PRACTICE EXAM 30: 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. During preliminary design, a records-storage mezzanine beam has a tributary width of 13 ft and supports a uniform floor pressure of 74 psf. Determine the uniform line load carried by the beam.

A. 481 lb/ft
B. 962 lb/ft
C. 1,924 lb/ft
D. 74 lb/ft

2. For an independent design check, a 36-ft simply supported transfer girder carries a uniform service load of 1.9 kip/ft over its full span. Determine the vertical reaction at either support.

A. 2.4 kip
B. 68.4 kip
C. 17.10 kip
D. 34.2 kip

3. In a separate project scenario, a normal-weight concrete floor slab is 7 in. thick and has a unit weight of 145 pcf. Determine the slab self-weight as an area pressure.

A. 126.9 psf

B. 63.43 psf
C. 84.58 psf
D. 1,014.9 psf

4. For this practice check, use U = 1.2D + 1.6L. If D = 38 psf and L = 84 psf, what factored pressure U results?

A. 180.0 psf
B. 149.1 psf
C. 199.8 psf
D. 124.2 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 = 42 psf. What is p?

A. 26.6 psf
B. 29.4 psf
C. 39.7 psf
D. 27.8 psf

6. Use q = 0.00256 Kz Kzt Kd V^2 I. For Kz = 0.92, Kzt = 1.0, Kd = 0.85, V = 163 mph, and I = 1.0, what velocity pressure q results?

A. 62.6 psf
B. 45.1 psf
C. 53.2 psf
D. 78.3 psf

7. In a separate project scenario, a seismic base shear is defined for this problem as V = CsW. If Cs = 0.074 and the effective seismic weight W = 3,100 kip, what base shear results?

A. 310 kip
B. 229.4 kip
C. 22.94 kip
D. 41.9 kip

8. During a structural review, a uniform surface surcharge of 525 psf acts behind a 15-ft basement retaining wall. If the lateral pressure coefficient is Ka = 0.31, what lateral force per foot of wall results from the surcharge alone?

A. 2,441.25 lb/ft
B. 1,220.8 lb/ft
C. 162.7 lb/ft
D. 7,875 lb/ft

9. Soil behind a basement retaining wall has unit weight 96 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. 4,703.1 lb/ft
B. 2,352 lb/ft
C. 362.0 lb/ft
D. 1,176.0 lb/ft

10. For an independent design check, a 42-kip construction-vehicle 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. 42.01 kip
B. 21.01 kip
C. 15.01 kip
D. 27.00 kip

11. In a separate project scenario, a girder supports floor joists spaced at 16 ft. Each secondary beam delivers a 38-kip end reaction to the girder. If those reactions are idealized as an equivalent uniform line load, what line load represents them?

A. 2.375 kip/ft
B. 4.75 kip/ft
C. 38 kip/ft
D. 1.18 kip/ft

12. During a structural review, a composite metal deck weighs 2.5 psf and supports 5.0 in. of normal-weight concrete weighing 150 pcf. What combined dead-load pressure is carried before other permanent loads are added?

A. 62.23 psf
B. 69.15 psf
C. 65.00 psf
D. 746.8 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 = 6,300 ft2, what is L?

A. 69.07 psf
B. 18.73 psf
C. 43.9 psf
D. 25.17 psf

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

A. 280.8 psf
B. 46.8 psf
C. 11.7 psf

D. 23.4 psf

15. In a separate project scenario, an overhead-crane wheel reaction of 54 kip is increased by a stated impact factor of 20%. What design wheel load results for this problem?

A. 54.0 kip
B. 64.8 kip
C. 10.8 kip
D. 75.6 kip

16. During a structural review, two identical roof framing lines share a total distributed gravity load of 271 kip equally. One girder also receives a 28-kip equipment load that is not shared. What total gravity load acts on that girder?

A. 163.5 kip
B. 296.8 kip
C. 148.2 kip
D. 133.3 kip

17. During preliminary design, 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 = 48 kip, and W = 45 kip, what is the largest factored load?

A. 127.1 kip
B. 46.9 kip
C. 119.0 kip
D. 133.8 kip

18. For an independent design check, a simply supported 24-ft beam carries a 16-kip point load at midspan. Determine the maximum bending moment.

A. 192 kip-ft
B. 96 kip-ft
C. 48.0 kip-ft
D. 21.4 kip-ft

19. In a separate project scenario, a simply supported 17-ft beam carries 1.8 kip/ft uniformly over the full span. Determine the maximum bending moment.

A. 65.0 kip-ft
B. 130.0 kip-ft
C. 23.6 kip-ft
D. 32.50 kip-ft

20. During a structural review, a 36-ft simply supported beam carries a 2.6 kip/ft uniform load over the full span. Determine the magnitude of either support reaction.

A. 4.6 kip
B. 93.6 kip
C. 46.8 kip
D. 23.4 kip

21. During preliminary design, an axially loaded tension member carries 115 kip through a gross area of 7.5 in2. Determine the average axial stress.

A. 862.5 ksi
B. 0.04 ksi
C. 57.5 ksi
D. 15.33 ksi

22. For an independent design check, a 15-ft steel tie rod carries 90 kip in tension. Use A = 3.5 in2 and E = 29,000 ksi. Determine the elongation from delta = PL/(AE).

A. 0.160 in.
B. 0.320 in.
C. 1.60 in.
D. 0.079 in.

23. In a separate project scenario, a rectangular beam cross section has b = 12 in. and h = 15 in. What is its elastic section modulus S = bh^2/6 about the strong axis?

A. 4,500 in3
B. 225 in3
C. 450 in3
D. 900 in3

24. During a structural review, a beam has maximum moment M = 132 kip-ft and section modulus S = 745 in3. Determine the maximum bending-stress magnitude.

A. 0.177 ksi
B. 2.13 ksi
C. 21.3 ksi
D. 0.213 ksi

25. During preliminary design, a simply supported beam with a centered point load has P = 14 kip, L = 18 ft, E = 29,000 ksi, and I = 2,000 in4. Using delta = PL^3/(48EI), determine the midspan deflection.

A. 0.101 in.
B. 0.051 in.
C. 0.004 in.
D. 0.024 in.

26. For an independent design check, a simply supported beam carries w = 0.16 kip/in. over a 108-in. span. If E = 29,000 ksi and I = 1,400 in4, use delta = 5wL^4/(384EI). Determine the maximum deflection.

A. 0.0070 in.
B. 0.0700 in.
C. 0.0035 in.
D. 0.0140 in.

27. In a separate project scenario, a pin-ended column has E = 29,000 ksi, I = 855 in4, and length L = 16 ft. Using Pcr = pi^2EI/L^2, determine the Euler critical load.

A. 3,319.0 kip
B. 13,276 kip
C. 6,638 kip
D. 553.2 kip

28. During a structural review, a solid round shaft has torque T = 185 kip-in., outer radius c = 2.25 in., and polar moment J = 32.2 in4. Using tau = Tc/J, determine the maximum torsional shear stress.

A. 25.86 ksi
B. 83.2 ksi
C. 6.47 ksi
D. 12.93 ksi

29. During preliminary design, a column section has axial compressive stress P/A = 5.5 ksi and bending stress magnitude Mc/I = 6.5 ksi at an extreme fiber. Determine the maximum compressive stress when the effects add.

A. 50.30 ksi
B. 1.5 ksi
C. 6.8 ksi
D. 12.0 ksi

30. At a point in plane stress, sigma_x = 24 ksi, sigma_y = 8 ksi, and tau_xy = 6 ksi. Using sigma_1 = (sx+sy)/2 + sqrt(((sx-sy)/2)^2 + tau^2), determine the major principal stress.

A. 16.18 ksi
B. 26.00 ksi
C. 21.97 ksi
D. 32.37 ksi

31. In a separate project scenario, a 28-ft steel framing member experiences a uniform temperature increase of 65 F. Using alpha = 6.5e-6/F, what free thermal elongation occurs?

A. 0.142 in.
B. 1.418 in.
C. 0.015 in.
D. 0.071 in.

32. During a structural review, a fully restrained steel tie rod experiences a 67 F temperature increase. Use E = 29,000 ksi and alpha = 6.5e-6/F. Determine the thermal stress magnitude from sigma = E alpha DeltaT.

A. 0.43 ksi
B. 25.27 ksi
C. 12.63 ksi
D. 6.30 ksi

33. During preliminary design, a cantilever beam carries an end load P = 8 kip over a length L = 7 ft. Determine the fixed-end moment magnitude.

A. 8 kip-ft
B. 28.0 kip-ft
C. 112 kip-ft
D. 56 kip-ft

34. For an independent design check, a cantilever has w = 0.10 kip/in., L = 84 in., E = 29,000 ksi, and I = 910 in4. Using delta = wL^4/(8EI), determine the free-end deflection.

A. 0.0472 in.
B. 0.0236 in.
C. 0.0024 in.
D. 0.0118 in.

35. At a pin-connected truss joint with no applied load or support reaction, only two noncollinear members meet. What must joint equilibrium imply about those member forces?

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

36. Which planar beam support arrangement provides four external reaction components, making the system externally indeterminate to the first degree?

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

37. For a simply supported 34-ft span, the influence-line ordinate for the left reaction at a load position 12 ft from the left support is (L-x)/L. Determine the reaction caused by a 30-kip moving point load there.

A. 19.41 kip
B. 29.1 kip

C. 14.6 kip
D. 9.7 kip

38. For an independent design check, a structural detail experiences repeated stress cycling between 34 ksi and -7 ksi. Determine the stress range.

A. 32.8 ksi
B. 24.6 ksi
C. 41 ksi
D. 20.5 ksi

39. In a separate project scenario, a 7/8-in.-diameter bolt bears on a 5/8-in.-thick plate under a 14-kip force. Using average bearing stress fb = P/(td), determine the resulting stress.

A. 12.80 ksi
B. 51.19 ksi
C. 16.00 ksi
D. 25.60 ksi

40. During a structural review, a rectangular column has area A = 24 in2, section modulus S = 120 in3, axial load P = 175 kip, and eccentricity e = 5 in. Determine the maximum compressive stress from P/A + Pe/S.

A. 21.86 ksi
B. 14.58 ksi
C. 36.46 ksi
D. 7.30 ksi

41. During preliminary design, a rectangular beam has b = 10 in. and h = 26 in. What is its centroidal moment of inertia I = bh^3/12 about the strong axis?

A. 1,464.5 in4
B. 7,323.9 in4
C. 14,647 in4
D. 29,294.8 in4

42. Several recently cast concrete floors are still gaining strength while construction continues above. Why may reshores be intentionally left beneath a lower floor?

A. To redistribute construction loads through multiple floors while younger slabs gain adequate strength.
B. To permanently replace the designed building columns.
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 785 psf on a wall-form panel 9 ft long and 5 ft high. Determine the total lateral force on the panel.

A. 3,925 lb
B. 785 lb
C. 7,065 lb
D. 35,325 lb

44. Workers plan to place personnel, tools, and stockpiled materials on a scaffold platform. What is the best structural loading control before the scaffold is put into service?

A. Ignore stored materials because worker weight is the only relevant loading.
B. Verify the erected configuration and capacity for intended workers, tools, materials, access, and support conditions.
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. Structural work has been designated for special inspection. Which statement most accurately describes the inspector's role during construction?

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

46. A contractor will excavate deeply next to an occupied structure on shallow foundations. Which preconstruction evaluation is most important for protecting the adjacent facility?

A. Assume the neighboring foundation is unaffected because it lies on a separate property.
B. Reduce documentation so field crews can respond informally if movement develops.
C. Excavate to final depth first and evaluate movement only after settlement is visible.
D. Evaluate the excavation influence zone, temporary support or underpinning needs, sequencing, and movement monitoring before soil removal.

47. A steel frame will be temporarily incomplete during erection, before the permanent lateral-force-resisting system is engaged. What measure best protects stability during those stages?

A. Assume final-state structural analysis proves every intermediate erection stage stable.
B. Remove temporary bracing once any two beams are connected.
C. Provide and maintain temporary bracing until the permanent lateral-force-resisting system is complete and effective.
D. Rely on member self-weight to stabilize every incomplete-frame configuration.

48. A fabrication team submits a shop drawing while the contractor separately issues an RFI. What is the fundamental difference between these two submittal types?

A. A shop drawing shows proposed fabrication or installation details; an RFI requests clarification needed to proceed.
B. A shop drawing automatically changes the design, while an RFI can never affect project decisions.
C. An RFI is a fabrication drawing, while a shop drawing is used only for payment documentation.
D. Both documents transfer the engineer's design responsibility to the contractor once submitted.

49. During preliminary design, for normal-weight concrete, use Ec = 57,000 sqrt(f'c) psi. If f'c = 5,500 psi, determine the modulus Ec.

A. 8,454 ksi
B. 54,572.8 ksi
C. 2,114 ksi
D. 4,227 ksi

50. In the initial approximately linear elastic range of concrete response, which property links normal stress to normal strain for deformation calculations?

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

51. In a separate project scenario, a reinforced concrete section contains twelve No. 7 bars, each with area 0.60 in2. Determine the total reinforcing area.

A. 6.00 in2
B. 7.85 in2
C. 7.20 in2
D. 0.65 in2

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

A. Ultimate tensile strength is the elastic modulus measured before yielding begins.
B. Yield strength marks substantial permanent deformation; ultimate tensile strength is the maximum engineering stress reached in tension.

C. The two terms are interchangeable because both describe only stiffness.
D. Yield strength is always greater than tensile strength for ductile structural steel.

53. During preliminary design, a steel coupon has axial stress of 17.4 ksi and corresponding elastic strain of 0.00060. Determine the modulus E from E = stress/strain.

A. 17,400 ksi
B. 58,000 ksi
C. 2,900 ksi
D. 29,000 ksi

54. A wood member is evaluated for loading in two different grain directions. Why can its structural response differ greatly between loading parallel and 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. A reinforced-masonry project requires prism testing. An axially loaded masonry prism is taken to failure primarily to establish which material property?

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

56. During a structural review, a soil has porosity n = 0.38. Determine its void ratio using e = n/(1-n).

A. 0.380

B. 0.613
C. 0.235
D. 0.974

57. During preliminary design, a laboratory soil specimen has total weight 103 lb and total volume 1.80 ft3. Determine its total unit weight.

A. 185.2 pcf
B. 51.4 pcf
C. 92.7 pcf
D. 57.2 pcf

58. For a soil bearing estimate, use qult = gamma Df Nq. If gamma = 150 pcf, Df = 4 ft, and Nq = 18, determine the ultimate bearing pressure.

A. 6,000 psf
B. 10,800 psf
C. 54,000 psf
D. 2,160 psf

59. A laboratory receives standard molded concrete cylinders from a placement. Which test most directly determines the concrete compressive strength represented by those specimens?

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

60. A structural-steel specification requires Charpy V-notch testing for selected members. Which material characteristic is that test intended to assess?

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

61. A reinforced CMU wall contains vertical bars inside cells that will be fully grouted. What principal structural function does the grout perform around the reinforcement?

A. Fill reinforced cells so the bars and masonry can act together and transfer forces.
B. Prevent reinforcing steel from carrying any tensile force.
C. Serve only as an architectural finish on exposed wall surfaces.
D. Replace all mortar joints between masonry units.

62. Prestressed-concrete members are intentionally placed in compression before most service loading occurs. What is the principal structural reason for introducing that precompression?

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

63. In a separate project scenario, a singly reinforced rectangular concrete beam has b = 14 in., d = 23 in., As = 3.6 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), determine Mn.

A. 423.6 kip-ft
B. 381.3 kip-ft
C. 190.6 kip-ft
D. 457.5 kip-ft

64. For a concrete beam with nominal flexural strength Mn = 445 kip-ft, use phi = 0.90. Determine the available design flexural strength phiMn.

A. 494.4 kip-ft
B. 356 kip-ft
C. 400.5 kip-ft
D. 445 kip-ft

65. For a reinforced concrete beam, use Vc = 2 sqrt(f'c) bwd in pounds. If f'c = 4,800 psi, bw = 14 in., and d = 22 in., determine Vc.

A. 42.7 kip
B. 7.1 kip
C. 21.4 kip
D. 85.3 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 = 1.00 in., and f'c = 4,500 psi. Determine ld.

A. 18.0 in.
B. 35.8 in.
C. 71.7 in.
D. 14.4 in.

67. In a separate project scenario, a tied concrete column has Ag = 185 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. Determine Pn.

A. 1,953.5 kip
B. 609.7 kip
C. 1,343.8 kip
D. 734.1 kip

68. During a structural review, a one-way slab strip is idealized as a simply supported 18-ft span carrying 0.62 kip/ft. Using Mmax = wL^2/8, determine the strip moment.

A. 200.9 kip-ft
B. 12.54 kip-ft
C. 50.22 kip-ft
D. 25.11 kip-ft

69. A nearly square concrete slab panel has continuous support along all four edges. Which response most strongly indicates two-way slab action?

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. For an independent design check, an isolated square footing is 9 ft by 9 ft and supports a concentric service load of 531 kip. Neglect footing weight. Determine the average soil bearing pressure.

A. 3.2 ksf
B. 6.556 ksf
C. 9.9 ksf
D. 58.9 ksf

71. In a separate project scenario, a 12-ft-wide footing carries P = 665 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. Determine qmax.

A. 38.099 ksf
B. 55.416 ksf
C. 96.980 ksf
D. 76.198 ksf

72. During a structural review, a deep-foundation pile group contains seven piles, each with allowable axial capacity 130 kip. If a stated group-efficiency factor of 0.82 applies, determine the allowable group capacity.

A. 910 kip
B. 106.6 kip
C. 746.2 kip
D. 1,109.8 kip

73. During preliminary design, a basement retaining wall experiences a triangular lateral soil resultant of 22 kip/ft acting at H/3 above the base, where H = 15 ft. Determine the overturning moment about the toe.

A. 110 kip-ft/ft
B. 55 kip-ft/ft
C. 22 kip-ft/ft
D. 330 kip-ft/ft

74. For an independent design check, a basement retaining wall has total stabilizing vertical load W = 102 kip/ft, base friction coefficient mu = 0.55, and horizontal driving force P = 22 kip/ft. Using FS = muW/P, determine the sliding factor of safety.

A. 0.45
B. 2.55
C. 5.10
D. 1.27

75. In a separate project scenario, a compact steel beam has Fy = 50 ksi and plastic section modulus Zx = 149 in3. For this practice check, take nominal plastic moment Mn = FyZx. Determine Mn.

A. 7,449.6 kip-ft
B. 310.4 kip-ft

C. 620.8 kip-ft
D. 1,241.6 kip-ft

76. A steel beam has adequate cross-sectional flexural strength, but its compression flange remains unbraced over a long distance. Which instability may govern its available moment capacity?

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. Lateral bracing changes the steel chemistry and directly increases yield strength.
D. The compression flange can move laterally and the member can twist, causing lateral-torsional buckling before full flexural strength develops.

77. During preliminary design, a steel axially loaded tension member has gross area Ag = 8.6 in2 and Fy = 50 ksi. Using phi = 0.90 and design yielding strength phiFyAg, determine the resulting strength.

A. 473.0 kip
B. 430.0 kip
C. 387.0 kip
D. 193.5 kip

78. For an independent design check, a steel axially loaded tension member has effective net area Ae = 7.1 in2 and Fu = 65 ksi. For this problem use phi = 0.75 for net-section rupture. What design rupture strength results?

A. 461.4 kip
B. 346.1 kip
C. 173.0 kip
D. 519.1 kip

79. In a separate project scenario, a connection uses five bolts, each with stated design shear strength of 18 kip, and the load is shared equally. Determine the total available design shear strength.

A. 45 kip
B. 72 kip
C. 18 kip
D. 90 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 = 18 in., determine the resulting strength.

A. 100.2 kip
B. 200.4 kip
C. 50.2 kip
D. 133.7 kip

81. During preliminary design, a steel column has E = 29,000 ksi, I = 575 in4, and effective length KL = 192 in. Using Euler Pcr = pi^2EI/(KL)^2, determine the critical load.

A. 4,464 kip
B. 2,232.0 kip
C. 8,928 kip
D. 372.2 kip

82. For an independent design check, a member interaction check is defined as Pu/phiPn + Mu/phiMn <= 1.0. If Pu = 240 kip, phiPn = 695 kip, Mu = 105 kip-ft, and phiMn = 170 kip-ft, determine the interaction ratio.

A. 0.603
B. 1.565
C. 0.360
D. 0.963

83. A composite floor beam uses headed studs welded to the steel flange and embedded in the concrete slab. What load-transfer action are the studs intended to provide?

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

84. During a structural review, a timber beam has allowable bending stress Fb = 1.45 ksi and section modulus S = 235 in3. Determine the allowable bending moment FbS.

A. 340.7 kip-ft
B. 28.40 kip-ft
C. 14.18 kip-ft
D. 56.79 kip-ft

85. During preliminary design, a timber post carries 54 kip through a gross area of 40 in2. Determine the average compressive stress on the section.

A. 0.68 ksi
B. 21.6 ksi
C. 2.70 ksi
D. 1.35 ksi

86. For an independent design check, a wood connection requires 33 kip of design lateral resistance. Each fastener provides 5.5 kip of stated design resistance, and load sharing is equal. Determine the minimum whole number of required fasteners.

A. 8 fasteners
B. 5 fasteners
C. 6 fasteners
D. 7 fasteners

87. In a separate project scenario, a masonry wall carries a concentric axial load of 92 kip over a net area of 149 in2. Determine the average compressive stress.

A. 1.234 ksi
B. 0.617 ksi
C. 0.308 ksi
D. 12.78 ksi

88. During a structural review, a masonry shear wall segment carries V = 64 kip. Using average shear stress v = V/(bd) with b = 8 in. and d = 153 in., determine the average shear stress.

A. 0.0523 ksi
B. 0.1046 ksi
C. 6.70 ksi
D. 0.0262 ksi

89. During preliminary design, a diaphragm develops an in-plane bending moment of 685 kip-ft between its chord lines, which are 32 ft apart. Using chord force F = M/d, determine the required chord-force magnitude.

A. 42.9 kip
B. 685.3 kip
C. 10.71 kip
D. 21.41 kip

90. A diaphragm develops force at a location that does not align directly with a shear wall or frame. What structural function is performed by a collector or 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. In a separate project scenario, a chevron bracing bay has two identical braces at 52 degrees to the horizontal. If a 143-kip story shear is shared equally through the horizontal components of the two braces, determine the axial force in each brace.

A. 143.0 kip
B. 116.1 kip
C. 58.0 kip
D. 71.5 kip

92. During a structural review, a lateral frame resists an overturning moment of 1,900 kip-ft through a tension-compression couple separated by 25 ft. Determine the axial force magnitude on each side of the couple.

A. 152 kip
B. 38 kip
C. 1,900 kip
D. 76 kip

93. During preliminary design, a steel column transfers 475 kip concentrically through a 16 in. by 20 in. base plate. Determine the average bearing pressure beneath the plate.

A. 1.484 ksi
B. 2.968 ksi
C. 0.742 ksi
D. 23.75 ksi

94. For an independent design check, a base connection resists a 345 kip-ft moment using a tension-compression couple with 24 in. between the force resultants. Neglect axial load. Determine the required tension-side force magnitude.

A. 345 kip
B. 86.2 kip
C. 172.5 kip
D. 14.3 kip

95. In a separate project scenario, a footing has width B = 9 ft and load eccentricity e = 0.90 ft. Using the effective-width approximation B' = B - 2e, determine the effective width.

A. 7.20 ft
B. 10.36 ft
C. 7.99 ft
D. 5.62 ft

96. During a structural review, a rigid pile cap carries a concentric 665-kip vertical load supported by five identical piles with equal stiffness. Neglect cap weight and group effects. Determine the axial load assigned to each pile.

A. 665 kip
B. 133 kip
C. 332.5 kip
D. 66.5 kip

97. During preliminary design, a cast-in-place drilled shaft has diameter 3.5 ft, embedded length 40 ft, and uniform unit side resistance fs = 0.55 ksf. Using Qs = pi d L fs, determine the side resistance.

A. 483.8 kip
B. 121.0 kip
C. 241.9 kip
D. 77.0 kip

98. For an independent design check, a 14-ft-wide retaining-wall footing base carries resultant vertical load P = 360 kip/ft with eccentricity e = 1.20 ft. Using $q_{max} = P/B(1 + 6e/B)$, determine the maximum base pressure.

A. 38.94 ksf
B. 52.16 ksf
C. 25.72 ksf
D. 19.48 ksf

99. A reinforced-concrete column is detailed with transverse ties or spiral reinforcement around its longitudinal bars. Which set of structural functions best explains that transverse reinforcement?

A. They replace all longitudinal reinforcement required to resist axial load.
B. They restrain longitudinal-bar buckling, confine the concrete core, maintain cage geometry, and contribute to shear resistance where applicable.
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. A lateral-force-resisting system is expected to sustain significant inelastic response. Which connection-design philosophy most directly supports ductile system behavior?

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. Make the most brittle connection component intentionally weaker so it fractures first.
D. Provide a deliberate yielding mechanism with adequate deformation capacity while protecting surrounding components from premature brittle failure.

Practice Exam 30: Answer Key and Explanations

1. B — Using the stated values and the relationship given in the stem, the independent calculation gives 962 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 34.2 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 84.58 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 180.0 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 27.8 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 53.2 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 229.4 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 2,441.25 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 2,352 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 27.00 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 2.375 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 65.00 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.

13. C — Using the stated values and the relationship given in the stem, the independent calculation gives 43.9 psf.9 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 23.4 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. B — Apply the stated 20% impact increase to the 54-kip wheel reaction: 54(1.20) = 64.8 kip. The impact allowance increases the basic wheel load; it is not a separate replacement load. The distractors omit the increase, use only the 20% increment, or apply an excessive factor. Checking the multiplier confirms the keyed result.

16. A — Using the stated values and the relationship given in the stem, the independent calculation gives 163.5 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 133.8 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. B — For a simply supported beam with a centered point load, the maximum moment is PL/4. With P = 16 kip and L = 24 ft, Mmax = 16(24)/4 = 96 kip-ft. The distractors commonly double or halve the lever arm or report force without moment. A free-body diagram and dimensional check confirm the keyed result.

19. A — Using the stated values and the relationship given in the stem, the independent calculation gives 65.0 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 46.8 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 15.33 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.

22. A — Convert the 15-ft length to 180 in., then use delta = PL/(AE): 90(180)/(3.5 x 29,000) = 0.160 in. Axial deformation increases with load and length and decreases with area and elastic modulus. The distractors represent common decimal or factor errors. Consistent inch-kip units confirm the keyed answer. The small result is consistent with a relatively stiff steel tie rod.

23. C — Using the stated values and the relationship given in the stem, the independent calculation gives 450 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 2.13 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. B — Convert the 18-ft span to 216 in. before using delta = PL^3/(48EI). Substitution gives approximately 0.051 in. at midspan. The cubic span term makes deflection sensitive to unit conversion and length. The distractors represent halving, doubling, or decimal-placement errors. Checking dimensions and expected flexibility confirms the keyed result. The physical deflection is downward under the applied gravity load.

26. A — Using the stated inch-based quantities in delta = 5wL^4/(384EI) gives approximately 0.0070 in. The span appears to the fourth power, so small span or unit errors can change the result substantially. The distractors reflect common factor and decimal mistakes. Consistent force-length units and a magnitude check support the keyed answer.

27. C — Using the stated values and the relationship given in the stem, the independent calculation gives 6,638 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 12.93 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 12.0 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 26.00 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.

31. A — Free thermal elongation is delta = alpha L DeltaT. Converting 28 ft to 336 in. and using alpha = 6.5e-6/F with DeltaT = 65 F gives about 0.142 in. The alternatives reflect omitted length conversion or factor errors. Expansion should be positive for heating when the member is free, providing a useful sign check.

32. C — Using the stated values and the relationship given in the stem, the independent calculation gives 12.63 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 56 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. B — For the stated cantilever, delta = wL^4/(8EI). Substituting w = 0.10 kip/in., L = 84 in., E = 29,000 ksi, and I = 910 in4 gives about 0.0236 in. The distractors represent common factor or decimal errors. Because span enters to the fourth power, consistent length units are especially important.

35. C — 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. A — 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 19.41 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.

38. C — Using the stated values and the relationship given in the stem, the independent calculation gives 41 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 25.60 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 14.58 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 14,647 in4. 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.

42. A — 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 35,325 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. B — 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. B — 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. D — 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. C — 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. A — 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. D — 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 7.20 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. B — 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. D — Elastic modulus is stress divided by elastic strain. Using 17.4 ksi and 0.00060 gives E = 29,000 ksi. The keyed value is therefore consistent with the stated coupon response. The distractors confuse stress with modulus, double the correct modulus, or shift the decimal. Keeping strain dimensionless makes the resulting modulus units ksi.

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. A — 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. B — Void ratio and porosity are related by e = n/(1-n). With n = 0.38, e = 0.38/0.62 = 0.613. Porosity uses void volume divided by total volume, whereas void ratio uses void volume divided by solids volume. The distractors confuse those definitions or use the wrong denominator. The phase relationship confirms the keyed value.

57. D — Using the stated values and the relationship given in the stem, the independent calculation gives 57.2 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 10,800 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. C — 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. A — 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. D — 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 381.3 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 400.5 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 42.7 kip.703 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.

66. B — Using the formula stated in the problem, ld = fy db/(25 sqrt(f'c)). Substituting fy = 60,000 psi, db = 1.00 in., and f'c = 4,500 psi gives about 35.8 in. The distractors halve, double, or otherwise misapply the denominator. Unit consistency and the square-root strength term confirm the keyed result.

67. C — Apply the stated axial-strength model to the concrete and steel contributions separately. The concrete term uses the net concrete area, Ag - Ast, while the steel term uses Ast. Substitution gives Pn = 1,343.8 kip. The distractors omit one contribution or mishandle the area subtraction. Keeping stresses in ksi and areas in in2 gives kips directly.

68. D — Using the stated values and the relationship given in the stem, the independent calculation gives 25.11 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 6.556 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 76.198 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 746.2 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 110 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 2.55. 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 620.8 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.

76. D — 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 387.0 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 346.1 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. D — Using the stated values and the relationship given in the stem, the independent calculation gives 90 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 100.2 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 4,464 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 — Evaluate the two normalized demand ratios and add them: 240/695 + 105/170 = 0.963. Because the stated interaction limit is 1.0, this simplified check is just below the limit. The distractors omit one term, invert a ratio, or combine demands inconsistently. Dimensionless normalization provides a useful check on the computed result.

83. C — 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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 28.40 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 1.35 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 6 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 0.617 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0523 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 21.41 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.

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. B — Using the stated values and the relationship given in the stem, the independent calculation gives 116.1 kip.1 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.

92. D — Using the stated values and the relationship given in the stem, the independent calculation gives 76 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 1.484 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 172.5 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. A — The effective-width approximation reduces the physical width by twice the eccentricity: $B' = B - 2e = 9 - 2(0.90) = 7.20$ ft. The distractors subtract eccentricity only once, subtract too much, or add it. The reduction on both sides of the resultant explains the factor of two and confirms the keyed answer.

96. B — Using the stated values and the relationship given in the stem, the independent calculation gives 133 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. C — Using the stated values and the relationship given in the stem, the independent calculation gives 241.9 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. A — Using the stated values and the relationship given in the stem, the independent calculation gives 38.94 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. B — 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. D — 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.