PRACTICE EXAM 26: 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 76 psf. What uniform line load acts on the beam?

A. 76 lb/ft
B. 494 lb/ft
C. 1,976 lb/ft
D. 988 lb/ft

2. A 30-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. 57.0 kip
B. 28.5 kip
C. 14.25 kip
D. 1.9 kip

3. A normal-weight concrete slab is 7.5 in. thick and has a unit weight of 150 pcf. What is the slab self-weight expressed as a uniform pressure?

A. 150 psf

B. 56.25 psf
C. 93.75 psf
D. 1,125 psf

4. For this practice check, use U = 1.2D + 1.6L. If D = 38 psf and L = 62 psf, what factored pressure U results?

A. 144.8 psf
B. 100.0 psf
C. 120.0 psf
D. 160.8 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 = 44 psf. What is p?

A. 29.1 psf
B. 30.8 psf
C. 41.6 psf
D. 27.7 psf

6. Use q = 0.00256 Kz Kzt Kd V^2 I. For Kz = 0.92, Kzt = 1.0, Kd = 0.85, V = 118 mph, and I = 1.0, what velocity pressure q results?

A. 32.8 psf
B. 23.7 psf
C. 27.9 psf
D. 41.1 psf

7. A seismic base shear is defined for this problem as V = CsW. If Cs = 0.074 and the effective seismic weight W = 3,200 kip, what base shear results?

A. 43.2 kip
B. 236.8 kip
C. 320 kip
D. 23.68 kip

8. A uniform surcharge of 500 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. 155 lb/ft
B. 7,500 lb/ft
C. 1,162.5 lb/ft
D. 2,325 lb/ft

9. Soil behind a retaining wall has unit weight 118 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. 2,892 lb/ft
B. 5,783 lb/ft
C. 445 lb/ft
D. 1,446 lb/ft

10. A 36-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. 12.86 kip
B. 36.00 kip
C. 18.00 kip
D. 23.14 kip

11. A girder supports secondary beams spaced at 16 ft. Each secondary beam delivers a 48-kip end reaction to the girder. If those reactions are idealized as an equivalent uniform line load, what line load represents them?

A. 48 kip/ft
B. 3.00 kip/ft
C. 1.50 kip/ft
D. 6.00 kip/ft

12. A metal deck weighs 2.5 psf and supports 4.5 in. of normal-weight concrete weighing 150 pcf. What combined dead-load pressure is carried before other permanent loads are added?

A. 56.25 psf
B. 152.5 psf
C. 58.75 psf
D. 677.5 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 = 6,400 ft2, what is L?

A. 25.0 psf
B. 68.75 psf
C. 18.75 psf
D. 43.75 psf

14. A roof contains 4.75 in. of ponded rainwater. Using a water unit weight of 62.4 pcf, what uniform roof pressure does the water create?

A. 24.7 psf
B. 296.4 psf
C. 12.35 psf
D. 62.4 psf

15. A crane wheel load of 64 kip is increased by a stated impact factor of 20%. What design wheel load results for this problem?

A. 64.0 kip
B. 76.8 kip
C. 12.8 kip
D. 89.6 kip

16. Two identical roof girders share a total distributed gravity load of 246 kip equally. One girder also receives a 28-kip equipment load that is not shared. What total gravity load acts on that girder?

A. 123 kip
B. 274 kip
C. 151 kip
D. 137 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 = 50 kip, and W = 45 kip, what is the largest factored load?

A. 47.6 kip
B. 120.8 kip
C. 135.8 kip
D. 129.0 kip

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

A. 198 kip-ft
B. 99 kip-ft
C. 49.5 kip-ft
D. 22 kip-ft

19. A simply supported 22-ft beam carries 1.8 kip/ft uniformly over the full span. What is the maximum bending moment?

A. 54.45 kip-ft
B. 217.8 kip-ft
C. 39.6 kip-ft
D. 108.9 kip-ft

20. A 20-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. 26 kip
B. 52 kip
C. 13 kip
D. 2.6 kip

21. A tension member carries 150 kip through a gross area of 7.5 in2. What average axial stress is produced?

A. 1,125 ksi
B. 20 ksi
C. 0.05 ksi
D. 75 ksi

22. A 15-ft steel bar carries 84 kip in tension. Use A = 3.5 in2 and E = 29,000 ksi. What elongation results from delta = PL/(AE)?

A. 0.074 in.
B. 0.298 in.
C. 1.49 in.
D. 0.149 in.

23. A rectangular beam section has b = 12 in. and h = 20 in. What is its elastic section modulus S = bh^2/6 about the strong axis?

A. 400 in3
B. 1,600 in3
C. 800 in3
D. 8,000 in3

24. A beam has maximum moment M = 132 kip-ft and section modulus S = 720 in3. What maximum bending stress magnitude is produced?

A. 2.20 ksi
B. 0.183 ksi
C. 22.0 ksi
D. 0.220 ksi

25. A simply supported beam with a centered point load has P = 14 kip, L = 18 ft, E = 29,000 ksi, and I = 2,500 in4. Using delta = PL^3/(48EI), what midspan deflection is obtained?

A. 0.020 in.
B. 0.041 in.
C. 0.081 in.
D. 0.004 in.

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

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

27. A pin-ended column has E = 29,000 ksi, I = 850 in4, and length L = 16 ft. Using Pcr = pi^2EI/L^2, what Euler critical load is obtained?

A. 6,600 kip
B. 3,300 kip
C. 13,200 kip
D. 550 kip

28. A solid circular shaft has torque T = 160 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. 5.59 ksi
B. 22.36 ksi
C. 72.0 ksi
D. 11.18 ksi

29. A column section has axial compressive stress P/A = 7.5 ksi and bending stress magnitude Mc/I = 9.5 ksi at an extreme fiber. What is the maximum compressive stress when the effects add?

A. 2.0 ksi
B. 17.0 ksi
C. 9.5 ksi
D. 71.25 ksi

30. At a point in plane stress, sigma_x = 18 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. 12.00 ksi
B. 17.00 ksi
C. 19.81 ksi
D. 24.00 ksi

31. A 28-ft steel member experiences a uniform temperature increase of 75 F. Using alpha = 6.5e-6/F, what free thermal elongation occurs?

A. 0.082 in.
B. 1.638 in.
C. 0.016 in.
D. 0.164 in.

32. A fully restrained steel bar experiences a 45 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. 8.48 ksi
B. 16.97 ksi
C. 4.24 ksi
D. 0.29 ksi

33. A cantilever beam carries an end load P = 13 kip over a length L = 7 ft. What is the fixed-end moment magnitude?

A. 13 kip-ft
B. 91 kip-ft
C. 45.5 kip-ft
D. 182 kip-ft

34. A cantilever has w = 0.10 kip/in., L = 84 in., E = 29,000 ksi, and I = 1,000 in4. Using delta = wL^4/(8EI), what free-end deflection results?

A. 0.0107 in.
B. 0.0430 in.
C. 0.0215 in.
D. 0.0022 in.

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

36. 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 36-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. 10.0 kip
B. 20.0 kip
C. 30.0 kip
D. 15.0 kip

38. A structural detail experiences repeated stress cycling between +28 ksi and -7 ksi. What is the stress range?

A. 21 ksi
B. 17.5 ksi
C. 28 ksi
D. 35 ksi

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

A. 21.94 ksi
B. 87.77 ksi
C. 43.89 ksi
D. 27.43 ksi

40. A rectangular column has area A = 24 in2, section modulus S = 120 in3, axial load P = 150 kip, and eccentricity e = 5 in. What maximum compressive stress is produced by P/A + Pe/S?

A. 12.50 ksi
B. 6.25 ksi
C. 18.75 ksi
D. 31.25 ksi

41. A rectangular beam has b = 10 in. and h = 28 in. What is its centroidal moment of inertia I = bh^3/12 about the strong axis?

A. 9,147 in4
B. 18,293 in4
C. 36,587 in4
D. 1,829 in4

42. 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 increase concrete compressive strength through mechanical confinement.
C. To redistribute construction loads through multiple floors while younger slabs gain adequate strength.
D. To eliminate the need to analyze construction sequencing.

43. Fresh concrete exerts an idealized uniform lateral pressure of 780 psf on a form panel 9 ft long and 5 ft high. What total lateral force acts on the panel?

A. 7,020 lb
B. 3,900 lb
C. 780 lb
D. 35,100 lb

44. 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. Assume the scaffold can carry the same load as the permanent floor.
C. Load the platform first and inspect only if visible deflection occurs.
D. Ignore stored materials because worker weight is the only relevant loading.

45. 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. 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 deep excavation will be made beside an occupied building supported on shallow footings. Which preconstruction action best addresses the structural interaction risk?

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

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

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

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

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

48. Which statement most accurately distinguishes a structural shop drawing submittal from a request for information (RFI)?

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

A. 4,031 ksi

B. 2,850 ksi

C. 8,061 ksi

D. 57,000 ksi

50. 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. Specified compressive strength alone.

B. Modulus of elasticity.

C. Unit weight alone.

D. Air content alone.

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

A. 3.60 in2
B. 5.40 in2
C. 0.60 in2
D. 4.80 in2

52. Which statement most accurately distinguishes structural-steel yield strength from ultimate tensile strength?

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

53. A steel coupon has axial stress of 18 ksi and corresponding elastic strain of 0.00060. What modulus E is indicated by E = stress/strain?

A. 18,000 ksi
B. 30,000 ksi
C. 10,800 ksi
D. 1,080 ksi

54. 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. Only connection design depends on grain direction; member strength does not.
D. Wood is orthotropic, so stiffness and strength depend strongly on loading direction relative to the grain.

55. When masonry prisms are tested in compression, which material property is the test intended to characterize most directly?

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

56. A soil has porosity n = 0.42. What is its void ratio e = n/(1-n)?

A. 0.724
B. 0.420
C. 1.381
D. 0.244

57. A soil sample has total weight 138 lb and total volume 1.80 ft3. What is its total unit weight?

A. 248.4 pcf
B. 69.0 pcf
C. 124.2 pcf
D. 76.7 pcf

58. For a soil bearing estimate, use qult = gamma Df Nq. If gamma = 125 pcf, Df = 5 ft, and Nq = 18, what ultimate bearing pressure results?

A. 2,250 psf

B. 6,250 psf
C. 11,250 psf
D. 56,250 psf

59. Which laboratory procedure is used most directly to establish compressive strength of a conventional molded concrete cylinder?

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

60. 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. In a reinforced CMU wall, grout is placed in cells containing vertical reinforcing bars. What is the principal structural reason for the grout?

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

62. What principal service-performance advantage is gained by prestressing a concrete member before most service loading is applied?

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

63. A singly reinforced rectangular concrete beam has b = 14 in., d = 22 in., As = 3.8 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. 424.0 kip-ft
B. 190.8 kip-ft
C. 381.6 kip-ft
D. 458.0 kip-ft

64. For a concrete beam with nominal flexural strength Mn = 420 kip-ft, use phi = 0.90. What design flexural strength phiMn is available?

A. 420 kip-ft
B. 378 kip-ft
C. 466.7 kip-ft
D. 336 kip-ft

65. For a reinforced concrete beam, use Vc = 2 sqrt(f'c) bwd in pounds. If f'c = 5,000 psi, bw = 14 in., and d = 22 in., what Vc results?

A. 21.8 kip
B. 87.1 kip
C. 43.6 kip
D. 7.3 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 = 1.0 in., and f'c = 5,000 psi. What ld results?

A. 17.0 in.
B. 33.9 in.
C. 67.9 in.
D. 13.6 in.

67. A tied concrete column has Ag = 180 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. 722.5 kip
B. 1,922.5 kip
C. 600 kip
D. 1,322.5 kip

68. A one-way slab strip is idealized as a simply supported 13-ft span carrying 0.62 kip/ft. Using Mmax = wL^2/8, what strip moment results?

A. 13.10 kip-ft
B. 6.55 kip-ft
C. 26.20 kip-ft
D. 104.8 kip-ft

69. A nearly square reinforced-concrete floor panel is supported continuously along all four edges. Which response most clearly indicates two-way slab behavior?

A. All load is carried only to the two supports along the short edges.
B. Significant bending and load transfer occur in both orthogonal directions.
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 486 kip. Neglect footing weight. What average soil bearing pressure is produced?

A. 54.0 ksf
B. 3.0 ksf
C. 9.0 ksf
D. 6.0 ksf

71. A 12-ft-wide footing carries P = 660 kip with eccentricity e = 0.75 ft about its centerline. For a one-foot strip, use $q_{max} = (P/A)(1 + 6e/B)$, with A = 12 ft2. What is qmax?

A. 75.625 ksf
B. 55.000 ksf
C. 96.250 ksf
D. 37.813 ksf

72. A pile group contains seven piles, each with allowable axial capacity 105 kip. If a stated group-efficiency factor of 0.82 applies, what allowable group capacity is used?

A. 735 kip
B. 86.1 kip
C. 602.7 kip
D. 896.3 kip

73. A retaining wall experiences a triangular lateral soil resultant of 24 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. 360 kip-ft/ft
B. 60 kip-ft/ft
C. 120 kip-ft/ft
D. 24 kip-ft/ft

74. A retaining wall has total stabilizing vertical load W = 96 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. 4.80
B. 2.40
C. 1.20
D. 0.42

75. A compact steel beam has Fy = 50 ksi and plastic section modulus Zx = 144 in3. For this practice check, take nominal plastic moment Mn = FyZx. What is Mn?

A. 7,200 kip-ft
B. 300 kip-ft
C. 1,200 kip-ft
D. 600 kip-ft

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

77. A steel tension member has gross area Ag = 8.4 in2 and Fy = 50 ksi. Using phi = 0.90 and design yielding strength phiFyAg, what strength results?

A. 378 kip
B. 420 kip
C. 189 kip
D. 462 kip

78. A steel tension member has effective net area Ae = 5.8 in2 and Fu = 65 ksi. For this problem use phi = 0.75 for net-section rupture. What design rupture strength results?

A. 377.0 kip
B. 141.38 kip
C. 424.1 kip
D. 282.75 kip

79. A connection uses five bolts, each with stated design shear strength of 28 kip, and the load is shared equally. What total design shear strength is available?

A. 28 kip
B. 70 kip
C. 140 kip
D. 112 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 = 12 in., what strength results?

A. 33.4 kip
B. 66.8 kip
C. 89.1 kip
D. 133.6 kip

81. A steel column has E = 29,000 ksi, I = 610 in4, and effective length KL = 192 in. Using Euler Pcr = pi^2EI/(KL)^2, what critical load results?

A. 2,368 kip
B. 9,472 kip
C. 4,736 kip
D. 395 kip

82. A member interaction check is defined as Pu/phiPn + Mu/phiMn <= 1.0. If Pu = 240 kip, phiPn = 650 kip, Mu = 105 kip-ft, and phiMn = 170 kip-ft, what interaction ratio results?

A. 0.369
B. 0.618
C. 1.604
D. 0.987

83. In a composite floor beam, headed studs connect the concrete slab to the supporting steel beam. What is their primary structural function?

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

84. A timber beam has allowable bending stress Fb = 1.45 ksi and section modulus S = 210 in3. What allowable bending moment is FbS?

A. 25.38 kip-ft
B. 304.5 kip-ft
C. 12.69 kip-ft
D. 50.75 kip-ft

85. A timber post carries 56 kip through a gross area of 40 in2. What average compressive stress acts on the section?

A. 2.80 ksi
B. 0.70 ksi
C. 22.4 ksi
D. 1.40 ksi

86. A wood connection requires 27 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. 5 fasteners
D. 7 fasteners

87. A masonry wall carries a concentric axial load of 92 kip over a net area of 144 in2. What average compressive stress is produced?

A. 0.639 ksi
B. 1.278 ksi
C. 0.319 ksi
D. 13.25 ksi

88. A masonry shear wall segment carries V = 64 kip. Using average shear stress v = V/(bd) with b = 8 in. and d = 128 in., what average shear stress results?

A. 0.0313 ksi
B. 0.0625 ksi
C. 0.1250 ksi
D. 8.00 ksi

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

A. 720 kip
B. 11.25 kip
C. 45.0 kip
D. 22.5 kip

90. 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. Collect diaphragm forces and deliver them to vertical lateral-force-resisting elements where direct transfer is discontinuous.

C. Reduce material yield strength so the calculated lateral forces become smaller.

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 126-kip story shear is shared equally through the horizontal components of the two braces, what axial force acts in each brace?

A. 63.0 kip

B. 126.0 kip

C. 98.0 kip

D. 49.0 kip

92. A lateral frame resists an overturning moment of 1,500 kip-ft through a tension-compression couple separated by 25 ft. What axial force magnitude is required in each side of the couple?

A. 60 kip

B. 30 kip

C. 1,500 kip

D. 120 kip

93. A steel column transfers 510 kip concentrically through a 16 in. by 20 in. base plate. What average bearing pressure acts beneath the plate?

A. 3.188 ksi

B. 0.797 ksi
C. 1.594 ksi
D. 25.50 ksi

94. A base connection resists a 300 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. 12.5 kip
B. 150 kip
C. 300 kip
D. 75 kip

95. A footing has width B = 10 ft and load eccentricity e = 0.90 ft. Using the effective-width approximation B' = B - 2e, what effective width results?

A. 8.20 ft
B. 9.10 ft
C. 6.40 ft
D. 11.80 ft

96. A rigid pile cap carries a concentric 640-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. 640 kip
B. 320 kip
C. 64 kip
D. 128 kip

97. A drilled shaft has diameter 3.5 ft, embedded length 42 ft, and uniform unit side resistance fs = 0.55 ksf. Using Qs = pi d L fs, what side resistance results?

A. 80.9 kip
B. 254.0 kip
C. 508.0 kip
D. 127.0 kip

98. A 14-ft-wide retaining-wall base carries resultant vertical load P = 315 kip/ft with eccentricity e = 1.20 ft. Using $q_{max} = P/B(1 + 6e/B)$, what maximum base pressure results?

A. 22.50 ksf
B. 17.04 ksf
C. 45.64 ksf
D. 34.07 ksf

99. 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. Which connection-design philosophy most directly supports ductile behavior when a lateral-force-resisting system is expected to undergo significant inelastic response?

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

Practice Exam 26: Answer Key and Explanations

1. D — Multiply the area pressure by tributary width: 76 psf times 13 ft equals 988 lb/ft. This conversion changes a load per square foot into the line load carried by the beam. The distractors omit the tributary width, use half the width, or double the correct line load. Units and magnitude are consistent with the stated model.

2. B — The total uniform load is 1.9 times 30, or 57 kip. Symmetry divides that load equally between the two simple supports, producing 28.5 kip at each support. The other choices assign the entire load to one support, halve the reaction twice, or ignore the span when converting line load to force.

3. C — Convert the slab thickness from inches to feet before multiplying by unit weight. A thickness of 7.5/12 ft times 150 pcf gives 93.75 psf. The alternatives treat the slab as one foot thick, use an incorrect half-thickness conversion, or multiply by inches without converting to feet. A quick unit check also confirms the scale and physical meaning of the result.

4. A — Apply the stated load factors separately: 1.2 times 38 equals 45.6 psf, and 1.6 times 62 equals 99.2 psf. Their sum is 144.8 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. Units and magnitude are consistent with the stated model.

5. A — Direct substitution gives 0.7 times 0.90 times 1.05 times 1.0 times 44, which rounds to 29.1 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. Units and magnitude are consistent with the stated model.

6. C — Substituting the stated coefficients and velocity into the provided equation gives approximately 27.9 psf. The velocity is squared, so treating it linearly creates a large error, while omitting Kd or Kz shifts the result materially. Keeping the coefficients dimensionless and reporting pressure in psf provides a straightforward reasonableness check. Units and magnitude are consistent with the stated model.

7. B — Multiply the dimensionless seismic coefficient by effective seismic weight: 0.074 times 3,200 kip equals 236.8 kip. The distractors move the decimal, substitute the full weight, or use an unrelated percentage. The result must be a force smaller than W because the given coefficient is substantially less than one. Units and magnitude are consistent with the stated model.

8. D — The uniform lateral pressure from the surcharge is Ka times q, or 0.31 times 500 = 155 psf. Multiplying that pressure by the 15-ft wall height gives 2,325 lb/ft of wall. 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.

9. A — Using the stated triangular-pressure resultant, 0.5 times 0.29 times 118 times 13 squared gives about 2,892 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. A quick unit check also confirms the scale and physical meaning of the result.

10. D — For a single point load on a simple span, the left reaction equals P(L-x)/L. Substituting 36 kip, L = 28 ft, and x = 10 ft gives 23.14 kip. The right reaction is 12.86 kip, and both reactions must sum to the 36-kip applied axle load. A quick unit check also confirms the scale and physical meaning of the result.

11. B — Convert the repeated concentrated reactions to an equivalent line load by dividing one reaction by its spacing. Forty-eight kip divided by 16 ft equals 3.00 kip/ft. The distractors retain the point load as a line load, divide twice, or double the correct distributed value. Units clearly distinguish force from force per length.

12. C — Concrete contributes 4.5/12 ft times 150 pcf = 56.25 psf. Adding the 2.5-psf deck weight gives 58.75 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. Units and magnitude are consistent with the stated model.

13. D — The square root of 6,400 is 80. Therefore the bracketed factor is 0.25 + 15/80 = 0.4375, and multiplying by 100 psf gives 43.75 psf. The distractors omit one term or mis-handle the square root. Use the formula exactly as stated rather than importing an unstated minimum. Units and magnitude are consistent with the stated model.

14. A — Convert 4.75 inches of water to feet and multiply by water unit weight. The depth is 4.75/12 ft, so the pressure is about 24.7 psf. The distractors multiply by inches directly, halve the proper pressure, or use one foot of water. Pressure equals unit weight times fluid depth. Units and magnitude are consistent with the stated model.

15. B — An impact increase of 20 percent means multiplying the static wheel load by 1.20. Thus 64 kip becomes 76.8 kip. The distractors leave the load unchanged, report only the increase, or apply a 40-percent increase. An impact allowance is added to the original demand; it does not replace that demand.

16. C — Each of the two identical girders receives one-half of the shared 246-kip gravity load, or 123 kip. The separate 28-kip equipment load acts entirely on the girder in question, giving 151 kip total. The distractors omit the equipment load, assign all shared load, or use an incorrect division of the shared load.

17. C — Evaluate every stated combination rather than assuming which governs. The three results are 47.6 kip, 120.8 kip, and 135.8 kip, so the third combination controls. The distractors reproduce the other combinations or an incorrect total. Load-combination questions require comparing complete factored cases and selecting the largest resulting demand. Units and magnitude are consistent with the stated model.

18. B — For a centered point load on a simply supported beam, the maximum moment is PL/4. Substituting 22 kip and 18 ft gives 99 kip-ft at midspan. The distractors double or halve the correct moment or report the load itself. The symmetric reactions are 11 kip each, providing a useful equilibrium check.

19. D — For a full-span uniform load on a simple beam, Mmax = wL squared/8. Using 1.8 kip/ft and 22 ft gives 108.9 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. Units and magnitude are consistent with the stated model.

20. A — The total applied load is 2.6 times 20 = 52 kip. Because the loading and support arrangement are symmetric, each reaction is half the total, or 26 kip. The distractors assign the full load, halve twice, or ignore span length. The two reactions must add back to 52 kip. Units and magnitude are consistent with the stated model.

21. B — Average axial stress equals force divided by gross area. Dividing 150 kip by 7.5 in2 gives 20 ksi because kip per square inch is ksi. The distractors multiply instead of divide, invert the ratio, or use an unrelated factor. Stress should scale upward with load and downward with area. Units and magnitude are consistent with the stated model.

22. D — Convert the 15-ft length to 180 inches so the units are consistent with area and modulus. Substituting into PL/(AE) gives approximately 0.149 in. The distractors halve, double, or shift the decimal. Axial deformation increases with load and length but decreases as area or elastic modulus increases. A quick unit check also confirms the scale and physical meaning of the result.

23. C — Using the stated rectangular-section formula, S = 12 times 20 squared divided by 6 = 800 in3. The distractors halve or double the correct result or mishandle the depth exponent. Section modulus has cubic length units because it relates bending moment to extreme-fiber stress through sigma = M/S. Units and magnitude are consistent with the stated model.

24. A — Convert 132 kip-ft to 1,584 kip-in. Dividing by the 720-in3 section modulus gives 2.20 kip/in2, or 2.20 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. A quick unit check also confirms the scale and physical meaning of the result.

25. B — Convert the 18-ft span to 216 inches before substituting because E and I use inch-based units. The stated formula gives about 0.041 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.

26. C — Direct substitution into the supplied uniform-load deflection expression gives approximately 0.0070 in. The distractors halve, double, or shift the decimal. Because the span appears to the fourth power, deflection changes rapidly with length. All quantities are already expressed in compatible kip-and-inch units, so no additional conversion is needed. Units and magnitude are consistent with the stated model.

27. A — Convert the 16-ft length to 192 inches, then apply Euler buckling with the stated pin-ended length. The result is about 6,600 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.

28. D — Maximum torsional shear stress follows directly from Tc/J. Multiplying 160 kip-in. by 2.25 in. and dividing by 32.2 in4 gives 11.18 ksi. The distractors halve or double the proper stress or misuse the torque-radius product. The resulting units reduce to kip per square inch, confirming a stress quantity. Units and magnitude are consistent with the stated model.

29. B — At the extreme fiber where bending compression acts in the same sense as axial compression, the stresses add. Thus 7.5 ksi plus 9.5 ksi equals 17.0 ksi. The opposite edge would involve subtraction. The distractors subtract, report only bending stress, or multiply the components. Combined-stress signs must follow the selected fiber.

30. C — The average normal stress is 12 ksi. The radius term is the square root of 6 squared plus 5 squared, approximately 7.81 ksi. Adding these quantities gives a major principal stress of 19.81 ksi. The distractors omit the shear contribution, use a simple sum, or report only the average stress.

31. D — Free thermal expansion is alpha L DeltaT. Convert 28 ft to 336 inches, then multiply by 6.5e-6/F and 75 F to obtain about 0.164 in. The distractors halve the result or shift the decimal. Because the member is free to expand, elastic modulus does not enter this deformation calculation. Units and magnitude are consistent with the stated model.

32. A — Full restraint prevents the free thermal strain, so the given stress relation applies directly. Multiplying 29,000 ksi by 6.5e-6/F and 45 F gives about 8.48 ksi. The distractors double or halve the result or mishandle the coefficient. The stress sign depends on heating versus cooling, but the question asks magnitude.

33. B — The end load acts with a 7-ft lever arm about the fixed support, so the support moment magnitude is PL = 13 times 7 = 91 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.

34. C — Substituting the stated load, span, modulus, and inertia into the cantilever uniform-load expression gives approximately 0.0215 in. The distractors halve, double, or shift the decimal. The span is already in inches, matching the section and modulus units. The fourth-power span dependence is a strong reasonableness check for deflection problems. Units and magnitude are consistent with the stated model.

35. A — 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. B — The left-reaction influence ordinate is (36-12)/36 = 2/3. Multiplying this ordinate by the 30-kip moving load gives 20 kip. The right reaction would be 10 kip, and the two reactions sum to the applied load. 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.

38. D — Stress range equals maximum stress minus minimum stress. Because the minimum is negative, the range is 28 - (-7) = 35 ksi. The distractors subtract absolute values incorrectly, report half the range, or repeat the maximum stress. Fatigue calculations distinguish stress range from mean stress and from either individual stress extreme.

39. C — The projected bearing area is plate thickness times bolt diameter: 5/8 in. times 7/8 in. Dividing 24 kip by that area gives 43.89 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.

40. A — The concentric stress is 150/24 = 6.25 ksi. The eccentric moment is Pe = 750 kip-in., giving another 6.25 ksi of bending stress at the extreme fiber. Where compression adds, the maximum is 12.50 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.

41. B — Using I = bh cubed/12, substitute b = 10 in. and h = 28 in. The result is approximately 18,293 in4. The distractors halve or double the correct value or shift the decimal. The fourth-power units are appropriate for a second moment of area, and the cubic depth term dominates section stiffness.

42. C — 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 — Total force from a uniform pressure equals pressure times loaded area. The panel area is 9 times 5 = 45 ft2, and 780 psf times 45 ft2 equals 35,100 lb. The distractors omit one panel dimension or repeat the pressure. Formwork demand depends on both pressure intensity and tributary panel area.

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. 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. A — Apply the stated empirical relationship using f'c in psi. The square root of 5,000 multiplied by 57,000 gives about 4.031 million psi, or 4,031 ksi. The distractors use an incorrect coefficient treatment or fail to convert psi to ksi. Elastic modulus describes stiffness rather than compressive strength itself. Units and magnitude are consistent with the stated model.

50. B — 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 — Total reinforcing area equals the number of identical bars times the area of one bar. Eight bars times 0.60 in2 gives 4.80 in2. The distractors use an incorrect bar count or report the area of one bar only. Summed steel area is used in strength and reinforcement-ratio calculations for the section.

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 — Elastic modulus equals stress divided by strain. Dividing 18 ksi by the dimensionless strain 0.00060 gives 30,000 ksi. The distractors multiply instead of divide or mishandle the decimal. Because strain has no units, the modulus retains stress units. The magnitude is also consistent with the expected order for structural steel stiffness.

54. D — 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. C — 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 — Void ratio is the volume of voids divided by volume of solids, while porosity is void volume divided by total volume. Using the supplied conversion, 0.42/(1-0.42) gives 0.724. The distractors repeat porosity, invert the relationship, or use an incorrect denominator. Void ratio can exceed porosity because its denominator is smaller.

57. D — Total unit weight equals total weight divided by total volume. Dividing 138 lb by 1.80 ft3 gives approximately 76.7 pcf. The distractors multiply instead of divide or use incorrect volume adjustments. Unit weight should carry force-per-volume units, and increasing the same weight over a larger sample volume would reduce the calculated value.

58. C — Using the simplified relationship supplied in the stem, multiply 125 pcf by 5 ft and by the dimensionless factor 18. The result is 11,250 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.

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. 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. C — The equivalent compression-block depth is a = 3.8 times 60 divided by 0.85 times 5 times 14, or about 3.83 in. Substituting into As fy(d-a/2) and converting kip-in. to kip-ft gives about 381.6 kip-ft. The distractors use incorrect lever arms or omit the unit conversion. A quick unit check also confirms the scale and physical meaning of the result.

64. B — Design strength equals the nominal strength multiplied by the stated resistance factor. Thus 0.90 times 420 kip-ft gives 378 kip-ft. The distractors leave the nominal value unfactored, divide by phi, or apply an excessive reduction. Because phi is less than one, design strength should be smaller than the nominal flexural strength.

65. C — Using the supplied expression, 2 times the square root of 5,000 times 14 times 22 gives about 43,560 lb, or 43.6 kip. The distractors halve or double the result or mishandle the pounds-to-kips conversion. The formula explicitly produces pounds, so dividing by 1,000 is required for the requested kip value.

66. B — Substitute the given values into the stated development-length expression. The denominator is 25 times the square root of 5,000, and the numerator is 60,000 times 1.0 in. The resulting length is about 33.9 in. The distractors halve or double the correct value or use an incorrect square-root treatment. Units and magnitude are consistent with the stated model.

67. D — Concrete carries 0.85 times 5 ksi over the net concrete area of 170 in2, while the steel contribution is 60 ksi times 10 in2. Adding these contributions gives 1,322.5 kip nominal axial strength. The distractors omit one material contribution or mis-handle the concrete area subtraction. Units reduce directly to kips.

68. A — Apply the simple-span uniform-load expression to the one-foot slab strip. Substituting 0.62 kip/ft and 13 ft gives 13.10 kip-ft. The distractors halve or double the correct moment or omit the divisor of eight. Treating a slab strip as a beam is an idealization, so the stated strip width and loading govern.

69. B — 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. D — Average bearing pressure equals vertical load divided by footing area. A 9-ft by 9-ft footing has 81 ft2 of area, and 486 kip divided by 81 ft2 equals 6.0 ksf. The distractors divide by one footing dimension, halve the proper pressure, or use an incorrect area. Concentric loading produces uniform average pressure in this idealization.

71. A — The average pressure is 660/12 = 55 ksf for the one-foot strip. The eccentricity multiplier is 1 + 6(0.75)/12 = 1.375. Multiplying gives q_{max} = 75.625 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.

72. C — First sum the individual allowable pile capacities: seven times 105 kip equals 735 kip. Applying the stated group efficiency of 0.82 gives 602.7 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.

73. C — The triangular soil-pressure resultant acts at one-third of the wall height above the base. For H = 15 ft, the lever arm is 5 ft. Multiplying 24 kip/ft by 5 ft gives 120 kip-ft/ft. The distractors use the full height, halve the moment, or report force without a lever arm.

74. B — Available friction resistance is muW = 0.55 times 96 = 52.8 kip/ft. Dividing by the 22-kip/ft driving force gives a sliding factor of safety of 2.40. The distractors double or halve the ratio or invert it. A factor of safety compares resisting capacity with driving demand using consistent force units.

75. D — Multiplying Fy by Zx gives 50 ksi times 144 in3 = 7,200 kip-in. Dividing by 12 converts the moment to 600 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. Units and magnitude are consistent with the stated model.

76. A — 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 — Design yielding strength is phi Fy Ag. Multiplying 0.90 by 50 ksi and 8.4 in2 gives 378 kip. The distractors omit phi, halve the proper strength, or use an unrelated increase. Because this check uses gross-section yielding, the gross area stated in the problem is the relevant section property for the calculation.

78. D — Net-section rupture strength is calculated from the stated effective net area, tensile strength, and resistance factor. Multiplying 0.75 times 65 ksi times 5.8 in2 gives 282.75 kip. The distractors omit phi, halve the result, or overstate the area effect. This rupture check is distinct from gross-section yielding. Units and magnitude are consistent with the stated model.

79. C — With five identical bolts and equal load sharing, total design shear strength is the sum of the individual bolt strengths. Five times 28 kip equals 140 kip. The distractors report one bolt, only half the group, or four bolts. The stated equal-sharing assumption allows direct addition without introducing eccentricity or group-reduction effects.

80. B — The effective weld throat is 0.707 times the weld size, so the effective area is 0.707(0.25)(12). Multiplying that by 0.6Fexx and phi gives approximately 66.8 kip. The distractors halve, omit phi, or double the proper strength. The formula is supplied, so careful substitution and unit consistency control the result. Units and magnitude are consistent with the stated model.

81. C — Applying Euler buckling with the stated effective length gives pi squared times 29,000 ksi times 610 in4 divided by 192 squared, or about 4,736 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.

82. D — Compute each normalized demand separately: 240/650 is about 0.369 and 105/170 is about 0.618. Their sum is approximately 0.987. The distractors report one component alone or add incorrectly. Under the stated criterion, a ratio not exceeding 1.0 satisfies the simplified interaction check, though this problem asks only for the ratio.

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 — Multiplying allowable bending stress by section modulus gives 1.45 ksi times 210 in3 = 304.5 kip-in. Dividing by 12 converts to 25.38 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.

85. D — Average compressive stress equals axial force divided by gross area. Dividing 56 kip by 40 in2 gives 1.40 ksi. The distractors double or halve the result or multiply force and area. This is an average stress calculation only; actual timber column design may also require stability and adjustment-factor checks beyond the simplified quantity requested here.

86. C — Dividing the required 27-kip resistance by 5.5 kip per fastener gives about 4.91 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. Minimum-count problems require rounding up, not to the nearest integer.

87. A — Average compressive stress is axial load divided by net area. Dividing 92 kip by 144 in2 gives approximately 0.639 ksi. The distractors double or halve the result or mishandle the area. Because the load is stated as concentric, this simplified average stress calculation does not include an additional flexural stress component from eccentricity.

88. B — The resisting area in the stated average-shear model is b times d = 8 times 128 = 1,024 in2. Dividing 64 kip by that area gives 0.0625 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.

89. D — Diaphragm chord forces form a tension-compression couple separated by the chord spacing. Dividing the in-plane moment of 720 kip-ft by 32 ft gives 22.5 kip. The distractors report the moment as force or halve or double the proper result. Force times chord spacing should recover the original diaphragm bending moment.

90. B — 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. C — Each brace contributes a horizontal component F cos 50 degrees. With two identical braces, equilibrium gives 2F cos 50 = 126 kip, so F is about 98.0 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.

92. A — A tension-compression couple resists moment through force times separation. Dividing 1,500 kip-ft by the 25-ft lever arm gives 60 kip in each side of the idealized couple. The distractors halve or double the correct force or report the moment magnitude as a force. Multiplying 60 kip by 25 ft recovers 1,500 kip-ft.

93. C — Base-plate area is 16 times 20 = 320 in2. Dividing the concentric 510-kip load by this area gives an average pressure of 1.594 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.

94. B — Convert 300 kip-ft to 3,600 kip-in. and divide by the 24-in. couple arm. The required tension and compression force magnitude is 150 kip. 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. Units and magnitude are consistent with the stated model.

95. A — Apply the stated effective-width approximation directly: B' = 10 - 2(0.90) = 8.20 ft. The distractors subtract the eccentricity only once, subtract too much, or add the eccentricity effect. Because eccentricity reduces the effective contact width in this approximation, the result must be smaller than the original 10-ft footing width.

96. D — Under the stated assumptions of a rigid cap, concentric loading, and five identical piles with equal stiffness, the vertical load divides equally. Dividing 640 kip by five gives 128 kip per pile. The distractors assign the full load, divide by two, or divide by ten. The five pile reactions must sum to 640 kip.

97. B — Shaft side resistance equals circumference times embedded length times unit side resistance. Using pi times 3.5 ft times 42 ft times 0.55 ksf gives about 254.0 kip. The distractors omit pi or halve or double the correct resistance. Circumference times length is shaft surface area, and ksf times ft2 produces kips.

98. D — Average pressure is P/B = 315/14 = 22.5 ksf. The eccentricity factor is 1 + 6(1.20)/14, giving about 1.514. Multiplying produces qmax = 34.07 ksf. The distractors report average pressure, halve the maximum, or overstate the eccentricity effect. The stated linear bearing-pressure model governs this calculation. A quick unit check also confirms the scale and physical meaning of the result.

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.