PCS Structural Solutions

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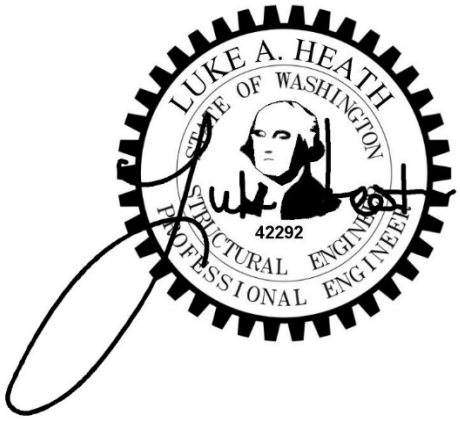
SUPPLEMENTAL STRUCTURAL CALCULATIONS

FOR

K2526 RESIDENCE
2526 70TH AVE SE
MERCER ISLAND, WA 98040

PREPARED BY
PCS STRUCTURAL *SOLUTIONS*



FEBRUARY 4, 2022
22-046

Project: K2526 Job Number: 22-046

Sheet: of Name: BRT

Originating Office: Tacoma Date: 10/29/2021

DESIGN CRITERIA CHECKLIST

CODE: IBC 2018, ASCE 7-16 LOCATION: MERCER ISLAND, WA

RISK CATEGORY: II (Per ASCE 7-16 Table 1.5-1 & IBC Table 1604.5)

VERTICAL DESIGN CRITERIA

	DEAD	LIVE	PARTITION	CONCENTRATED
ROOF:	15 PSF	25 PSF		
FLOOR	15 PSF	40 PSF	+ 15 PSF	1000 #

WIND DESIGN CRITERIA

BASIC WIND SPEED (V) =	97 MPH	(Per ASCE 7-16 Sec. 26.5.1, Fig. 26.5-1A; 1B; 1C & 1D, or as required by Bld'g Dept.)
EXPOSURE CATEGORY:	B	(Per ACSE 7-16 Section 26.7.3)
DIRECTIONALITY FACTOR (K_d):	0.85	(Per ASCE 7-16 Table 26.6-1)
GUST EFFECT FACTOR (G):	0.85	(Per ASCE 7-16 Section 26.11)
TOPOGRAPHIC FEATURE:	3-D Axisymmetrical	(See ASCE 7-16 Figure 26.8-1)
HILL HEIGHT (H):	233 FT	(See ASCE 7-16 Figure 26.8-1)
UPWIND DISTANCE TO HALF HILL (Lh):	655 FT	(See ASCE 7-16 Figure 26.8-1)
DISTANCE FROM CREST TO SITE (x):	70 FT UPWIND	(See ASCE 7-16 Figure 26.8-1)
MEAN ROOF HEIGHT:	30 FT	(See ASCE 7-16 Section 26.2 - Definitions)
ELEVATION:	257 FT	(See ASCE 7-16 Section 26.9)
ENCLOSURE CLASSIFICATION:	Enclosed	(See ASCE 7-16 Section 26.2 & Table 26.13-1)
ROOF TYPE:	Monoslope	(See ASCE 7-16 Figure 27.3-1)
ROOF SLOPE (__:12):	2.00:12	(Enter vertical rise in 12 horizontal units) θ (degrees): 9.46

SEISMIC DESIGN CRITERIA

SITE CLASS:	D	(Per IBC Section 1613.2.2, Assumed as "D" or per Geotech.)
IMPORTANCE FACTOR (I_E):	1	(Per ASCE 7-16 Table 1.5-2)
STRUCTURAL SYSTEM (R):	6.5	(Per ASCE 7-16 Table 12.2-1)
OVERSTRENGTH FACTOR (Ω_o):	3.0	(Per ASCE 7-16 Table 12.2-1)

INFORMATION BELOW FROM APPLIED TECHNOLOGY COUNCIL (ATC) "HAZARDS BY LOCATION"

LATITUDE:	47.587	S_S =	1.396	F_a =	1.200
LONGITUDE:	-122.245	S_1 =	0.486	F_v =	NULL

DEFLECTION CRITERIA

FLOOR (LIVE):	L/	480	ROOF (LIVE):	L/	360
FLOOR (TOTAL):	L/	360	ROOF (TOTAL):	L/	240
WALLS:	L/	360	SPECIAL:	L/	

SOIL DESIGN CRITERIA

REPORT: NO

BEARING: 1500 PSF
ACTIVE: 35 PCF
PASSIVE: 250 PCF
COEFFICIENT OF FRICTION: 0.35

PILE TYPE: NONE
VERTICAL CAPACITY : N/A
UPLIFT CAPACITY: N/A

MINIMUM FOOTING DIMENSIONS:

CONTINUOUS: 1'-4"
SPREAD: 1'-6"
FROST DEPTH: 1'-0"

LATERAL CAPACITY: N/A
SIZE: N/A

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DESIGN CRITERIA - WIND

BASIC WIND SPEED (V):	97 MPH	MEAN ROOF HEIGHT:	30 FT
RISK CATEGORY:	II	GROUND ELEVATION FACTOR (Ke):	0.99
EXPOSURE CATEGORY:	B	ENCLOSURE CLASSIFICATION:	Enclosed
DIRECTIONALITY FACTOR (K_d):	0.85	ROOF TYPE:	Monoslope
GUST EFFECT FACTOR (G):	0.85	ROOF SLOPE (__:12):	2.0:12
		θ (degrees):	9.46

ROOF PRESSURES (Figure 27.3-1)

		External Pressures (q_h*(GC_p)):			Internal Pressures (±q_i*(GC_{pi}))
Wind Direction:	h/L:	Windward (Positive)	Windward (Negative)	Leeward	All Roofs
Normal to Ridge for θ ≥ 10°	≤0.25	N/A	N/A	N/A	4.1
	0.50	N/A	N/A	N/A	
	≥1.0	N/A	N/A	N/A	

			External Pressures (q*(GC_p)):		Internal Pressures (±q_i*(GC_{pi}))
	h/L:	Horizontal Distance from Windward Edge	Positive Pressure	Negative Pressure	All Roofs
Normal to Ridge for θ < 10° and Parallel to Ridge for All θ	≤0.5	0 to h	-3.5	-17.3	4.1
		h to 2h		-9.6	
		>2h		-5.8	
	≥1.0	0 to h/2	-3.5	-25.0	
		>h/2		-13.4	

ASCE 7-16 CHAPTER 27: WIND LOADS ON BUILDINGS: MWFRS (DIRECTIONAL PROCEDURE)
PART 1: ENCLOSED AND PARTIALLY ENCLOSED BUILDINGS OF ALL HEIGHTS
HORIZONTAL WALL PRESSURES (Figure 27.3-1)

Windward External Pressures (q_z*(GC_p)):			Leeward & Sidewall External Pressures (q_h*(GC_p)):			Internal Pressures (±q_i*(GC_{pi}))
Height Above Ground Level, z	K_{zt}	Windward wall	L/B:	Leeward wall	Sidewall	All walls
15	1.65	13.0	0-1	-9.6	-13.4	4.1
20	1.63	14.0	2	-5.8		
25	1.61	14.7	≥4	-3.8		
30	1.59	15.4				
40	1.55	16.3				
50	1.52	16.9				
60	1.48	17.4				
70	1.45	17.8				
80	1.42	18.2				
90	1.40	18.5				
100	1.37	18.7				
120	1.32	19.0				
140	1.28	19.3				
160	1.25	19.5				
180	1.22	19.7				
200	1.19	19.8				
250	1.14	20.1				
300	1.10	20.5				
350	1.08	20.9				
400	1.06	21.4				
450	1.04	21.8				
500	1.03	22.2				

NOTES:

1) Minimum Design Wind Loads (Per ASCE 7-16 27.1.5): The wind load used for design of the MWFRS shall not be less than 16 PSF multiplied by the wall area of the building, and 8 PSF multiplied by the roof area of the building projected on a vertical plane normal to the assumed wind direction. Wall and roof loads shall be applied simultaneously.

2) q_i has conservatively been taken equal to q_h

K_{ht} = 1.59

q_h = 23.1PSF

Project: K2526 Job Number: 22-046

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DESIGN CRITERIA - WIND

BASIC WIND SPEED (V):	97 MPH	MEAN ROOF HEIGHT:	30 FT
RISK CATEGORY:	II	GROUND ELEVATION FACTOR (Ke):	0.99
EXPOSURE CATEGORY:	B	ENCLOSURE CLASSIFICATION:	Enclosed
DIRECTIONALITY FACTOR (K_d):	0.85	ROOF TYPE:	Monoslope
GUST EFFECT FACTOR (G):	0.85	ROOF SLOPE (__:12):	2.0:12
		θ (degrees):	9.46

ASCE 7-16 CHAPTER 30: WIND LOADS: COMPONENTS AND CLADDING
PART 1: LOW-RISE BUILDINGS (h≤60 ft)

ROOF SURFACES

Effective Wind Area	POSITIVE PRESSURES	NEGATIVE PRESSURES					
	ZONE						
	ALL ZONES	1	2	2'	3	3'	N/A
10 SF	16.0	-28.9	-33.4	-40.2	-44.7	-62.8	N/A
20 SF	16.0	-28.9	-33.0	-39.8	-40.2	-56.0	N/A
50 SF	16.0	-28.9	-31.6	-39.1	-35.7	-47.0	N/A
100 SF	16.0	-28.9	-31.2	-38.0	-31.2	-40.2	N/A

WALL SURFACES & ROOF OVERHANGS

Effective Wind Area	WALL ZONES				ROOF OVERHANG ZONES					
	POSITIVE PRESSURES		NEGATIVE PRESSURES		NEGATIVE PRESSURES					
	4	5	4	5	1	2	2'	3	3'	N/A
10 SF	26.7	26.7	-28.9	-35.7	-47.4	-52.0	-58.7	-63.3	-81.3	N/A
20 SF	25.5	25.5	-27.7	-33.3	-46.2	-50.3	-57.1	-57.5	-73.3	N/A
50 SF	23.9	23.9	-26.1	-30.1	-44.6	-47.4	-54.8	-51.4	-62.7	N/A
100 SF	22.7	22.7	-24.9	-27.7	-43.4	-45.7	-52.5	-45.7	-54.7	N/A
500 SF	19.9	19.9	-22.1	-22.1	-40.7	-42.9	-49.7	-42.9	-52.0	N/A

NOTES:

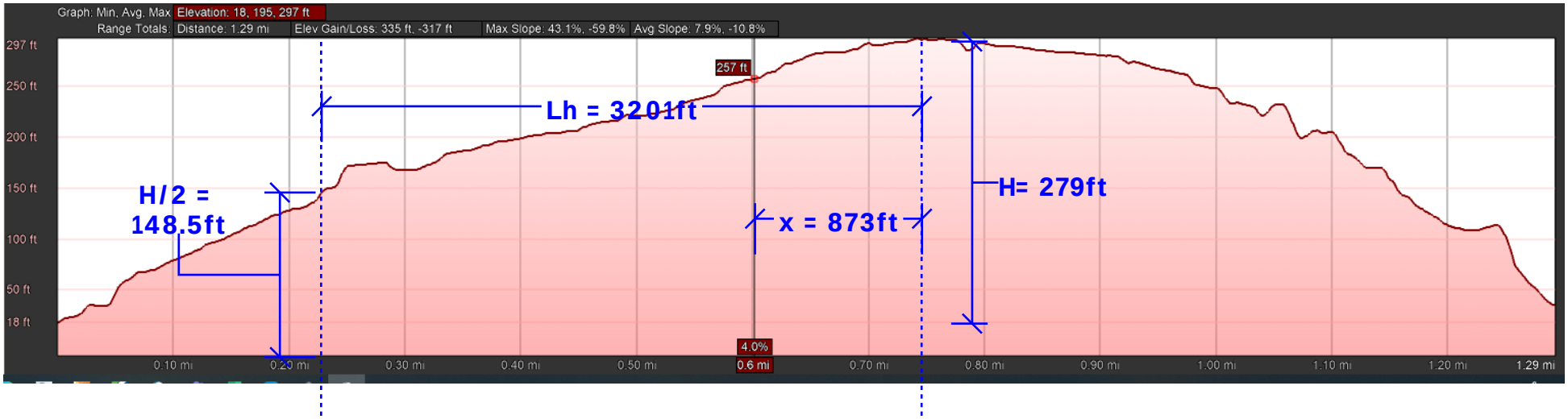
1) ASCE 7-16 30.2.2: Minimum Design Wind Loads: The design wind pressure for C&C of buildings shall not be less than a net pressure of 16 PSF acting in either direction normal to the surface.

2) q_i has conservatively been taken equal to q_h

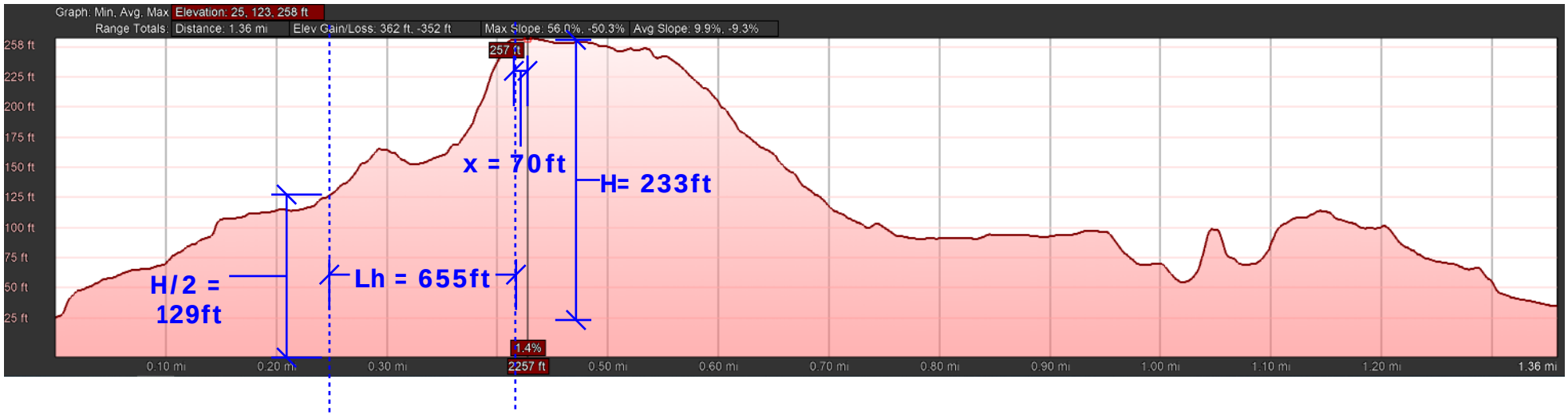
K_{ht} = 1.59

q_h = 23 PSF

N-S DIRECTION



E-W DIRECTION



HAND K_{zt} CALCULATION

EXPOSURE B, 3-D AXISYMMETRICAL HILL

N/S DIRECTION:

H/Lh = 279ft/3201ft = 0.088

z/Lh = 33ft/3201ft = 0.01

x/Lh = 873/3201ft = 0.273

$K_{zt} = (1+K_1*K_2*K_3)^2$

$K_1 = 0.95*(H/Lh) = 0.95(0.088) = 0.083$

$K_2 = 1-(x/(mu*Lh)) = 1-(873ft/(1.5*3201ft)) = 0.82$

$K_3 = e^(-y*z/Lh) = e^(-4*33ft/3201ft) = 0.96$

$K_{zt} = (1+K_1*K_2*K_3)^2 = (1+(0.083*0.82*0.96))^2 = \underline{1.14} < 1.317$

E/W DIRECTION:

H/Lh = 233ft/655ft = 0.366

z/Lh = 33ft/655ft = 0.051

x/Lh = 70/655ft = 0.107

$K_{zt} = (1+K_1*K_2*K_3)^2$

$K_1 = 0.95*(H/Lh) = 0.95(0.366) = 0.338$

$K_2 = 1-(x/(mu*Lh)) = 1-(70ft/(1.5*655ft)) = 0.929$

$K_3 = e^(-y*z/Lh) = e^(-4*33ft/655ft) = 0.818$

$K_{zt} = (1+K_1*K_2*K_3)^2 = (1+(0.338*0.929*0.818))^2 = \underline{1.58} > 1.317$

REVISE CALCS FOR NEW Kzt

SEISMIC

Roof weight = 1.4 psf + 2.75 psf + 0.56 psf + 2.1 psf + 0.75 psf + 2.7 psf + 1 psf + 1 psf = 12.9 psf

(15/32" sht'g; 5/8" gwb; 14" batt insulation; 14" TJI 560 @ 24" o.c.; solar panels; interior wall weight; lighting; roofing membrane + underlay)

Roof = 15 psf

Deck = 40 psf

Floor (including +15 psf for interior partition walls) = 30 psf

A_{ROOF} = 2080 sf (Roof)

A_{3RD} = 1520 sf (floor) + 80 sf (roof) + 430 sf (deck) + 140 sf (deck)+ 240 (roof)

A_{2ND} = 1810 sf (floor) + 490 sf (deck) + 140 sf (deck)

Roof:

Wwalls = 10 psf * [(4.25ft*54ft)+(6.75ft*54ft)+((6.75ft+4.25ft)*(32ft))] = 9.5 k

Wroof = (15 psf * 2080 sf) + 9.5 k = 40.7 k

3rd:

Wwalls = 10 psf * [(4.25ft*54ft)+(6.75ft*54ft)+((6.75ft+4.25ft)*(32ft))] + (6ft*(40ft+60ft+46ft+64ft) = 22.2 k

W3rd = (30 psf * 1520 sf) + (15 psf * (80 sf + 240 sf)) + (40psf *(140sf + 430 sf)) + 22.2 k = 95.4 k

2nd:

Wwalls = [10 psf * (6ft*(40ft+60ft+46ft+64ft)] + (100psf*(64ft+92ft+44ft)*4.375ft) = 100 k

W2nd = (30 psf * 1810 sf) + (40 psf* (490 sf + 140 sf)) + 100 k = 180 k

Total:

Wtot = 40.7 k + 95.4 k + 180 k = 317 k

Vtot = 317 k * 0.172 = 55 k

Vasd = 55 k * 0.7 = 38 k > 22.2 k — EQ controls

22.2 k (1.59/1.317) = 26.8 k < 38 k — EQ still controls

updated Kzt factor

REVISED WALL PRESSURES

STUD WALLS

13.5ft STUD WALL EFFECTIVE WIND AREA = 13.5ft*(13.5ft/3) = 60 SF --> 29.7 PSF

12ft STUD WALL EFFECTIVE WIND AREA = 12ft*(12ft/3) = 48 SF --> 30.4 PSF

SECOND AND THIRD STORY STUD WALL CALCULATIONS UPDATED FOR NEW WALL PRESSURES... SEE NEXT PAGES FOR REVISED DESIGNS.

FULL-HT STUD WALLS

H1 EFFECTIVE WIND AREA = 13.5ft*(5.67ft) = 76 SF --> 28.3 PSF

H2 EFFECTIVE WIND AREA = 8.5ft*(5.67ft) = 48 SF --> 30.4 PSF

H3 EFFECTIVE WIND AREA = 12ft*(4.67ft) = 56 SF --> 29.7 PSF

H4 EFFECTIVE WIND AREA = 12ft*(12ft/3) = 48 SF --> 30.4 PSF

H5 EFFECTIVE WIND AREA = 10ft*(5.67ft) = 56 SF --> 29.7 PSF

FULL-HT STUD WALL CALCULATIONS UPDATED FOR NEW WALL PRESSURES... SEE NEXT PAGES FOR REVISED DESIGNS.

Project: K2526 Job Number: 21-046 NOTES:

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Originating Office: Tacoma Date: 02/03/22

Seattle
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STUD WALL DESIGN - THIRD STORY

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b =	900	PSI
F_c =	1350	PSI
$F_{c\perp}$ =	405	PSI
E =	1.50E+06	PSI

APPLIED LOADS:

W_{WIND} =	29.7	PSF
$W_{SEISMIC}$ =	0.0	PSF

P_{DEAD} =	555	LBS
P_{LIVE} =	0	LBS
P_{SNOW} =	925	LBS
P_{WIND} =	0	LBS
$P_{SEISMIC}$ =	0	LBS

STUD SIZE: (1) 2x6

A_X =	8.25	IN^2
S_X =	7.56	IN^3
I_X =	20.80	IN^4
$C_{F(BENDING)}$ =	1.3	(NDS 4.3.6)
F_{cE} =	518.7	PSI
C_b =	1.25	(NDS 3.10.4)

MISCELLANEOUS:

HEIGHT =	13.5	FT	
SPACING =	16	IN	
ECCENTRICITY =	0.1	IN	
$C_{F(COMPRESSION)}$ =	1.10	(NDS 4.3.6)	
	APPLY?		
$C_{SYS(BENDING)}$ =	1.35	YES	(SDPWS T3.1.1.1) Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.15	YES	(NDS 4.3.9) Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1 DEAD + LIVE + 5 PSF LAT.
CASE 2 DEAD + SNOW + 5 PSF LAT.
CASE 3 DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.
CASE 4 DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 5 DEAD + 0.60WIND
CASE 6 DEAD + 0.75EISMIC
CASE 7 DEAD + 0.53EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.35	0.319	474	1346	506
2 & 3	1.15	1708	0.30	0.282	481	1547	506
4 & 5	1.60	2376	0.22	0.207	493	2527	506
6 & 7	1.60	2376	0.22	0.207	493	2153	506

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	555	67	152	5	155	246
2	1480	179	152	12	160	253
3	1249	151	152	10	158	251
4	1249	151	406	10	412	654
5	555	67	541	5	544	863
6	555	67	0	5	3	5
7	1249	151	0	10	7	10

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.14	0.18	0.13	0.23	0.13	0.16	L/995
2	0.37	0.16	0.35	0.39	0.35	0.17	L/965
3	0.31	0.16	0.30	0.33	0.29	0.17	L/973
4*	0.31	0.26	0.30	0.46	0.29	0.22	L/720
5*	0.14	0.34	0.13	0.41	0.13	0.30	L/546
6	0.14	0.00	0.13	0.02	0.13	0.00	L/53293
7	0.31	0.00	0.30	0.10	0.29	0.01	L/23686
MAX. --->	0.37	0.34	0.35	0.46	0.35	0.30	L/546
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} =	1.15	(NDS 4.3.7)
F_V =	150	PSI

ALLOWABLE STRESSES:

F_V' =	173	PSI
F_b' =	1547	PSI

STUD REACTIONS (OUT - OF - PLANE)

267 LB

DBL TOP PLATE PROPERTIES:

A_X =	16.50	IN^2
S_X =	4.13	IN^3
I_X =	3.09	IN^4

APPLIED STRESSES:

f_v =	90	PSI	<--- O.K.
f_b =	1435	PSI	<--- O.K.
Δ_{MAX} =	0.027	IN	

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Originating Office: Tacoma Date: 02/03/22

Seattle
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STUD WALL DESIGN - SECOND STORY

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b =	900	PSI	
F_c =	1350	PSI	
$F_{c\perp}$ =	405	PSI	
E =	1.50E+06	PSI	

APPLIED LOADS:

W_{WIND} =	30.4	PSF
$W_{SEISMIC}$ =	0.0	PSF

P_{DEAD} =	960	LBS
P_{LIVE} =	960	LBS
P_{SNOW} =	0	LBS
P_{WIND} =	0	LBS
$P_{SEISMIC}$ =	0	LBS

STUD SIZE: (1) 2x6

A_X =	8.25	IN^2
S_X =	7.56	IN^3
I_X =	20.80	IN^4
$C_{F(BENDING)}$ =	1.3	(NDS 4.3.6)
F_{cE} =	656.5	PSI
C_b =	1.25	(NDS 3.10.4)

MISCELLANEOUS:

HEIGHT =	12	FT		
SPACING =	16	IN		
ECCENTRICITY =	0.1	IN		
$C_{F(COMPRESSION)}$ =	1.10	(NDS 4.3.6)		
	APPLY?			
$C_{SYS(BENDING)}$ =	1.35	YES	(SDPWS T3.1.1.1)	Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.15	YES	(NDS 4.3.9)	Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1 DEAD + LIVE + 5 PSF LAT.
CASE 2 DEAD + SNOW + 5 PSF LAT.
CASE 3 DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.
CASE 4 DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 5 DEAD + 0.60WIND
CASE 6 DEAD + 0.75EISMIC
CASE 7 DEAD + 0.535EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.44	0.392	582	1346	506
2 & 3	1.15	1708	0.38	0.347	593	1547	506
4 & 5	1.60	2376	0.28	0.258	614	2527	506
6 & 7	1.60	2376	0.28	0.258	614	2153	506

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	1920	233	120	16	130	206
2	960	116	120	8	125	198
3	1680	204	120	14	129	204
4	1680	204	328	14	337	535
5	960	116	438	8	443	703
6	960	116	0	8	5	8
7	1680	204	0	14	9	14

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.40	0.15	0.46	0.40	0.35	0.11	L/1333
2	0.20	0.13	0.23	0.19	0.18	0.10	L/1386
3	0.34	0.13	0.40	0.31	0.31	0.11	L/1346
4*	0.33	0.21	0.40	0.42	0.31	0.15	L/992
5*	0.19	0.28	0.23	0.37	0.18	0.19	L/755
6	0.19	0.00	0.23	0.04	0.18	0.00	L/34661
7	0.33	0.01	0.40	0.12	0.31	0.01	L/19807
MAX. --->	0.40	0.28	0.46	0.42	0.35	0.19	L/755
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} =	1.15	(NDS 4.3.7)
F_V =	150	PSI

DBL TOP PLATE PROPERTIES:

A_X =	16.50	IN^2
S_X =	4.13	IN^3
I_X =	3.09	IN^4

ALLOWABLE STRESSES:

F_V' =	150	PSI
F_b' =	1346	PSI

APPLIED STRESSES:

f_v =	58	PSI	<--- O.K.
f_b =	931	PSI	<--- O.K.
Δ_{MAX} =	0.018	IN	

STUD REACTIONS (OUT - OF - PLANE)
243 LB

Project: K2526 Job Number: 21-046 NOTES:

Sheet: _____ of _____ Name: BRT

Originating Office: Tacoma Date: 02/03/22

Seattle
Tacoma
Portland

STUD WALL DESIGN - FULL-HT (1)

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b =	900	PSI
F_c =	1350	PSI
$F_{c\perp}$ =	405	PSI
E =	1.50E+06	PSI

APPLIED LOADS:

W_{WIND} =	28.3	PSF
$W_{SEISMIC}$ =	0.0	PSF

P_{DEAD} =	0	LBS
P_{LIVE} =	0	LBS
P_{SNOW} =	0	LBS
P_{WIND} =	0	LBS
$P_{SEISMIC}$ =	0	LBS

STUD SIZE: (3) 2x6

A_X =	24.75	IN^2
S_X =	22.69	IN^3
I_X =	62.39	IN^4
$C_{F(BENDING)}$ =	1.3	(NDS 4.3.6)
F_{cE} =	518.7	PSI
C_b =	1.08	(NDS 3.10.4)

MISCELLANEOUS:

HEIGHT =	13.5	FT	
SPACING =	68	IN	
ECCENTRICITY =	0.1	IN	
$C_{F(COMPRESSION)}$ =	1.10	(NDS 4.3.6)	
		APPLY?	
$C_{SYS(BENDING)}$ =	1.00	NO	(SDPWS T3.1.1.1) Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.00	NO	(NDS 4.3.9) Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1 DEAD + LIVE + 5 PSF LAT.
CASE 2 DEAD + SNOW + 5 PSF LAT.
CASE 3 DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.
CASE 4 DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 5 DEAD + 0.60WIND
CASE 6 DEAD + 0.75EISMIC
CASE 7 DEAD + 0.535EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.35	0.319	474	1170	439
2 & 3	1.15	1708	0.30	0.282	481	1346	439
4 & 5	1.60	2376	0.22	0.207	493	1872	439
6 & 7	1.60	2376	0.22	0.207	493	1872	439

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	0	0	645	0	645	341
2	0	0	645	0	645	341
3	0	0	645	0	645	341
4	0	0	1644	0	1644	870
5	0	0	2192	0	2192	1159
6	0	0	0	0	0	0
7	0	0	0	0	0	0

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.00	0.29	0.00	0.29	0.00	0.23	L/716
2	0.00	0.25	0.00	0.25	0.00	0.23	L/716
3	0.00	0.25	0.00	0.25	0.00	0.23	L/716
4*	0.00	0.46	0.00	0.46	0.00	0.40	L/402
5*	0.00	0.62	0.00	0.62	0.00	0.54	L/301
6	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
7	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
MAX. --->	0.00	0.62	0.00	0.62	0.00	0.54	#DIV/0!
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} =	1.15	(NDS 4.3.7)
F_V =	150	PSI

DBL TOP PLATE PROPERTIES:

A_X =	16.50	IN^2
S_X =	4.13	IN^3
I_X =	3.09	IN^4

ALLOWABLE STRESSES:

F_V' =	150	PSI
F_b' =	1346	PSI

APPLIED STRESSES:

f_v =	0	PSI	<--- O.K.
f_b =	0	PSI	<--- O.K.
Δ_{MAX} =	0.000	IN	

STUD REACTIONS (OUT - OF - PLANE)
1082 LB

Project: K2526 Job Number: 21-046 NOTES:

Sheet: _____ of _____ Name: BRT

Originating Office: Tacoma Date: 02/03/22

Seattle
Tacoma
Portland

STUD WALL DESIGN - FULL-HT (2)

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b =	900	PSI
F_c =	1350	PSI
$F_{c\perp}$ =	405	PSI
E =	1.50E+06	PSI

APPLIED LOADS:

W_{WIND} =	30.4	PSF
$W_{SEISMIC}$ =	0.0	PSF

P_{DEAD} =	0	LBS
P_{LIVE} =	0	LBS
P_{SNOW} =	0	LBS
P_{WIND} =	0	LBS
$P_{SEISMIC}$ =	0	LBS

STUD SIZE: (1) 2x6

A_X =	8.25	IN^2
S_X =	7.56	IN^3
I_X =	20.80	IN^4
$C_{F(BENDING)}$ =	1.3	(NDS 4.3.6)
F_{cE} =	1308.4	PSI
C_b =	1.25	(NDS 3.10.4)

MISCELLANEOUS:

HEIGHT =	8.5	FT
SPACING =	68	IN
ECCENTRICITY =	0.1	IN
$C_{F(COMPRESSION)}$ =	1.10	(NDS 4.3.6)

		APPLY?		
$C_{SYS(BENDING)}$ =	1.00	NO	(SDPWS T3.1.1.1)	Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.00	NO	(NDS 4.3.9)	Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1	DEAD + LIVE + 5 PSF LAT.	CASE 4	DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 2	DEAD + SNOW + 5 PSF LAT.	CASE 5	DEAD + 0.60WIND
CASE 3	DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.	CASE 6	DEAD + 0.75EISMIC
		CASE 7	DEAD + 0.525EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.88	0.646	959	1170	506
2 & 3	1.15	1708	0.77	0.593	1013	1346	506
4 & 5	1.60	2376	0.55	0.468	1112	1872	506
6 & 7	1.60	2376	0.55	0.468	1112	1872	506

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	0	0	256	0	256	406
2	0	0	256	0	256	406
3	0	0	256	0	256	406
4	0	0	700	0	700	1111
5	0	0	933	0	933	1481
6	0	0	0	0	0	0
7	0	0	0	0	0	0

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.00	0.35	0.00	0.35	0.00	0.11	L/956
2	0.00	0.30	0.00	0.30	0.00	0.11	L/956
3	0.00	0.30	0.00	0.30	0.00	0.11	L/956
4*	0.00	0.59	0.00	0.59	0.00	0.20	L/499
5*	0.00	0.79	0.00	0.79	0.00	0.27	L/374
6	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
7	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
MAX. --->	0.00	0.79	0.00	0.79	0.00	0.27	#DIV/0!
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} =	1.15	(NDS 4.3.7)
F_V =	150	PSI

DBL TOP PLATE PROPERTIES:

A_X =	16.50	IN^2
S_X =	4.13	IN^3
I_X =	3.09	IN^4

ALLOWABLE STRESSES:

F_V' =	150	PSI
F_b' =	1346	PSI

APPLIED STRESSES:

f_v =	0	PSI	<--- O.K.
f_b =	0	PSI	<--- O.K.
Δ_{MAX} =	0.000	IN	

STUD REACTIONS (OUT - OF - PLANE)
732 LB

Project: K2526 Job Number: 21-046 NOTES:

Sheet: _____ of _____ Name: BRT

Originating Office: Tacoma Date: 02/03/22

Seattle
Tacoma
Portland

STUD WALL DESIGN - FULL-HT (3)

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b =	900	PSI
F_c =	1350	PSI
$F_{c\perp}$ =	405	PSI
E =	1.50E+06	PSI

APPLIED LOADS:

W_{WIND} =	29.7	PSF
$W_{SEISMIC}$ =	0.0	PSF

P_{DEAD} =	0	LBS
P_{LIVE} =	0	LBS
P_{SNOW} =	0	LBS
P_{WIND} =	0	LBS
$P_{SEISMIC}$ =	0	LBS

STUD SIZE: (2) 2x6

A_X =	16.50	IN^2
S_X =	15.13	IN^3
I_X =	41.59	IN^4
$C_{F(BENDING)}$ =	1.3	(NDS 4.3.6)
F_{cE} =	656.5	PSI
C_b =	1.13	(NDS 3.10.4)

MISCELLANEOUS:

HEIGHT =	12	FT	
SPACING =	56	IN	
ECCENTRICITY =	0.1	IN	
$C_{F(COMPRESSION)}$ =	1.10	(NDS 4.3.6)	
	APPLY?		
$C_{SYS(BENDING)}$ =	1.00	NO	(SDPWS T3.1.1.1) Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.00	NO	(NDS 4.3.9) Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1	DEAD + LIVE + 5 PSF LAT.	CASE 4	DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 2	DEAD + SNOW + 5 PSF LAT.	CASE 5	DEAD + 0.60WIND
CASE 3	DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.	CASE 6	DEAD + 0.75EISMIC
		CASE 7	DEAD + 0.535EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.44	0.392	582	1170	456
2 & 3	1.15	1708	0.38	0.347	593	1346	456
4 & 5	1.60	2376	0.28	0.258	614	1872	456
6 & 7	1.60	2376	0.28	0.258	614	1872	456

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	0	0	420	0	420	333
2	0	0	420	0	420	333
3	0	0	420	0	420	333
4	0	0	1123	0	1123	891
5	0	0	1497	0	1497	1188
6	0	0	0	0	0	0
7	0	0	0	0	0	0

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.00	0.28	0.00	0.28	0.00	0.17	L/825
2	0.00	0.25	0.00	0.25	0.00	0.17	L/825
3	0.00	0.25	0.00	0.25	0.00	0.17	L/825
4*	0.00	0.48	0.00	0.48	0.00	0.33	L/441
5*	0.00	0.63	0.00	0.63	0.00	0.44	L/331
6	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
7	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
MAX. --->	0.00	0.63	0.00	0.63	0.00	0.44	#DIV/0!
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} =	1.15	(NDS 4.3.7)
F_V =	150	PSI

DBL TOP PLATE PROPERTIES:

A_X =	16.50	IN^2
S_X =	4.13	IN^3
I_X =	3.09	IN^4

ALLOWABLE STRESSES:

F_V' =	150	PSI
F_b' =	1346	PSI

APPLIED STRESSES:

f_v =	0	PSI	<--- O.K.
f_b =	0	PSI	<--- O.K.
Δ_{MAX} =	0.000	IN	

STUD REACTIONS (OUT - OF - PLANE)
832 LB

Project: K2526 Job Number: 21-046 NOTES:

Sheet: _____ of _____ Name: BRT

Originating Office: Tacoma Date: 02/03/22

Seattle
Tacoma
Portland

STUD WALL DESIGN - FULL-HT (4)

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b = 900 PSI
F_c = 1350 PSI
$F_{c\perp}$ = 405 PSI
E = 1.50E+06 PSI

APPLIED LOADS:

W_{WIND} = 30.4 PSF
$W_{SEISMIC}$ = 0.0 PSF

P_{DEAD} = 0 LBS
P_{LIVE} = 0 LBS
P_{SNOW} = 0 LBS
P_{WIND} = 0 LBS
$P_{SEISMIC}$ = 0 LBS

STUD SIZE: (1) 2x6

A_X = 8.25 IN^2
S_X = 7.56 IN^3
I_X = 20.80 IN^4
$C_{F(BENDING)}$ = 1.3 (NDS 4.3.6)
F_{cE} = 656.5 PSI
C_b = 1.25 (NDS 3.10.4)

MISCELLANEOUS:

HEIGHT = 12 FT
SPACING = 29 IN
ECCENTRICITY = 0.1 IN
$C_{F(COMPRESSION)}$ = 1.10 (NDS 4.3.6)

		APPLY?	
$C_{SYS(BENDING)}$ =	1.00	NO	(SDPWS T3.1.1.1) Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.00	NO	(NDS 4.3.9) Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1 DEAD + LIVE + 5 PSF LAT.
CASE 2 DEAD + SNOW + 5 PSF LAT.
CASE 3 DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.
CASE 4 DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 5 DEAD + 0.60WIND
CASE 6 DEAD + 0.75EISMIC
CASE 7 DEAD + 0.535EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.44	0.392	582	1170	506
2 & 3	1.15	1708	0.38	0.347	593	1346	506
4 & 5	1.60	2376	0.28	0.258	614	1872	506
6 & 7	1.60	2376	0.28	0.258	614	1872	506

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	0	0	218	0	218	345
2	0	0	218	0	218	345
3	0	0	218	0	218	345
4	0	0	595	0	595	944
5	0	0	793	0	793	1259
6	0	0	0	0	0	0
7	0	0	0	0	0	0

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.00	0.29	0.00	0.29	0.00	0.18	L/797
2	0.00	0.26	0.00	0.26	0.00	0.18	L/797
3	0.00	0.26	0.00	0.26	0.00	0.18	L/797
4*	0.00	0.50	0.00	0.50	0.00	0.35	L/416
5*	0.00	0.67	0.00	0.67	0.00	0.46	L/312
6	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
7	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
MAX. --->	0.00	0.67	0.00	0.67	0.00	0.46	#DIV/0!
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} = 1.15 (NDS 4.3.7)
F_V = 150 PSI

DBL TOP PLATE PROPERTIES:

A_X = 16.50 IN^2
S_X = 4.13 IN^3
I_X = 3.09 IN^4

ALLOWABLE STRESSES:

F_V' = 150 PSI
F_b' = 1346 PSI

APPLIED STRESSES:

f_v = 0 PSI <--- O.K.
f_b = 0 PSI <--- O.K.
Δ_{MAX} = 0.000 IN

STUD REACTIONS (OUT - OF - PLANE)
441 LB

Project: K2526 Job Number: 21-046 NOTES:

Sheet: _____ of _____ Name: BRT

Originating Office: Tacoma Date: 02/03/22

Seattle Tacoma PCS Structural Solutions

STUD WALL DESIGN - FULL-HT GARAGE

2018 NDS/2018 IBC

WALL DATA

LUMBER TYPE: DF#2/HF#1

F_b =	900	PSI
F_c =	1350	PSI
$F_{c\perp}$ =	405	PSI
E =	1.50E+06	PSI

STUD SIZE: (2) 2x6

A_X =	16.50	IN^2
S_X =	15.13	IN^3
I_X =	41.59	IN^4
$C_{F(BENDING)}$ =	1.3	(NDS 4.3.6)
F_{cE} =	945.3	PSI
C_b =	1.13	(NDS 3.10.4)

APPLIED LOADS:

W_{WIND} =	29.7	PSF
$W_{SEISMIC}$ =	0.0	PSF

P_{DEAD} =	0	LBS
P_{LIVE} =	0	LBS
P_{SNOW} =	0	LBS
P_{WIND} =	0	LBS
$P_{SEISMIC}$ =	0	LBS

MISCELLANEOUS:

HEIGHT =	10	FT	
SPACING =	68	IN	
ECCENTRICITY =	0.1	IN	
$C_{F(COMPRESSION)}$ =	1.10	(NDS 4.3.6)	
	APPLY?		
$C_{SYS(BENDING)}$ =	1.00	NO	(SDPWS T3.1.1.1) Is not applied w/ Cr
$C_{r(BENDING)}$ =	1.00	NO	(NDS 4.3.9) Is not applied w/ Csys

LOAD CASES - IBC 1605.3.1

CASE 1 DEAD + LIVE + 5 PSF LAT.
CASE 2 DEAD + SNOW + 5 PSF LAT.
CASE 3 DEAD + 0.75LIVE + 0.75SNOW + 5 PSF LAT.
CASE 4 DEAD + 0.45WIND + 0.75LIVE + 0.75SNOW
CASE 5 DEAD + 0.60WIND
CASE 6 DEAD + 0.75EISMIC
CASE 7 DEAD + 0.535EISMIC + 0.75LIVE + 0.75SNOW

ALLOWABLE STRESSES - Cd PER NDS T2.3.2, Cp PER NDS 3.7.1, ASSUME Cm, Ct, Ci, CL = 1.0

CASE	C_D	F_c*	F_{cE}/F_c*	C_P	F_c'	F_b'	$F_{c\perp}$
1	1.00	1485	0.64	0.522	776	1170	456
2 & 3	1.15	1708	0.55	0.470	803	1346	456
4 & 5	1.60	2376	0.40	0.358	850	1872	456
6 & 7	1.60	2376	0.40	0.358	850	1872	456

APPLIED STRESSES - NDS CHAPTER 3 DESIGN EQUATIONS

CASE	$P_{APPLIED}$	f_c	$M_{LAT. LOAD}$	$M_{ECC.}$	M_{TOTAL}	f_b
1	0	0	354	0	354	281
2	0	0	354	0	354	281
3	0	0	354	0	354	281
4	0	0	947	0	947	751
5	0	0	1262	0	1262	1001
6	0	0	0	0	0	0
7	0	0	0	0	0	0

DESIGN CHECKS - COMBINED STRESS CHECK PER NDS EQN 3.9-3

CASE	f_c/F_c'	f_b/F_b'	$f_c/F_{c\perp}$	Combined	f_c/F_{cE}	Deflection	L/?
1	0.00	0.24	0.00	0.24	0.00	0.10	L/1174
2	0.00	0.21	0.00	0.21	0.00	0.10	L/1174
3	0.00	0.21	0.00	0.21	0.00	0.10	L/1174
4*	0.00	0.40	0.00	0.40	0.00	0.19	L/628
5*	0.00	0.53	0.00	0.53	0.00	0.25	L/471
6	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
7	0.00	0.00	0.00	0.00	0.00	0.00	#DIV/0!
MAX. --->	0.00	0.53	0.00	0.53	0.00	0.25	#DIV/0!
	O.K.	O.K.	O.K.	O.K.	O.K.		

* Deflections reduced by 0.42 per IBC Table 1604.3 footnote f. Increase deflection by 1.4 for jambs supporting glass.

PLATE BENDING - *ALIGN STUDS WITH JOISTS WHERE POSSIBLE*

MISCELLANEOUS:

C_{fu} =	1.15	(NDS 4.3.7)
F_V =	150	PSI

DBL TOP PLATE PROPERTIES:

A_X =	16.50	IN^2
S_X =	4.13	IN^3
I_X =	3.09	IN^4

ALLOWABLE STRESSES:

F_V' =	150	PSI
F_b' =	1346	PSI

APPLIED STRESSES:

f_v =	0	PSI	<--- O.K.
f_b =	0	PSI	<--- O.K.
Δ_{MAX} =	0.000	IN	

STUD REACTIONS (OUT - OF - PLANE)
842 LB