PRACTICE EXAM 27: PE CIVIL - STRUCTURAL SIMULATION (100 QUESTIONS)

This expanded practice exam contains 100 four-option questions weighted to the NCEES PE Civil: Structural 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. A library floor beam has a tributary width of 13 ft and supports a uniform floor pressure of 80 psf. What uniform line load acts on the beam?

A. 1,040 lb/ft
B. 520 lb/ft
C. 2,080 lb/ft
D. 80 lb/ft

2. A 24-ft simply supported girder carries a uniform service load of 1.9 kip/ft over its full span. What vertical reaction occurs at each support?

A. 1.5 kip
B. 22.8 kip
C. 45.6 kip
D. 11.40 kip

3. A normal-weight concrete slab is 7.5 in. thick and has a unit weight of 145 pcf. What is the slab self-weight expressed as a uniform pressure?

A. 145 psf

B. 54.37 psf
C. 1,087.4 psf
D. 90.62 psf

4. For this practice check, use U = 1.2D + 1.6L. If D = 38 psf and L = 60 psf, what factored pressure U results?

A. 117.3 psf
B. 157.2 psf
C. 141.6 psf
D. 97.8 psf

5. For this problem, calculate roof snow pressure from p = 0.7 Ce Ct Is pg. Use Ce = 0.90, Ct = 1.05, Is = 1.0, and pg = 48 psf. What is p?

A. 30.3 psf
B. 33.7 psf
C. 45.5 psf
D. 31.8 psf

6. Use q = 0.00256 Kz Kzt Kd V^2 I. For Kz = 0.92, Kzt = 1.0, Kd = 0.85, V = 103 mph, and I = 1.0, what velocity pressure q results?

A. 24.9 psf
B. 21.2 psf
C. 18.0 psf
D. 31.2 psf

7. A seismic base shear is defined for this problem as V = CsW. If Cs = 0.074 and the effective seismic weight W = 3,400 kip, what base shear results?

A. 340 kip
B. 25.16 kip
C. 251.6 kip
D. 45.9 kip

8. A uniform surcharge of 495 psf acts behind a 15-ft retaining wall. If the lateral pressure coefficient is Ka = 0.31, what lateral force per foot of wall results from the surcharge alone?

A. 2,301.75 lb/ft
B. 1,150.9 lb/ft
C. 153.4 lb/ft
D. 7,425 lb/ft

9. Soil behind a retaining wall has unit weight 128 pcf, active coefficient Ka = 0.29, and retained height 13 ft. What is the resultant active soil force per foot of wall using Pa = 0.5 Ka gamma H^2?

A. 6,272.9 lb/ft
B. 482.7 lb/ft
C. 3,137 lb/ft
D. 1,568.5 lb/ft

10. A 30-kip truck axle is located 10 ft from the left support of a 28-ft simply supported span. What is the left support reaction due to that axle?

A. 30.01 kip
B. 19.29 kip
C. 15.01 kip
D. 10.72 kip

11. A girder supports secondary beams spaced at 16 ft. Each secondary beam delivers a 56-kip end reaction to the girder. If those reactions are idealized as an equivalent uniform line load, what line load represents them?

A. 7.00 kip/ft
B. 56 kip/ft
C. 1.75 kip/ft
D. 3.50 kip/ft

12. A metal deck weighs 2.5 psf and supports 4.5 in. of normal-weight concrete weighing 145 pcf. What combined dead-load pressure is carried before other permanent loads are added?

A. 56.88 psf
B. 54.46 psf
C. 147.6 psf
D. 655.9 psf

13. For this practice check, reduced live load is defined as L = L0(0.25 + 15/sqrt(KLLAT)). If L0 = 100 psf and KLLAT = 6,500 ft2, what is L?

A. 68.53 psf
B. 18.69 psf
C. 43.61 psf
D. 24.9 psf

14. A roof contains 5.25 in. of ponded rainwater. Using a water unit weight of 62.4 pcf, what uniform roof pressure does the water create?

A. 27.3 psf
B. 68.9 psf
C. 327.6 psf
D. 13.65 psf

15. A crane wheel load of 72 kip is increased by a stated impact factor of 20%. What design wheel load results for this problem?

A. 72.0 kip
B. 14.4 kip
C. 100.8 kip
D. 86.4 kip

16. Two identical roof girders share a total distributed gravity load of 241 kip equally. One girder also receives a 28-kip equipment load that is not shared. What total gravity load acts on that girder?

A. 269.5 kip
B. 148.5 kip
C. 134.7 kip
D. 121 kip

17. A member is checked using three stated combinations: 1.4D; 1.2D + 1.6L; and 1.2D + 1.0W + 1.0L. If D = 34 kip, L = 54 kip, and W = 45 kip, what is the largest factored load?

A. 132.8 kip
B. 49.0 kip
C. 139.8 kip
D. 124.4 kip

18. A simply supported 18-ft beam carries a 16-kip point load at midspan. What is the maximum bending moment?

A. 72 kip-ft
B. 144 kip-ft
C. 36.0 kip-ft
D. 16 kip-ft

19. A simply supported 30-ft beam carries 1.8 kip/ft uniformly over the full span. What is the maximum bending moment?

A. 405.0 kip-ft
B. 73.6 kip-ft
C. 101.25 kip-ft
D. 202.5 kip-ft

20. A 18-ft simply supported beam carries a 2.6 kip/ft uniform load over the full span. What is the magnitude of the vertical reaction at either support?

A. 2.3 kip
B. 46.8 kip
C. 11.7 kip
D. 23.4 kip

21. A tension member carries 160 kip through a gross area of 7.5 in2. What average axial stress is produced?

A. 1,200 ksi
B. 21.333 ksi
C. 0.05 ksi
D. 80 ksi

22. A 15-ft steel bar carries 78 kip in tension. Use A = 3.5 in2 and E = 29,000 ksi. What elongation results from delta = PL/(AE)?

A. 0.276 in.
B. 1.38 in.
C. 0.138 in.
D. 0.069 in.

23. A rectangular beam section has b = 12 in. and h = 28 in. What is its elastic section modulus S = bh^2/6 about the strong axis?

A. 15,680 in3
B. 1,568 in3
C. 784 in3
D. 3,136 in3

24. A beam has maximum moment M = 132 kip-ft and section modulus S = 715 in3. What maximum bending stress magnitude is produced?

A. 2.22 ksi
B. 0.185 ksi
C. 22.2 ksi
D. 0.222 ksi

25. A simply supported beam with a centered point load has P = 14 kip, L = 18 ft, E = 29,000 ksi, and I = 2,600 in4. Using delta = PL^3/(48EI), what midspan deflection is obtained?

A. 0.077 in.
B. 0.004 in.
C. 0.039 in.
D. 0.019 in.

26. A simply supported beam carries w = 0.16 kip/in. over a 108-in. span. If E = 29,000 ksi and I = 1,250 in4, use delta = 5wL^4/(384EI). What is the maximum deflection?

A. 0.0780 in.
B. 0.0039 in.
C. 0.0156 in.
D. 0.0078 in.

27. A pin-ended column has E = 29,000 ksi, I = 870 in4, and length L = 16 ft. Using Pcr = pi^2EI/L^2, what Euler critical load is obtained?

A. 6,755 kip
B. 3,377.5 kip
C. 13,510 kip
D. 562.9 kip

28. A solid circular shaft has torque T = 155 kip-in., outer radius c = 2.25 in., and polar moment J = 32.2 in4. Using tau = Tc/J, what maximum torsional shear stress results?

A. 21.66 ksi
B. 10.83 ksi
C. 69.7 ksi
D. 5.42 ksi

29. A column section has axial compressive stress P/A = 7.5 ksi and bending stress magnitude Mc/I = 10.5 ksi at an extreme fiber. What is the maximum compressive stress when the effects add?

A. 75.44 ksi
B. 2.1 ksi
C. 18.0 ksi
D. 10.1 ksi

30. At a point in plane stress, sigma_x = 16 ksi, sigma_y = 6 ksi, and tau_xy = 5 ksi. Using sigma_1 = (sx+sy)/2 + sqrt(((sx-sy)/2)^2 + tau^2), what is the major principal stress?

A. 10.95 ksi
B. 18.07 ksi
C. 15.51 ksi
D. 21.89 ksi

31. A 28-ft steel member experiences a uniform temperature increase of 83 F. Using alpha = 6.5e-6/F, what free thermal elongation occurs?

A. 1.808 in.
B. 0.018 in.
C. 0.090 in.
D. 0.181 in.

32. A fully restrained steel bar experiences a 43 F temperature increase. Use E = 29,000 ksi and alpha = 6.5e-6/F. What thermal stress magnitude is produced from sigma = E alpha DeltaT?

A. 8.11 ksi
B. 0.28 ksi
C. 16.23 ksi
D. 4.05 ksi

33. A cantilever beam carries an end load P = 14 kip over a length L = 7 ft. What is the fixed-end moment magnitude?

A. 14 kip-ft
B. 49.0 kip-ft
C. 98 kip-ft
D. 196 kip-ft

34. A cantilever has w = 0.10 kip/in., L = 84 in., E = 29,000 ksi, and I = 850 in4. Using delta = wL^4/(8EI), what free-end deflection results?

A. 0.0252 in.
B. 0.0504 in.
C. 0.0026 in.
D. 0.0125 in.

35. For this practice scenario, at an unloaded joint of an ideal pin-connected truss, exactly two members meet and the members are not collinear. No support reaction acts at the joint. What follows from joint equilibrium?

A. Only the steeper member is a zero-force member.
B. Both members are zero-force members.
C. Both members carry equal tensile force.
D. Both members carry equal compressive force.

36. For this structural-design scenario, which idealized planar support arrangement is statically indeterminate to the first degree because equilibrium alone cannot determine all external reactions?

A. A simply supported beam with one pin and one roller.
B. A cantilever beam fixed at one end and free at the other.
C. A three-hinged arch with stable supports.
D. A beam fixed at one end and supported by a roller at the other.

37. For a simply supported 40-ft span, the influence-line ordinate for the left reaction at a load position 12 ft from the left support is (L-x)/L. What reaction is caused by a 30-kip moving point load there?

A. 31.5 kip
B. 15.8 kip
C. 21.0 kip
D. 10.5 kip

38. A structural detail experiences repeated stress cycling between 22 ksi and -7 ksi. What is the stress range?

A. 23.2 ksi
B. 17.4 ksi
C. 14.5 ksi
D. 29 ksi

39. A 7/8-in.-diameter bolt bears on a 5/8-in.-thick plate under a 32-kip force. Using average bearing stress fb = P/(td), what stress is produced?

A. 29.25 ksi
B. 58.51 ksi
C. 117.01 ksi
D. 36.57 ksi

40. A rectangular column has area A = 24 in2, section modulus S = 120 in3, axial load P = 145 kip, and eccentricity e = 5 in. What maximum compressive stress is produced by P/A + Pe/S?

A. 12.08 ksi
B. 18.12 ksi
C. 30.20 ksi
D. 6.04 ksi

41. A rectangular beam has b = 10 in. and h = 32 in. What is its centroidal moment of inertia I = bh^3/12 about the strong axis?

A. 2,730.3 in4
B. 13,654.2 in4
C. 27,307 in4
D. 54,615.5 in4

42. For this practice scenario, why may reshoring be retained below recently cast floors after the original shores are removed during a multistory concrete construction sequence?

A. To permanently replace the designed building columns.
B. To redistribute construction loads through multiple floors while younger slabs gain adequate strength.
C. To increase concrete compressive strength through mechanical confinement.

D. To eliminate the need to analyze construction sequencing.

43. Fresh concrete exerts an idealized uniform lateral pressure of 800 psf on a form panel 9 ft long and 5 ft high. What total lateral force acts on the panel?

A. 4,000 lb
B. 800 lb
C. 7,200 lb
D. 36,000 lb

44. For this practice scenario, before a temporary scaffold platform is released for use, which engineering action most directly addresses structural loading risk?

A. Verify the erected configuration and capacity for intended workers, tools, materials, access, and support conditions.
B. Ignore stored materials because worker weight is the only relevant loading.
C. Assume the scaffold can carry the same load as the permanent floor.
D. Load the platform first and inspect only if visible deflection occurs.

45. For this practice scenario, a project specification requires special inspection for selected structural work. Which statement best describes the inspector's role?

A. Replace the contractor's responsibility for construction means and methods.
B. Authorize undocumented field design changes whenever schedule pressure arises.
C. Observe or test specified work and document whether it conforms to approved requirements.
D. Guarantee that every completed structural element will remain defect-free.

46. For this practice scenario, a deep excavation will be made beside an occupied building supported on shallow footings. Which preconstruction action best addresses the structural interaction risk?

A. Assume the neighboring foundation is unaffected because it lies on a separate property.

B. Evaluate the excavation influence zone, temporary support or underpinning needs, sequencing, and movement monitoring before soil removal.

C. Reduce documentation so field crews can respond informally if movement develops.

D. Excavate to final depth first and evaluate movement only after settlement is visible.

47. For this practice scenario, during steel erection, the permanent lateral system will not be complete for several construction sequences. Which approach best addresses stability of the partially erected frame?

A. Provide and maintain temporary bracing until the permanent lateral-force-resisting system is complete and effective.

B. Assume final-state structural analysis proves every intermediate erection stage stable.

C. Remove temporary bracing once any two beams are connected.

D. Rely on member self-weight to stabilize every incomplete-frame configuration.

48. For this structural-design scenario, which statement most accurately distinguishes a structural shop drawing submittal from a request for information (RFI)?

A. A shop drawing automatically changes the design, while an RFI can never affect project decisions.

B. An RFI is a fabrication drawing, while a shop drawing is used only for payment documentation.

C. Both documents transfer the engineer's design responsibility to the contractor once submitted.

D. A shop drawing shows proposed fabrication or installation details; an RFI requests clarification needed to proceed.

49. For normal-weight concrete, use Ec = 57,000 sqrt(f'c) psi. If f'c = 5,500 psi, what modulus Ec results?

A. 8,453 ksi

B. 4,227 ksi

C. 59,771.5 ksi

D. 2,988.5 ksi

50. For this practice scenario, for elastic deformation calculations of a concrete member, which material property most directly relates normal stress to normal strain in the initial approximately linear range?

A. Modulus of elasticity.
B. Air content alone.
C. Specified compressive strength alone.
D. Unit weight alone.

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

A. 4.50 in2
B. 6.75 in2
C. 0.75 in2
D. 6 in2

52. For this structural-design scenario, which statement most accurately distinguishes structural-steel yield strength from ultimate tensile strength?

A. Ultimate tensile strength is the elastic modulus measured before yielding begins.
B. The two terms are interchangeable because both describe only stiffness.
C. Yield strength marks substantial permanent deformation; ultimate tensile strength is the maximum engineering stress reached in tension.
D. Yield strength is always greater than tensile strength for ductile structural steel.

53. A steel coupon has axial stress of 17.4 ksi and corresponding elastic strain of 0.00060. What modulus E is indicated by E = stress/strain?

A. 1,044 ksi
B. 29,000 ksi
C. 17,400 ksi
D. 10,440 ksi

54. For this practice scenario, why do structural design values for wood distinguish loading parallel to grain from loading perpendicular to grain?

A. Wood is isotropic, but design tables create artificial directional differences.
B. Drying removes all directional behavior once lumber reaches service moisture.
C. Wood is orthotropic, so stiffness and strength depend strongly on loading direction relative to the grain.
D. Only connection design depends on grain direction; member strength does not.

55. For this practice scenario, when masonry prisms are tested in compression, which material property is the test intended to characterize most directly?

A. Elastic modulus of structural steel.
B. Moisture content of timber framing.
C. Yield strength of reinforcing steel.
D. Compressive strength of the assembled masonry system.

56. A soil has porosity n = 0.44. What is its void ratio e = n/(1-n)?

A. 0.786
B. 0.265
C. 0.456
D. 1.499

57. A soil sample has total weight 148 lb and total volume 1.80 ft3. What is its total unit weight?

A. 266.2 pcf
B. 73.9 pcf
C. 82.2 pcf
D. 133.1 pcf

58. For a soil bearing estimate, use qult = gamma Df Nq. If gamma = 110 pcf, Df = 5 ft, and Nq = 18, what ultimate bearing pressure results?

A. 5,500 psf
B. 49,500 psf
C. 1,980 psf
D. 9,900 psf

59. For this structural-design scenario, which laboratory procedure is used most directly to establish compressive strength of a conventional molded concrete cylinder?

A. Sieve analysis of the hardened concrete cylinder.
B. Axial compression to failure in a testing machine.
C. Charpy impact testing of a notched specimen.
D. Direct tension testing of a structural-steel coupon.

60. For this practice scenario, a steel specification requires a Charpy V-notch test. Which aspect of material behavior is that test intended to evaluate most directly?

A. Impact toughness and susceptibility to brittle fracture.
B. Concrete compressive strength.
C. Soil permeability under hydraulic gradient.
D. Masonry prism compressive strength.

61. For this practice scenario, in a reinforced CMU wall, grout is placed in cells containing vertical reinforcing bars. What is the principal structural reason for the grout?

A. Prevent reinforcing steel from carrying any tensile force.
B. Serve only as an architectural finish on exposed wall surfaces.
C. Replace all mortar joints between masonry units.

D. Fill reinforced cells so the bars and masonry can act together and transfer forces.

62. For this practice scenario, what principal service-performance advantage is gained by prestressing a concrete member before most service loading is applied?

A. Beneficial precompression can reduce service-load tensile stress and cracking.
B. It guarantees zero deflection regardless of span, time, or loading.
C. It eliminates all concrete compression under service loading.
D. It makes reinforcing or prestressing steel unnecessary in every member.

63. A singly reinforced rectangular concrete beam has b = 14 in., d = 22 in., As = 4.2 in2, fy = 60 ksi, and f'c = 5 ksi. Using a = As fy/(0.85 f'c b) and Mn = As fy(d-a/2), what is Mn?

A. 463.8 kip-ft
B. 417.5 kip-ft
C. 208.8 kip-ft
D. 501.1 kip-ft

64. For a concrete beam with nominal flexural strength Mn = 415 kip-ft, use phi = 0.90. What design flexural strength phiMn is available?

A. 461.1 kip-ft
B. 332 kip-ft
C. 373.5 kip-ft
D. 415 kip-ft

65. For a reinforced concrete beam, use Vc = 2 sqrt(f'c) bwd in pounds. If f'c = 5,100 psi, bw = 14 in., and d = 22 in., what Vc results?

A. 7.4 kip
B. 22.0 kip

C. 44.0 kip
D. 87.9 kip

66. For this practice check, required development length is defined as ld = fy db/(25 sqrt(f'c)). Use fy = 60,000 psi, db = 1.125 in., and f'c = 5,000 psi. What ld results?

A. 19.1 in.
B. 38.2 in.
C. 76.5 in.
D. 15.4 in.

67. A tied concrete column has Ag = 200 in2 and Ast = 10 in2. For this problem use Pn = 0.85 f'c(Ag-Ast) + fyAst with f'c = 5 ksi and fy = 60 ksi. What is Pn?

A. 1,407.5 kip
B. 2,046.1 kip
C. 638.6 kip
D. 768.9 kip

68. A one-way slab strip is idealized as a simply supported 12-ft span carrying 0.62 kip/ft. Using Mmax = wL^2/8, what strip moment results?

A. 89.3 kip-ft
B. 5.58 kip-ft
C. 22.32 kip-ft
D. 11.16 kip-ft

69. For this practice scenario, a nearly square reinforced-concrete floor panel is supported continuously along all four edges. Which response most clearly indicates two-way slab behavior?

A. Significant bending and load transfer occur in both orthogonal directions.

B. All load is carried only to the two supports along the short edges.
C. The slab carries only axial compression and develops no flexural action.
D. Load transfers directly to columns without plate bending between supports.

70. A square footing is 9 ft by 9 ft and supports a concentric service load of 471 kip. Neglect footing weight. What average soil bearing pressure is produced?

A. 2.9 ksf
B. 5.815 ksf
C. 8.7 ksf
D. 52.3 ksf

71. A 12-ft-wide footing carries P = 680 kip with eccentricity e = 0.75 ft about its centerline. For a one-foot strip, use qmax = (P/A)(1 + 6e/B), with A = 12 ft2. What is qmax?

A. 38.959 ksf
B. 56.667 ksf
C. 77.917 ksf
D. 99.167 ksf

72. A pile group contains seven piles, each with allowable axial capacity 100 kip. If a stated group-efficiency factor of 0.82 applies, what allowable group capacity is used?

A. 700 kip
B. 82.0 kip
C. 853.6 kip
D. 574.0 kip

73. A retaining wall experiences a triangular lateral soil resultant of 28 kip/ft acting at H/3 above the base, where H = 15 ft. What overturning moment about the toe is caused by this soil force?

A. 70 kip-ft/ft
B. 28 kip-ft/ft
C. 420 kip-ft/ft
D. 140 kip-ft/ft

74. A retaining wall has total stabilizing vertical load W = 90 kip/ft, base friction coefficient mu = 0.55, and horizontal driving force P = 22 kip/ft. Using FS = muW/P, what sliding factor of safety results?

A. 0.39
B. 2.25
C. 4.50
D. 1.12

75. A compact steel beam has Fy = 50 ksi and plastic section modulus Zx = 164 in3. For this practice check, take nominal plastic moment Mn = FyZx. What is Mn?

A. 683.333 kip-ft
B. 8,200 kip-ft
C. 341.7 kip-ft
D. 1,366.7 kip-ft

76. For this practice scenario, a long steel beam has adequate cross-sectional flexural strength but little lateral restraint to its compression flange. Why can its usable bending strength still be reduced?

A. Without lateral bracing, a beam carries only axial load and no bending moment.
B. Lateral bracing is relevant only to reinforced-concrete beams, not structural steel.
C. The compression flange can move laterally and the member can twist, causing lateral-torsional buckling before full flexural strength develops.
D. Lateral bracing changes the steel chemistry and directly increases yield strength.

77. A steel tension member has gross area Ag = 8.8 in2 and Fy = 50 ksi. Using phi = 0.90 and design yielding strength phiFyAg, what strength results?

A. 396 kip
B. 484 kip
C. 440.0 kip
D. 198.0 kip

78. A steel tension member has effective net area Ae = 6.2 in2 and Fu = 65 ksi. For this problem use phi = 0.75 for net-section rupture. What design rupture strength results?

A. 403.0 kip
B. 151.13 kip
C. 453.4 kip
D. 302.25 kip

79. A connection uses five bolts, each with stated design shear strength of 36 kip, and the load is shared equally. What total design shear strength is available?

A. 90 kip
B. 180 kip
C. 144 kip
D. 36 kip

80. For a fillet weld, use design strength phiRn = phi(0.6Fexx)(0.707wL). With phi = 0.75, Fexx = 70 ksi, weld size w = 0.25 in., and length L = 13 in., what strength results?

A. 144.8 kip
B. 36.3 kip
C. 72.4 kip
D. 96.6 kip

81. A steel column has E = 29,000 ksi, I = 620 in4, and effective length KL = 192 in. Using Euler Pcr = pi^2EI/(KL)^2, what critical load results?

A. 2,407 kip
B. 9,628 kip
C. 4,814 kip
D. 401.5 kip

82. A member interaction check is defined as Pu/phiPn + Mu/phiMn <= 1.0. If Pu = 240 kip, phiPn = 635 kip, Mu = 105 kip-ft, and phiMn = 170 kip-ft, what interaction ratio results?

A. 0.624
B. 1.619
C. 0.372
D. 0.996

83. For this practice scenario, in a composite floor beam, headed studs connect the concrete slab to the supporting steel beam. What is their primary structural function?

A. Eliminate the need for both flexural reinforcement and a structural steel section.
B. Transfer longitudinal interface shear so the slab and steel beam can act compositely in flexure.
C. Prevent all vertical shear from entering the steel web.
D. Increase concrete compressive strength by changing its material chemistry.

84. A timber beam has allowable bending stress Fb = 1.45 ksi and section modulus S = 205 in3. What allowable bending moment is FbS?

A. 24.77 kip-ft
B. 297.2 kip-ft
C. 12.38 kip-ft
D. 49.53 kip-ft

85. A timber post carries 60 kip through a gross area of 40 in2. What average compressive stress acts on the section?

A. 0.75 ksi
B. 24.0 ksi
C. 3.00 ksi
D. 1.50 ksi

86. A wood connection requires 21 kip of design lateral resistance. Each fastener provides 5.5 kip of stated design resistance, and load sharing is equal. What minimum whole number of fasteners is required?

A. 4 fasteners
B. 6 fasteners
C. 3 fasteners
D. 5 fasteners

87. A masonry wall carries a concentric axial load of 92 kip over a net area of 164 in2. What average compressive stress is produced?

A. 1.122 ksi
B. 0.561 ksi
C. 0.280 ksi
D. 11.63 ksi

88. A masonry shear wall segment carries V = 64 kip. Using average shear stress v = V/(bd) with b = 8 in. and d = 123 in., what average shear stress results?

A. 0.1300 ksi
B. 8.32 ksi
C. 0.0650 ksi
D. 0.0326 ksi

89. A diaphragm develops an in-plane bending moment of 730 kip-ft between its chord lines, which are 32 ft apart. Using chord force F = M/d, what chord force magnitude is required?

A. 45.6 kip
B. 730 kip
C. 11.41 kip
D. 22.812 kip

90. For this practice scenario, within a diaphragm load path, what is the primary function of a collector, sometimes called a drag strut?

A. Support only gravity loads from floor finishes and nonstructural partitions.
B. Reduce material yield strength so the calculated lateral forces become smaller.
C. Collect diaphragm forces and deliver them to vertical lateral-force-resisting elements where direct transfer is discontinuous.
D. Replace every diaphragm chord, boundary element, and vertical lateral system member.

91. A chevron bracing bay has two identical braces at 50 degrees to the horizontal. If a 146-kip story shear is shared equally through the horizontal components of the two braces, what axial force acts in each brace?

A. 113.6 kip
B. 146.1 kip
C. 56.8 kip
D. 73.0 kip

92. A lateral frame resists an overturning moment of 1,450 kip-ft through a tension-compression couple separated by 25 ft. What axial force magnitude is required in each side of the couple?

A. 116 kip
B. 58 kip
C. 29 kip

D. 1,450 kip

93. A steel column transfers 520 kip concentrically through a 16 in. by 20 in. base plate. What average bearing pressure acts beneath the plate?

A. 3.250 ksi
B. 0.812 ksi
C. 26.00 ksi
D. 1.625 ksi

94. A base connection resists a 285 kip-ft moment using a tension-compression couple with 24 in. between the force resultants. Neglect axial load. What force magnitude is required in the tension side?

A. 285 kip
B. 142.5 kip
C. 71.2 kip
D. 11.9 kip

95. A footing has width B = 12 ft and load eccentricity e = 0.90 ft. Using the effective-width approximation B' = B - 2e, what effective width results?

A. 14.68 ft
B. 11.32 ft
C. 10.20 ft
D. 7.96 ft

96. A rigid pile cap carries a concentric 635-kip vertical load supported by five identical piles with equal stiffness. Neglect cap weight and group effects. What axial load is assigned to each pile?

A. 127 kip
B. 635 kip

C. 317.5 kip
D. 63.5 kip

97. A drilled shaft has diameter 3.5 ft, embedded length 46 ft, and uniform unit side resistance fs = 0.55 ksf. Using Qs = pi d L fs, what side resistance results?

A. 556.4 kip
B. 278.2 kip
C. 139.1 kip
D. 88.6 kip

98. A 14-ft-wide retaining-wall base carries resultant vertical load P = 300 kip/ft with eccentricity e = 1.20 ft. Using qmax = P/B(1 + 6e/B), what maximum base pressure results?

A. 43.47 ksf
B. 21.43 ksf
C. 16.23 ksf
D. 32.45 ksf

99. For this practice scenario, what structural functions are provided by ties or spiral reinforcement surrounding the longitudinal bars in a reinforced-concrete column?

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

100. For this structural-design scenario, which connection-design philosophy most directly supports ductile behavior when a lateral-force-resisting system is expected to undergo significant inelastic response?

A. Maximize connection stiffness without considering deformation capacity or force redistribution.

B. Rely on a single field attachment without verifying how forces enter and leave the connected members.

C. Provide a deliberate yielding mechanism with adequate deformation capacity while protecting surrounding components from premature brittle failure.

D. Make the most brittle connection component intentionally weaker so it fractures first.

Practice Exam 27: Answer Key and Explanations

1. A — Using the stated values and the relationship given in the stem, the independent calculation gives 1,040 lb/ft. This conversion changes a load per square foot into the line load carried by the beam. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

2. B — Using the stated values and the relationship given in the stem, the independent calculation gives 22.8 kip. The other choices assign the entire load to one support, halve the reaction twice, or ignore the span when converting line load to force. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

3. D — Using the stated values and the relationship given in the stem, the independent calculation gives 90.62 psf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

4. C — Using the stated values and the relationship given in the stem, the independent calculation gives 141.6 psf. The distractors reflect unfactored addition or incorrect factor application. Because the combination is provided in the stem, no other load factor belongs in this calculation. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

5. D — Using the stated values and the relationship given in the stem, the independent calculation gives 31.8 psf. The distractors omit or misapply one of the given multipliers. Since the formula and coefficients are supplied explicitly, the task is careful substitution rather than recalling an unstated snow-load provision. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

6. B — Using the stated values and the relationship given in the stem, the independent calculation gives 21.2 psf. The velocity is squared, so treating it linearly creates a large error, while omitting Kd or Kz shifts the result materially. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

7. C — Using the stated values and the relationship given in the stem, the independent calculation gives 251.6 kip. The distractors move the decimal, substitute the full weight, or use an unrelated percentage.

Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

8. A — Using the stated values and the relationship given in the stem, the independent calculation gives 2,301.75 lb/ft. The distractors stop at pressure, omit Ka, or halve the total force without a stated reason. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

9. C — Using the stated values and the relationship given in the stem, the independent calculation gives 3,137 lb/ft. The alternatives omit the one-half factor, mishandle the height-squared term, or halve the correct force again. Earth-pressure resultants depend strongly on retained height because the pressure increases with depth. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

10. B — Using the stated values and the relationship given in the stem, the independent calculation gives 19.29 kip. For a single point load on a simple span, the left reaction equals P(L-x)/L. A quick unit check also confirms the scale and physical meaning of the result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

11. D — Using the stated values and the relationship given in the stem, the independent calculation gives 3.50 kip/ft. Convert the repeated concentrated reactions to an equivalent line load by dividing one reaction by its spacing. Units clearly distinguish force from force per length. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

12. A — Using the stated values and the relationship given in the stem, the independent calculation gives 56.88 psf. The distractors omit the deck, treat the concrete as one foot thick, or multiply by inches without conversion. Dead-load components should be converted to common pressure units before summation. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

13. C — Using the stated values and the relationship given in the stem, the independent calculation gives 43.61 psf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

14. A — Using the stated values and the relationship given in the stem, the independent calculation gives 27.3 psf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

15. D — Using the stated values and the relationship given in the stem, the independent calculation gives 86.4 kip. An impact allowance is added to the original demand; it does not replace that demand. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

16. B — Using the stated values and the relationship given in the stem, the independent calculation gives 148.5 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

17. C — Using the stated values and the relationship given in the stem, the independent calculation gives 139.8 kip. Evaluate every stated combination rather than assuming which governs. The distractors reproduce the other combinations or an incorrect total. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

18. A — Using the stated values and the relationship given in the stem, the independent calculation gives 72 kip-ft. The distractors double or halve the correct moment or report the load itself. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

19. D — Using the stated values and the relationship given in the stem, the independent calculation gives 202.5 kip-ft. The distractors halve or double the correct moment or report the total load. Moment carries force-length units, not force alone, which helps screen the alternatives. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

20. D — Using the stated values and the relationship given in the stem, the independent calculation gives 23.4 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

21. B — Using the stated values and the relationship given in the stem, the independent calculation gives 21.333 ksi. Average axial stress equals force divided by gross area. The distractors multiply instead of divide, invert the ratio, or use an unrelated factor. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

22. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.138 in.. The distractors halve, double, or shift the decimal. Axial deformation increases with load and length but decreases as area or elastic modulus increases. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

23. B — Using the stated values and the relationship given in the stem, the independent calculation gives 1,568 in3. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

24. A — Using the stated values and the relationship given in the stem, the independent calculation gives 2.22 ksi. The distractors omit the feet-to-inches conversion or shift the decimal. Consistent length units are essential whenever a moment in kip-ft is divided by a section property in inches. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

25. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.039 in.. of midspan deflection. The distractors halve, double, or move the decimal. The cubic span term makes deflection very sensitive to length, so unit conversion deserves special attention. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

26. D — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0078 in.. The distractors halve, double, or shift the decimal. Because the span appears to the fourth power, deflection changes rapidly with length. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

27. A — Using the stated values and the relationship given in the stem, the independent calculation gives 6,755 kip. The distractors halve or double the result or effectively omit part of the span conversion. Euler capacity varies inversely with the square of effective length, making length assumptions especially important. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

28. B — Using the stated values and the relationship given in the stem, the independent calculation gives 10.83 ksi. Maximum torsional shear stress follows directly from Tc/J. The distractors halve or double the proper stress or misuse the torque-radius product. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

29. C — Using the stated values and the relationship given in the stem, the independent calculation gives 18.0 ksi. At the extreme fiber where bending compression acts in the same sense as axial compression, the stresses add. The opposite edge would involve subtraction. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

30. B — Using the stated values and the relationship given in the stem, the independent calculation gives 18.07 ksi. The distractors omit the shear contribution, use a simple sum, or report only the average stress. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

31. D — Using the stated values and the relationship given in the stem, the independent calculation gives 0.181 in.. Free thermal expansion is alpha L DeltaT. The distractors halve the result or shift the decimal. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

32. A — Using the stated values and the relationship given in the stem, the independent calculation gives 8.11 ksi. Full restraint prevents the free thermal strain, so the given stress relation applies directly. The distractors double or halve the result or mishandle the coefficient. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

33. C — Using the stated values and the relationship given in the stem, the independent calculation gives 98 kip-ft. The distractors report the load itself or halve or double the correct moment. A free-body diagram shows the fixed support resisting both shear and moment. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

34. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0252 in.. The distractors halve, double, or shift the decimal. The span is already in inches, matching the section and modulus units. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

35. B — Joint equilibrium requires the vector sum of member forces to vanish. With only two non-collinear member directions and no external load or support reaction, nonzero forces cannot cancel each other. Therefore both member forces must be zero. Equal nonzero forces would cancel only if the two members were collinear and opposite in direction.

36. D — A fixed support provides three planar reaction components and the additional roller supplies one, giving four external unknown reactions. Only three independent planar equilibrium equations are available, leaving one redundant. Compatibility and deformation information are therefore required. The other listed arrangements are externally determinate under their usual idealized support assumptions and can be solved by equilibrium.

37. C — Using the stated values and the relationship given in the stem, the independent calculation gives 21.0 kip. Influence-line ordinates directly scale the effect of a moving concentrated load. A quick unit check also confirms the scale and physical meaning of the result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

38. D — Using the stated values and the relationship given in the stem, the independent calculation gives 29 ksi. Stress range equals maximum stress minus minimum stress. The distractors subtract absolute values incorrectly, report half the range, or repeat the maximum stress. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

39. B — Using the stated values and the relationship given in the stem, the independent calculation gives 58.51 ksi. The distractors halve or double the proper stress or use an incorrect projected area. Bearing checks use the projected contact dimensions, not the full plate gross area. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

40. A — Using the stated values and the relationship given in the stem, the independent calculation gives 12.08 ksi. The distractors report one component alone or combine the terms incorrectly. A quick unit check also confirms the scale and physical meaning of the result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

41. C — Using the stated values and the relationship given in the stem, the independent calculation gives 27,307 in4. The distractors halve or double the correct value or shift the decimal. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

42. B — Reshoring creates an intentional temporary load path that distributes construction loads among several floors while newly cast slabs continue gaining strength and stiffness. It does not replace permanent columns, directly increase material strength, or eliminate sequence analysis. Proper reshoring design considers load redistribution, timing, support stiffness, placement sequence, and the order in which temporary supports are removed.

43. D — Using the stated values and the relationship given in the stem, the independent calculation gives 36,000 lb. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

44. A — A temporary scaffold should be checked for the actual erected configuration and all intended loading before workers use it. Worker loads, tools, stored materials, access conditions, bracing, supports, and connections can affect demand and stability. Permanent-floor capacity does not automatically apply, and observing distress after loading is not a substitute for engineering verification before use.

45. C — Special inspection provides targeted observation or testing of work identified by applicable requirements and approved documents. It creates an independent record of whether specified materials and installation conditions conform. The inspector does not assume the contractor's means-and-methods responsibility, authorize informal design changes, or guarantee flawless long-term performance. Nonconforming observations should be documented and resolved through the project process.

46. B — Excavation can remove confinement or bearing support relied upon by nearby foundations, causing settlement, rotation, or lateral movement. Engineering should evaluate the influence zone before soil removal and plan shoring, underpinning, sequencing, and monitoring as appropriate. Property boundaries do not interrupt soil-structure interaction, and waiting for visible movement is reactive rather than preventive risk control.

47. A — An incomplete frame may lack the diaphragms, connections, stiffness, or lateral systems assumed in the completed design. Temporary bracing must provide a stable load path during erection and remain until the permanent system can perform that function. Final-state adequacy does not demonstrate stability for each intermediate sequence, especially under construction wind or erection loads.

48. D — Shop drawings communicate how particular items are proposed to be fabricated, assembled, or installed. An RFI asks for clarification where contract information is incomplete, conflicting, or uncertain. Neither document automatically transfers design responsibility or authorizes every change. Reviews and responses should follow the project roles, approved documents, and formal change process rather than informal assumptions.

49. B — Using the stated values and the relationship given in the stem, the independent calculation gives 4,227 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

50. A — Modulus of elasticity is the slope relating normal stress and elastic strain in the approximately linear response range, so it directly controls calculated elastic shortening and deflection. Compressive strength is a strength measure, unit weight primarily affects self-weight, and air content influences durability and fresh-concrete behavior. Those properties may correlate with stiffness but do not replace E.

51. D — Using the stated values and the relationship given in the stem, the independent calculation gives 6 in2. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

52. C — Yield strength identifies the stress level associated with the onset of significant inelastic deformation, while ultimate tensile strength is the maximum engineering stress reached during a tensile test. Elastic modulus instead describes stiffness. For typical ductile structural steels, tensile strength exceeds yield strength, so treating the two values as interchangeable would distort strength and ductility assessments.

53. B — Using the stated values and the relationship given in the stem, the independent calculation gives 29,000 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

54. C — Wood has a cellular, fiber-oriented structure, so its mechanical properties differ substantially along and across the grain. This orthotropic behavior affects stiffness, tension, compression, bearing, and connection response. Drying changes moisture-dependent properties but does not make wood isotropic. Grain direction therefore remains important for both member design and connection behavior under structural loading.

55. D — A masonry prism combines units and mortar in an assemblage intended to represent important features of constructed masonry. Compression testing therefore characterizes masonry compressive strength rather than the properties of unrelated materials. It does not measure reinforcing-steel yield strength, structural-steel stiffness, or timber moisture. The assemblage approach captures interactions among units, mortar, workmanship, and geometry.

56. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.786. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

57. C — Using the stated values and the relationship given in the stem, the independent calculation gives 82.2 pcf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

58. D — Using the stated values and the relationship given in the stem, the independent calculation gives 9,900 psf. The distractors omit one multiplier or over-apply the embedment depth. The pcf times ft product produces psf, confirming that the requested result is a pressure. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

59. B — Concrete cylinder compressive strength is determined by loading the prepared cylinder axially in compression and relating the maximum load to its cross-sectional area. Charpy testing evaluates impact toughness of metals, steel coupon tension tests characterize metal behavior, and sieve analysis measures particle-size distribution. Those procedures do not directly establish hardened concrete compressive strength from a molded cylinder.

60. A — The Charpy V-notch test measures energy absorbed by a notched metal specimen during impact, providing an indicator of toughness and sensitivity to brittle fracture. It is not a concrete compression, soil permeability, or masonry prism test. The notch and rapid loading intentionally create demanding fracture conditions, so the result addresses toughness rather than ordinary static yield strength.

61. D — Grout fills designated masonry cells and surrounds reinforcement, creating contact and load transfer so the reinforced masonry can act as an integrated structural element. It does not replace bed and head-joint mortar, prevent reinforcement from carrying tension, or function merely as a finish. Proper placement and consolidation are important to the intended composite load path.

62. A — Prestressing introduces an initial compressive force, often with eccentricity, that counteracts tensile stresses produced by later service loads. This can reduce cracking and improve serviceability for longer spans. Prestressing does not eliminate concrete compression, remove the need for steel, or guarantee zero deflection. Losses, time-dependent effects, geometry, and applied loading still require evaluation.

63. B — Using the stated values and the relationship given in the stem, the independent calculation gives 417.5 kip-ft. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

64. C — Using the stated values and the relationship given in the stem, the independent calculation gives 373.5 kip-ft. Design strength equals the nominal strength multiplied by the stated resistance factor. The distractors leave the nominal value unfactored, divide by phi, or apply an excessive reduction. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

65. C — Using the stated values and the relationship given in the stem, the independent calculation gives 44.0 kip. The distractors halve or double the result or mishandle the pounds-to-kips conversion. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

66. B — Using the stated values and the relationship given in the stem, the independent calculation gives 38.2 in.. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

67. A — Using the stated values and the relationship given in the stem, the independent calculation gives 1,407.5 kip. The distractors omit one material contribution or mis-handle the concrete area subtraction. Units reduce directly to kips. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

68. D — Using the stated values and the relationship given in the stem, the independent calculation gives 11.16 kip-ft. Apply the simple-span uniform-load expression to the one-foot slab strip. The distractors halve or double the correct moment or omit the divisor of eight. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

69. A — Two-way slab action means flexural stiffness and load transfer in both principal directions contribute materially to the response. Similar panel dimensions and support along four edges make that behavior plausible. A one-way idealization sends load primarily across one span direction. Slabs still develop flexure, and direct column support does not eliminate plate action between supports.

70. B — Using the stated values and the relationship given in the stem, the independent calculation gives 5.815 ksf. Average bearing pressure equals vertical load divided by footing area. The distractors divide by one footing dimension, halve the proper pressure, or use an incorrect area. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

71. C — Using the stated values and the relationship given in the stem, the independent calculation gives 77.917 ksf. The distractors report average pressure, overstate the eccentricity effect, or halve the maximum. The stated linear-pressure expression governs this idealized check. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

72. D — Using the stated values and the relationship given in the stem, the independent calculation gives 574.0 kip. The distractors omit the efficiency factor, apply it to one pile only, or divide by efficiency. A factor below one should reduce the simple sum of individual capacities. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

73. D — Using the stated values and the relationship given in the stem, the independent calculation gives 140 kip-ft/ft. The triangular soil-pressure resultant acts at one-third of the wall height above the base. The distractors use the full height, halve the moment, or report force without a lever arm. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

74. B — Using the stated values and the relationship given in the stem, the independent calculation gives 2.25. The distractors double or halve the ratio or invert it. A factor of safety compares resisting capacity with driving demand using consistent force units. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

75. A — Using the stated values and the relationship given in the stem, the independent calculation gives 683.333 kip-ft. The distractors omit the inch-to-foot conversion or halve or double the correct moment. Because ksi times cubic inches reduces to kip-in., the unit conversion is essential. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

76. C — A beam in major-axis flexure has a compression region that may buckle laterally while the cross-section twists. Adequate bracing restrains this lateral-torsional mode and can permit greater flexural resistance. Bracing does not change steel yield strength, eliminate bending, or apply only to concrete. Stability and cross-sectional strength are distinct design considerations that must both be satisfied.

77. A — Using the stated values and the relationship given in the stem, the independent calculation gives 396 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

78. D — Using the stated values and the relationship given in the stem, the independent calculation gives 302.25 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

79. B — Using the stated values and the relationship given in the stem, the independent calculation gives 180 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

80. C — Using the stated values and the relationship given in the stem, the independent calculation gives 72.4 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

81. C — Using the stated values and the relationship given in the stem, the independent calculation gives 4,814 kip. The distractors halve or double the result or effectively omit part of the length-squared dependence. Column buckling capacity is highly sensitive to effective length and stiffness. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

82. D — Using the stated values and the relationship given in the stem, the independent calculation gives 0.996. The distractors report one component alone or add incorrectly. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

83. B — Composite action requires the steel beam and concrete slab to develop compatible longitudinal deformation rather than freely slip at their interface. Shear connectors transfer the interface forces needed for that behavior. They do not remove all web shear, alter concrete chemistry, or eliminate the participating structural components. Connector strength and spacing therefore support the intended composite load path.

84. A — Using the stated values and the relationship given in the stem, the independent calculation gives 24.77 kip-ft. The distractors omit the unit conversion or halve or double the proper moment. Stress times section modulus produces a moment, so the dimensional path is straightforward to verify. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

85. D — Using the stated values and the relationship given in the stem, the independent calculation gives 1.50 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

86. A — Using the stated values and the relationship given in the stem, the independent calculation gives 4 fasteners. Because a connection cannot use a fraction of a fastener, round upward to five. Four fasteners provide insufficient stated resistance, while six or seven would exceed the minimum count. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

87. B — Using the stated values and the relationship given in the stem, the independent calculation gives 0.561 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

88. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0650 ksi. The distractors halve or double the stress or divide by only one dimension. The calculation is an average stress idealization, not a complete wall design check. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

89. D — Using the stated values and the relationship given in the stem, the independent calculation gives 22.812 kip. Diaphragm chord forces form a tension-compression couple separated by the chord spacing. The distractors report the moment as force or halve or double the proper result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

90. C — Collectors provide a deliberate in-plane load path from distributed diaphragm forces to shear walls, braced frames, or moment frames, particularly where those vertical elements do not align continuously with the diaphragm edge or force source. They are not merely gravity members, do not change material strength, and do not automatically replace chords or other boundary-force components.

91. A — Using the stated values and the relationship given in the stem, the independent calculation gives 113.6 kip. The distractors divide the shear without accounting for brace angle, assign the full story shear to each brace, or halve the required axial force again. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

92. B — Using the stated values and the relationship given in the stem, the independent calculation gives 58 kip. A tension-compression couple resists moment through force times separation. The distractors halve or double the correct force or report the moment magnitude as a force. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

93. D — Using the stated values and the relationship given in the stem, the independent calculation gives 1.625 ksi. The distractors double or halve the correct pressure or divide by only one plate dimension. The concentric-load assumption makes the idealized average pressure uniform across the plate area. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

94. B — Using the stated values and the relationship given in the stem, the independent calculation gives 142.5 kip. couple arm. The distractors omit the feet-to-inches conversion, report the moment number as force, or halve the proper force. Force times separation must reproduce the applied moment. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

95. C — Using the stated values and the relationship given in the stem, the independent calculation gives 10.20 ft. The distractors subtract the eccentricity only once, subtract too much, or add the eccentricity effect. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides an independent screen before accepting the result.

96. A — Using the stated values and the relationship given in the stem, the independent calculation gives 127 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

97. B — Using the stated values and the relationship given in the stem, the independent calculation gives 278.2 kip. Shaft side resistance equals circumference times embedded length times unit side resistance. The distractors omit pi or halve or double the correct resistance. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

98. D — Using the stated values and the relationship given in the stem, the independent calculation gives 32.45 ksf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

99. A — Transverse reinforcement performs several structural functions: it restrains longitudinal bars against local buckling, confines the concrete core, helps resist shear where required, and holds the reinforcement cage in its intended geometry. It does not replace longitudinal steel, prevent every form of concrete damage, or become structurally irrelevant after curing. Detailing therefore affects both strength and ductility.

100. C — Ductile design seeks controlled inelastic deformation in intended yielding regions while protecting brittle or low-ductility failure modes such as fracture, pullout, or abrupt connection rupture. That requires a clear load path and a deliberate capacity hierarchy. Simply maximizing stiffness, relying on one unverified attachment, or allowing a brittle component to fail first undermines reliable energy dissipation.