NOTE: Configurations, geometry, units, AND questions can and will be changed on the final exam.

ARCH 614. Practice Final Examination

Note: No aids are allowed for part 1. For part 2, a reference document and any necessary charts will be provided (also posted), and <u>*two single sides*</u> *of letter sized paper with notes are allowed along with a silent,* ***non-programmable*** *calculator.*

Part 1) *Worth 10%* *(conceptual questions)*

Part 2) Clearly show all your work and record your **final answers in the boxes**.

Question 1) Worth 45%

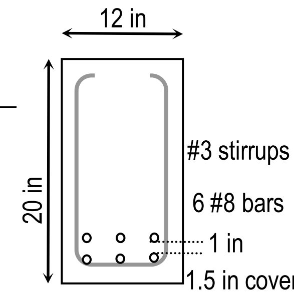


Figure 1a

- Solid slabs 5 in.-thick are integrally supported on three beams in a two-story frame. The center to center beam spacing is 25 ft.
- The floor slab has a dead load of 30 lb/ft^2 (not including self weight), and a live load of 50 lb/ft^2. The roof slab has a dead load of 25 lb/ft^2 (not including self weight) and live load of 20 lb/ft^2.
- The cross section geometry of the girders supporting the beams which support the slab is shown in Figure 1a. The 12 in. by 20 in. beam has 6 #-8 bars (two layers), #3 stirrups, and I = 5200 in^4. The self weight is 233 lb/ft.
- The material is light-weight concrete (140 lb/ft^3) with E = 3,460 ksi and f'_c = 4,000 psi with grade 60 reinforcement.
- The beams are supported on girders. Figure 1b shows the *factored* total loading on a girder section in the frame from live, dead, and wind loading.

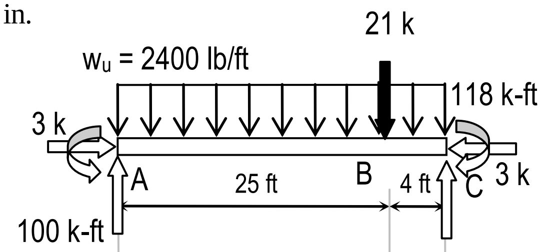


Figure 1b

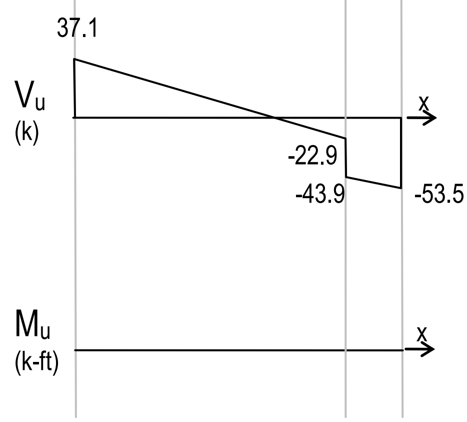


Figure 1c

<u>FIND:</u>

a) If the first floor slab is adequate for shear assuming d=4 in. and the clear span, l_n= 24 ft.

b) The maximum factored moment , M_u, and the completed bending moment diagram for the girder (Figure 1b & c).

c) If the girder is adequate for bending and reinforcement knowing d = 16.625 in..

d) If the girder stirrups, which are spaced at 8 in, are adequate when the concrete capacity, ϕV_c = 18.9 k, assuming the supports are at A and C.

e) The most economical W section of A992 (F_y = 50 ksi) steel that could be used for a 29 ft. simply supported beam using the provided Beam Design Moment diagrams if the unbraced length is 11 ft and M_u = 160 k-ft at midspan when no self weight has been included (yet).

f) The maximum deflection of a W 12 x 53 due to *only* the unfactored load of 14 k at B when ends A and C can be considered fixed. E = 30 x 10^3 ksi, I_x = 425 in^4, and I_y = 95.8 in^4.

g) The minimum dimension required for a square footing 18 in. deep when the dead load is 105.7 kips and the live load is 36.5 kips for a soil with $q_{allowed}$ = 1800 lb/ft^2 and a density of 80 lb/ft^3. Assume normal weight concrete.

h) The maximum two-way design shear in a 10 ft. square footing having the loads in part g) when the column is 18 in. square and d = 13.5 in..

Disclaimer: Answers have NOT been painstakingly researched.

a) yes (2567 lb/unit < ϕV_c)	b)	
c) no ($M_u \leq$ 280.3 k-ft, $\rho \not\leq \rho_{max}$)	d) no ($s_{req'd}$ = 5.3 in., s_{max} = 8.3 in.)	e)
f) 0.051 in	g)	h) 172.2 k

Question 2) Worth 45%

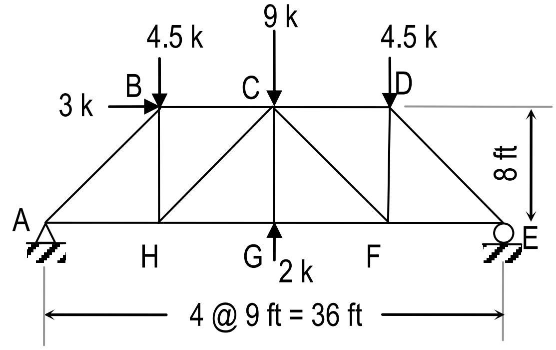


Figure 2a

- A parallel chord truss is shown in the Figure 2a supports dead load and 7 day roof live load. It also has a lateral live load at B of 3 kips. The reactions at the pin and roller supports have been determined to be: A_x = -3 k, A_y = 7.33 k and E = 8.67 k.
- The truss is constructed with 5 1/8 in. x 12 in. glu-lam lumber for the top and bottom chords having E =1.85 x 10^6 psi, α = 3.8 x 10^{-6} /°F, F_c = 1700 psi (no adjustment factors); F'_p = 750 psi (<u>with</u> adjustment factors).
- The top chord is connected to a vertical web member as shown in Figure 2b with 2 – ¾" A 325-SC bolts, standard bolt holes and 3 in. spacing.
- The truss is constructed with timber 2x's for the diagonal web members as shown in Figure 2b. The material is Douglas Fir Larch No. 1 with F'_v = 95 psi (<u>with</u> adjustment factors.)
- The truss is constructed with a L 4 x 3 x ½ in. steel angle welded flush to a 0.75" x 3 in. plate for the vertical web members as shown in Figures 2b and c. Both are A36 steel. The weld material is EXX60.

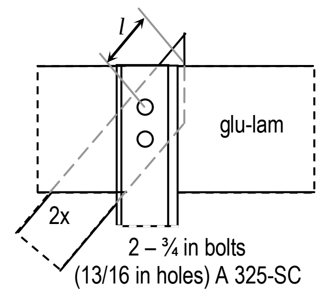


Figure 2b (side)

<u>FIND:</u>

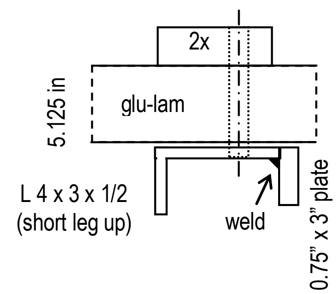


Figure 2c (top)

i) The member forces in BC and HC using the method of sections.
j) The moment of inertia about the *x* axis for the steel web members by completing the chart of Table 2 when $\hat{y}$ = 1.102" from the top of the section.
k) The maximum factored compressive load capacity for the vertical steel web members when r_x = 0.93 in. and r_y = 1.78 in..
l) If the top glu-lam chord from C to D is adequate with a member force of 9.75 kips in compression and a maximum unbraced length of 9 ft. laterally. The ends are pinned in the plane of the truss.
m) The size of the weld required when the factored shear per unit length is 4.6 k/in.
n) The minimum length, *l*, in the 2x from the center of the bolt holes to the vertically cut end of the member as shown in Figure 2b when the maximum shear force transmitted by the bolts is 2500 lb.
o) The maximum (factored) shear in the bolts of the connection shown considering the vertical member only.
p) The *design capacity* of the bolted connection shown with respect to bearing in the steel **and** the top chord.
q) The *design capacity* of the bolted connection shown with respect to tension for the steel member when the shear lag factor, *U* = 0.8.

Table 2

	A (in^2)	I_x (in^4)	d_y (in)	Ad_y^2 (in^3)
angle	3.25			
plate	2.25			

Disclaimer: Answers have NOT been painstakingly researched.

i) BC = 11.25 k (C)	j)	k) 100.65 k
l)	m) 1/4 in.	n) 4.39 in.
o) 18.98 k	p) 5.8 k (78.3 k)	q) 178.2 k (220.2 k)

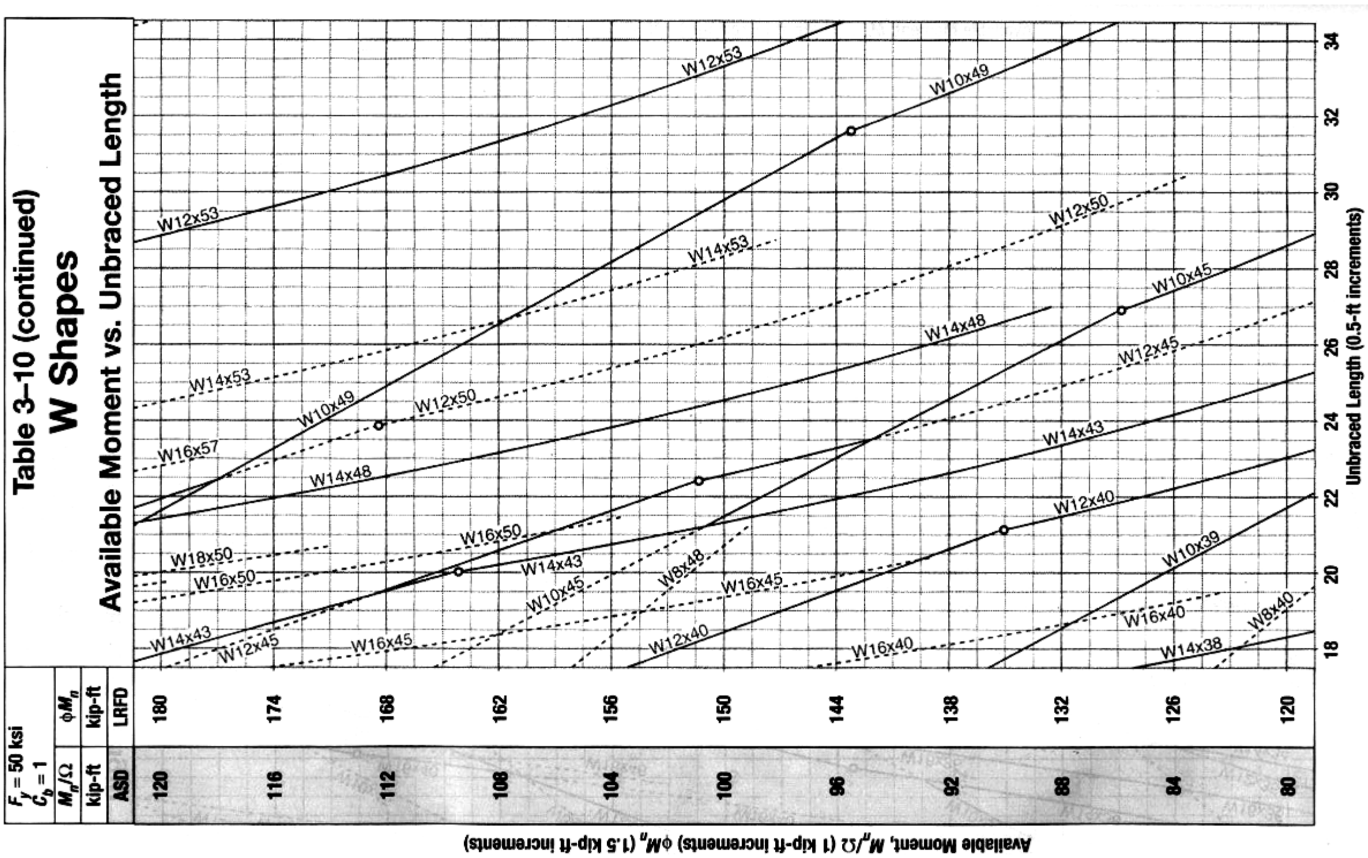
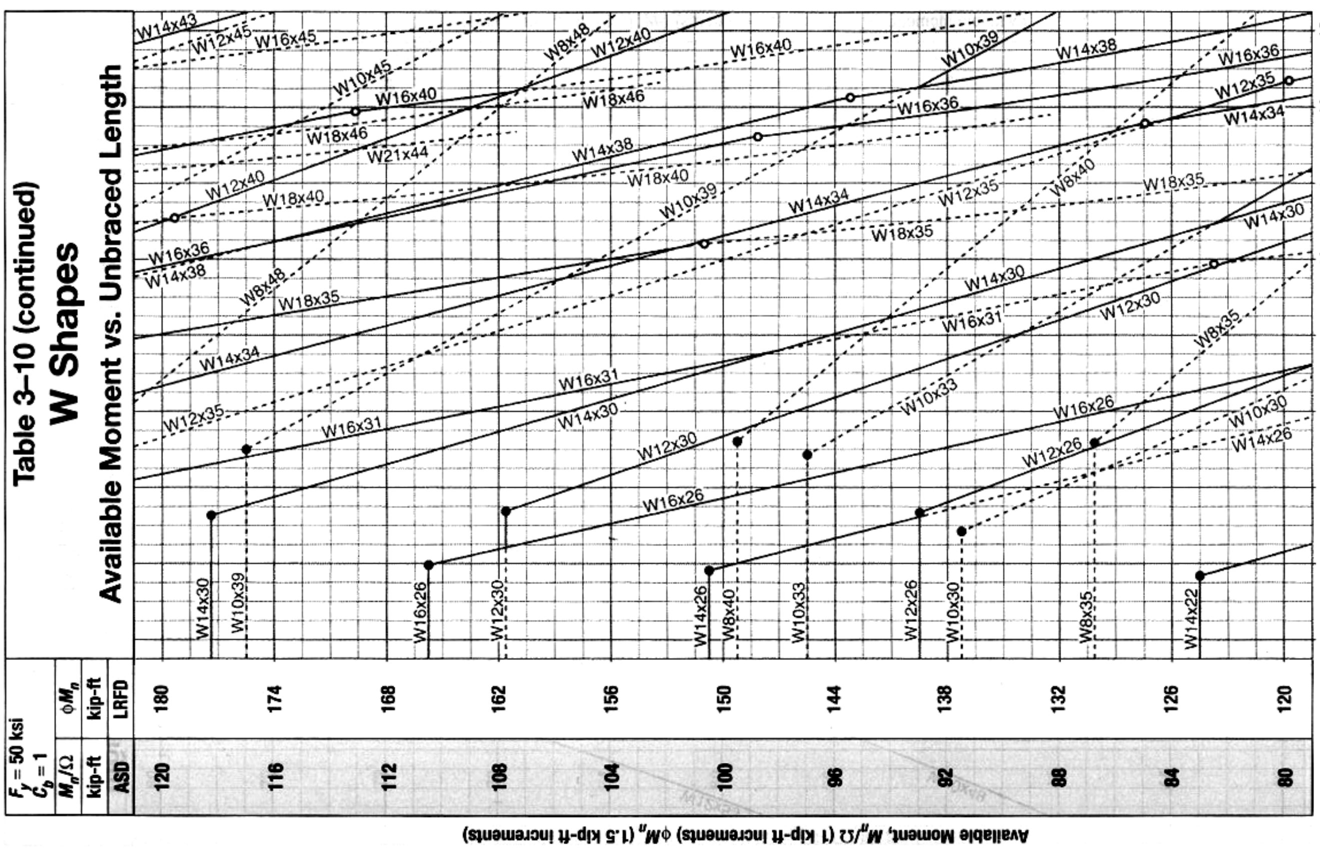


Table 3–10 (continued)
W Shapes
Available Moment vs. Unbraced Length
F_y = 50 ksi
C_b = 1
Available Moment, M_n/Ω (1 kip-ft increments) ϕM_n (1.5 kip-ft increments)
Unbraced Length (0.5-ft increments)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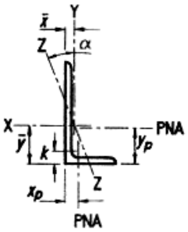

Table 1–7 / Table 1–7 (continu
Angles
Properties

(Values with respect to orientation with longer leg vertical)

Shape	k	Wt.	Area, A	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X $\bar{y}$	Axis X-X Z	Axis X-X y_p	Flexural-Torsional Properties J	Flexural-Torsional Properties C_w	Flexural-Torsional Properties $\bar{r}_o$	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r	Axis Y-Y $\bar{x}$	Axis Y-Y Z	Axis Y-Y x_p
	in.	lb/ft	in.^{2}	in.^{4}	in.^{3}	in.	in.	in.^{3}	in.	in.^{4}	in.^{6}	in.	in.^{4}	in.^{3}	in.	in.	in.^{3}	in.
L4×4×3/4	1 1/8	18.5	5.44	7.62	2.79	1.18	1.27	5.02	0.679	1.02	1.12	2.10	7.62	2.79	1.18	1.27	5.01	0.679
×5/8	1	15.7	4.61	6.62	2.38	1.20	1.22	4.28	0.576	0.610	0.680	2.13	6.62	2.38	1.20	1.22	4.28	0.576
×1/2	7/8	12.8	3.75	5.52	1.96	1.21	1.18	3.50	0.468	0.322	0.366	2.16	5.52	1.96	1.21	1.18	3.50	0.468
×7/16	13/16	11.3	3.31	4.93	1.73	1.22	1.15	3.10	0.413	0.220	0.252	2.18	4.93	1.73	1.22	1.15	3.10	0.413
×3/8	3/4	9.80	2.86	4.32	1.50	1.23	1.13	2.69	0.357	0.141	0.162	2.19	4.32	1.50	1.23	1.13	2.68	0.357
×5/16	11/16	8.20	2.40	3.67	1.27	1.24	1.11	2.26	0.300	0.0832	0.0963	2.21	3.67	1.27	1.24	1.11	2.26	0.300
×1/4	5/8	6.60	1.94	3.00	1.03	1.25	1.08	1.82	0.242	0.0438	0.0505	2.22	3.00	1.03	1.25	1.08	1.82	0.242
L4×3 1/2×1/2	7/8	11.9	3.50	5.30	1.92	1.23	1.24	3.46	0.497	0.301	0.302	2.03	3.76	1.50	1.04	0.994	2.69	0.438
×3/8	3/4	9.10	2.67	4.15	1.48	1.25	1.20	2.66	0.433	0.132	0.134	2.06	2.96	1.16	1.05	0.947	2.06	0.334
×5/16	11/16	7.70	2.25	3.53	1.25	1.25	1.17	2.24	0.401	0.0782	0.0798	2.08	2.52	0.980	1.06	0.923	1.74	0.281
×1/4	5/8	6.20	1.81	2.89	1.01	1.26	1.14	1.81	0.368	0.0412	0.0419	2.09	2.07	0.794	1.07	0.897	1.40	0.227
L4×3×5/8	1	13.6	3.89	6.01	2.28	1.23	1.37	4.08	0.810	0.529	0.472	1.91	2.85	1.34	0.845	0.867	2.45	0.498
×1/2	7/8	11.1	3.25	5.02	1.87	1.24	1.32	3.36	0.747	0.281	0.255	1.94	2.40	1.10	0.858	0.822	1.99	0.407
×3/8	3/4	8.50	2.48	3.94	1.44	1.26	1.27	2.60	0.683	0.123	0.114	1.97	1.89	0.851	0.873	0.775	1.52	0.311

Available Critical Stress, $\phi_c F_{cr}$, for Compression Members, ksi ($F_y = 36$ ksi and $\phi_c = 0.90$)

KL/r	$\phi_c F_{cr}$	KL/r	$\phi_c F_{cr}$	KL/r	$\phi_c F_{cr}$	KL/r	$\phi_c F_{cr}$	KL/r	$\phi_c F_{cr}$
1	32.4	41	29.7	81	22.9	121	15.0	161	8.72
2	32.4	42	29.5	82	22.7	122	14.8	162	8.61
3	32.4	43	29.4	83	22.5	123	14.6	163	8.50
4	32.4	44	29.3	84	22.3	124	14.4	164	8.40
5	32.4	45	29.1	85	22.1	125	14.2	165	8.30
6	32.3	46	29.0	86	22.0	126	14.0	166	8.20
7	32.3	47	28.8	87	21.8	127	13.9	167	8.10
8	32.3	48	28.7	88	21.6	128	13.7	168	8.00
9	32.3	49	28.6	89	21.4	129	13.5	169	7.91
10	32.2	50	28.4	90	21.2	130	13.3	170	7.82
11	32.2	51	28.3	91	21.0	131	13.1	171	7.73
12	32.2	52	28.1	92	20.8	132	12.9	172	7.64
13	32.1	53	27.9	93	20.5	133	12.8	173	7.55
14	32.1	54	27.8	94	20.3	134	12.6	174	7.46
15	32.0	55	27.6	95	20.1	135	12.4	175	7.38
16	32.0	56	27.5	96	19.9	136	12.2	176	7.29
17	31.9	57	27.3	97	19.7	137	12.0	177	7.21
18	31.9	58	27.1	98	19.5	138	11.9	178	7.13
19	31.8	59	27.0	99	19.3	139	11.7	179	7.05
20	31.7	60	26.8	100	19.1	140	11.5	180	6.97
21	31.7	61	26.6	101	18.9	141	11.4	181	6.90
22	31.6	62	26.5	102	18.7	142	11.2	182	6.82
23	31.5	63	26.3	103	18.5	143	11.0	183	6.75
24	31.4	64	26.1	104	18.3	144	10.9	184	6.67
25	31.4	65	25.9	105	18.1	145	10.7	185	6.60
26	31.3	66	25.8	106	17.9	146	10.6	186	6.53
27	31.2	67	25.6	107	17.7	147	10.5	187	6.46
28	31.1	68	25.4	108	17.5	148	10.3	188	6.39
29	31.0	69	25.2	109	17.3	149	10.2	189	6.32
30	30.9	70	25.0	110	17.1	150	10.0	190	6.26
31	30.8	71	24.8	111	16.9	151	9.91	191	6.19
32	30.7	72	24.7	112	16.7	152	9.78	192	6.13
33	30.6	73	24.5	113	16.5	153	9.65	193	6.06
34	30.5	74	24.3	114	16.3	154	9.53	194	6.00
35	30.4	75	24.1	115	16.2	155	9.40	195	5.94
36	30.3	76	23.9	116	16.0	156	9.28	196	5.88
37	30.1	77	23.7	117	15.8	157	9.17	197	5.82
38	30.0	78	23.5	118	15.6	158	9.05	198	5.76
39	29.9	79	23.3	119	15.4	159	8.94	199	5.70
40	29.8	80	23.1	120	15.2	160	8.82	200	5.65