1. KLx=480 inches, KLy=120 inches. Initial Trial: W21x83 => allowable load=534 kips. Subsequent trial: W21x73 => allowable load=467 kips, which exceeds applied load of 450 kips. Adopt W21x73.

2. KLx=633”, KLy=0. X-axis controls. Slenderness=72.8 => allowable buckling stress=20.34 ksi => allowable load=555 kips, which exceeds applied load of 475 kips. W21x93 is adequate.


4. KLx=22’, KLx=(1.83)(22)=40.3’ by Gb/Gs. KLx= 40.3/2.16=18.6’. Therefore, KLy controls. Table 4-1 => allowable load=78.8 kips

5. Hollow: larger radius of gyration, for fixed area.

6. W24. If x-x controls, the strategy should maximize rx.

7. A. The y-axis radius of gyration must be made larger because the corresponding KL is 144”, while the KL corresponding with the x-axis is only 12”.

8. TRUE

9. TRUE

10. FALSE

11. FALSE

12. FALSE

13. TRUE

14. A rigid frame with a set of supports that resist horizontal forces

15. A). A funicular shape may be determined by directly measuring the shape of a cable, loaded in the same way as the arch, but inverted. B). A funicular shape may be determined by scaling the moment diagram of a simply-supported beam that has the same loads (locations and magnitudes) as the intended arch.

16. The problem cannot be solved by statics because it is indeterminate to the third degree and it not funicular.

17. The geometry is funicular. It can be solved by statics, assuming pins at any convenient location => Pab=12kips => stress = 0.333ksi

18. Using uniformly-loaded cable equation: y=(h/L^2)x^2 => y=0.0347x^2

19. From the Moment diagram of a simply-supported, uniformly-loaded beam: M=12w – 0.5wx^2. Scaling this to a height of 5’ => y=0.833x – 0.0347x^2

20. From the Moment diagram of a simply-supported beam with the given loads, maximum moment is 40w, while the moment at the point of interest is 32w. Therefore, the height should be (32/40)*5’ = 4’

21. The funicular shape will consist of 4 line segments, connecting hanger points and the supports (it IS NOT A SMOOTH CURVE). The three heights are: HA = 2.727’, HB = 4’, HC = 2.364’

22. Because cables resist zero moment, applied loads cause them to take shapes such that they are in static equilibrium while resisting zero moment. Hence, the inverted shape of cable is also one that has no internal moments, for the applied loads.

23. Zero. The shape is funicular. All internal moments are zero.

24. Using uniformly-loaded cable equation, y=(h/L^2)x^2 = (20/50^2)x^2 => y=2.222’ at x=16.66’ => Y=20-y=17.77’.

25. Ax=7.76 kips, Ay=12 kips. Cut at B => Mb=33.12 kip-ft (compression on inside of structure). P/A +/- Mc/I => 1.48 ksi in compression on inside of structure at point B.

26. Ax=2.286w, Ay=4w => resultant at support=4.607w. With cross-section crushing at 18000lbs, w=3907 lbs/ft => TOTAL RESULTANT FORCE = 31260 lbs.

27. From previous, tan^-1(4/2.286)=60.3°

28. By definition, a funicular arch has zero internal moments at all positions. Consequently, the analyst may place pins at any location, analyzing the arch as a determinate 3-pin arch.

29. FALSE. It has a degree of indeterminacy of 3.

30. A). Stones that are placed without mortar can resist no tension. Hence, these arches cannot resist moment unless there is significant axial compression. A pile of uniform dirt compresses the blocks, increasing the amount of moment that may be applied without resulting in extreme-fiber tension at any
location. B). Without horizontal-resisting supports, the structure ceases to be an arch, resulting in a radical increase in bending moment, causing the arch to fail.

31. False. Table is for Fy=50, not 36.

32. True.

33. False. KL_y is not 24’

34. False. KL_{eq}=14.5 ft, which exceeds KL_y=8’

35. 36 ksi. See Part 2 Material tables.

36. P_n/\Omega = 1483 kips (or 1480 kips, with 3 digits) w/ KL_{eq}=11.17’. Therefore, P_n = 2472 kips

37. W14x90 w/ \phi_Pn=1100 kips at KL_{eq}=10’

38. ASD P=662.5 kips. Select W14x99 w/ allowable load=716 kips at KL_y=16’. Idiotic bracing design because the strong axis KL is less than the weak axis KL (useless brace).

39. KL_y=24’. Initial trial, take KL_x=48’ and assess W14x90 w/ Allow load=509 kips at KL=24’. W14x90 has KL_{eq}=29’=>W14x90 allow load=415 kips (no good). Next, evaluate W14x99=> KL_x=(1.91)(24’)=45.8’ by G_a/G_b method => KL_{eq}=27.6’. Table 4-1 has Allow Load=478 kips w/ KL=28’. Therefore, adopt W14x99.

40. If the elements of a column cross-section are slender (e.g., the walls of a hollow tube are thin and long or the flanges or webs of a W shape are long and thin), then local buckling of these slender elements may occur rather than the global buckling of the column.

41. 38.66°

42. Statics => T=28.89 kips. Definition of stress => A=0.5777 in² => Minimum Diameter = 0.858”

43. Funicular shapes eliminate bending. Bending deformations are generally much larger than axial deformations and modest forces cause relatively high bending stresses, but relatively low axial stresses. Consequently, funicular shapes are efficient due to the elimination of bending.