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Subject: Load Calculations for Wood Stud and Steel Stud Walls for ASTM E119 Test

Dear Mr. Zhao,

Intertek has calculated the necessary loads for testing if a wood stud wall and a steel stud in accordance with ASTM E119-20, *Standard Test Methods for Fire Tests of Building Construction and Materials.* The materials and wall assemblies are described in Priest & Associates Consulting, LLC, Test Plan 11011A, Dated August 3, 2021, and Test Plan 11011B, Dated July 30, 2021, for the wood stud wall assembly and steel stud wall assembly, respectively.

Wood Stud Wall Calculation

The wood stud wall is constructed with nominal 2x4 studs, spaced 16 in. on center, with a double top plate and a single bottom plate. The overall wall dimensions are 10 x 10 ft, and the design drawing has a total of nine studs. The load calculations are the Allowable Stress Design Method as detailed in the National Design Standard, Sections 3.6 and 3.7. The calculations are based on actual dimensions of the studs at 1-1/2 x 3-1/2 in., with an effective length of 115-1/2 in., considering the top and bottom plates. The stud properties used are based on Grade No. 2, Spruce-Pine-Fir.

Axial Load Calculation - Allowable Stress Design Method - National Design Standard Section 3.6 and 3.7

2X4 Wood Studs

Actual Dimensions: Wall Height = 10 ft 0 in.

	1.5	in.	Number of Bottom Plates = 1	l_e =	115.50	Effective Stud Length
	3.5	in.	Number of Top Plates = 2	d =	3.50	Dimension in Bending
Area =	5.25	$in.^2$		l_e/d =	33.00	Slenderness Ratio
					33.00	

C_D =	1.00	Load Duration Factor (Table 2.3.2)	
C_M =	1.00	Wet Service Factor For Wood Moisture Greater than 19%(Tables 4A-4E)	Section 4.3
C_t =	1.00	Temperature Factor (Table 2.3.3)	
C_F =	1.15	Size Factor (Tables 4A-4B)	
C_i =	1.00	Incising Factor (Table 4.3.8)	
C =	0.80	for sawn lumber (See 3.7.1)	
K_C =	1.00	Buckling Length Coefficient (Appendix G)	
C_T =	1.00	Buckling Stiffness Factor (See 4.3.11, 1.0 is conservative)	

Species = Spruce-Pine-Fir Grade No. 2

From Table 4A

F_C =	1150	psi
E_{min} =	510000	psi

F_C* =	1323	psi	Table 4.3.1 Less C_p
E_{min}' =	510000	psi	Table 4.3.1
F_{CE} =	385	psi	
C_p =	0.27		
F_C' =	358	psi	
	100%	Percent Factored	
P_A =	**1881**	**lb/Stud**	

Plate Compressive

$F_{C\perp}$ = 425 psi

Stud Cross Sectional Area = 5.25 $in.^2$

2053 lb

9 Number of Studs

16,931 lb Total Load

The axial load capacity of a single stud that is 115-1/2 in. long, is 1881 lb. This is for the strong axis since the weak axis is braced by the wall sheathing on both sides. The plate compressive strength, perpendicular to the grain, calculates to 2053 lb. Since the plate compressive strength is greater than the axial strength, the axial strength governs. The overall load to be applied to the wall assembly is calculated based on nine studs, and equals **16,931 lb**.

Steel Stud Wall Calculation

The steel stud wall is constructed with 350S162-33 sections. The studs are 3-1/2 x 1-5/8 in., 20 GA, and have a yield strength of 33 ksi. The top and bottom of the wall has 350T162-33, 20-GA track. The studs are spaced 24

in. The overall wall dimensions are 10 x 10 ft, and the design drawing has a total of six studs. The load calculations are the Load and Resistance Factor Design Method.

From the AISI Manual, Cold-Formed Steel Design, 2002 edition, Table III-5 provides a nominal axial strength, P_n, for a 10-ft long 350S162-33, 33-ksi, continuously braced by the wall sheathing, of 4.765 kips. This value for the 10-ft stud was interpolated between the 8-ft and 11-ft studs. Applying a strength reduction factor φ =0.85 and a conservative load factor α=1.25, the axial load applied for the test becomes

$$P_s = \frac{\varphi P_n}{\alpha} = \frac{(0.85)\ 4.765\ kips}{1.25} = 3.240\frac{kips}{stud} = 3240\frac{lb}{stud},$$
$$Therefore, total\ assembly\ load = 6 * 3240\frac{lb}{stud} = \mathbf{19,440\ lb}$$

The overall load to be applied to the wall assembly is calculated based on six studs, and equals **19,440 lb**.

In conclusion, the following loads shall be applied to the test assemblies described in Priest & Associates Consulting, LLC, Test Plan 11011A, Dated August 3, 2021, and Test Plan 11011B, Dated July 30, 2021, for fire resistance tests in accordance with ASTM E119.

Wood Stud Wall Assembly – 16,931 lb total
Steel Stud Wall Assembly – 19,440 lb total

These values are based on materials and dimensions described in the referenced test plans. Any deviation in the materials or dimensions will require the loads to be recalculated.

Sincerely,

INTERTEK TESTING SERVICES NA, INC.

Reported by:

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Reviewed by:

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