ARCH 331. Assignment #8

Date: 6/25/14, due 6/27/14 Pass-fail work

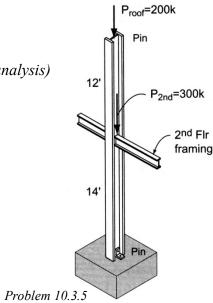
Problems: supplemental problems (8A, etc.) and from Onouye Chapter 10

Notes: Problems marked with a * have been altered with respect to the problem stated in the text. Selected problems not required to be worked will be announced in class.

96 (14%)* 10.3.5 A two-story, continuous W12×106 column supports a roof load of 200 kips and an intermediate (second floor) load of 300 kips. Assume the top and bottom have pin connections. Is the column section shown adequate? (unified ASD column analysis) Assume A36 steel ($F_y = 36$ ksi, $E = 29 \times 10^3$ ksi)

$$kL/r_x = 57.4$$
, $kL/r_y = 54.4$, $P_n/\Omega = 510$ k, so...

(8%) 8A) For the column of problem 10.3.5, assume the roof load is a live load, and the 2nd floor framing load is a dead load. Using LRFD design and the tables for the critical unfactored compressive stress, determine if the column section shown is adequate. (LRFD column analysis)



Partial answers to check with:

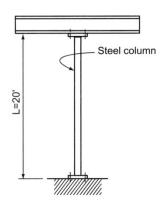
$$\phi P_n = 767 \, k, \, so...$$

wide flange

(22%)*10.3.9 What is the most economical $\frac{1}{4}$ (W200) column for Problem 10.3.8 to support a load of 92 k dead and 140 k live and a length of L=20 ft. Assume $F_y=50$ ksi and K=1.0. (LRFD steel column design)

Partial answers to check with:

LRFD:
$$A_{req'd} \ge 10.2 \text{ in}^2 \text{ with } \phi F_{cr} = 16.35 \text{ ksi, so...}$$



Problem 10.3.8

(6%) 8B) For the column of problem 10.3.9, use the LRFD column capacity tables provided to determine to determine the most economical wide flange column.

(LRFD column design by tables)

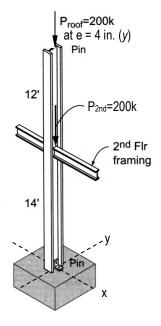
Partial answers to check with: LRFD: $P_u = 334.4 \text{ k}$, $\phi_c P_n = \underline{\hspace{1cm}} k$, so

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(18%) 8C) For the column of problem 10.3.5 (A36), the roof load (live) is applied at an eccentricity of 4 inches out of plane of the wall (y), and the dead load at the 2nd floor framing has been reduced to 200 k. Is the W12x96 adequate when ϕM_{nx} =545 k-ft? (*LRFD beam-column analysis*)

Partial answers to check with: $P_r/P_c = 0.73$, $P_{e1} = 2450$ k, $B_1 = 1.0$, interaction value < 1.0

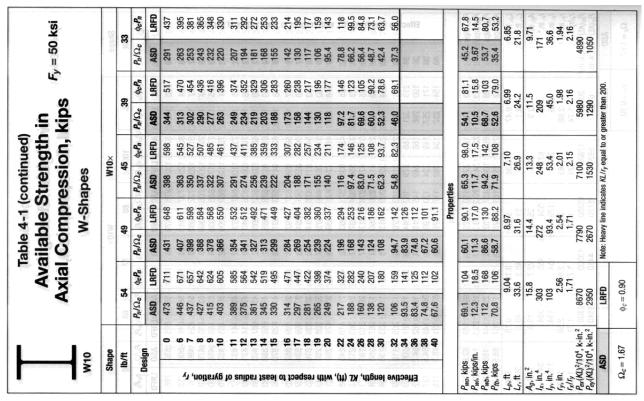
F _y = 8	Table 4-1 (continued) vailable Strength in al Compression, kips W Shapes												
												W8	
Sha				1		1	W		_	_	1 _		
Wt	/ft	$P_n/\Omega_c \mid \phi_c P_n$		P_n/Ω_c	φ _c P _n	P_n/Ω_c	8 φ _c P _n	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	5 φ _c P _n	P_n/Ω_c	φ _c P _n
Des	ign	ASD	Ψ _C , n	ASD	LRFD	ASD	Ψc' n LRFD	ASD	LRFD	ASD	Ψc' n	ASD	LRFD
	0	589	886	512	769	422	634	351	528	308	463	273	410
of gyration $r_{ m y}$	6 7 8 9	542 525 507 487 466	814 790 762 733 701	469 455 439 422 403	706 684 660 634 606	387 375 361 347 331	581 563 543 521 497	321 310 299 286 273	482 467 449 430 410	281 272 261 250 238	422 408 393 376 358	249 241 232 222 211	374 362 348 333 317
Effective length KL (ft) with respect to least radius of gyration $t_{\mathbf{y}}$	11 12 13 14 15	444 421 397 372 348	667 632 596 560 523	383 363 342 320 299	576 545 514 482 449	314 297 280 262 244	473 447 420 394 367	259 244 229 214 199	389 367 344 322 299	226 213 200 187 173	340 320 300 280 260	200 188 177 165 153	300 283 265 248 230
L (ft) with respe	16 17 18 19 20	323 299 276 253 231	486 450 415 380 347	278 257 236 216 197	417 386 355 325 296	226 209 192 175 159	340 314 288 263 239	184 169 155 141 127	276 254 233 212 192	160 147 135 122 111	241 221 202 184 166	141 130 118 108 97.1	212 195 178 162 146
fective length K	22 24 26 28 30	191 160 137 118 103	287 241 205 177 154	162 137 116 100 87.4	244 205 175 151 131	132 111 94.2 81.2 70.7	198 166 142 122 106	105 88.5 75.4 65.0 56.7	158 133 113 97.8 85.2	91.4 76.8 65.4 56.4 49.1	137 115 98.3 84.8 73.9	80.3 67.4 57.5 49.6 43.2	121 101 86.4 74.5 64.9
<u>.</u>	32 34	90.2 79.9	136 120	76.8 68.0	115 102	62.2 55.1	93.4 82.8	49.8 44.1	74.8 66.3	43.2	64.9	37.9	57.0
		13.3	120	00.0	102	Propert		71.1	00.0				
P_{wo} (kips) P_{wi} (kips/in.) P_{wb} (kips) P_{fb} (kips)		126 19.0 505 164	189 28.5 760 246	102 17.0 362 123	154 25.5 544 185	71.9 13.3 175 87.8	108 20.0 262 132	57.2 12.0 127 58.7	85.9 18.0 191 88.2	45.9 10.3 81.3 45.9	68.9 15.5 122 68.9	39.4 9.50 63.2 35.4	59.1 14.3 94.9 53.2
L_{ρ} (ft) L_{ϵ} (ft)		/	7.49 7.42 47.7 41.7		7.35 35.2		7.21 29.9		7.17 27.0		7.18 24.8		
L _r (tt) A _g (in.²) L _s (in.4) L _s (in.4) L _s (in.4) A _g (in.		1 27	9.7 2 88.6 2.12 1.75	41.7 17.1 228 75.1 2.10 1.74 6530 2150		14.1 184 60.9 2.08 1.74 5270		11.7 146 49.1 2.04 1.73 4180 1410		10.3 127 42.6 2.03 1.73 3630 1220		9.12 110 37.1 2.02 1.72 3150 1060	
$\Omega_c = 1$		LRF $\phi_c = 0$		Note: He	Note: Heavy line indicates KI/r equal to or greater than 200.								



Problem 10.3.5

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.

Name		1	d	Ava	Available Strength in kial Compression, kip	ole S mpr	strei	ngth ion,	Available Strength in Axial Compression, kips		$F_{y} = 50 \text{ ksi}$	S
SER	>	2				N-Sh	apes					
ASD SS SO 45 1.0 ASD LRFD φePn Pu/Ωe pu/Ωe </th <th>Sh</th> <th>abe</th> <th></th> <th></th> <th>MS×</th> <th>N</th> <th>W</th> <th>12×</th> <th></th> <th></th> <th>808</th> <th>SI</th>	Sh	abe			MS×	N	W	12×			808	SI
ASD LRFD ASD ASD ASD ASD ASD	- IP	/#	61	88	9.8	3	152 75	0:	9.4	2	40	0
ASD LRFD ASD	Popular Popula	P4/04	P_n/Ω_c	92	P,10c	$\phi_c P_n$	P,100	ocPn →	Pn/Qc	ocPn	Pn/10c	¢cPn
509 765 467 702 437 657 392 589 350 479 720 439 660 396 595 355 534 317 469 705 429 660 396 595 355 534 317 469 705 429 660 382 574 342 595 387 317 396 397 347 289 494 293 317 396 396 397 447 266 396 396 396 234 347 266 396 396 396 396 234 347 266 396 296 396 396 396 234 347 266 396 236 348 228 349 286 343 366 369 346 396 234 346 366 366 348 366 348 366 348 366 348 366 348	GRAD.	III III	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
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458 705 429 646 382 574 342 515 305 451 451 652 451 515 305 451 652 367 551 329 494 283 451 647 394 592 332 500 297 447 265 419 529 449 529 440 529 440 529 441 229 510 316 651 365 549 295 443 268 396 224 318 478 236 355 210 316 187 332 499 301 453 217 326 193 290 177 326 448 222 344 216 220 193 290 177 326 448 222 318 478 252 378 162 244 144 216 127 314 475 281 128 192 174 128 192 174 128 192 174 128 192 174 128 192 174 128 192 174 128 192 174 128 192 174 128 192 174 128 192 174 116 69.4 104 57.2 112 66.3 99.7 86.6 112.0 18.0 17.1 16.7 65.0 97.8 19.8 19.8 17.1 16.8 19.9 10.5 62.6 94.1 128 19.5 60.3	8	9	479	720	439	099	396	595	355	534	317	476
457 668 419 629 367 551 329 494 283 441 668 407 611 350 526 313 471 279 440 601 365 549 295 443 263 396 294 384 577 350 526 275 413 263 396 294 384 577 350 526 275 413 268 369 218 382 499 301 453 217 326 193 290 177 314 472 285 428 198 298 176 265 156 298 448 222 378 180 270 160 240 142 278 448 252 378 180 270 160 240 142 278 448 252 378 180 270 160 240 142 278 448 252 378 180 270 160 240 142 278 448 252 378 180 270 160 240 142 278 448 252 378 180 270 160 240 142 278 448 252 378 180 270 160 240 142 278 448 268 354 146 220 130 195 115 278 448 222 378 180 270 160 97.8 86.8 148 222 378 192 74.7 112 66.3 90.5 86.8 149 307 121 16 65.0 97.8 57.8 86.8 51.1 109 164 97.8 173 12.3 18.5 11.2 66.3 90.5 50.2 277 44 112 67.9 102 70.3 105 60.3 90.5 50.2 288 378 6.6 97.8 6.6 97.8 66.8 93 288 1 125 73.3 110 76.6 115 61.9 93.0 49.6 251 20 300 12200 11200 9960 879 250 3000 2740 11200 9960 1879 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99618 170 250 3000 2740 11200 99610 100 99610 100 9000 9000 9000 90	ט' נ	7	469	705	429	646	382	574	342	515	305	459
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14	of 1	16	332	499	301	453	217	326	193	290	171	257
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169	nəl e	30	124	187	11	167	65.0	87.8	57.8	86.8	51.1	76.8
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77.4 116 69.4 104 69.9 105 62.6 94.1 Properties 74.4 112 67.9 102 70.3 105 60.3 90.5 50.2 12.0 18.0 11.5 17.3 12.3 18.5 11.2 16.8 9.88 76.6 11.5 67.9 10.2 70.3 10.5 60.3 90.5 50.2 12.0 18.0 11.5 17.3 12.3 18.5 11.2 16.8 9.88 76.6 11.5 61.9 93.0 76.6 11.5 61.9 93.0 49.6 8.87 29.8 28.2 23.8 22.4 2 17.0 15.6 14.6 13.1 11.0 2.51 2.48 56.3 50.0 44 13600 12200 11200 9960 879 3060 2740 11200 9961 1264 12600 12700 1610 14300	ette	¥ %	96.7	130	86.6	116	1000 E		999		100	
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125 73.3 110 88.4 133 65.6 98.6 44.8 14.8 15.6 115 61.9 93.0 76.6 115 61.9 93.0 49.6 115 61.9 93.0 49.6 129.8 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.4 22.6 22.4 22.4 22.6 22.4 22.6	wi, kips/	în.	12.0	18.0	11.5	17.3	12.3	18.5	11.2	16.8	9.83	14.8
29.8 28.7 28.7 6.89 22.4 6.89 2 22.4 475 425 391 348 30 475 2.10 2.51 2.11 2.64 360 2.74 0 1200 1610 1430 1610 0 greater than 200.	wb, kips	2.82	83.1	125	73.3	110	88.4	133	65.6	98.6	44.8	67.4
29.8 28.2 23.8 22.4 17.0 15.6 14.6 13.1 475 42.5 391 348 17.0 2.51 2.48 56.3 50.0 2.51 2.48 1.96 1.95 2.10 2.740 11200 1430 3060 2740 1610 1430	p, ft			8.87	S	8.76		6.92	24.5	3.89		6.85
17.0 15.6 14.6 13.1 348 475 425 391 348 348 348 36.3 2.51 2.48 1.96 1.95 2.64 13600 12200 11200 11200 1430 3060 2740 1610 1610 1430 161	ر, ال		37.5	8.6	98.2	8.2	2	3.8	22	2.4	2	21.1
251 2.48 56.3 50.0 2.10 2.11 2.64 1.96 1.95 3060 2740 1610 1430 1430 1430 1430	lg, in. ²	ro	2 4	7.0	42	5.6	39	4.6	348	3.1	30.	1.
2.51 2.48 1.96 1.95 2.64 2.64 3.60 3.060 2.740 1610 1430 1430 1430 1430 1430 1430 1430 14	, in.4		10	2(6	5.8	5	6.3	20	0.0	4	44.1
13600 12200 11200 9960 3060 2740 1610 1430 1430 LRFD Note: Heavy line indicates <i>KL Ir_{fr}</i> equal to or greater than 200.	⊒,			2.51	40.87	2.48	200	1.96	3.09	1.95		1.94
LRFD Note: Heavy line indicates KL/r _f equal to or greater than 200.	ex(KL) ² /-	104, k-in. ²	1360	0.0	1220		1120	0 0	9960		8790	
CCC	AS	0,0		-0	Note: Heav	y line indic	ates KL/ry	equal to or	greater tha	an 200.	118	
000 = 0	0	1 67	4	000								



MORE NEXT PAGE

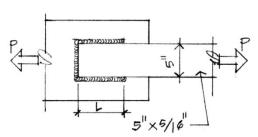
based on shear, bearing, and tension. The plates are made of A36 steel and the four bolts on each side of the splice are A325-SC with standard round holes at 3 inch spacing. Assume the hole spacing is such that block shear rupture is not a concern.

(LRFD steel connection analysis)

Partial answers to check with: 76.0 k (shear), 156.6 k (bearing), 129.6 k (yielding), 135.9 k (rupture), so ...

(6%) 8E) Determine the capacity of the welded connection shown. The weld size is 3/16 in.. Assume the base metal is A36 steel and electrodes are E70XX in each problem. Use L = 4.5". (LRFD steel connection analysis)

Partial answers to check with: 50.625 k (yielding), 58.52 k (shear), so ...



(14%) 8F) Determine the capacity and adequacy of the framed beam connection shown when the factored beam reaction is 300 k and ½" angles of sufficient length are used. The column and beam are A992 steel. The angles are A36 steel with 3" spacing of holes and 1 ¼" edge distances (see table). The bolts are A490-X. (LRFD steel connection analysis)

Partial answers to check with:

529.9 k (shear), 314.2 k (bearing), 606.9 k (bearing), 344 k (angles), so ...

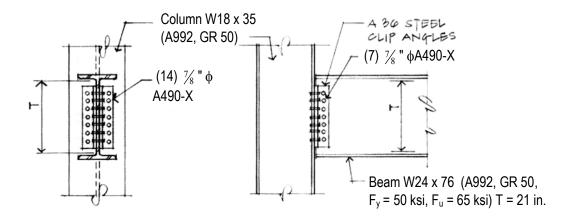


TABLE NEXT PAGE

Angle Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		sTued) Be-IIA	olted Con	Do	ubl tio	e-A	Ang		iO ksi i5 ksi i6 ksi i8 ksi	7/8 Bol	-in. Its
	7 Rows	eamiol	Angle T		Taigio	· · · · · · · · · · · · · · · · · · ·		gle Thic		, in. ϵ	B Row	
W44	4, 40, 36, 33, 30,	Bolt Group	Thread Cond.	Hole Type	1	/4	5	16	3	30, 28	16, 33,	/204W
	27, 24		ASO LOF	THE LEFT	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
292	222 185 2 222 197 2	148	N X	STD STD	115 115	172 172	144 144	215 215	172 172	258 258	227 230	341 344
35	Varies I	Group A	SC Class A	STD OVS SSLT	115 105 113	172 157 170	123 105 123	185 157 185	123 105 123	185 157 185	123 105 123	185 157 185
10	3	148	SC Class B	STD OVS SSLT	115 110 113	172 165 170	144 137 142	215 206 213	172 165 170	258 247 255	206 175 206	308 262 308
3	197 197	148	N S I	STD STD	115 115	172 172	144	215 215	172 172	258 258	230	344 344
19 133 g		Group B	SC Class A	STD OVS SSLT	115 110 113	172 165 170	144 132 142	215 198 213	155 132 155	233 198 233	155 132 155	233 198 233
		148	SC Class B	STD OVS SSLT	115 110 113	172 165 170	144 137 142	215 206 213	172 165 170	258 247 255	230 220 227	344 329 340