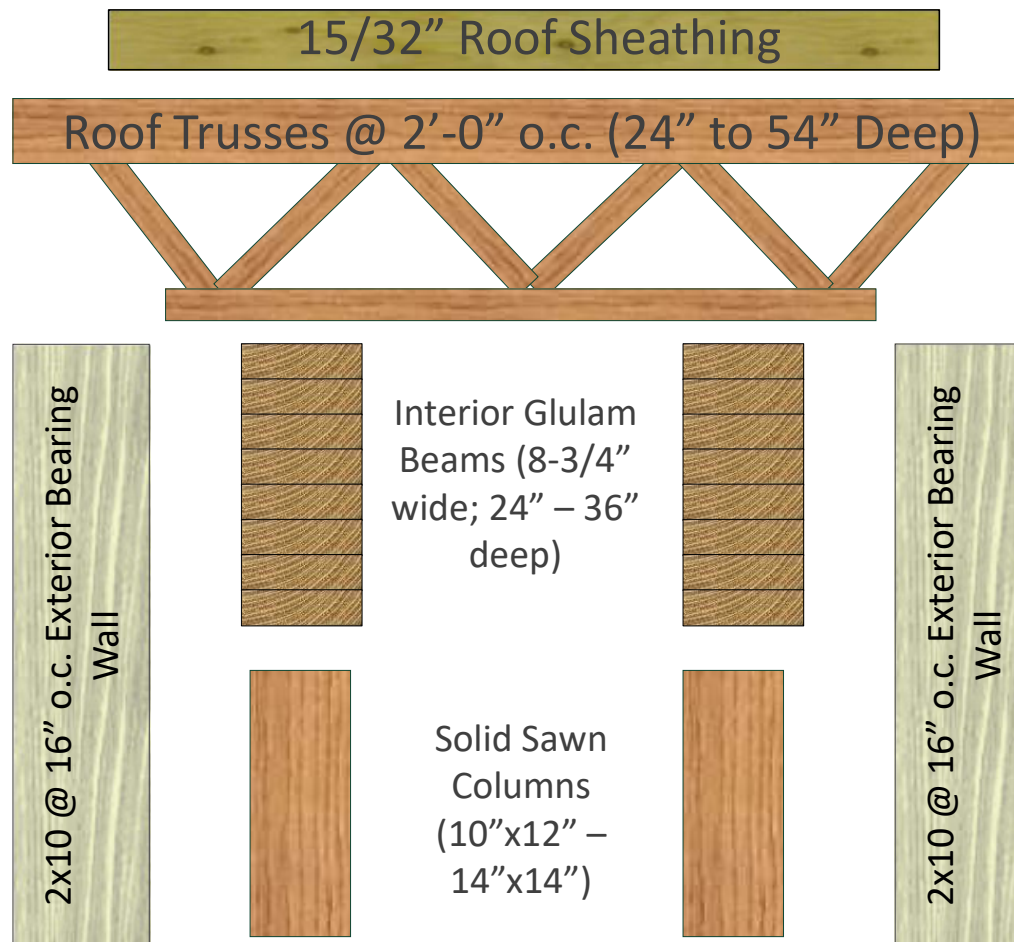


Source: APA



Source: LP Building Products

Retail Store: Gravity Framing System

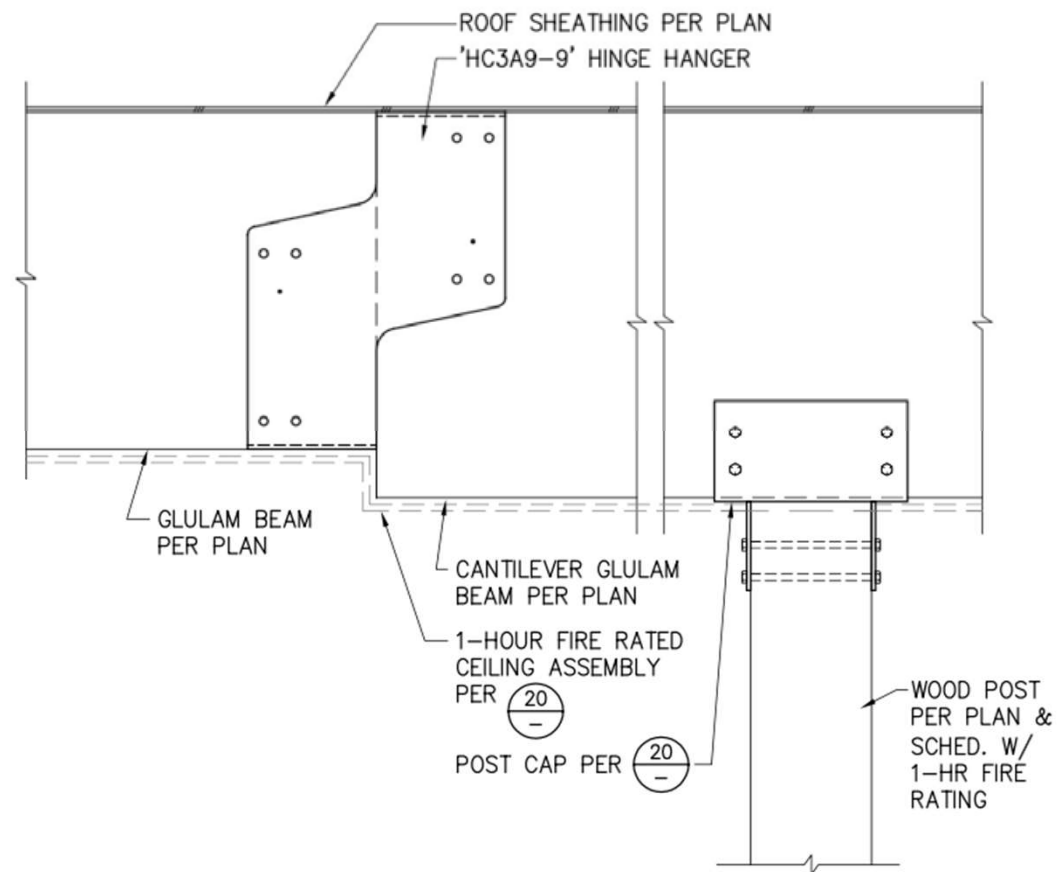


Cost Savings Factor: Structure

Category	Steel Bldg Element	Wood Bldg Element	Wood Bldg Cost Savings
Roof Beams	Open web steel joist girders	Glulam Beams	<u>\$164k</u>
Roof Decking	1-1/2" Steel Deck	15/32" Sheathing	<u>\$114k</u>
Columns	HSS Columns	Solid Sawn Columns	<u>\$107k</u>
Primary Roof Framing	Open web steel joists	Prefab Trusses	<u>\$66k</u>
Wall Framing	6" metal studs & 8" masonry	2x10 @ 16" o.c.	<u>\$54k</u>
Ceiling	N.A.	5/8" gyp & RC	<u>\$80k Extra</u>
Total Wood Structure Cost Savings			<u>\$425k</u>

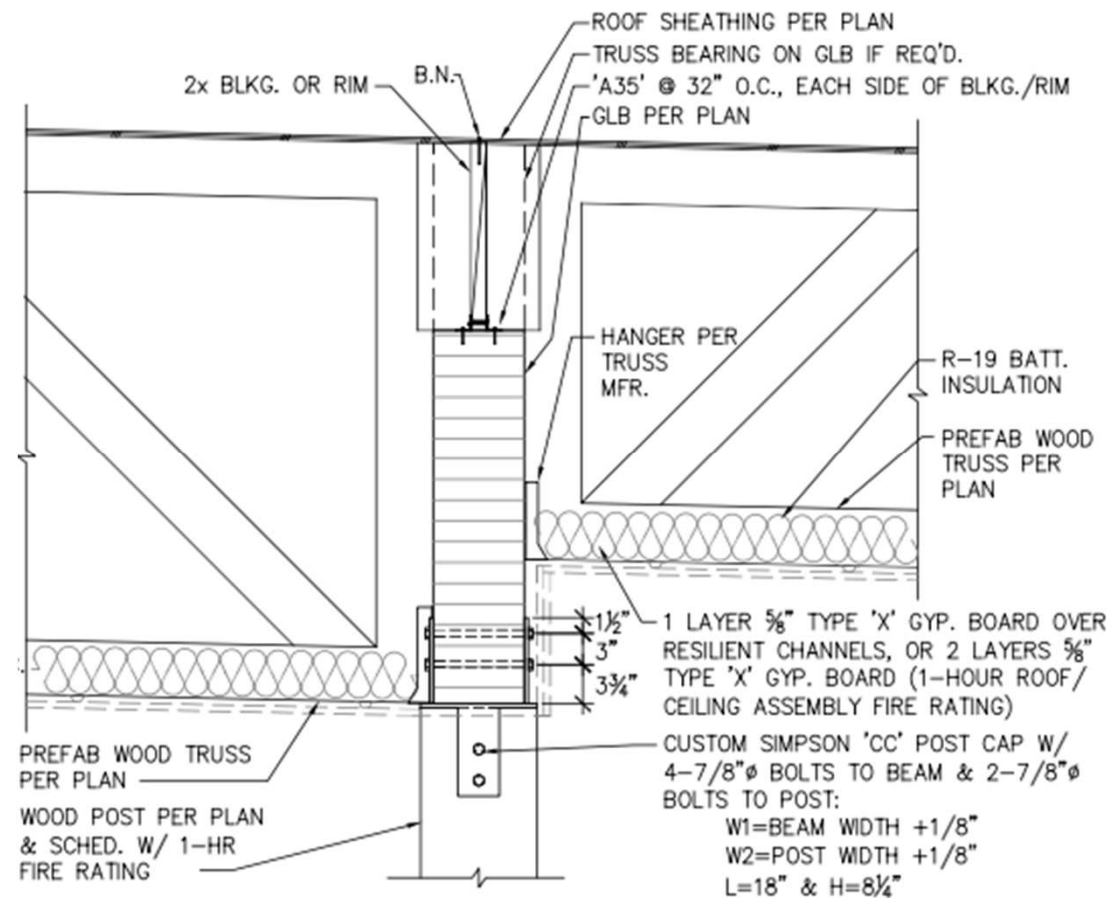
Retail Store: Gravity Framing System

Glulam Roof Beam Connection Details



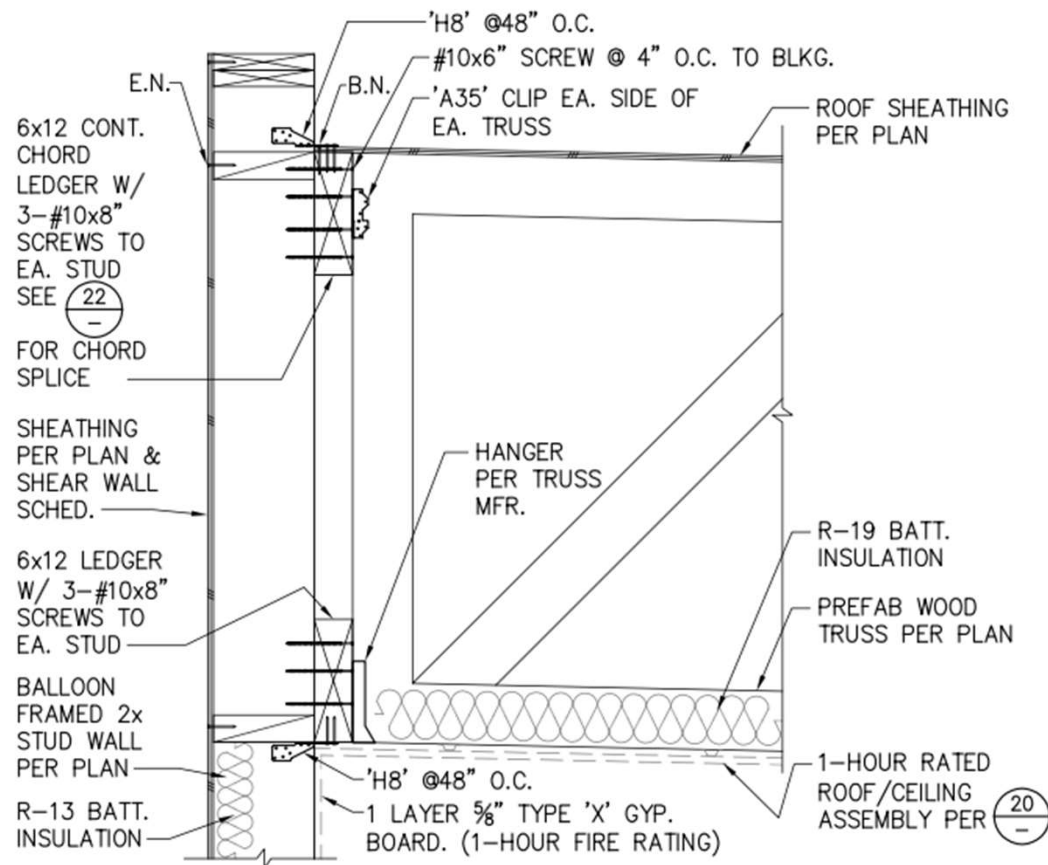
Retail Store: Gravity Framing System

Glulam Roof Beam Connection Details



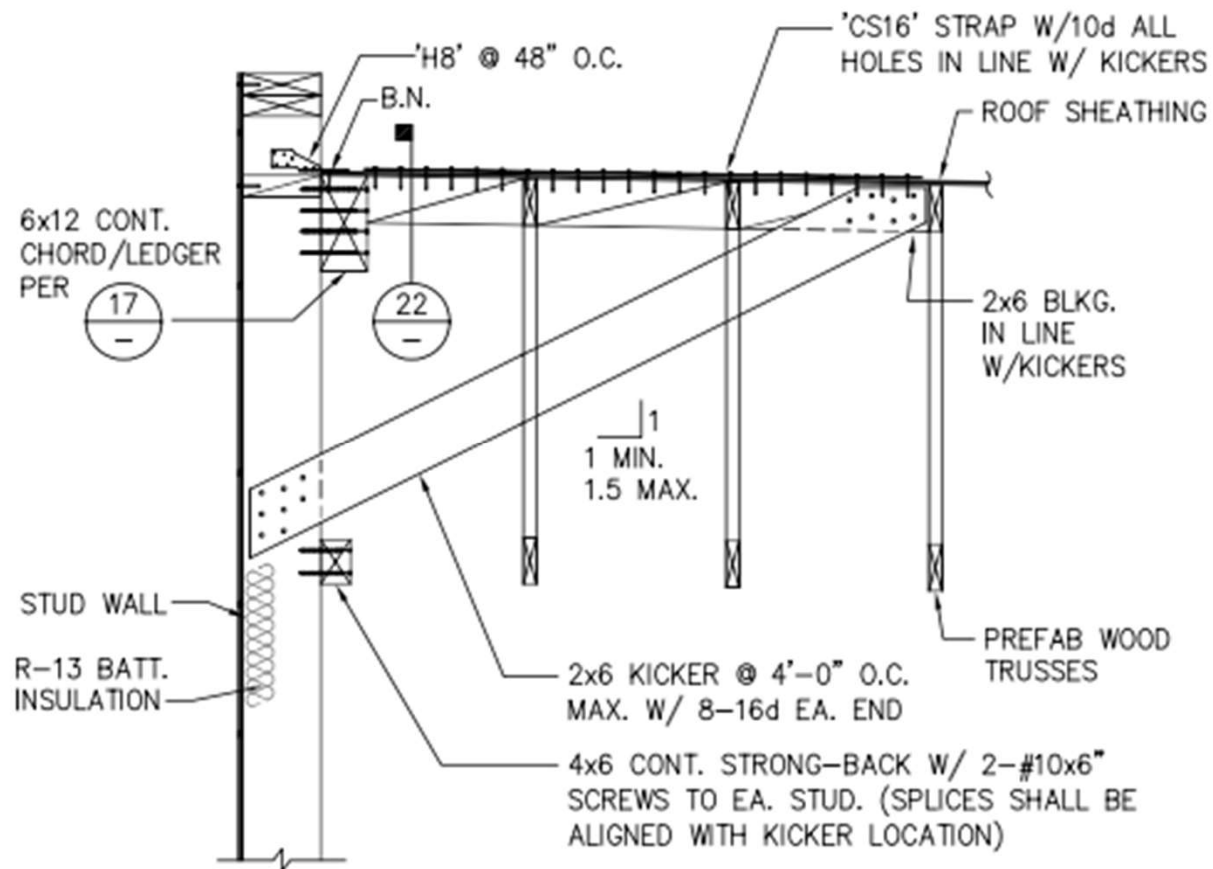
Retail Store: Gravity Framing System

Exterior Wall Details



Retail Store: Gravity Framing System

Exterior Wall Details



Summary & Conclusions

Yard House Bar & Grill

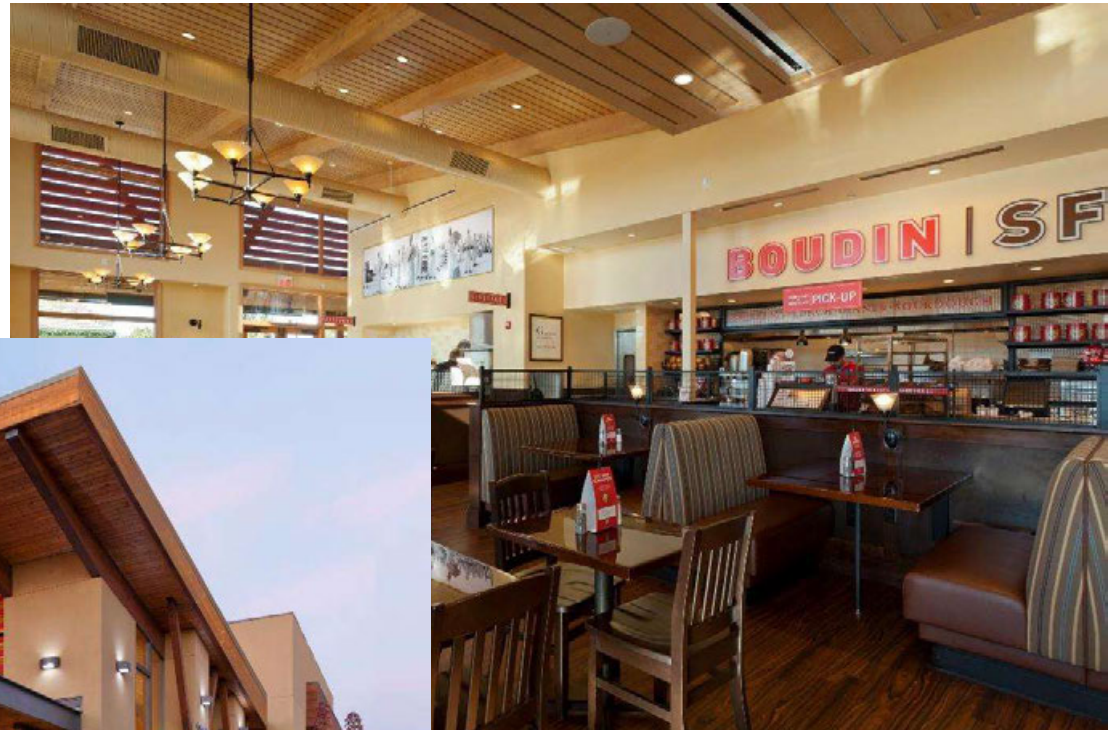
6,500 sq ft restaurant
Chino Hills, CA



Architectural Grade Glulam Beams
I-Joist Roof Framing
Doug Fir Posts
Wood Stud Exterior Walls

Boudin SF

Santa Rosa, CA



7200 sq ft
Restaurant
& Coffee Shop

Boudin SF

Alaskan Yellow Cedar Glulam Beams

Doug Fir Ceiling Planks

Engineered Wood Wall Studs



Additional Resources

American Wood Council Publications: www.awc.org

National Design Specification (NDS) for Wood Construction
Special Design Provisions for Wind and Seismic (SDPWS)
Wood Frame Construction Manual (WFCM)
Code Conforming Wood Design Series

Force Transfer Around Openings Paper by APA

www.apawood.org/Data/Sites/1/documents/technicalresearch/seaoc-2015-ftao.pdf

Metal Plated Wood Trusses:

Structural Building Components Association. www.SBCIndustry.com

Big Box Retail Design Case Study:

www.woodworks.org/wp-content/uploads/Big-Box-Retail-Wood-vs-Steel-Oct-2015.pdf

Questions? Ask us anything.



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901 East Sixth, Thoughtbarn-Delineate Studio, Leap!Structures, photo Casey Dunn



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Funding provided in part by the Softwood Lumber Board

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