ARCH 631. Exam 1 Practice

Disclaimer: Answers have NOT been painstakingly researched.

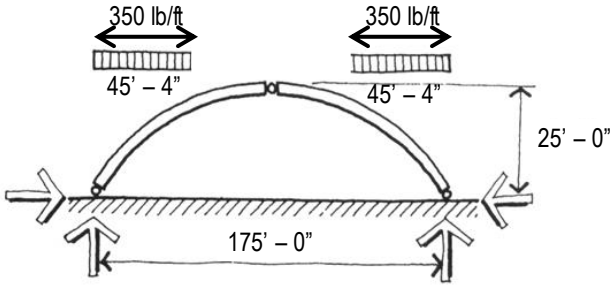
Problems:

1.1 A 32-foot-long aluminum beam is installed when the temperature is 60°F. If the beam contracts 0.038 in., what is the final temperature when the coefficient of thermal expansion is 12.8×10^{-6} /°F.

Answer: 52.3 °F

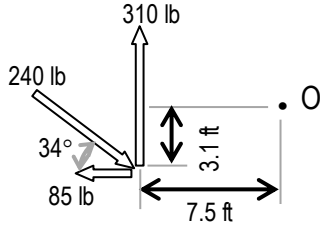
1.2 What is the horizontal thrust at each end of the three-hinged arch shown?

Answer: 14.38 k



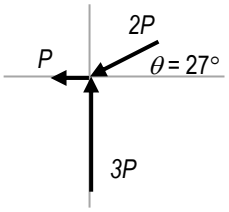
1.3 What is the moment about point O of the three forces shown?

Answer: 728 lb-ft



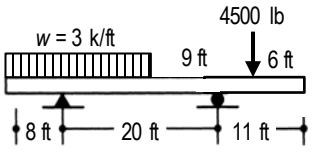
1.4 The following three points act through a point: P at $\theta_x = 180°$, $2P$ at $\theta_x = 27°$, and $3P$ at $\theta_x = 90°$. Find the equivalent resultant force.

Answer: $3.99P$ at 143.1°



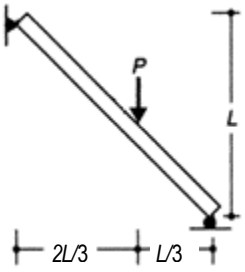
1.5 Determine the reactions for the structure shown.

Answer: R_A = 56,475 lb ↑ and R_B = 20,025 lb ↑



1.6 Determine the reactions for the beam shown.

Answer: $R_{Ax} = 0$, $R_{Ay} = P/3$ ↑, $R_B = 2P/3$ ↑



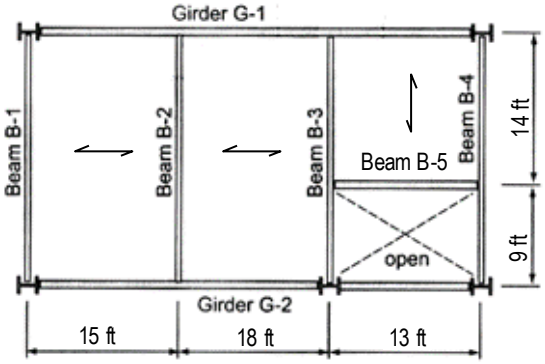
1.7 What is the stress present in a titanium-alloy specimen if the strain is 0.011? Assume that E_t = 100,000 MPa.

Answer: 1100 x 10^3 KPa

1.8 A 2x4 of southern pine that is 1.5 in. by 3.5 in. in cross section is 12 feet long and carries a tension force of 21.8 kips. How much is the unit strain in the timber? Assume E_t = 1,300 x 10^3 psi.

Answer: 0.0032

2.1 Determine the reactions to beam G-1. Assume that the total factored dead and live load is 165 lb/ft^2, the factored self-weight of the beams is 30 lb/ft, and the factored self-weight of the girders is 45 lb/ft. The spanning direction of the steel decking with concrete is indicated by the arrows.

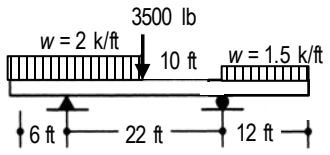


Answers: 38,911 lb, 30,264 lb

2.2 What is the maximum bending moment in beam G-1 of problem 2.1.

Answer: 449 k-ft

2.3 Draw shear and moment diagrams for the beam shown



Answer: V_{max} = 18 k and M_{max} = -108 k-ft

2.4 An overhanging beam 20 ft long with the overhanging support at 5.85 ft from the end carries a uniformly distributed load of 210 lb/ft. Assume that the beam is 1.5 in x 11.25 in. in cross section and is laterally braced. Assume also that the beam is made of timber that has an allowable stress in bending of 1300 psi and in shear of 110 psi. Is the beam adequate with respect to bending and shear stress considerations? What is the maximum deflection of the beam (comparing the deflection at 7 ft. from an end support to the deflection of the overhang)? Assume that E = 1.8 x 10^6 psi. Is the deflection acceptable when considering the span between supports for total load and a limit of L/360?

Answer: (f_b = 1363) $\not<$ (F_b = 1300), $\therefore$ no good in bending: (f_b = 309) $\not<$ (F_v = 110), $\therefore$ no good in shear; and (max of 0.35 in and -0.08 in) < (L/360 = 0.47), $\therefore$ deflections are okay

2.5 A steel beam which is fixed at one end and supported at the other will be used to span 40 ft and support a uniformly distributed live and dead load of 850 lb/ft. Assume that the yield stress in bending is 50 ksi and that the allowable bending stress is 33 ksi. Using ASD determine the most efficient wide-flange shape to be used, based on a bending stress analysis and using one of the shapes listed in Appendix 17. Ignore dead loads due to self weight.

Answer: $S_{req'd} \geq 61.8$ in.^{3}, so W16 x 50 works with $S_x = 81$ in.^{3}

TABLE A.17.1 Member Properties

			AXIS X-X				AXIS Y-Y				AXIS X-X
Shape	Area (in.^{2})	Web Thick-ness (in.)	I_x (in.^{4})	S_x (in.^{3})	r_x (in.)	Z_x (in.^{3})	I_y (in.^{4})	S_y (in.^{3})	r_y (in.)	Z_y (in.^{3})	S_x (mm^3 × 10)
W 36 × 282	82.9	0.885	19,600	1050	15.4	1,190	1200	144	3.8	223	17190
W 33 × 201	59.2	0.715	11,600	686	14	773	749	95.2	3.56	147	11231
W 30 × 99	29.1	0.520	3990	269	11.7	312	128	24.5	2.1	38.6	4404
W 27 × 102	30	0.515	3620	267	11	305	139	27.8	2.15	27.8	4371
W 14 × 90	26.5	0.440	999	143	6.14	157	362	49.9	3.7	75.6	2341
W 21 × 68	20	0.430	1480	140	8.6	160	64.7	15.7	1.8	24.4	2292
W 14 × 82	24	0.510	881	123	6.05	139	148	29.3	2.48	44.8	2014
W 14 × 74	21.8	0.450	795	112	6.04	126	134	26.6	2.48	40.5	1834
W 18 × 60	17.6	0.415	984	108	7.47	123	50.1	13.3	1.69	20.6	1768
W 16 × 50	14.7	0.380	659	81	6.68	92	37.2	10.5	1.59	16.3	1326
W 12 × 26	7.65	0.230	204	33.4	5.17	37.2	17.3	5.34	1.51	8.17	547
W 8 × 31	9.12	0.285	110	27.5	3.47	30.4	37.1	9.27	2.02	14.1	450
W 10 × 22	6.49	0.240	118	23.2	4.27	26	11.4	3.97	1.33	6.1	380
W 8 × 24	7.08	0.245	82.7	20.9	3.42	23.1	18.3	5.63	1.61	8.57	342
W 8 × 18	5.26	0.230	61.9	15.2	3.43	17	7.97	3.04	1.23	4.66	249
C 9 × 15	4.41	0.285	51	11.3	3.4	13.6	1.91	1.01	0.661	2.04	185
C 6 × 13	3.81	0.437	17.3	5.8	2.13	7.29	1.05	0.642	0.525	1.35	95

The beams in the table are arranged according to their relative S values in descending order of magnitude. The first entry in a group represents a light member and one with a relatively large section modulus. It is thus an efficient and often preferred member. W: wide-flange shape; C: channel shape; MC: miscellaneous shape; WT: structural tees cut from W shapes. Typical designation:

W 21 × 68
- 68 — weight per linear foot, lb
- 21 — nominal depth
- W — shape designation

3.1 An unbraced pin-ended W 8 x 18 steel column is 45 ft long. What is the critical buckling load for this column? Assume that $E = 29 \times 10^6$ psi.

Answer: 7823 lb

3.2 An unbraced steel W 14 x 82 column is pinned at each end and is subjected to an axial force. Assume that $F_y = 50$ ksi, and $E = 29 \times 10^6$ psi. Find the transition point between short- and long-behavior.

Answer: 15.65 ft (by weak axis)

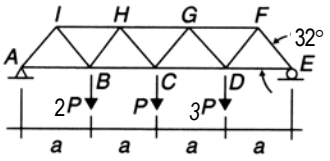
3.3 A pin-ended steel column is braced at mid-height about the weak axis and is 40 ft long. It is a W10 x 88 with $I_x = 534$ in.^{4} and $I_y = 179$ in.^{4}. What is the critical buckling load for this column? Assume that $E = 29 \times 10^3$ ksi.

Answer: 663 k

3.4 Is a 75 mm x 100 mm timber column, fixed at the base, which is 2.75 m high adequate to support an axial loading of 115 kN? Assume that the crushing strength, $F_c = 9000$ kPa and the allowable stress for buckling, $F'_c = 1680$ kPa.

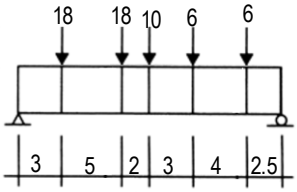
Answer: yes ($f_{actual} = 1533$ kPa $< F'_c$)

3.5 Determine the force in member CD in the truss shown by using a method of sections approach.

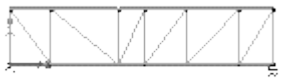


Answer: $F_{CD} = 10.8P$

3.6 Consider the parallel chord truss shown. Obviously, the truss needs diagonal elements for stability. Add the diagonal elements in an arrangement such that *all* the diagonals are in a state of tension under the loading condition indicated.



Answer:



3.7 What is the maximum force developed in a cable carrying a uniform load of 950 lb/ft that spans 200 ft? Assume that the cable has a maximum midspan sag of 40 ft.

Answer: 152.1 kips

3.8 A simple arch spans 50 m and has a rise of 7 m. It carries a total dead and live load of 6.5 kN/m along the center 40 m of the length (symmetrically). What is the maximum force developed in the arch and where does it occur? What is the force at the crown of the arch?

Answer: 307.4 kN (at the base), 278.6 kN