ARCH 331. Assignment #10

Date: 10/31/13, *due 11/7/13* *Pass-fail work*

Problems: supplemental problems (10A, etc.) **and** from Onouye Chapters 10
*Notes: Problems marked with a * have been altered with respect to the problem stated in the text.*

(10%) 10A) A long span steel joist with a span of 80 feet is required to support a roof. The joists are spaced at 4 ft apart, the dead load is 12 lb/ft^2, the live load is 28 lb/ft^2 and the live load deflection is limited to L/360 (which is that used to determine the live load limit based on deflection in the Joist catalogue tables). Remembering to estimate a joist weight, use the table provided to select the most economical joist that can be used. *(LRFD open web joist charts)*

Partial answers to check with: 44LH likely

STANDARD LOAD TABLE FOR LONGSPAN STEEL JOISTS, LH-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown in Pounds per Linear Foot (plf)

Joist Designation	Approx. Wt in Lbs. Per Linear Ft. (Joists Only)	Depth in inches	SAFELOAD* in Lbs. Between		CLEAR SPAN IN FEET															
			47-59	60-64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
40LH08	16	40	24900	24900	381	370	361	351	342	333	325	316	309	301	294	288	280	274	267	261
					150	144	138	132	127	122	117	112	108	104	100	97	93	90	86	83
40LH09	21	40	32700	32700	498	484	472	459	447	436	424	414	403	394	384	375	366	358	349	342
					196	188	180	173	166	160	153	147	141	136	131	126	122	118	113	109
40LH10	21	40	36000	36000	550	535	520	507	493	481	469	457	445	435	424	414	403	393	382	373
					216	207	198	190	183	176	169	162	156	150	144	139	134	129	124	119
40LH11	22	40	39300	39300	598	582	567	552	537	523	510	498	484	472	462	450	439	429	418	409
					234	224	215	207	198	190	183	176	169	163	157	151	145	140	135	130
40LH12	25	40	47850	47850	729	708	688	670	652	636	619	603	588	573	559	546	532	519	507	495
					285	273	261	251	241	231	222	213	205	197	189	182	176	169	163	157
40LH13	30	40	56400	56400	859	835	813	792	771	750	730	712	694	676	660	643	628	613	598	585
					334	320	307	295	283	271	260	250	241	231	223	214	207	199	192	185
40LH14	35	40	64500	64500	984	957	930	904	880	856	834	813	792	772	753	735	717	699	682	666
					383	367	351	336	323	309	297	285	273	263	252	243	233	225	216	209
40LH15	36	40	72150	72150	1101	1068	1036	1006	978	949	924	898	874	850	828	807	786	766	747	729
					427	408	390	373	357	342	328	315	302	290	279	268	258	248	239	230
40LH16	42	40	79500	79500	1212	1194	1176	1158	1141	1126	1095	1065	1036	1009	982	957	933	909	886	864
					469	455	441	428	416	404	387	371	356	342	329	316	304	292	282	271
			52-59	**60-72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**
44LH09	19	44	30000	30000	408	397	388	379	370	363	354	346	339	331	324	316	310	303	297	291
					158	152	146	141	136	131	127	122	118	114	110	106	103	99	96	93
44LH10	21	44	33150	33150	450	439	429	418	408	399	390	381	373	364	357	349	342	334	327	321
					174	168	162	155	150	144	139	134	130	125	121	117	113	110	106	103
44LH11	22	44	35850	35850	487	475	465	453	442	433	423	414	403	396	387	378	370	363	354	348
					188	181	175	168	162	157	151	146	140	136	131	127	123	119	115	111
44LH12	25	44	44400	44400	603	589	574	561	547	534	520	508	496	484	472	462	450	439	430	420
					232	224	215	207	200	192	185	179	172	166	160	155	149	144	139	134
44LH13	30	44	52650	52650	715	699	681	666	649	634	619	606	592	579	565	553	541	529	519	507
					275	265	254	246	236	228	220	212	205	198	191	185	179	173	167	161
44LH14	31	44	60600	60600	823	801	780	759	739	721	703	685	669	654	637	622	609	594	580	568
					315	302	291	279	268	259	249	240	231	223	215	207	200	193	187	181
44LH15	36	44	70500	70500	958	934	912	889	868	847	826	805	786	768	750	732	714	699	682	667
					366	352	339	326	314	303	292	281	271	261	252	243	234	227	219	211
44LH16	42	44	81300	81300	1105	1078	1051	1026	1002	978	955	933	912	891	870	852	832	814	796	780
					421	405	390	375	362	348	336	324	313	302	291	282	272	263	255	246
44LH17	47	44	87300	87300	1185	1170	1153	1138	1125	1098	1072	1048	1024	1000	978	957	936	915	895	876
					450	438	426	415	405	390	376	363	351	338	327	316	305	295	285	276
			56-59	**60-80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**
48LH10	21	48	30000	30000	369	361	354	346	339	331	325	318	312	306	300	294	288	282	277	271
					141	136	132	127	123	119	116	112	108	105	102	99	96	93	90	87
48LH11	22	48	32550	32550	399	390	382	373	366	358	351	343	337	330	324	318	312	306	300	294
					152	147	142	137	133	129	125	120	117	113	110	106	103	100	97	94
48LH12	25	48	41100	41100	504	493	483	472	462	451	442	433	424	415	408	399	391	384	376	369
					191	185	179	173	167	161	156	151	147	142	138	133	129	126	122	118
48LH13	29	48	49200	49200	603	589	576	564	552	540	529	517	507	498	487	477	468	459	450	441
					228	221	213	206	199	193	187	180	175	170	164	159	154	150	145	141
48LH14	32	48	58050	58050	712	696	681	666	651	637	624	610	598	585	574	562	550	540	529	519
					269	260	251	243	234	227	220	212	206	199	193	187	181	176	171	165
48LH15	36	48	66750	66750	817	799	781	765	748	732	717	702	687	672	658	645	633	619	607	595
					308	298	287	278	269	260	252	244	236	228	221	214	208	201	195	189
48LH16	42	48	76950	76950	943	922	901	882	864	844	826	810	792	777	760	745	730	715	702	688
					355	343	331	320	310	299	289	280	271	263	255	247	239	232	225	218
48LH17	47	48	86400	86400	1059	1035	1012	990	969	948	928	909	889	871	853	837	820	804	787	772
					397	383	371	358	346	335	324	314	304	294	285	276	268	260	252	245

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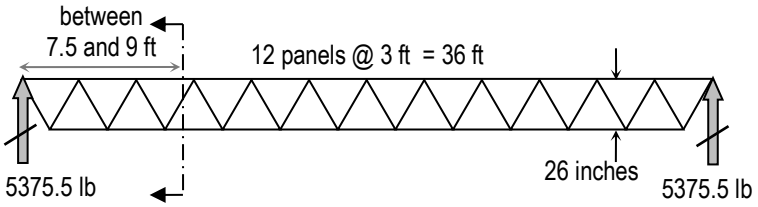
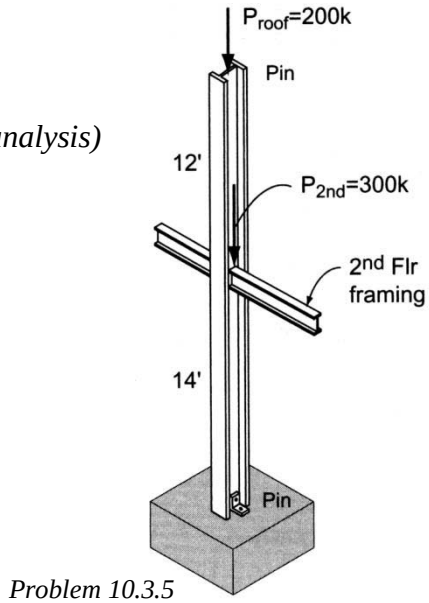
(14%) 10B) If a simply supported 36 ft parallel chord open-web joist has 12 panels at 3 ft for the top chord and the support reactions shown, *use the method of sections* to determine the member forces in the top chord, bottom chord, and the web for the section indicated in the figure at the section location shown for LRFD design. The joists are 2 ft. on center, the distributed load over the top of the truss is is 25 lb/ft^2 dead load and 70 lb/ft^2 live and the self weight is 12.2 lb/ft. *NOTE: Remember that the tributary width for the end joints is only half what it is for the rest of the top joints.* *(load tracing and method of sections)*

Partial answers to check with:
top chord = 14.6 k (C)
bottom chord = 16.7 k (T)
web (diagonal) = 3.8 k (C)



*(15%)** **10.3.5** A two-story, continuous W12×~~106~~ 96 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 x 10^3 ksi)

Partial answers to check with:
kL/r_x = 57.4, kL/r_y = 54.4, P_n/Ω = 510 k, so...



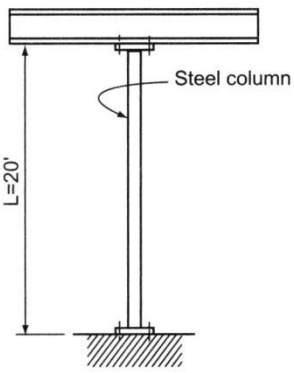
Problem 10.3.5

(9%) 10C) 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:
ϕP_n = 767 k, so...

*(25%)** **10.3.9** What is the most economical **wide flange** ~~W8 (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 $\mathbf{F_y}$ **= 50 ksi** and K = 1.0. (*LRFD steel column design)*

Partial answers to check with:
LRFD: final efficiency > 97%



Problem 10.3.8

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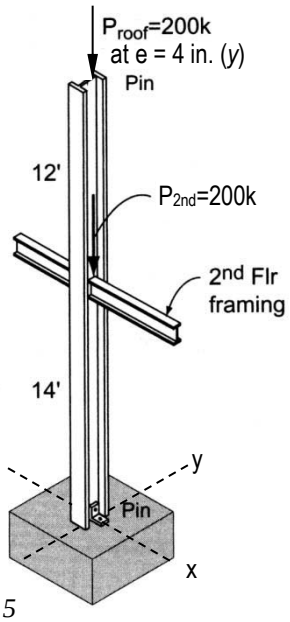
(18%) 10D) For the column of problem 10.3.9, use the LRFD column capacity tables provided to determine the most economical wide flange column. *(LRFD column design by tables)*

Partial answers to check with: LRFD: P_u = 334.4 k, $\phi_c P_n$ = ___k, so .....

(20%) 10E) 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



Problem 10.3.5

Table 4–1 (continued)
Available Strength in Axial Compression, kips
W Shapes
F_y = 50 ksi

W8

Shape		W8×																			
Wt/ft		67		58		48		40		35		31									
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$								
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD								
Effective length KL (ft) with respect to least radius of gyration r_y	0	589	886	512	769	422	634	351	528	308	463	273	410								
	6	542	814	469	706	387	581	321	482	281	422	249	374								
	7	525	790	455	684	375	563	310	467	272	408	241	362								
	8	507	762	439	660	361	543	299	449	261	393	232	348								
	9	487	733	422	634	347	521	286	430	250	376	222	333								
	10	466	701	403	606	331	497	273	410	238	358	211	317								
	11	444	667	383	576	314	473	259	389	226	340	200	300								
	12	421	632	363	545	297	447	244	367	213	320	188	283								
	13	397	596	342	514	280	420	229	344	200	300	177	265								
	14	372	560	320	482	262	394	214	322	187	280	165	248								
	15	348	523	299	449	244	367	199	299	173	260	153	230								
	16	323	486	278	417	226	340	184	276	160	241	141	212								
	17	299	450	257	386	209	314	169	254	147	221	130	195								
	18	276	415	236	355	192	288	155	233	135	202	118	178								
	19	253	380	216	325	175	263	141	212	122	184	108	162								
	20	231	347	197	296	159	239	127	192	111	166	97.1	146								
	22	191	287	162	244	132	198	105	158	91.4	137	80.3	121								
	24	160	241	137	205	111	166	88.5	133	76.8	115	67.4	101								
	26	137	205	116	175	94.2	142	75.4	113	65.4	98.3	57.5	86.4								
	28	118	177	100	151	81.2	122	65.0	97.8	56.4	84.8	49.6	74.5								
	30	103	154	87.4	131	70.7	106	56.7	85.2	49.1	73.9	43.2	64.9								
	32	90.2	136	76.8	115	62.2	93.4	49.8	74.8	43.2	64.9	37.9	57.0								
	34	79.9	120	68.0	102	55.1	82.8	44.1	66.3												
Properties	P_{wo} (kips)	126	189	102	154	71.9	108	57.2	85.9	45.9	68.9	39.4	59.1								
	P_{wi} (kips/in.)	19.0	28.5	17.0	25.5	13.3	20.0	12.0	18.0	10.3	15.5	9.50	14.3								
	P_{wd} (kips)	505	760	362	544	175	262	127	191	81.3	122	63.2	94.9								
	P_{fb} (kips)	164	246	123	185	87.8	132	58.7	88.2	45.9	68.9	35.4	53.2								
	L_p (ft)	7.49		7.42		7.35		7.21		7.17		7.18									
	L_r (ft)	47.7		41.7		35.2		29.9		27.0		24.8									
	A_g (in.^{2})	19.7		17.1		14.1		11.7		10.3		9.12									
	I_x (in.^{4})	272		228		184		146		127		110									
	I_y (in.^{4})	88.6		75.1		60.9		49.1		42.6		37.1									
	r_y (in.)	2.12		2.10		2.08		2.04		2.03		2.02									
	Ratio r_x/r_y	1.75		1.74		1.74		1.73		1.73		1.72									
	$P_{ex}(KL_x^2)/10^4$ (k-in.^{2})	7790		6530		5270		4180		3630		3150									
	$P_{ey}(KL_y^2)/10^4$ (k-in.^{2})	2540		2150		1740		1410		1220		1060									
	ASD	LRFD	Note: Heavy line indicates KL/r equal to or greater than 200.																		
	Ω_c = 1.67	ϕ_c = 0.90																			

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Table 4-1 (continued)
Available Strength in Axial Compression, kips
W-Shapes

W12 — F_y = 50 ksi

Shape		W12×									
lb/ft		58		53		50		45		40	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length, KL (ft), with respect to least radius of gyration, r_y	0	509	765	467	702	437	657	392	589	350	526
	6	479	720	439	660	396	595	355	534	317	476
	7	469	705	429	646	382	574	342	515	305	459
	8	457	687	419	629	367	551	329	494	293	440
	9	445	668	407	611	350	526	313	471	279	420
	10	431	647	394	592	332	500	297	447	265	398
	11	416	625	380	571	314	472	281	422	250	375
	12	400	601	365	549	295	443	263	396	234	352
	13	384	577	350	526	275	413	246	369	218	328
	14	367	551	334	502	255	384	228	343	202	304
	15	349	525	318	478	236	355	210	316	187	281
	16	332	499	301	453	217	326	193	290	171	257
	17	314	472	285	428	198	298	176	265	156	235
	18	296	445	268	403	180	270	160	240	142	213
	19	278	418	252	378	162	244	144	216	127	191
	20	261	392	235	354	146	220	130	195	115	173
	22	227	341	204	307	121	182	107	161	95.0	143
	24	194	292	174	261	102	153	90.3	136	79.8	120
	26	165	249	148	223	86.6	130	76.9	116	68.0	102
	28	143	214	128	192	74.7	112	66.3	99.7	58.6	88.1
	30	124	187	111	167	65.0	97.8	57.8	86.8	51.1	76.8
	32	109	164	97.8	147	57.2	85.9	50.8	76.3	44.9	67.5
	34	96.7	145	86.6	130						
	36	86.3	130	77.3	116						
	38	77.4	116	69.4	104						
	40	69.9	105	62.6	94.1						
Properties											
P_{wo}, kips		74.4	112	67.9	102	70.3	105	60.3	90.5	50.2	75.2
P_{wi}, kips/in.		12.0	18.0	11.5	17.3	12.3	18.5	11.2	16.8	9.83	14.8
P_{wb}, kips		83.1	125	73.3	110	88.4	133	65.6	98.6	44.8	67.4
P_{fb}, kips		76.6	115	61.9	93.0	76.6	115	61.9	93.0	49.6	74.6
L_p, ft		8.87		8.76		6.92		6.89		6.85	
L_r, ft		29.8		28.2		23.8		22.4		21.1	
A_g, in.^{2}		17.0		15.6		14.6		13.1		11.7	
I_x, in.^{4}		475		425		391		348		307	
I_y, in.^{4}		107		95.8		56.3		50.0		44.1	
r_y, in.		2.51		2.48		1.96		1.95		1.94	
r_x/r_y		2.10		2.11		2.64		2.64		2.64	
$P_{ex}(KL)^2/10^4$, k-in.^{2}		13600		12200		11200		9960		8790	
$P_{ey}(KL)^2/10^4$, k-in.^{2}		3060		2740		1610		1430		1260	

ASD	LRFD	Note: Heavy line indicates KL/r_y equal to or greater than 200.
$\Omega_c = 1.67$	$\phi_c = 0.90$	

Table 4-1 (continued)
Available Strength in Axial Compression, kips
W-Shapes

W10 — F_y = 50 ksi

Shape		W10×									
lb/ft		54		49		45		39		33	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length, KL (ft), with respect to least radius of gyration, r_y	0	473	711	431	648	398	598	344	517	291	437
	6	446	671	407	611	363	545	313	470	263	395
	7	437	657	398	598	350	527	302	454	253	381
	8	427	642	388	584	337	507	290	436	243	365
	9	415	624	378	568	322	485	277	416	232	348
	10	403	605	366	550	307	461	263	396	220	330
	11	389	585	354	532	291	437	249	374	207	311
	12	375	564	341	512	274	411	234	352	194	292
	13	361	542	327	492	256	385	219	329	181	272
	14	345	519	313	471	239	359	203	306	168	253
	15	330	495	299	449	222	333	188	283	155	233
	16	314	471	284	427	204	307	173	260	142	214
	17	297	447	269	404	188	282	158	238	130	195
	18	281	422	254	382	171	257	144	217	117	177
	19	265	398	239	360	155	234	130	196	106	159
	20	249	374	224	337	140	211	118	177	95.4	143
	22	217	327	196	294	116	174	97.2	146	78.8	118
	24	188	282	168	253	97.4	146	81.7	123	66.2	99.5
	26	160	240	143	216	83.0	125	69.6	105	56.4	84.8
	28	138	207	124	186	71.5	108	60.0	90.2	48.7	73.1
	30	120	180	108	162	62.3	93.7	52.3	78.6	42.4	63.7
	32	106	159	94.7	142	54.8	82.3	46.0	69.1	37.3	56.0
	34	93.5	141	83.9	126						
	36	83.4	125	74.8	112						
	38	74.8	112	67.2	101						
	40	67.6	102	60.6	91.1						
Properties											
P_{wo}, kips		69.1	104	60.1	90.1	65.3	98.0	54.1	81.1	45.2	67.8
P_{wi}, kips/in.		12.3	18.5	11.3	17.0	11.7	17.5	10.5	15.8	9.67	14.5
P_{wb}, kips		112	168	86.6	130	94.2	142	68.7	103	53.7	80.7
P_{fb}, kips		70.8	106	58.7	88.2	71.9	108	52.6	79.0	35.4	53.2
L_p, ft		9.04		8.97		7.10		6.99		6.85	
L_r, ft		33.6		31.6		26.9		24.2		21.8	
A_g, in.^{2}		15.8		14.4		13.3		11.5		9.71	
I_x, in.^{4}		303		272		248		209		171	
I_y, in.^{4}		103		93.4		53.4		45.0		36.6	
r_y, in.		2.56		2.54		2.01		1.98		1.94	
r_x/r_y		1.71		1.71		2.15		2.16		2.16	
$P_{ex}(KL)^2/10^4$, k-in.^{2}		8670		7790		7100		5980		4890	
$P_{ey}(KL)^2/10^4$, k-in.^{2}		2950		2670		1530		1290		1050	

ASD	LRFD	Note: Heavy line indicates KL/r_y equal to or greater than 200.
$\Omega_c = 1.67$	$\phi_c = 0.90$	