Tall Walls Workbook

A guide to designing wood stud walls up to 10.7 m (35 ft) high for single storey commercial wood structures

Canadian Wood Council

Conseil canadien du bois

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ISBN 0-921628-59-5

8M00-3

Photographs courtesy of:
Crestbrook Forest Industries
D.E. Schaefer Architect Ltd.

Design and production:
Eton Systems

Printing:
Lomor Printers Ltd.

Produced with the financial assistance of
Natural Resources Canada,
Canadian Forest Service

Printed in Canada on recycled paper

Preface

In Canada, wood is well suited to commercial buildings of one to four storeys. The modifications to the fire resistance requirements in building codes and the development of stronger engineered wood products has expanded the permitted use of wood to longer spans with heavier loads. A new series of design publications has been produced to assist specifiers of larger commercial wood structures. A previous publication, *Design and Costing Workbook*, gives detailed design and costing information for a single storey commercial building typical of retail or commercial buildings up to 14400 m^2. The *Design and Costing Workbook* can be downloaded from *http://www.wood-works.org/* or ordered from the Canadian Wood Council at 1-800-463-5091.

This follow-up publication provides detailed information on stud and tall wall design for commercial and industrial buildings which typically feature wall heights over 6.1 m (20 ft).

The *Tall Walls Workbook* provides stud tables for lumber studs and studs made from engineered wood products up to 10.7 m (35 ft). In addition, a detailed design example of a manufacturing facility is provided describing structural, thermal and fire considerations for tall walls.

The Canadian Wood Council has a complete set of publications and design tools to facilitate designing and building with wood. These include the *Wood Design Manual 1995,* referenced in the example, and the complete software for wood design, WoodWorks®, Design Office. WoodWorks®, Design Office includes SIZER, CONNECTIONS and SHEARWALLS to assist in the design process. A working demonstration of the software can be viewed at *http://www.woodworks-software.com/.*

The latest software, CodeCHEK, is a feasibility tool allowing the user to easily determine if a building, based on size and occupancy, is permitted to be built with wood according to the Building Code.

This free applet, or downloadable software, is available at *http://www.wood-works.org/.* This same web site also contains supplementary information on tall walls.

In particular, the web site contains the easy-to-use TallWALL sizer that provides stud sizes for a wider range of materials, lengths and load conditions than the stud tables published in this Workbook.

Http://wood-works.org/ has a feedback form used to collect your comments. Your comments play an important role in assisting the Canadian Wood Council to meet its goal of providing valuable design aids, such as this series.

In addition to structural and economic factors, environmental concerns may play a role in construction project decision making. In this area, wood has the following advantages:

- Wood is the only major building material that is renewable
- The volume of wood in Canada's commercial forests has increased over the past 20 years
- Wood produces less pollution during manufacturing and use than any other building material
- Wood provides superior energy savings because of its thermal performance.

Every effort has been made to ensure the data and information in this publication are as accurate as possible. The Canadian Wood Council does not, however, assume any responsibility for errors or omissions in the publication nor for any designs or plans prepared from it.

For more information, contact the Canadian Wood Council at 1-800-463-5091.

The Canadian Wood Council acknowledges the contributions of the following in the preparation of this workbook.

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Natural Resources Canada,
Canadian Forest Service

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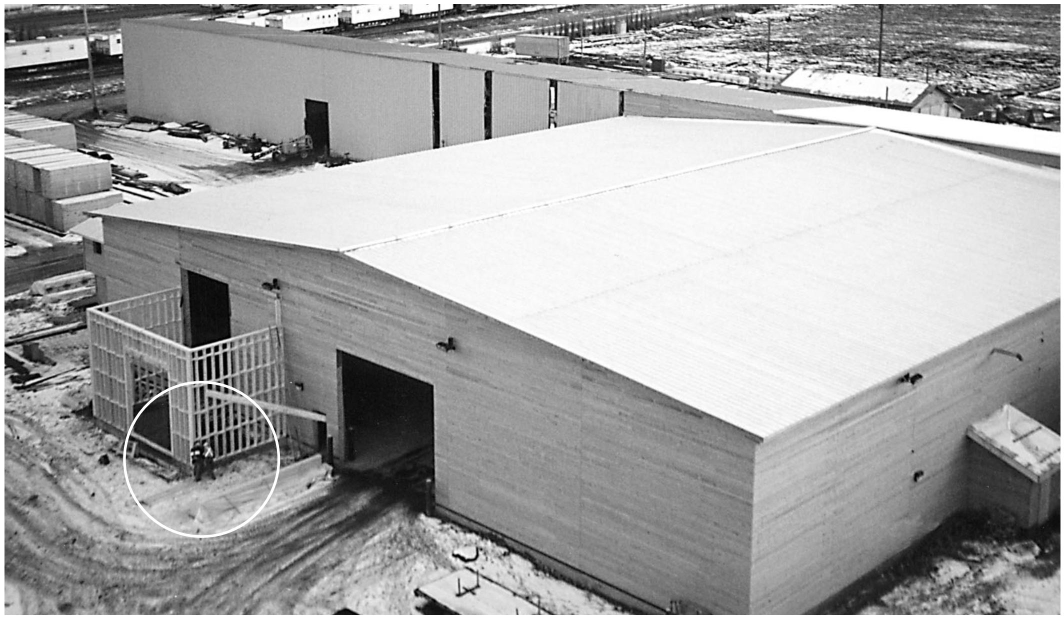


1. Introduction

This Workbook is intended to assist in determining the feasibility of using wood for the design of tall walls in commercial and industrial structures and to provide a step-by-step guide to the design of these walls. The popularity of single storey commercial projects, coupled with the wide availability of wood in Canada presents designers with many opportunities to use wood economically in these applications. Stud design tables for both lumber and engineered wood studs and a design example are provided to demonstrate wood's suitability for engineered tall wall construction.

The engineered tall walls described in this Workbook are extensions of the traditional stud walls used in Canada for over a hundred years. The traditional stud wall has proven to be such a successful construction technique because:

- The wood studs and framing can efficiently resist the snow loads on the roof and the wind loads on the wall and remove the need for an additional load bearing frame.
- When sheathing is added to the studs, the wall is very effective in resisting the lateral racking loads caused by wind and earthquakes.
- The walls can be easily insulated to provide excellent thermal resistance.
- Wood stud walls are readily finished with a wide range of finishing materials.
- Stud walls can be modified to adapt to the changing needs of the building.

The same rationale that has made the traditional stud wall so successful can be applied to the taller stud walls required for commercial structures. Larger lumber sizes or engineered wood products can be used to obtain the same wall strength in taller and longer walls. Shearwalls and connections can readily be designed to provide the required lateral resistance. Thermal requirements can be easily achieved with tall stud walls. By paying attention to details and selecting the correct finishing materials, tall stud walls can meet the more stringent fire and acoustical separation requirements for most commercial structures.

This publication is a design tool for tall walls used in single storey commercial structures. It will assist in evaluating the feasibility of using these walls and may also aid in design. This Workbook includes:

- Stud tables to determine the feasibility of building a tall wall out of wood studs.
- A step by step design example for a tall wall to assist in designs.

This Workbook is subdivided as follows:

1. **INTRODUCTION** gives background information.
2. **STUD TABLES** are provided for lumber studs up to 6.1 m (20 ft) and proprietary engineered wood studs up to 10.7 m (35 ft). These stud tables are intended for use in determining the feasibility of using tall wood stud walls for a given application. In a commercial application, a fully engineered design is required for each tall wall to consider the specific design considerations for that site, the connections and the other details required. In addition to the stud wall tables presented in the Workbook, *http://www.wood-works.org/* contains the easy to use TallWALL sizer that provides stud sizes for a wider range of materials, lengths and load conditions.
3. **EXAMPLE** provides a detailed design example of a 7.72 m (25 ft 4 in) tall wall using the Crestbrook Value Added Centre in Cranbrook, BC. References are noted as follows:

WDM	*Wood Design Manual 1995*
CSA O86.1	*CSA O86.1–94 Engineering Design in Wood (Limit States Design)*
NBCC	*National Building Code of Canada*
NBCC	*User's Guide – NBC 1995 Structural Commentaries (Part 4)*

The design example features stud and connection design, shearwall design, design around wall openings and wall requirements for thermal resistance and fire resistance rating.

Wood structures offer many advantages for commercial and industrial buildings. This publication will allow the user to quickly evaluate a wood option for their projects. In addition, wood offers a range of choices that include the following:

- Competitive material costs
- Availability of labour
- Ease of installation and material handling
- Shortened construction schedules
- Finishing options
- Ability to create complex building shapes with relative ease
- Increased thermal performance and energy efficiency

2. Stud Tables

Scope

This section features stud tables for lumber studs and proprietary engineered wood studs. These stud tables are intended for determining the feasibility of using tall wood stud walls for a given application. In a commercial application, a fully engineered design is required for each tall wall to consider the specific design considerations for that site, the effect of openings, the connections and other details. A full design example for a tall wall is given in Section 3. TallWALL, an easy to use tool that provides stud sizes for a wider range of materials, lengths and load conditions, can be found at *http://www.wood-works.org/*.

Assumptions Used to Develop the Stud Tables

- The studs are laterally braced to prevent buckling in the narrow dimension.
- The loads are uniformly distributed along the top of the wall.
- The 1/10 and 1/30 hourly wind pressures ($q_{1/10}$ and $q_{1/30}$) specified wind loads have been modified by the following coefficients:

  C_e = 0.9 for studs up to 6 m in length and 1.0 for studs 6 m to 12 m

  C_pC_g = –2.0

  C_{pi} = ±0.7

  C_{gi} = 1
- The 1/10 hourly wind pressure ($q_{1/10}$) is used in deflection calculations.
- The 1/30 hourly wind pressure ($q_{1/30}$) is used in strength calculations.
- Total load deflection criteria is stud length/180. Calculated total load deflection for each stud is given in the Tables.
- The ratio of specified axial dead load to live load is 1. The tables can be used conservatively when the specified axial dead load is less than the specified axial live load.
- Stud sizes are based on Limit States Design. The Limit States Design load combinations considered are:

  1. axial load alone

  2. wind plus axial dead load and

  3. wind plus axial live load plus axial dead load.
- In conformance with Limit States Design philosophy a load combination factor of 0.7 is applied to the wind and axial live loads in load combination 3.
- Load cases 2 and 3 are considered short term loads.
- Eccentric axial loading of the studs is considered with maximum eccentricity equal to $1/6^{th}$ of the stud depth.
- The Moment Magnifier Method is used to account for the secondary bending moment ($P\Delta$) effect.
- Deflections from wind and eccentric axial loads are amplified to account for the $P\Delta$ effect.
- Studs are assumed to be pinned at both ends.
- The tables can only be used for untreated studs in dry service conditions.

For the lumber stud tables:

- Resistance values were calculated based on CSA Standard O86.1-94.
- A “Case 2” load sharing system, as defined in CSA O86.1-94, is assumed. In order to meet this requirement, the studs must be sheathed with plywood, waferboard, or OSB of minimum 9.5 mm thickness and attached to the studs to provide a minimum stiffness equivalent to that provided by 2-inch common nails at 150 mm centres at edges of sheathing panels and 300 mm centres elsewhere.

How to Use the Tables

- Determine the 1/10 and 1/30 ($q_{1/10}$ and $q_{1/30}$) Hourly Wind Pressures for the building location. This is found in the Climatic Data Section of the *National Building Code* or appropriate Provincial Building Code.
- Calculate the specified uniformly distributed dead load based on materials supported. Consideration is to be given to the self weight of the wall. Under many conditions it is appropriate to include the weight of the top half of the wall.
- Calculate the specified uniformly distributed live load based on specified live loads due to snow and associated rain in the Building Code and tributary width of roof.
- The stud tables are appropriate for the typical case where the specified axial dead load does not exceed the specified axial live load.
- Calculate the factored uniformly distributed load (1.25D + 1.5L) kN/m along the stud wall.
- Select the table(s) for the stud material(s) being considered. The table(s) selected should have $q_{1/30}$ and $q_{1/10}$ wind loads which are greater than or equal to the climatic data for the building site.
- Based on the length of the stud, the spacing of the stud and the axial load, select a stud depth. The associated deflection should be considered for appropriateness where finishes are susceptible to cracking.

Table 2.1 - Lumber Studs

Wind pressure $q_{1/30}$ 0.6 kPa; $q_{1/10}$ 0.5 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		S-P-F No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	D.Fir-L No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	184	184	235	140	184	184	184	235
		deflection	L/335	L/211	L/324	L/228	L/314	L/389	L/245	L/376	L/264	L/364
	20	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/321	L/202	L/314	L/220	L/306	L/374	L/236	L/365	L/256	L/356
	30	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/308	L/193	L/304	L/213	L/299	L/359	L/226	L/354	L/249	L/348
	40	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/295	L/185	L/294	L/206	L/292	L/345	L/217	L/343	L/241	L/340
	50	depth	140	184	184	184	235	140	184	184	235	235
		deflection	L/283	L/422	L/285	L/200	L/285	L/332	L/492	L/333	L/500	L/333
406	10	depth	140	184	184	235	235	140	140	184	184	235
		deflection	L/250	L/361	L/242	L/357	L/235	L/290	L/183	L/281	L/197	L/272
	20	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/238	L/347	L/233	L/346	L/228	L/277	L/404	L/271	L/402	L/265
	30	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/226	L/334	L/225	L/336	L/222	L/265	L/390	L/262	L/391	L/258
	40	depth	140	184	184	235	235	140	184	184	235	286
		deflection	L/215	L/322	L/216	L/326	L/216	L/253	L/376	L/253	L/380	L/459
	50	depth	184	184	235	235	235	184	184	235	235	286
		deflection	L/484	L/310	L/447	L/317	L/210	L/565	L/363	L/521	L/370	L/449
610	10	depth	184	184	235	235	286	184	184	235	235	286
		deflection	L/378	L/239	L/336	L/236	L/282	L/439	L/277	L/390	L/274	L/327
	20	depth	184	184	235	235	286	184	184	235	286	N/A
		deflection	L/361	L/228	L/324	L/228	L/274	L/419	L/266	L/377	L/481	N/A
	30	depth	184	184	235	235	286	184	235	235	286	N/A
		deflection	L/344	L/218	L/313	L/220	L/266	L/401	L/537	L/364	L/467	N/A
	40	depth	184	235	235	286	N/A	184	235	235	286	N/A
		deflection	L/328	L/444	L/301	L/389	N/A	L/384	L/517	L/352	L/453	N/A
	50	depth	235	235	235	286	N/A	235	235	286	286	N/A
		deflection	L/657	L/428	L/291	L/378	N/A	L/765	L/499	L/616	L/440	N/A

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional lengths are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.1 (continued) - Lumber Studs

Wind pressure $q_{1/30}$ 0.6 kPa; $q_{1/10}$ 0.5 kPa

Depth required (mm) for 38 mm thick studs

			Hem-Fir No. 2 Grade (or better)					Northern Species No. 2 Grade (or better)				
Stud spacing mm	Factored axial load kN/m		Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	184	184	235	140	184	184	235	235
		deflection	L/389	L/245	L/376	L/264	L/364	L/245	L/355	L/238	L/350	L/230
	20	depth	140	140	184	184	235	140	184	184	235	235
		deflection	L/374	L/236	L/365	L/256	L/356	L/233	L/341	L/229	L/340	L/224
	30	depth	140	140	184	184	235	140	184	184	235	235
		deflection	L/359	L/226	L/354	L/249	L/348	L/222	L/328	L/220	L/330	L/218
	40	depth	140	140	184	184	235	184	184	184	235	286
		deflection	L/345	L/217	L/343	L/241	L/340	L/495	L/316	L/212	L/320	L/388
	50	depth	140	184	184	184	235	184	184	235	235	286
		deflection	L/332	L/492	L/333	L/234	L/333	L/475	L/304	L/439	L/311	L/379
406	10	depth	140	140	184	184	235	140	184	235	235	286
		deflection	L/290	L/183	L/281	L/197	L/272	L/182	L/265	L/372	L/262	L/312
	20	depth	140	184	184	184	235	184	184	235	235	286
		deflection	L/277	L/404	L/271	L/190	L/265	L/400	L/253	L/359	L/253	L/303
	30	depth	140	184	184	235	235	184	184	235	235	286
		deflection	L/265	L/390	L/262	L/391	L/258	L/382	L/242	L/347	L/244	L/295
	40	depth	140	184	184	235	235	184	235	235	286	286
		deflection	L/253	L/376	L/253	L/380	L/252	L/365	L/493	L/335	L/432	L/288
	50	depth	184	184	235	235	235	235	235	235	286	N/A
		deflection	L/565	L/363	L/521	L/370	L/245	L/729	L/475	L/324	L/419	N/A
610	10	depth	140	184	235	235	286	184	235	286	286	N/A
		deflection	L/191	L/277	L/390	L/274	L/327	L/277	L/367	L/446	L/314	N/A
	20	depth	184	184	235	235	286	184	235	286	N/A	N/A
		deflection	L/419	L/266	L/377	L/265	L/318	L/263	L/351	L/429	N/A	N/A
	30	depth	184	184	235	286	286	235	235	286	N/A	N/A
		deflection	L/401	L/255	L/364	L/467	L/310	L/524	L/336	L/414	N/A	N/A
	40	depth	184	235	235	286	N/A	286	286	286	N/A	N/A
		deflection	L/384	L/517	L/352	L/453	N/A	L/891	L/583	L/399	N/A	N/A
	50	depth	235	235	235	286	N/A	N/A	N/A	N/A	N/A	N/A
		deflection	L/765	L/499	L/340	L/440	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional lengths are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.1 (continued) - MSR Lumber Studs

Wind pressure $q_{1/30}$ 0.6 kPa; $q_{1/10}$ 0.5 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		Grade 1650f-1.5E Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	Grade 2100f-1.8E Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	184	184	235	140	140	140	184	184
		deflection	L/364	L/229	L/352	L/247	L/341	L/439	L/277	L/185	L/299	L/196
	20	depth	140	140	184	184	235	140	140	184	184	184
		deflection	L/349	L/220	L/341	L/240	L/333	L/423	L/267	L/413	L/290	L/191
	30	depth	140	140	184	184	235	140	140	184	184	184
		deflection	L/335	L/211	L/331	L/232	L/325	L/407	L/257	L/401	L/282	L/185
	40	depth	140	140	184	184	235	140	140	184	184	184
		deflection	L/322	L/202	L/320	L/225	L/318	L/392	L/248	L/389	L/274	L/180
	50	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/309	L/194	L/311	L/218	L/310	L/378	L/238	L/378	L/266	L/377
406	10	depth	140	184	184	184	235	140	140	184	184	235
		deflection	L/271	L/392	L/263	L/184	L/255	L/328	L/206	L/317	L/223	L/307
	20	depth	140	184	184	235	235	140	140	184	184	235
		deflection	L/259	L/378	L/254	L/376	L/248	L/314	L/197	L/307	L/216	L/300
	30	depth	140	184	184	235	235	140	140	184	184	235
		deflection	L/247	L/364	L/245	L/365	L/241	L/301	L/189	L/297	L/208	L/293
	40	depth	140	184	184	235	235	140	140	184	184	235
		deflection	L/235	L/351	L/236	L/355	L/235	L/288	L/181	L/288	L/202	L/286
	50	depth	140	184	184	235	235	140	184	184	184	235
		deflection	L/225	L/338	L/228	L/345	L/229	L/276	L/412	L/278	L/195	L/279
610	10	depth	184	184	235	235	286	140	184	184	235	235
		deflection	L/411	L/259	L/365	L/257	L/306	L/217	L/313	L/210	L/310	L/204
	20	depth	184	184	235	235	286	140	184	184	235	235
		deflection	L/392	L/248	L/352	L/248	L/298	L/205	L/301	L/202	L/300	L/198
	30	depth	184	184	235	235	286	140	184	184	235	235
		deflection	L/374	L/238	L/340	L/240	L/290	L/195	L/289	L/194	L/291	L/192
	40	depth	184	184	235	235	286	140	184	184	235	235
		deflection	L/358	L/227	L/328	L/231	L/282	L/184	L/278	L/186	L/282	L/186
	50	depth	235	235	235	235	286	184	184	235	235	235
		deflection	L/715	L/466	L/317	L/224	L/274	L/418	L/267	L/386	L/273	L/180

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. All sizes may not be available in both grades. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional grades are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.2 - Lumber Studs

Wind pressure $q_{1/30}$ 0.5 kPa; $q_{1/10}$ 0.4 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		S-P-F No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	D.Fir-L No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	184	184	184	140	140	140	184	184
		deflection	L/416	L/263	L/404	L/284	L/186	L/483	L/305	L/204	L/329	L/216
	20	depth	140	140	184	184	235	140	140	140	184	184
		deflection	L/397	L/250	L/389	L/274	L/381	L/462	L/292	L/195	L/318	L/209
	30	depth	140	140	184	184	235	140	140	184	184	184
		deflection	L/378	L/238	L/375	L/264	L/370	L/441	L/279	L/437	L/308	L/202
	40	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/360	L/227	L/361	L/254	L/360	L/422	L/267	L/422	L/298	L/420
	50	depth	140	184	184	184	235	140	184	184	184	235
		deflection	L/344	L/513	L/349	L/245	L/351	L/403	L/599	L/408	L/288	L/409
406	10	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/310	L/195	L/301	L/211	L/292	L/361	L/227	L/350	L/246	L/339
	20	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/294	L/184	L/289	L/203	L/283	L/342	L/216	L/336	L/236	L/329
	30	depth	140	184	184	184	235	140	184	184	184	235
		deflection	L/278	L/411	L/277	L/194	L/275	L/325	L/479	L/323	L/227	L/320
	40	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/263	L/394	L/266	L/401	L/266	L/309	L/460	L/311	L/467	L/311
	50	depth	184	184	184	235	235	184	184	184	235	235
		deflection	L/585	L/378	L/255	L/388	L/258	L/682	L/442	L/299	L/453	L/302
610	10	depth	140	184	184	235	235	140	184	184	235	286
		deflection	L/204	L/297	L/199	L/294	L/193	L/238	L/345	L/231	L/342	L/407
	20	depth	140	184	184	235	286	140	184	235	235	286
		deflection	L/191	L/282	L/189	L/283	L/340	L/223	L/328	L/466	L/329	L/395
	30	depth	184	184	235	235	286	184	184	235	235	286
		deflection	L/421	L/268	L/384	L/271	L/329	L/490	L/313	L/448	L/317	L/383
	40	depth	184	235	235	235	286	184	235	235	286	286
		deflection	L/399	L/540	L/369	L/261	L/319	L/466	L/630	L/430	L/555	L/372
	50	depth	235	235	235	286	286	184	235	235	286	N/A
		deflection	L/787	L/517	L/354	L/460	L/309	L/444	L/603	L/414	L/537	N/A

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional lengths are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.2 (continued) - Lumber Studs

Wind pressure $q_{1/30}$ 0.5 kPa; $q_{1/10}$ 0.4 kPa

Depth required (mm) for 38 mm thick studs

			Hem-Fir No. 2 Grade (or better)					Northern Species No. 2 Grade (or better)				
			Stud length					Stud length				
Stud spacing mm	Factored axial load kN/m		3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	140	184	184	140	140	184	184	235
		deflection	L/483	L/305	L/204	L/329	L/216	L/305	L/192	L/296	L/208	L/287
	20	depth	140	140	140	184	184	140	140	184	184	235
		deflection	L/462	L/292	L/195	L/318	L/209	L/288	L/181	L/284	L/199	L/278
	30	depth	140	140	140	184	184	140	184	184	235	235
		deflection	L/441	L/279	L/186	L/308	L/202	L/273	L/404	L/272	L/407	L/270
	40	depth	140	140	184	184	184	140	184	184	235	235
		deflection	L/422	L/267	L/422	L/298	L/196	L/258	L/387	L/261	L/394	L/261
	50	depth	140	140	184	184	235	184	184	235	235	235
		deflection	L/403	L/255	L/408	L/288	L/409	L/574	L/371	L/534	L/381	L/253
406	10	depth	140	140	184	184	235	140	184	184	235	235
		deflection	L/361	L/227	L/350	L/246	L/339	L/227	L/329	L/220	L/326	L/214
	20	depth	140	140	184	184	235	140	184	184	235	286
		deflection	L/342	L/216	L/336	L/236	L/329	L/212	L/313	L/210	L/313	L/376
	30	depth	140	140	184	184	235	184	184	235	235	286
		deflection	L/325	L/205	L/323	L/227	L/320	L/467	L/298	L/426	L/302	L/365
	40	depth	140	184	184	235	235	184	184	235	235	286
		deflection	L/309	L/460	L/311	L/467	L/311	L/444	L/284	L/410	L/290	L/354
	50	depth	184	184	184	235	235	235	235	235	286	286
		deflection	L/682	L/442	L/299	L/453	L/302	L/874	L/575	L/394	L/511	L/343
610	10	depth	140	184	184	235	286	184	235	235	286	N/A
		deflection	L/238	L/345	L/231	L/342	L/407	L/344	L/455	L/306	L/391	N/A
	20	depth	140	184	235	235	286	184	235	235	286	N/A
		deflection	L/223	L/328	L/466	L/329	L/395	L/323	L/433	L/292	L/375	N/A
	30	depth	184	184	235	235	286	184	235	286	286	N/A
		deflection	L/490	L/313	L/448	L/317	L/383	L/304	L/412	L/507	L/360	N/A
	40	depth	184	184	235	235	286	286	286	286	286	N/A
		deflection	L/466	L/299	L/430	L/305	L/372	L/1068	L/705	L/486	L/346	N/A
	50	depth	235	235	235	286	286	N/A	N/A	N/A	N/A	N/A
		deflection	L/917	L/603	L/414	L/537	L/361	N/A	N/A	N/A	N/A	N/A

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional lengths are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.2 (continued) - MSR Lumber Studs

Wind pressure $q_{1/30}$ 0.5 kPa; $q_{1/10}$ 0.4 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		Grade 1650f-1.5E Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	Grade 2100f-1.8E Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	140	184	184	140	140	140	184	184
		deflection	L/452	L/285	L/191	L/308	L/202	L/546	L/345	L/231	L/372	L/244
	20	depth	140	140	140	184	184	140	140	140	184	184
		deflection	L/431	L/272	L/182	L/297	L/195	L/522	L/331	L/221	L/360	L/237
	30	depth	140	140	184	184	184	140	140	140	184	184
		deflection	L/412	L/260	L/408	L/287	L/189	L/500	L/317	L/212	L/349	L/230
	40	depth	140	140	184	184	184	140	140	140	184	184
		deflection	L/393	L/248	L/394	L/277	L/182	L/479	L/304	L/203	L/338	L/223
	50	depth	140	140	184	184	235	140	140	140	184	184
		deflection	L/376	L/237	L/380	L/268	L/382	L/459	L/292	L/194	L/327	L/216
406	10	depth	140	140	184	184	235	140	140	184	184	184
		deflection	L/337	L/212	L/327	L/230	L/317	L/407	L/257	L/395	L/278	L/182
	20	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/320	L/201	L/314	L/221	L/308	L/388	L/245	L/380	L/268	L/372
	30	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/303	L/190	L/302	L/212	L/299	L/370	L/233	L/367	L/258	L/362
	40	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/288	L/180	L/290	L/203	L/290	L/352	L/222	L/353	L/249	L/352
	50	depth	140	184	184	184	235	140	140	184	184	235
		deflection	L/273	L/412	L/278	L/195	L/281	L/336	L/211	L/341	L/240	L/343
610	10	depth	140	184	184	235	235	140	184	184	184	235
		deflection	L/222	L/322	L/216	L/319	L/210	L/269	L/389	L/261	L/183	L/254
	20	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/208	L/307	L/206	L/307	L/202	L/254	L/372	L/250	L/372	L/245
	30	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/195	L/292	L/196	L/296	L/195	L/239	L/355	L/239	L/359	L/237
	40	depth	184	184	184	235	235	140	184	184	235	235
		deflection	L/435	L/278	L/186	L/284	L/188	L/225	L/340	L/228	L/346	L/230
	50	depth	235	235	235	235	235	184	184	184	235	235
		deflection	L/856	L/563	L/386	L/274	L/181	L/504	L/325	L/218	L/334	L/222

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. All sizes may not be available in both grades. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional grades are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.3 - Lumber Studs

Wind pressure $q_{1/30}$ 0.4 kPa; $q_{1/10}$ 0.3 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		S-P-F No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	D.Fir-L No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	140	184	184	140	140	140	140	184
		deflection	L/550	L/347	L/233	L/376	L/247	L/638	L/404	L/271	L/189	L/287
	20	depth	140	140	140	184	184	140	140	140	184	184
		deflection	L/519	L/329	L/220	L/360	L/237	L/604	L/383	L/257	L/420	L/277
	30	depth	140	140	140	184	184	140	140	140	184	184
		deflection	L/490	L/311	L/207	L/346	L/228	L/572	L/364	L/244	L/403	L/267
	40	depth	140	140	184	184	184	140	140	184	184	184
		deflection	L/463	L/295	L/469	L/332	L/219	L/542	L/346	L/547	L/388	L/257
	50	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/438	L/279	L/449	L/318	L/456	L/515	L/329	L/526	L/373	L/532
406	10	depth	140	140	184	184	184	140	140	140	184	184
		deflection	L/410	L/258	L/399	L/280	L/184	L/476	L/301	L/201	L/326	L/214
	20	depth	140	140	184	184	235	140	140	140	184	235
		deflection	L/384	L/242	L/379	L/267	L/374	L/448	L/283	L/189	L/311	L/434
	30	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/360	L/227	L/361	L/254	L/360	L/422	L/267	L/422	L/298	L/420
	40	depth	140	184	184	184	235	140	184	184	184	235
		deflection	L/338	L/507	L/344	L/242	L/348	L/398	L/592	L/403	L/285	L/406
	50	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/318	L/482	L/328	L/500	L/335	L/375	L/565	L/386	L/583	L/392
610	10	depth	140	184	184	184	235	140	140	184	235	235
		deflection	L/270	L/392	L/263	L/185	L/257	L/314	L/197	L/306	L/452	L/298
	20	depth	140	184	184	235	235	140	184	184	235	235
		deflection	L/249	L/369	L/248	L/371	L/245	L/292	L/430	L/290	L/432	L/286
	30	depth	184	184	184	235	235	184	184	235	235	286
		deflection	L/541	L/347	L/234	L/354	L/235	L/631	L/406	L/581	L/413	L/501
	40	depth	184	184	235	235	286	184	184	235	235	286
		deflection	L/508	L/328	L/475	L/338	L/414	L/594	L/384	L/554	L/395	L/483
	50	depth	235	235	235	235	286	184	235	235	235	286
		deflection	L/982	L/654	L/453	L/323	L/399	L/560	L/763	L/529	L/379	L/466

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional lengths are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.3 (continued) - Lumber Studs

Wind pressure $q_{1/30}$ 0.4 kPa; $q_{1/10}$ 0.3 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		Hem-Fir No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	Northern Species No. 2 Grade (or better) Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	140	140	184	140	140	184	184	184
		deflection	L/638	L/404	L/271	L/189	L/287	L/402	L/254	L/391	L/275	L/181
	20	depth	140	140	140	184	184	140	140	184	184	235
		deflection	L/604	L/383	L/257	L/420	L/277	L/377	L/238	L/373	L/262	L/367
	30	depth	140	140	140	184	184	140	140	184	184	235
		deflection	L/572	L/364	L/244	L/403	L/267	L/354	L/223	L/355	L/250	L/354
	40	depth	140	140	184	184	184	140	184	184	235	235
		deflection	L/542	L/346	L/547	L/388	L/257	L/332	L/498	L/338	L/510	L/341
	50	depth	140	140	184	184	184	184	184	184	235	235
		deflection	L/515	L/329	L/526	L/373	L/247	L/724	L/473	L/322	L/490	L/329
406	10	depth	140	140	140	184	184	140	140	184	184	235
		deflection	L/476	L/301	L/201	L/326	L/214	L/299	L/188	L/292	L/205	L/284
	20	depth	140	140	140	184	184	140	184	184	235	235
		deflection	L/448	L/283	L/189	L/311	L/205	L/278	L/409	L/276	L/412	L/272
	30	depth	140	140	184	184	235	140	184	184	235	235
		deflection	L/422	L/267	L/422	L/298	L/420	L/258	L/387	L/261	L/394	L/261
	40	depth	140	184	184	184	235	184	184	235	235	286
		deflection	L/398	L/592	L/403	L/285	L/406	L/565	L/365	L/528	L/376	L/460
	50	depth	184	184	184	235	235	235	235	235	235	286
		deflection	L/860	L/565	L/386	L/583	L/392	L/1089	L/727	L/504	L/360	L/444
610	10	depth	140	140	184	184	235	140	184	235	235	286
		deflection	L/314	L/197	L/306	L/215	L/298	L/196	L/286	L/405	L/285	L/341
	20	depth	140	184	184	235	235	184	184	235	235	286
		deflection	L/292	L/430	L/290	L/432	L/286	L/420	L/267	L/383	L/270	L/327
	30	depth	140	184	184	235	235	184	235	235	286	N/A
		deflection	L/272	L/406	L/274	L/413	L/274	L/391	L/531	L/362	L/468	N/A
	40	depth	184	184	235	235	286	286	286	286	286	N/A
		deflection	L/594	L/384	L/554	L/395	L/483	L/1334	L/893	L/622	L/447	N/A
	50	depth	235	235	235	235	286	N/A	N/A	N/A	N/A	N/A
		deflection	L/1143	L/763	L/529	L/379	L/466	N/A	N/A	N/A	N/A	N/A

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional lengths are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.3 (continued) - MSR Lumber Studs

Wind pressure $q_{1/30}$ 0.4 kPa; $q_{1/10}$ 0.3 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		**Grade 1650f-1.5E** Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)	**Grade 2100f-1.8E** Stud length 3.66 m (12 ft)	4.27 m (14 ft)	4.88 m (16 ft)	5.49 m (18 ft)	6.10 m (20 ft)
305	10	depth	140	140	140	184	184	89	140	140	140	184
		deflection	L/597	L/377	L/253	L/408	L/269	L/180	L/456	L/306	L/214	L/324
	20	depth	140	140	140	184	184	140	140	140	140	184
		deflection	L/564	L/358	L/240	L/392	L/258	L/683	L/434	L/291	L/204	L/313
	30	depth	140	140	140	184	184	140	140	140	140	184
		deflection	L/534	L/340	L/227	L/376	L/249	L/648	L/414	L/278	L/194	L/303
	40	depth	140	140	140	184	184	140	140	140	140	184
		deflection	L/505	L/322	L/215	L/362	L/239	L/616	L/394	L/264	L/184	L/292
	50	depth	140	140	140	184	184	140	140	140	184	184
		deflection	L/479	L/306	L/203	L/347	L/230	L/586	L/376	L/252	L/425	L/282
406	10	depth	140	140	140	184	184	140	140	140	184	184
		deflection	L/445	L/281	L/188	L/304	L/200	L/538	L/340	L/228	L/368	L/242
	20	depth	140	140	184	184	184	140	140	140	184	184
		deflection	L/418	L/264	L/413	L/291	L/191	L/507	L/322	L/215	L/353	L/232
	30	depth	140	140	184	184	184	140	140	140	184	184
		deflection	L/393	L/248	L/394	L/277	L/182	L/479	L/304	L/203	L/338	L/223
	40	depth	140	140	184	184	235	140	140	140	184	184
		deflection	L/370	L/234	L/376	L/265	L/379	L/453	L/288	L/191	L/324	L/214
	50	depth	140	140	184	184	235	140	140	184	184	184
		deflection	L/348	L/219	L/359	L/253	L/366	L/428	L/272	L/439	L/311	L/205
610	10	depth	140	140	184	184	235	140	140	184	184	235
		deflection	L/293	L/184	L/286	L/201	L/279	L/355	L/224	L/346	L/243	L/337
	20	depth	140	184	184	184	235	140	140	184	184	235
		deflection	L/272	L/401	L/270	L/189	L/267	L/332	L/209	L/328	L/231	L/324
	30	depth	140	184	184	235	235	140	140	184	184	235
		deflection	L/253	L/379	L/255	L/386	L/256	L/310	L/194	L/312	L/219	L/311
	40	depth	184	184	184	235	235	140	184	184	184	235
		deflection	L/554	L/358	L/241	L/369	L/245	L/290	L/437	L/296	L/207	L/300
	50	depth	235	235	235	235	235	184	184	184	184	235
		deflection	L/1068	L/713	L/494	L/353	L/235	L/636	L/415	L/281	L/197	L/288

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions.
2. The Canadian Wood Council recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. All sizes may not be available in both grades. Before specifying, the designer should ensure that the studs are available in the size, length and grade specified. Stud tables for additional grades are available at www.wood-works.org.
5. Nominal imperial equivalents for the stud depths are:

depth mm	140	184	235	286
nominal depth inches	6	8	10	12

Table 2.4 - SelecTem™ Studs by Tembec

Wind pressure $q_{1/30}$ 0.6 kPa; $q_{1/10}$ 0.5 kPa

Depth required (mm) for 44 mm (1-3/4") thick studs

Stud spacing mm	Factored axial load kN/m		**1.8 E SelecTem™** Stud length 5.18 m (17 ft)	5.79 m (19 ft)	6.40 m (21 ft)	7.01 m (23 ft)	7.62 m (25 ft)	8.23 m (27 ft)	8.84 m (29 ft)	9.45 m (31 ft)	10.06 m (33 ft)	10.67 m (35 ft)
305	10	depth	184	184	184	235	235	235	286	286	286	302
		deflection	L/411	L/295	L/197	L/314	L/244	L/194	L/283	L/232	L/192	L/190
	20	depth	184	184	184	235	235	235	286	286	286	302
		deflection	L/400	L/287	L/191	L/308	L/239	L/190	L/279	L/228	L/189	L/187
	30	depth	184	184	184	235	235	235	286	286	286	302
		deflection	L/390	L/280	L/187	L/302	L/235	L/186	L/274	L/224	L/186	L/184
	40	depth	184	184	184	235	235	235	286	286	286	302
		deflection	L/380	L/272	L/182	L/296	L/230	L/182	L/270	L/221	L/182	L/181
	50	depth	184	184	235	235	235	241	286	286	292	318
		deflection	L/370	L/265	L/380	L/290	L/226	L/193	L/265	L/217	L/191	L/209
406	10	depth	184	184	235	235	235	286	286	292	318	356
		deflection	L/307	L/220	L/308	L/235	L/182	L/262	L/212	L/184	L/198	L/233
	20	depth	184	184	235	235	241	286	286	292	318	356
		deflection	L/298	L/213	L/301	L/229	L/193	L/258	L/208	L/181	L/194	L/230
	30	depth	184	184	235	235	241	286	286	302	318	356
		deflection	L/289	L/207	L/294	L/224	L/188	L/253	L/204	L/197	L/191	L/226
	40	depth	184	184	235	235	241	286	286	302	318	356
		deflection	L/281	L/200	L/288	L/219	L/184	L/248	L/200	L/193	L/188	L/223
	50	depth	184	184	235	235	286	286	286	302	318	356
		deflection	L/272	L/194	L/281	L/214	L/307	L/244	L/196	L/190	L/185	L/219
610	10	depth	184	235	235	286	286	292	318	356	356	406
		deflection	L/203	L/306	L/204	L/282	L/219	L/185	L/194	L/223	L/185	L/230
	20	depth	184	235	235	286	286	292	318	356	356	406
		deflection	L/196	L/297	L/199	L/275	L/214	L/181	L/190	L/219	L/181	L/227
	30	depth	184	235	235	286	286	302	318	356	406	406
		deflection	L/189	L/289	L/193	L/269	L/210	L/197	L/186	L/215	L/266	L/223
	40	depth	184	235	235	286	286	302	318	356	406	406
		deflection	L/181	L/280	L/188	L/263	L/205	L/192	L/182	L/211	L/262	L/219
	50	depth	235	235	235	286	286	302	356	356	406	406
		deflection	L/378	L/272	L/183	L/257	L/200	L/188	L/253	L/207	L/258	L/216

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions. For additional design information, contact Tembec at 1-800-463-0456.
2. Tembec recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Stud tables for 2.0 E SelecTem™ are available at www.wood-works.org.
5. Imperial equivalents for the stud depths are:

depth mm	184	235	241	286	292	302	318	356	406
depth inches	7-1/4	9-1/4	9-1/2	11-1/4	11-1/2	11-7/8	12-1/2	14	16

Table 2.5 - SelecTem™ Studs by Tembec

Wind pressure $q_{1/30}$ 0.5 kPa; $q_{1/10}$ 0.4 kPa

Depth required (mm) for 44 mm (1-3/4") thick studs

Stud spacing mm	Factored axial load kN/m		1.8 E SelecTem™ Stud length 5.18 m (17 ft)	5.79 m (19 ft)	6.40 m (21 ft)	7.01 m (23 ft)	7.62 m (25 ft)	8.23 m (27 ft)	8.84 m (29 ft)	9.45 m (31 ft)	10.06 m (33 ft)	10.67 m (35 ft)
305	10	depth	184	184	184	184	235	235	235	286	286	286
		deflection	L/512	L/367	L/245	L/186	L/305	L/242	L/195	L/289	L/240	L/201
	20	depth	184	184	184	184	235	235	235	286	286	286
		deflection	L/497	L/357	L/238	L/181	L/298	L/236	L/190	L/284	L/235	L/197
	30	depth	184	184	184	235	235	235	235	286	286	286
		deflection	L/482	L/346	L/232	L/374	L/292	L/231	L/186	L/279	L/231	L/193
	40	depth	184	184	184	235	235	235	235	286	286	286
		deflection	L/467	L/336	L/225	L/366	L/285	L/226	L/182	L/274	L/227	L/190
	50	depth	184	184	184	235	235	235	241	286	286	286
		deflection	L/454	L/326	L/219	L/358	L/279	L/221	L/192	L/269	L/223	L/186
406	10	depth	184	184	184	235	235	235	286	286	292	318
		deflection	L/383	L/274	L/183	L/292	L/228	L/181	L/264	L/216	L/191	L/207
	20	depth	184	184	235	235	235	241	286	286	292	318
		deflection	L/370	L/265	L/374	L/285	L/222	L/190	L/259	L/212	L/187	L/203
	30	depth	184	184	235	235	235	241	286	286	292	318
		deflection	L/357	L/256	L/365	L/278	L/216	L/185	L/253	L/207	L/183	L/199
	40	depth	184	184	235	235	235	241	286	286	302	318
		deflection	L/345	L/247	L/356	L/271	L/211	L/180	L/248	L/203	L/199	L/195
	50	depth	184	184	235	235	235	286	286	286	302	318
		deflection	L/334	L/239	L/347	L/264	L/205	L/301	L/243	L/198	L/195	L/191
610	10	depth	184	184	235	235	286	286	292	318	356	356
		deflection	L/253	L/181	L/255	L/194	L/274	L/217	L/187	L/198	L/231	L/193
	20	depth	184	235	235	235	286	286	292	318	356	356
		deflection	L/243	L/369	L/247	L/188	L/267	L/212	L/182	L/193	L/226	L/189
	30	depth	184	235	235	235	286	286	302	318	356	356
		deflection	L/233	L/357	L/239	L/182	L/260	L/206	L/197	L/189	L/221	L/185
	40	depth	184	235	235	241	286	286	302	318	356	356
		deflection	L/223	L/345	L/232	L/191	L/253	L/201	L/192	L/184	L/217	L/181
	50	depth	184	235	235	241	286	286	302	356	356	406
		deflection	L/214	L/334	L/225	L/185	L/247	L/196	L/187	L/256	L/212	L/267

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions. For additional design information, contact Tembec at 1-800-463-0456.
2. Tembec recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Stud tables for 2.0 E SelecTem™ are available at www.wood-works.org.
5. Imperial equivalents for the stud depths are:

depth mm	184	235	241	286	292	302	318	356	406
depth inches	7-1/4	9-1/4	9-1/2	11-1/4	11-1/2	11-7/8	12-1/2	14	16

Table 2.6 - SelecTem™ Studs by Tembec

Wind pressure $q_{1/30}$ 0.4 kPa; $q_{1/10}$ 0.3 kPa

Depth required (mm) for 44 mm (1-3/4") thick studs

Stud spacing mm	Factored axial load kN/m		**1.8 E SelecTem™** Stud length 5.18 m (17 ft)	5.79 m (19 ft)	6.40 m (21 ft)	7.01 m (23 ft)	7.62 m (25 ft)	8.23 m (27 ft)	8.84 m (29 ft)	9.45 m (31 ft)	10.06 m (33 ft)	10.67 m (35 ft)
305	10	depth	184	184	184	184	184	235	235	235	241	286
		deflection	L/678	L/487	L/326	L/248	L/193	L/321	L/259	L/212	L/190	L/267
	20	depth	184	184	184	184	184	235	235	235	241	286
		deflection	L/654	L/470	L/315	L/240	L/186	L/313	L/253	L/206	L/185	L/261
	30	depth	184	184	184	184	235	235	235	235	286	286
		deflection	L/630	L/455	L/305	L/232	L/385	L/305	L/246	L/201	L/306	L/256
	40	depth	184	184	184	184	235	235	235	235	286	286
		deflection	L/608	L/439	L/295	L/224	L/375	L/298	L/240	L/196	L/299	L/251
	50	depth	184	184	184	184	235	235	235	235	286	286
		deflection	L/587	L/424	L/286	L/216	L/366	L/290	L/234	L/190	L/293	L/245
406	10	depth	184	184	184	184	235	235	235	286	286	286
		deflection	L/507	L/364	L/243	L/184	L/302	L/240	L/193	L/287	L/238	L/199
	20	depth	184	184	184	235	235	235	235	286	286	286
		deflection	L/487	L/350	L/234	L/377	L/294	L/233	L/188	L/281	L/232	L/195
	30	depth	184	184	184	235	235	235	235	286	286	286
		deflection	L/467	L/336	L/225	L/366	L/285	L/226	L/182	L/274	L/227	L/190
	40	depth	184	184	184	235	235	235	241	286	286	286
		deflection	L/449	L/323	L/216	L/356	L/277	L/219	L/191	L/267	L/221	L/185
	50	depth	184	184	184	235	235	235	241	286	286	286
		deflection	L/432	L/311	L/208	L/345	L/269	L/213	L/185	L/261	L/216	L/180
610	10	depth	184	184	235	235	235	286	286	286	302	318
		deflection	L/335	L/240	L/338	L/257	L/200	L/288	L/233	L/190	L/186	L/182
	20	depth	184	184	235	235	235	286	286	286	302	356
		deflection	L/320	L/229	L/326	L/248	L/193	L/280	L/226	L/185	L/181	L/251
	30	depth	184	184	235	235	235	286	286	292	318	356
		deflection	L/305	L/218	L/314	L/239	L/186	L/272	L/219	L/191	L/206	L/245
	40	depth	184	184	235	235	241	286	286	292	318	356
		deflection	L/290	L/207	L/303	L/231	L/194	L/264	L/213	L/185	L/201	L/239
	50	depth	184	184	235	235	241	286	286	302	318	356
		deflection	L/277	L/197	L/293	L/223	L/187	L/256	L/206	L/200	L/195	L/234

Notes:

1. The designer must ensure that the assumptions used to develop the tables are appropriate for the application. See Page 3 for stud table assumptions. For additional design information, contact Tembec at 1-800-463-0456.
2. Tembec recommends that both faces of the studs be covered by sheathing or cladding. At least one face of the stud should be sheathed with 9.5 mm or thicker waferboard, plywood or OSB and fastened to meet the requirements of the *National Building Code of Canada*. The other face may be sheathed with cladding, sheathing or drywall meeting the requirements of the *National Building Code of Canada*. The sheathing and fastening must meet the shearwall requirements for the application.
3. Maximum spacing of full depth blocking of 2.4 m is recommended. The blocking must meet the shearwall requirements for the application.
4. Stud tables for 2.0 E SelecTem™ are available at www.wood-works.org.
5. Imperial equivalents for the stud depths are:

depth mm	184	235	241	286	292	302	318	356	406
depth inches	7-1/4	9-1/4	9-1/2	11-1/4	11-1/2	11-7/8	12-1/2	14	16

Table 2.7 - Timberstrand® Studs - Trus Joist

Wind pressure $q_{1/30}$ 0.6 kPa; $q_{1/10}$ 0.5 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		**Timberstrand® 1.5E Grade Studs** Stud length 5.2 m (17 ft)	5.8 m (19 ft)	6.4 m (21 ft)	7.0 m (23 ft)	7.6 m (25 ft)	8.2 m (27 ft)	8.8 m (29 ft)	9.4 m (31 ft)	10.1 m (33 ft)	10.7 m (35 ft)
305	10	depth	184	184	235	235	286	286	286	337	337	337
		deflection	L/287	L/207	L/290	L/222	L/313	L/250	L/203	L/272	L/220	L/185
	20	depth	184	184	235	235	286	286	286	337	337	337
		deflection	L/278	L/201	L/284	L/217	L/307	L/245	L/199	L/268	L/216	L/182
	30	depth	184	184	235	235	286	286	286	337	337	N/A
		deflection	L/269	L/194	L/277	L/212	L/302	L/241	L/195	L/264	L/213	N/A
	40	depth	184	184	235	235	286	286	286	337	337	N/A
		deflection	L/261	L/188	L/271	L/207	L/296	L/236	L/191	L/259	L/209	N/A
	50	depth	184	184	235	235	286	286	286	337	337	N/A
		deflection	L/253	L/182	L/265	L/203	L/290	L/232	L/188	L/255	L/206	N/A
406	10	depth	184	235	235	286	286	286	337	337	N/A	N/A
		deflection	L/214	L/322	L/217	L/299	L/235	L/187	L/248	L/204	N/A	N/A
	20	depth	184	235	235	286	286	286	337	337	N/A	N/A
		deflection	L/207	L/313	L/211	L/293	L/230	L/183	L/243	L/200	N/A	N/A
	30	depth	184	235	235	286	286	337	337	337	N/A	N/A
		deflection	L/199	L/305	L/206	L/286	L/225	L/294	L/239	L/196	N/A	N/A
	40	depth	184	235	235	286	286	337	337	337	N/A	N/A
		deflection	L/192	L/296	L/200	L/280	L/220	L/289	L/235	L/193	N/A	N/A
	50	depth	184	235	235	286	286	337	337	337	N/A	N/A
		deflection	L/185	L/288	L/195	L/274	L/215	L/284	L/230	L/189	N/A	N/A
610	10	depth	235	235	286	286	337	337	N/A	N/A	N/A	N/A
		deflection	L/294	L/213	L/258	L/198	L/253	L/202	N/A	N/A	N/A	N/A
	20	depth	235	235	286	286	337	337	N/A	N/A	N/A	N/A
		deflection	L/284	L/206	L/251	L/193	L/248	L/198	N/A	N/A	N/A	N/A
	30	depth	235	235	286	286	337	337	N/A	N/A	N/A	N/A
		deflection	L/275	L/199	L/245	L/188	L/242	L/193	N/A	N/A	N/A	N/A
	40	depth	235	235	286	286	337	337	N/A	N/A	N/A	N/A
		deflection	L/265	L/192	L/238	L/183	L/237	L/189	N/A	N/A	N/A	N/A
	50	depth	235	235	286	337	337	337	N/A	N/A	N/A	N/A
		deflection	L/257	L/186	L/232	L/294	L/231	L/185	N/A	N/A	N/A	N/A

Notes:

1. **THIS TABLE IS FOR PRELIMINARY SIZING ONLY** and should not be used for designing or specifying final stud sizes. For project specific design, contact your Trus Joist representative at 1-800-661-6240.
2. The assumptions on page 3, along with the following assumptions were all used to develop this table.
3. Studs are assumed to have adequate support on each side to prevent buckling, (K_L=1). Trus Joist recommends full-width blocking installed at a maximum 2.4 m (8 ft) on-center vertically with wood structural panel wall sheathing fastened per the code to one edge and either wood structural panel wall sheathing or gypsum wallboard fastened per the code to the other edge.
4. Maximum moment for Load Case 1 is assumed to occur at the top of the stud, $M_f = P_f \times$ eccentricity.
5. Maximum moment for Load Cases 2 and 3 is assumed to occur at the mid height of the stud, $M_f = W_{f(wind)}L^2/8 + P_f \times 0.5 \times$ eccentricity.
6. A system factor = 1.04 was considered for moment only, based on Clause 13.4.4.4 of CSA O86.1S1-98 Supplement No. 1 to CSA O86.1-94.
7. Resistance values were calculated based on CSA O86.1S1-98 using the values from the CCMC Evaluation Report # 12627-R

For longer stud sizes, please contact your Trus Joist Representative at 1-800-661-6240 to discuss the possibilities.

Table 2.8 - Timberstrand® Studs - Trus Joist

Trus Joist A Weyerhaeuser Business

Wind pressure $q_{1/30}$ 0.5 kPa; $q_{1/10}$ 0.4 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		**Timberstrand® 1.5E Grade Studs** Stud length									
			5.2 m (17 ft)	5.8 m (19 ft)	6.4 m (21 ft)	7.0 m (23 ft)	7.6 m (25 ft)	8.2 m (27 ft)	8.8 m (29 ft)	9.4 m (31 ft)	10.1 m (33 ft)	10.7 m (35 ft)
305	10	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/357	L/258	L/362	L/277	L/217	L/312	L/253	L/208	L/274	L/231
	20	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/345	L/249	L/352	L/270	L/212	L/305	L/248	L/203	L/270	L/227
	30	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/333	L/241	L/343	L/263	L/206	L/299	L/242	L/199	L/265	L/223
	40	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/322	L/232	L/335	L/257	L/201	L/293	L/237	L/195	L/260	L/219
	50	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/311	L/224	L/326	L/250	L/195	L/287	L/232	L/190	L/255	L/215
406	10	depth	184	184	235	235	286	286	286	337	337	N/A
		deflection	L/267	L/193	L/271	L/207	L/293	L/234	L/189	L/254	L/206	N/A
	20	depth	184	184	235	235	286	286	286	337	337	N/A
		deflection	L/256	L/185	L/263	L/201	L/286	L/228	L/185	L/249	L/201	N/A
	30	depth	184	235	235	235	286	286	286	337	337	N/A
		deflection	L/246	L/376	L/255	L/195	L/279	L/222	L/180	L/244	L/197	N/A
	40	depth	184	235	235	235	286	286	337	337	337	N/A
		deflection	L/237	L/365	L/248	L/189	L/272	L/217	L/291	L/239	L/193	N/A
	50	depth	184	235	235	235	286	286	337	337	337	N/A
		deflection	L/227	L/354	L/240	L/184	L/265	L/212	L/285	L/234	L/189	N/A
610	10	depth	235	235	286	286	286	337	337	N/A	N/A	N/A
		deflection	L/366	L/265	L/321	L/247	L/194	L/252	L/205	N/A	N/A	N/A
	20	depth	235	235	286	286	286	337	337	N/A	N/A	N/A
		deflection	L/352	L/255	L/312	L/240	L/188	L/246	L/200	N/A	N/A	N/A
	30	depth	235	235	286	286	286	337	337	N/A	N/A	N/A
		deflection	L/338	L/246	L/303	L/233	L/182	L/240	L/195	N/A	N/A	N/A
	40	depth	235	235	286	286	337	337	337	N/A	N/A	N/A
		deflection	L/326	L/337	L/294	L/226	L/292	L/234	L/190	N/A	N/A	N/A
	50	depth	235	235	286	286	337	337	337	N/A	N/A	N/A
		deflection	L/314	L/228	L/285	L/219	L/285	L/228	L/185	N/A	N/A	N/A

Notes:

1. **THIS TABLE IS FOR PRELIMINARY SIZING ONLY** and should not be used for designing or specifying final stud sizes. For project specific design, contact your Trus Joist representative at 1-800-661-6240.
2. The assumptions on page 3, along with the following assumptions were all used to develop this table.
3. Studs are assumed to have adequate support on each side to prevent buckling, (K_L=1). Trus Joist recommends full-width blocking installed at a maximum 2.4 m (8 ft) on-center vertically with wood structural panel wall sheathing fastened per the code to one edge and either wood structural panel wall sheathing or gypsum wallboard fastened per the code to the other edge.
4. Maximum moment for Load Case 1 is assumed to occur at the top of the stud, $M_f = P_f \times$ eccentricity.
5. Maximum moment for Load Cases 2 and 3 is assumed to occur at the mid height of the stud, $M_f = W_{f(wind)}L^2/8 + P_f \times 0.5 \times$ eccentricity.
6. A system factor = 1.04 was considered for moment only, based on Clause 13.4.4.4 of CSA O86.1S1-98 Supplement No. 1 to CSA O86.1-94.
7. Resistance values were calculated based on CSA O86.1S1-98 using the values from the CCMC Evaluation Report # 12627-R

For longer stud sizes, please contact your Trus Joist Representative at 1-800-661-6240 to discuss the possibilities.

Table 2.9 - Timberstrand® Studs - Trus Joist

Wind pressure $q_{1/30}$ 0.4 kPa; $q_{1/10}$ 0.3 kPa

Depth required (mm) for 38 mm thick studs

Stud spacing mm	Factored axial load kN/m		Timberstrand® 1.5E Grade Studs Stud length 5.2 m (17 ft)	5.8 m (19 ft)	6.4 m (21 ft)	7.0 m (23 ft)	7.6 m (25 ft)	8.2 m (27 ft)	8.8 m (29 ft)	9.4 m (31 ft)	10.1 m (33 ft)	10.7 m (35 ft)
305	10	depth	N/A	184	184	235	235	235	235	286	286	286
		deflection	N/A	L/342	L/230	L/368	L/288	L/230	L/186	L/276	L/223	L/188
	20	depth	N/A	184	184	235	235	235	235	286	286	286
		deflection	N/A	L/329	L/221	L/357	L/280	L/223	L/180	L/270	L/218	L/183
	30	depth	N/A	184	184	235	235	235	286	286	286	337
		deflection	N/A	L/316	L/213	L/347	L/272	L/216	L/320	L/263	L/212	L/295
	40	depth	184	184	184	235	235	235	286	286	286	337
		deflection	L/419	L/304	L/205	L/337	L/264	L/210	L/313	L/257	L/207	L/289
	50	depth	184	184	184	235	235	235	286	286	286	337
		deflection	L/402	L/292	L/197	L/327	L/256	L/203	L/305	L/251	L/202	L/283
406	10	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/353	L/256	L/359	L/275	L/216	L/310	L/252	L/207	L/273	L/230
	20	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/337	L/244	L/347	L/266	L/208	L/302	L/245	L/201	L/267	L/225
	30	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/322	L/233	L/335	L/257	L/201	L/293	L/238	L/195	L/261	L/219
	40	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/308	L/222	L/324	L/248	L/194	L/285	L/231	L/189	L/254	L/214
	50	depth	184	184	235	235	235	286	286	286	337	337
		deflection	L/294	L/212	L/313	L/240	L/187	L/277	L/225	L/184	L/248	L/209
610	10	depth	184	235	235	235	286	286	337	337	337	N/A
		deflection	L/233	L/352	L/237	L/182	L/257	L/205	L/272	L/224	L/181	N/A
	20	depth	184	235	235	286	286	286	337	337	N/A	N/A
		deflection	L/220	L/336	L/227	L/316	L/248	L/198	L/264	L/217	N/A	N/A
	30	depth	184	235	235	286	286	286	337	337	N/A	N/A
		deflection	L/208	L/322	L/218	L/306	L/240	L/191	L/257	L/211	N/A	N/A
	40	depth	184	235	235	286	286	286	337	337	N/A	N/A
		deflection	L/196	L/308	L/209	L/295	L/232	L/185	L/249	L/205	N/A	N/A
	50	depth	235	235	235	286	286	337	337	337	N/A	N/A
		deflection	L/403	L/295	L/200	L/286	L/224	L/298	L/242	L/199	N/A	N/A

Notes:

1. **THIS TABLE IS FOR PRELIMINARY SIZING ONLY** and should not be used for designing or specifying final stud sizes. For project specific design, contact your Trus Joist representative at 1-800-661-6240.
2. The assumptions on page 3, along with the following assumptions were all used to develop this table.
3. Studs are assumed to have adequate support on each side to prevent buckling, (K_L=1). Trus Joist recommends full-width blocking installed at a maximum 2.4 m (8 ft) on-center vertically with wood structural panel wall sheathing fastened per the code to one edge and either wood structural panel wall sheathing or gypsum wallboard fastened per the code to the other edge.
4. Maximum moment for Load Case 1 is assumed to occur at the top of the stud, $M_f = P_f \times$ eccentricity.
5. Maximum moment for Load Cases 2 and 3 is assumed to occur at the mid height of the stud, $M_f = W_{f(wind)}L^2/8 + P_f \times 0.5 \times$ eccentricity.
6. A system factor = 1.04 was considered for moment only, based on Clause 13.4.4.4 of CSA O86.1S1-98 Supplement No. 1 to CSA O86.1-94.
7. Resistance values were calculated based on CSA O86.1S1-98 using the values from the CCMC Evaluation Report # 12627-R

For longer stud sizes, please contact your Trus Joist Representative at 1-800-661-6240 to discuss the possibilities.

Table 2.10 - Westlam® Structural Lumber (WSL) Wall Studs

WESTERN ARCHRIB BEAMS TRUSSES ARCHRIBS A DIVISION OF 316291 ALBERTA LTD

Wind pressure $q_{1/30}$ 0.6 kPa; $q_{1/10}$ 0.5 kPa

Depth required (mm) for 40 mm thick studs

Stud spacing mm	Factored axial load kN/m		Westlam® Structural Lumber (WSL) Stud length 5.18 m (17 ft)	5.79 m (19 ft)	6.40 m (21 ft)	7.01 m (23 ft)	7.62 m (25 ft)	8.23 m (27 ft)	8.84 m (29 ft)	9.45 m (31 ft)	10.06 m (33 ft)	10.67 m (35 ft)
305	10	depth	190	190	241	241	241	292	292	292	356	356
		deflection	L/340	L/244	L/334	L/254	L/198	L/281	L/227	L/185	L/280	L/234
	20	depth	190	190	241	241	241	292	292	292	356	356
		deflection	L/330	L/236	L/327	L/249	L/193	L/275	L/222	L/182	L/275	L/231
	30	depth	190	190	241	241	241	292	292	301	356	356
		deflection	L/320	L/229	L/319	L/243	L/189	L/270	L/218	L/196	L/271	L/227
	40	depth	190	190	241	241	241	292	292	301	356	356
		deflection	L/311	L/222	L/312	L/237	L/184	L/265	L/214	L/192	L/267	L/224
	50	depth	190	190	241	241	292	292	292	301	356	356
		deflection	L/301	L/215	L/305	L/232	L/328	L/260	L/210	L/188	L/263	L/220
406	10	depth	190	190	241	241	292	292	301	356	356	N/A
		deflection	L/254	L/182	L/250	L/190	L/265	L/210	L/186	L/253	L/210	N/A
	20	depth	190	241	241	241	292	292	301	356	356	N/A
		deflection	L/246	L/364	L/244	L/185	L/259	L/206	L/182	L/248	L/206	N/A
	30	depth	190	241	241	241	292	292	356	356	356	N/A
		deflection	L/237	L/354	L/237	L/180	L/254	L/201	L/298	L/244	L/202	N/A
	40	depth	190	241	241	292	292	292	356	356	356	N/A
		deflection	L/229	L/344	L/231	L/319	L/248	L/197	L/293	L/240	L/198	N/A
	50	depth	190	241	241	292	292	292	356	356	356	N/A
		deflection	L/221	L/335	L/225	L/312	L/243	L/192	L/288	L/235	L/195	N/A
610	10	depth	241	241	292	292	301	356	356	N/A	N/A	N/A
		deflection	L/346	L/248	L/296	L/225	L/192	L/254	L/205	N/A	N/A	N/A
	20	depth	241	241	292	292	301	356	356	N/A	N/A	N/A
		deflection	L/334	L/240	L/288	L/219	L/187	L/248	L/200	N/A	N/A	N/A
	30	depth	241	241	292	292	301	356	356	N/A	N/A	N/A
		deflection	L/323	L/232	L/281	L/214	L/182	L/243	L/196	N/A	N/A	N/A
	40	depth	241	241	292	292	356	356	356	N/A	N/A	N/A
		deflection	L/312	L/224	L/273	L/208	L/299	L/238	L/192	N/A	N/A	N/A
	50	depth	241	241	292	292	356	356	356	N/A	N/A	N/A
		deflection	L/302	L/216	L/266	L/203	L/293	L/232	L/187	N/A	N/A	N/A

Notes:

1. Sizes shown in the table are based on Dry Service conditions.
2. The designer must ensure that the design assumptions used to develop the table are appropriate for the application. See Page 3 for stud table design assumptions.
3. Both faces of the stud must be laterally supported by sheathing. At least one face of the stud must be sheathed with plywood, waferboard, or OSB of minimum 9.5 mm thickness, and fastened to meet the requirements of the *National Building Code of Canada* and the shear wall requirements for the application. The other face must be sheathed with either structural sheathing or drywall meeting the requirements of the *National Building Code of Canada*.
4. Maximum spacing of full depth blocking is 2.4 m. The blocking must meet the shearwall requirements for the application.
5. Stud tables for additional lengths and spacings are available at www.wood-works.org. For additional design information, contact Western Archrib at 1-780-465-9771.

Table 2.11 - Westlam® Structural Lumber (WSL) Wall Studs

Wind pressure $q_{1/30}$ 0.5 kPa; $q_{1/10}$ 0.4 kPa

Depth required (mm) for 40 mm thick studs

Stud spacing mm	Factored axial load kN/m		Westlam® Structural Lumber (WSL) Stud length									
			5.18 m (17 ft)	5.79 m (19 ft)	6.40 m (21 ft)	7.01 m (23 ft)	7.62 m (25 ft)	8.23 m (27 ft)	8.84 m (29 ft)	9.45 m (31 ft)	10.06 m (33 ft)	10.67 m (35 ft)
305	10	depth	190	190	190	241	241	241	292	292	292	356
		deflection	L/423	L/304	L/202	L/317	L/247	L/196	L/283	L/231	L/192	L/292
	20	depth	190	190	190	241	241	241	292	292	292	356
		deflection	L/409	L/294	L/196	L/309	L/241	L/191	L/277	L/226	L/187	L/287
	30	depth	190	190	190	241	241	241	292	292	292	356
		deflection	L/395	L/284	L/189	L/301	L/234	L/186	L/271	L/222	L/183	L/283
	40	depth	190	190	190	241	241	241	292	292	301	356
		deflection	L/382	L/274	L/183	L/294	L/228	L/181	L/265	L/217	L/197	L/278
	50	depth	190	190	241	241	24l	292	292	292	301	356
		deflection	L/369	L/265	L/376	L/287	L/223	L/322	L/260	L/212	L/193	L/273
406	10	depth	190	190	241	241	241	292	292	301	356	356
		deflection	L/317	L/227	L/312	L/237	L/185	L/262	L/212	L/190	L/261	L/219
	20	depth	190	190	241	241	292	292	292	301	356	356
		deflection	L/305	L/218	L/303	L/230	L/322	L/256	L/206	L/185	L/256	L/215
	30	depth	190	190	241	241	292	292	292	301	356	356
		deflection	L/293	L/209	L/294	L/224	L/315	L/250	L/201	L/181	L/251	L/210
	40	depth	190	190	241	241	292	292	292	356	356	356
		deflection	L/282	L/201	L/285	L/217	L/307	L/244	L/196	L/297	L/246	L/206
	50	depth	190	190	241	241	292	292	292	356	356	356
		deflection	L/271	L/193	L/277	L/211	L/300	L/238	L/191	L/291	L/241	L/202
610	10	depth	190	241	241	292	292	301	356	356	N/A	N/A
		deflection	L/209	L/309	L/206	L/281	L/219	L/190	L/255	L/209	N/A	N/A
	20	depth	190	241	241	292	292	301	356	356	N/A	N/A
		deflection	L/199	L/297	L/199	L/273	L/212	L/185	L/249	L/204	N/A	N/A
	30	depth	190	241	241	292	292	356	356	356	N/A	N/A
		deflection	L/189	L/286	L/191	L/265	L/206	L/301	L/243	L/199	N/A	N/A
	40	depth	241	241	241	292	292	356	356	356	N/A	N/A
		deflection	L/382	L/275	L/185	L/257	L/200	L/294	L/237	L/194	N/A	N/A
	50	depth	241	241	292	292	292	356	356	356	N/A	N/A
		deflection	L/368	L/265	L/327	L/249	L/194	L/287	L/232	L/189	N/A	N/A

Notes:

1. Sizes shown in the table are based on Dry Service conditions.
2. The designer must ensure that the design assumptions used to develop the table are appropriate for the application. See Page 3 for stud table design assumptions.
3. Both faces of the stud must be laterally supported by sheathing. At least one face of the stud must be sheathed with plywood, waferboard, or OSB of minimum 9.5 mm thickness, and fastened to meet the requirements of the *National Building Code of Canada* and the shear wall requirements for the application. The other face must be sheathed with either structural sheathing or drywall meeting the requirements of the *National Building Code of Canada*.
4. Maximum spacing of full depth blocking is 2.4 m. The blocking must meet the shearwall requirements for the application.
5. Stud tables for additional lengths and spacings are available at www.wood-works.org. For additional design information, contact Western Archrib at 1-780-465-9771.

Table 2.12 - Westlam® Structural Lumber (WSL) Wall Studs

Wind pressure $q_{1/30}$ 0.4 kPa; $q_{1/10}$ 0.3 kPa

Depth required (mm) for 40 mm thick studs

Stud spacing mm	Factored axial load kN/m		Westlam® Structural Lumber (WSL) Stud length									
			5.18 m (17 ft)	5.79 m (19 ft)	6.40 m (21 ft)	7.01 m (23 ft)	7.62 m (25 ft)	8.23 m (27 ft)	8.84 m (29 ft)	9.45 m (31 ft)	10.06 m (33 ft)	10.67 m (35 ft)
305	10	depth	190	190	190	190	241	241	241	292	292	292
		deflection	L/561	L/403	L/269	L/204	L/328	L/260	L/210	L/307	L/255	L/213
	20	depth	190	190	190	190	241	241	241	292	292	292
		deflection	L/538	L/387	L/259	L/196	L/318	L/253	L/203	L/300	L/249	L/208
	30	depth	190	190	190	190	241	241	241	292	292	292
		deflection	L/517	L/372	L/249	L/189	L/309	L/245	L/197	L/293	L/243	L/203
	40	depth	190	190	190	190	241	241	241	292	292	292
		deflection	L/497	L/358	L/240	L/181	L/300	L/238	L/191	L/286	L/237	L/198
	50	depth	190	190	190	241	241	241	241	292	292	292
		deflection	L/477	L/344	L/231	L/374	L/292	L/231	L/185	L/279	L/231	L/193
406	10	depth	190	190	190	241	241	241	292	292	292	356
		deflection	L/419	L/301	L/201	L/315	L/245	L/194	L/281	L/230	L/191	L/291
	20	depth	190	190	190	241	241	241	292	292	292	356
		deflection	L/401	L/287	L/192	L/304	L/237	L/188	L/273	L/224	L/185	L/285
	30	depth	190	190	190	241	241	241	292	292	301	356
		deflection	L/383	L/275	L/183	L/294	L/229	L/181	L/266	L/217	L/198	L/278
	40	depth	190	190	241	241	241	292	292	292	301	356
		deflection	L/366	L/262	L/373	L/285	L/221	L/320	L/258	L/211	L/192	L/272
	50	depth	190	190	241	241	241	292	292	292	301	356
		deflection	L/350	L/251	L/361	L/275	L213	L/311	L/251	L/205	L/186	L/266
610	10	depth	190	190	241	241	292	292	292	356	356	356
		deflection	L/277	L/198	L/273	L/208	L/290	L/230	L/186	L/278	L/230	L/193
	20	depth	190	190	241	241	292	292	301	356	356	356
		deflection	L/262	L/187	L/262	L/199	L/280	L/222	L/197	L/270	L/224	L/187
	30	depth	190	241	241	241	292	292	301	356	356	356
		deflection	L/247	L/374	L/251	L/191	L/271	L/215	L/190	L/262	L/217	L/182
	40	depth	190	241	241	241	292	292	301	356	356	N/A
		deflection	L/234	L/358	L/241	L/183	L/262	L/207	L/184	L/255	L/211	N/A
	50	depth	190	241	241	292	292	292	356	356	356	N/A
		deflection	L/221	L/343	L/231	L/325	L/253	L/200	L/303	L/248	L/205	N/A

Notes:

1. Sizes shown in the table are based on Dry Service conditions.
2. The designer must ensure that the design assumptions used to develop the table are appropriate for the application. See Page 3 for stud table design assumptions.
3. Both faces of the stud must be laterally supported by sheathing. At least one face of the stud must be sheathed with plywood, waferboard, or OSB of minimum 9.5 mm thickness, and fastened to meet the requirements of the *National Building Code of Canada* and the shear wall requirements for the application. The other face must be sheathed with either structural sheathing or drywall meeting the requirements of the *National Building Code of Canada*.
4. Maximum spacing of full depth blocking is 2.4 m. The blocking must meet the shearwall requirements for the application.
5. Stud tables for additional lengths and spacings are available at www.wood-works.org. For additional design information, contact Western Archrib at 1-780-465-9771.

3. Example

There are many aspects of wall construction that must be considered in a Tall Wall design. As a minimum, the following must be accounted for:

- Design of the studs
- Design of the stud connections
- Shearwall design including; overturning/hold-down design, shear panel design, shearwall chord design, base plate anchorage and drag strut design
- Design of the members around wall openings including; lintel design; jack post stud design, king post stud design and the design of the connections.
- Non-structural aspects of wall design including fire and thermal resistance.

This design example is based on the Crestbrook Value Added Centre built in 1999/2000. The example uses design assumptions outlined in the *National Building Code of Canada*, *CSA O86.1-94 Engineering Design in Wood (Limit States Design)* and Tembec's proprietary design information for Selectem™ 2.0E laminated veneer lumber.

Details in the design example are not necessarily the same as the final details used in the building construction. The details shown here have been adapted for more general building assumptions.

3.1 Overview of Building

Crestbrook Forest Industries is a lumber manufacturing facility in Cranbrook British Columbia. Additional space was required for their lumber remanufacturing and finger-joining operations. The facilities required large open areas without columns. As well, the North wall could not be load-bearing so that future plant expansion could be accommodated. Originally, a steel structure was specified but Tembec Forest Products, Crestbrook's parent company had recently adopted a policy which required wood to be considered for all their construction and used where cost effective. Analysis indicated a wood building could be constructed for the same cost as the pre-engineered steel building originally specified.

The building is a 2100 m^2 (22,300 ft^2) one storey wood frame with a concrete slab on grade floor and foundation. Figure 3.1 gives an overview of the building.

Figure 3.1
Isometric diagram of new building

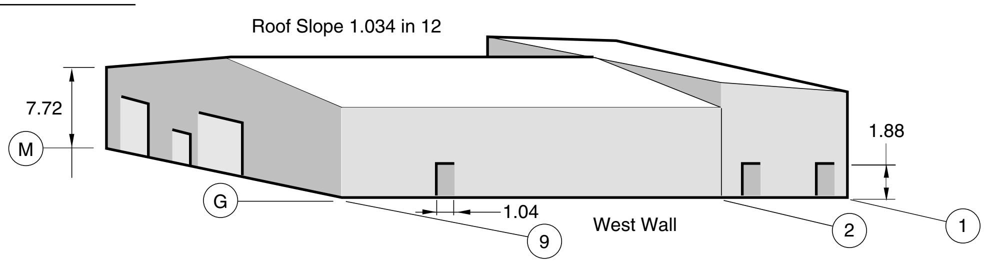
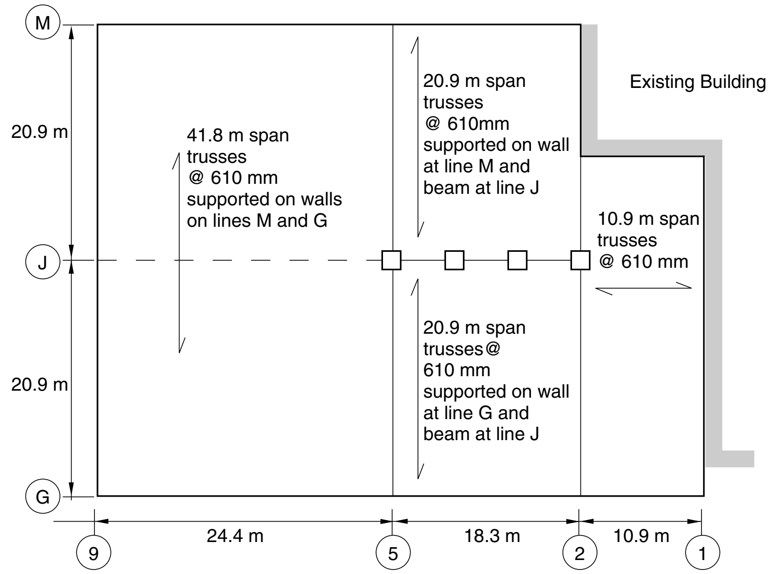


Figure 3.2
Roof framing plan



A roof framing plan is illustrated in Figure 3.2. The west wall, "Wall G" will be used for this example. The wall is 7.72 m (25 ft 4 in) tall and at the north end supports trusses spanning 41.8 m (137 ft).

Cranbrook has the following design data:

- Specified ground snow load, S_s, 2.7 kPa
- Associated rain load, S_r, 0.2 kPa
- 1/30 hourly wind pressure, $q_{1/30}$, 0.29 kPa
- 1/10 hourly wind pressure, $q_{1/10}$, 0.22 kPa
- Seismic design loads are minimal and did not affect the design of this structure.

3.2 Stud Design

Studs used in this project were 44 x 235 mm (1-3/4 x 9-1/4 in) SelecTem™ 2.0E studs manufactured by Tembec. Studs were spaced at 610 mm o/c and blocked at 1220 mm. Figure 3.3 shows a typical wall section. The stud length is the height of the wall minus the thickness of the top and bottom plates – 7.59 m. This stud design example will be for studs supporting the 41.8 m span trusses.

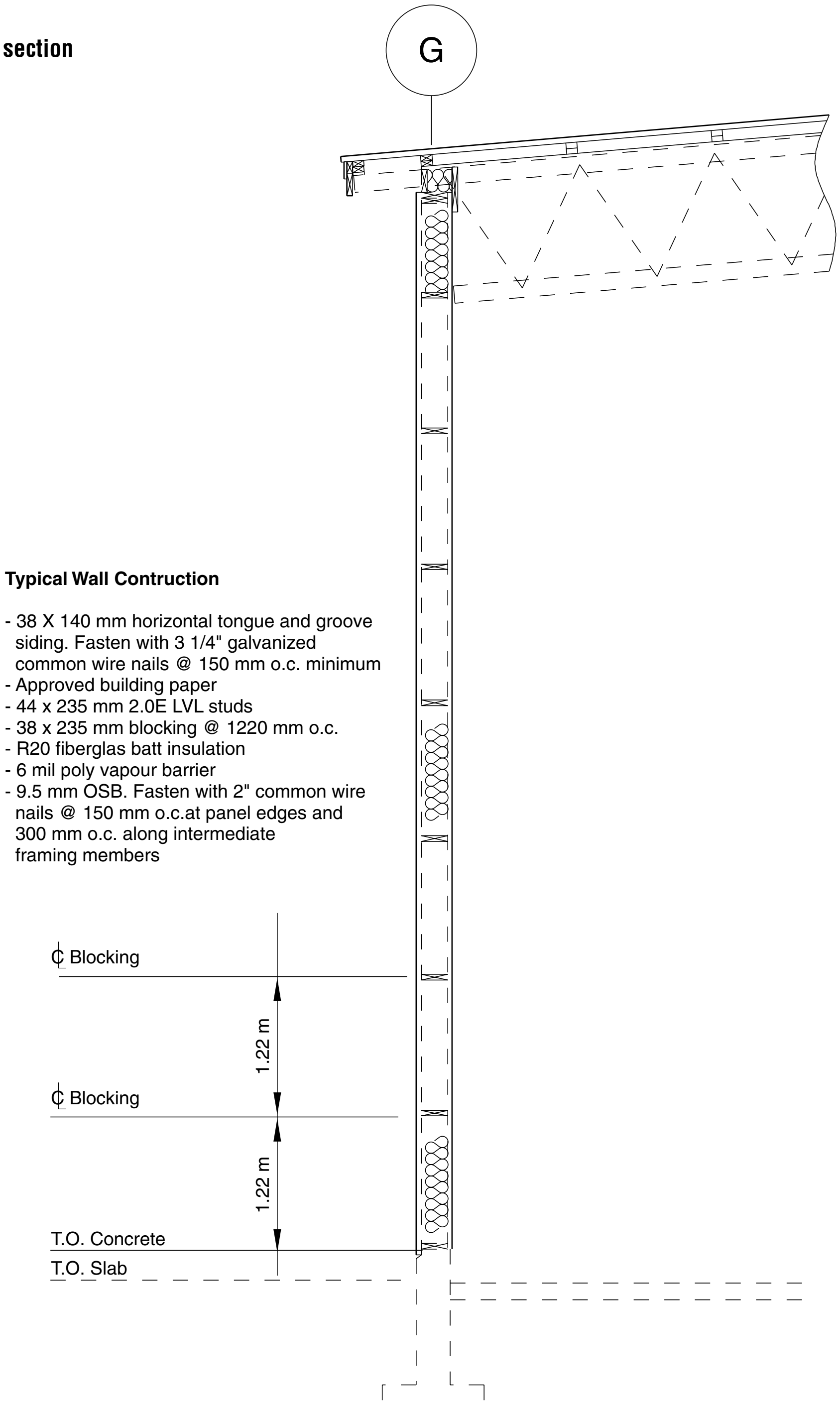
Load information

Stud axial loads

Roof dead load

Specified roof dead load	= 0.718 kPa
Roof load tributary width	= truss span/2 = 20.9 m
Specified roof dead load on wall	= 0.718 x 20.9 = 15.0 kN/m
Factored roof dead load on wall	= 1.25 x 15.0 = 18.8 kN/m

Figure 3.3
Typical wall section



Wall dead load

Specified wall dead load = 0.40 kPa

The critical section for combined bending and axial loads on a stud is generally the mid-height of the stud. Therefore, consider half of the wall dead weight in the stud design.

Tributary height of wall dead load = 7.72/2 = 3.86 m

Specified wall dead load = 0.40 x 3.86
= 1.54 kN/m

Factored wall dead load = 1.25 x 1.54
= 1.93 kN/m

Roof snow load, S

$$S = S_s(C_b C_w C_s C_a) + S_r$$ NBCC 4.1.7.1 (1)

Ground snow load S_s = 2.7 kPa NBCC Appendix C

Associated rain load S_r = 0.2 kPa NBCC Appendix C

Basic roof snow factor C_b = 0.8 NBCC 4.1.7.1 (1)

All other factors C_w, C_s, C_a = 1.0

S = 2.7 x (0.8 x 1 x 1 x 1) + 0.2
= 2.36 kPa

Specified snow load on wall = 2.36 x 20.9
= 49.3 kN/m

Factored snow load on wall = 1.5 x 49.3
= 74.0 kN/m

Table 3.1
Summary of axial loads

	Specified Load	Factored Load
Wall + Roof Dead Load	16.5 kN/m	20.7 kN/m
Snow Load	49.3 kN/m	74.0 kN/m
Total Load	65.8 kN/m	94.7 kN/m
Stud Dead Load	10.1 kN	12.6 kN
Stud Snow Load	30.1 kN	45.1 kN
Total Stud Load	40.2 kN	57.7 kN

Stud wind loads

$$p = qC_eC_gC_p \pm qC_eC_{gi}C_{pi}$$ NBCC 4.1.8

Wind load for strength	$q_{1/30}$ = 0.29 kPa	NBCC Appendix C
Wind load for deflection	$q_{1/10}$ = 0.22 kPa	NBCC Appendix C
Exposure factor	C_e = 1.0	NBCC 4.1.8.1
External pressure coefficient and gust factor	C_pC_g = -2.0	NBCC Figure B8
Internal gust factor	C_{gi} = 1.0	NBCC Commentary B
Internal pressure coefficient	C_{pi} = ± 0.7	NBCC Commentary B

Table 3.2
Summary of wind loads

	Specified Load	Factored Load
Strength area load	0.783 kPa	1.17 kPa
Deflection area load	0.594 kPa	N/A
Strength stud load	0.478 kN/m	0.717 kN/m
Deflection stud load	0.362 kN/m	N/A

Stud resistance

Product design information for SelecTem™ 2.0E – Available from Tembec

Specified bending strength	f_b = 42.7 MPa
Specified shear strength	f_v = 3.65 MPa
Specified compression parallel to grain strength	f_c = 29.7 MPa
Specified compression perpendicular to grain strength	f_{cp} = 6.21 MPa
Specified tension strength	f_t = 29.0 MPa
Size factor for tension	K_{zt} = 1
Mean Modulus of Elasticity	E_{50} = 13800 MPa
5th percentile Modulus of Elasticity ($0.87E_{50}$)	E_{05} = 12000 MPa
Size factor in bending	K_{zb} = (305/d)0.15 = 1.04

Modification factors

Bending resistance factor	$\phi = 0.9$	CSA 086.1	Supplement, 13.4.5
Shear resistance factor	$\phi = 0.9$	CSA 086.1	Supplement, 13.4.5
Compression parallel to grain resistance factor	$\phi = 0.8$	CSA 086.1	Supplement, 13.4.5
Compression perpendicular to grain resistance factor	$\phi = 0.8$	CSA 086.1	Supplement, 13.4.5
Tension resistance factor	$\phi = 0.9$	CSA 086.1	Supplement, 13.4.5
Load duration factor:			
Load combinations with wind	$K_D = 1.15$	CSA 086.1	Supplement, 13.4.4
All other load combinations	$K_D = 1.00$		
System factor for bending	$K_H = 1.05$	CSA 086.1	Supplement, 13.4.4
Length of bearing factor	$K_B = 1.19$	CSA 086.1	5.5.7
Size factor for bearing	$K_{Zcp} = 1.15$	CSA 086.1	5.5.7

Resistance of 44 x 235 mm stud of length 7.62 m CSA 086.1 Supplement, 13.4.5

With wind loads:

$$\mathbf{M_r = \phi F_b S K_{zb} K_L}$$
$$= 19.5 \text{ kN}\bullet\text{m}$$

$$\mathbf{V_r = \phi F_v \, {}^2/_3 A}$$
$$= 26.0 \text{ kN}$$

$$\mathbf{P_r = \phi F_c A K_{Zc} K_c}$$
$$= 75.4 \text{ kN}$$

$$\mathbf{T_r = \phi F_t A_n K_{Zt}}$$
$$= 290 \text{ kN (for a member with a 1/2 in dia. bolt)}$$

Without wind loads:

$$\mathbf{M_r = \phi F_b S K_{zb} K_L}$$
$$= 17.0 \text{ kN}\bullet\text{m}$$

$$\mathbf{P_r = \phi F_c A K_{Zc} K_c}$$
$$= 72.5 \text{ kN}$$

$$\mathbf{Q'_r = ({}^2/_3)\, \phi F_{cp} A'_b K_B K_{Zcp}}$$
$$= 59.8 \text{ kN}$$

Note: At the top plate, a 16000 mm^2 steel bearing plate is provided at the truss support.

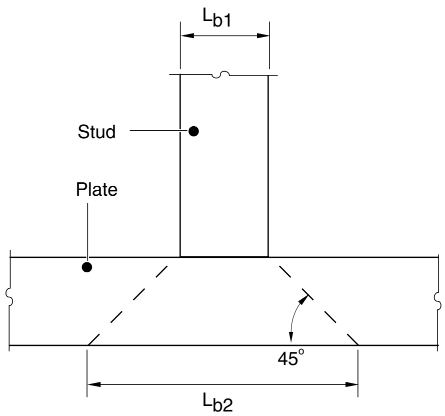
$$A'_b = \frac{\left(16000 + 44 \times 235\right)}{2} \quad \text{but} \leq 1.5 \times 44 \times 235$$
$$= 13200 \text{ mm}^2$$

At the bottom plate, axial load from the stud is assumed to be distributed through the sill plate at a 45° angle as shown in Figure 3.4.

$$A'_b = b\left[\frac{L_{b1} + L_{b2}}{2}\right], \text{ but } \leq 1.5\ L_{b1}$$

$= 15500\ mm^2 > 13200$ Therefore, bearing of the top plate will govern

Figure 3.4
Bearing of stud on sill plate



Load Case 1 – axial loads alone (1.25 D +1.5 L)

$P_f = 57.7$ kN   per stud

Combined Loading:

Axial load may not be applied concentrically and is conservatively assumed to be applied at 1/6th the depth of the stud from the centre of the stud creating a moment as shown in Figure 3.5

The design should consider the more critical of:

- the unamplified moment at the top of the stud, and
- the amplified moment at the middle of the stud

(In the stud tables, the conservative case of amplified moment at the top of the stud was considered)

In this design example, the critical case is the amplified moment at the middle of the stud.

$$M'_f = \frac{1}{2} P_f \times \frac{d}{6}$$

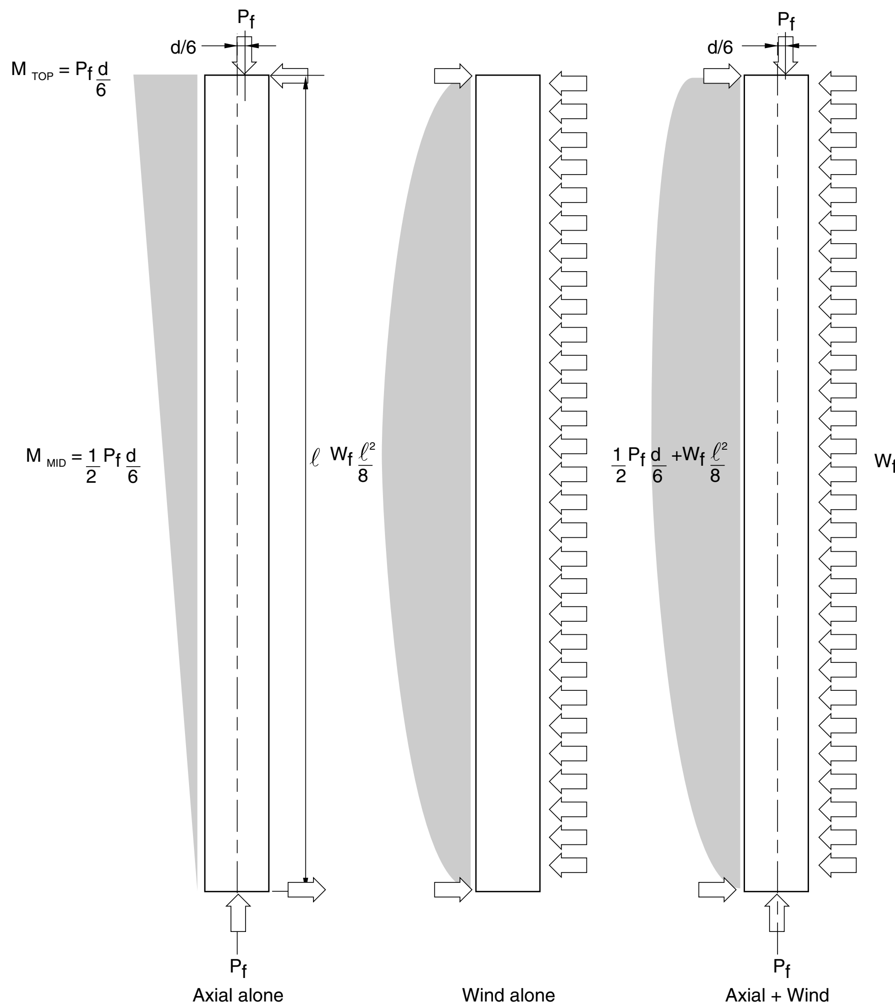
$= 1.13$ kN•m   per stud

The following formula is used for the amplified moment due to eccentric load

$$\frac{P_f}{P_r} + \frac{M_f}{M_r} \leq 1.0$$

$$M_f = M'_f \left[\frac{1}{1 - \frac{P_f}{P_E}}\right]$$

Figure 3.5
Eccentric load, lateral load and moments on the stud



$$\mathbf{P_E = \frac{\pi^2 E_s I}{(K_e \ell)^2}}$$

= 112 kN per stud

E_sI = 657 x 10^9 N•mm²

M_f = 2.33 kN•m per stud

$$\mathbf{\frac{P_f}{P_r} + \frac{M_f}{M_r} \leq 1.0}$$

= 0.93 ≤ 1.0 (Acceptable)

Bearing on top and bottom plates

Q_f = 57.7 kN < 59.8 kN (Acceptable)

Load Case 2 - axial dead load plus wind load (1.25 D + 1.5 W)

Factored wind load (w_f) 0.717 kN/m per stud

Factored axial load (P_f) 12.6 kN per stud

Maximum moment (M'_f) at centre of stud

$$M'_f = \frac{w_f \ell^2}{8} + \frac{1}{2} P_f \times \frac{d}{6}$$

$= 5.41$ kN•m per stud

$M_f = 6.10$ kN•m per stud

Combined loading:

$$\frac{P_f}{P_r} + \frac{M_f}{M_r} \le 1.0$$

$= 0.48 \le 1.0$ (Acceptable)

Shear:

$$V = w_f \times \frac{\ell}{2}$$

$= 2.72$ kN ≤ 26.0 kN (Acceptable)

Deflection:

Wall finishes, in this case OSB and lumber siding, are not brittle or subject to cracking. Acceptable total load deflection criteria is span/180 = 42 mm. Deflection is calculated at mid-span of the studs. In this Tall Wall example and the stud tables in Section 2, the deflections incorporate the deflections caused by the offset axial loads. The deflections from the wind loads and axial loads are amplified to account for the PΔ effect. These are conservative assumptions for determining stud deflection.

Specified wind load (w_s) = 0.362 kN/m per stud

Specified axial dead load (P_s) = 10.1 kN per stud

Δ_T = **deflection from wind + deflection from eccentric load**

$$= \frac{5 w_s \ell^4}{384 EI} + \frac{P_s e \ell^2}{16 EI}$$

$= 26.0$ mm

Δ_A = **amplified deflection to account for PΔ effect**

$$= \Delta_T \left[\frac{1}{1 - \frac{P_s}{P_E}} \right]$$

$= 28.6$ mm $<$ 42 mm (Acceptable)

Load Case 3 - axial dead load + 0.7 axial live load + 0.7 wind load [1.25 D + 0.7 (1.5 L + 1.5 W)]

A load combination factor of 0.7 is used for combined wind load and snow load. NBCC 4.1.3.2

Factored wind load (w_f) 0.7 x 0.717 = 0.502 kN/m per stud

Factored axial load (P_f) 12.6 kN + 0.7 x 45.1 kN = 44.2 kN per stud

Maximum moment (M'_f) at centre of stud

$$M'_f = \frac{w_f \ell^2}{8} + \frac{1}{2} P_f \times \frac{d}{6}$$

= 4.48 kN•m per stud

M_f = 7.40 kN•m per stud

Combined loading:

$$\frac{P_f}{P_r} + \frac{M_f}{M_r} \leq 1.0$$

= 0.97 ≤ 1.0 (Acceptable)

Deflection:

Specified wind load (w_s) = 0.7 x 0.362 = 0.253 kN/m per stud

Specified axial dead load (P_s) = 10.1 + 0.7 x 30.1 = 31.2 kN per stud

Δ_T = **deflection from wind + deflection from eccentric load**

$$= \frac{5 w_s \ell^4}{384 EI} + \frac{P_s e \ell^2}{16 EI}$$

= 23.3 mm

Δ_A = **amplified deflection to account for P∆ effect**

$$= \Delta_T \left[\frac{1}{1 - \frac{P_s}{P_E}} \right]$$

= 32.4 mm < 42 mm (Acceptable)

Results:
Use 44 x 235 mm (1-3/4 x 9-1/4 in) SelecTem™ 2.0E spaced at 610 mm.

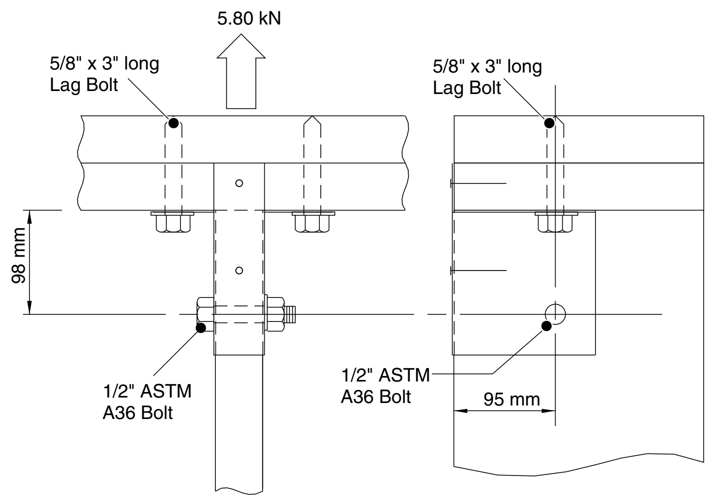
Other considerations:

1) Ensure that walls are laterally braced to prevent buckling about the narrow stud axis. The tongue and groove siding on the wall exterior, the OSB sheathing on the wall interior and the full depth blocking at 1.2 m will provide adequate bracing. For additional information on lateral bracing contact the stud manufacturer.
2) For wall segments used as shearwalls ensure all edges of sheathing are blocked. Blocking at 1.2 m intervals will provide edge support for all shearwall panels.

3.3 Stud Connection Design

Stud to wall plate connections must be designed to resist the uplift force on the stud and the wind loads resulting from the wind pressures/suctions on the face of the wall. For this project, special stud anchors were designed for the stud to plate connections. The top plate anchor is shown in Figure 3.6. SelecTem™ 2.0E studs have the same specific gravity as Hem-Fir and Tembec recommends using Hem-Fir connection design values for this product.

Figure 3.6
Stud to top plate connection



Load information

Factored uplift load at the eave (wind load – 0.85 roof dead load)

Critical wind uplift will be at the corner of the building NBCC Figure B7

y = end zone width
= 6.18 m

End Zone

C_pC_g = -2.0 windward side of roof
= -1.0 leeward side of roof

C_{pi} = 0.7

C_e = 1.0

Wind uplift at eave

= 22.3 kN/m

Factored dead load at eave

= 15.0 kN/m x 0.85
= 12.8 kN/m

Net uplift at eave

= 9.5 kN/m

Uplift load/stud

= 9.5 x 0.61
= 5.80 kN

Wind pressures on stud

= stud shear load (pg 31)
= 2.72 kN

Uplift resistance

Top plate connected to stud anchor with lag screws

Two 5/8 in dia. x 3 in long lag screws

$$\mathbf{P_{rw} = P'_{rw}L_t n_F K'J_E}$$ WDM pg 262

Length of threaded portion, L_t, in top plate WDM pg 262

L_t = L/2 + 12.7 - tip
= 50.8 - 9.5
= 41.3 mm

n_F = 2

K_D = 1.15 = K'

P'_{rw} = 78 N/mm WDM pg 262

P_{rw} = 7.41 kN > 5.80 kN (Acceptable)

Stud anchor connected to stud with single bolt loaded in double shear parallel to the grain

One 1/2 in dia. bolt

$$\mathbf{P_r = P'_r n_s n_F K'J'}$$ WDM pg 250

Member end distance = 98 mm = 7.71 bolt diameters

J_L = 1.0 @ 10 dia. WDM pg 239
= 0.75 @ 7 dia.
= 0.81 @ 7.71 dia.
= J'

K_D = 1.15 = K'

For 38 mm thick member, double shear, steel side plate

P'_r = 3.42 kN WDM pg 252

P_r = 6.37 kN > 5.80 kN (Acceptable)

Resistance to wind pressures/suctions on the wall

Top plate connected to stud anchor with lag screws loaded perpendicular to the grain

Two 5/8 in dia. x 3 in long lag screws

Length of penetration, L_p, in top plate

L_p = length of lag screw - thickness of washer and steel in anchor - tip
= 76 - 9 - 9.5
= 57.5 mm

Standard length of penetration = 159 mm WDM pg 262

Strength reduction for reduced penetration
= 57.5/159
= 0.36

n_{Fe} = 2

n_R = 1

K_D = 1.15 = K'

Q'_r = 5.61 kN WDM pg 264

Q_r = $Q'_r n_{Fe} n_R K'$ x 0.36
= 4.65 kN > 2.72 kN (Acceptable)

Stud anchor connected to stud with single bolt loaded in double shear loaded perpendicular to the grain

One 1/2 in dia. bolt

Member edge distance = 95 mm = 7.5 dia. > 4 dia. (Acceptable)

$\mathbf{Q_r = Q'_r n_s n_F K' J_R}$ WDM pg 250

$n_s = 2$

$n_F = 1$

$K_D = 1.15 = K'$

For 38 mm thick member, double shear, steel side plate

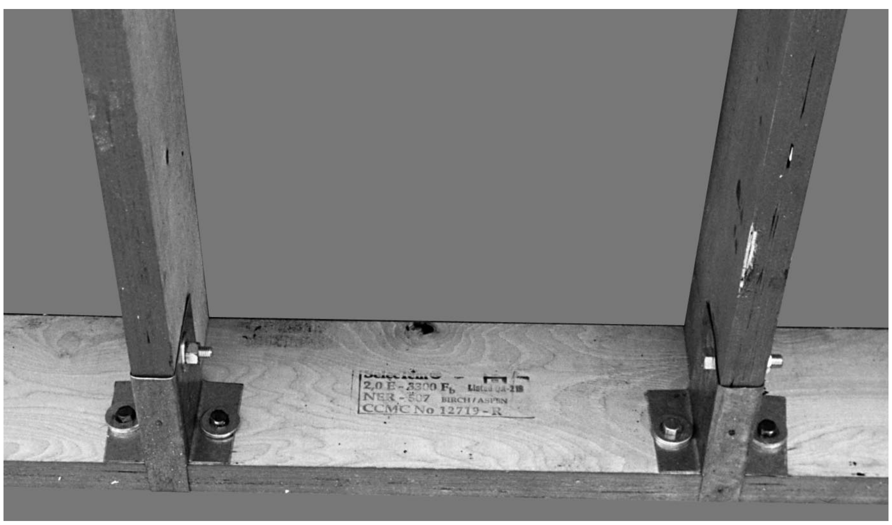
$Q'_r = 1.49$ kN WDM pg 252

$Q_r = 3.43$ kN > 2.72 kN (Acceptable)

Results:
Stud anchor connections are adequate to resist the stud uplift and pressure/suction loads.

Other considerations:

1) Steel in stud anchor must be checked to ensure the anchor is capable of transferring the loads.
2) Stud to bottom plate anchor must also be checked. In this project, similar anchors were used at the top and bottom of the studs. The weight of the wall is beneficial to the connection at the bottom of the stud.
3) The connections between the roof framing and the top plate must be capable of resisting the uplift loads and the wind pressures/suctions. A load path must be detailed to ensure that the wind pressures/suctions, on the face of the wall, are resisted by the roof diaphragm acting in the plane of the roof sheathing.



3.4 Shearwall Design

The Crestbrook Value Added Centre uses a system of diaphragms and shearwalls to resist the lateral loads. Wind pressures and suctions on the north and south end walls of the buildings are resisted by the end wall studs which transfer half of the wind load into the foundation and the other half to the roof diaphragm. The roof diaphragm acts as a deep beam and transfers the wind loads into east and west walls along Gridlines G and M. The walls on gridlines G and M must be designed as shearwalls to ensure that they are capable of transferring the shear loads at the eave level into the foundation at the base of the wall.

3.4.1 Lateral Load Path and Overturning

The diaphragm load on the roof is assumed to be uniformly distributed along the top of the wall plate. This load is transferred through the effective shear-wall segments to the foundation. All of Wall G is sheathed with OSB sheathing with only 3 door openings to reduce the shear capacity – see Figure 3.7. Therefore, most of the wall can be considered capable of transferring lateral loads.

A shearwall segment is defined as a section of a shearwall with uniform construction that forms a structural unit designed to resist lateral forces parallel to the plane of the wall. The wall segments around openings are not considered as part of the shearwall. As well, a wall section where the height of the wall is more than 3.5 times greater than the length of the segment is considered too narrow to carry load. This means there are three potential shearwall segments in Wall G as illustrated in Figure 3.7.

The wall sheathing nailed to the studs transfers the shear load from the top of the wall to the bottom of the wall. The overturning of each shearwall segment is resisted by dead loads on the wall segment and chords at the ends of the segments designed to transfer tension and compression forces into the foundation. Shearwall chords acting in tension require hold-down connections to the foundation. Where possible, wall geometry may be chosen to avoid using hold-down connections.

Load Information

Lateral loads

The factored roof diaphragm reaction at Wall G is 85 kN resulting from wind loads on the existing structure and the new Value Added Centre. The wall length is 53.9 m and the distributed diaphragm load along the top of the wall is 1.58 kN/m.

Dead loads

In wind load analysis, 85% of the specified dead load may be used to resist overturning. Since the roof dead load was considered to resist wind uplift, it will not be considered to resist overturning. Only the dead load of the wall will be considered in the overturning calculation.

Specified weight of wall = 0.4 kPa

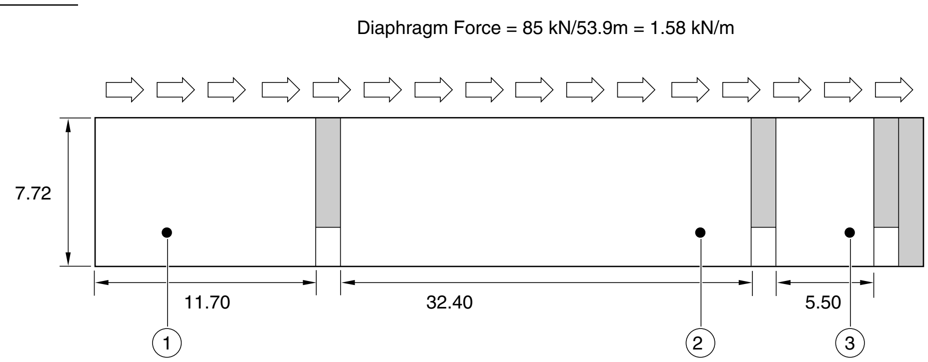
Wall height = 7.72 m

Factored weight of the wall at the base of the wall

= 0.85 x 0.4 x 7.72

= 2.62 kN/m

Figure 3.7
Wall G showing shearwall segments

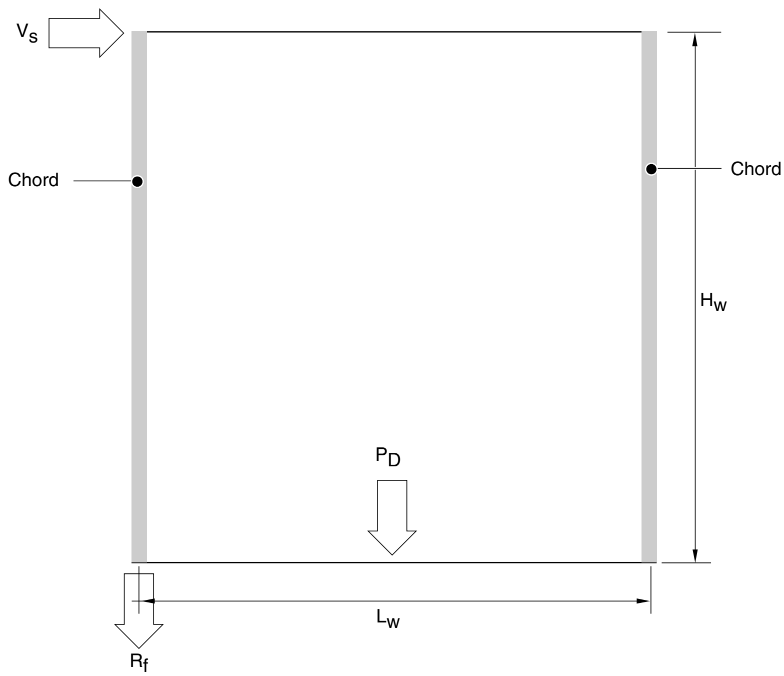


Load paths

Each shearwall segment must be considered separately. In this analysis, all shearwall segments are constructed in the same manner. Due to the low aspect ratio, shear deformation is dominant and each shearwall segment is assumed to have the same stiffness per unit length and the load in each segment is assumed to be proportional to the length of the segment.

Figure 3.8 shows a free body diagram for a shearwall segment. The sheathed panels above the openings are conservatively ignored in the shearwall design.

Figure 3.8
Free body diagram of a shearwall segment



From static equilibrium

$$\mathbf{R_f = \frac{M_{overturning} - M_{resisting}}{L_w}}$$

Where:

R_f = Hold-down force (positive is tension, negative is compression)

$M_{overturning}$ is the overturning moment

= $V_s \times H_w$

$M_{resisting}$ is the resisting moment

= $P_D \times L_w/2$

L_w = The length of the shearwall segment

H_w = The height of the shearwall
= 7.72 m

V_s = Load on the shearwall segment = $V_T \dfrac{L_w}{\sum L_w}$

V_T = Total shear load on the shearwall
= 85 kN

P_D = Total factored dead load on the shearwall segment
= 2.62 kN/m x L_w

Option 1 – 3 shearwall segments

ΣL_w = 11.7 + 32.4 + 5.5
= 49.6 m

	Length	Overturning Moment		Resisting Moment		
	L_w	V_s	V_sH_w	P_D	$P_DL_w/2$	R_f
Segment	m	kN	kN•m	kN	kN•m	kN
1	11.7	20.1	155	30.7	180	-2.14
2	32.4	55.4	428	84.9	1370	-29.1
3	5.5	9.42	72.6	14.4	39.6	6.00

Option 2 – Only consider segments 1 and 2 as resisting lateral load

ΣL_w = 11.7 + 32.35
= 44.1 m

	Length	Overturning Moment		Resisting Moment		
	L_w	V_s	V_sH_w	P_D	$P_DL_w/2$	R_f
Segment	m	kN	kN•m	kN	kN•m	kN
1	11.7	22.6	174	30.7	180	-0.51
2	32.4	62.4	481	84.9	1370	-27.4

In option 2, hold-downs would not be required. Base shearwall design on Option 2.

Results:
Only consider shearwall segments 1 and 2 in shearwall design.

Other considerations:

1) The top plate of the shearwall must be designed as a drag strut to transfer the diaphragm shear loads into the shearwall segments. See Section 3.4.5.

3.4.2 Shear Panel Design

Shear panels are 9.5 mm thick OSB nailed with 2 in common nails at 150 mm at panel edges and 300 mm at interior framing members. Alternatively, nailed plywood sheathing could be used for shear panels. OSB and plywood sheathing of the same thickness have equivalent shearwall shear capacity when nailed with the same size and number of nails. Panels are applied horizontally and blocking provides a nailing surface for all panel edges.

Shearwall capacity is given for 2 in nails used with 7.5 mm sheathing and 2-1/2 in nails used with 9.5 mm sheathing. The shearwall capacity is a function of the strength of the nail and the strength of the sheathing. Size of nail will govern shearwall capacity. Base shearwall capacity on 7.5 mm panel with 2 in common nails. Use capacity for Hem-Fir framing as recommended by Tembec.

Factored shear resistance of shearwall segments is 3.35 kN/m WDM pg 473

Factored shear load

$= V_T/\Sigma L_w$
$= 85/44.1$
$= 1.93$ kN/m $<$ 3.35 kN/m (Acceptable)

Results:
The interior sheathing consisting of 9.5 mm thick OSB nailed with 2 in common nails at 150 mm at the panel edges and 300 mm at interior framing members provides adequate shear resistance for lateral loads.

Other considerations:

1) Power nails cannot be substituted for common nails in shearwall construction. Power nails generally have smaller diameters and do not have the same capacity as common nails. See the power nail manufacturer for adjustments to shearwall capacity.

3.4.3 Chord Design

Typically, the chords of each shearwall segment will act in compression and tension alternately depending on the direction of the lateral load. Studs are usually doubled at the ends of the shearwall segments to act as the chords. The double member chord must be capable of resisting the chord force, roof gravity loads and wind loads on the face of the stud.

In the example given, there are no tie downs required, therefore there will not be tension in the chord, only compression.

Chord force

When calculating the compression force in the shearwall chord resulting from the shear force, the weight of the wall does not need to be considered. The weight of the wall is resisted by all of the studs in the shearwall segment. The design of the studs acting as chords must also consider the gravity loads and wind pressures/suctions on the stud.

Useful length of wall = L_w-300 mm to allow room for connections

$R_{fc} = V_s \times H_w/(L_w-300)$

Segment 1

$= 15.3$ kN

Segment 2

$= 15.0$ kN

Stud design

For studs used as a chord, check stud capacity considering extra axial load from chord. Check capacity of a double stud using resistance values from Section 3.2 Load Case 3 (pg 32).

Wind load on the face of the stud:

Since design is considering wind loads on multiple surfaces of the structure, use Figure B-7 of the Structural Commentaries to the NBCC – wind blowing on the end wall.

$C_pC_g = 0.9$ NBCC Figure B7

Wind plus snow:

$w_f = 0.424 \times 0.7$
$= 0.297$ kN/m per double stud

$P_f = 44.2$ kN + 0.7×15.3 kN
$= 54.9$ kN per double stud

$P_r = 2 \times 75.4$
$= 151$ kN per double stud

$M_r = 2 \times 19.5/1.05$
$= 37.1$ kN•m per double stud

Combined loading:

$$\frac{P_f}{P_r} + \frac{M_f}{M_r} \leq \mathbf{1.0}$$

$= 0.48 \leq 1.0$ (Acceptable)

Deflection:

$w_s = 0.150$ kN/m per double stud

$P_s = 31.2 + 0.7 \times 15.3/1.5$
$= 38.3$ kN per double stud

$\Delta_A = 10.9$ mm $<$ 42 mm (Acceptable)

Results:
Two 44 x 235 mm (1-3/4 x 9-1/4 in) SelecTem™ 2.0E studs are acceptable as a shearwall chord.

Other considerations:

1) Studs around openings must be designed to resist the additional loads imposed at the openings – See Section 3.5.3 (pg 48).

3.4.4 Anchor Bolt Design

The anchor bolts which connect the base plate to the foundation, must be designed to resist the wind uplift force on the wall, the wind loads resulting from the wind pressures/suctions on the face of the wall and the wind shearwall shear forces acting parallel to the plane of the wall. For this project, 5/8 in dia. anchor bolts were used with a minimum embedment of 127 mm into the concrete. SelecTem™ 2.0E base plates have the same specific gravity as Hem-Fir and Tembec recommends using Hem-Fir connection design values for this product.

Load information

Factored uplift load at the eave (pg 33)

= (wind load – 0.85 roof dead load)
= 9.5 kN/m

Wind pressures (pg 33)

= 2.72/0.61
= 4.46 kN/m

Lateral shear loads along shearwall (pg 39)

= 1.93 kN/m

Uplift resistance

70 x 70 x 6 mm thick square washers resist wind uplift forces

Check bearing of washers on the wall plate.

Bearing area:

$$\mathbf{Q_r = \phi F_{cp} A_b K_B K_{Zcp}}$$

$A_b = 70 \times 70 - \pi \times 18^2/4$
$= 4650 \text{ mm}^2$

$K_B = 1.13$

$K_{Zcp} = 1.15$

$Q_r = 34.5 \text{ kN}$

Anchor bolt spacing for uplift:

= 34.5/9.5
= 3.63 m

Resistance to wind pressures/suctions on the wall

44 mm bottom plate; 5/8 in dia. anchor bolt; plate loaded perpendicular to grain

Design connection assuming wood and concrete have the same embedding strength and the concrete is twice as thick as the wood. (CSA O86.1 10.4.2.3)

$$\mathbf{Q_r = \phi Q_u n_s n_F J_R}$$

where:

$\phi = 0.7$

$n_s = 1$

$n_F = 1$

$J_R = 1$

$$Q_u = q_u(K_D K_{SF} K_T)$$

q_u is calculated in accordance with 10.4.4.2 using CSA O86.1 10.4.4.2

l_1 = 44 mm

l_2 = 88 mm

f_1 = 10.6 MPa

f_2 = 10.6 MPa

Q_r = 2.9 kN

Anchor bolt spacing for face loads:

= 2.9/4.46
= 0.65 m (Governs)

Resistance to lateral shear loads parallel to the wall

44 mm bottom plate; 5/8 in dia. anchor bolt; plate loaded parallel to grain

Design connection assuming wood and concrete have the same embedding strength and the concrete is twice as thick as the wood. CSA O86.1 10.4.2.3

$$P_r = \phi P_u n_s n_F J_F$$

where:

ϕ = 0.7

n_s = 1

n_F = 1

J_F = 1

$$P_u = p_u(K_D K_{SF} K_T)$$

p_u is calculated in accordance with 10.4.4.2 using CSA O86.1 10.4.4.2

l_1 = 44 mm

l_2 = 88 mm

f_1 = 24.4 MPa

f_2 = 24.4 MPa

P_r = 6.3 kN

Anchor bolt spacing for lateral loads:

= 6.3/1.93
= 3.26 m

Face loads will govern the spacing of the anchor bolts. Use 0.61 m anchor bolt spacing to match stud spacing.

Results:
Use 5/8 in dia. anchor bolts with 70 x 70 mm plate washers spaced at 0.61 m.

Other considerations:

1) The resistance of the concrete to the connection forces needs to be checked.
2) When anchor bolts are widely spaced, the bending capacity of the wall plate needs to be checked in both the strong and weak axis.

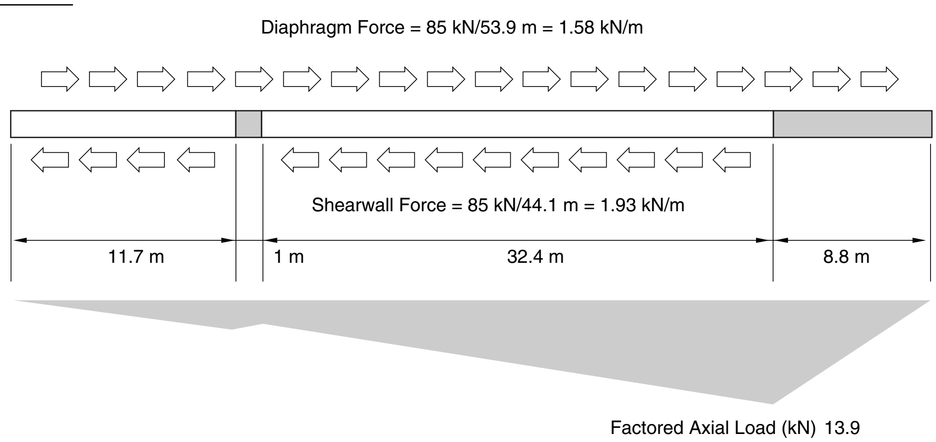
3.4.5 Drag Strut Design

A drag strut – also known as a collector, tie or diaphragm strut - is a diaphragm or shearwall boundary element parallel to the applied load that collects and transfers diaphragm shear forces to the shearwall segments. Typically the wall top plate acts as the drag strut and the connections in the top plate must be designed to resist the drag strut axial tension or axial compression forces.

The south 8.8 m segment of Wall G was not designed as a shearwall segment. Therefore, the diaphragm shear force at the south end of the wall has to be transferred to the shearwall segments at the north end of the wall. Figure 3.9 is a force diagram which illustrates the drag strut forces along wall G.

The maximum drag strut force is 13.9 kN. Since the shear force can occur from either the north or south direction, this can be either a tension force or a compression force. The maximum tension or compression stress in a single plate is 1.35 MPa. By observation, a single 44 x 235 mm member is capable of resisting this force. The plate members must be connected to provide continuity.

Figure 3.9
Drag strut forces along wall G



Drag strut connection

Stagger the butt joints in each of the top chord members and nail the top plates together. Use 2 rows of 3-1/2 in common nails.

ϕn_u = 0.9 kN   WDM pg 234

K_D = 1.15

Capacity per nail

= 1.0 kN

Number of nails/row

= 13.9/(2 x1)
= 7

Space nails at 300 mm.

Stagger end joints in the top plate 2.1 m.

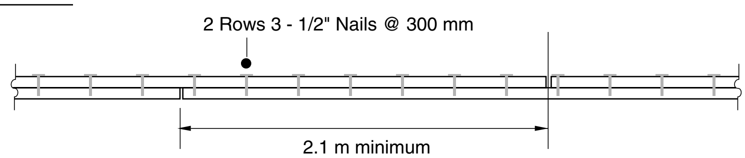


Figure 3.10
Top plate designed as drag strut

Results:
Design the wall top plate to act as a drag strut. Stagger end joints in the wall plate members a minimum of 2.1 m. Nail plates with 2 rows of 3-1/2" nails spaced at 300 mm.

Other considerations:

1) The wall top plate is often used as the diaphragm chord. The splice connections in the top plate should be designed for the most critical of the diaphragm chord force or the drag strut force.

3.5 Design of Members and Connections Around the Wall Opening

Loads must be transferred around the openings in a wall. The members and their connections listed below must be designed for the following load cases:

Member	Load considerations
Lintel over opening	gravity loads above the opening
	uplift loads above the opening
	wind pressures and suctions acting on the face of the wall and door or window
Jack post stud	gravity reactions from lintel
King post stud	loads for a typical stud
	chord forces if the opening is adjacent to a shearwall segment
	lateral load reactions from the lintel
	uplift reactions from the lintel

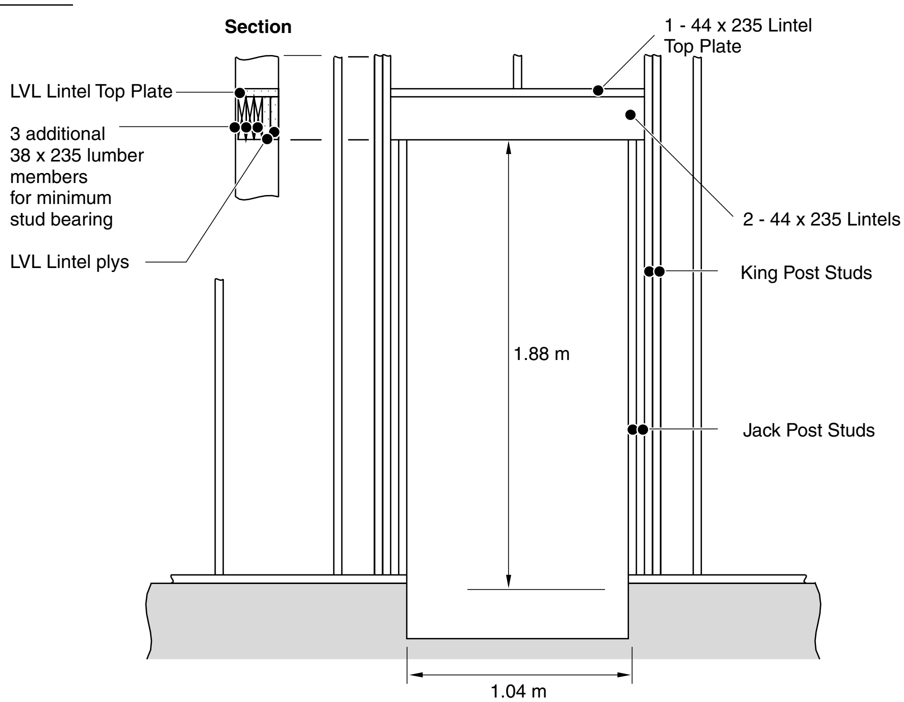
This design example will focus on the door opening near the north end of Wall G – see Figure 3.1. The opening is 1.04 m wide x 1.88 m high. At this location, the wall supports trusses spanning 41.8 m and there are shearwall segments either side of the opening. The opening is far enough away from the north end of the building to use the reduced wind loads for members away from building corners.

3.5.1 Lintel Member and Connection Design

Figure 3.11 illustrates the opening and the framing around the opening. A portion of the axial loads and wind loads is resisted directly by the studs adjacent to the opening. The lintel has to resist the loads from the stud supported on the lintel.

The lintel is LVL 2-Ply with an LVL lintel top plate – see Figure 3.11.
All of the lintel members are 44 x 235 mm SelecTem™ 2.0E.

Figure 3.11
Framing around the opening



2-Ply lintel design to resist gravity loads and uplift loads

From Table 3.1 (pg 26):

Total factored gravity load is 57.7 kN

Specified live snow load is 30.1 kN

For the factored gravity load acting as a point load in the centre of the span:

M_f = 15.0 kN•m

K_H = 1

M_r = 16.8/1.05 x 2
= 32.0 kN•m > 15.0 kN•m (Acceptable)

V_f = 28.9 kN

K_D = 1

V_r = 26/1.15 x 2
= 45.2 kN > 28.9 kN (Acceptable)

Deflection

P_s = 30.1 kN

span = 1.04 m

Δ < 1 mm (Acceptable)

Check bearing

Bearing reaction = 28.9 kN

$\mathbf{Q_r = \phi F_{cp} A_b K_B K_{zcp}}$ CSA O86.1 Supplement, 13.4.5.7.2

Bearing width for 2-ply lintel

= 2 x 44
= 88 mm

Assume 2 jack post studs

Bearing length

= 2 x 44
= 88 mm

K_B = 1

K_{zcp} = 1

Q_r = 38 kN > 28.9 kN (Acceptable)

Factored uplift load away from the corner of the building

= 4.0 kN/m x 0.61
= 2.44 kN

Uplift reaction on the 2-ply beam = 1.22 kN

End-nail the king post stud to the 2-ply lintels using 3-1/2 in. common nails

Use nail design values for Hem-Fir lumber.

Resistance per nail

$\mathbf{N_r = \phi N_u J_F}$ CSA O86.1 10.9.4.1

Factor for end-nailing J_E = 0.67

Wind load K_D = 1.15

N_r = 0.69 kN

Two nails required – better to use two nails per ply.

End nail with two 3-1/2 in nails each ply of lintel

Results:
Use a 2-ply 44 x 235 mm SelecTem™ 2.0E lintel. Support the lintel on two jack post studs at each end.
End nail the king post stud to the lintel using two 3-1/2 in nails per ply.

Other considerations:

1) Lintel plys should be nailed together in accordance with the manufacturer's recommendations.

2) Use filler members to provide full support to the lintel top plate-see Figure 3.11

Lintel top plate designed to resist wind pressures and suctions on the face of the wall

Lateral loads – wind loads away from the corner of the building

C_pC_g = -1.75 NBCC Figure B8

C_e = 1.0

C_{gi} = 1.0

C_{pi} = ± 0.7

Factored load for strength calculations = 1.07 kPa

Specified load for deflection calculations = 0.54 kPa

Tributary area for lintel

= 7.62/2 x 0.61
= 2.32 m^2

For strength calculations load = 2.48 kN

For deflection calculations load = 1.25 kN

For the wind suction acting as a point load in the centre of the1.04 m span beam:

M_f = 0.64 kN•m

K_H = 1

M_r = 19.4/1.05
= 18.5 kN•m > 0.64 kN•m (Acceptable)

V_f = 1.24 kN

K_D = 1.15

V_r = 26 kN (Acceptable)

Deflection

Using conservative assumption of

P_s = 1.25 kN

span = 1.04 m

Δ < 1 mm (Acceptable)

Lateral reaction on the lintel top plate = 1.24 kN

End-nail the king post stud to the lintel top plate using 3-1/2 in common nails

Resistance per nail

N_r = 0.69 kN

2 nails required

End nail with two 3-1/2 in common nails

> Results:
> Use a 44 x 235 mm SelecTem™ 2.0E lintel top plate. End nail the king post stud to the lintel top plate using two 3-1/2 in nails per ply.

3.5.2 Jack Post Stud Design

Factored Axial Load/Stud = 14.5kN

Stud Length = 1.88 m

P_r for 1.88 m stud = 237 kN

By observation, 2-jack post studs each end of lintel are adequate

3.5.3 King Post Member and Connection Design

Check the capacity of a double king post stud. The king post stud must be designed to resist the combined uplift and lateral loads from the lintel and the combined axial and lateral loads from the wind loads on the face of the wall, the shearwall chords, and the lintel.

The lintel is at 1/4 the height of the stud. Lateral load is 1.24 kN. Additional moment caused by wind load on the face of the studs away from the opening must be considered – See Section 3.4.3 (pg 39)

$M_f = 1.76 + 0.424 \times 7.59^2/8$
$= 4.81$ kN•m   per double stud

$K_H = 1$

$M_r = 37.1$ kN•m   per double stud

$T_f = 1.22 + 2.44$
$= 3.66$ kN   per double stud

$T_r = 2 \times 290$
$= 580$ kN   per double stud

$$\frac{T_f}{T_r} + \frac{M_f}{M_r} \leq 1.0$$

$= 0.14 < 1.0$ (Acceptable)

$V_f = 0.75 \times 1.24 + 2.48$
$= 3.41$ kN   per double stud

$K_D = 1.15$

V_r = 2 x 26 per double stud
= 52 kN (Acceptable)

Wind plus snow plus chord force:

M_{wind} = 4.81 x 0.7
= 3.37 kN•m per double stud

P_f = 44.2 kN + 0.7 x 15.3 kN
= 54.9 kN per double stud

P_r = 2 x 75.4
= 151 kN per double stud

M_r = 2 x 19.5/1.05
= 37.1 kN•m per double stud

Combined loading:

$$\frac{P_f}{P_r} + \frac{M_f}{M_r} \leq 1.0$$

= 0.52 (Acceptable)

Connection

A double steel connection was developed similar to the connection shown in Figure 3.6. See Example Section 3.3 (pg 33).

Uplift capacity of connection:

Withdrawal capacity of lag screws = 7.41 kN

Shear capacity of bolt (38 mm thick member) = 6.37 kN

Note: shear capacity would be greater for the double stud

Uplift load = 3.66 kN < 6.37 kN (Acceptable)

Capacity of connection to resist wind loads on the face of the wall:

Lag screw capacity = 4.65 kN

Shear capacity of bolt (38 mm thick member) = 3.43 kN

Note: shear capacity would be greater for the double stud

Lateral load

= 2.48 + 0.93
= 3.41 kN < 3.43 kN (Acceptable)

Results:
Double the studs around the opening.
Use a double stud anchor to resist the stud uplift and pressure/suction loads.

3.6 Non-structural Considerations

3.6.1 Fire Resistance

The Crestbrook Facility is classified as a Group F Division 2, industrial medium hazard occupancy. All Group F Division 2 buildings over 1500 m^2 must be sprinklered regardless of construction.

NBCC 3.2.2.70

As per NBCC 3.2.2.70, the building is permitted to be of combustible construction. The roof does not require a fire resistance rating because the building is sprinklered. The walls do not require a fire resistance rating because the roof that they are supporting does not require a fire resistance rating. Fire tests at the National Research Centre in Ottawa have demonstrated that wood stud walls have the same or better fire resistance as sheet metal stud walls with the same wall finishes.

For more information on fire resistance of wood buildings, refer to CWC publication, *Fire Safety Design of Buildings*. Code requirements for buildings can be determined using the CWC's CodeCHEK software, available free of charge by downloading from the web site at *www.wood-works.org*.

3.6.2 Thermal Resistance

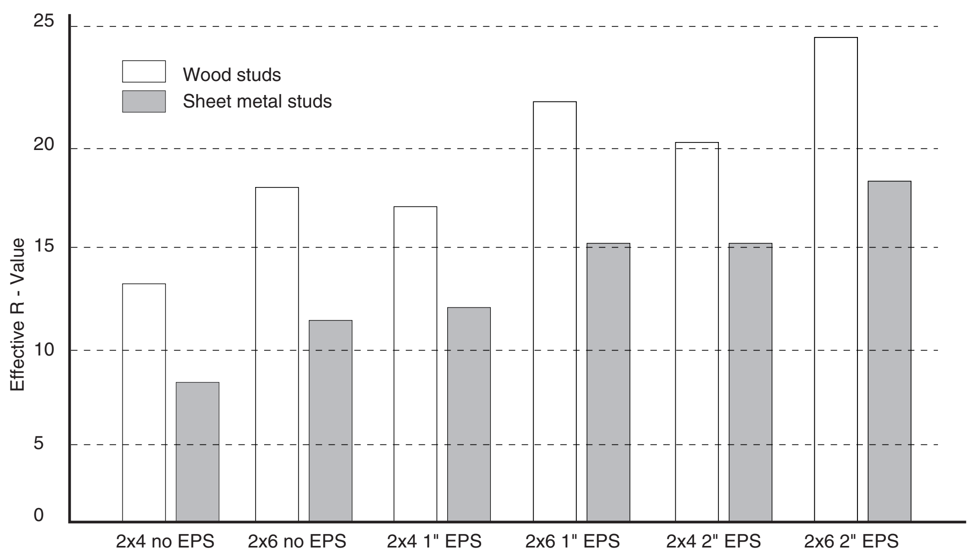
Wood is a good insulator compared to other structural materials. The cellular structure of wood traps air which results in its good insulating properties. Steel framing members conduct heat and cold and act as a thermal bridge through wall assemblies. This thermal bridging lowers the effective R-value or actual insulation value or the assembly.

As shown in Figure 3.12, sheet metal framing lowers the effective R-value of the cavity insulation by close to 50 percent while wood framing impacts the effective R-value by less than 10 percent. In other words, a 2 x 6 in. sheet metal frame wall would need to add 51 mm (2.0 in.) of foam insulation to achieve the same insulating value as a wood-frame wall with cavity insulation. This results in additional costs for the sheet metal system to provide the same thermal performance.

In this case, the R20 batt insulation in the wood stud wall provides an effective R-value of R18. A steel frame building, using non-loadbearing 2x4 sheet metal studs with R12 batt insulation and 2 in of EPS foam would have a lower effective R-value of R15 even though the insulation costs would be greater. The lower effective R-value would result in higher heating costs for the building.

For more information, refer to Canadian Wood Council publication, *The Thermal Performance of Light Frame Assemblies* available at *www.cwc.ca*.

Figure 3.12
Wood vs. steel framing – effective insulation values



Source: National Energy Code for Houses 1995