PRACTICE EXAM 24: PE CIVIL - STRUCTURAL SIMULATION (100 QUESTIONS)

This expanded practice exam contains 100 four-option questions weighted to the NCEES PE Civil: Structural CBT specification effective before April 2027. The actual PE Civil exam contains 80 questions and provides 8 hours of exam time within a 9-hour appointment. To preserve the official six-minute-per-question pace, allow 10 hours for this 100-question simulation. Use the NCEES PE Civil Reference Handbook and the design standards listed for the applicable Civil: Structural exam. NCEES reports results as pass/fail and does not publish a fixed passing percentage.

1. An office floor beam has a tributary width of 9 ft and supports a uniform floor pressure of 96 psf. What uniform line load acts on the beam?

A. 96 lb/ft
B. 864 lb/ft
C. 432 lb/ft
D. 1,728 lb/ft

2. A 28-ft simply supported girder carries a uniform service load of 2.1 kip/ft over its full span. What vertical reaction occurs at each support?

A. 29.4 kip
B. 58.8 kip
C. 14.7 kip
D. 2.1 kip

3. A normal-weight concrete slab is 7 in. thick and has a unit weight of 150 pcf. What is its self-weight as a uniform pressure?

A. 150.0 psf

B. 75.0 psf
C. 87.5 psf
D. 1,050.0 psf

4. For this problem, use $U = 1.2D + 1.6L$. If $D = 45$ psf and $L = 70$ psf, what factored pressure U results?

A. 115 psf
B. 138 psf
C. 184 psf
D. 166 psf

5. For this problem, calculate roof snow pressure from $p = 0.7 Ce\ Ct\ Is\ pg$. Use $Ce = 1.0$, $Ct = 0.95$, $Is = 1.0$, and $pg = 42$ psf. What is p?

A. 29.4 psf
B. 39.9 psf
C. 27.9 psf
D. 26.5 psf

6. Use $q = 0.00256\ Kz\ Kzt\ Kd\ V^2\ I$. For $Kz = 0.88$, $Kzt = 1.0$, $Kd = 0.85$, $V = 130$ mph, and $I = 1.0$, what velocity pressure q results?

A. 32.4 psf
B. 38.1 psf
C. 27.5 psf
D. 43.3 psf

7. A seismic base shear is defined for this problem as $V = CsW$. If $Cs = 0.078$ and $W = 3,100$ kip, what base shear results?

A. 39.7 kip
B. 241.8 kip
C. 310.0 kip
D. 216.0 kip

8. A uniform surcharge of 480 psf acts behind a 13-ft retaining wall. If Ka = 0.35, what lateral force per foot of wall results from the surcharge alone?

A. 0.168 kip/ft
B. 1.092 kip/ft
C. 6.240 kip/ft
D. 2.184 kip/ft

9. Soil has unit weight 125 pcf, active coefficient Ka = 0.28, and retained height 14 ft. Using Pa = 0.5 Ka gamma H^2, what active resultant acts per foot of wall?

A. 3.43 kip/ft
B. 6.86 kip/ft
C. 4.90 kip/ft
D. 0.24 kip/ft

10. A 36-kip axle load is located 10 ft from the left support of a 30-ft simple span. What is the left support reaction due to that axle?

A. 12 kip
B. 36 kip
C. 24 kip
D. 18 kip

11. Floor beams frame into a girder at 10-ft spacing. Each floor beam delivers a 42-kip end reaction. What equivalent uniform line load represents those reactions?

A. 42.0 kip/ft
B. 4.2 kip/ft
C. 2.1 kip/ft
D. 8.4 kip/ft

12. A metal deck weighs 4 psf and supports 3.5 in. of concrete with unit weight 145 pcf. What combined dead-load pressure results?

A. 42.3 psf
B. 149.0 psf
C. 54.8 psf
D. 46.3 psf

13. For this problem, reduced live load is L = L0(0.25 + 15/sqrt(KLLAT)). If L0 = 75 psf and KLLAT = 3,600 ft2, what is L?

A. 18.8 psf
B. 56.2 psf
C. 37.5 psf
D. 75.0 psf

14. A roof temporarily holds 4.5 in. of rainwater. Using water unit weight 62.4 pcf, what uniform pressure does the water create?

A. 23.4 psf
B. 31.2 psf
C. 4.5 psf
D. 280.8 psf

15. A crane wheel carries a 56-kip static load. A stated impact allowance increases the load by 20%. What design wheel load results?

A. 11.2 kip
B. 67.2 kip
C. 56.0 kip
D. 70.0 kip

16. Three identical girders share a 270-kip gravity load equally. One girder also supports a 30-kip equipment load not shared by the others. What total load acts on that girder?

A. 90 kip
B. 100 kip
C. 300 kip
D. 120 kip

17. A member is checked with 1.4D; 1.2D + 1.6L; and 1.2D + 1.0W + 1.0L. If D = 35 kip, L = 45 kip, and W = 50 kip, what is the largest stated factored load?

A. 49 kip
B. 114 kip
C. 132 kip
D. 137 kip

18. A 22-ft simply supported beam carries an 18-kip point load at midspan. What maximum bending moment results?

A. 198 kip-ft
B. 99 kip-ft
C. 49.50 kip-ft
D. 396 kip-ft

19. A 20-ft simple beam carries a uniform load of 1.6 kip/ft. What maximum bending moment occurs?

A. 80 kip-ft
B. 64 kip-ft
C. 160 kip-ft
D. 40 kip-ft

20. A 16-ft simply supported beam carries 2.5 kip/ft uniformly over the span. What is the shear reaction magnitude at either support?

A. 40 kip
B. 10 kip
C. 20 kip
D. 2.500 kip

21. A tension rod carries 135 kip through a gross area of 7.5 in2. What average axial stress is produced?

A. 10 ksi
B. 18 ksi
C. 20.25 ksi
D. 1,012.5 ksi

22. A 10-ft steel bar carries 72 kip in tension. Use A = 3.6 in2 and E = 29,000 ksi. What elongation results from delta = PL/(AE)?

A. 0.083 in.
B. 0.041 in.
C. 0.166 in.
D. 0.008 in.

23. A rectangular beam section is 11 in. wide and 19 in. deep. What is its strong-axis elastic section modulus S = bh^2/6?

A. 331.0 in3
B. 1,254.0 in3
C. 661.8 in3
D. 209.0 in3

24. A beam has maximum moment M = 105 kip-ft and section modulus S = 700 in3. What maximum bending stress magnitude results?

A. 0.1 ksi
B. 15.0 ksi
C. 9.0 ksi
D. 1.8 ksi

25. A simply supported beam with a centered load has P = 12 kip, L = 15 ft, E = 29,000 ksi, and I = 2,400 in4. Using delta = PL^3/(48EI), what midspan deflection results?

A. 0.010 in.
B. 0.042 in.
C. 0.210 in.
D. 0.021 in.

26. A simple beam carries w = 0.18 kip/in. over a 132-in. span. If E = 29,000 ksi and I = 1,800 in4, use delta = 5wL^4/(384EI). What maximum deflection results?

A. 0.007 in.
B. 0.014 in.
C. 0.028 in.
D. 0.140 in.

27. A pin-ended column has E = 29,000 ksi, I = 900 in4, and length 16 ft. Using Pcr = pi^2EI/L^2, what Euler critical load results?

A. 6,988 kip
B. 3,494 kip
C. 13,976 kip
D. 437 kip

28. A solid circular shaft has torque T = 135 kip-in., radius c = 2.25 in., and polar moment J = 32.2 in4. Using tau = Tc/J, what maximum torsional shear stress results?

A. 4.72 ksi
B. 18.90 ksi
C. 9.43 ksi
D. 60.40 ksi

29. At an extreme fiber, a column has 7 ksi compressive axial stress and 11 ksi compressive bending stress. What maximum compressive stress results when they add?

A. 4 ksi
B. 11 ksi
C. 18 ksi
D. 77 ksi

30. At a point, sigma_x = 24 ksi, sigma_y = 6 ksi, and tau_xy = 5 ksi. Using the principal-stress equation, what major principal stress results?

A. 25.3 ksi
B. 15.0 ksi
C. 19.0 ksi
D. 30.0 ksi

31. A 32-ft steel member experiences a uniform temperature increase of 75 F. Using alpha = 6.5e-6/F, what free thermal elongation occurs?

A. 0.094 in.
B. 0.187 in.
C. 0.374 in.
D. 0.020 in.

32. A fully restrained steel bar undergoes a 65 F temperature increase. Use E = 29,000 ksi and alpha = 6.5e-6/F. What thermal stress magnitude is produced?

A. 6.13 ksi
B. 24.51 ksi
C. 0.42 ksi
D. 12.25 ksi

33. A cantilever carries a 9-kip downward point load at its free end over a 7-ft length. What fixed-end moment magnitude results?

A. 63 kip-ft
B. 31.50 kip-ft
C. 9 kip-ft
D. 126 kip-ft

34. A cantilever has w = 0.12 kip/in., L = 108 in., E = 29,000 ksi, and I = 1,500 in4. Using delta = wL^4/(8EI), what free-end deflection results?

A. 0.094 in.
B. 0.024 in.
C. 0.047 in.
D. 0.470 in.

35. At an unloaded joint of an ideal pin-jointed truss, three members meet and two are collinear. What can be concluded about the third, non-collinear member?

A. All three members must carry equal axial force.

B. The non-collinear member is a zero-force member for the stated joint condition.

C. The two collinear members are both zero-force members.

D. The third member must carry the sum of the other two forces.

36. Which support arrangement makes a planar beam externally statically indeterminate to the first degree?

A. A simple span with one pin and one vertical roller.

B. A cantilever fixed at one end and free at the other.

C. A beam supported by two vertical rollers only, with no horizontal restraint.

D. A beam supported by one pin and two vertical rollers at distinct locations.

37. For a 40-ft simple span, the influence-line ordinate for the right reaction at a load position 12 ft from the left support is x/L. What reaction is caused by a 28-kip moving point load?

A. 19.6 kip

B. 28.0 kip

C. 8.4 kip

D. 7.0 kip

38. A fatigue-sensitive detail cycles between +26 ksi and -8 ksi. What is the stress range?

A. 18 ksi

B. 34 ksi

C. 26 ksi

D. 17 ksi

39. A 7/8-in.-diameter bolt bears on a 5/8-in.-thick plate under a 24-kip force. Using fb = P/(td), what average bearing stress results?

A. 21.9 ksi
B. 35.1 ksi
C. 87.8 ksi
D. 43.9 ksi

40. A column has area A = 24 in2, section modulus S = 120 in3, axial load P = 144 kip, and eccentricity e = 5 in. What maximum compressive stress is produced by P/A + Pe/S?

A. 12 ksi
B. 6 ksi
C. 18 ksi
D. 30 ksi

41. A rectangular beam is 10 in. wide and 26 in. deep. What is its centroidal strong-axis moment of inertia I = bh^3/12?

A. 7,323.3 in4
B. 17,576 in4
C. 14,647 in4
D. 5,633 in4

42. Why is reshoring commonly used below recently cast elevated concrete floors?

A. To distribute construction loads through multiple levels while younger slabs continue gaining sufficient strength and stiffness.
B. To permanently replace the building columns after construction is complete.
C. To increase concrete strength by mechanically compressing the slab from below.
D. To eliminate the need to evaluate construction sequencing and load paths.

43. Fresh concrete produces an idealized uniform lateral pressure of 820 psf on a form panel 9 ft long and 5.5 ft high. What total lateral force acts on the panel?

A. 7,380 lb
B. 4,510 lb
C. 820 lb
D. 40,590 lb

44. Before loading a temporary work platform with crews, tools, and stored materials, what action is most appropriate?

A. Assume any erected platform has the same capacity as the permanent floor.
B. Verify the actual platform configuration, supports, bracing, access conditions, and load capacity for all intended construction loads.
C. Load the platform first and evaluate it only if visible distress develops.
D. Check worker weight only because stored materials and access loads are nonstructural.

45. What is the most appropriate function of a required structural special inspection?

A. Replace the contractor's responsibility for construction means, methods, and quality control.
B. Authorize undocumented structural design changes whenever the schedule is delayed.
C. Observe or test specified work and document whether it conforms to the approved construction requirements within the inspector's assigned scope.
D. Guarantee every completed structural component will remain defect-free for its entire service life.

46. A deep excavation is planned beside an occupied building supported on shallow footings. Which action best addresses structural risk before excavation?

A. Evaluate the excavation influence zone, support or underpinning needs, construction sequence, and movement monitoring before removing supporting soil.
B. Excavate to final depth first, then decide whether observed settlement is acceptable.
C. Assume the adjacent foundation is unaffected because it is on separate property.
D. Reduce documentation so field crews can modify the excavation support informally.

47. A steel frame requires temporary bracing during erection. When should that bracing generally be removed?

A. As soon as two beams are connected because self-weight stabilizes the frame.
B. Immediately after columns are plumbed even if diaphragms remain incomplete.
C. Whenever removal accelerates erection because the final design proves all intermediate stages stable.
D. Only after the permanent lateral system is complete, connected, and capable of providing the required stability for the relevant construction stage.

48. Which statement best distinguishes a fabrication submittal from a request for information (RFI)?

A. A fabrication submittal automatically changes the structural design, while an RFI cannot affect project decisions.
B. An RFI is the contractor's fabrication drawing, while a submittal is used only for payment quantities.
C. A fabrication submittal presents proposed fabrication or installation details, while an RFI seeks clarification of information needed to proceed.
D. Both documents transfer the engineer's design responsibility to the contractor once transmitted.

49. For normal-weight concrete, use Ec = 57,000 sqrt(f'c) psi. If f'c = 4,500 psi, what modulus Ec results?

A. 2,850 ksi
B. 3,824 ksi
C. 4,500 ksi
D. 7,648 ksi

50. Which concrete property directly represents initial elastic stiffness in a stress-strain model?

A. Compressive strength alone.
B. Modulus of elasticity.
C. Unit weight alone.
D. Coefficient of thermal expansion alone.

51. A reinforced concrete section contains seven No. 7 bars, each with area 0.60 in2. What total reinforcing area is provided?

A. 4.2 in2
B. 3.6 in2
C. 4.9 in2
D. 0.6 in2

52. Which statement correctly distinguishes structural-steel yield strength from tensile strength?

A. Yield strength is always greater than tensile strength for ductile structural steel.
B. Tensile strength is another name for elastic modulus and measures only stiffness.
C. Yield strength and tensile strength are interchangeable because both equal the elastic stress-strain slope.
D. Yield strength marks the onset of substantial permanent deformation, while tensile strength is the maximum engineering stress reached in a tension test.

53. A steel coupon sustains 22 ksi of elastic stress at strain 0.00076. What modulus E = stress/strain is indicated?

A. 14,474 ksi
B. 44,000 ksi
C. 28,947 ksi
D. 16,720 ksi

54. Why are timber design properties different parallel and perpendicular to grain?

A. Wood is anisotropic; its cellular fiber structure creates direction-dependent strength and stiffness.
B. Wood is isotropic but building codes arbitrarily assign different values.
C. Moisture affects only color, so directional properties are unnecessary.

D. Perpendicular-to-grain properties are always identical to steel because both resist compression.

55. A masonry prism test is used primarily to characterize which property?

A. Tensile yield strength of reinforcing steel.
B. Elastic modulus of structural steel.
C. Soil permeability beneath a footing.
D. Compressive strength of assembled masonry construction.

56. A soil has porosity n = 0.36. What is its void ratio e = n/(1-n)?

A. 0.3600
B. 0.5625
C. 0.6400
D. 1.7800

57. A soil sample weighs 126 lb and occupies 1.80 ft3. What is its total unit weight?

A. 70 pcf
B. 63 pcf
C. 126 pcf
D. 226.8 pcf

58. For a simplified bearing estimate, use qult = gamma Df Nq. If gamma = 118 pcf, Df = 5 ft, and Nq = 16, what ultimate bearing pressure results?

A. 0.59 ksf
B. 18.88 ksf
C. 9,440.00 ksf
D. 9.44 ksf

59. Which laboratory test most directly determines the compressive strength of a conventional concrete cylinder?

A. Charpy impact testing of a notched steel bar.
B. Sieve analysis of dry soil particles.
C. Axial compression testing of the cured cylinder to failure.
D. Direct shear testing of a timber connection.

60. What material behavior is most directly evaluated by a Charpy V-notch test?

A. Concrete compressive strength under slow axial loading.
B. Notch toughness and energy absorbed during impact fracture.
C. Soil consolidation settlement under sustained stress.
D. Timber moisture content based on oven-dry mass.

61. In reinforced masonry, what is a primary structural purpose of grout in cells containing reinforcing bars?

A. Fill reinforced cells to transfer force among masonry, grout, and steel while supporting the bars.
B. Provide a removable void so reinforcing bars can slide freely under load.
C. Replace mortar at every bed joint in the wall.
D. Eliminate the need for reinforcing steel wherever grout is present.

62. What is a principal structural benefit of prestressing concrete before significant service loading?

A. It eliminates concrete compression so only reinforcing steel carries load.
B. It introduces compression that can offset service-load tension, improving cracking and deflection behavior.
C. It guarantees zero long-term losses from creep, shrinkage, and relaxation.
D. It removes the need to check ultimate strength because service stresses always govern.

63. A singly reinforced rectangular concrete beam has b = 14 in., d = 21 in., As = 3.2 in2, fy = 60 ksi, and f'c = 4.5 ksi. Using a = As fy/(0.85 f'c b) and Mn = As fy(d-a/2), what is Mn?

A. 368.8 kip-ft
B. 153.7 kip-ft
C. 307.3 kip-ft
D. 288.0 kip-ft

64. A concrete beam has nominal flexural strength Mn = 345 kip-ft. If phi = 0.90, what design flexural strength phiMn is available?

A. 345.0 kip-ft
B. 276.0 kip-ft
C. 383.3 kip-ft
D. 310.5 kip-ft

65. For a reinforced concrete beam, use Vc = 2 sqrt(f'c) bwd in pounds. If f'c = 5,000 psi, bw = 12 in., and d = 20 in., what Vc results?

A. 17.0 kip
B. 67.9 kip
C. 24.0 kip
D. 33.9 kip

66. For this problem, development length is ld = fy db/(25 sqrt(f'c)). Use fy = 60,000 psi, db = 0.875 in., and f'c = 5,000 psi. What ld results?

A. 14.8 in.
B. 59.4 in.
C. 29.7 in.
D. 21.0 in.

67. A tied concrete column has Ag = 160 in2 and Ast = 10 in2. Use Pn = 0.85 f'c(Ag-Ast) + fyAst with f'c = 5 ksi and fy = 60 ksi. What nominal axial strength Pn results?

A. 637.5 kip
B. 1,237.5 kip
C. 1,837.5 kip
D. 1,062.5 kip

68. A one-way slab strip is idealized as a simply supported 13-ft span carrying 0.50 kip/ft. Using Mmax = wL^2/8, what strip moment results?

A. 10.56 kip-ft
B. 5.28 kip-ft
C. 21.13 kip-ft
D. 84.50 kip-ft

69. A nearly square floor panel is supported continuously along all four edges. Which response best describes two-way slab action?

A. The slab carries all load in only the shorter direction regardless of support conditions.
B. Two-way action means the slab has no bending moment in either direction.
C. The slab distributes flexural load in both principal directions rather than acting primarily as independent one-way strips.
D. The slab transfers load directly to foundations without using supporting beams or walls.

70. A 9 ft by 9 ft square footing supports a concentric 405-kip service load. Neglect footing weight. What average soil pressure is produced?

A. 2.500 ksf
B. 5 ksf
C. 10 ksf
D. 45 ksf

71. A 12-ft-wide footing carries P = 600 kip with eccentricity e = 0.75 ft. For a one-foot strip, use qmax = (P/A)(1 + 6e/B), with A = 12 ft2. What is qmax?

A. 50.00 ksf
B. 31.25 ksf
C. 87.50 ksf
D. 68.75 ksf

72. A group contains seven piles, each with allowable axial capacity 85 kip. If a stated group-efficiency factor of 0.80 applies, what allowable group capacity is used?

A. 476 kip
B. 595 kip
C. 340 kip
D. 68 kip

73. A retaining wall has a triangular soil resultant of 22 kip/ft acting at H/3 above the base, where H = 15 ft. What overturning moment about the base results?

A. 330 kip-ft/ft
B. 73.30 kip-ft/ft
C. 44 kip-ft/ft
D. 110 kip-ft/ft

74. A retaining wall has stabilizing vertical load W = 96 kip/ft, base friction coefficient mu = 0.45, and horizontal driving force P = 24 kip/ft. Using FS = muW/P, what sliding factor of safety results?

A. 0.5
B. 1.8
C. 4.0

D. 2.4

75. A compact steel beam has Fy = 50 ksi and plastic section modulus Zx = 135 in3. Using Mn = FyZx, what nominal plastic moment results?

A. 6,750.0 kip-ft
B. 281.3 kip-ft
C. 562.5 kip-ft
D. 675.0 kip-ft

76. Why can inadequate lateral bracing reduce the flexural capacity of a slender steel beam?

A. The compression flange and cross section can displace laterally and twist, producing lateral-torsional buckling before full cross-sectional flexural strength develops.
B. Lateral bracing reduces steel yield strength whenever it is installed.
C. An unbraced beam cannot carry any vertical load, even at very low stress.
D. Lateral bracing matters only for axial tension members and never for beams.

77. A steel tension member has gross area Ag = 9.0 in2 and Fy = 50 ksi. Using phi = 0.90 and design yielding strength phiFyAg, what strength results?

A. 450 kip
B. 337.5 kip
C. 225 kip
D. 405 kip

78. A steel tension member has effective net area Ae = 6.2 in2 and Fu = 65 ksi. Using phi = 0.75 for net-section rupture, what design rupture strength results?

A. 403.00 kip
B. 201.50 kip

C. 302.25 kip
D. 325.00 kip

79. A connection uses five bolts, each with stated design shear strength of 31 kip, and the load is shared equally. What total design shear strength is available?

A. 155 kip
B. 31 kip
C. 124 kip
D. 186 kip

80. For a fillet weld, use phiRn = phi(0.6Fexx)(0.707wL). With phi = 0.75, Fexx = 70 ksi, w = 0.3125 in., and L = 12 in., what design strength results?

A. 41.8 kip
B. 83.5 kip
C. 111.3 kip
D. 59.1 kip

81. A steel column has E = 29,000 ksi, I = 500 in4, and effective length KL = 192 in. Using Euler Pcr = pi^2EI/(KL)^2, what critical load results?

A. 1,941 kip
B. 3,882 kip
C. 7,764 kip
D. 1,053 kip

82. A member interaction check is Pu/phiPn + Mu/phiMn <= 1.0. If Pu = 210 kip, phiPn = 700 kip, Mu = 84 kip-ft, and phiMn = 140 kip-ft, what interaction ratio results?

A. 0.30

B. 0.60
C. 1.20
D. 0.90

83. In a composite steel-concrete beam, what is the primary structural role of shear connectors at the interface?

A. Transfer interface shear so the concrete slab and steel beam act compositely with limited slip.
B. Prevent all vertical deflection by creating an infinitely rigid member.
C. Replace the steel beam web and carry the entire vertical shear alone.
D. Eliminate concrete compression so the slab carries only tension.

84. A timber beam has allowable bending stress Fb = 1.35 ksi and section modulus S = 200 in3. What allowable bending moment FbS results?

A. 270.0 kip-ft
B. 11.2 kip-ft
C. 22.5 kip-ft
D. 16.7 kip-ft

85. A timber post carries 48 kip through a gross area of 40 in2. What average compressive stress acts on the section?

A. 0.83 ksi
B. 1.20 ksi
C. 2.40 ksi
D. 19.20 ksi

86. A wood connection requires 22 kip of design lateral resistance. Each fastener provides 4.0 kip of stated design resistance with equal sharing. What minimum number of fasteners is required?

A. 5 fasteners
B. 5.500 fasteners
C. 6 fasteners
D. 8 fasteners

87. A masonry wall carries a concentric axial load of 84 kip over a net area of 140 in2. What average compressive stress results?

A. 1.667 ksi
B. 0.300 ksi
C. 11.76 ksi
D. 0.600 ksi

88. A masonry shear-wall segment carries V = 54 kip. Using v = V/(bd) with b = 8 in. and d = 135 in., what average shear stress results?

A. 0.050 ksi
B. 0.025 ksi
C. 0.100 ksi
D. 6.750 ksi

89. A diaphragm develops an in-plane bending moment of 720 kip-ft between chord lines 32 ft apart. Using F = M/d, what chord force magnitude is required?

A. 22.5 kip
B. 11.2 kip
C. 32.0 kip
D. 23,040.0 kip

90. What is the primary purpose of a collector, sometimes called a drag strut, in a diaphragm system?

A. Carry only gravity loads from finishes while remaining isolated from the lateral system.
B. Reduce material yield strength so the design lateral force becomes smaller.
C. Replace every diaphragm chord, boundary element, and connection in the structure.
D. Gather diaphragm forces and transfer them into the designated vertical lateral-force-resisting elements.

91. A chevron-braced bay uses two identical braces at 50 degrees to the horizontal. If a 120-kip story shear is shared equally through their horizontal components, what axial force acts in each brace?

A. 60.0 kip
B. 93.3 kip
C. 120.0 kip
D. 186.7 kip

92. A lateral frame resists an overturning moment of 1,350 kip-ft through a tension-compression couple separated by 27 ft. What axial force magnitude is required on each side?

A. 25 kip
B. 100 kip
C. 50 kip
D. 1,350 kip

93. A steel column transfers 560 kip concentrically through an 18 in. by 22 in. base plate. What average bearing pressure acts beneath the plate?

A. 31.100 ksi
B. 25.500 ksi
C. 2.828 ksi
D. 1.414 ksi

94. A base connection resists a 330 kip-ft moment using a tension-compression couple with 30 in. between resultants. Neglect axial load. What force magnitude is required in the tension side?

A. 11 kip
B. 132 kip
C. 264 kip
D. 330 kip

95. A footing has width B = 9 ft and eccentricity e = 0.80 ft. Using B' = B - 2e, what effective width results?

A. 8.2 ft
B. 6.6 ft
C. 7.4 ft
D. 9.8 ft

96. A rigid pile cap carries a concentric 720-kip load supported by six identical piles of equal stiffness. Neglect cap weight and group effects. What axial load is assigned to each pile?

A. 120 kip
B. 60 kip
C. 240 kip
D. 720 kip

97. A drilled shaft has diameter 3.75 ft, embedded length 40 ft, and uniform unit side resistance fs = 0.50 ksf. Using Qs = pi d L fs, what side resistance results?

A. 117.8 kip
B. 471.2 kip
C. 235.6 kip
D. 75.0 kip

98. A 14-ft-wide retaining-wall base carries vertical load P = 280 kip/ft with eccentricity e = 1.0 ft. Using qmax = P/B(1 + 6e/B), what maximum base pressure results?

A. 20.00 ksf
B. 28.57 ksf
C. 11.43 ksf
D. 40.00 ksf

99. Why are transverse ties or spiral reinforcement provided around the longitudinal bars of a reinforced concrete column?

A. They replace all longitudinal reinforcement needed to resist axial load.
B. They eliminate concrete cracking and crushing under every possible load combination.
C. They serve only as construction spacers and have no structural role after curing.
D. They restrain longitudinal-bar buckling, confine the concrete core, maintain cage geometry, and contribute to shear resistance where required.

100. Which connection-detailing strategy most directly supports ductile behavior in a lateral-force-resisting system?

A. Provide an intentional yielding mechanism with adequate deformation capacity while proportioning surrounding components to avoid premature brittle failure.
B. Make the most brittle component intentionally weaker so it fractures before yielding occurs.
C. Maximize connection stiffness without considering deformation capacity or force redistribution.
D. Rely on a single field attachment without verifying how forces enter and leave the connected members.

Practice Exam 24: Answer Key and Explanations

1. B — Multiply the area pressure by the tributary width: 96 psf times 9 ft equals 864 lb/ft. The alternatives omit the width, use half the tributary width, or double the correct line load. Distinguish pressure, line load, force, and moment so tributary dimensions are applied only once. A quick dimensional check often exposes a missing span, width, or conversion factor.

2. A — The total applied load is 2.1 times 28, or 58.8 kip. Symmetry divides that load equally between the two simple supports, producing a 29.4-kip reaction at each support. A quick dimensional check often exposes a missing span, width, or conversion factor. Keep characteristic loads separate until the stated combination or distribution rule is applied.

3. C — Convert 7 inches to 7/12 ft, then multiply by 150 pcf. The self-weight is 87.5 psf. The distractors treat the slab as one foot, six inches, or seven feet thick. Keep characteristic loads separate until the stated combination or distribution rule is applied. For support reactions, verify that the reactions sum to the applied vertical load.

4. D — Apply the factors separately: 1.2 times 45 equals 54 psf and 1.6 times 70 equals 112 psf. Their sum is 166 psf. The other values reflect omitted or misapplied factors. For support reactions, verify that the reactions sum to the applied vertical load. Check the load path and units before accepting a numerical result.

5. C — Direct substitution gives 0.7 times 1.0 times 0.95 times 1.0 times 42, or about 27.9 psf. The distractors omit a coefficient, omit the 0.7 factor, or apply an extra reduction. Check the load path and units before accepting a numerical result. Distinguish pressure, line load, force, and moment so tributary dimensions are applied only once.

6. A — Substitution into the stated velocity-pressure relation gives approximately 32.4 psf. Wind speed is squared, while the remaining coefficients enter linearly. The alternatives reflect omitted coefficients or a different multiplier. Distinguish pressure, line load, force, and moment so tributary dimensions are applied only once. A quick dimensional check often exposes a missing span, width, or conversion factor.

7. B — Multiply the effective seismic weight by the stated coefficient: 0.078 times 3,100 kip equals 241.8 kip. The distractors divide, use ten percent of the weight, or apply an incorrect coefficient. A quick dimensional check often exposes a missing span, width, or conversion factor. Keep characteristic loads separate until the stated combination or distribution rule is applied.

8. D — The surcharge creates a uniform lateral pressure of 480 times 0.35, or 168 psf. Multiplying by 13 ft gives 2,184 lb/ft, or 2.184 kip/ft. The alternatives stop at pressure, halve the height, or omit Ka. Keep characteristic loads separate until the stated combination or distribution rule is applied. Check units.

9. A — The triangular active-pressure resultant is one-half Ka gamma H squared. Substitution gives 3,430 lb/ft, or 3.43 kip/ft. The distractors omit the one-half factor, use a different coefficient, or fail to square the height. For support reactions, verify that the reactions sum to the applied vertical load. Check the load path and units before accepting a numerical result.

10. C — For a point load on a simple span, the left reaction is P(L-x)/L. Substituting 36 kip, L = 30 ft, and x = 10 ft gives 24 kip. The right reaction is 12 kip, and both reactions sum to the axle load. Check the load path and units before accepting a numerical result.

11. B — An equivalent uniform line load equals the repeated point reaction divided by beam spacing. Dividing 42 kip by 10 ft gives 4.2 kip/ft. The other choices repeat the point load, halve the line load, or double it. Distinguish pressure, line load, force, and moment so tributary dimensions are applied only once.

12. D — The concrete contributes 145 times 3.5/12 = about 42.3 psf. Adding the 4-psf deck gives 46.3 psf. The distractors omit the deck, treat pcf as psf, or use an incorrect thickness conversion. A quick dimensional check often exposes a missing span, width, or conversion factor. Keep characteristic loads separate until the stated combination or distribution rule is applied.

13. C — The square root of 3,600 is 60, so the bracket is 0.25 + 15/60 = 0.50. Multiplying by 75 psf gives 37.5 psf. The alternatives apply only part of the expression or leave the live load unreduced. Keep characteristic loads separate until the stated combination or distribution rule is applied.

14. A — Convert 4.5 inches to 0.375 ft and multiply by 62.4 pcf. The resulting water pressure is 23.4 psf. The distractors use six inches, repeat the depth, or multiply by inches without converting to feet. For support reactions, verify that the reactions sum to the applied vertical load. Check the load path and units before accepting a numerical result.

15. B — A 20 percent impact increase multiplies the static wheel load by 1.20. Thus 56 kip becomes 67.2 kip. The alternatives report only the increment, ignore impact, or add a rounded but incorrect amount. Check the load path and units before accepting a numerical result. Distinguish pressure, line load, force, and moment so tributary dimensions are applied only once.

16. D — The shared gravity load contributes 270/3 = 90 kip to each girder. Adding the separate 30-kip equipment load gives 120 kip on the affected girder. The distractors omit the equipment load, divide incorrectly, or assign the total system load. Distinguish pressure, line load, force, and moment so tributary dimensions are applied only once.

17. D — Evaluate all three stated combinations: 49 kip, 114 kip, and 137 kip. The third combination governs. The distractors correspond to the other combinations or to an incorrect summation rather than the largest required result. A quick dimensional check often exposes a missing span, width, or conversion factor. Keep characteristic loads separate until the stated combination or distribution rule is applied.

18. B — For a centered point load on a simple span, Mmax = PL/4. Multiplying 18 kip by 22 ft and dividing by four gives 99 kip-ft. The alternatives omit or over-apply the divisor. Check limiting behavior and dimensions to catch arithmetic or sign errors. Member response depends on both loading and boundary conditions, so identify each before choosing an equation.

19. A — For a uniformly loaded simple span, Mmax = wL squared/8. Substitution gives 1.6 times 400 divided by 8, or 80 kip-ft. The distractors use other common denominators or omit the division. Member response depends on both loading and boundary conditions, so identify each before choosing an equation. A free-body diagram and consistent sign convention are reliable checks for analysis questions.

20. C — The total load is 2.5 times 16 = 40 kip, and symmetry divides it equally between two supports. Each support therefore carries 20 kip. The alternatives assign the full load, halve twice, or ignore span length. A free-body diagram and consistent sign convention are reliable checks for analysis questions. Check units.

21. B — Average axial stress is P/A. Dividing 135 kip by 7.5 square inches gives 18 ksi. The distractors divide by an incorrect area, multiply instead of divide, or use a nearby round value. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units. Equilibrium determines force effects, while stiffness and compatibility govern many deformation results.

22. A — Convert 10 ft to 120 in. and apply PL/AE. The elongation is about 0.083 in. The alternatives halve, double, or shift the decimal. Consistent inch-based length units are required because E is given in ksi. Equilibrium determines force effects, while stiffness and compatibility govern many deformation results. Check limiting behavior and dimensions to catch arithmetic or sign errors.

23. C — Using S = bh squared/6 gives 11 times 19 squared divided by 6, or about 661.8 cubic inches. The distractors use half the correct value, omit the divisor, or use a first-power depth term. Check limiting behavior and dimensions to catch arithmetic or sign errors. Check units and signs carefully.

24. D — Convert 105 kip-ft to 1,260 kip-in. and divide by 700 in3. The bending stress is 1.8 ksi. The distractors omit the foot-to-inch conversion, shift a decimal, or use an incorrect divisor. Member response depends on both loading and boundary conditions, so identify each before choosing an equation. A free-body diagram and consistent sign convention are reliable checks for analysis questions.

25. D — Convert the span to 180 in. and substitute into PL cubed divided by 48EI. The calculated midspan deflection is about 0.021 in. The distractors halve, double, or move the decimal. A free-body diagram and consistent sign convention are reliable checks for analysis questions. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units.

26. B — Applying the stated uniform-load deflection equation with consistent inch units gives approximately 0.014 in. The other choices halve, double, or shift the decimal. The fourth-power span term makes the result sensitive to span length. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units. Check units.

27. A — Convert 16 ft to 192 in. and substitute into the Euler equation. The critical load is about 6,988 kip. The alternatives halve, double, or omit the squared-length effect in the denominator. Equilibrium determines force effects, while stiffness and compatibility govern many deformation results. Check limiting behavior and dimensions to catch arithmetic or sign errors.

28. C — Torsional shear stress is Tc/J. Substituting 135 kip-in., 2.25 in., and 32.2 in4 gives about 9.43 ksi. The distractors halve or double the result or divide by the radius incorrectly. Check limiting behavior and dimensions to catch arithmetic or sign errors. Member response depends on both loading and boundary conditions, so identify each before choosing an equation.

29. C — At the more compressed edge, axial and bending compression act in the same direction, so their magnitudes add. Seven plus eleven equals 18 ksi. Other choices subtract the stresses, report one component, or multiply them. Member response depends on both loading and boundary conditions, so identify each before choosing an equation.

30. A — The average normal stress is 15 ksi and the radius term is sqrt(9 squared + 5 squared) = about 10.3 ksi. Adding them gives a major principal stress of about 25.3 ksi. A free-body diagram and consistent sign convention are reliable checks for analysis questions. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units.

31. B — Free thermal expansion is alpha DeltaT L. With L = 384 in., the elongation is approximately 0.187 in. The distractors halve, double, or omit most of the length conversion. No stress develops when expansion is truly unrestrained. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units.

32. D — For full restraint, thermal stress magnitude is E alpha DeltaT. Substitution gives about 12.25 ksi. The distractors halve or double the value or report thermal strain rather than stress. The actual sign depends on heating versus cooling. Equilibrium determines force effects, while stiffness and compatibility govern many deformation results. Check limiting behavior and dimensions to catch arithmetic or sign errors.

33. A — A cantilever end load produces a fixed-end moment magnitude PL. Multiplying 9 kip by 7 ft gives 63 kip-ft. The alternatives halve the lever arm, report the load only, or double the correct moment. Check limiting behavior and dimensions to catch arithmetic or sign errors. Check units and signs carefully.

34. C — Substitution into the stated cantilever uniform-load expression gives about 0.047 in. The alternatives double, halve, or shift the decimal. The fourth-power span term means modest span changes can materially affect deflection. Member response depends on both loading and boundary conditions, so identify each before choosing an equation. A free-body diagram and consistent sign convention are reliable checks for analysis questions.

35. B — Joint equilibrium requires the transverse force component to vanish. With no external load or support reaction at the joint, the two collinear members can balance along their line, so the non-collinear member carries zero force under the idealized conditions. A free-body diagram and consistent sign convention are reliable checks for analysis questions.

36. D — A pin supplies two reaction components and two vertical rollers supply one each, for four external reaction unknowns. Planar equilibrium provides three independent equations, leaving one redundant reaction. The other arrangements are determinate or unstable under the idealized support assumptions. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units.

37. C — The right-reaction influence ordinate is x/L = 12/40 = 0.30. Multiplying by the 28-kip moving load gives 8.4 kip. The left reaction would be 19.6 kip, and both reactions sum to 28 kip. Equilibrium determines force effects, while stiffness and compatibility govern many deformation results. Check limiting behavior and dimensions to catch arithmetic or sign errors.

38. B — Stress range equals maximum stress minus minimum stress. Because the minimum is negative, the range is 26 - (-8) = 34 ksi. The alternatives subtract absolute values, report the maximum only, or give half the range. Check limiting behavior and dimensions to catch arithmetic or sign errors. Verify units carefully.

39. D — Projected bearing area is t times d = 5/8 times 7/8 square inches. Dividing 24 kip by that area gives about 43.9 ksi. The distractors halve the load effect or use incorrect projected areas. Member response depends on both loading and boundary conditions, so identify each before choosing an equation.

40. A — The concentric stress is 144/24 = 6 ksi. Eccentric bending contributes Pe/S = 720/120 = 6 ksi. At the more compressed edge, the stresses add to 12 ksi. The other choices report one component or over-combine them. A free-body diagram and consistent sign convention are reliable checks for analysis questions.

41. C — Using bh cubed/12 gives 10 times 26 cubed divided by 12, or about 14,647 in4. The distractors halve the result, omit the divisor, or use an incorrect power of depth. Confirm whether the requested result is stress, force, rotation, deflection, or moment before selecting units. Equilibrium determines force effects, while stiffness and compatibility govern many deformation results.

42. A — Reshoring redistributes construction loads among multiple floors while recently cast slabs and supporting elements continue developing capacity. It is a temporary load-path strategy, not a permanent replacement for columns, a method of increasing material strength, or a substitute for construction-sequence analysis. Field convenience does not replace engineering verification of temporary support, access, or adjacent-facility risk.

43. D — Total force from uniform pressure equals pressure times loaded area. The panel area is 9 times 5.5 = 49.5 ft2, so the force is 820 times 49.5 = 40,590 lb. The distractors omit one panel dimension or repeat pressure. Special inspections and submittals support conformance, but they do not transfer the contractor's means-and-methods responsibility.

44. B — Temporary platforms should be verified for the actual erected configuration and the full set of intended loads before use. Stored materials, access, tools, and worker loads all matter. Waiting for visible distress is not an acceptable design method, and permanent-floor capacity does not automatically transfer to temporary works. Check units.

45. C — Special inspection provides independent observation or testing for specified work and records whether that work conforms to approved requirements. It does not transfer means-and-methods responsibility, create authority for undocumented design changes, or guarantee perfect long-term performance of every completed component. Construction-stage stability must be evaluated for the actual sequence, not inferred from the completed structure.

46. A — Excavation can remove confinement or bearing support relied upon by adjacent foundations. Engineering should therefore evaluate influence zones, temporary support or underpinning, sequencing, and monitoring before soil is removed. Reactive observation after settlement begins does not adequately control the structural risk. Temporary works require a deliberate load path, adequate bracing, and documented review before loading.

47. D — Incomplete frames can have very different stiffness and load paths from the finished structure. Temporary bracing should remain until the permanent lateral system is actually capable of providing required stability for the construction stage. Final-design adequacy alone does not prove erection-stage stability. Field convenience does not replace engineering verification of temporary support, access, or adjacent-facility risk.

48. C — Shop or fabrication submittals communicate proposed fabrication and installation details for review, while RFIs ask for clarification of contract information. Neither document automatically transfers design responsibility, and neither should be used as an undocumented shortcut for changing the structural design. Special inspections and submittals support conformance, but they do not transfer the contractor's means-and-methods responsibility.

49. B — Substituting 4,500 psi into the stated modulus relation gives about 3,824 ksi. The distractors confuse strength with modulus, use an incorrect square-root operation, or double the correct stiffness value. For phase relationships, keep total volume, void volume, water content, and unit weight definitions distinct. Check the governing units and mechanism.

50. B — The modulus of elasticity is the slope relating stress and strain in the initial elastic range, so it directly characterizes stiffness. Compressive strength describes a strength limit, unit weight describes mass per volume, and thermal expansion describes strain caused by temperature change rather than mechanical loading. Check units and assumptions.

51. A — Total reinforcing area equals the number of bars times the area of one bar. Seven times 0.60 in2 gives 4.20 in2. The distractors use six or eight bars or report the area of only one bar. Keep stress units and specimen geometry consistent when converting a laboratory result into a material property.

52. D — Yield and tensile strengths describe different points on the stress-strain response. Yield strength identifies the beginning of significant permanent deformation, while tensile strength is the maximum engineering stress. Elastic modulus is stiffness, not either strength. For ordinary ductile steel, tensile strength exceeds yield strength. Check the governing units and mechanism.

53. C — Dividing 22 ksi by 0.00076 strain gives about 28,947 ksi, consistent with the expected order of magnitude for structural steel. The distractors halve the result, use an incorrect decimal, or multiply rather than divide. A test result is meaningful only when the measured quantity corresponds to the design property under review.

54. A — Wood has a directional cellular structure, so load carried along fibers produces different stiffness and strength from load acting across them. This anisotropy is a physical material characteristic, not a code convention. Moisture can also affect behavior, but it does not eliminate directional differences. For phase relationships, keep total volume, void volume, water content, and unit weight definitions distinct.

55. D — A masonry prism contains representative masonry units, mortar, and often grout arranged to reflect construction. Compression testing therefore characterizes the compressive strength of the masonry assemblage rather than an isolated steel, concrete, or soil property. The specimen basis is important when relating test results to design values. Verify units carefully.

56. B — Void ratio is void volume divided by solids volume, while porosity is void volume divided by total volume. Using e = n/(1-n) gives 0.36/0.64 = 0.5625. The alternatives repeat porosity, use solids fraction, or invert the ratio. Keep stress units and specimen geometry consistent when converting a laboratory result into a material property.

57. A — Total unit weight is weight divided by total volume. Dividing 126 lb by 1.80 ft3 gives 70 pcf. The distractors use an incorrect divisor, repeat total weight as a unit weight, or multiply instead of divide. Soil, concrete, steel, timber, and masonry use different constitutive behavior, so the governing property must fit the mechanism.

58. D — The stated relation gives 118 times 5 times 16 = 9,440 psf, which is 9.44 ksf. The alternatives omit the depth or conversion, double the result, or leave the answer in psf while labeling it as ksf. A test result is meaningful only when the measured quantity corresponds to the design property under review.

59. C — Concrete cylinder compressive strength is obtained by loading the prepared and cured cylinder axially in compression and dividing the maximum load by its cross-sectional area. The other tests evaluate toughness, particle-size distribution, or connection shear rather than concrete compressive strength. For phase relationships, keep total volume, void volume, water content, and unit weight definitions distinct.

60. B — The Charpy V-notch test measures the energy absorbed when a notched specimen fractures under impact loading, providing an indicator of notch toughness and ductile-to-brittle behavior. It is not a test for concrete compression, soil consolidation, or timber moisture content. Match the material property to the physical behavior being evaluated: strength, stiffness, toughness, durability, or phase condition.

61. A — Grout fills reinforced cells and creates contact that allows force transfer among masonry units, grout, and reinforcing bars. It also helps support and protect reinforcement. Grout does not replace mortar joints, eliminate steel requirements, or intentionally create slip around the bars. Keep stress units and specimen geometry consistent when converting a laboratory result into a material property.

62. B — Prestressing introduces a deliberate compressive force and associated moment before service load acts. That precompression can reduce tensile stress, cracking, and deflection under service conditions. Prestressing does not eliminate compression, long-term losses, or ultimate-strength checks; those effects remain part of design. Soil, concrete, steel, timber, and masonry use different constitutive behavior, so the governing property must fit the mechanism.

63. C — First compute the equivalent compression-block depth, then multiply steel tension force by the internal lever arm. Substitution gives a nominal moment of about 307.3 kip-ft. The distractors use incorrect block depth, halve the result, or omit part of the lever arm. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible.

64. D — Design strength equals the resistance factor times nominal strength. Multiplying 345 kip-ft by 0.90 gives 310.5 kip-ft. The alternatives leave the strength unfactored, use a lower factor, or divide by phi instead of multiplying. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

65. D — Substitution into the stated concrete shear relation gives about 33.9 kip. The distractors halve or double the result or omit the square-root strength term. Units convert from pounds to kips after evaluating the expression. Identify the governing limit state and compare the stated demand with the available resistance using consistent units.

66. C — Using the stated expression, multiply 60,000 psi by the 0.875-in. bar diameter and divide by 25 times sqrt(5,000). The result is about 29.7 in. The distractors halve, double, or mis-handle the square root. Good detailing is part of the load path; adequate member strength alone does not guarantee a reliable structural system.

67. B — The concrete contribution is 0.85 times 5 ksi times 150 in2 = 637.5 kip, while steel contributes 600 kip. Summing the two gives 1,237.5 kip nominal axial strength. The alternatives omit one component or use incorrect concrete area. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them.

68. A — For the stated simple-span idealization, maximum moment is wL squared/8. Substitution gives 0.50 times 169 divided by 8 = 10.56 kip-ft. The distractors halve, double, or omit the divisor. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

69. C — Two-way slab behavior occurs when geometry and support conditions allow meaningful flexural load sharing in both orthogonal directions. It does not eliminate bending, force all load into one direction, or bypass the supporting framing. Relative span lengths and edge support strongly influence the distribution. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

70. B — Footing area is 81 ft2. Dividing the 405-kip concentric load by 81 ft2 gives an average soil pressure of 5 ksf. The distractors halve or double the correct pressure or divide by only one footing dimension. Identify the governing limit state and compare the stated demand with the available resistance using consistent units.

71. D — Average pressure is 600/12 = 50 ksf. The eccentricity factor is 1 + 4.5/12 = 1.375, giving qmax = 68.75 ksf. The alternatives ignore eccentricity, use the minimum edge pressure, or apply too large a multiplier. Good detailing is part of the load path; adequate member strength alone does not guarantee a reliable structural system.

72. A — The sum of individual allowable capacities is 7 times 85 = 595 kip. Applying the stated 0.80 group efficiency gives 476 kip. The alternatives omit efficiency, use only four piles, or report a per-pile value. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them. Check assumptions.

73. D — The triangular pressure resultant acts one-third of the wall height above the base. For H = 15 ft, the lever arm is 5 ft. Multiplying 22 kip/ft by 5 ft gives 110 kip-ft per foot of wall. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible.

74. B — Available friction is mu W = 0.45 times 96 = 43.2 kip/ft. Dividing by the 24-kip/ft driving force gives a sliding factor of safety of 1.8. The alternatives repeat an input or use an incorrect ratio. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

75. C — Multiplying 50 ksi by 135 in3 gives 6,750 kip-in. Dividing by 12 converts to 562.5 kip-ft. The distractors omit the unit conversion, halve the moment, or misplace the decimal. Identify the governing limit state and compare the stated demand with the available resistance using consistent units. Check units and assumptions.

76. A — Lateral-torsional buckling is a stability limit state involving sideways movement of the compression region and twisting of the cross section. Sufficient bracing restrains that mode so greater flexural strength can develop. The issue is stability, not a change in the material yield strength itself. Check the governing units and mechanism.

77. D — Gross-section yielding design strength is phi Fy Ag. Multiplying 0.90 times 50 ksi times 9.0 in2 gives 405 kip. The alternatives omit phi, use a lower factor, or halve the gross area. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them. Check units and assumptions.

78. C — Net-section rupture strength is phi Fu Ae. Multiplying 0.75 times 65 ksi times 6.2 in2 gives 302.25 kip. The distractors omit phi, use a 0.50 factor, or substitute a different strength value. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible. Verify units carefully.

79. A — With equal load sharing and five identical bolts, total design shear strength is the sum of the individual strengths: 5 times 31 = 155 kip. The distractors report one bolt, use four bolts, or use six bolts. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

80. B — The effective throat area is 0.707 times weld size times length. Multiplying by 0.6Fexx and phi gives about 83.5 kip. The distractors omit the resistance factor, halve the result, or use an incorrect effective throat. Identify the governing limit state and compare the stated demand with the available resistance using consistent units.

81. B — Substitution into the Euler equation gives approximately 3,882 kip. The alternatives halve or double the result or mishandle the squared effective length. This idealized result represents elastic buckling under the stated pin-ended-equivalent assumptions. Good detailing is part of the load path; adequate member strength alone does not guarantee a reliable structural system.

82. D — The axial term is 210/700 = 0.30 and the moment term is 84/140 = 0.60. Their sum is 0.90, which satisfies the stated interaction limit. The alternatives report only one term or over-add the contributions. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them. Check assumptions.

83. A — Composite action requires the steel beam and concrete slab to develop compatible longitudinal strain. Shear connectors transfer interface shear and limit relative slip so the components can share flexural resistance. They do not eliminate deflection, replace the web, or force concrete to carry tension only. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible.

84. C — Multiplying 1.35 ksi by 200 in3 gives 270 kip-in. Dividing by 12 gives 22.5 kip-ft of allowable bending moment. The distractors omit the unit conversion, halve the value, or use an incorrect divisor. When several components share a load, confirm the stated distribution rule before summing or dividing forces. Check units.

85. B — Average compressive stress is load divided by gross area. Dividing 48 kip by 40 in2 gives 1.20 ksi. The distractors invert the ratio, double the stress, or multiply load and area. Identify the governing limit state and compare the stated demand with the available resistance using consistent units. Check units.

86. C — Required fastener count is 22/4.0 = 5.5, and a fractional fastener is not possible, so the count must round up to six. The distractors round down, leave a non-integer count, or add unnecessary fasteners. Good detailing is part of the load path; adequate member strength alone does not guarantee a reliable structural system.

87. D — Average compressive stress is P/A = 84/140 = 0.60 ksi. The alternatives invert the ratio, halve the correct stress, or multiply load and area rather than dividing. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible.

88. A — The resisting area is 8 times 135 = 1,080 in2. Dividing 54 kip by 1,080 in2 gives 0.050 ksi, or 50 psi. The distractors halve, double, or divide by only the wall thickness. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible. Check units.

89. A — A chord couple resists diaphragm in-plane moment through equal axial forces separated by the chord distance. Dividing 720 kip-ft by 32 ft gives 22.5 kip. The distractors halve the force, repeat the spacing, or multiply instead of divide. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

90. D — Collectors provide a deliberate in-plane load path between distributed diaphragm forces and vertical resisting elements such as shear walls or frames. They are especially important where those elements are discontinuous or offset. Collectors do not change material strength and do not automatically replace chords or other boundary components. Check units.

91. B — The two horizontal brace components together resist the story shear, so 2F cos50 = 120 kip. Solving gives F approximately 93.3 kip per brace. The distractors ignore brace angle, assign the full shear to each brace, or omit the factor of two. Verify the force path and units before selection.

92. C — For a force couple, moment equals one force times the separation between equal and opposite resultants. Dividing 1,350 kip-ft by 27 ft gives 50 kip. The alternatives halve or double the force or repeat the moment magnitude. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them.

93. D — The base-plate area is 18 times 22 = 396 in2. Dividing 560 kip by 396 in2 gives about 1.414 ksi average bearing pressure. The distractors divide by one plate dimension or double the pressure. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible. Check units.

94. B — Convert 330 kip-ft to 3,960 kip-in. and divide by the 30-in. couple arm. The required tension-side force is 132 kip, with equal opposite compression. The distractors omit unit conversion, use half the lever arm, or repeat the moment magnitude. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

95. C — The effective-width approximation subtracts twice the eccentricity from the footing width. Two times 0.80 ft is 1.60 ft, so B prime = 9 - 1.60 = 7.40 ft. The alternatives subtract once, subtract three times, or add eccentricity. Identify the governing limit state and compare the stated demand with the available resistance using consistent units.

96. A — With concentric loading and six identical equally stiff piles, symmetry gives equal load sharing. Dividing 720 kip by six gives 120 kip per pile. The alternatives divide by twelve or three, or assign the entire load to one pile. Good detailing is part of the load path; adequate member strength alone does not guarantee a reliable structural system.

97. C — Shaft side area is perimeter times length, pi times 3.75 times 40. Multiplying that area by 0.50 ksf gives about 235.6 kip side resistance. The distractors halve or double the result or omit pi. Check strength, stability, serviceability, anchorage, and connection behavior separately when the problem requires them. Check units.

98. B — Average pressure is 280/14 = 20 ksf. The eccentricity multiplier is 1 + 6/14 = about 1.4286, producing qmax about 28.57 ksf. The distractors ignore eccentricity, report the minimum edge pressure, or use an excessive multiplier. For foundations and retaining walls, structural resistance and the assumed soil-reaction model must remain compatible.

99. D — Transverse reinforcement restrains longitudinal bars against local buckling, confines the concrete core, helps maintain the reinforcement cage, and can contribute to shear resistance. It does not replace longitudinal steel, prevent every form of concrete damage, or become irrelevant once the concrete hardens. When several components share a load, confirm the stated distribution rule before summing or dividing forces.

100. A — Ductile detailing seeks controlled inelastic deformation in intended regions while protecting brittle modes such as fracture, pullout, or abrupt connection rupture. That requires a clear load path and a capacity hierarchy. Simply maximizing stiffness or allowing brittle failure first undermines reliable energy dissipation. Identify the governing limit state and compare the stated demand with the available resistance using consistent units.