Tall Wall Design Using Engineered Wood Products

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Tall Wall Design Using Engineered Wood Products

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Description: Provides an overview of the design considerations and code requirements for using engineered wood lumber in tall wall design – building walls over 10 feet tall using composite lumber wall studs in residential and commercial projects.

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Learning Objectives

Upon completing this course, you will be able to:

- discuss how the manufacturing process of engineered wood products uses natural forest resources more efficiently
- recognize the steps involved in designing studs, headers and columns using engineered wood products
- identify the practical and structural advantages, and performance benefits of using engineered wood products as wall framing members
- differentiate and apply the basic design considerations beyond prescriptive code for walls over 10 feet tall, and
- discuss AC-202 code acceptance criteria and discern the effects of deflection and lateral wind on walls.

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Introduction:

Engineered Wood Products

What are Engineered Wood Products?

Essentially, the manufacturing process of engineered wood products is the practice of taking a tree apart, removing the defects, and reassembling it into wood products for use in the construction industry.

Engineered Wood Products are becoming increasingly necessary as older trees with large diameter sections of wood in high grades and long lengths, are exhausted.

Engineered wood products use forest resources more efficiently, and the high performance end products provide many practical and structural advantages in places where traditional lumber products are used.

What are Engineered Wood Products? cont'd...

Today's engineered wood products include I-joists, beams, and boards. Wood fibers are processed into veneers or strands, coated with adhesive, compressed into large boards, dried, and then sawn into standard lumber dimensions.

Typically one thinks of engineered wood products as lumber substitutes in beam and header applications, but they are excellent wall framing members with strength and performance benefits that can far exceed those of traditional lumber products, and can be used as direct replacements for 2 x 4, 2 x 6, 2 x 8, and 2 x 10 lumber.

What are Engineered Wood Products? cont'd...

Engineered wood products make an ideal material for wall framing because they surpass traditional lumber in length, strength, and consistency.

Their uniform density means they start straight and stay straight, with a predictable performance from piece to piece.

Engineered Wood Products in Walls

Common uses for engineered wood products in walls include:

- walls used for cabinetry and countertops, especially in kitchens and bathrooms
- walls with chair rails
- around exterior door openings
- for brittle exterior finishes
- where high load carrying capacity is required, and
- walls over 10’ high.

Walls Used for Cabinetry, Countertops and Chair Rails

Cabinets don't always rest flush against a wall using lumber studs. Imagine a homeowner spending thousands of dollars on expensive cabinetry and granite or marble countertops that are crooked, need to be shimmed, or have a wide, ugly bead of caulk between the wall and the countertops.

Walls using engineered wood products as studs are less likely to wave and bow. Where precision is required by other trades, engineered wood products studs can reduce call back costs and provide a reliable substrate to attach to.

Engineered wood product studs are an excellent choice for tiled walls and showers or stucco finishes.

Walls Around Exterior Window and Door Openings

The imperfections of dimensional lumber framing can cause windows and doors not to function properly.

When engineered wood products are used in framing it makes for easier installation, better operation of windows and doors, and also fewer leaks.

Engineered wood studs are strong, straight, true studs. They reduce product waste and labor time when used instead of traditional lumber studs.

Walls in High Wind Load Areas

Engineered wood studs are manufactured to withstand both gravity and wind loads. Walls have a different deflection criteria than roofs and floors.

Always check with the component and finish manufacturer's requirements as they may be more stringent than code requirements. We'll get more into wind velocity and wind pressure later in the course.

Tall Walls Over 10’

The length of natural wood resources limits the availability of traditional lumber studs for tall wall design. For tall walls, engineered wood products are the perfect alternative to traditional lumber studs as they are available in consistent, straight, long lengths; they resist warping and twisting, and they eliminate many of the imperfections inherent in traditional lumber.

Designing Tall Walls Beyond Conventional Framing

Engineered wood studs provide straighter, taller, and stronger walls. Through the use of examples, this course illustrates the main points necessary to understand the design considerations for tall wall studs using engineered wood lumber.

Code Requirements,

Code Acceptance

Code Acceptance – AC202

Building codes mandate that any wall stud over 10 feet must be designed in accordance with accepted engineering practice.

In order to market and sell engineered wood products as studs, EWP manufacturers should be qualified, and their products must meet all requirements under ICC-ES AC202. With code acceptance clearances under ICC-ES AC202, building professionals can be confident that engineered wood studs are manufactured to the appropriate standards.

Products used in projects without this qualification may be red tagged by building inspectors and this process will hold up the build cycle.

More About AC-202

AC-202 is the ICC-ES acceptance criteria that establishes minimum requirements for recognition of structural wood based products in evaluation reports under Sections 104.11 and 2303.1.9 (Standards for Structural Composite Lumber) of the 2003 International Building Code (IBC). Testing is done on these products in accordance with ASTM D 5456 which is the Standard Specification for Evaluation of Structural Composite Lumber Products.

In order for an EWP manufacturer to market and sell engineered wood products for a wall stud application, their products must be evaluated by the ICC Evaluation Service, Inc. (ICC-ES) through a series of tests that include full-scale lateral load transfer (shear wall), nail, fire resistance, axial load, holes and notching tests. Additional testing on the mechanical and physical properties are also performed.

Full-scale fire tests demonstrate that stud walls built with engineered wood products not only meet a one-hour fire rating, but also meet hose stream tests in accordance with ASTM E 119 codes.

Why Be Concerned About Walls over Ten Feet?

There are several reasons why walls over 10 feet in height need to be designed in accordance with accepted engineering practices and the provisions of the code. Tall walls are more susceptible to high winds and other lateral forces on a structure which unless properly designed will result in excessive movement. This movement could lead to stress cracks and leaking seals in and around windows and doors and damage to exterior finishes that have deflection limitations.

To reduce the possibility of these occurrences, the prescriptive code limits floor to floor heights to 10 feet, and imposes other limitations on wind speed, allowable deflection factors, load carrying capabilities, to name a few.

For the all code requirements consult section IBC 2308.2 of the International Building Code.

IBC 2308.2 Limitations

The limitations to the prescriptive code are found in section 2308.2 in the IBC. Keep in mind, in general these are the limitations but certain seismic design categories may be different. There may also be exceptions. Please consult the full IBC 2308.2 Limitations section of the code. The prescriptive limitations are summarized here:

- limited to no more than three stories
- floor to floor height does not exceed 10'
- average dead loads shall not exceed 15 psf for combined roof and ceiling, exterior walls, floors, and partitions
- live loads shall not exceed 40 psf for floors
- ground snow loads shall not exceed 50 psf
- wind speeds shall not exceed 100 mph
- roof span carried of the roof structure shall not exceed 40'

If you don't exceed these limits you can use the IBC. If you meet the limits you can use the IRC. Most applications today exceed the limitations of prescriptive code. Once you get beyond these limitations, that's when the applications require design and that is when engineered wood products have an advantage. Most engineered wood products manufacturers have technical literature as well as proprietary software to assist in designing for axial and wind loads, deflection, bearing reactions and connection to plates for the same. Wind load design is for loads perpendicular to the wall.

IBC 2308.2 Limitations cont'd...

Although a complete discussion of shear walls is beyond the scope of this course, some considerations do need to be taken into account and are required when designing tall walls. Also, most engineered wood products manufacturers recommend the Designer of Record take design responsibility for shear walls, or in some cases the APA has prescriptive designs that will provide the information required.

Below is a list of some considerations for shear walls. Determine the use of the building and refer to the appropriate code.

- wind restrictions
- seismic restriction
- height restrictions for wall and building
- maximum length of unbraced wall
- maximum distance between openings
- sheathing and blocking requirements for various products
- topographic features
- roof height and pitch
- foundation restrictions
- review of the code for other minor but important considerations

The Effects of Deflection, Lateral Wind and Suction

In the next few slides we will look at how deflection requirements, lateral wind and suction affect tall walls.

1. Deflection Requirements

- Damage from excessive deflection ranges from damage to interior or exterior finishes to structural instability
- Prescriptive code limits dimensional lumber studs to 10 feet
- Limitations include wind speed, allowable deflection factors, load carrying capabilities, to name a few

2. Lateral Wind

- Stress cracks and leaking seals can occur
- Excessive movement in the walls can occur if they are not adequately designed.

3. Suction

- Outward pressure can occur, causing windows to shatter
- Walls and roofs are pulled outward

Deflection

The measurable amount a stud will bend under a wind load is called deflection. Deflection is measured in inches. Most codes mandate the maximum allowable deflection for a wood stud is L/120.

Different exterior finishes may require a lower deflection based on code. Note that some manufacturer's requirements for component and finish may be more stringent than local building codes.

Lateral Wind

Lateral wind loads have a tendency to try and blow a structure over. Wind loads have to be resisted by structural framing components – like wall studs and sheathing. Sheathing, bracing, and nailing types and requirements all play a critical part in resisting wind loads and the proper design.

Composite lumber is the perfect solution for strengthening tall walls because shear walls and connections can readily be designed to provide the required lateral resistance.

Suction

Winds flowing over exterior surfaces create suction, pulling walls and roofs outward.

Open windows or doors allow wind to enter and increase outward pressure.

Tall Wall Design Considerations

Tall Wall Design Considerations

This section of the presentation discusses the following tall wall design considerations, which should always be taken into account before designing tall walls. As always, be sure to check all of your local code requirements.

- building configurations and wall heights
- allowable deflection
- plate connections
- appropriate header design
- installation
- wind velocity and wind pressures
- exposure Categories
- loads induced on Walls

Building and Wall Height Geometry

As defined by the IRC, the length of a stud is the distance between points of lateral support placed perpendicular to the plane of the wall.

Check with your local code agency for their specific design requirements.

Allowable Deflection

Maximum deflection limits are set by building codes and also by building components and finish manufacturers' requirements. Additionally, further deflection limits can be required by other building components manufacturer's recommendations.

Deflection limits are expressed as a fraction of the unsupported stud height in inches. For example: a 10 ft. wall stud with an L/360 deflection limit shall deflect no more than 120"/360 – 1/3 inches under maximum design loads.

The maximum allowable deflection limit is dependent upon the different types of finishes.

Common deflection limits are:

Flexible finish = L/120

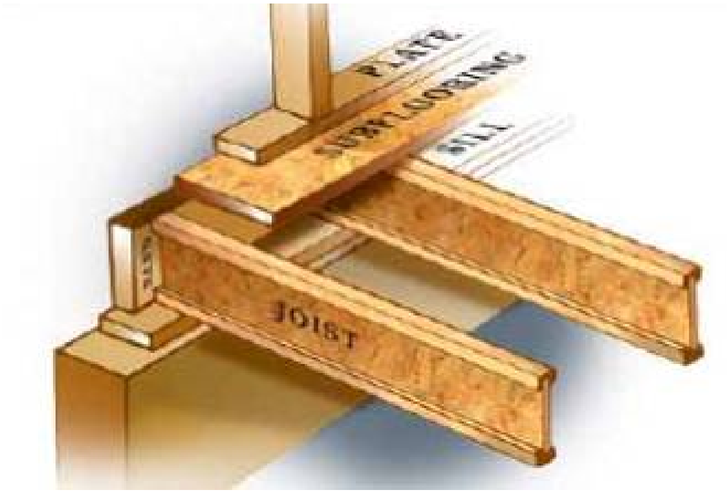
Brittle finish = L/240

Plaster/Stucco finish = L/360

Walls with windows/doors = L/175

Plate Connections

Plates tie the studs together and serve as a connecting link between the wall and the floor and/or roof framing. The wall stud rests on the bottom plate and is capped by the top plate(s).



When connecting a tall wall stud to the plate, the standard is to use two 16d common or box nails. Additional nails or metal connectors may be required when the load amount exceeds the capacity of the two 16d nails.

Installation

During the design process, installation must be considered. The stud and plate components, once assembled, are placed at the area of the sub floor where they will be nailed together, measured for squareness, and then raised into place and nailed down. Securing the plate to the foundation must meet the code requirements. Blocking is typically required at 8 foot increments and/or at all panel joints.

WARNING: Adequate bracing shall be used during construction.

For adequate bracing recommendations check your local code requirements. Also consult other resources such as the APA - Engineered Wood Association or wood wall framing construction methods handbooks.

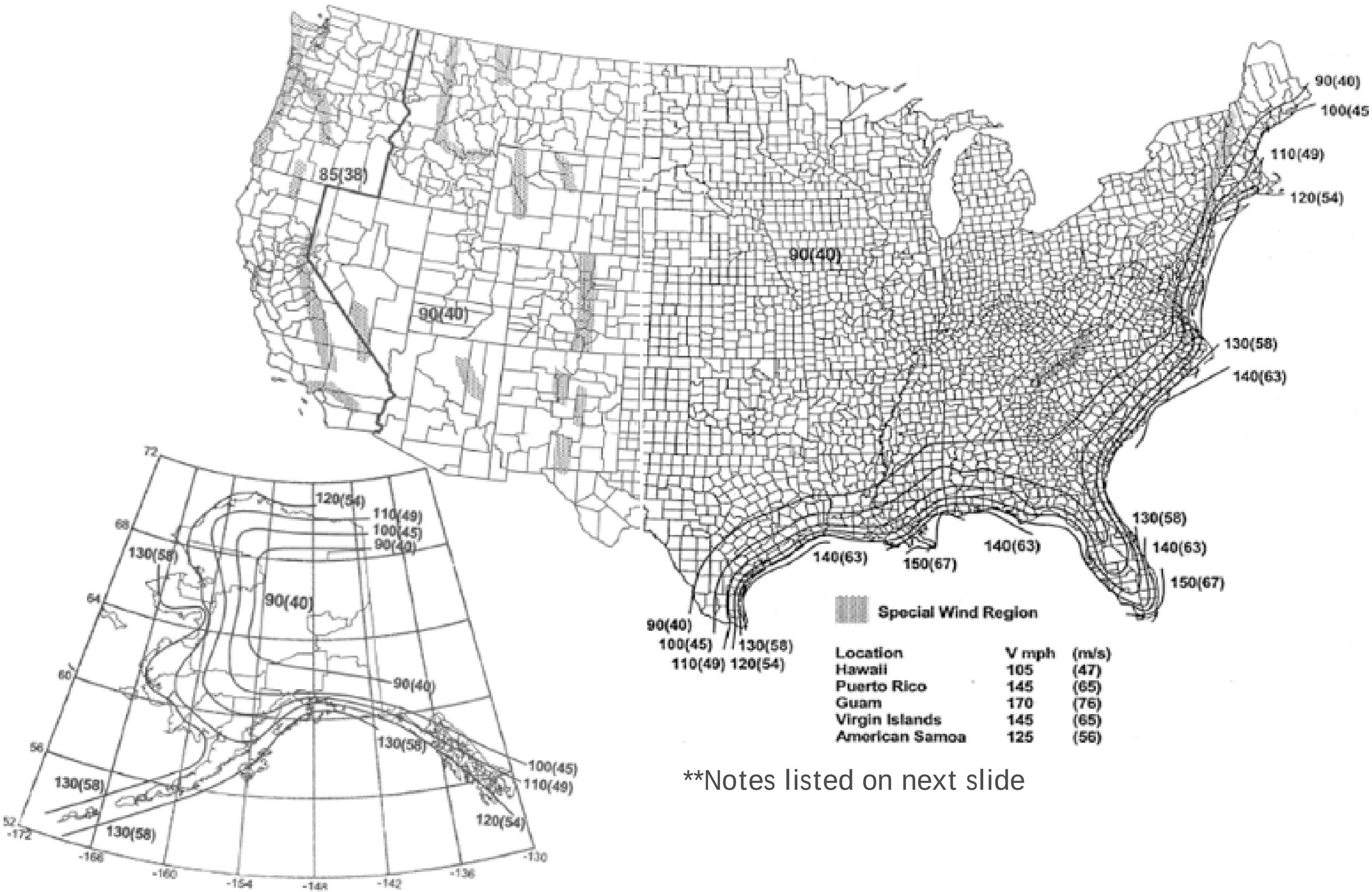
Wind Speed

The main considerations in wind design are the design wind velocity and the structure importance. The design velocity is taken from the wind map provided by ASCE (see next slide) or by local requirements in certain special regions.

These wind speeds are considered 50-year-winds, that is, they are likely to occur during the lifetime of a typical structure. The minimum wind design velocity is 85 mph and the maximum is 150 mph.

The code standard does not cover tornadoes. Check your local building code for the wind speed in your area.

2006 IBC/Chapter 16 Structural Design/Section Figure 1609 Basic Wind Speed (3 Second Gust)



**Notes listed on next slide

Used with permission from IBC. See Code book for additional maps & clarification.

2006 IBC/Chapter 16 Structural Design/Section Figure 1609 Basic Wind Speed (3 Second Gust) cont'd...

Notes:

- Values are nominal design 3 second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
- Linear Interpolation between wind contours is permitted.
- Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
- Mountainous terrain, gorges, ocean promontories and special wind regions shall be examined for unusual wind conditions.
- Wind speeds vary. Refer to local building code for wind design speed in your region.

Importance of Structure Factor

It is important to know what a building will be used for. Importance factors are established for use in the equations to account for the type of building being designed. For example, a shed or barn won't be designed with the same factor of safety as an elementary school with 150 children .

The importance factor is defined by the American National Standards Institute (ANSI) as "a factor that accounts for the degree of hazard to human life and damage to property." Unimportant structures are those where the potential for loss of human life is particularly low – like minor storage facilities and agriculture facilities.

Importance of Structure Categories

The importance of a structure depends on its use. Each building type has different code categories. The importance factor can be thought of as a factor based upon occupancy.

Category I:
- Minor structures (most agriculture buildings)

Category II:
- Residential and light commercial buildings

Category III:
- Large structures (churches, schools, large occupancy)

Category IV:
- Critical structures (hospitals, fire, police, defense)

Effective Wind Area

Effective wind area is the greater of the wall span times the tributary width, or $L^2/3$. See chart below. For values of effective wind areas not listed, interpolations between $10ft^2$ and $100ft^2$ are allowed.

Wall Height	Stud/ Column Effective Wind Area (sq. ft.)
≥18	100
16	85
14	65
12	48
≤10	33

Exposure Categories

For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities needs to be determined for the building site. For a site located in the transition zone between categories, the category resulting in the largest wind forces should be applied.

It is also necessary to take into account the different variations in ground surface roughness that arise from natural topography and vegetation in addition to the constructed features.

For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of three categories. When applying the simplified wind load method of Section 1609.6 of the codes, a single exposure category shall be used based upon the most restrictive for any given wind direction.

Exposure Categories cont'd...

There are 3 steps in designing for the appropriate wind pressure in your area:

1. Choose your exposure category from the chart.
2. Choose the effective wind area from the previous slide.
3. Choose the basic wind speed in your area.

Where the effective wind area and the basic wind speed meet, in the table below, is the wind pressure in psf for your area.

B – Urban and suburban areas; wooded areas

C – Open terrain with scattered obstructions (less than 30' high)

D – Flat, unobstructed areas and water surface areas outside of hurricane prone regions.

(Generally defined, see ASCE 7-05 section 6.5.6 for complete definition.
Check local codes for special wind pressures).

WALL DESIGN WIND PRESSURE (PSF)(A)

Exposure Category(B)	Effective Wind Area(C) (ft²)	Basic Wind Speed (mph)							
		85	90	100	110	120	130	140	150
B	≤10	14.5	16.2	20.1	24.3	28.9	33.9	39.3	45.1
	50	13.1	14.7	18.1	21.9	26.1	30.6	35.5	40.8
	≥100	12.5	14.0	17.3	20.9	24.9	29.2	33.9	38.9
C	≤10	20.1	22.6	27.9	33.7	40.1	47.1	54.6	62.7
	50	18.2	20.4	25.2	30.5	36.2	42.5	49.3	56.6
	≥100	17.3	19.4	24.0	29.1	34.6	40.6	47.1	54.0
D	≤10	23.7	26.6	32.9	39.8	47.3	55.5	64.4	73.9
	50	21.5	24.1	29.7	35.9	42.8	50.2	58.2	66.8
	≥100	20.5	22.9	28.3	34.3	40.8	47.9	55.5	63.7

Exposure Category B - Urban and Suburban Areas; Wooded Areas

Exposure B applies to urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Exposure B is typically associate with site location in a residential subdivision. Most site locations are assumed to be Exposure C unless the site meets the definition of another type of exposure.

Exposure B category yields the lowest wind pressures. The terrain must prevail in the upwind direction for a distance of 2,600 ft. and 20 times the structure's height.

Exposure Category C - Open Terrain with Scattered Obstructions

Exposure category C applies to open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 ft from the building site, extending more than 1,500 feet (457.2) from the building site in any quadrant.This exposure shall also apply to any building located within Exposure B-type terrain where the building is directly adjacent to open areas of Exposure C-type terrain in any quadrant for a distance of more than 600 feet (182.9 m). This category includes flat open country, grasslands and shorelines in hurricane-prone regions.

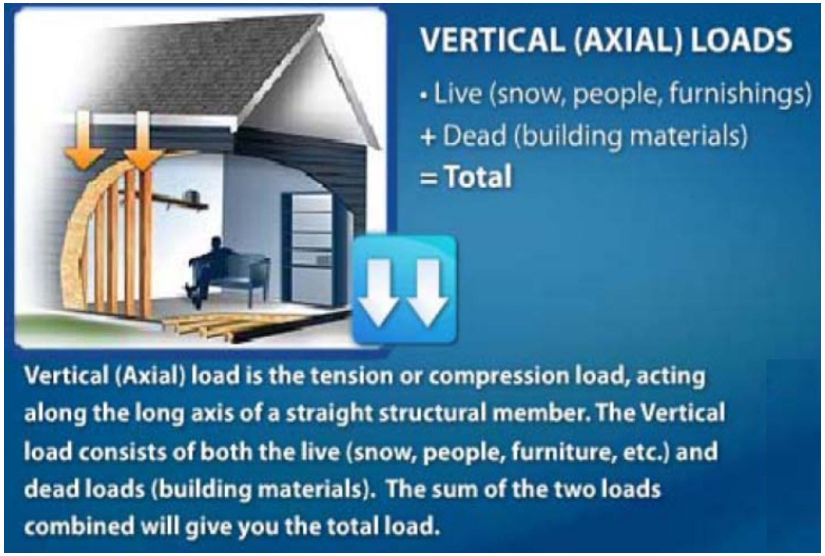
Exposure Category D - Flat, Unobstructed Areas

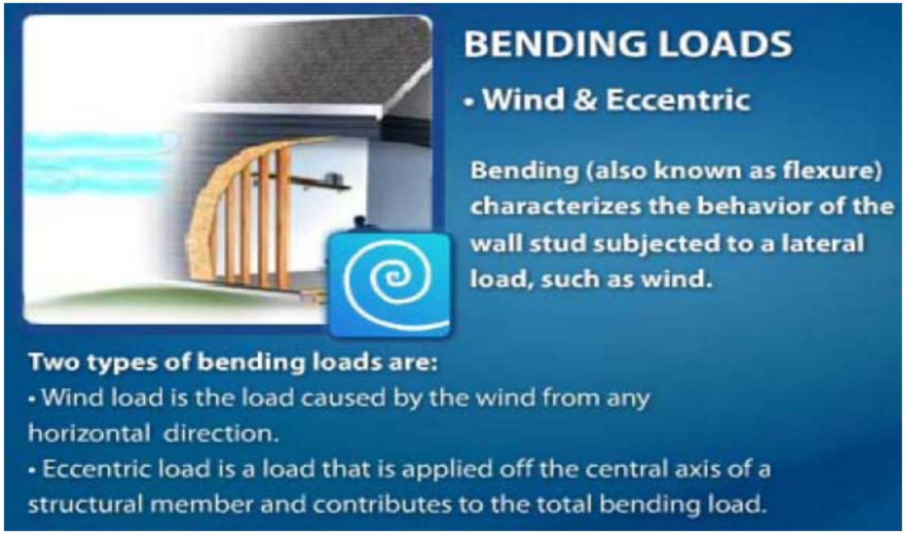
Exposure category D applies to flat, unobstructed areas exposed to wind flowing over open water (excluding shorelines in hurricane-prone regions) for a distance of at least 1 mile. These areas also include smooth mud flats, salt flats, and unbroken ice. The terrain in this category must prevail in the upwind direction for a distance of 5,000 ft. or 20 times the structure’s height, whichever is greater.

Exposure D includes shorelines in inland waterways, the Great Lakes, and coastal areas of California, Oregon, Washington, and Alaska. This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the water. Exposure D extends inland from the shoreline a distance of 1,500 feet (460 m) or 10 times the height of the building or structure, whichever is greater.

Loads Induced On Walls

When designing studs you must consider the loads induced on walls.





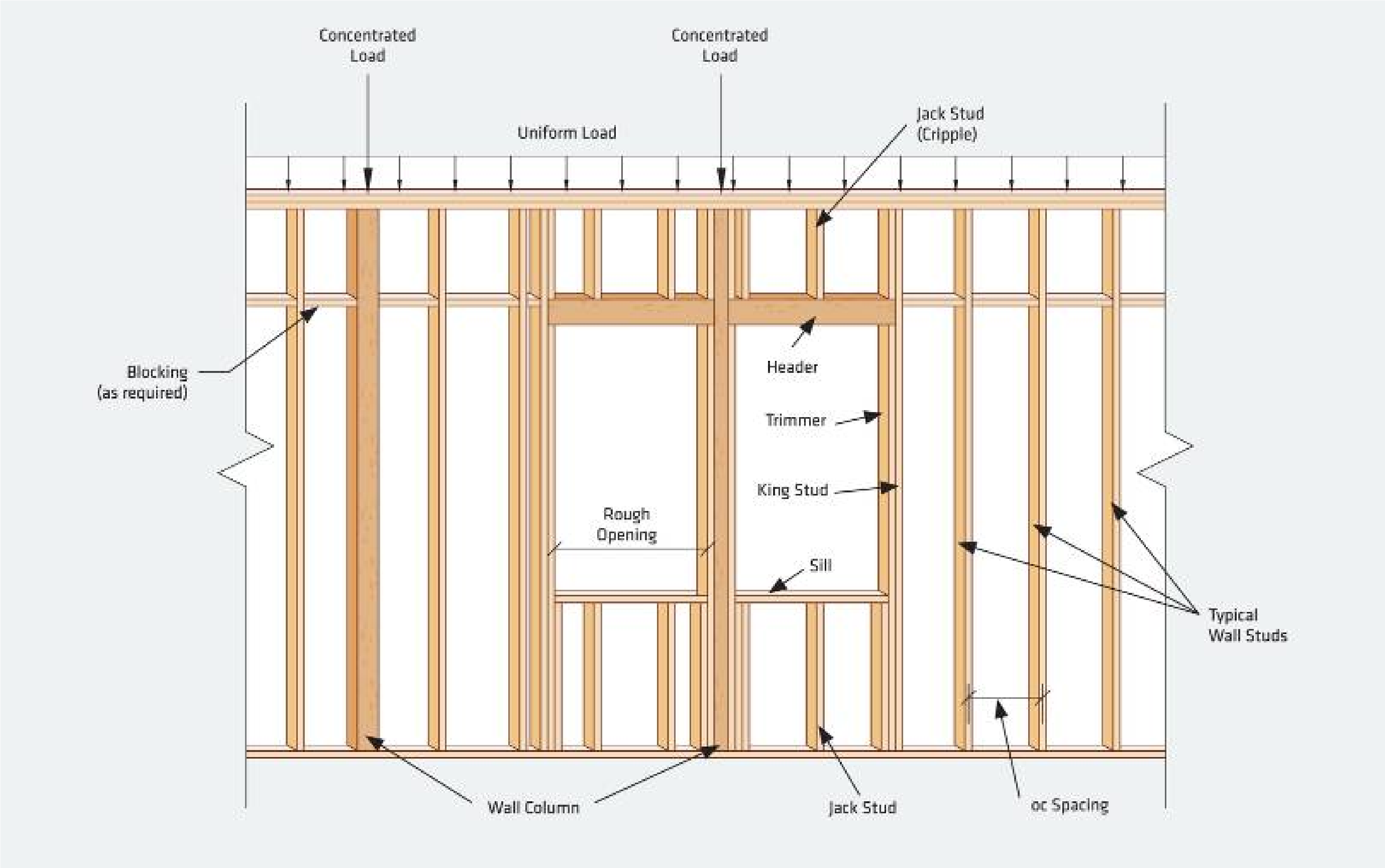
Examples & Exercises

Typical Wall Framing and Wall Stud Example Criteria

Before we tackle a tall wall, let's design a typical 9' stud wall (illustration on next slide).

- Select a suitable wall stud for a 9' first story wall for a residential structure located in a typical urban development in the central Midwest.
- The wall supports the second floor and the roof of a 36' wide home.
- The second floor is supported at midspan and the roof trusses have a 1' overhang.
- The floor loads are 40 psf Live and 15 psf Dead load.
- The roof loads are 30 psf Snow (115%) and 17 psf Dead.
  Assume 100 psf for the weight of the second story wall.
- The exterior finish is stucco.

Typical Wall Framing and Wall Stud Example Criteria cont'd...



Typical Wall Stud Design Example

This slide and the next list the steps you'll need to design an Laminated Strand Lumber (LSL) stud wall. A practice example follows these steps.

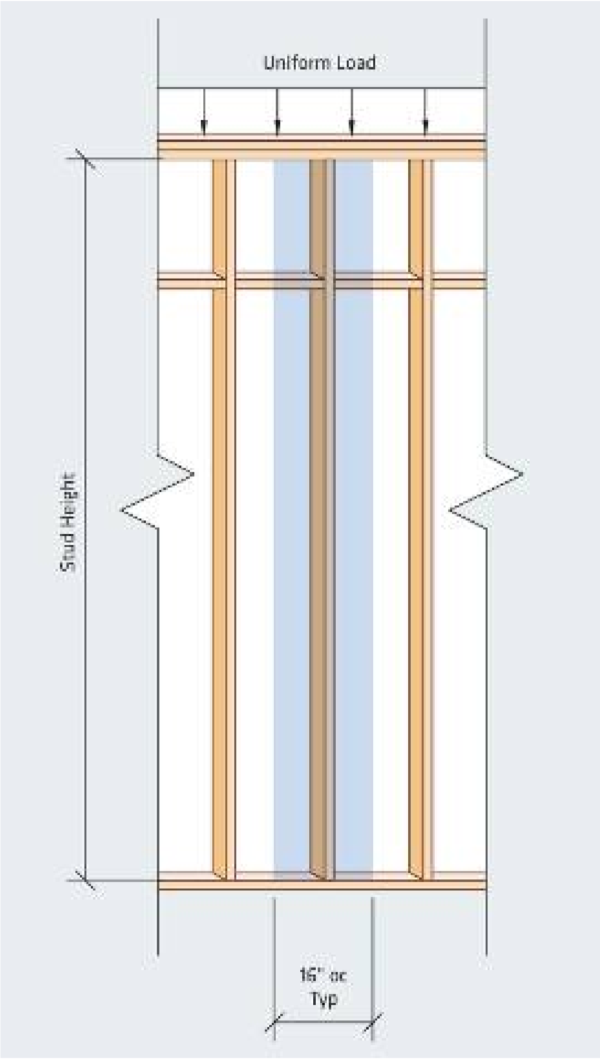
How to Size:

1. Determine the basic wind speed. Refer to information and the wind map on slides 32-34.
2. Determine the exposure category. Refer to the information on slides 38-42.
3. Determine the clear height of the wall stud.
4. Determine the total vertical load (plf) applied to the wall studs from the roof and floor. Don't forget the wall weight!

Typical Wall Stud Design Example cont'd...

5. Determine the allowable deflection ratio based on the wall construction.

6. Select the required grade and size from the appropriate chart from the manufacturers technical specification guide for the desired wall stud spacing.



Solution: Typical Wall Stud Design Example

1. The example states the structure is located in the Midwest which, from the maps in the IBC, is normally considered 90 mph Basic Wind Speed.

2. A typical urban development is normally an exposure B category provided that other structures of single-family size or larger are located in close proximity in all directions.

3. Use the height of the wall (9') as an approximation of the stud height.

4. The vertical load applied to each wall stud is:

   Roof: (30 psf + 17 psf) x (36' / 2 + 1') = 798 plf

   Wall: 100 plf

   Floor: (40 psf + 15 psf) x (18' / 2) = 495 plf

   Total Vertical Load = 893 + 100 + 495 = 1488 plf

Solution: Typical Wall Stud Design Example cont'd...

5. With a stucco finish, the deflection ratio shall be L/360 or better.

6. Using the 90 mph, Exposure B chart from the Wall Stud Capacity table (click here to view .pdf), for a standard wall stud spacing of 16” o.c., what would you select?

(Answer: 1-1/2” x 3-1/2” 1.35E LSL at 16” oc can support a vertical load of 1560 plf with a deflection ratio of L/375).

Typical Wall Framing: Trimmer Example Criteria

Select a suitable trimmer for a 3’ (36”) rough opening located in the first story wall of the typical wall stud design example.

Assume the bottom of the window header is at a height of 7’-6”.

Typical Wall Framing Trimmer Example

This slide and the next list the steps you'll need to design an Laminated Strand Lumber (LSL) trimmer. A practice example follows these steps.

How to Size:

Note: Trimmers are designed only for the vertical load applied by the header. The king stud will be designed for the lateral wind pressures.

1. Determine the clear height of the trimmer.

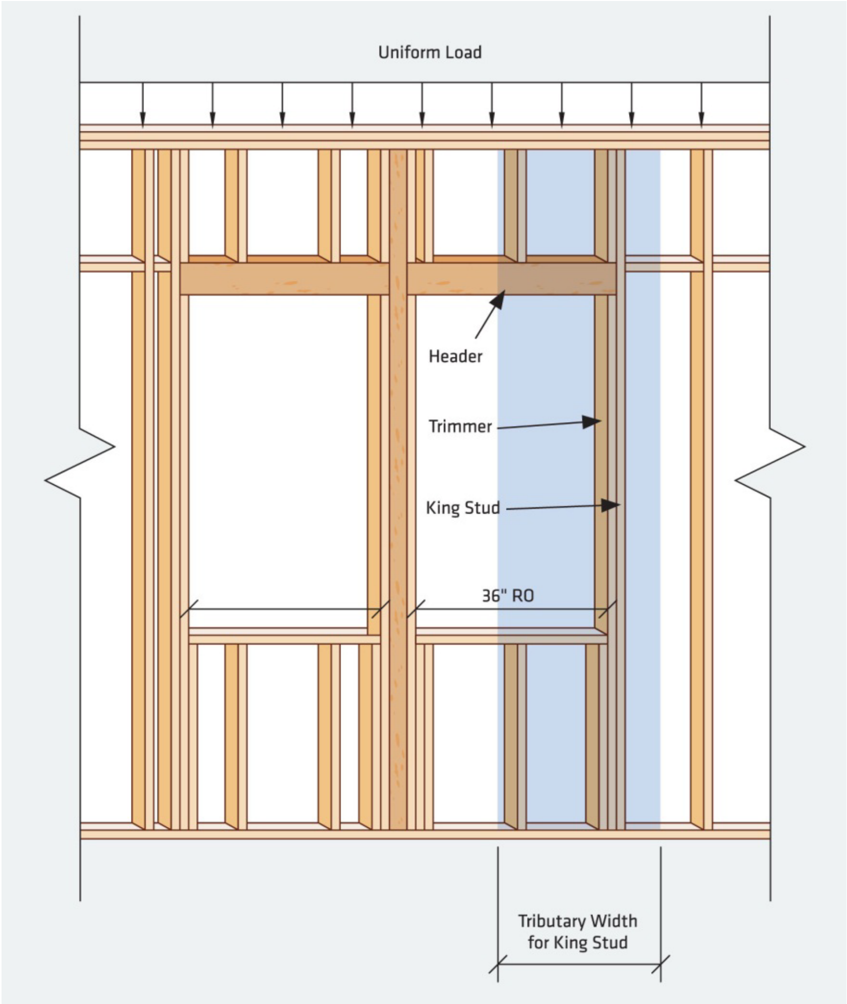
2. Determine the Tributary width associated with the trimmer.

3. Determine the vertical load applied to the trimmer from the window header.

Typical Wall Framing Trimmer Example cont'd...

4. Select the required grade and size from the appropriate chart from the manufacturers technical specification guide.

Hint: To size a trimmer, use the 12” oc row for the required height from the appropriate Wall Stud Capacity table in the manufacturers technical specification guide. At 12” oc, the vertical capacity in plf is equivalent to the vertical capacity in lbs. Ignore the deflection for the trimmer.



Solution: Typical Wall Framing Trimmer Example

1. With a header height of 7'-6", use 8' for the trimmer height in the tables.

2. Add 3" to the rough opening to approximate the overall length of the headers, assuming single trimmers.
   Tributary Width = (36" RO + 3") / 2 = 19.5"

3. The vertical load applied to the trimmer from the header is:
   Roof: 893 plf (from Typical Wall Stud example)
   Wall: 100 plf x (1.5' / 9') = 17 plf (adjusted to the wall height supported by the header, approximately 1.5')
   Floor: 495 plf (From Typical Wall Stud example)
   Total Vertical Load on Trimmer = (893 + 17 + 495) x 19.5" / 12 = 2283 lbs.

4. Using the 90 mph, Exposure B chart from the Wall Stud Capacity table (click here to view .pdf), for a spacing of 12" oc, what would you select?

(Answer: 1-1/2" x 3-1/2" 1.35E LSL trimmer can support a vertical load of 2805 lbs.)

Typical Wall Framing: King Stud Example Criteria

Select a suitable king stud for the same rough opening from the trimmer example.

Typical Wall Framing King Stud Example

This slide and the next list the steps you'll need to design a Laminated Strand Lumber (LSL) king stud. A practice example follows these steps.

How to Size:

Note: Design the king stud like an exterior wall column. To size as a single 1-1/2" thick member, the king stud must be attached to the adjacent wall stud by an exterior wall sheathing and interior gypsum wall board (or similar).

1. Determine the clear height of the king stud.

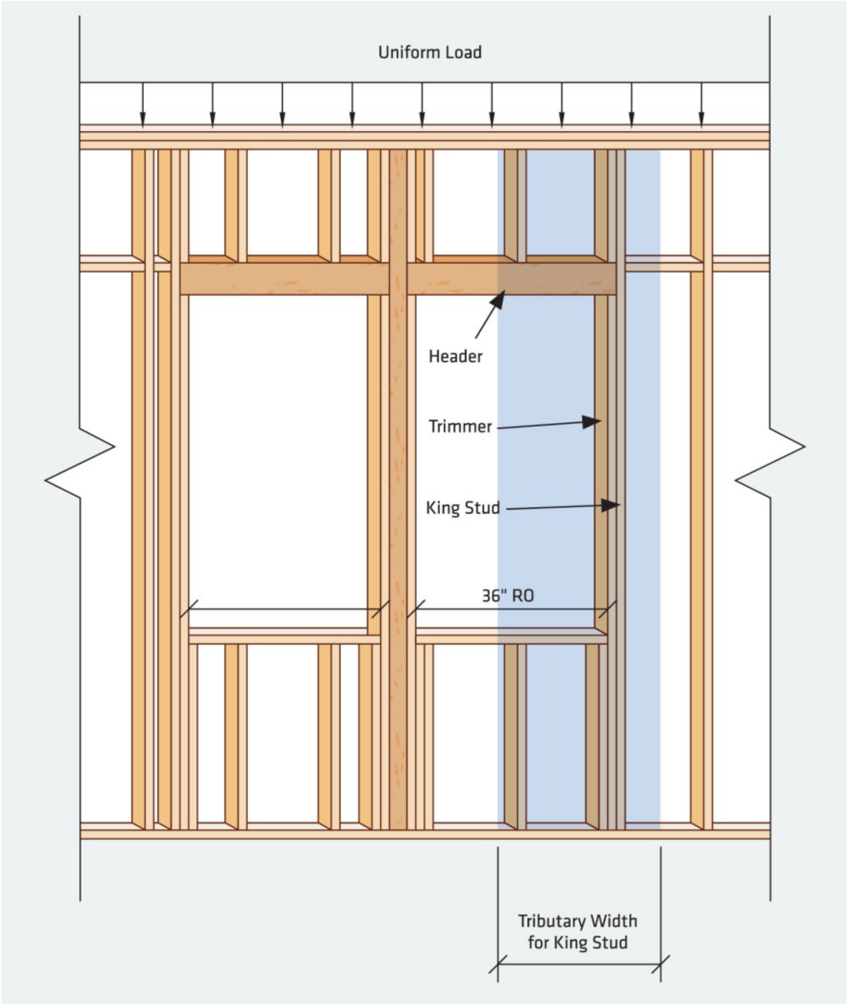
2. Determine the Tributary width for the lateral wind pressure.

3. Determine the total vertical load (lbs) applied to the king stud.

Typical Wall Framing King Stud Example cont'd...

4. Determine the allowable deflection ratio based on the wall construction.

5. Select the required grade and size from the appropriate chart from the manufacturers technical specification guide.



Solution: Typical Wall Framing King Stud Example

1. The king stud will be the same height as the typical wall stud – 9’ in this example.

2. The tributary width for the wind pressure on the king stud is from the middle of the rough opening to half the clear distance from the king stud to the adjacent typical wall stud. Check the distance from the king stud to adjacent wall stud on both sides of the window.
   If not known, as for this example, assume a full wall stud spacing.

   Tributary Width = 19.5” (from the Trimmer example) + 16” / 2 (to next stud) + 1.5” (assuming a single king stud) = 29”.

   Use 36” as next largest Tributary Width.

Solution: Typical Wall Framing King Stud Example cont'd…

3. The applied vertical load on the king stud is based on half the spacing to the next adjacent wall stud. Again, check the distance on both sides of the opening. If not known, and for this example, assume a full wall stud spacing.

   Total Vertical Load = 1488 plf x (16” / 12)/2 = 992 lbs.

4. As in the Typical Wall Stud example, use a deflection ratio of L/360 for stucco.

5. Using the table from Exterior Wall Column Capacity: 2x4 and 2 x 6 for 90mph Wind, Exposure B (click here to view .pdf), what would you select?

(Answer: 3-1/2” x 3-1/2” 1.35E LSL king stud can support a vertical load of 4510 lb with a deflection ratio of L/389.)

Typical Wall Framing: Window Column Example Criteria

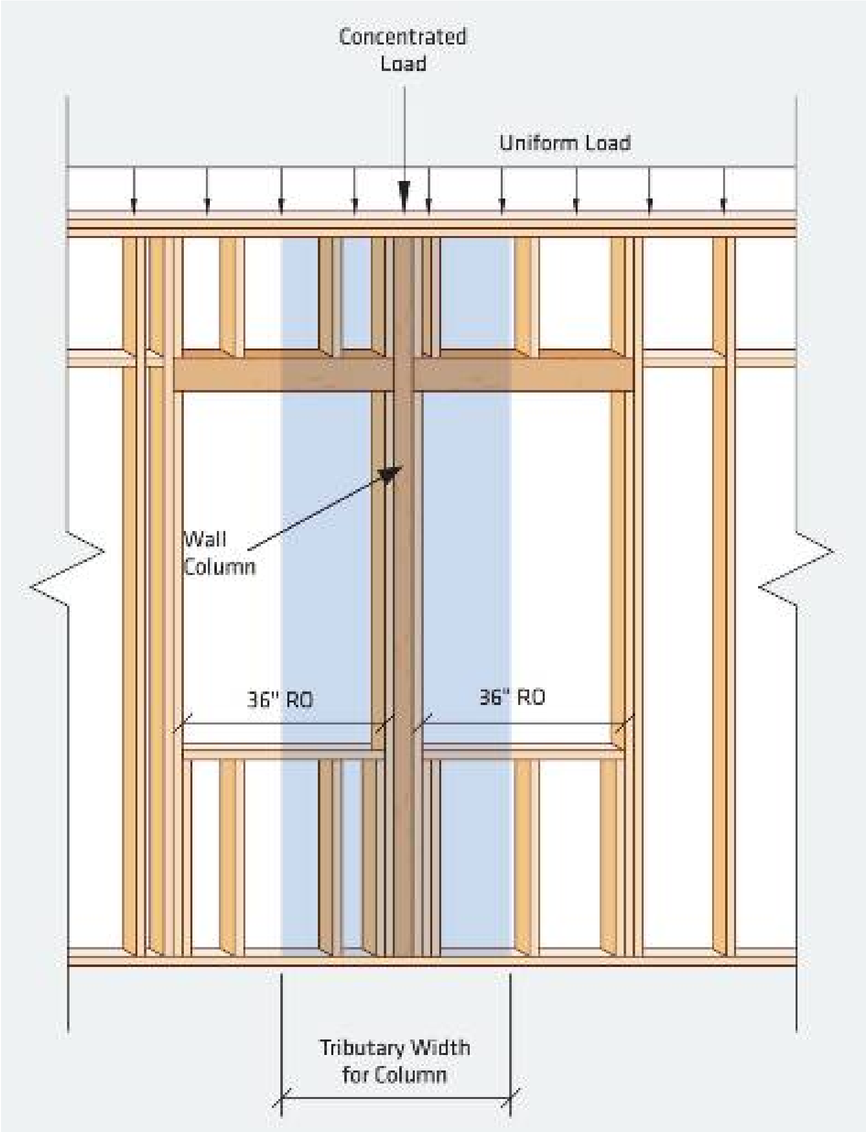
This column sits between two windows, both 36” rough openings, in the wall from the previous example. For this example, there is no additional concentrated load applied. The only vertical loads will be the uniform load from the roof trusses, second story wall and the second floor.

Typical Wall Framing Window Column Example

This slide lists the steps you'll need to design an LSL wall framing window column. A practice example follows these steps.

How to Size:

1. Determine the clear height of the column.
2. Determine the Tributary width for the lateral wind pressure.
3. Determine the total vertical load (lbs) applied to the column.
4. Determine the allowable deflection ratio based on the wall construction.
5. Select the required grade and size from the appropriate chart from the manufacturers technical specification guide.



Solution: Typical Wall Framing Window Column Example

1. The column will be the same height as the typical wall stud – 9’ in this example.

2. The tributary width for the wind pressure will be half the rough opening to both sides plus the width of the column and the trimmers.
   Since the width of the column is not known but the only vertical loads are the uniform loads from the common trusses, try a double 1-1/2” x 3-1/2” column.

   Tributary Width = 2 x (36” / 2) + 2 x 1-1/2” (trimmers) + 2 x 1-1/2” (double 1-1/2” column) = 42”

   Use 48” as next largest Tributary Width.

Solution: Typical Wall Framing Window Column Example cont'd...

3. The applied vertical load on the column will only be the uniform load from the common roof trusses between the trimmers – assume a typical stud spacing of 16” for simplicity. The trimmers will support the vertical load from the window headers.

   Total Vertical Load = 1488 plf
   (from Typical Wall Stud example) x 16” oc / 12 = 1984 lbs

4. Again, use a deflection ratio of L/360 for stucco.

5. Using the table from Exterior Wall Column Capacity: 2x4 and 2 x 6 for 90mph Wind, Exposure B (click here to view .pdf), what would you select?

(Answer: 5-1/2” x 3-1/2” 1.35E LSL column can support a vertical load of 7700 lbs with a deflection ratio of L/467.)

Typical Wall Framing: Wall Column Example Criteria

Based on the conditions from the typical wall stud design example, select a wall column in the same first story wall to support a girder truss load of 4020 lbs.

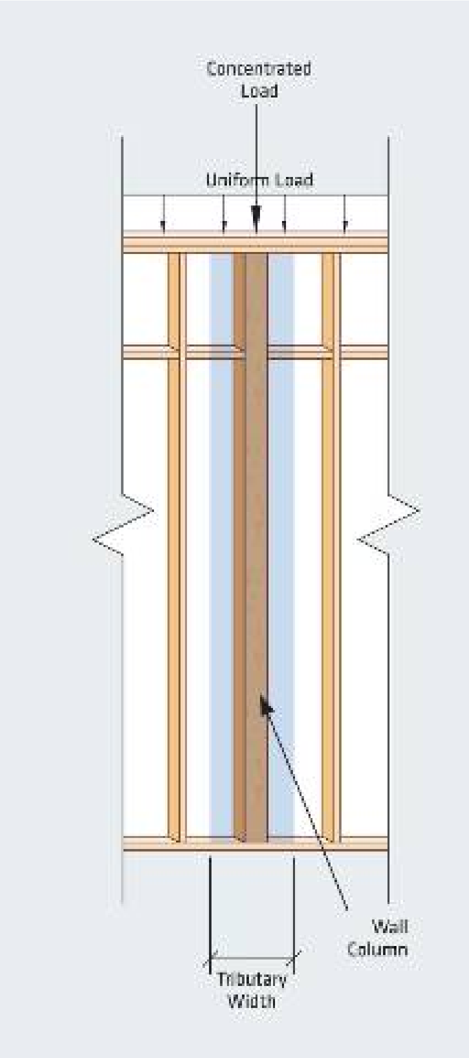
The design must include the weight of the second story wall and the load from the second floor.

Typical Wall Framing Wall Column Example

This slide lists the steps you'll need to design an LSL wall framing wall column. A practice example follows these steps.

How to Size:

1. Determine the clear height of the column.
2. Determine the Tributary width for the lateral wind pressure.
3. Determine the total vertical load (lbs) applied to the column.
4. Determine the allowable deflection ratio based on the wall construction.
5. Select the required grade and size from the appropriate chart from the manufacturers technical specification guide.



Solution: Typical Wall Framing Wall Column Example

1. The column will be the same height as the typical wall stud – 9’ in this example.

2. The tributary width for the wind pressure will be the same as that from the Typical Stud example – 16”. Hint: Even if the column falls off-center between two typical studs, the tributary width is still 16” (in this case) as the total oc distance between the adjacent studs is 32”.

3. The applied vertical load on the column will be the girder truss load transferred through the second story wall column, the tributary area of the second floor and the tributary weight of the second story wall (both the same as in the Typical Wall Stud example).

   Roof: 4020 lbs

   Wall: 100 plf x 16” oc / 12 = 134 lbs

   Floor: 495 plf x 16” oc / 12 = 660 lbs

   Total Vertical Load = 4020 + 134 + 660 = 4814 lbs

Solution: Typical Wall Framing Wall Column Example cont'd...

4. As in the Typical Wall Stud example, use a minimum deflection ratio of L/360.

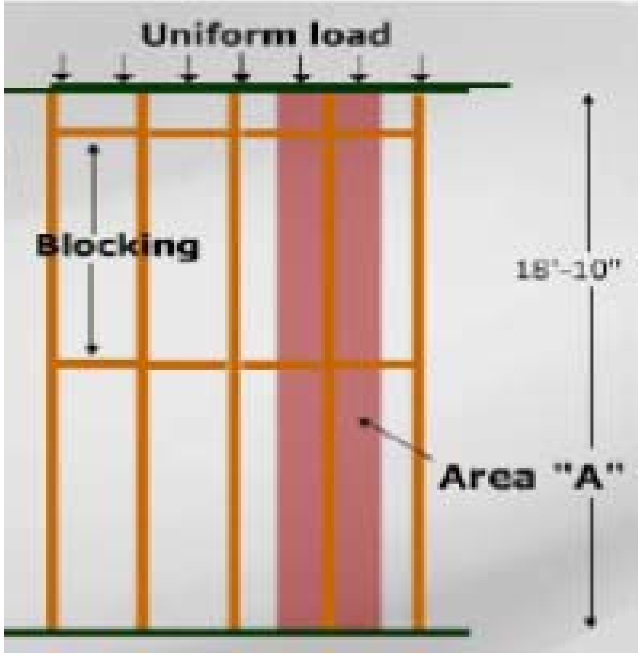
5. Using the table from Exterior Wall Columns: 2x4 and 2 x 6 for 90mph Wind, Exposure B (click here to view .pdf), what would you select?

(Answer: 3-1/2" x 3-1/2" 1.35E LSL column can support a vertical load of 5000 lbs with a deflection ratio of L/876.)

★ Please remember the **exam password** SOLUTION. You will be required to enter it in order to proceed with the online examination.

Typical Wall Framing: Tall Wall Entry Way Example Criteria

- Select a suitable wall stud for this tall wall entry way for residential structure located in Peoria, IL in an open terrain with scattered obstructions.
- The wall supports the second floor and the roof of a 36' wide home. The second floor is supported at midspan and the roof trusses have a 1' overhang.
- The roof loads are 30 psf Snow (115%) and 17 psf Dead. Assume 100 plf for the weight of the second story wall.
- The exterior finish is flexible finish and window.



- Red shaded area is wind load on stud
- Black arrows are axial loads
- Brown is the LSL product
- Green is dimension lumber

Typical Wall Framing Tall Wall Entry Way Example

On this slide and the next we'll go over the steps that you'll need to design an LSL tall wall entry way. A practice example follows these steps.

How to Size:

1. Determine the stud height in feet.

2. Determine the stud spacing in inches.

3. Determine the correct exposure category.

4. Determine the effective wind area in ft^2. Check $L^2/3$. Will equal 120 ft^2 but you are not required to use more than 100 ft^2.

5. Determine the basic wind speed using the wind map on slide 33.

Typical Wall Framing Tall Wall Entry Way Example cont'd...

6. Determine the wind design pressure in psf using the wind pressure chart in the Wall Framing technical guide. From the chart, select the exposure category and effective wind area and move across the chart to the column corresponding to the basic wind speed to determine your design wind pressure (psf). You will need to convert the Wind Pressure to plf (psf x o.c. spacing in feet = plf). If spacing is anything other than what's on the charts, figure out your wind speed, then convert to a plf load by multiplying that by your spacing and feet. In the chart, the 26plf load is a common wind load for studs spaced 16" o.c. for 90 mph wind speed in exposure C, with effective wind area greater than $100ft^2$.

7. Determine the vertical (gravity) load acting on the stud.

8. Next, determine the allowable deflection – (L/?) based on code and/or component and finish manufacturer's requirements.

9. You are now ready to go to the chart with the stud lengths, wind and vertical load, and deflection requirements to determine the correct stud size and grade.

Solution: Typical Tall Wall Entry Way Example

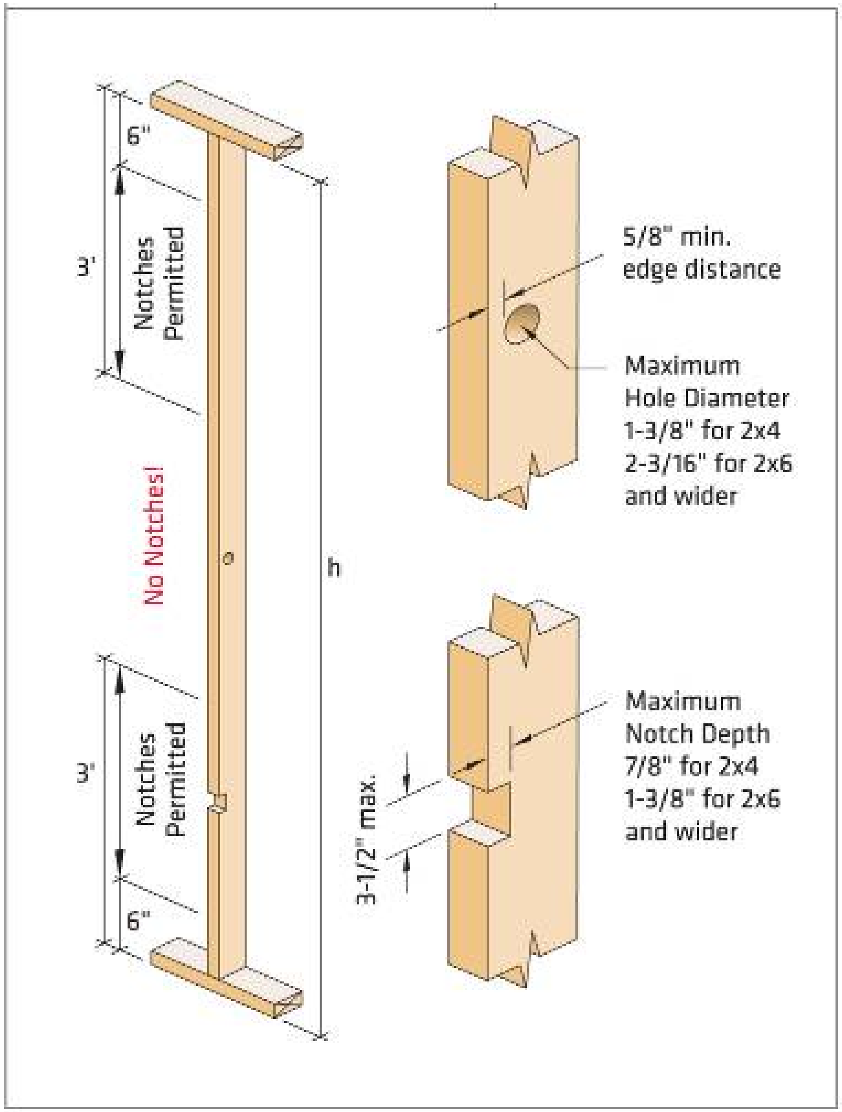
Using the process on the previous page, let's design a stud.

1. Determine the stud length = 18'-10" (use 20')
2. Determine the stud spacing in inches = 16" oc
3. Determine the correct exposure category = "C"
4. Determine the effective wind area in ft^2 = > 100
5. Determine the basic wind speed = 100 mph
6. Determine the vertical (gravity) load acting on the stud = 893 plf
7. Determine the allowable deflection = L/175 (use L/180)
8. Using the Wall Stud Capacity (plf) Table: 100mph Wind Speed, Exposure C, (click here to view .pdf), what would you select?

(Answer: 1-1/2" x 7-1/4" 1.55E LSL or 1.5E LVL stud can support a vertical load of 2,290 lbs with a deflection ratio of L/220.)

Understanding Holes and Notching

These recommendations are typical, but you'll need to consult the manufacturer's literature for any other restrictions on hole placement and requirements.



Holes

- Holes must be 5/8" minimum from the edge of the stud.
- The maximum hole diameter is 1-3/8" for 2 x 4 and 2-3/16" for 2 x 6 or wider.

Notches

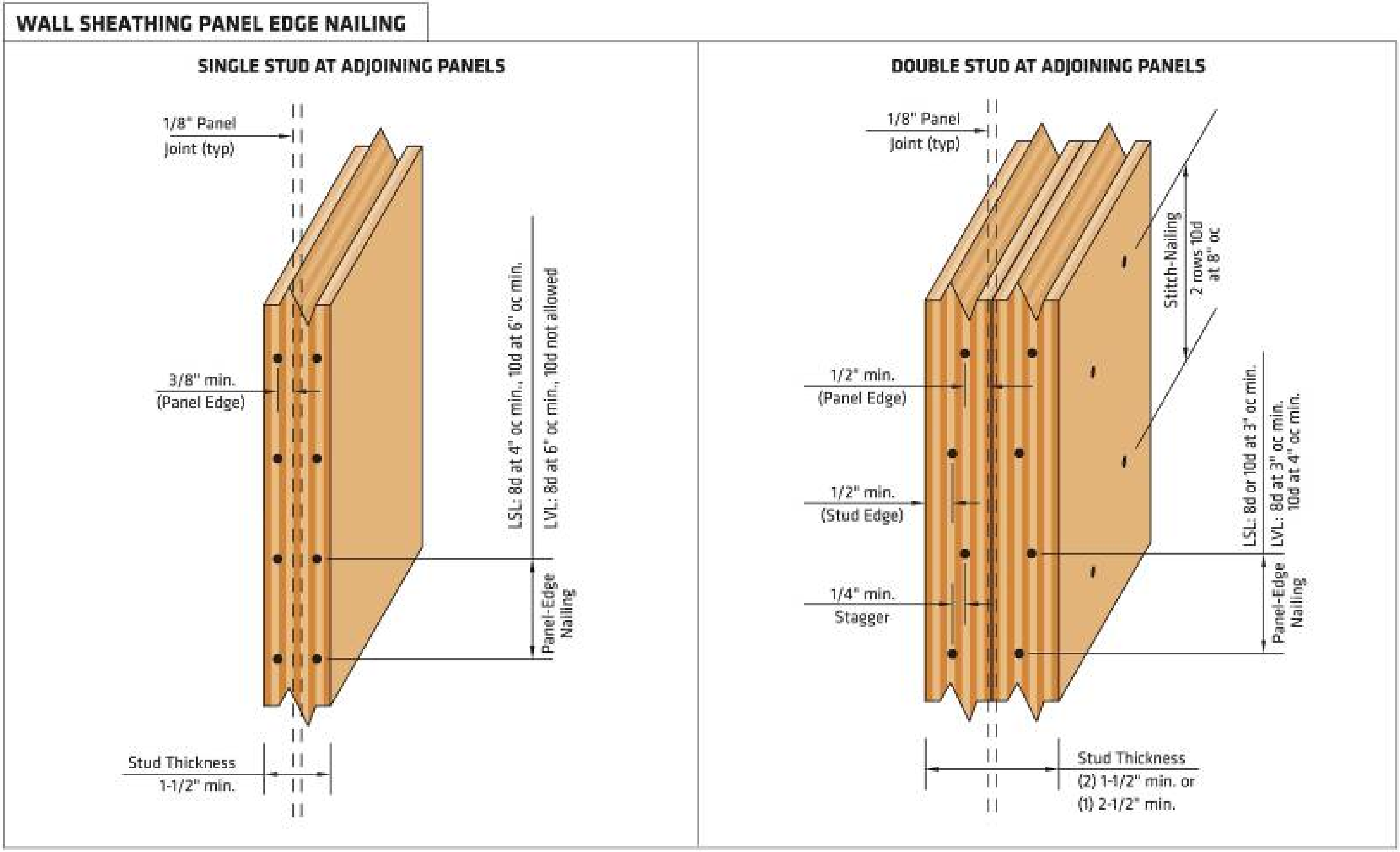
- No notches allowed in the center 1/3 of the stud.
- Maximum notch depth is 7/8" for 2 x 4 and 1-3/8" for 2 x 6 or wider.

Nailing Details and Guidelines

These recommendations are typical, but you'll need to consult the manufacturer's literature for any other restrictions on hole placement and requirements. Also, refer to the manufacturer's guidelines for securing plates to the studs with the appropriate connections based on lateral reaction of the stud.

Engineered wood products may be used as a direct replacement for stud-grade lumber wall framing in accordance with the prescriptive requirements of the International Building Code (IBC) and International Residential Code (IRC) under the conditions illustrated on the next slide and listed on slide 75.

Nailing Details and Guidelines cont'd...



Nailing Details and Guidelines cont'd...

1. Minimum LVL or LSL thickness for a single stud is 1-1/2“
2. A double stud (or a minimum 2-1/2” single stud) are required at adjoining panel edges as follows:
   - for LSL or LVL when using 8d common nails spaced closer than 4” oc or 10d common nails spaced closer than 6” oc, and
   - for LVL when using 8d common nails spaced closer than 6” oc. 10d common nails are not allowed for a single stud.
3. The panel edge nailing at a double stud shall be installed a minimum ½” from both the panel edge and the edge of the stud, and shall be installed with every other nail staggered a minimum ¼” horizontally.
4. The minimum nail spacing into the edge of the stud shall not be less than:
   - for LSL: 3” oc for both 8d and 10d common nails, and
   - for LVL: 3” oc for 8d common nails or 4” oc for 10d common nails.
5. Do not use nails larger than 10d common nails for wall sheathing nailing.
6. In lieu of engineering analysis for prescriptive wall framing, the double studs shall be stitch-nailed together with 2 staggered rows of 10d common nails spaced 8” oc in each row. For engineered walls, the stitch nailing shall be designed to transfer the required lateral shear.

Product Dimensions and Sizes

What is the longest stud length that works on exterior walls?

Product		L/180	L/120 deflection
2 x 4	1.5E	11'-0	12'-6"
2 x 4	2.0E	12'-0	13'-9"
2 x 6	1.5E	17'-3"	19'-6"
2 x 6	2.0E	19'-0"	21'-6"
2 x 8	1.5E	22'-6"	26'-0"
2 x 8	2.0E	25'-0"	28'-6"

Note:
L/175 is the minimum deflection allowed around windows.
The assumptions above are based on 16" centers & 90 MPH wind.
Studs used on interior walls can achieve longer lengths.

Some wholesalers buy 8', 9', 10', 12', 14', 16' 18', 20, 22', 24. Others buy 16' 18', 20, 22', 24' because they can get all lengths typically needed from these lengths. This also allows some dealers and wholesalers to stock the product inside. A few also buy some 92 5/8" precut. These carry a 10% surcharge, however.

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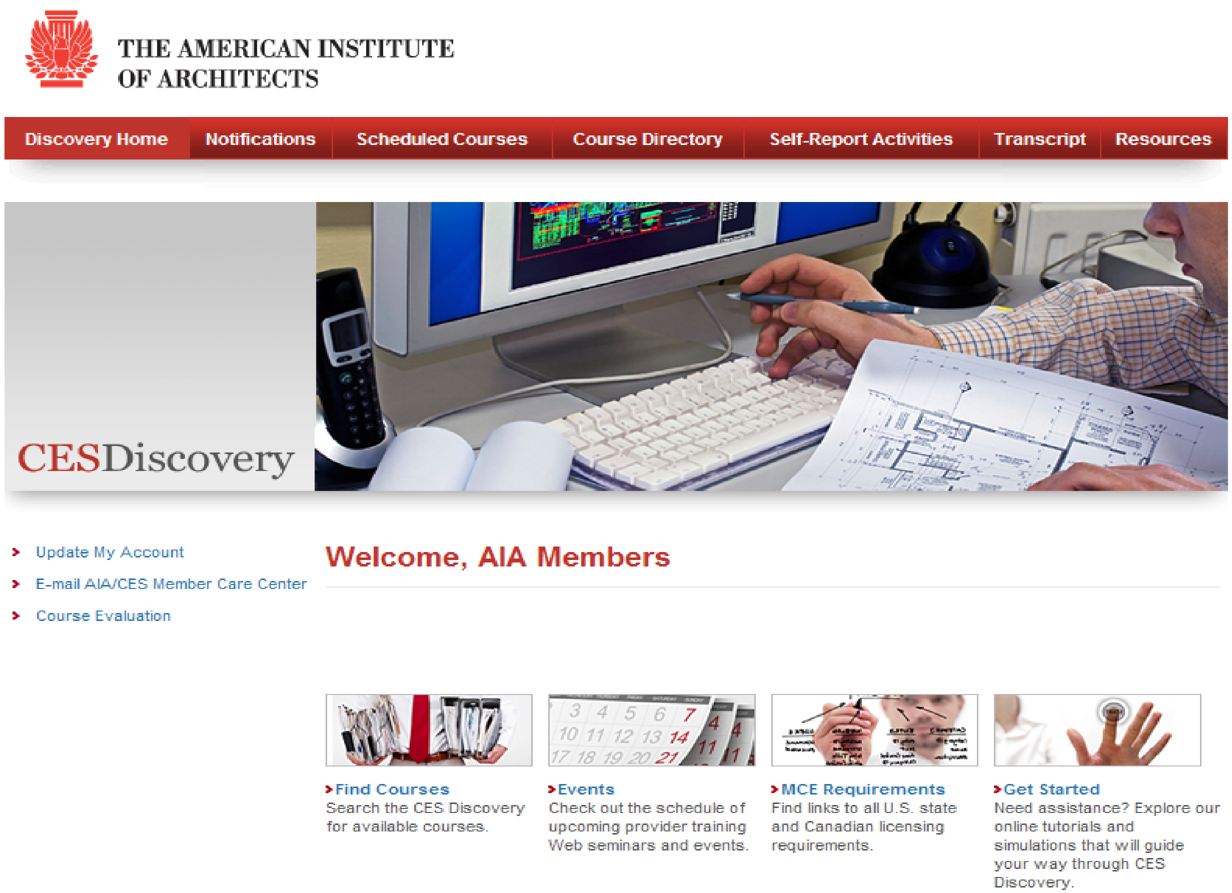

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