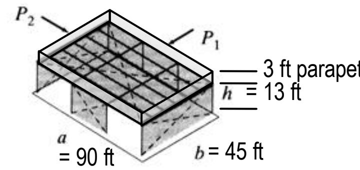
ARCH 631. Assignment #8

Date: 10/15/13, *due 11/7/13* *Worth 25 pts.*

Problems:

1. A 45 ft x 90 ft structure has the openings and shear walls shown in Figure 14.7 on page 534 (with no rear shear walls). The roof diaphragm is 13 ft from the base, but this structure has a parapet wall extending 3 ft *past* the roof level where the loads are transmitted. Determine the shear forces in the shear walls, R_1, R_2 and R_3, when the design wind load is 23 lb/ft^2.



(a) Basic structure with fully rigid roof plane (diaphragm) and three shear walls

Answer: $R_1 = R_2 = 9{,}832.5$ lb, $R_3 = 9{,}832.5$ lb

2. For the shear wall on the long side (R_3) of the building in Problem 1, determine the overturning moment.

Answer: $M_0 = 127{,}822$ lb-ft

3. If the shear wall on the long side (R_3) of the building in Problem 1 is removed, the diaphragm can be considered to behave like a deep truss with a distributed load on it. Determine the maximum force in the top and bottom "chords" from the maximum moment.

Answer: $T = C = 4{,}916$ lb

4. You are designing a building in seismic zone 3 which is a large auditorium (>300 occupancy) (I = 1.25). Z = 0.30, C = 1.25S/T$^{2/3}$, S =1.2, T = 0.5, R_W = 6, and the total dead load = 85,000 lbs. What is the base shear?

Answer: V = 12.6 kips

5. Complete text problem 16.2 on page 514.

16.2 With respect to shear stresses alone, what is the required diameter for a bolt in single shear that transfers a shear force of 6000 lb between two plates? Assume that $F_v = 14{,}000$ lb/in.^{2}

Answer: $^3/_4$-in. diameter.

6. Complete text problem 16.3 on page 514.

16.3 How many inches of $^1/_8$-in. weld are necessary to transfer a shear force of 6000 lb from one plate to another? Assume that $F_v = 13{,}600$ lb/in.^{2}

Answer: 5 in.

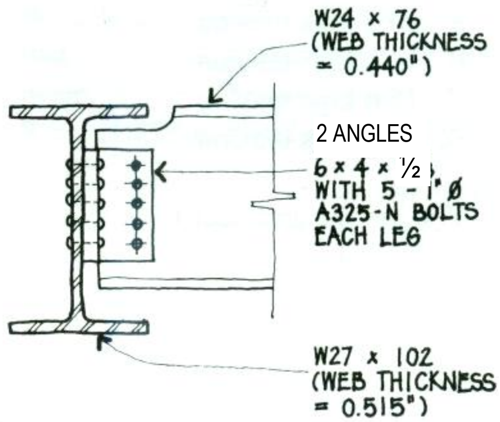
7. Complete text problem 16.4 on page 588. *Note: Assume F_v = 14,000 psi.*

16.4. Will a bolt $^1/_2$ in. in diameter used in double shear carry a force of 2000 lb? What shear stress is present?

Answer: Yes. $f_v = 5093$ lb/in.^{2}

8. What is the capacity of the connection shown? All connection material is ASTM A36 (F_y = 36 ksi, F_u = 58 ksi), while the beams are A992 (F_y = 50 ksi, F_u = 65 ksi). Assume that the connection angles are adequate with standard holes and 3 in. spacing, and that the coping distances (L_{ev} & L_{eh}) are sufficiently large.

***Partial** answer:* ASD **possible** limits are 154, 212, 166.3, or 389.3 kips; *or* LRFD **possible** limits are 232, 318, 248.6 or 582 kips, *so …*

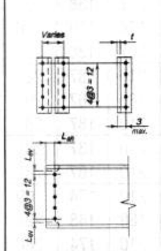


Beam F_y = 50 ksi, F_u = 65 ksi
Angle F_y = 36 ksi, F_u = 58 ksi

Table 10-1 (continued)
All-Bolted Double-Angle Connections

1-in. Bolts

Bolt and Angle Available Strength, kips



5 Rows W30, 27, 24, 21, 18 Bolt Group	Thread Cond.	Hole Type	1/4 ASD	1/4 LRFD	5/16 ASD	5/16 LRFD	3/8 ASD	3/8 LRFD	1/2 ASD	1/2 LRFD
Group A	N	STD	77.2	116	96.5	145	116	174	154	232
	X	STD	77.2	116	96.5	145	116	174	154	232
	SC Class A	STD	77.2	116	96.5	145	115	173	115	173
		OVS	69.1	104	86.3	129	98.2	147	98.2	147
		SSLT	77.2	116	96.5	145	115	173	115	173
	SC Class B	STD	77.2	116	96.5	145	116	174	154	232
		OVS	69.1	104	86.3	129	104	155	138	207
		SSLT	77.2	116	96.5	145	116	174	154	232
Group B	N	STD	77.2	116	96.5	145	116	174	154	232
	X	STD	77.2	116	96.5	145	116	174	154	232
	SC Class A	STD	77.2	116	96.5	145	116	174	145	217
		OVS	69.1	104	86.3	129	104	155	123	184
		SSLT	77.2	116	96.5	145	116	174	145	217
	SC Class B	STD	77.2	116	96.5	145	116	174	154	232
		OVS	69.1	104	86.3	129	104	155	138	207
		SSLT	77.2	116	96.5	145	116	174	154	232

Beam Web Available Strength per Inch Thickness, kips/in.

Hole Type		STD				OVS				SSLT			
		L_{eh}*, in.											
L_{ev}, in.		1½		1¾		1½		1¾		1½		1¾	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Coped at Top Flange Only	1¼	182	273	190	285	163	244	171	256	178	267	186	279
	1⅜	184	277	193	289	165	247	173	260	180	271	189	283
	1½	187	280	195	293	167	251	176	263	183	274	191	286
	1⅝	189	284	197	296	170	255	178	267	185	278	193	290
	2	197	295	205	307	177	266	185	278	193	289	201	301
	3	216	324	224	336	197	295	205	307	212	318	220	330
Coped at Both Flanges	1¼	173	260	173	260	155	232	155	232	173	260	173	260
	1⅜	178	267	178	267	160	239	160	239	178	267	178	267
	1½	183	274	183	274	165	247	165	247	183	274	183	274
	1⅝	188	282	188	282	169	254	169	254	185	278	188	282
	2	197	295	202	303	177	266	184	276	193	289	201	301
	3	216	324	224	336	197	295	205	307	212	318	220	330
Uncoped		380	570	380	570	351	527	351	527	380	570	380	570

Support Available Strength per Inch Thickness, kips/in.

Hole Type	ASD	LRFD
STD/SSLT	761	1140
OVS	702	1050

Notes:
STD = Standard holes
OVS = Oversized holes
SSLT = Short-slotted holes transverse to direction of load
N = Threads included
X = Threads excluded
SC = Slip critical

* Tabulated values include ¼-in. reduction in end distance, L_{eh}, to account for possible underrun in beam length.

Note: Slip-critical bolt values assume no more than one filler has been provided or bolts have been added to distribute loads in the fillers.

Table 7-4
Available Bearing Strength at Bolt Holes Based on Bolt Spacing
kips/in. thickness

Hole Type	Bolt Spacing, *s*, in.	F_u, ksi	5/8 r_n/Ω ASD	5/8 ϕr_n LRFD	3/4 r_n/Ω ASD	3/4 ϕr_n LRFD	7/8 r_n/Ω ASD	7/8 ϕr_n LRFD	1 r_n/Ω ASD	1 ϕr_n LRFD
STD SSLT	$2^2/_3\, d_b$	58	34.1	51.1	41.3	62.0	48.6	72.9	55.8	83.7
		65	38.2	57.3	46.3	69.5	54.4	81.7	62.6	93.8
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	67.4	101
		65	48.8	73.1	58.5	87.8	68.3	102	75.6	113
SSLP	$2^2/_3\, d_b$	58	27.6	41.3	34.8	52.2	42.1	63.1	47.1	70.7
		65	30.9	46.3	39.0	58.5	47.1	70.7	52.8	79.2
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	58.7	88.1
		65	48.8	73.1	58.5	87.8	68.3	102	65.8	98.7
OVS	$2^2/_3\, d_b$	58	29.7	44.6	37.0	55.5	44.2	66.3	49.3	74.0
		65	33.3	50.0	41.4	62.2	49.6	74.3	55.3	82.9
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	60.9	91.4
		65	48.8	73.1	58.5	87.8	68.3	102	68.3	102
LSLP	$2^2/_3\, d_b$	58	3.62	5.44	4.35	6.53	5.08	7.61	5.80	8.70
		65	4.06	6.09	4.88	7.31	5.69	8.53	6.50	9.75
	3 in.	58	43.5	65.3	39.2	58.7	28.3	42.4	17.4	26.1
		65	48.8	73.1	43.9	65.8	31.7	47.5	19.5	29.3
LSLT	$2^2/_3\, d_b$	58	28.4	42.6	34.4	51.7	40.5	60.7	46.5	69.8
		65	31.8	47.7	38.6	57.9	45.4	68.0	52.1	78.2
	3 in.	58	36.3	54.4	43.5	65.3	50.8	76.1	56.2	84.3
		65	40.6	60.9	48.8	73.1	56.9	85.3	63.0	94.5
STD, SSLT, SSLP, OVS, LSLP	$s \geq s_{full}$	58	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104
		65	48.8	73.1	58.5	87.8	68.3	102	78.0	117
LSLT	$s \geq s_{full}$	58	36.3	54.4	43.5	65.3	50.8	76.1	58.0	87.0
		65	40.6	60.9	48.8	73.1	56.9	85.3	65.0	97.5
Spacing for full bearing strength s_{full}[a], in.		STD, SSLT, LSLT	$1^{15}/_{16}$		$2^5/_{16}$		$2^{11}/_{16}$		$3^1/_{16}$	
		OVS	$2^1/_{16}$		$2^7/_{16}$		$2^{13}/_{16}$		$3^1/_4$	
		SSLP	$2^1/_8$		$2^1/_2$		$2^7/_8$		$3^5/_{16}$	
		LSLP	$2^{13}/_{16}$		$3^3/_8$		$3^{15}/_{16}$		$4^1/_2$	
Minimum Spacing[a] = $2^2/_3 d$, in.			$1^{11}/_{16}$		2		$2^5/_{16}$		$2^{11}/_{16}$	

STD = standard hole
SSLT = short-slotted hole oriented transverse to the line of force
SSLP = short-slotted hole oriented parallel to the line of force
OVS = oversized hole
LSLP = long-slotted hole oriented parallel to the line of force
LSLT = long-slotted hole oriented transverse to the line of force

ASD	LRFD	Note: Spacing indicated is from the center of the hole or slot to the center of the adjacent hole or slot in the line of force. Hole deformation is considered. When hole deformation is not considered, see AISC *Specification* Section J3.10.
$\Omega = 2.00$	$\phi = 0.75$	[a] Decimal value has been rounded to the nearest sixteenth of an inch.

Table 7-1
Available Shear Strength of Bolts, kips

ASTM Desig.	Thread Cond.	F_{nv}/Ω (ksi) ASD	ϕF_{nv} (ksi) LRFD	Loading	5/8 r_n/Ω ASD	5/8 ϕr_n LRFD	3/4 r_n/Ω ASD	3/4 ϕr_n LRFD	7/8 r_n/Ω ASD	7/8 ϕr_n LRFD	1 r_n/Ω ASD	1 ϕr_n LRFD
Nominal Bolt Area, in.^{2}					0.307		0.442		0.601		0.785	
Group A	N	27.0	40.5	S	8.29	12.4	11.9	17.9	16.2	24.3	21.2	31.8
				D	16.6	24.9	23.9	35.8	32.5	48.7	42.4	63.6
	X	34.0	51.0	S	10.4	15.7	15.0	22.5	20.4	30.7	26.7	40.0
				D	20.9	31.3	30.1	45.1	40.9	61.3	53.4	80.1
Group B	N	34.0	51.0	S	10.4	15.7	15.0	22.5	20.4	30.7	26.7	40.0
				D	20.9	31.3	30.1	45.1	40.9	61.3	53.4	80.1
	X	42.0	63.0	S	12.9	19.3	18.6	27.8	25.2	37.9	33.0	49.5
				D	25.8	38.7	37.1	55.7	50.5	75.7	65.9	98.9
A307	–	13.5	20.3	S	4.14	6.23	5.97	8.97	8.11	12.2	10.6	15.9
				D	8.29	12.5	11.9	17.9	16.2	24.4	21.2	31.9

ASTM Desig.	Thread Cond.	F_{nv}/Ω (ksi) ASD	ϕF_{nv} (ksi) LRFD	Loading	1 1/8 r_n/Ω ASD	1 1/8 ϕr_n LRFD	1 1/4 r_n/Ω ASD	1 1/4 ϕr_n LRFD	1 3/8 r_n/Ω ASD	1 3/8 ϕr_n LRFD	1 1/2 r_n/Ω ASD	1 1/2 ϕr_n LRFD
Nominal Bolt Area, in.^{2}					0.994		1.23		1.48		1.77	
Group A	N	27.0	40.5	S	26.8	40.3	33.2	49.8	40.0	59.9	47.8	71.7
				D	53.7	80.5	66.4	99.6	79.9	120	95.6	143
	X	34.0	51.0	S	33.8	50.7	41.8	62.7	50.3	75.5	60.2	90.3
				D	67.6	101	83.6	125	101	151	120	181
Group B	N	34.0	51.0	S	33.8	50.7	41.8	62.7	50.3	75.5	60.2	90.3
				D	67.6	101	83.6	125	101	151	120	181
	X	42.0	63.0	S	41.7	62.6	51.7	77.5	62.2	93.2	74.3	112
				D	83.5	125	103	155	124	186	149	223
A307	–	13.5	20.3	S	13.4	20.2	16.6	25.0	20.0	30.0	23.9	35.9
				D	26.8	40.4	33.2	49.9	40.0	60.1	47.8	71.9

ASD	LRFD	For end loaded connections greater than 38 in., see AISC *Specification* Table J3.2 footnote b.
$\Omega = 2.00$	$\phi = 0.75$	