

## Technical Bulletin

### Insulspan SIP System ASD and LRFD Shear Wall Design Loads

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This technical bulletin summarizes racking shear strength test results from a test program completed for the Insulspan® Structural Insulating Panel (SIP) System. Racking shear loads were determined in accordance with ICC-ES **Acceptance Criteria for Sandwich Panels (AC04)**, section 4.5, Wall Panel Racking Shear Tests using ASTM E72, **Standard Test Methods of Conducting Strength Tests of Panels for Building Construction**, as modified within AC04.

Figure 1 illustrates the 8 ft x 8 ft (2.4 m x 2.4 m) wall assemblies tested which consisted of two 4 ft x 8 ft (1.2 m x 2.4 m) Insulspan SIPs.

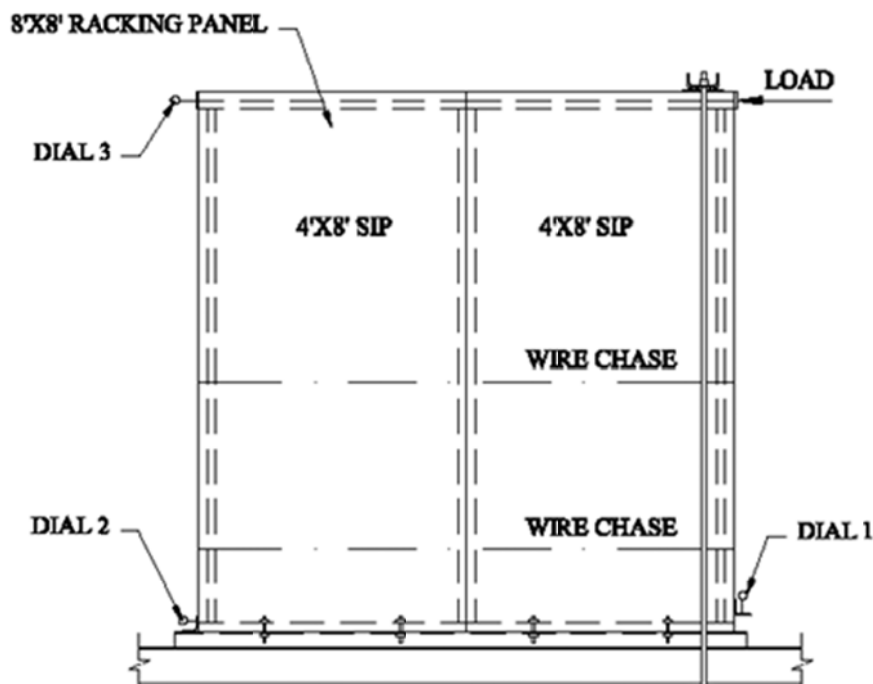


Figure 1 - Typical Test Setup

In jurisdictions that enforce the International Building Code (IBC) and International Residential Code (IRC), allowable loads determined using ASTM E72 are applicable for shear walls that resist wind and seismic loads in Seismic Design Categories A, B and C. As per AC04, section 4.5.2, the allowable racking shear loads were determined as the lowest value based upon the following criteria:

- load at which a net horizontal deflection of 1/8 inch (3.18 mm) occurred.
- the ultimate load divided by a factor of safety of 3.0 as per AC04, section 4.2.4, or
- the allowable fastener loads.

Allowable loads are used for Allowable Stress Design (ASD) as required by the IBC and IRC.

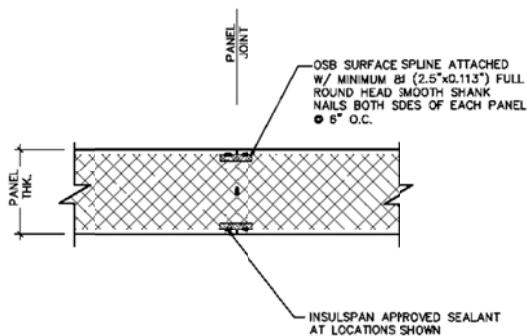
Table 1 below provides allowable loads (adjusted design values required for ASD) from the test program for Insulspan SIP System installation configurations as noted.

**Table 1 – ASD Allowable Racking Shear Loads for Insulspan SIP System**

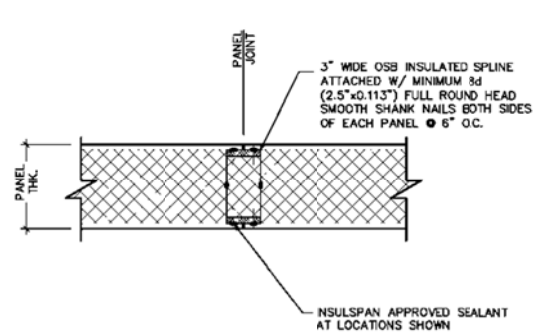
Installation Configuration	Spline Type	Minimum SIP Core Thickness (inches)	Bottom Plate	Top Plate	End Posts	Nail Spacing (inches)	Allowable Shear Load (plf)
A	Figure 2 or 3	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 6" o.c.	349
B	Figure 2 or 3	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 3" o.c.	557
C	Figure 4	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 6" o.c.	366
D	Figure 4	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 3" o.c.	639
E	Figure 5	6 ½"	Single 4-by	Single 4-by	Single 4-by	Single row @ 4" o.c.	591
F	Figure 5	6 ½"	Single 4-by	Single 4-by	Single 4-by	Two staggered rows @ 2" o.c. (4" o.c. each row)	881

**Notes to Table 1:**

1. Nails used to fasten OSB skins at panel to panel connections, top & bottom plates and end posts are 8d box nails (0.113" x 2-3/8" pneumatically driven nails).
2. Double 2-by plates are stitch-nailed together with two staggered rows of 10d box nails (0.131" x 3" pneumatically driven nails) spaced at 8" (203 mm) on center.
3. For installation configurations A to E with 3, 4 and 6-inch nail spacing, the rows of nails must be 3/4 inch from the edges and ends of the panels.
4. For installation configuration F with two staggered rows of nails installed into the shear wall perimeter (top plate, bottom plate and end posts) the first row of nails must be 3/4 inch from the panel edges and the second row of nails must be 1-1/2 inches from the first row. For nails installed into the vertical splines, the first row of nails must be 5/8 inch from the sandwich panel edge and the second row of nails must be 1-1/8 inches from the first row.
5. The shear wall end posts and splines must be continuous between the top and bottom plates.



**Figure 2 - OSB Surface Spline Connection**



**Figure 3 - OSB Block Spline Connection**

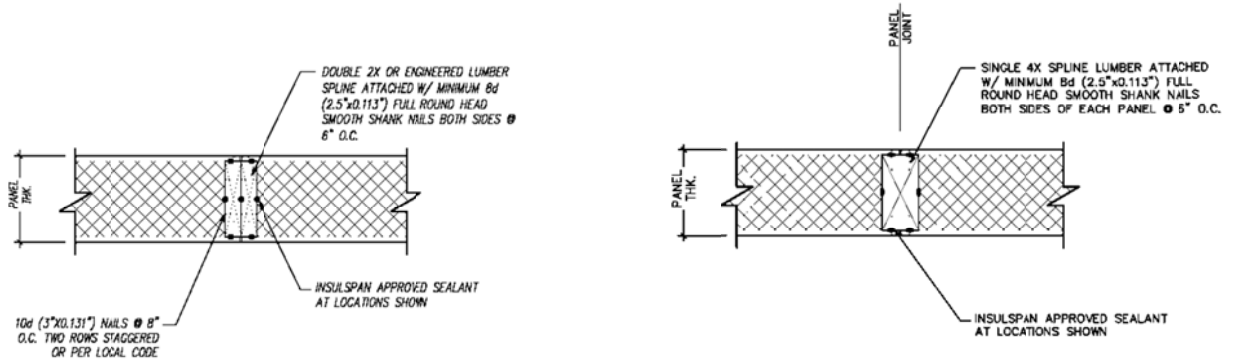


Figure 4 - Double 2-by Connection

Figure 5 - Single 4-by Connection

The **2005 National Design Standard (NDS) for Wood Construction** provides design requirements for wood using either Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD). Since the primary failure mechanism in shear wall design is connection failure, the conversion of *ASD adjusted design values* (allowable loads) to *LRFD adjusted design values* focuses on adjustment factors for connections as per Table 10.3.1 from the 2005 NDS.

**Table 10.3.1 Applicability of Adjustment Factors for Connections**

		ASD Only	ASD and LRFD								LRFD Only			
		Load Duration Factor <sup>1</sup>	Wet Service Factor <sup>2</sup>	Temperature Factor	Group Action Factor	Geometry Factor <sup>3</sup>	Penetration Depth Factor <sup>3</sup>	End Grain Factor <sup>3</sup>	Metal Side Plate Factor <sup>3</sup>	Diaphragm Factor <sup>3</sup>	Toe-Nail Factor <sup>3</sup>	Format Conversion Factor	Resistance Factor	Time Effect Factor
<b>Lateral Loads</b>														
Dowel-type Fasteners	$Z' = Z \times$	$C_D$	$C_M$	$C_t$	$C_g$	$C_\Delta$	-	$C_{eg}$	-	$C_{di}$	$C_{tn}$	$K_F$	$\phi_z$	$\lambda$
Split Ring and Shear Plate Connectors	$P' = P \times$ $Q' = Q \times$	$C_D$	$C_M$	$C_t$	$C_g$	$C_\Delta$	$C_d$	-	$C_{st}$	-	-	$K_F$	$\phi_z$	$\lambda$
Timber Rivets	$P' = P \times$ $Q' = Q \times$	$C_D^4$	$C_M$	$C_t$	-	-	-	-	$C_{st}^5$	-	-	$K_F$	$\phi_z$	$\lambda$
Metal Plate Connectors	$Z' = Z \times$	$C_D$	$C_M$	$C_t$	-	-	-	-	-	-	-	$K_F$	$\phi_z$	$\lambda$
Spike Grids	$Z' = Z \times$	$C_D$	$C_M$	$C_t$	-	$C_\Delta$	-	-	-	-	-	$K_F$	$\phi_z$	$\lambda$
<b>Withdrawal Loads</b>														
Nails, spikes, lag screws, wood screws, and drift pins	$W' = W \times$	$C_D$	$C_M$	$C_t$	-	-	-	$C_{eg}$	-	-	$C_{tn}$	$K_F$	$\phi_z$	$\lambda$

- The load duration factor,  $C_D$ , shall not exceed 1.6 for connections (see 10.3.2).
- The wet service factor,  $C_M$ , shall not apply to toe-nails loaded in withdrawal (see 11.5.4.1).
- Specific information concerning geometry factors  $C_g$ , penetration depth factors  $C_d$ , end grain factors,  $C_{eg}$ , metal side plate factors,  $C_{st}$ , diaphragm factors,  $C_{di}$ , and toe-nail factors,  $C_{tn}$ , is provided in Chapters 11, 12, and 13.
- The load duration factor,  $C_D$ , is only applied when wood capacity ( $P_w$ ,  $Q_w$ ) controls (see Chapter 13).
- The metal side plate factor,  $C_{st}$ , is only applied when rivet capacity ( $P_r$ ,  $Q_r$ ) controls (see Chapter 13).
- The geometry factor,  $C_\Delta$ , is only applied when wood capacity,  $Q_w$ , controls (see Chapter 13).

Figure 6 - NDS 2005, Table 10.3.1

From Table 10.3.1 the relationship between *ASD adjusted design value* and *LRFD adjusted design value* can be determined as follows:

1. The *ASD adjusted design value* for lateral load for dowel-type fasteners is:

$$\text{ASD adjusted design value (Z')} = Z \times C_D C_M C_t C_g C_{\Delta} C_{eg} C_{di} C_{tn}$$

2. The *LRFD adjusted design value* for lateral load for dowel-type fasteners is:

$$\text{LRFD adjusted design value (Z')} = Z \times C_M C_t C_g C_{\Delta} C_{eg} C_{di} C_{tn} K_F \phi_z \lambda$$

where Z is the reference design value for lateral load for dowel-type fasteners.

3. From these relationship the following relationships can be derived:

$$\frac{\text{LRFD adjusted design value}}{\text{ASD adjusted design value}} = \frac{Z \times C_M C_t C_g C_{\Delta} C_{eg} C_{di} C_{tn} K_F \phi_z \lambda}{Z \times C_D C_M C_t C_g C_{\Delta} C_{eg} C_{di} C_{tn}} = \frac{K_F \phi_z \lambda}{C_D}$$

and 
$$\text{LRFD adjusted design value} = \text{ASD adjusted design value} \times \frac{K_F \phi_z \lambda}{C_D}$$

Typical ratio values to convert *ASD adjusted design values* (allowable loads from Table 1) to *LRFD adjusted design values* are provided in Table 2 below by substituting NDS 2005 adjustment factors into the above equation.

**Table 2 - Typical Ratio Values to Convert ASD Adjusted Design Loads**

Adjustment Factors	Live Load	Snow Load	Wind/Earthquake
C <sub>D</sub>	1.0	1.15	1.6
K <sub>F</sub> φ <sub>z</sub>	2.16	2.16	2.16
λ	0.8	0.8	1.0
Ratio Values			
LRFD/ASD (K <sub>F</sub> φ <sub>z</sub> λ/C <sub>D</sub> )	1.728	1.503	1.35

Table 3 below provides adjusted design values for the installation configurations as noted for use in Load Resistance and Factor Design (LRFD) as required by the National Building Code of Canada.

**Table 3 – LRFD Adjusted Design Racking Shear Loads for Insulspan SIP System**

Installation Configuration	Spline Type	Minimum SIP Core Thickness (inches)	Bottom Plate	Top Plate	End Posts	Nail Spacing (inches)	Adjusted Shear Load (plf)
A	Figure 2 or 3	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 6" o.c.	471
B	Figure 2 or 3	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 3" o.c.	752
C	Figure 4	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 6" o.c.	494
D	Figure 4	4 ½"	Single 2-by	Double 2-by	Double 2-by or Single 4-by	Single row @ 3" o.c.	863
E	Figure 5	6 ½"	Single 4-by	Single 4-by	Single 4-by	Single row @ 4" o.c.	798
F	Figure 5	6 ½"	Single 4-by	Single 4-by	Single 4-by	Two staggered rows @ 2" o.c. (4" o.c. each row)	1189