PRACTICE EXAM 23: 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 floor beam has a tributary width of 11 ft and supports a uniform floor pressure of 72 psf. What uniform line load acts on the beam?

A. 72 lb/ft
B. 396 lb/ft
C. 1,584 lb/ft
D. 792 lb/ft

2. A 26-ft simply supported beam carries a uniform load of 2.4 kip/ft over its full span. What is the vertical reaction at each support?

A. 15.6 kip
B. 31.2 kip
C. 62.4 kip
D. 2.4 kip

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

A. 90.6 psf

B. 145 psf
C. 54.4 psf
D. 1,087.5 psf

4. For this problem, use the load combination U = 1.2D + 1.6L. If D = 35 psf and L = 55 psf, what is U?

A. 90 psf
B. 112 psf
C. 130 psf
D. 144 psf

5. For this problem, use p = 0.7 Ce Ct Is pg. If Ce = 0.95, Ct = 1.05, Is = 1.0, and pg = 36 psf, what is p?

A. 25.1 psf
B. 23.9 psf
C. 26.5 psf
D. 35.2 psf

6. For this problem, compute velocity pressure from q = 0.00256 Kz Kzt Kd V^2 I. Use Kz = 0.90, Kzt = 1.0, Kd = 0.85, V = 125 mph, and I = 1.0. What is q?

A. 24.5 psf
B. 30.6 psf
C. 36.0 psf
D. 15.3 psf

7. A seismic base shear is defined for this problem as V = CsW. If Cs = 0.092 and the effective seismic weight W = 2,750 kip, what is V?

A. 29.9 kip
B. 275 kip

C. 253 kip
D. 2,750 kip

8. A uniform surcharge of 520 psf acts behind a 14-ft retaining wall. If the lateral pressure coefficient is Ka = 0.32, what lateral force per foot of wall results from the surcharge alone?

A. 0.166 kip/ft
B. 7.28 kip/ft
C. 1.17 kip/ft
D. 2.33 kip/ft

9. For this problem, the active soil pressure is triangular and its resultant is Pa = 0.5 Ka gamma H^2. If Ka = 0.30, gamma = 120 pcf, and H = 15 ft, what is Pa per foot of wall?

A. 2.70 kip/ft
B. 8.10 kip/ft
C. 0.54 kip/ft
D. 4.05 kip/ft

10. A triangular lateral pressure distribution is zero at the top and maximum at the base of a 16-ft wall. How far above the base does the resultant act?

A. 8.00 ft
B. 5.33 ft
C. 10.67 ft
D. 4.00 ft

11. An interior column supports a rectangular tributary area 24 ft by 30 ft carrying a uniform gravity pressure of 95 psf. What service load reaches the column from this area?

A. 68.4 kip

B. 34.2 kip
C. 95.0 kip
D. 6.84 kip

12. A roof panel 18 ft by 24 ft carries a uniform rain load of 42 psf and is supported equally by two parallel girders. Neglect self-weight. What reaction from the rain load reaches each girder?

A. 18.14 kip
B. 4.54 kip
C. 9.07 kip
D. 42.0 kip

13. A 32-kip point load is located 14 ft from the left support of a 40-ft simply supported beam. What is the left support reaction?

A. 20.8 kip
B. 11.2 kip
C. 32.0 kip
D. 18.0 kip

14. A crane wheel produces a static vertical load of 48 kip. For this problem, apply a 25% impact increase to obtain the design wheel load. What load results?

A. 12 kip
B. 48 kip
C. 72 kip
D. 60 kip

15. A beam has a tributary width of 9 ft and supports 55 psf dead load plus 80 psf live load. What total unfactored uniform line load acts on the beam?

A. 735 lb/ft
B. 1,215 lb/ft
C. 495 lb/ft
D. 135 lb/ft

16. For this problem, a point-load combination is U = 1.2D + 1.6L. If D = 18 kip and L = 25 kip, what is U?

A. 43.0 kip
B. 54.0 kip
C. 61.6 kip
D. 68.8 kip

17. Which description best represents a complete gravity-load path in a typical framed building?

A. Floor loads are resisted only by the slab and do not need a continuous path to the foundation.
B. Gravity loads transfer directly from roof cladding to soil without passing through framing or foundations.
C. Each structural member may be designed independently without checking how reactions are delivered to adjoining members.
D. Floor loads transfer through slabs or deck to beams and girders, then to columns or walls, foundations, and supporting soil.

18. A 24-kip point load acts 8 ft from the left support of a 30-ft simply supported beam. What is the left reaction?

A. 6.4 kip
B. 17.6 kip
C. 12.0 kip
D. 24.0 kip

19. A 22-ft simply supported beam carries a full-span uniform load of 1.6 kip/ft. What is the maximum bending moment?

A. 193.6 kip-ft
B. 35.2 kip-ft
C. 96.8 kip-ft
D. 48.4 kip-ft

20. A 12-ft cantilever carries a 0.8-kip/ft uniform load over its full length and a 5-kip downward point load at its free end. What vertical shear magnitude acts at the fixed support?

A. 14.6 kip
B. 9.6 kip
C. 5.0 kip
D. 19.6 kip

21. A prismatic member carries 54 kip of shear across a gross rectangular area 6 in. by 10 in. Using average shear stress V/A, what value results?

A. 0.90 ksi
B. 9.0 ksi
C. 0.45 ksi
D. 5.4 ksi

22. A steel tension bar carries P = 75 kip over a length of 168 in. The area is 4.5 in2 and E = 29,000 ksi. Using delta = PL/(AE), what elongation occurs?

A. 0.0483 in.
B. 0.0966 in.
C. 0.193 in.
D. 0.0130 in.

23. For a prismatic beam segment, curvature is approximated by phi = M/(EI). If M = 240 kip-in., E = 29,000 ksi, and I = 900 in4, what curvature results?

A. 9.20e-5 1/in.
B. 4.60e-6 1/in.
C. 9.20e-6 1/in.
D. 1.84e-5 1/in.

24. A solid circular section has diameter d = 10 in. Using S = pi d^3/32, what section modulus results?

A. 196.3 in3
B. 49.1 in3
C. 785.4 in3
D. 98.2 in3

25. A cantilever carries a 6-kip point load at its free end. Use delta = PL^3/(3EI) with L = 120 in., E = 29,000 ksi, and I = 850 in4. What is the free-end deflection?

A. 0.070 in.
B. 0.280 in.
C. 0.0117 in.
D. 0.140 in.

26. A 20-ft simply supported beam carries an 18-kip point load at midspan. Using delta = PL^3/(48EI), with E = 29,000 ksi and I = 1,600 in4, what midspan deflection results?

A. 0.056 in.
B. 0.112 in.
C. 0.224 in.
D. 0.0093 in.

27. A cantilever column has E = 29,000 ksi, I = 500 in4, actual length L = 144 in., and effective-length factor K = 2.0. Using Pcr = pi^2 EI/(KL)^2, what Euler load results?

A. 1,725 kip
B. 6,909 kip
C. 863 kip
D. 3,454 kip

28. A solid circular shaft transmits T = 90 kip-in. and has diameter d = 5 in. Using tau_max = 16T/(pi d^3), what maximum torsional shear stress results?

A. 7.33 ksi
B. 1.83 ksi
C. 3.67 ksi
D. 11.46 ksi

29. A member has area A = 16 in2, section modulus S = 60 in3, compressive axial load P = 80 kip, and bending moment M = 480 kip-in. What maximum compressive stress is P/A + M/S?

A. 8.0 ksi
B. 5.0 ksi
C. 13.0 ksi
D. 3.0 ksi

30. At a point, sigma_x = 22 ksi, sigma_y = -2 ksi, and tau_xy = 8 ksi. Using sigma1 = (sigma_x+sigma_y)/2 + sqrt(((sigma_x-sigma_y)/2)^2 + tau^2), what is the major principal stress?

A. 10.0 ksi
B. 24.4 ksi
C. 14.4 ksi
D. 36.0 ksi

31. A 30-ft steel member is free to expand through a temperature increase of 70 F. Using alpha = 6.5e-6/F, what free elongation occurs?

A. 0.082 in.
B. 1.64 in.
C. 0.0137 in.
D. 0.164 in.

32. A steel member is fully restrained against thermal expansion. Using E = 29,000 ksi, alpha = 6.5e-6/F, and DeltaT = 40 F, what thermal stress magnitude E alpha DeltaT develops?

A. 7.54 ksi
B. 3.77 ksi
C. 15.08 ksi
D. 0.260 ksi

33. A fixed-fixed beam carries a uniform load w = 2.2 kip/ft over an 18-ft span. Using the fixed-end moment magnitude wL^2/12, what end moment results?

A. 89.1 kip-ft
B. 59.4 kip-ft
C. 29.7 kip-ft
D. 712.8 kip-ft

34. A cantilever carries a 4.5-kip point load at its free end. Using theta = PL^2/(2EI), with L = 108 in., E = 29,000 ksi, and I = 600 in4, what end rotation results?

A. 0.00302 rad
B. 0.000754 rad
C. 0.00151 rad
D. 0.0181 rad

35. At an unloaded pin-jointed truss joint, two members are collinear and a third member is non-collinear. No support reaction acts at the joint. Which member is a zero-force member?

A. The non-collinear third member.
B. Both collinear members only.
C. All three members necessarily.
D. No member can be identified.

36. A planar propped cantilever has a fixed support at one end and a vertical roller at the other. Ignoring internal releases, what is its external degree of static indeterminacy?

A. 0
B. 2
C. 3
D. 1

37. For a simply supported 40-ft span, the influence-line ordinate for the right reaction at a load position x from the left support is x/L. What right reaction is caused by a 26-kip moving load at x = 15 ft?

A. 9.75 kip
B. 16.25 kip
C. 26.0 kip
D. 6.50 kip

38. A detail cycles between a maximum normal stress of +24 ksi and a minimum stress of -10 ksi. What is the stress range?

A. 14 ksi
B. 17 ksi
C. 34 ksi
D. 24 ksi

39. A 7/8-in.-diameter bolt bears on a 5/8-in.-thick plate under a 22-kip force. Using fb = P/(td), what average bearing stress is produced?

A. 20.1 ksi
B. 40.2 ksi
C. 25.1 ksi
D. 50.3 ksi

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

A. 6.0 ksi
B. 18.0 ksi
C. 9.0 ksi
D. 12.0 ksi

41. A column has cross-sectional area A = 20 in2, moment of inertia I = 320 in4, effective length KL = 180 in. Using r = sqrt(I/A) and slenderness KL/r, what slenderness ratio results?

A. 45
B. 22.5
C. 90
D. 16

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

A. To permanently replace the building columns after concrete reaches design strength.
B. To increase concrete compressive strength by mechanically squeezing the slab from below.
C. To distribute construction loads through multiple levels while younger slabs continue gaining adequate strength.
D. To eliminate the need to evaluate construction sequencing and temporary load paths.

43. Fresh concrete produces an idealized uniform lateral pressure of 780 psf on an 8-ft-long form panel that is 5 ft high. What total lateral force acts on the panel?

A. 6,240 lb
B. 3,900 lb
C. 780 lb
D. 31,200 lb

44. Before workers and stored materials use a temporary work platform, what engineering action is most appropriate?

A. Assume any erected platform can carry the same loads as the permanent floor system.
B. Verify the platform configuration, support conditions, bracing, and load capacity for the intended workers, tools, materials, and access loads.
C. Load the platform first and evaluate it only if visible deflection or distress develops.
D. Check worker weight only because stored materials and access loads are not structural loads.

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

A. Observe or test specified work and document whether it conforms to the approved construction requirements within the inspector's assigned scope.
B. Replace the contractor's responsibility for construction means, methods, and overall quality control.
C. Approve undocumented design changes whenever a schedule delay makes formal review inconvenient.
D. Guarantee that every completed structural component is completely free of defects for its entire service life.

46. A deep excavation is planned immediately beside an existing shallow foundation. Which action best addresses structural risk before excavation begins?

A. Excavate to final depth first, then decide whether observed settlement is acceptable.

B. Evaluate the excavation influence zone, support or underpinning needs, sequencing, and movement monitoring before removing soil that may support the existing foundation.

C. Assume the neighboring foundation is unaffected because it belongs to a separate property.

D. Reduce documentation so field crews can change excavation support informally as conditions develop.

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

A. As soon as the first two beams are connected because member self-weight stabilizes the frame.

B. Immediately after columns are plumbed, even if diaphragms and permanent bracing are incomplete.

C. Whenever removal speeds erection, because the final design automatically proves every intermediate stage stable.

D. Only after the permanent lateral-force-resisting system is complete, connected, and capable of providing the required stability for the relevant construction stage.

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

A. A fabrication submittal automatically changes the structural design, while an RFI can never affect project decisions.

B. An RFI is the contractor's fabrication drawing, while a fabrication submittal is used only to document payment quantities.

C. A fabrication submittal communicates proposed fabrication or installation details, while an RFI asks for clarification of information needed to proceed with the work.

D. Both documents transfer the engineer's design responsibility to the contractor once they are transmitted.

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. 5,700 ksi

D. 8,062 ksi

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

A. 3.60 in2
B. 4.80 in2
C. 5.60 in2
D. 0.60 in2

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

A. Yield strength is always greater than tensile strength for ordinary ductile structural steel.
B. Tensile strength is another name for elastic modulus and describes only initial stiffness.
C. Yield strength and tensile strength are interchangeable because both are defined as the slope of the elastic stress-strain curve.
D. Yield strength marks the onset of significant permanent deformation, while tensile strength is the maximum engineering stress reached in a tension test before necking dominates.

52. A steel coupon carries an elastic normal stress of 24 ksi. If E = 29,000 ksi, what axial strain epsilon = sigma/E results?

A. 0.000828
B. 0.00828
C. 0.000414
D. 1,208

53. For a wood member, why can moisture-service conditions matter when selecting design properties?

A. Moisture has no meaningful effect on wood behavior once the member is installed in a building.

B. Higher moisture always increases both strength and stiffness because the fibers become more flexible.

C. Higher in-service moisture can alter wood strength and stiffness, so design values may require appropriate service-condition adjustments rather than using dry-condition values without review.

D. Moisture affects only the member's color and surface finish, not dimensional change or structural response.

54. A masonry pier has a gross loaded area of 384 in2 and carries a concentric service load of 180 kip. What average compressive stress P/A results?

A. 4.69 ksi

B. 0.234 ksi

C. 0.469 ksi

D. 1.80 ksi

55. A precast concrete element has volume 18 ft3 and an average unit weight of 135 pcf. What is its weight?

A. 7,290 lb

B. 1,215 lb

C. 135 lb

D. 2,430 lb

56. An isotropic material has Poisson's ratio nu = 0.30 and experiences axial tensile strain of 0.0012. Using lateral strain = -nu times axial strain, what lateral strain results?

A. 0.00036

B. -0.00036

C. -0.0036

D. -0.00012

57. A 25-ft steel member undergoes a temperature increase of 45 F. Using alpha = 6.5e-6/F, what free thermal elongation occurs?

A. 0.0439 in.
B. 0.878 in.
C. 0.00731 in.
D. 0.0878 in.

58. Which material property controls the initial slope of a uniaxial stress-strain curve in the linear elastic range?

A. Ultimate tensile strength.
B. Yield strength.
C. Modulus of elasticity.
D. Coefficient of thermal expansion.

59. A reinforced concrete beam requires a longitudinal steel ratio rho = 0.012 based on b = 12 in. and effective depth d = 20 in. Using As = rho b d, what steel area is required?

A. 2.88 in2
B. 1.44 in2
C. 5.76 in2
D. 0.288 in2

60. Concrete is modeled elastically with Ec = 3,600 ksi and carries a compressive stress magnitude of 2.0 ksi. What strain magnitude epsilon = sigma/Ec results?

A. 0.00556
B. 0.000556
C. 0.00180
D. 1,800

61. What is the primary purpose of a masonry prism compression test used to establish masonry compressive strength?

A. To determine tensile strength of individual masonry units without mortar.
B. To measure reinforcing-bar yield strength inside a completed masonry wall.
C. To measure compressive behavior of an assembled unit-and-mortar masonry specimen.
D. To determine soil bearing capacity beneath the masonry foundation system.

62. A wood specimen has average density 35 pcf. Using water density 62.4 pcf, what specific gravity ratio 35/62.4 results?

A. 0.561
B. 1.783
C. 0.280
D. 2.240

63. For a singly reinforced rectangular concrete beam, use a = As fy/(0.85 f'c b) and Mn = As fy(d - a/2). Let As = 3.0 in2, fy = 60 ksi, f'c = 4 ksi, b = 12 in., and d = 22 in. What nominal moment Mn results?

A. 267.2 kip-ft
B. 296.9 kip-ft
C. 329.9 kip-ft
D. 148.5 kip-ft

64. A flexural member has nominal moment capacity Mn = 325 kip-ft. For this problem, use resistance factor phi = 0.90. What design strength phi Mn results?

A. 361.1 kip-ft
B. 325.0 kip-ft
C. 260.0 kip-ft
D. 292.5 kip-ft

65. For this problem, estimate concrete shear strength from Vc = 2 sqrt(f'c) bwd in pounds. If f'c = 5,000 psi, bw = 14 in., and d = 20 in., what Vc results?

A. 19.8 kip
B. 79.2 kip
C. 7.92 kip
D. 39.6 kip

66. For this problem, use ld = (fy/sqrt(f'c)) db/20, with fy = 60,000 psi, f'c = 4,000 psi, and db = 1.0 in. What development length results?

A. 23.7 in.
B. 94.9 in.
C. 47.4 in.
D. 37.9 in.

67. For a short reinforced concrete column, use Pn = 0.85 f'c(Ag - Ast) + fy Ast. Let f'c = 5 ksi, Ag = 196 in2, Ast = 10 in2, and fy = 60 ksi. What nominal axial strength results?

A. 791 kip
B. 1,390.5 kip
C. 1,433 kip
D. 600 kip

68. A one-way slab strip is idealized as a simply supported beam with uniform factored load w = 0.50 kip/ft over a 14-ft span. What maximum moment wL^2/8 results?

A. 12.25 kip-ft
B. 24.50 kip-ft
C. 6.13 kip-ft
D. 98.0 kip-ft

69. A slab-column connection transfers V = 320 kip through a critical perimeter b0 = 120 in. with effective depth d = 8 in. Using average punching shear stress v = V/(b0 d), what stress results?

A. 0.333 ksi
B. 0.667 ksi
C. 0.167 ksi
D. 3.33 ksi

70. Which slab condition most strongly suggests two-way flexural action?

A. A long narrow slab supported mainly on two opposite sides, with load transferred primarily across the short span.
B. A panel supported along four sides with comparable spans in both principal directions, so bending and load transfer occur materially in both directions.
C. A slab strip analyzed only as a cantilever from one supporting wall with no transverse support.
D. A deck panel whose geometry and supports force essentially all gravity load into one set of parallel beams.

71. A prestressing tendon group has total steel area 2.1 in2 and initial steel stress 180 ksi. Neglect losses. What initial prestressing force P = fA results?

A. 189 kip
B. 360 kip
C. 756 kip
D. 378 kip

72. A concrete bearing surface 18 in. by 24 in. carries a concentric load of 450 kip. What average bearing pressure P/A acts on the surface?

A. 0.52 ksi
B. 2.08 ksi
C. 1.04 ksi

D. 25.0 ksi

73. A steel tension member has gross area Ag = 8.5 in2 and yield strength Fy = 50 ksi. For this problem, use phi = 0.90 for gross-section yielding. What design strength phi Fy Ag results?

A. 425.0 kip
B. 337.5 kip
C. 191.3 kip
D. 382.5 kip

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

A. 302.25 kip
B. 403.0 kip
C. 226.7 kip
D. 151.1 kip

75. A steel compression member has calculated critical stress Fcr = 24 ksi and gross area Ag = 15 in2. What nominal compressive strength Pn = Fcr Ag results?

A. 180 kip
B. 576 kip
C. 360 kip
D. 39 kip

76. A compact steel beam is evaluated with phiMn = phi Fy Zx. Use phi = 0.90, Fy = 50 ksi, and Zx = 110 in3. What design flexural strength results?

A. 458.3 kip-ft
B. 412.5 kip-ft

C. 206.3 kip-ft
D. 495.0 kip-ft

77. Five identical bolts each have an allowable shear resistance of 18 kip for the stated connection model. If load is shared equally, what total shear resistance is available?

A. 72 kip
B. 90 kip
C. 108 kip
D. 18 kip

78. For this problem, nominal weld strength is Rn = 0.707 w L (0.60 Fexx). Use weld size w = 0.25 in., length L = 12 in., and Fexx = 70 ksi. What Rn results?

A. 44.5 kip
B. 126.0 kip
C. 89.1 kip
D. 74.2 kip

79. For a bolt bearing check, use Rn = 1.2 Lc t Fu. If clear distance Lc = 1.5 in., plate thickness t = 0.50 in., and Fu = 58 ksi, what nominal resistance results?

A. 26.1 kip
B. 43.5 kip
C. 104.4 kip
D. 52.2 kip

80. What does a block-shear limit state in a bolted steel connection represent?

A. A combined rupture or yielding path involving shear along connection planes and tension across a transverse plane around a block of material.

B. Pure elastic buckling of the entire connected member without any connection material rupture.
C. Only bearing compression directly beneath one bolt, with no possible shear or tension path.
D. Only weld-metal yielding in a connection that contains no bolts or holes.

81. Why is lateral bracing important for a steel beam with a compression flange?

A. It eliminates all vertical shear so the web no longer carries transverse force.
B. It restrains lateral movement and twist of the compression region, reducing susceptibility to lateral-torsional buckling and helping the beam develop greater flexural resistance.
C. It increases steel yield strength by changing the metallurgy of the compression flange.
D. It guarantees zero deflection regardless of span, loading, and member stiffness.

82. A beam span is 30 ft. If a serviceability criterion limits deflection to L/360, what deflection limit results?

A. 0.50 in.
B. 2.00 in.
C. 1.00 in.
D. 0.083 in.

83. A wood beam carries bending moment M = 36 kip-ft and has section modulus S = 180 in3. What bending stress magnitude fb = M/S results?

A. 0.20 ksi
B. 4.80 ksi
C. 7.20 ksi
D. 2.40 ksi

84. A wood post carries a concentric axial load of 48 kip over a net area of 30 in2. What average compressive stress P/A results?

A. 0.80 ksi
B. 3.20 ksi
C. 1.60 ksi
D. 18.0 ksi

85. Which detailing concern is especially important for dowel-type fasteners placed near the end of a wood member?

A. Adequate end distance and spacing are needed to reduce splitting and localized bearing or tear-out along the grain near the fastener group.
B. Fasteners should be placed as close to the end as possible because end distance has no structural effect.
C. Only steel-yield strength matters; wood geometry around the fasteners does not influence connection behavior.
D. End distance is relevant only for concrete anchors and has no role in wood connection detailing.

86. An 8-in.-thick masonry wall segment 48 in. long carries a concentric axial load of 96 kip. Using gross area, what average compressive stress results?

A. 0.500 ksi
B. 0.250 ksi
C. 0.125 ksi
D. 2.00 ksi

87. A masonry wall has unsupported height 144 in. and thickness 8 in. What geometric slenderness ratio h/t results?

A. 18
B. 9
C. 36
D. 1.8

88. A simply supported masonry lintel idealization carries a uniform line load of 1.2 kip/ft over an 8-ft span. What maximum moment wL^2/8 results?

A. 4.8 kip-ft
B. 19.2 kip-ft
C. 76.8 kip-ft
D. 9.6 kip-ft

89. A footing must support a service column load of 480 kip on soil with allowable bearing pressure 4.0 ksf. Ignoring footing weight, what minimum required footing area P/qallow results?

A. 60 ft2
B. 96 ft2
C. 192 ft2
D. 120 ft2

90. If the 120-ft2 footing area from a preliminary sizing check is provided by a square footing, what side length sqrt(A) results?

A. 7.75 ft
B. 12.00 ft
C. 10.95 ft
D. 14.14 ft

91. A 12-ft-wide footing carries resultant vertical load P = 360 kip/ft with eccentricity e = 0.75 ft. Using qmax = P/B(1 + 6e/B), what maximum base pressure results?

A. 41.25 ksf
B. 30.00 ksf
C. 18.75 ksf
D. 52.50 ksf

92. For this problem, active earth force is Pa = 0.5 Ka gamma H^2. If Ka = 0.33, gamma = 120 pcf, and H = 12 ft, what Pa results per foot of wall?

A. 5.70 kip/ft
B. 2.85 kip/ft
C. 1.43 kip/ft
D. 4.75 kip/ft

93. The triangular earth-pressure resultant in the previous type of model acts H/3 above the base. If Pa = 2.85 kip/ft and H = 12 ft, what overturning moment about the base results?

A. 34.2 kip-ft/ft
B. 17.1 kip-ft/ft
C. 5.70 kip-ft/ft
D. 11.4 kip-ft/ft

94. A rigid pile cap carries a concentric 600-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. 120 kip
B. 300 kip
C. 100 kip
D. 600 kip

95. A drilled shaft has diameter 3.5 ft, embedded length 35 ft, and uniform unit side resistance fs = 0.45 ksf. Using Qs = pi d L fs, what side resistance results?

A. 86.6 kip
B. 173.2 kip
C. 346.4 kip
D. 55.1 kip

96. A drilled shaft has diameter 4 ft and nominal unit end bearing qp = 10 ksf. Using Qp = Ap qp with Ap = pi d^2/4, what end-bearing resistance results?

A. 62.8 kip
B. 251.3 kip
C. 125.7 kip
D. 40.0 kip

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

A. 1.625 ksi
B. 3.25 ksi
C. 0.81 ksi
D. 26.0 ksi

98. A base connection resists a 300 kip-ft moment through a tension-compression couple with 24 in. between resultants. Neglect axial load. What force magnitude is required in the tension side?

A. 12.5 kip
B. 300 kip
C. 150 kip
D. 75 kip

99. Which connection-detailing strategy most directly supports ductile seismic or lateral-system behavior?

A. Make the most brittle component intentionally weaker so it fractures before any yielding can occur.
B. Maximize connection stiffness without considering force redistribution or deformation capacity.
C. Rely on one field attachment alone without verifying how forces enter and leave the connected members.

D. Provide a deliberate yielding mechanism with adequate deformation capacity while proportioning surrounding connection components to avoid premature brittle fracture, pullout, or other nonductile failures.

100. A connection transfers 198 kip of direct shear equally through six identical bolts. Neglect eccentricity and prying. What shear force is assigned to each bolt?

A. 66 kip
B. 33 kip
C. 198 kip
D. 16.5 kip

Practice Exam 23: Answer Key and Explanations

1. D — Multiply pressure by tributary width: 72 psf times 11 ft equals 792 lb/ft. The 72-lb/ft choice omits tributary width, 396 lb/ft uses half the width, and 1,584 lb/ft doubles the result. The conversion changes an area load into the line load carried by the beam. Verify the load path and units before selecting the answer.

2. B — The total load is 2.4 times 26, or 62.4 kip. Symmetry divides this load equally between the two supports, giving 31.2 kip per reaction. The distractors halve twice, assign the full load to one support, or ignore span length. Reaction calculations should satisfy both vertical force equilibrium and symmetry. Verify the load path and units before selecting the answer.

3. A — Convert 7.5 inches to 0.625 ft, then multiply by 145 pcf to obtain about 90.6 psf. Using 145 psf treats the topping as one foot thick, 54.4 psf uses an incorrect thickness conversion, and 1,087.5 psf multiplies by inches without converting. Thickness must be expressed in feet with pcf. Verify the load path and units before selecting the answer.

4. C — Apply the factors separately: 1.2 times 35 is 42 psf and 1.6 times 55 is 88 psf. Their sum is 130 psf. The alternatives reflect using unfactored loads, applying one factor incorrectly, or combining the loads before using an improper multiplier. The stated combination governs this calculation exactly. Verify the load path and units before selecting the answer.

5. A — Substitute each coefficient into the stated equation: 0.7 times 0.95 times 1.05 times 1.0 times 36 equals about 25.1 psf. The other values result from omitting or misapplying a coefficient. Because the formula is provided, the task is careful substitution rather than recalling any external snow-load provision. Verify the load path and units before selecting the answer.

6. B — Using the stated velocity-pressure equation gives 0.00256 times 0.90 times 1.0 times 0.85 times 125 squared, which is about 30.6 psf. The distractors reflect omitted factors or halving. Squaring the wind speed is important because pressure varies with V squared in the supplied relationship, not linearly with speed. Verify the load path and units before selecting the answer.

7. C — Multiply the stated coefficient by the effective seismic weight: 0.092 times 2,750 kip equals 253 kip. The 29.9-kip choice reverses the relationship, 275 kip uses an approximate ten-percent factor, and 2,750 kip simply repeats the weight. Base shear is a force derived from the coefficient-weight product in this problem. Verify the load path and units before selecting the answer.

8. D — The surcharge creates a uniform lateral pressure of 520 times 0.32, or 166.4 psf. Multiplying by the 14-ft wall height gives 2,329.6 lb/ft, approximately 2.33 kip/ft. The distractors omit wall height, omit the coefficient, or halve the resultant. Uniform lateral pressure integrates to pressure times height. Verify the load path and units before selecting the answer.

9. D — Substitution gives one-half times 0.30 times 120 pcf times 15 squared, or 4,050 lb/ft = 4.05 kip/ft. The alternatives omit the one-half factor, double the triangular resultant, or fail to square wall height. Triangular earth pressure grows linearly with depth, so its resultant depends on H squared. Verify the load path and units before selecting the answer.

10. B — The centroid of a triangular pressure diagram lies one-third of the height from the larger-intensity end. For a 16-ft wall, the resultant therefore acts 16/3 = 5.33 ft above the base. Eight feet is the centroid of a rectangle, while 10.67 ft measures from the wrong end of the triangle.

11. A — The tributary area is 24 times 30 = 720 square feet. Multiplying by 95 psf gives 68,400 lb, or 68.4 kip. The distractors halve the area load, repeat the pressure as a force, or shift the decimal. Column gravity load follows from the supported area times the applied pressure. Verify the load path and units before selecting the answer.

12. C — The total rain load is 18 times 24 times 42 = 18,144 lb, or 18.144 kip. Equal support by two girders gives 9.072 kip each, rounded to 9.07 kip. The distractors use the full panel load, divide twice, or confuse pressure with force. Symmetry justifies the equal split. Verify the load path and units before selecting the answer.

13. A — Taking moments or using the simple-span reaction relation gives RA = 32(40 - 14)/40 = 20.8 kip. The 11.2-kip value is the right reaction, 32 kip assigns the entire load to one support, and 18 kip uses an incorrect lever arm. Both reactions should sum to the applied 32 kip.

14. D — A 25% impact increase multiplies the static load by 1.25. Thus 48 kip becomes 60 kip. The 12-kip choice is only the added impact portion, 48 kip ignores impact, and 72 kip applies a fifty-percent increase. When an impact percentage is specified, distinguish the increment from the total amplified load.

15. B — Add the pressures first: 55 + 80 = 135 psf. Multiplying by the 9-ft tributary width gives 1,215 lb/ft. The 735 and 495 choices include only one load component, while 135 lb/ft fails to convert area pressure to a line load. The question asks for unfactored combined service loading. Verify the load path and units before selecting the answer.

16. C — The dead-load contribution is 1.2 times 18 = 21.6 kip, and the live-load contribution is 1.6 times 25 = 40 kip. Their sum is 61.6 kip. The alternatives use unfactored addition or incorrect factors. Apply each factor to its associated load before summing the design effect. Verify the load path and units before selecting the answer.

17. D — A complete gravity-load path carries applied loads through successive structural elements to the ground. Slabs or deck deliver reactions to beams, girders, columns or walls, and foundations before the soil receives them. The distractors break that continuity or assume isolated member design is sufficient. Reactions from one component become loads on the next.

18. B — For a simple span, the left reaction equals P times the distance from the load to the right support divided by span. Thus 24(22)/30 = 17.6 kip. The 6.4-kip choice is the right reaction, 12 kip assumes a centered load, and 24 kip assigns all load left. Verify units and signs before selecting the answer.

19. C — For a simply supported beam with full-span uniform load, Mmax = wL squared/8. Substituting 1.6 kip/ft and 22 ft gives 96.8 kip-ft. The distractors omit the divisor, use total load as moment, or divide by sixteen. The maximum occurs at midspan because loading and support conditions are symmetric. Verify units and signs before selecting the answer.

20. A — The support shear balances all vertical load on the cantilever. The uniform load contributes 0.8 times 12 = 9.6 kip, and the tip load adds 5 kip, giving 14.6 kip. The distractors include only one load or add an extra 5 kip. Vertical equilibrium alone determines the support shear magnitude.

21. A — Using the stated average relation, area is 6 times 10 = 60 square inches. Dividing 54 kip by 60 square inches gives 0.90 ksi. The alternatives shift a decimal, halve the result, or divide by one dimension only. Average shear is not the same as the peak distribution in every cross-section.

22. B — Substitute compatible kip-inch units into delta = PL/(AE): 75 times 168 divided by 4.5 times 29,000 equals about 0.0966 in. The distractors halve or double the deformation or mishandle stiffness. Axial elongation increases with load and length but decreases with area and elastic modulus, consistent with the formula. Verify units and signs before selecting the answer.

23. C — Curvature equals moment divided by flexural rigidity. Substituting 240 kip-in. over 29,000 ksi times 900 in4 gives approximately 9.20e-6 per inch. The alternatives shift a decimal, halve, or double the curvature. The units reduce to inverse length because EI has force-length-squared units while moment has force-length units. Verify units and signs before selecting the answer.

24. D — For a solid circle, substitute d = 10 in. into S = pi d cubed/32. The result is approximately 98.2 in3. The distractors double or halve the result, or use an area-related expression rather than section modulus. Because d is cubed, section modulus is very sensitive to changes in diameter.

25. D — Using the cantilever point-load expression gives 6 times 120 cubed divided by 3 times 29,000 times 850, which is about 0.140 in. The distractors halve, double, or omit a span factor. Cubic dependence on span makes length conversion especially important before evaluating elastic deflection. Verify units and signs before selecting the answer.

26. B — Convert 20 ft to 240 in. and substitute into PL cubed/(48EI). The result is about 0.112 in. The distractors halve or double the response or reflect a length-conversion error. Deflection formulas are highly sensitive to span, so all dimensions must be in one consistent unit system before substitution. Verify units and signs before selecting the answer.

27. A — Euler buckling uses the effective length KL. Here KL = 288 in., so pi squared times 29,000 times 500 divided by 288 squared gives about 1,725 kip. The alternatives ignore K, halve the result, or use only one power of the effective-length change. Buckling capacity varies inversely with effective length squared. Verify units and signs before selecting the answer.

28. C — Substitute the torque and diameter into the stated solid-shaft relation: 16 times 90 divided by pi times 5 cubed gives about 3.67 ksi. The alternatives double, halve, or use a different diameter power. Torsional shear in a solid circular shaft reaches its maximum at the outside surface. Verify units and signs before selecting the answer.

29. C — The axial stress is 80/16 = 5 ksi and the bending stress is 480/60 = 8 ksi. At the extreme fiber where both are compressive, they add to 13 ksi. The other choices report only one component or subtract them. Combined stress requires algebraic superposition at the specific fiber being checked.

30. B — The average normal stress is 10 ksi. Half the normal-stress difference is 12 ksi, so the Mohr-circle radius is sqrt(12 squared + 8 squared) = 14.4 ksi. Adding the radius gives a major principal stress of about 24.4 ksi. The distractors use only the average, radius, or an incorrect direct sum.

31. D — Free thermal elongation is alpha DeltaT L. Converting 30 ft to 360 in. and multiplying by 6.5e-6 per F and 70 F gives approximately 0.164 in. The alternatives halve the result, shift a decimal, or leave length in feet. Free expansion creates deformation without stress when no restraint is present.

32. A — Full restraint converts the free thermal strain alpha DeltaT into stress E alpha DeltaT. Substitution gives 29,000 times 6.5e-6 times 40 = 7.54 ksi. The distractors halve or double the result or omit the elastic modulus. The stress sign depends on heating versus cooling and the direction of restraint. Verify units and signs before selecting the answer.

33. B — Using the stated fixed-end relation, 2.2 times 18 squared divided by 12 equals 59.4 kip-ft. The alternatives use a different denominator, halve the correct result, or omit division by 12. Fixed-end moments arise because rotational restraint develops end couples that alter the moment diagram relative to a simple span. Verify units and signs before selecting the answer.

34. C — Substituting into theta = PL squared/(2EI) gives approximately 0.00151 rad. The distractors double or halve the rotation or omit part of the stiffness denominator. Rotation is dimensionless in radians, although the calculation still requires consistent force and length units. The squared span makes the response sensitive to length. Verify units and signs before selecting the answer.

35. A — Joint equilibrium provides the zero-force rule. With no external load or support reaction, the two collinear members can balance one another along their common line, so the non-collinear member must carry zero force to satisfy equilibrium in the transverse direction. The rule applies to ideal pin-jointed trusses under the stated joint conditions.

36. D — The fixed support supplies three planar reaction components and the roller supplies one, for four unknown external reactions. Planar equilibrium provides three independent equations, leaving one redundant reaction. Therefore the external degree of static indeterminacy is 4 - 3 = 1. Compatibility and deformation relations are needed in addition to equilibrium to solve it.

37. A — The right-reaction influence ordinate is x/L = 15/40 = 0.375. Multiplying by the 26-kip moving load gives 9.75 kip. The 16.25-kip value is the left reaction, 26 kip uses an ordinate of one, and 6.50 kip uses an incorrect quarter-span factor. The two reactions sum to 26 kip. Verify units and signs before selecting the answer.

38. C — Stress range is maximum stress minus minimum stress. Because the minimum is -10 ksi, the range is 24 - (-10) = 34 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 a single extreme stress value.

39. B — Average bearing stress is force divided by projected bearing area td. Using 22 kip, t = 5/8 in., and d = 7/8 in. gives about 40.2 ksi. The distractors halve the force effect or use incorrect projected areas. Bearing checks use the contact projection, not the full plate gross area.

40. D — The concentric stress is 144/24 = 6 ksi. The eccentric moment is Pe = 720 kip-in., giving bending stress 720/120 = 6 ksi. At the more compressed edge the stresses add to 12 ksi. The distractors report one component, over-add, or use an incorrect bending contribution. Eccentricity creates combined axial and flexural stress.

41. A — The radius of gyration is sqrt(320/20) = 4 in. Dividing the effective length 180 in. by 4 in. gives a slenderness ratio of 45. The distractors halve or double this result or report the radius-related value incorrectly. Slenderness is dimensionless and links effective length to cross-sectional stiffness distribution. Verify units and signs before selecting the answer.

42. C — Reshoring helps transfer construction loads through several floors while recently cast slabs are still developing strength and stiffness. It is part of a planned temporary load path, not a permanent substitute for columns. Reshores do not mechanically increase concrete strength, and their use does not eliminate the need to evaluate sequencing, loads, or slab capacity.

43. D — The form area is 8 times 5 = 40 square feet. Multiplying by the uniform 780-psf pressure gives 31,200 lb of total lateral force. The alternatives multiply by only one panel dimension or repeat pressure as force. A uniform pressure resultant equals pressure times loaded area and acts through the area centroid.

44. B — Temporary work platforms must be checked for the actual configuration and intended loading, including workers, tools, stored materials, support conditions, and bracing. Assuming equivalence to a permanent floor or waiting for visible distress is unsafe. All significant loads contribute to demand, and the erected system must have a complete stable load path before use.

45. A — Special inspection provides specified observation or testing and documentation of conformance within the assigned scope. It does not transfer the contractor's means-and-methods responsibility, authorize informal design changes, or guarantee a defect-free structure. The inspection program is one quality-assurance layer that supports, rather than replaces, the responsibilities of designers, contractors, and other project participants.

46. B — Excavation can remove lateral or vertical soil support relied upon by an adjacent foundation. The risk should be evaluated in advance, including underpinning or support systems, excavation sequence, and monitoring. Waiting for movement or assuming property boundaries eliminate soil interaction is inappropriate. Planned support and observation reduce the chance of damaging the existing structure.

47. D — Partially completed frames can have very different stability and load paths from the finished building. Temporary bracing should remain until the permanent lateral system is complete and effective for the construction stage. Self-weight, partial beam connections, or final-design adequacy alone do not prove erection stability. Sequencing must preserve a reliable lateral resistance system throughout construction.

48. C — A fabrication or shop-drawing submittal presents how the contractor or fabricator proposes to fabricate or install work. An RFI seeks clarification of contract information needed to proceed. Neither document automatically transfers design responsibility, and neither should be treated as an informal mechanism for undocumented design changes. Their purposes and review paths are distinct.

49. A — Substituting f'c = 5,000 psi gives Ec = 57,000 sqrt(5,000) = about 4,030,509 psi, or 4,031 ksi. The distractors use incorrect square-root handling or simple multiples. Elastic modulus represents stiffness, not compressive strength itself, so the result is several thousand ksi rather than approximately 5 ksi. Match the property definition to the requested response.

50. B — Total reinforcing area is the number of identical bars times the area of one bar. Eight times 0.60 in2 equals 4.80 in2. The distractors use six bars, confuse bar designation with area, or report one bar only. Reinforcement calculations should sum the actual cross-sectional areas of all participating bars. Match the property definition to the requested response.

51. D — Yield strength identifies the stress level associated with the onset of substantial permanent deformation, while tensile strength is the maximum engineering stress reached during a tension test. Elastic modulus is instead the initial stress-strain slope. For ordinary ductile structural steel, tensile strength exceeds yield strength, so the terms are not interchangeable measures of stiffness or strength.

52. A — Elastic strain is stress divided by elastic modulus. Dividing 24 ksi by 29,000 ksi gives 0.0008276, rounded to 0.000828. The distractors shift a decimal, halve the strain, or invert the ratio. Strain is dimensionless because the stress units cancel, and the result should be small within the elastic range. Match the property definition to the requested response.

53. C — Wood is hygroscopic, so moisture changes can affect dimensions, stiffness, strength, and connection behavior. Design values therefore need to reflect the expected service condition rather than assuming dry behavior in every environment. The distractors ignore material response or reverse its typical trend. Moisture effects are especially relevant where members experience sustained humid or wet conditions.

54. C — Average compressive stress is load divided by gross loaded area. Dividing 180 kip by 384 in2 gives 0.46875 ksi, rounded to 0.469 ksi. The distractors shift the decimal, halve the stress, or use an unrelated divisor. This average value does not by itself account for eccentricity, slenderness, or local bearing effects.

55. D — Weight equals unit weight times volume. Multiplying 135 lb/ft3 by 18 ft3 gives 2,430 lb. The distractors triple the result, halve it, or simply repeat unit weight as total weight. Volume units cancel cubic feet in the unit-weight term, leaving pounds, which provides a straightforward dimensional check on the calculation.

56. B — Poisson's ratio relates lateral strain to axial strain with the opposite sign for ordinary tensile loading. Thus -0.30 times 0.0012 equals -0.00036. The positive distractor misses contraction, -0.0036 shifts a decimal, and -0.00012 uses the wrong multiplier. The negative sign indicates lateral contraction while the specimen elongates axially. Match the property definition to the requested response.

57. D — Convert 25 ft to 300 in. and apply delta = alpha DeltaT L. Multiplying 6.5e-6 by 45 and 300 gives 0.08775 in., rounded to 0.0878 in. The distractors halve the response, shift a decimal, or leave length in feet. Thermal movement depends directly on coefficient, temperature change, and length. Match the property definition to the requested response.

58. C — The modulus of elasticity is the ratio of stress to strain in the linear elastic range and therefore defines the initial stress-strain slope. Yield and tensile strengths identify strength levels rather than elastic stiffness. The thermal expansion coefficient relates temperature change to free thermal strain, so it does not define the mechanical stress-strain slope under ordinary loading.

59. A — Using the stated reinforcement ratio relation gives As = 0.012 times 12 times 20 = 2.88 in2. The distractors halve, double, or shift the decimal. Because rho is dimensionless, multiplying by width and effective depth produces square inches of steel area. The calculation is purely geometric once the required ratio is given.

60. B — Elastic strain magnitude is stress divided by modulus. Dividing 2.0 ksi by 3,600 ksi gives 0.0005556, rounded to 0.000556. The distractors shift the decimal, use an incorrect ratio, or invert the expression. Stress and modulus share the same units, so strain is dimensionless and should be much less than one.

61. C — A masonry prism includes units and mortar assembled in a representative configuration, so its compression test reflects composite masonry behavior rather than the strength of a single unit alone. It does not measure reinforcing-steel yield strength or soil bearing capacity, and it is not primarily a tensile test. The specimen helps characterize compressive performance of the masonry assemblage.

62. A — Specific gravity is a dimensionless density ratio. Dividing the wood density 35 pcf by water density 62.4 pcf gives approximately 0.561. The distractors invert the ratio, halve the correct value, or use an unrelated multiplier. A value below one is physically reasonable for ordinary wood because its average density is less than water's.

63. B — First compute a = 180/(0.85 times 4 times 12) = about 4.41 in. Then Mn = 180(22 - 4.41/2) = about 3,563 kip-in., or 296.9 kip-ft. The distractors reflect omitted compression-block effects or incorrect conversion. The stated simplified flexural model requires consistent ksi-inch units throughout. Verify the governing limit state and force path.

64. D — Design strength equals the stated resistance factor times nominal strength. Multiplying 0.90 by 325 kip-ft gives 292.5 kip-ft. The distractors divide by phi, omit phi, or apply an excessive reduction. Demand should be compared with the factored design resistance when the problem explicitly asks for phi Mn rather than nominal capacity alone.

65. D — The square root of 5,000 is about 70.71. Multiplying by 2, 14 in., and 20 in. gives about 39,598 lb, or 39.6 kip. The distractors halve, double, or shift the decimal. Because the formula is given in pounds, convert the final force to kips only after completing the multiplication. Verify the governing limit state and force path.

66. C — Substitute directly into the provided relation. The ratio 60,000/sqrt(4,000) is about 948.7; multiplying by 1.0 and dividing by 20 gives about 47.4 in. The alternatives halve, double, or use another denominator. Development length is a detailing requirement tied to transferring bar force into the surrounding concrete. Verify the governing limit state and force path.

67. B — Concrete area excluding steel is 196 - 10 = 186 in2. Its contribution is 0.85 times 5 times 186 = 790.5 kip, while steel contributes 600 kip. Summing gives 1,390.5 kip. The distractors omit one contribution or incorrectly include gross concrete area without subtracting steel. Verify the governing limit state and force path.

68. A — For the stated simple-span idealization, maximum moment is wL squared/8. Substituting 0.50 kip/ft and 14 ft gives 12.25 kip-ft per strip. The distractors double or halve the result or omit the division by eight. The model assumes one-way action and the specified support condition, so use that idealization consistently. Verify the governing limit state and force path.

69. A — The critical shear area is b0 d = 120 times 8 = 960 in2. Dividing 320 kip by 960 in2 gives 0.333 ksi. The distractors double, halve, or shift the decimal. Punching shear checks use a perimeter-based shear area, so neither column area nor slab plan area is the appropriate denominator here.

70. B — Two-way action occurs when a plate or slab transfers load by bending in both principal directions. Support on four sides and comparable spans makes that behavior likely. Long narrow panels or systems supported mainly on two opposite sides behave predominantly one-way. The support arrangement and aspect ratio determine the practical load-transfer idealization used for analysis and design.

71. D — Initial prestressing force equals steel stress times tendon area. Multiplying 180 ksi by 2.1 in2 gives 378 kip because ksi times square inches yields kips. The distractors halve the result, use an approximate area, or double it. Prestress-loss effects are excluded explicitly, so no reduction should be applied in this calculation.

72. C — The bearing area is 18 times 24 = 432 in2. Dividing 450 kip by 432 in2 gives 1.0417 ksi, rounded to 1.04 ksi. The distractors halve or double the result or divide by one dimension. Average bearing pressure is a contact stress and should be distinguished from total force and local peak stress.

73. D — Gross-section yielding design strength is the stated phi times Fy times Ag. Multiplying 0.90 by 50 ksi by 8.5 in2 gives 382.5 kip. The alternatives omit phi, apply a larger reduction, or halve the result. This check concerns gross yielding only; other tension-member limit states require their own effective areas and factors.

74. A — Using the provided rupture expression, 0.75 times 65 ksi times 6.2 in2 equals 302.25 kip. The distractors omit phi, apply an excessive reduction, or halve the correct resistance. Net-section rupture must be checked separately from gross yielding because the controlling area and strength parameter differ. Verify the governing limit state and force path.

75. C — Nominal compressive strength is critical stress times gross area. Multiplying 24 ksi by 15 in2 gives 360 kip. The distractors halve the result, multiply by an unrelated factor, or add quantities instead of multiplying. The critical stress already represents the stability effect assumed by the problem, so it should not be recomputed from another buckling equation.

76. B — Multiplying phi Fy Zx gives 0.90 times 50 times 110 = 4,950 kip-in. Dividing by 12 converts to 412.5 kip-ft. The distractors omit phi, halve the result, or keep an incorrect conversion. This simplified check assumes the stated compact-section model and does not introduce additional lateral-torsional-buckling reductions. Verify the governing limit state and force path.

77. B — With equal load sharing, total resistance is the number of bolts times resistance per bolt: 5 times 18 = 90 kip. The distractors use four or six bolts or report one bolt only. This arithmetic combination is valid only under the problem's stated equal-sharing idealization; connection geometry can produce nonuniform forces in other cases.

78. C — The effective throat is 0.707 times 0.25 in. Multiplying that by 12 in. of weld length and 0.60 times 70 ksi gives about 89.1 kip. The distractors halve the result, omit the throat factor, or use an incorrect electrode-strength factor. The supplied relation already defines the intended nominal weld model.

79. D — Substitution gives 1.2 times 1.5 in. times 0.50 in. times 58 ksi = 52.2 kip. The distractors halve, omit the 1.2 factor, or double the resistance. The equation is based on the stated clear distance, thickness, and material strength; changing any of those quantities changes the bearing limit. Verify the governing limit state and force path.

80. A — Block shear describes a potential failure path that tears out a block of connected material through combined shear planes and a transverse tension plane. It is distinct from whole-member buckling, local bolt bearing alone, or weld-only behavior. Connection design checks several limit states because yielding, rupture, bearing, bolt failure, and block mechanisms can control differently.

81. B — Lateral bracing restrains sideways movement and twist associated with lateral-torsional buckling of a beam's compression region. Effective bracing can therefore increase usable flexural resistance. It does not eliminate web shear, alter steel material yield strength, or make deflection vanish. Bracing must have adequate stiffness, strength, and connection to provide the intended restraint.

82. C — Convert 30 ft to 360 in. and divide by 360, giving a 1.00-in. deflection limit. The distractors halve or double the limit or fail to convert feet to inches correctly. A limit such as L/360 is a serviceability criterion; actual calculated deflection must be compared with that allowable deformation. Verify the governing limit state and force path.

83. D — Convert 36 kip-ft to 432 kip-in., then divide by 180 in3. The bending stress is 2.40 ksi. The 0.20-ksi choice omits the foot-to-inch conversion, while the larger options double or triple the correct stress. Flexural stress uses moment and section modulus expressed in compatible length units. Verify the governing limit state and force path.

84. C — Average axial compression is load divided by area. Dividing 48 kip by 30 in2 gives 1.60 ksi. The distractors halve or double the stress or use an unrelated area conversion. Actual wood-column design may require stability and adjustment factors, but the question asks only for the average stress under the stated concentric load.

85. A — Wood can split or tear out along the grain when fasteners are too close to member ends or to one another. Adequate end distance, edge distance, and spacing help develop connection capacity and limit localized damage. Connection behavior depends on both the fastener and surrounding wood, so steel strength alone does not define the limit state.

86. B — The gross area is 8 times 48 = 384 in2. Dividing 96 kip by 384 in2 gives 0.250 ksi. The distractors double or halve the result or divide by only one dimension. This is an average gross-section stress; a complete wall design may also require eccentricity, slenderness, reinforcement, and strength checks.

87. A — The geometric ratio is unsupported height divided by thickness: 144/8 = 18. The distractors halve or double the ratio or shift the decimal. Slenderness is dimensionless and provides a simple measure of wall proportions; more complete design procedures may use additional effective-height, support, and load eccentricity considerations. Verify the governing limit state and force path.

88. D — Using the simple-span uniform-load expression gives 1.2 times 8 squared divided by 8 = 9.6 kip-ft. The distractors halve or double the result or omit the divisor. This moment is the analysis demand for the stated idealization; reinforcement, masonry strength, bearing, and detailing must then be checked separately. Verify the governing limit state and force path.

89. D — Required area is service load divided by allowable bearing pressure. Dividing 480 kip by 4.0 ksf gives 120 square feet. The distractors halve the area, use an incorrect pressure, or overestimate the requirement. This sizing check addresses average soil pressure only; footing thickness and structural reinforcement require separate design checks.

90. C — A square footing with area 120 ft2 has side length equal to sqrt(120), which is approximately 10.95 ft. The alternatives correspond to substantially smaller or larger areas or a common square-root error. After selecting a practical footing dimension, bearing pressure should be recalculated using the actual provided plan area. Verify the governing limit state and force path.

91. A — Average pressure is P/B = 360/12 = 30 ksf. The eccentricity multiplier is 1 + 6(0.75)/12 = 1.375. Multiplying gives qmax = 41.25 ksf. The distractors ignore eccentricity, use the opposite-edge pressure, or apply an excessive multiplier. Eccentric loading produces a linear pressure variation in this model. Verify the governing limit state and force path.

92. B — Substitution gives one-half times 0.33 times 120 times 12 squared = 2,851.2 lb/ft, or 2.85 kip/ft. The distractors double or halve the resultant or use an incorrect coefficient treatment. The force corresponds to the area of the triangular lateral-pressure diagram defined by the stated model. Verify the governing limit state and force path.

93. D — For a triangular pressure diagram, the resultant acts H/3 above the base. With H = 12 ft, the lever arm is 4 ft. Multiplying 2.85 kip/ft by 4 ft gives 11.4 kip-ft per foot of wall. The distractors use the full height, midheight, or half the correct moment. Verify the governing limit state and force path.

94. A — With a concentric load and five identical equally stiff piles, symmetry gives equal load sharing. Dividing 600 kip by five produces 120 kip per pile. The distractors divide by two or six or assign the entire group load to one pile. Eccentricity or unequal stiffness would require a different distribution model.

95. B — Shaft perimeter is pi times 3.5 ft. Multiplying perimeter by 35 ft of embedded length gives side area, and multiplying by 0.45 ksf gives approximately 173.2 kip. The distractors halve or double the result or omit pi. Side resistance depends on shaft circumference, not cross-sectional end area. Verify the governing limit state and force path.

96. C — The shaft base area is pi times 4 squared divided by 4 = 12.566 ft2. Multiplying by 10 ksf gives 125.7 kip. The distractors halve or double the result or multiply unit bearing by diameter only. End bearing uses plan area at the shaft tip, unlike side resistance which uses perimeter times length.

97. A — The base-plate area is 16 times 20 = 320 in2. Dividing 520 kip by 320 in2 gives 1.625 ksi. The distractors double or halve the pressure or divide by one plate dimension. This is average pressure for concentric loading; moment can create a nonuniform bearing distribution. Verify the governing limit state and force path.

98. C — Convert 300 kip-ft to 3,600 kip-in. and divide by the 24-in. couple arm, giving 150 kip in the tension side with an equal opposite compression resultant. The 12.5-kip answer omits the foot-to-inch conversion, 300 repeats the moment magnitude, and 75 kip uses twice the stated lever arm. Verify the governing limit state and force path.

99. D — Ductile detailing aims to concentrate inelastic deformation in intended yielding regions while protecting brittle failure modes. That requires a clear load path, adequate deformation capacity, and a capacity hierarchy for surrounding components. Intentionally weakening a brittle element, maximizing stiffness without regard to behavior, or ignoring force transfer undermines reliable energy dissipation and predictable performance.

100. B — Under the stated equal-sharing assumption, divide the total direct shear by six bolts: 198/6 = 33 kip per bolt. The distractors divide by three, assign the entire load to one bolt, or divide by twelve. Equal distribution is an idealization appropriate only when the connection geometry and stiffness assumptions support it and eccentric effects are excluded.