

A strategic alliance of Canadian Home Builders' Association – Alberta, the Alberta New Home Warranty Program, the cities of Edmonton and Calgary, Alberta Municipal Affairs, Canada Mortgage and Housing Corporation and Alberta Building Officials Association.



# **Guidelines for Lateral Bracing of Residential Concrete Foundation Walls**

**September 2009**

## **INTRODUCTION**

### **Purpose of the Manual**

This manual contains recommended guidelines for the lateral bracing of and reinforcing requirements for residential concrete foundation walls.

### **Background to the Preparation of the Guidelines**

This document is the second edition of the lateral bracing guideline published by the Alberta Housing Industry Technical Committee (AHITC). The first edition was printed in July 1999.

Prior to the publication of the original guideline some Alberta municipalities had expressed concern that construction practices for building detached houses, semi-detached houses, and row houses did not provide sufficient lateral bracing for the concrete foundation walls. One of the reasons for the concern was the lack of bracing provided to foundation walls parallel to the floor joists. Another was the increasing popularity of using nine foot basements with backfill heights exceeding 7'-6" (2.30 metres).

In response to these concerns, the AHITC commissioned Bearden Engineering Consultants Ltd. to 1) Assess the adequacy of the current construction practices to resist lateral loads from standard concrete foundation walls, and 2) develop generic cost-effective lateral bracing construction details for the concrete walls at the wall-to-main floor interface.

That work was documented in the first edition of this document, and has been updated for this version of the guideline.

### **Changes to the Guidelines**

With the adoption of the new Alberta Building Code 2006 (ABC 2006), the AHITC felt that the timing was right to update the guideline to the new code and to address questions and comments received from builders and municipalities regarding the first edition.

There have been several significant changes made including:

- 1) Updating the design parameters to reflect the new ABC 2006
- 2) Updating the soil parameters based upon additional information received over the past 10 years and to simplify the guideline to eliminate the section on code minimum lateral pressures. The code minimum backfill pressure was derived from very ideal site conditions with a very clean sand/ gravel backfill material and controlled compaction. This does not reflect the vast majority of

residential sites in Alberta. Most new developments now have geotechnical information available to classify the site soils and to assist in the selection of appropriate soil parameters.

The soil types used and the associated lateral fluid pressures assumed for this document are: Sand/ Gravel (50 pcf), Low Plastic Clay/ Silt (70 pcf), and High Plastic Clay (80 pcf).

- 3) Simplifying the guideline to eliminate the reference to unsupported wall lengths and relate all information to soil type and backfill height only. All foundation walls will be laterally supported at the top by at least a toe-nailed connection commonly used by builders. Typical top of wall lateral bracing is not required within 8'-0" of a 90 degree corner in the concrete foundation wall for all soil types and backfill heights provided that the abutting section of wall is a minimum of 48 inches long. However, where joists frame perpendicular to the wall they should still be toe-nailed as per the standard minimum practice up to any corners.
- 4) Simplifying the connection types to reduce lag screwed connections in favour of nailed connections that are faster and more economical to install, and to reduce the overall variety of connection types from seven down to five.
- 5) Updating the Figures and details so that they are easier to read.

### Scope of the Guidelines

The guidelines may be considered as good construction practice for lateral bracing of residential foundation walls and includes the following situations:

- Walls exceeding 2.5m (8'-4") up to 2.8m (9'-4"). Wall height is measured from top of the footing to the top of the concrete wall.
- Backfill heights over 2.3m (7'-6") up to 2.6m (8'-6"). Backfill height is measured from top of basement slab to top of exterior grade.
- Generic reinforcing and lateral bracing guidelines for basement windows and stairwell openings.
- Walls supporting backfill other than free-draining sand/ gravel material
- Use of Insulated Concrete Form (ICF) walls is not covered within the scope of this guideline.

It should be noted that there is overlap between the recommendations in this guideline and the minimum requirements specified in the Alberta Building Code and that the details contained herein exceed the minimum requirements of Part 9 of the code. Part 9 of the ABC 2006 is based on "average stable soils" with a much lower assumed lateral earth pressure. However, no part of this guideline precludes a builder from using the minimum requirements of the ABC 2006, where they apply.

## Parameters for the Guidelines

The guidelines are applicable to residential concrete foundation walls where the following conditions are met:

- 1) Minimum foundation wall thickness is 8" (203 mm).
- 2) Minimum concrete strength is 20 MPa at 28 days.
- 3) Minimal reinforcing typical of residential foundations is used that includes: (2) – 10M horizontals within 2 feet from top of the wall, and (2) – 10M horizontals within two feet of bottom of the wall, unless required otherwise in the guideline.
- 4) Typical minimum 2x4 (38 x 89) ladder sill framing is provided at the top of the wall, although other code permitted top of wall conditions are not precluded so long as they are compatible with the details contained herein.
- 5) The use of insulated rimboards is allowed for top of wall connection Types 1, 2, and 3, but is **not** compatible with connection Types 4 or 5.
- 6) The bottom of wall is laterally supported by basement slab once poured or by adequate dowels or formed keyway to the footing prior to backfill.
- 7) Perimeter drainage is provided to prevent the build-up of hydrostatic pressures on the wall, and positive site drainage around the building to direct all building and site water well away from the foundation.
- 8) There are no significant surcharges on the backfill within a zone equivalent to the backfill depth. If driveways or garages are located such that vehicle loading will occur within a distance equal to the backfill depth from the wall, the assumed backfill height for the purposes of this guideline shall be based on a backfill height 6 inches (150 mm) greater than the actual backfill height.
- 9) Unless noted otherwise, construction is assumed to be in accordance with Part 9 of the Alberta Building Code 2006.

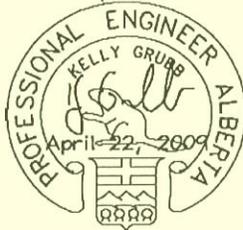
## Certification and Limitations

The guidelines contained herein are certified by Bearden Engineering Consultants Ltd. to provide adequate lateral resistance to backfill pressures for the specific circumstances described. No surcharges other than vehicle driveways as described above have been considered in the design such as may occur from locating heavy objects or buildings adjacent to the foundation wall. Also, extreme backfill pressures due to frost heave or swelling clays have not been considered in the design. Positive drainage of all site water away from the building to minimize moisture infiltration is of utmost importance in reducing the risk from these extreme pressures. If the soil type is uncertain, seek the advice of a professional geotechnical engineer.

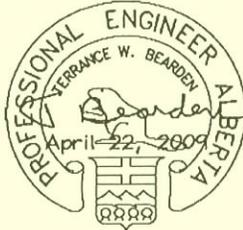
Bearden Engineering Consultants Ltd. does not assume responsibility for errors or consequences resulting from the misuse of information contained herein.

per: Bearden Engineering Consultants Ltd.  
(APEGGA Permit to Practice P2427)

BECL#: 98-070



Kelly Grubb, M.Eng., P.Eng., Struct. Eng., MBA  
Senior Structural Engineer



Terry Bearden, M.A.Sc., P.Eng.  
Principal

The Alberta Housing Industry Technical Committee and Bearden Engineering would like to acknowledge the valuable and practical input, advice and review of the following individuals and organizations provided during the creation of this document:

The Members of the Alberta Housing Industry Technical Committee and  
Ryan Moon, Heartland Homes  
Derrick Hiltz, Classic Landmarks Master Builder  
Len Walters, Coventry Homes  
Claude Rekken, Reid Built Homes  
Tony Ruggieri, A. Ruggieri Engineering  
Mark Brodgesell, City of Edmonton  
Marco Civitarese and the City of Calgary Building Inspections Group  
Brian Boddez, City of St. Albert  
Joan Maisonneuve, Alberta New Home Warranty

## LATERAL BRACING GUIDELINES

The guidelines for determining lateral bracing and related requirements are presented in three steps as follows:

### Step 1: Determine Reinforcement Requirements for Foundation Walls

For a given wall height (as measured from top of footing to top of concrete wall), compare the backfill height (as measured above the top of the basement floor slab) with the maximum allowable backfill heights for vertically unreinforced walls shown in Table 1a.

Wall Height	Backfill Soil Type	Maximum Backfill Height
8'-4" (2.5 m)	Sand/ Gravel	<b>7'-6" (2.30m)</b>
	Low Plastic Clay/ Silt	<b>7'-0" (2.15m)</b>
	High Plastic Clay	<b>6'-6" (2.00m)</b>
9'-4" (2.8m)	Sand/ Gravel	<b>8'-6" (2.60m)</b>
	Low Plastic Clay/ Silt	<b>6'-9" (2.05m)</b>
	High Plastic Clay	<b>6'-3" (1.90m)</b>

Notes:

- 1) Proper wall lateral support as described in this guideline must be provided to achieve these backfill heights.

- **If the backfill height is less than the maximum allowed, then no vertical reinforcing is required, ie. Conventional construction is appropriate.**
- **If the backfill height is greater than the maximum allowed, vertical and horizontal reinforcing is required in the foundation walls in accordance with Table 1b.**

Wall Height	Backfill Soil Type	Vertical Reinforcing	Horizontal Reinforcing
8'-4" (2.5 m)	Sand/ Gravel		15M at 24" (600) o/c
	Low Plastic Clay/ Silt	15M at 24" (610) o/c	
	High Plastic Clay	15M at 24" (610) o/c	
9'-4" (2.8 m)	Sand/ Gravel		15M at 24" (600) o/c
	Low Plastic Clay/ Silt	15M at 20" (508) o/c	
	High Plastic Clay	15M at 20" (508) o/c	

Notes:

- 1) Reinforcement shall be deformed billet steel bars conforming to CAN/CSA G30.18-M92 (R2002) "Billet-steel bars for concrete reinforcement", with a minimum yield strength of 400 MPa.
- 2) Vertical reinforcement to be installed with 1" (25 mm) concrete cover from inside face of wall.
- 3) Builders may substitute (2) -10M reinforcing bars for each (1)-15M reinforcing bar at their discretion.

## Step 2: Determine Lateral Bracing Requirements for Foundation Wall

The procedure for selecting an appropriate type of top of wall lateral bracing connection is as follows:

- Select the appropriate soil type table (**Table 2a, 2b, or 2c**)
- Select the applicable wall height and backfill height
- Select one of the alternative connection types and the corresponding maximum spacing to be used from the tables. Since connectors must align with joists and/or blocking this will also dictate the maximum allowable joist/blocking spacing that may be used.
- Top of wall lateral bracing is **not** required within 8' -0" of a 90 degree corner in the concrete foundation wall for all soil types and backfill heights provided that the abutting wall section is a minimum of 48 inches long. However, where joists frame perpendicular to the wall they should still be toe-nailed as per the standard minimum practice up to any corners.
- Descriptions of each of the top of wall lateral connection types are contained in Figures 1 through 6 which detail the connection type including the required hardware and fasteners.
- Where rim joists are shown parallel to the joist span, pony walls may be substituted provided that the pony wall studs, the blocking and connectors are all in alignment. Additionally, the connectors must not exceed the stud width.

## Step 3: Determine Lateral Bracing Requirements for Each Side of Windows and Stairwell Openings Adjacent to foundation walls

The procedure is as follows:

- Select the applicable wall height, backfill type, backfill height, and applicable opening width.
- Select the corresponding top of wall connection type from **Table 3**.
- For window and stairwell openings located entirely within 8'-0" of a 90 degree corner in a foundation wall, the additional specified top of wall bracing each side is not required provided that the abutting wall section is a minimum of 48 inches long.

## EXPLANATION OF CONNECTIONS

The top of wall lateral connection types are based upon the following fastener and material specifications:

- 1) Toe-nails to ladder sills to be minimum 3.25" x 0.148" diameter.
- 2) Simpson or equivalent galvanized steel connectors to be of the type specified with the specified fasteners.
- 3) Hilti X-U or equivalent powder-actuated fasteners to be installed in accordance with the manufacturers specifications.
- 4) For wood to wood connections requiring 3.25" x 0.148" nails, #8 x 3" wood screws may be substituted. For connection of blocking to sheathing, #6 x 2" wood screws may be used in lieu of the specified 2" x 0.113" nails.
- 5) As an alternate to pre-drilling lag screws, Simpson SDS type screws may be used. However, depending on the type of wood and moisture content, pre-drilling may still be required to avoid splitting of members.

The construction details for each of the top of wall lateral bracing connection types are given in the following Figures 1 through 6. Since the connections must align with joists and/or blocking the builder must coordinate the joist/ blocking and connection locations for each specific project.

The construction details for reinforcing around window openings is given in Figure 7, and the construction details for additional reinforcing at stairwell openings is given in Figure 8.

Wall Height	Connection Type <sup>2</sup>	Maximum backfill Height									
		4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"
8'-4" (2.5m)	1		48"	24"	16"						
	2				48"	32"	24"	16"	12"		
	3				48"	36"	24"	24"	16"		
	4				48"	36"	24"	24"	16"		
	5						48"	36"	24"		
9'-4" (2.8m)	1		48"	24"	16"						
	2				48"	36"	24"	19.2"	16"	12"	
	3				48"	48"	36"	24"	19.2"	16"	12"
	4				48"	48"	36"	24"	19.2"	16"	12"
	5						48"	38.4"	32"	24"	19.2"

Notes:

- 1) The equivalent lateral earth pressure assumed for Sand/ Gravel type backfill is 50 pcf.
- 2) Refer to Figures 1,2,3,4, and 5 for specific details of each top of wall connection type.

Wall Height	Connection Type <sup>2</sup>	Maximum backfill Height									
		4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"
8'-4" (2.5m)	1	38.4"	19.2"	12"							
	2		48"	36"	24"	16"	12"				
	3			48"	36"	24"	19.2"	12"			
	4			48"	36"	24"	19.2"	12"			
	5				48"	38.4"	32"	24"	19.2"		
9'-4" (2.8m)	1	48"	24"	12"							
	2			48"	32"	19.2"	16"	12"			
	3			48"	38.4"	24"	19.2"	16"	12"		
	4			48"	38.4"	24"	19.2"	16"	12"		
	5					48"	36"	24"	19.2"	16"	12"

Notes:

- 1) The equivalent lateral earth pressure assumed for Low Plastic Clay/ Silt backfill is 70 pcf.
- 2) Refer to Figures 1,2,3,4, and 5 for specific details of each top of wall connection type.

Wall Height	Connection Type <sup>2</sup>	Maximum backfill Height									
		4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"
8'-4" (2.5m)	1	24"	16"								
	2		48"	32"	19.2"	16"	12"				
	3		48"	38.4"	24"	19.2"	16"	12"			
	4		48"	38.4"	24"	19.2"	16"	12"			
	5				48"	36"	24"	19.2"	16"		
9'-4" (2.8m)	1	32"	16"	12"							
	2		48"	36"	24"	16"	12"				
	3			48"	32"	24"	16"	12"			
	4			48"	32"	24"	16"	12"			
	5				48"	38.4"	24"	19.2"	16"	12"	12"

Notes:

- 1) The equivalent lateral earth pressure assumed for High Plastic Clay is 80 pcf.
- 2) Refer to Figures 1,2,3,4, and 5 for specific details of each top of wall connection type.

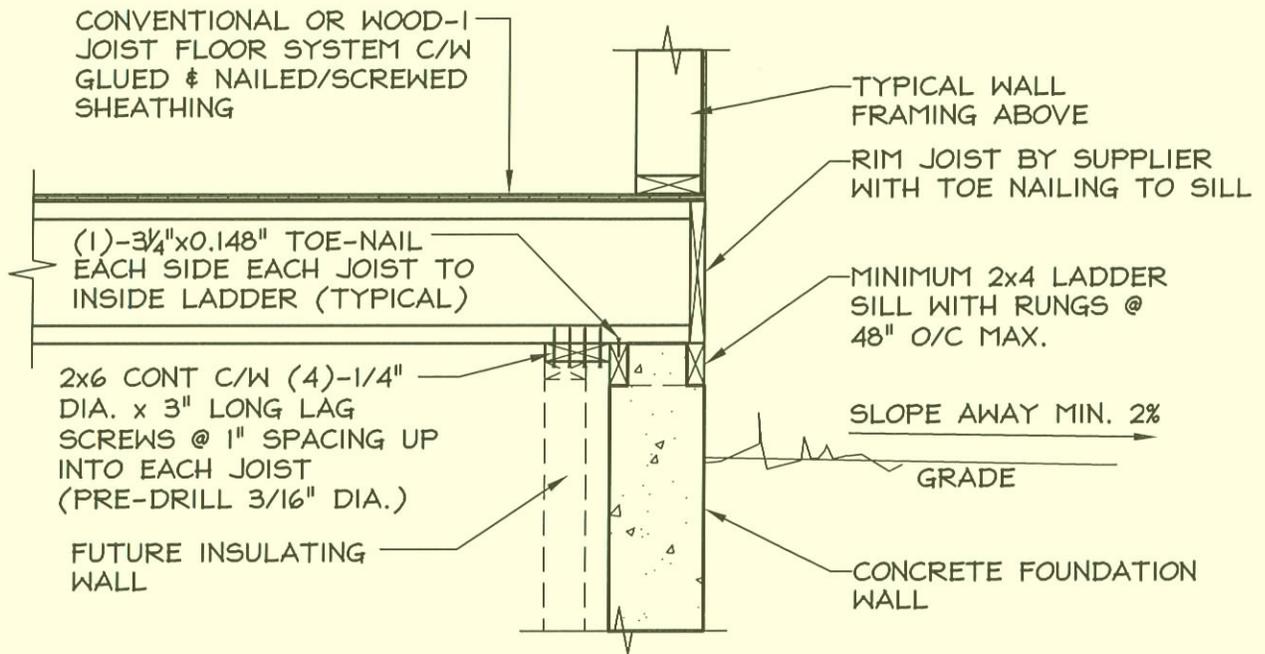
Table 3: Lateral Bracing Connection Type Required Each Side of Windows and Stairwells						
Wall Height <sup>1</sup>	Backfill Type <sup>2</sup>	Backfill Height <sup>3</sup>	Connection Type <sup>4</sup>			
			Each Side of Window	Each Side of Stairwell Opening		
				8'-0" wide	10'-0" wide	12'-0" wide
8'-4" (2.5m)	Sand/ Gravel	4'-0"	1	1	1	1
		4'-6"	1	DBL1/2,3,4	DBL1/2,3,4	DBL1/2,3,4
		5'-0"	DBL1/2,3,4	TPL1/2,3,4	2,3,4	2,3,4
		5'-6"	TPL1/2,3,4	DBL2,3,4	DBL3,4/5	DBL3,4/5
		6'-0"	DBL2,3,4	DBL2,3,4	DBL3,4/5	TPL2,3,4
		6'-6"	DBL2,3,4	TPL2,3,4	TPL2,3,4	DBL5
		7'-0"	TPL2,3,4	DBL5	DBL5	TPL5
		7'-6"	TPL3,4	DBL5	TPL5	TPL5
8'-4" (2.5m)	Low Plastic Clay/ Silt	4'-0"	DBL1/2,3,4	DBL1/2,3,4	DBL1/2,3,4	TPL1/2,3,4
		4'-6"	TPL1/2,3,4	TPL1/2,3,4	2,3,4	DBL2,3,4
		5'-0"	DBL3,4/5	DBL2,3,4	DBL2,3,4/5	DBL3,4/5
		5'-6"	DBL2,3,4	DBL3,4/5	TPL2,3,4	TPL2,3,4
		6'-0"	TPL2,3,4	TPL2,3,4	DBL5	DBL5
		6'-6"	TPL2,3,4	DBL5	TPL5	TPL5
		7'-0"	DBL5	TPL5	TPL5	4 PLY 5
		7'-6"	TPL5	TPL5	4 PLY 5	5 PLY 5
8'-4" (2.5m)	High Plastic Clay	4'-0"	DBL1/2,3,4	TPL1/2,3,4	TPL1/2,3,4	2,3,4
		4'-6"	TPL1/2,3,4	DBL2,3,4	DBL2,3,4	DBL2,3,4
		5'-0"	DBL2,3,4	DBL2,3,4	DBL3,4/5	TPL2,3,4
		5'-6"	DBL2,3,4	TPL2,3,4	TPL2,3,4	DBL5
		6'-0"	TPL2,3,4	DBL5	DBL5	TPL5
		6'-6"	DBL5	TPL5	TPL5	4 PLY 5
		7'-0"	DBL5	TPL5	4 PLY 5	4 PLY 5
		7'-6"	TPL5	4 PLY 5	5 PLY 5	5 PLY 5
9'-4" (2.8m)	Sand/ Gravel	4'-0"	1	1	1	1
		4'-6"	1	1	DBL1/2,3,4	DBL1/2,3,4
		5'-0"	DBL1/2,3,4	TPL1/2,3,4	TPL1/2,3,4	TPL1/2,3,4
		5'-6"	TPL1/2,3,4	2,3,4	DBL2,3,4	DBL2,3,4
		6'-0"	DBL2,3,4	DBL2,3,4	DBL2,3,4	DBL2,3,4
		6'-6"	DBL2,3,4	TPL2,3,4/5	TPL2,3,4	TPL2,3,4
		7'-0"	TPL2,3,4	TPL2,3,4	DBL5	DBL5
		7'-6"	TPL2,3,4	DBL5	DBL5	TPL5
		8'-0"	4 PLY2,3,4	TPL5	TPL5	4 PLY 5
		8'-6"	DBL5	TPL5	4 PLY 5	4 PLY 5
9'-4" (2.8m)	Low Plastic Clay/ Silt	4'-0"	1	DBL1	DBL1	DBL1/2,3,4
		4'-6"	DBL1	TPL1/2,3,4	TPL1/2,3,4	2,3,4
		5'-0"	2,3,4	DBL2,3,4	DBL2,3,4	DBL2,3,4/5
		5'-6"	DBL2,3,4	DBL2,3,4	TPL2,3,4	TPL2,3,4
		6'-0"	DBL2,3,4	TPL2,3,4	TPL2,3,4	DBL5
		6'-6"	TPL2,3,4	DBL5	DBL5	TPL5
		7'-0"	DBL5	DBL5	TPL5	TPL5
		7'-6"	DBL5	TPL5	4 PLY 5	4 PLY 5
		8'-0"	TPL5	4 PLY 5	4 PLY 5	5 PLY 5
		8'-6"	TPL5	5 PLY 5	5 PLY 5	6 PLY 5

		4'-0"	DBL1 / 2,3,4	DBL1 / 2,3,4	TPL1 / 2,3,4	TPL1 / 2,3,4
9'-4" (2.8m)	High Plastic Clay	4'-6"	TPL1 / 2,3,4	2,3,4	DBL2,3,4	DBL2,3,4
		5'-0"	DBL3,4 / 5	DBL2,3,4	DBL2,3,4	DBL2,3,4
		5'-6"	DBL3,4 / 5	TPL2,3,4	TPL2,3,4	TPL2,3,4
		6'-0"	TPL2,3,4	TPL3,4	DBL5	DBL5
		6'-6"	TPL3,4/ DBL5	DBL5	TPL5	TPL5
		7'-0"	DBL5	TPL5	TPL5	4 PLY 5
		7'-6"	TPL5	4 PLY 5	4 PLY 5	5 PLY 5
		8'-0"	TPL5	4 PLY 5	5 PLY 5	6 PLY 5
		8'-6"	4 PLY 5	5 PLY 5	6 PLY 5	7 PLY 5

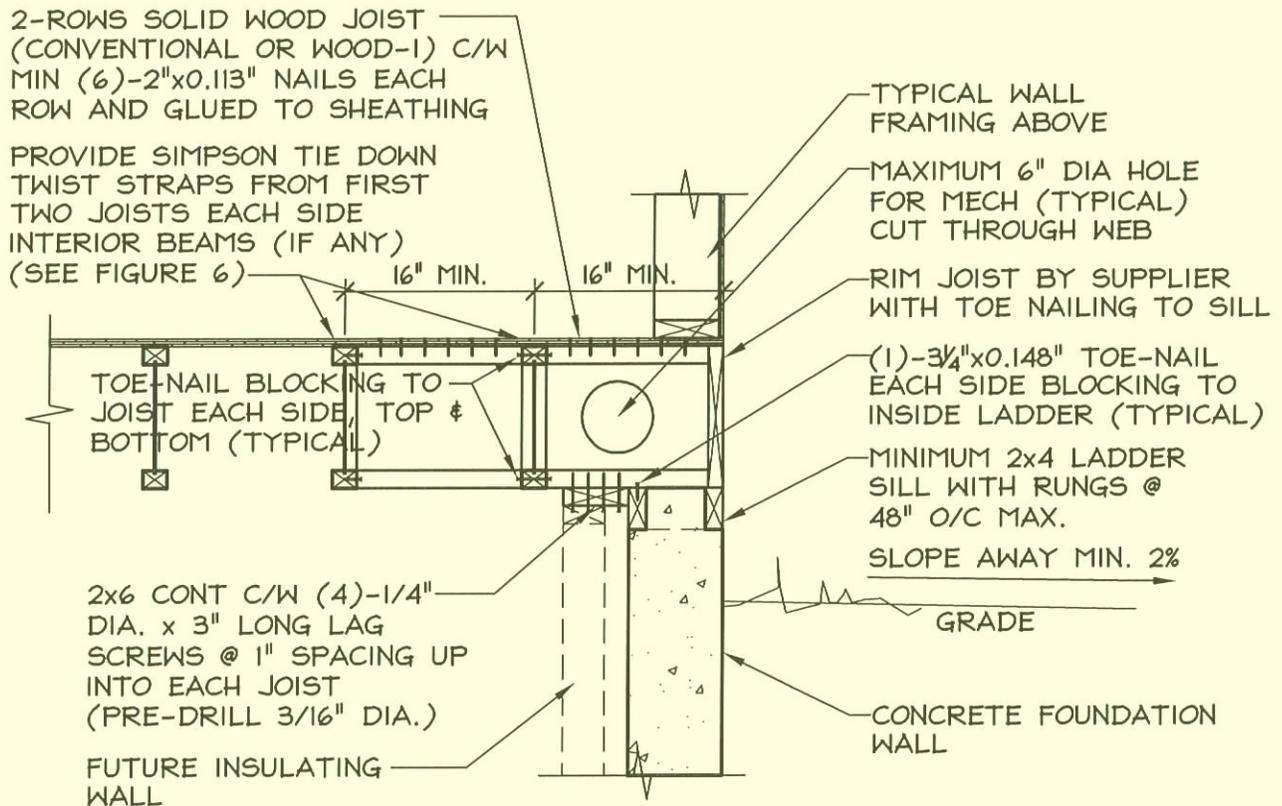
Notes:

- 1) Wall height is measured from top of footing to top of concrete wall.
- 2) Equivalent lateral earth pressures assumed by Sand/ Gravel, Low Plastic Clay/ Silt, and High Plastic Clay are 50 pcf, 70 pcf, and 80 pcf respectively.
- 3) Backfill height is measured above top of basement floor slab.
- 4) Refer to Figures 1 through 6 for specific top of wall connection details. Where DBL connections are specified use two (2) of the type indicated and double joists or blocking members. Where TPL connections are specified use three (3) of the type indicated and triple joists or blocking members. Where more than (3) plies are required the minimum number of plies is indicated. eg. 5 PLY 5 refers to (5) joists or blocking members each connected with connection TYPE 5.
- 5) DBL 2,3,4 means that a double connection type 2 or a double connection type 3 or a double connection type 4 may be used.
- 6) TPL 3,4/ DBL 5 means that a triple type 3 or a triple type 4, or a double type 5 may be used.
- 7) Built-up beams with the same number of plies specified may be used in lieu of blocking or joists provided that the connections are made in accordance with the connection type specified, and the built-up beam is connected to a concrete foundation wall at both ends.

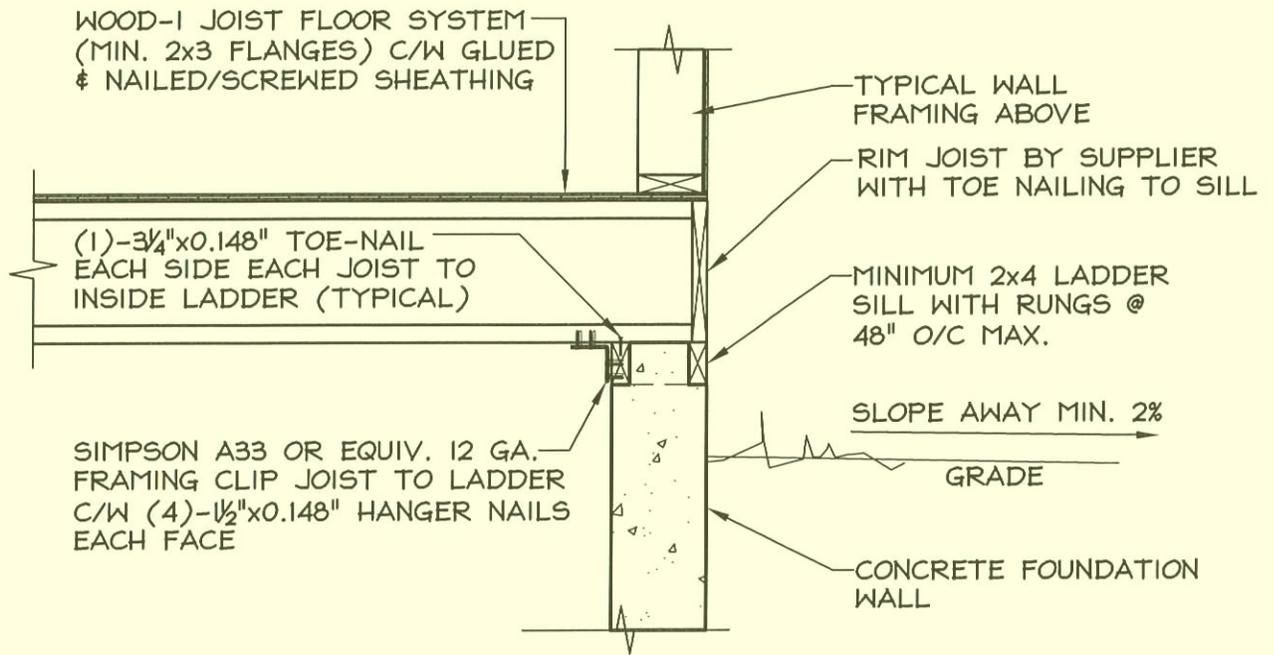




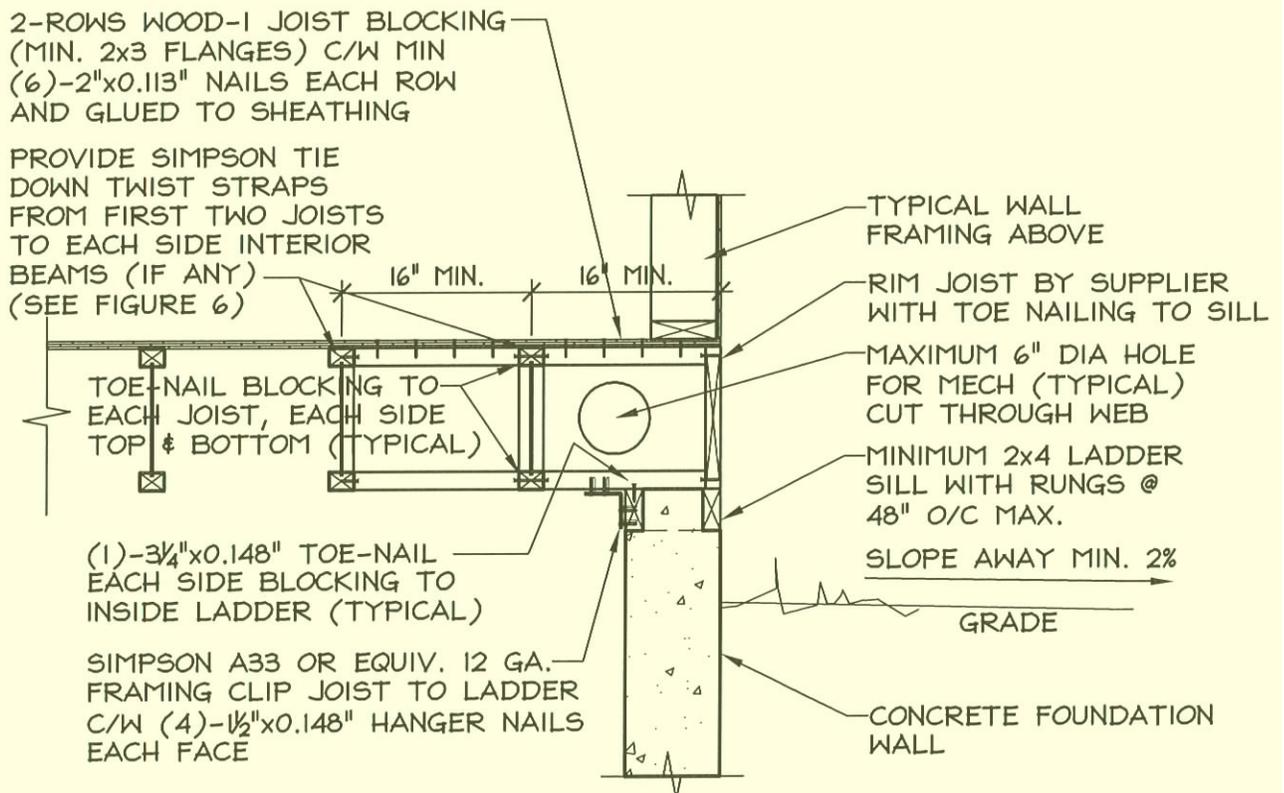
**Figure 2a - Lateral Connection TYPE 2 (Joists Perpendicular)**



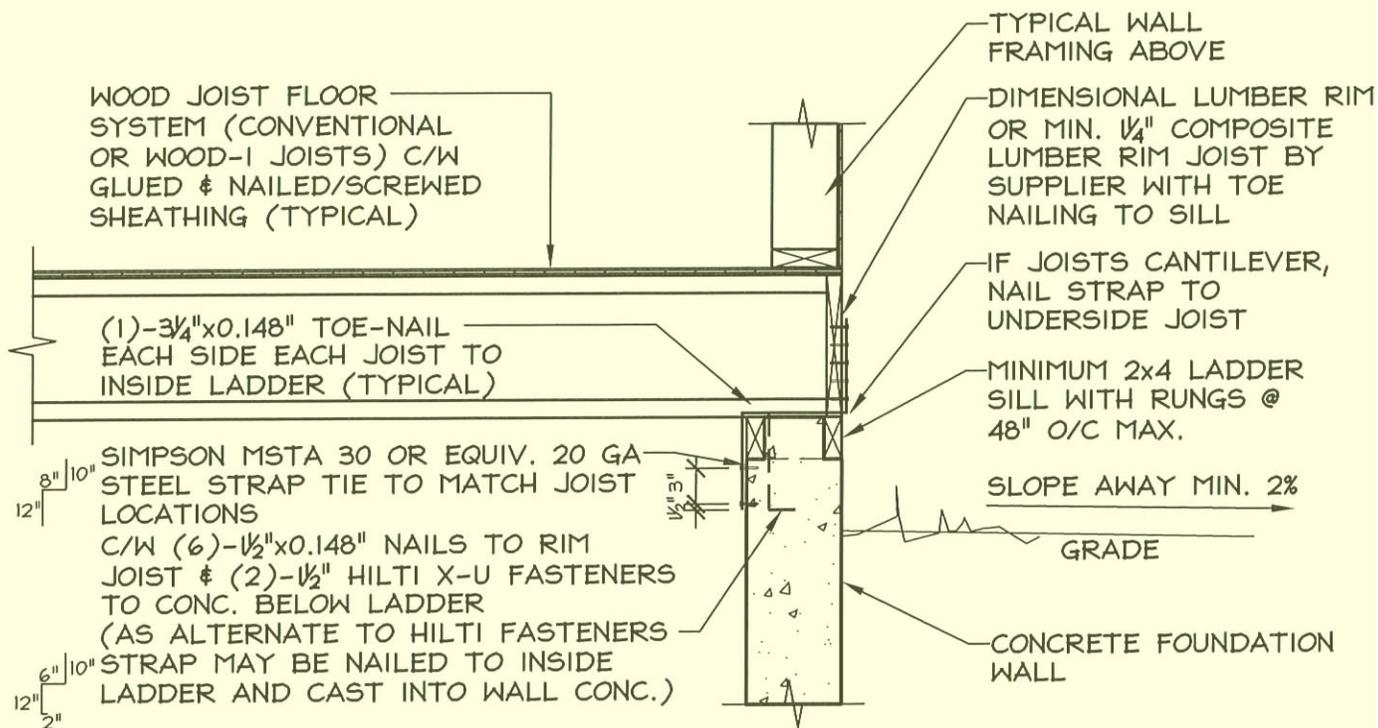
**Figure 2b - Lateral Connection TYPE 2 (Joists Parallel)**



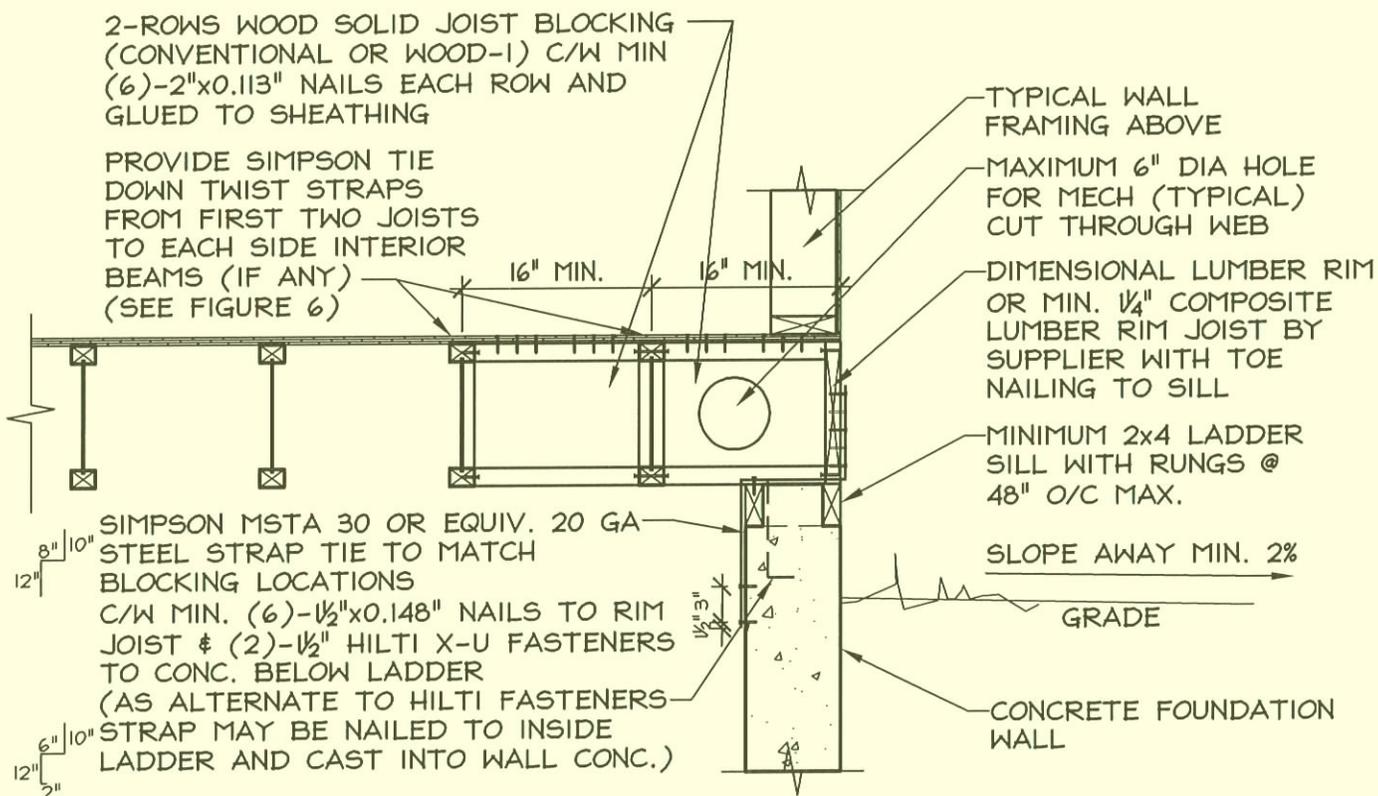
**Figure 3a - Lateral Connection TYPE 3 (Joists Perpendicular)**



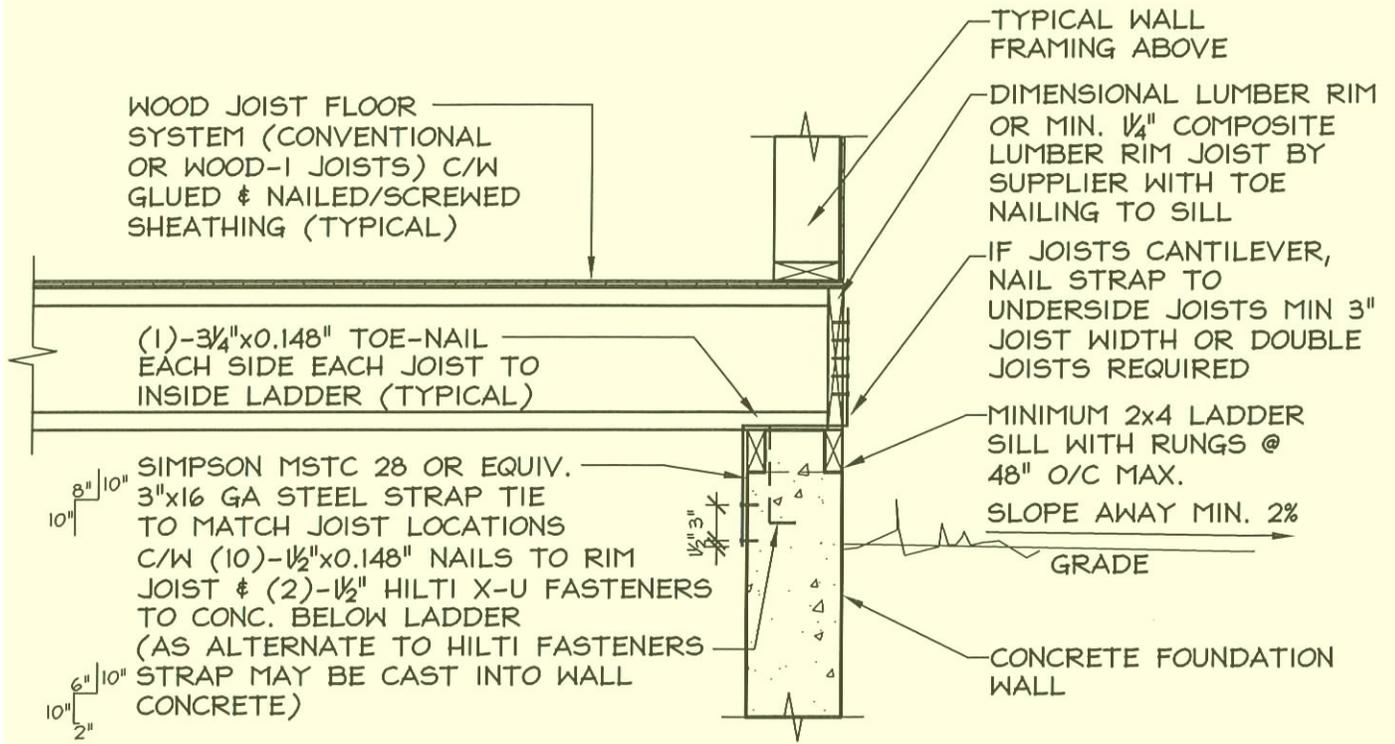
**Figure 3b - Lateral Connection TYPE 3 (Joists Parallel)**



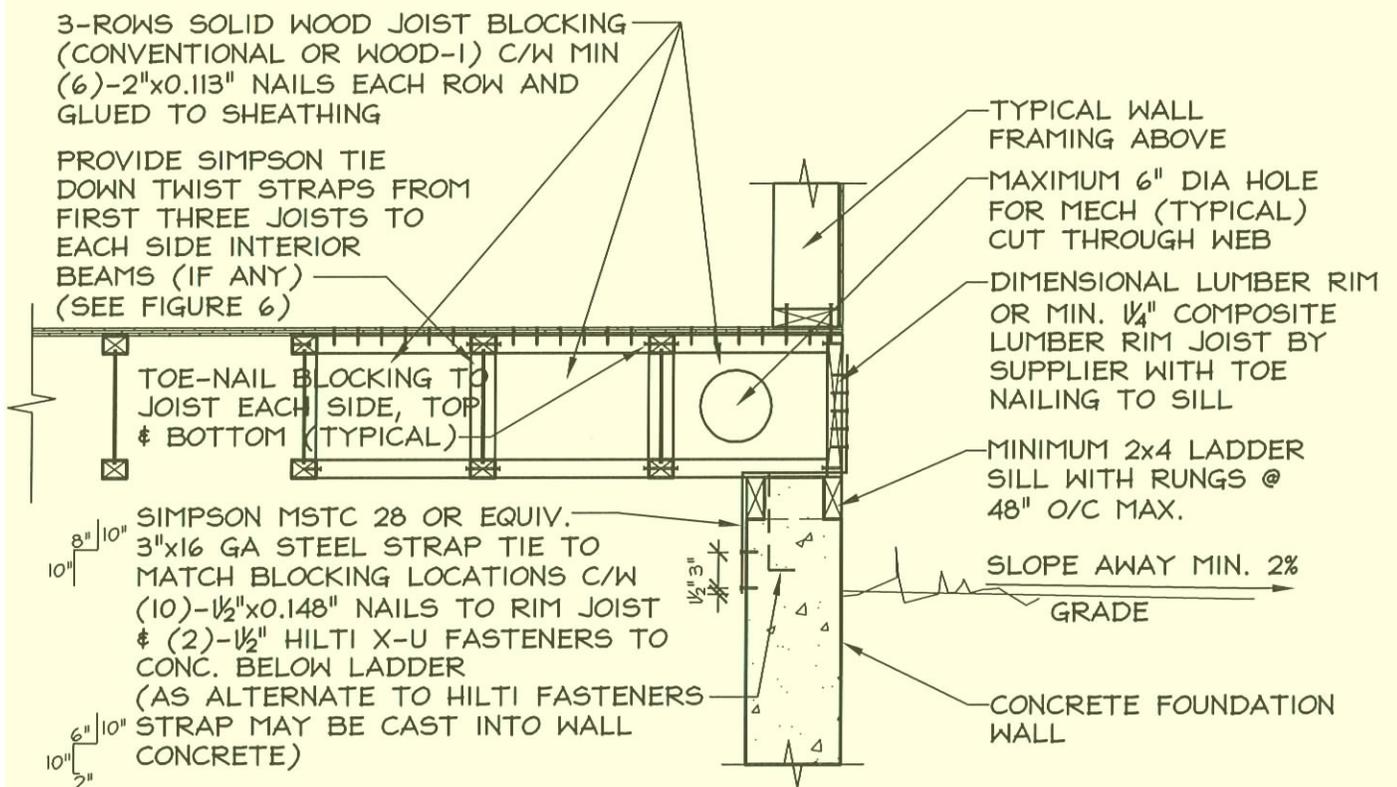
**Figure 4a - Lateral Connection TYPE 4 (Joists Perpendicular)**



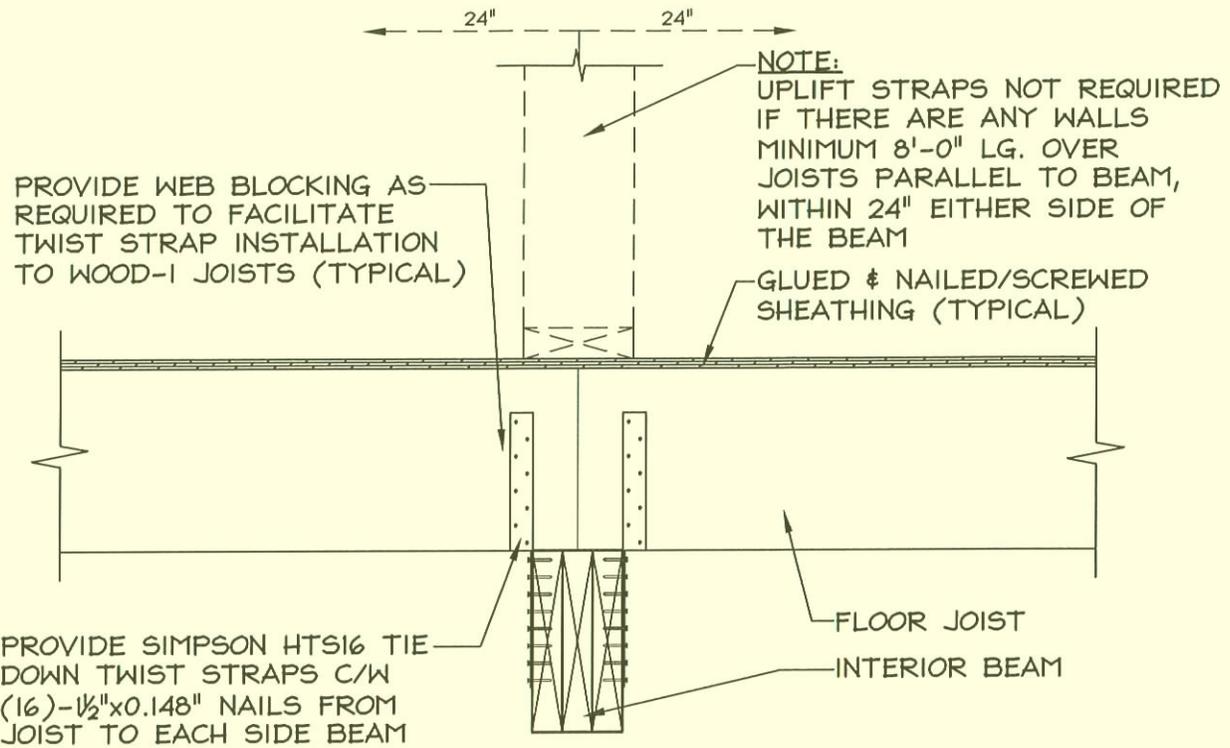
**Figure 4b - Lateral Connection TYPE 4 (Joists Parallel)**



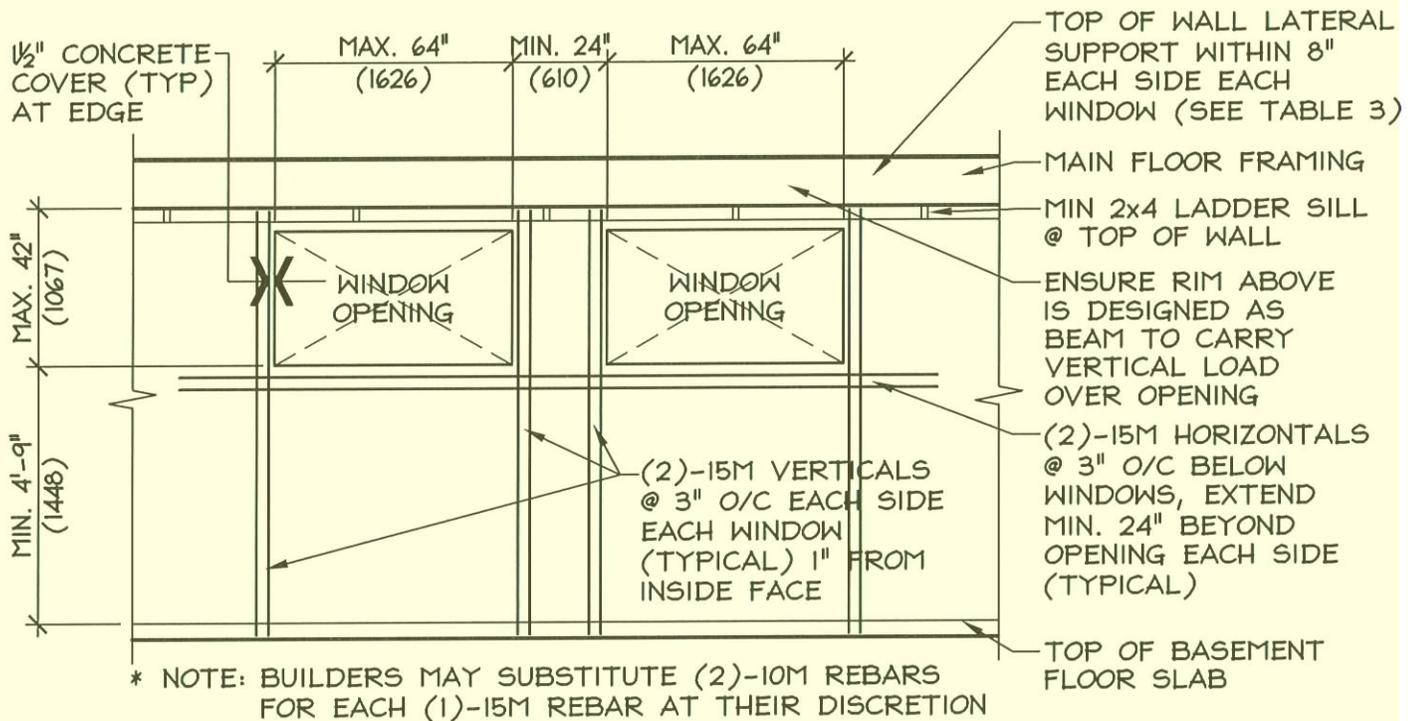
**Figure 5a - Lateral Connection TYPE 5 (Joists Perpendicular)**



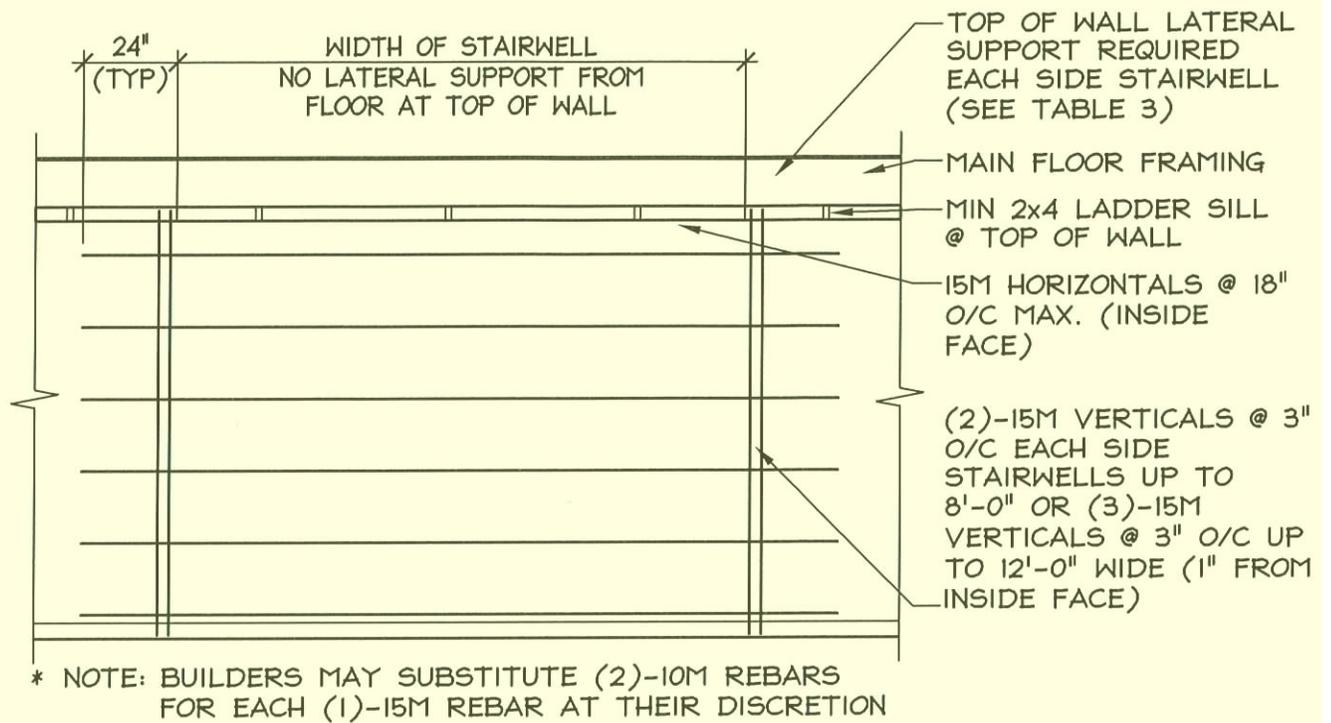
**Figure 5b - Lateral Connection TYPE 5 (Joists Parallel)**



**Figure 6 - Joist to Interior Beam Connection**



**Figure 7 - Additional Reinforcement at Windows**



**Figure 8 - Additional Reinforcement at Stairwells**