PRACTICE EXAM 31: 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. For a peer review on a different project, an archive-room floor beam has a tributary width of 13 ft and supports a uniform floor pressure of 80 psf. What uniform line load must the beam carry?

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

2. During a design-office check, a 27-ft simply supported podium girder carries a uniform service load of 1.9 kip/ft over its full span. What reaction develops at each support?

A. 1.8 kip
B. 25.6 kip
C. 51.3 kip
D. 12.83 kip

3. For a separate structural calculation, a normal-weight concrete corridor slab is 6.50 in. thick and has a unit weight of 145 pcf. What uniform pressure represents the slab self-weight?

A. 58.90 psf
B. 942.4 psf
C. 78.54 psf
D. 117.8 psf

4. For this practice check, use U = 1.2D + 1.6L. If D = 38 psf and L = 78 psf, what factored pressure U results?

A. 117.6 psf
B. 141.1 psf
C. 189.1 psf
D. 170.4 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 = 51 psf. What is p?

A. 33.7 psf
B. 32.2 psf
C. 35.6 psf
D. 48.1 psf

6. Use q = 0.00256 Kz Kzt Kd V^2 I. For Kz = 0.92, Kzt = 1.0, Kd = 0.85, V = 153 mph, and I = 1.0, what velocity pressure q results?

A. 39.8 psf
B. 46.9 psf
C. 69.0 psf
D. 55.2 psf

7. For a separate structural calculation, a seismic base shear is defined for this problem as V = CsW. If Cs = 0.074 and the effective seismic weight W = 3,300 kip, what base shear results?

A. 44.6 kip
B. 330 kip
C. 24.42 kip
D. 244.2 kip

8. As part of an independent QA review, a uniform surface surcharge of 495 psf acts behind a 15-ft site retaining wall. If the lateral pressure coefficient is Ka = 0.31, what lateral force per foot of wall results from the surcharge alone?

A. 1,151.0 lb/ft
B. 153.4 lb/ft
C. 2,301.75 lb/ft
D. 7,425 lb/ft

9. Soil behind a site retaining wall has unit weight 99 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. 373.4 lb/ft
B. 1,213.0 lb/ft
C. 4,851.1 lb/ft
D. 2,426 lb/ft

10. During a design-office check, a 36-kip maintenance-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. 23.14 kip
C. 36.00 kip
D. 18.01 kip

11. For a separate structural calculation, a girder supports secondary floor beams spaced at 16 ft. Each secondary beam delivers a 47-kip end reaction to the girder. If those reactions are idealized as an equivalent uniform line load, what line load represents them?

A. 5.88 kip/ft
B. 47 kip/ft
C. 2.938 kip/ft
D. 1.46 kip/ft

12. As part of an independent QA review, a steel floor deck weighs 2.5 psf and supports 4.25 in. of normal-weight concrete weighing 150 pcf. What combined dead-load pressure is carried before other permanent loads are added?

A. 55.62 psf
B. 59.17 psf
C. 639.0 psf
D. 53.25 psf

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

A. 25.00 psf
B. 68.61 psf
C. 18.61 psf
D. 43.61 psf

14. A roof contains 5.5 in. of ponded rainwater. Using a water unit weight of 62.4 pcf, what uniform roof pressure does the water create?

A. 28.6 psf
B. 343.2 psf
C. 57.2 psf
D. 14.3 psf

15. For a separate structural calculation, a bridge-crane wheel load of 57 kip is increased by a stated impact factor of 20%. What design wheel load results for this problem?

A. 11.4 kip
B. 68.4 kip
C. 79.8 kip
D. 57.0 kip

16. As part of an independent QA review, two identical parallel roof girders share a total distributed gravity load of 251 kip equally. One girder also receives a 28-kip equipment load that is not shared. What total gravity load acts on that girder?

A. 125.1 kip
B. 278.6 kip
C. 153.5 kip
D. 139.1 kip

17. For a peer review on a different project, 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 = 57 kip, and W = 45 kip, what is the largest factored load?

A. 135.6 kip
B. 50.1 kip
C. 127.0 kip
D. 142.8 kip

18. During a design-office check, a simply supported 21-ft beam carries a 16-kip point load at midspan. What maximum bending moment results?

A. 42.0 kip-ft
B. 84 kip-ft
C. 18.7 kip-ft
D. 168 kip-ft

19. For a separate structural calculation, a simply supported 18-ft beam carries 1.8 kip/ft uniformly over the full span. What maximum bending moment results?

A. 36.45 kip-ft
B. 145.8 kip-ft
C. 72.9 kip-ft
D. 26.5 kip-ft

20. As part of an independent QA review, a 27-ft simply supported beam carries a 2.6 kip/ft uniform load over the full span. What is the magnitude of either support reaction?

A. 35.1 kip
B. 3.4 kip
C. 70.2 kip
D. 17.5 kip

21. For a peer review on a different project, a tension brace carries 125 kip through a gross area of 7.5 in2. What average axial stress results?

A. 16.67 ksi
B. 0.04 ksi
C. 62.5 ksi
D. 937.9 ksi

22. During a design-office check, a 15-ft steel hanger rod carries 84 kip in tension. Use A = 3.5 in2 and E = 29,000 ksi. Determine the elongation from delta = PL/(AE).

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

23. For a separate structural calculation, a rectangular beam section has b = 12 in. and h = 17 in. What is its elastic section modulus S = bh^2/6 about the strong axis?

A. 5,780 in3
B. 578 in3
C. 289 in3
D. 1,156 in3

24. As part of an independent QA review, a beam has maximum moment M = 132 kip-ft and section modulus S = 735 in3. What maximum bending stress results?

A. 21.6 ksi

B. 0.216 ksi

C. 0.179 ksi

D. 2.16 ksi

25. For a peer review on a different project, a simply supported beam with a centered point load has P = 14 kip, L = 18 ft, E = 29,000 ksi, and I = 2,200 in4. Using delta = PL^3/(48EI), determine the midspan deflection.

A. 0.022 in.

B. 0.091 in.

C. 0.046 in.

D. 0.004 in.

26. During a design-office check, a simply supported beam carries w = 0.16 kip/in. over a 108-in. span. If E = 29,000 ksi and I = 1,100 in4, use delta = 5wL^4/(384EI). What maximum deflection results?

A. 0.0890 in.

B. 0.0044 in.

C. 0.0178 in.

D. 0.0089 in.

27. For a separate structural calculation, a pin-ended column has E = 29,000 ksi, I = 865 in4, and length L = 16 ft. Using Pcr = pi^2EI/L^2, determine the Euler critical load.

A. 13,432 kip

B. 6,716 kip

C. 559.7 kip

D. 3,358.0 kip

28. As part of an independent QA review, a solid circular shaft has torque T = 165 kip-in., outer radius c = 2.25 in., and polar moment J = 32.2 in4. Using tau = Tc/J, determine the maximum torsional shear stress.

A. 11.53 ksi

B. 5.77 ksi

C. 23.06 ksi

D. 74.2 ksi

29. For a peer review on a different project, a column section has axial compressive stress P/A = 5.5 ksi and bending stress magnitude Mc/I = 8.75 ksi at an extreme fiber. What is the maximum compressive stress when the effects add?

A. 59.73 ksi

B. 1.8 ksi

C. 14.25 ksi

D. 8.1 ksi

30. At a point in plane stress, sigma_x = 21 ksi, sigma_y = 8 ksi, and tau_xy = 6 ksi. Using sigma_1 = (sx+sy)/2 + sqrt(((sx-sy)/2)^2 + tau^2), determine the major principal stress.

A. 19.73 ksi

B. 29.07 ksi

C. 14.53 ksi

D. 23.35 ksi

31. For a separate structural calculation, a 28-ft steel framing member experiences a uniform temperature increase of 71 F. Using alpha = 6.5e-6/F, what free thermal elongation occurs?

A. 0.155 in.

B. 0.077 in.

C. 1.548 in.

D. 0.016 in.

32. As part of an independent QA review, a fully restrained steel hanger rod experiences a 58 F temperature increase. Use E = 29,000 ksi and alpha = 6.5e-6/F. Determine the thermal stress magnitude from sigma = E alpha DeltaT.

A. 0.37 ksi

B. 10.93 ksi

C. 21.87 ksi

D. 5.45 ksi

33. For a peer review on a different project, a cantilever beam carries an end load P = 9 kip over a length L = 7 ft. What fixed-end moment magnitude results?

A. 63 kip-ft

B. 31.5 kip-ft

C. 126 kip-ft

D. 9 kip-ft

34. During a design-office check, a cantilever has w = 0.10 kip/in., L = 84 in., E = 29,000 ksi, and I = 890 in4. Using delta = wL^4/(8EI), determine the free-end deflection.

A. 0.0120 in.

B. 0.0482 in.

C. 0.0241 in.

D. 0.0025 in.

35. At an unloaded pin joint in an ideal truss, three members meet; two members are collinear and the third is not. No support reaction acts at the joint. What can be concluded about the noncollinear member?

A. It must be in compression whenever the collinear members are in tension.

B. Its force cannot be assessed without knowing member elastic moduli.

C. It must carry the sum of the two collinear member forces.

D. It is a zero-force member under the stated loading condition.

36. A planar beam is fixed at its left end and rests on a roller at its right end. How should the external static determinacy of this support arrangement be classified?

A. Externally indeterminate to the second degree.

B. Externally indeterminate to the first degree.

C. Externally determinate because three equilibrium equations are available.

D. Unstable because the roller cannot resist horizontal force.

37. A 40-ft simply supported beam is crossed by a 30-kip point load located 12 ft from the left support. Using the left-reaction influence-line ordinate (L-x)/L, what left-support reaction results?

A. 10.5 kip

B. 31.5 kip

C. 15.8 kip

D. 21.00 kip

38. During a design-office check, a structural detail experiences repeated stress cycling between 25 ksi and -7 ksi. What stress range results?

A. 32 ksi

B. 25.6 ksi

C. 19.2 ksi

D. 16.0 ksi

39. For a separate structural calculation, a 7/8-in.-diameter bolt bears on a 5/8-in.-thick plate under a 15-kip force. Using average bearing stress fb = P/(td), determine the resulting stress.

A. 54.85 ksi

B. 27.43 ksi

C. 17.14 ksi

D. 13.71 ksi

40. As part of an independent QA review, a rectangular column has area A = 24 in2, section modulus S = 120 in3, axial load P = 155 kip, and eccentricity e = 5 in. Determine the maximum compressive stress from P/A + Pe/S.

A. 6.47 ksi

B. 19.37 ksi

C. 12.92 ksi

D. 32.31 ksi

41. For a peer review on a different project, a rectangular beam has b = 10 in. and h = 35 in. What is its centroidal moment of inertia I = bh^3/12 about the strong axis?

A. 3,572.4 in4

B. 35,729 in4

C. 17,865.5 in4

D. 71,460.0 in4

42. A concrete contractor removes shores from an upper floor but leaves reshores below while new slabs above continue to be placed. What is the primary structural purpose of the reshores?

A. Make construction-sequence analysis unnecessary.
B. Increase the specified compressive strength of concrete by confinement.
C. Share construction loads among multiple floors while younger slabs continue gaining capacity.
D. Replace permanent columns after the building opens.

43. Fresh concrete exerts an idealized uniform lateral pressure of 805 psf on a concrete wall form 9 ft long and 5 ft high. What total lateral force acts on the form?

A. 36,225 lb
B. 7,245 lb
C. 4,025 lb
D. 805 lb

44. A suspended work platform will carry workers, power tools, and staged facade materials. Before use, what loading check is most appropriate?

A. Use the capacity of the nearest permanent floor as the platform capacity.
B. Load the platform to service level first and investigate only if distress appears.
C. Assume worker weight controls and ignore stored materials.
D. Verify the actual erected platform, supports, bracing, connections, and all intended loads before occupancy.

45. During concrete placement, a special inspector observes reinforcing placement and specified construction operations. Which statement best describes that role?

A. Guarantee that the completed structure will remain free of defects.

B. Direct the contractor’s means and methods for all construction activities.

C. Observe or test designated work and document whether it conforms to approved requirements.

D. Approve undocumented structural design changes in the field.

46. A new excavation will extend below the footing elevation of an adjacent occupied building. Which action most directly addresses the structural risk before excavation begins?

A. Treat the property line as a boundary that prevents soil movement from affecting the neighbor.

B. Excavate first, then design support only if visible settlement develops.

C. Rely on the adjacent building’s original design drawings without reviewing existing conditions.

D. Evaluate the excavation influence zone and plan support, underpinning, sequencing, and movement monitoring as needed.

47. During steel erection, several bays lack their permanent diaphragm and braced-frame connections. What is the most appropriate stability measure for this incomplete condition?

A. Remove temporary bracing as soon as gravity connections are snug-tight.

B. Provide temporary bracing and maintain it until the permanent lateral system is complete and effective.

C. Rely on member self-weight to stabilize the unfinished frame against lateral loading.

D. Assume the completed-building analysis proves every erection stage stable.

48. A steel fabricator submits connection details for review, while the contractor sends a separate request asking how to interpret a conflicting drawing note. How are these documents best distinguished?

A. The shop drawing presents proposed fabrication or installation details; the RFI requests clarification of contract information.

B. Both documents transfer the engineer of record’s design responsibility to the contractor.

C. The RFI automatically revises the structural design, while the shop drawing cannot affect construction.

D. The shop drawing is only a payment document, while the RFI is the fabrication drawing.

49. For normal-weight concrete, use Ec = 57,000 sqrt(f'c) psi. If f'c = 6,000 psi, what modulus Ec results?

A. 4,415 ksi

B. 2,208 ksi

C. 8,830 ksi

D. 57,000.0 ksi

50. For a service-load deflection calculation, a concrete member is idealized in its initial approximately linear elastic range. Which material property directly relates normal stress to normal strain?

A. Concrete unit weight by itself.

B. Modulus of elasticity.

C. Entrained-air content by itself.

D. Specified compressive strength by itself.

51. For a separate structural calculation, a reinforced concrete section contains ten No. 7 bars, each with area 0.60 in2. What total reinforcing area is present?

A. 6.54 in2

B. 0.54 in2

C. 5.00 in2

D. 6.00 in2

52. A tensile coupon from structural steel is loaded through yielding and then to its maximum engineering stress. Which statement correctly distinguishes Fy from Fu?

A. Fy is the elastic modulus, while Fu is Poisson’s ratio.

B. Fy and Fu are interchangeable measures of stiffness.

C. Fy represents the onset of significant yielding, while Fu is the maximum engineering tensile stress reached.

D. For ordinary ductile structural steel, Fy is always greater than Fu.

53. For a peer review on a different project, a steel coupon has axial stress of 18.85 ksi and corresponding elastic strain of 0.00065. Determine the modulus E from E = stress/strain.

A. 18,850 ksi

B. 29,000 ksi

C. 58,000 ksi

D. 2,900 ksi

54. The same wood species is checked for compression parallel to grain and bearing perpendicular to grain. Why can the design properties differ substantially?

A. Grain direction affects only fasteners and never affects member behavior.

B. Wood becomes isotropic once it reaches service moisture content.

C. Published design values create directional differences that do not exist physically.

D. Wood is orthotropic, so strength and stiffness depend strongly on direction relative to its grain structure.

55. A masonry quality-control program tests representative prisms made from the project units and mortar. What property is the axial compression test primarily intended to establish?

A. Yield strength of the reinforcing bars.

B. Elastic modulus of structural steel framing.

C. Compressive strength of the masonry assemblage.

D. Moisture content of adjacent wood framing.

56. As part of an independent QA review, a soil has porosity n = 0.42. Determine its void ratio using e = n/(1-n).

A. 0.724

B. 0.449

C. 0.278

D. 1.150

57. For a peer review on a different project, a compacted soil specimen has total weight 113 lb and total volume 1.80 ft3. Determine its total unit weight.

A. 62.8 pcf

B. 56.4 pcf

C. 101.8 pcf

D. 203.3 pcf

58. For a soil bearing estimate, use qult = gamma Df Nq. If gamma = 150 pcf, Df = 5 ft, and Nq = 18, determine the ultimate bearing pressure.

A. 2,700 psf
B. 7,500 psf
C. 67,500 psf
D. 13,500 psf

59. Standard concrete cylinders are delivered to a testing laboratory after curing. Which procedure directly determines the compressive strength represented by those cylinders?

A. Run a Charpy V-notch impact test on the concrete specimen.
B. Pull a structural-steel coupon in direct tension and use its yield stress.
C. Load each prepared cylinder axially in compression to failure and divide the peak load by its cross-sectional area.
D. Perform a sieve analysis on fragments from the hardened cylinder.

60. A bridge steel specification calls for Charpy V-notch testing at a stated temperature. What material behavior is that requirement intended to evaluate?

A. Compressive strength of a masonry prism.
B. Notch toughness and resistance to brittle fracture under impact-type loading.
C. Static compressive strength of concrete.
D. Hydraulic conductivity of foundation soil.

61. Vertical reinforcing bars are placed in selected CMU cells that will be fully grouted. What structural role does the grout serve in those reinforced cells?

A. It prevents the reinforcing bars from developing tensile force.
B. It replaces every bed and head mortar joint in the wall.
C. It fills the cells around the bars so reinforcement and masonry can transfer forces and act together.
D. It functions only as a cosmetic finish and has no structural purpose.

62. A prestressed concrete girder is given an initial compressive force before service gravity loads are applied. What serviceability benefit is primarily sought?

A. Eliminate all compressive stress from the concrete during service.
B. Offset later tensile stresses so cracking and service-load tensile demand are reduced.
C. Remove the need for prestressing or reinforcing steel after transfer.
D. Guarantee zero deflection for every span and load history.

63. For a separate structural calculation, a singly reinforced rectangular concrete beam has b = 14 in., d = 23 in., As = 4.0 in2, fy = 60 ksi, and f'c = 5 ksi. Using a = As fy/(0.85 f'c b) and Mn = As fy(d-a/2), determine Mn.

A. 419.7 kip-ft
B. 209.8 kip-ft
C. 503.6 kip-ft
D. 466.3 kip-ft

64. As part of an independent QA review, for a concrete beam with nominal flexural strength Mn = 425 kip-ft, use phi = 0.90. What design flexural strength phiMn is available?

A. 425 kip-ft
B. 472.2 kip-ft
C. 340 kip-ft
D. 382.5 kip-ft

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

A. 7.3 kip
B. 44.0 kip
C. 22.1 kip
D. 87.9 kip

66. For this practice check, required development length is defined as ld = fy db/(25 sqrt(f'c)). Use fy = 60,000 psi, db = 1.00 in., and f'c = 5,000 psi. Determine ld.

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

67. For a separate structural calculation, a tied concrete column has Ag = 205 in2 and Ast = 10 in2. For this problem use Pn = 0.85 f'c(Ag-Ast) + fyAst with f'c = 5 ksi and fy = 60 ksi. Determine Pn.

A. 780.5 kip
B. 2,077.1 kip
C. 1,428.8 kip
D. 648.3 kip

68. As part of an independent QA review, a one-way slab strip is idealized as a simply supported 16-ft span carrying 0.62 kip/ft. Using Mmax = wL^2/8, determine the strip moment.

A. 19.84 kip-ft
B. 158.7 kip-ft
C. 9.91 kip-ft
D. 39.68 kip-ft

69. A reinforced-concrete slab panel is nearly square and continuously supported on all four sides. Which behavior is most characteristic of two-way slab action?

A. Loads jump directly to columns without plate bending between supports.
B. The entire gravity load travels only across the short-span direction.
C. The panel carries gravity load only through membrane compression with no bending.
D. Flexural resistance and load distribution develop significantly in both orthogonal directions.

70. During a design-office check, a square column footing is 9 ft by 9 ft and supports a concentric service load of 511 kip. Neglect footing weight. What average soil bearing pressure results?

A. 56.7 ksf
B. 6.309 ksf
C. 3.1 ksf
D. 9.5 ksf

71. For a separate structural calculation, a 12-ft-wide footing carries P = 695 kip with eccentricity e = 0.75 ft about its centerline. For a one-foot strip, use qmax = (P/A)(1 + 6e/B), with A = 12 ft2. Determine qmax.

A. 79.635 ksf
B. 39.818 ksf
C. 57.916 ksf
D. 101.354 ksf

72. As part of an independent QA review, a pile foundation group contains seven piles, each with allowable axial capacity 120 kip. If a stated group-efficiency factor of 0.82 applies, determine the allowable group capacity.

A. 98.4 kip

B. 1,024.4 kip

C. 688.8 kip

D. 840 kip

73. For a peer review on a different project, a site retaining wall experiences a triangular lateral soil resultant of 28 kip/ft acting at H/3 above the base, where H = 15 ft. What overturning moment about the toe results?

A. 420 kip-ft/ft

B. 140 kip-ft/ft

C. 70 kip-ft/ft

D. 28 kip-ft/ft

74. During a design-office check, a site retaining wall has total stabilizing vertical load W = 72 kip/ft, base friction coefficient mu = 0.55, and horizontal driving force P = 22 kip/ft. Using FS = muW/P, determine the sliding factor of safety.

A. 0.32

B. 3.60

C. 0.90

D. 1.80

75. For a separate structural calculation, a compact steel beam has Fy = 50 ksi and plastic section modulus Zx = 159 in3. For this practice check, take nominal plastic moment Mn = FyZx. Determine Mn.

A. 662.5 kip-ft
B. 331.2 kip-ft
C. 1,325.0 kip-ft
D. 7,950.0 kip-ft

76. A compact steel beam has adequate section strength, but the compression flange is unbraced for a long segment. Which limit state can reduce its available flexural strength?

A. Loss of all bending resistance because an unbraced beam can carry only axial load.
B. A change in steel chemistry caused by the missing lateral brace.
C. Lateral-torsional buckling of the beam.
D. Concrete-style punching shear through the compression flange.

77. For a peer review on a different project, a steel tension brace has gross area Ag = 9.4 in2 and Fy = 50 ksi. Using phi = 0.90 and design yielding strength phiFyAg, determine the resulting strength.

A. 517.0 kip
B. 423.0 kip
C. 470.0 kip
D. 211.5 kip

78. During a design-office check, a steel tension brace has effective net area Ae = 6.8 in2 and Fu = 65 ksi. For this problem use phi = 0.75 for net-section rupture. What design rupture strength results?

A. 331.5 kip
B. 165.7 kip
C. 497.2 kip
D. 441.9 kip

79. For a separate structural calculation, a connection uses five bolts, each with stated design shear strength of 20 kip, and the load is shared equally. What total design shear strength is available?

A. 20 kip
B. 50 kip
C. 100 kip
D. 80 kip

80. As part of an independent QA review, 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 = 16 in., determine the resulting strength.

A. 178.2 kip
B. 44.6 kip
C. 118.9 kip
D. 89.1 kip

81. For a peer review on a different project, a steel column has E = 29,000 ksi, I = 585 in4, and effective length KL = 192 in. Using Euler Pcr = pi^2EI/(KL)^2, determine the critical load.

A. 9,084 kip
B. 4,542 kip
C. 378.7 kip
D. 2,271.0 kip

82. During a design-office check, a member interaction check is defined as Pu/phiPn + Mu/phiMn <= 1.0. If Pu = 240 kip, phiPn = 675 kip, Mu = 105 kip-ft, and phiMn = 170 kip-ft, determine the interaction ratio.

A. 0.973

B. 0.364

C. 0.609

D. 1.581

83. Headed shear studs connect a concrete slab to the top flange of a steel floor beam. What action allows the two materials to develop composite flexural behavior?

A. The studs chemically increase the concrete compressive strength.

B. The studs eliminate the need for both the steel beam and slab reinforcement.

C. The studs transfer longitudinal interface shear and limit slip between the slab and steel beam.

D. The studs prevent all vertical shear from entering the steel web.

84. As part of an independent QA review, a timber beam has allowable bending stress Fb = 1.45 ksi and section modulus S = 225 in3. What allowable bending moment FbS results?

A. 13.58 kip-ft

B. 27.19 kip-ft

C. 54.37 kip-ft

D. 326.2 kip-ft

85. For a peer review on a different project, a timber post carries 60 kip through a gross area of 40 in2. What average compressive stress acts on the section?

A. 3.00 ksi

B. 0.76 ksi

C. 24.0 ksi

D. 1.50 ksi

86. During a design-office check, a wood connection requires 24 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. 7 fasteners

D. 5 fasteners

87. For a separate structural calculation, a masonry wall carries a concentric axial load of 92 kip over a net area of 159 in2. What average compressive stress results?

A. 0.289 ksi

B. 11.99 ksi

C. 0.579 ksi

D. 1.158 ksi

88. As part of an independent QA review, a masonry shear wall segment carries V = 64 kip. Using average shear stress v = V/(bd) with b = 8 in. and d = 133 in., determine the average shear stress.

A. 0.0602 ksi

B. 0.0302 ksi

C. 0.1204 ksi

D. 7.71 ksi

89. For a peer review on a different project, a diaphragm develops an in-plane bending moment of 715 kip-ft between its chord lines, which are 32 ft apart. Using chord force F = M/d, determine the required chord-force magnitude.

A. 44.8 kip

B. 22.34 kip

C. 715.1 kip

D. 11.18 kip

90. A floor diaphragm must transfer lateral force around a large opening to a shear wall that is offset from the force source. What is the collector’s primary job?

A. Replace every chord, boundary member, and shear wall in the system.

B. Carry only finish and partition gravity loads.

C. Gather diaphragm force and deliver it through a defined in-plane load path to the vertical lateral system.

D. Lower the yield strength of the framing so seismic demand decreases.

91. For a separate structural calculation, a chevron bracing bay has two identical braces at 52 degrees to the horizontal. If a 163-kip story shear is shared equally through the horizontal components of the two braces, determine the axial force in each brace.

A. 132.4 kip

B. 81.5 kip

C. 163.1 kip

D. 66.1 kip

92. As part of an independent QA review, a lateral frame resists an overturning moment of 1,600 kip-ft through a tension-compression couple separated by 25 ft. What axial force magnitude is required on each side of the couple?

A. 128 kip
B. 32 kip
C. 1,600 kip
D. 64 kip

93. For a peer review on a different project, a steel column transfers 485 kip concentrically through a 16 in. by 20 in. base plate. What average bearing pressure acts beneath the plate?

A. 1.516 ksi
B. 0.758 ksi
C. 24.26 ksi
D. 3.032 ksi

94. During a design-office check, a base connection resists a 325 kip-ft moment using a tension-compression couple with 24 in. between the force resultants. Neglect axial load. What tension-side force magnitude is required?

A. 13.5 kip
B. 162.5 kip
C. 325 kip
D. 81.2 kip

95. For a separate structural calculation, a footing has width B = 11 ft and load eccentricity e = 0.90 ft. Using the effective-width approximation B' = B - 2e, determine the effective width.

A. 13.24 ft
B. 10.21 ft
C. 9.20 ft
D. 7.18 ft

96. As part of an independent QA review, a rigid pile cap carries a concentric 655-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. 327.5 kip
B. 65.5 kip
C. 655 kip
D. 131 kip

97. For a peer review on a different project, a drilled pier has diameter 3.5 ft, embedded length 46 ft, and uniform unit side resistance fs = 0.55 ksf. Using Qs = pi d L fs, determine the side resistance.

A. 278.2 kip
B. 88.6 kip
C. 556.4 kip
D. 139.2 kip

98. During a design-office check, a 14-ft-wide retaining-wall base slab carries resultant vertical load P = 330 kip/ft with eccentricity e = 1.20 ft. Using qmax = P/B(1 + 6e/B), determine the maximum base pressure.

A. 47.81 ksf

B. 23.57 ksf

C. 35.69 ksf

D. 17.85 ksf

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

A. They act only as temporary construction spacers and have no structural function after curing.

B. They replace the longitudinal reinforcement that carries axial and flexural demand.

C. They guarantee that concrete cannot crack, spall, or crush under any loading.

D. They confine core concrete, restrain longitudinal-bar buckling, hold the cage, and contribute to shear resistance where required.

100. A seismic connection is expected to experience cyclic inelastic demand. Which design approach best promotes ductile system response?

A. Make the most brittle connection component the intentionally weakest link.

B. Provide a deliberate yielding mechanism with adequate deformation capacity while protecting brittle failure modes and surrounding components.

C. Maximize stiffness without checking deformation capacity or force redistribution.

D. Rely on one attachment without tracing how force enters and leaves the connected members.

Practice Exam 31: Answer Key and Explanations

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

2. B — Using the stated values and the relationship given in the stem, the independent calculation gives 25.6 kip. The other choices assign the entire load to one support, halve the reaction twice, or ignore the span when converting line load to force. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

3. C — Using the stated values and the relationship given in the stem, the independent calculation gives 78.54 psf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

4. D — Using the stated values and the relationship given in the stem, the independent calculation gives 170.4 psf. The distractors reflect unfactored addition or incorrect factor application. Because the combination is provided in the stem, no other load factor belongs in this calculation. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

5. A — Using the stated values and the relationship given in the stem, the independent calculation gives 33.7 psf. The distractors omit or misapply one of the given multipliers. Since the formula and coefficients are supplied explicitly, the task is careful substitution rather than recalling an unstated snow-load provision. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

6. B — Using the stated values and the relationship given in the stem, the independent calculation gives 46.9 psf. The velocity is squared, so treating it linearly creates a large error, while omitting Kd or Kz shifts the result materially. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

7. D — Using the stated values and the relationship given in the stem, the independent calculation gives 244.2 kip. The distractors move the decimal, substitute the full weight, or use an unrelated percentage. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

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

9. D — Using the stated values and the relationship given in the stem, the independent calculation gives 2,426 lb/ft. The alternatives omit the one-half factor, mishandle the height-squared term, or halve the correct force again. Earth-pressure resultants depend strongly on retained height because the pressure increases with depth. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

10. B — Using the stated values and the relationship given in the stem, the independent calculation gives 23.14 kip. For a single point load on a simple span, the left reaction equals P(L-x)/L. A quick unit check also confirms the scale and physical meaning of the result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

11. C — Using the stated values and the relationship given in the stem, the independent calculation gives 2.938 kip/ft. Convert the repeated concentrated reactions to an equivalent line load by dividing one reaction by its spacing. Units clearly distinguish force from force per length. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

12. A — Using the stated values and the relationship given in the stem, the independent calculation gives 55.62 psf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

13. D — Apply the stated reduced-live-load expression directly. With L0 = 100 psf and KLLAT = 6,500 ft2, the calculation gives 43.61 psf. The alternatives represent keeping only the minimum term, over-applying the reduction expression, or using an incorrect subtraction. Because the square-root term is dimensionless here, the result retains pressure units of psf.

14. A — Using the stated values and the relationship given in the stem, the independent calculation gives 28.6 psf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

15. B — Using the stated values and the relationship given in the stem, the independent calculation gives 68.4 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

16. C — Using the stated values and the relationship given in the stem, the independent calculation gives 153.5 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

17. D — Using the stated values and the relationship given in the stem, the independent calculation gives 142.8 kip. Evaluate every stated combination rather than assuming which governs. The distractors reproduce the other combinations or an incorrect total. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

18. B — Using the stated values and the relationship given in the stem, the independent calculation gives 84 kip-ft. The distractors commonly double or halve the lever arm or report force without moment. A free-body diagram and dimensional check confirm the keyed result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

19. C — Using the stated values and the relationship given in the stem, the independent calculation gives 72.9 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. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

20. A — Using the stated values and the relationship given in the stem, the independent calculation gives 35.1 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

21. A — Using the stated values and the relationship given in the stem, the independent calculation gives 16.67 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

22. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.149 in. Axial deformation increases with load and length and decreases with area and elastic modulus. The distractors represent common decimal or factor errors. Consistent inch-kip units confirm the keyed answer. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

23. B — Using the stated values and the relationship given in the stem, the independent calculation gives 578 in3. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

24. D — Using the stated values and the relationship given in the stem, the independent calculation gives 2.16 ksi. The distractors omit the feet-to-inches conversion or shift the decimal. Consistent length units are essential whenever a moment in kip-ft is divided by a section property in inches. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

25. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.046 in. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

26. D — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0089 in. The span appears to the fourth power, so small span or unit errors can change the result substantially. The distractors reflect common factor and decimal mistakes. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

27. B — Using the stated values and the relationship given in the stem, the independent calculation gives 6,716 kip. The distractors halve or double the result or effectively omit part of the span conversion. Euler capacity varies inversely with the square of effective length, making length assumptions especially important. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

28. A — Using the stated values and the relationship given in the stem, the independent calculation gives 11.53 ksi. Maximum torsional shear stress follows directly from Tc/J. The distractors halve or double the proper stress or misuse the torque-radius product. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

29. C — Axial compression and bending compression add at the extreme fiber where they act in the same sense. Using the stated values gives 5.5 + 8.75 = 14.25 ksi. At the opposite edge, bending would subtract from the axial stress. The distractors represent using only one component, subtracting incorrectly, or applying an unrelated factor.

30. D — Using the stated values and the relationship given in the stem, the independent calculation gives 23.35 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

31. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.155 in. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

32. B — Using the stated values and the relationship given in the stem, the independent calculation gives 10.93 ksi. Full restraint prevents the free thermal strain, so the given stress relation applies directly. The distractors double or halve the result or mishandle the coefficient. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

33. A — Using the stated values and the relationship given in the stem, the independent calculation gives 63 kip-ft. The distractors report the load itself or halve or double the correct moment. A free-body diagram shows the fixed support resisting both shear and moment. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

34. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0241 in. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

35. D — Joint equilibrium provides the classic zero-force-member result. If two members are collinear and there is no external load or support reaction at the joint, their axial forces can balance along the common line. No force is available to balance a component in the third direction, so the noncollinear member must carry zero force for that loading case.

36. B — A fixed support supplies three planar reactions: horizontal force, vertical force, and moment. The roller adds one vertical reaction, for four external unknowns. Planar statics provides only three independent equilibrium equations, so one redundant reaction remains. The system is stable but requires a compatibility or deformation relation in addition to equilibrium, making it first-degree externally indeterminate.

37. D — Using the stated values and the relationship given in the stem, the independent calculation gives 21.00 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

38. A — Using the stated values and the relationship given in the stem, the independent calculation gives 32 ksi. Stress range equals maximum stress minus minimum stress. The distractors subtract absolute values incorrectly, report half the range, or repeat the maximum stress. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

39. B — Using the stated values and the relationship given in the stem, the independent calculation gives 27.43 ksi. The distractors halve or double the proper stress or use an incorrect projected area. Bearing checks use the projected contact dimensions, not the full plate gross area. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

40. C — Using the stated values and the relationship given in the stem, the independent calculation gives 12.92 ksi. The distractors report one component alone or combine the terms incorrectly. A quick unit check also confirms the scale and physical meaning of the result. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

41. B — Using the stated values and the relationship given in the stem, the independent calculation gives 35,729 in4. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

42. C — Reshores create a temporary load path through several levels after original shores are removed. They help distribute construction loads while recently cast slabs and supporting members continue developing strength and stiffness. They do not change specified concrete strength, replace permanent framing, or eliminate the need to evaluate construction sequence, support stiffness, removal timing, and load redistribution.

43. A — Using the stated values and the relationship given in the stem, the independent calculation gives 36,225 lb. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

44. D — Temporary platforms must be checked for their actual configuration and the complete set of anticipated loads before use. Workers, tools, staged materials, access, supports, bracing, and connections all affect demand and stability. A nearby permanent floor does not establish platform capacity, and observing distress after loading is not an acceptable substitute for prior engineering verification.

45. C — Special inspection is targeted quality assurance for work identified by the applicable requirements and approved construction documents. The inspector observes or tests designated materials and installation and records conformity or deficiencies. That role does not transfer the contractor's responsibility for means and methods, authorize informal design changes, or guarantee future performance of every completed structural component.

46. D — Deep excavation can remove lateral confinement or bearing support relied upon by nearby foundations, producing settlement, rotation, or lateral movement. The prudent approach is to evaluate the influence zone and existing conditions before soil removal, then design shoring, underpinning, sequence, and monitoring as needed. Property boundaries do not stop soil-structure interaction, and reactive stabilization may come too late.

47. B — An erection-stage frame may have load paths and stiffness very different from the completed building because diaphragms, connections, and permanent lateral elements are incomplete. Temporary bracing should provide stability for construction wind, erection loads, and geometric imperfections until the permanent system is effective. Final-state analysis alone does not demonstrate adequacy of every intermediate configuration.

48. A — Shop drawings communicate proposed fabrication, assembly, or installation details for specific work. An RFI asks for clarification when the contract documents are unclear, incomplete, or conflicting. Neither document automatically transfers design responsibility or authorizes every change. Review comments and responses should follow defined project roles and the formal process for documenting approved design revisions.

49. A — Using the stated values and the relationship given in the stem, the independent calculation gives 4,415 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

50. B — Modulus of elasticity is the stiffness parameter that relates normal stress to elastic strain in the linear response range. It therefore enters calculations of shortening, extension, curvature, and deflection. Compressive strength measures resistance to failure, unit weight primarily affects dead load, and air content influences durability and fresh-concrete behavior; none of those properties alone replaces E in elastic deformation calculations.

51. D — Using the stated values and the relationship given in the stem, the independent calculation gives 6.00 in2. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

52. C — Yield strength identifies the stress associated with the onset of substantial inelastic deformation, while ultimate tensile strength is the maximum engineering stress reached during the tensile test. Elastic modulus describes stiffness rather than strength. For ordinary ductile structural steels, Fu exceeds Fy. Confusing these quantities can distort member strength, connection rupture checks, and expected ductility.

53. B — Elastic modulus is stress divided by elastic strain. Using 18.85 ksi and 0.00065 gives E = 29,000 ksi. The keyed value is consistent with typical structural-steel stiffness. The distractors confuse stress with modulus, double the expected modulus, or shift the decimal. Keeping strain dimensionless leaves the modulus in ksi and provides a direct units check.

54. D — Wood's cellular fibers create strongly directional mechanical behavior. Properties parallel to grain can differ greatly from properties perpendicular to grain in compression, tension, stiffness, and bearing. Moisture changes may modify values, but they do not make wood isotropic. Grain orientation therefore matters in both member and connection design because the material's internal structure governs how load is transferred.

55. C — A masonry prism is an assemblage of units and mortar configured to represent important aspects of constructed masonry. Loading the prism in axial compression provides a measure of masonry compressive strength for that assemblage. It does not determine reinforcing-steel yield strength, structural-steel stiffness, or timber moisture. The test captures combined effects of units, mortar, geometry, and workmanship.

56. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.724. Porosity uses void volume divided by total volume, whereas void ratio uses void volume divided by solids volume. The distractors confuse those definitions or use the wrong denominator. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

57. A — Using the stated values and the relationship given in the stem, the independent calculation gives 62.8 pcf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

58. D — Using the stated values and the relationship given in the stem, the independent calculation gives 13,500 psf. The distractors omit one multiplier or over-apply the embedment depth. The pcf times ft product produces psf, confirming that the requested result is a pressure. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

59. C — Concrete cylinder compressive strength is determined by applying axial compressive load to a prepared cylinder until failure and dividing the maximum load by the cross-sectional area. Sieve analysis measures particle-size distribution, Charpy testing evaluates metal impact toughness, and steel coupon tension testing characterizes steel. Those procedures do not directly measure the concrete compressive strength represented by the molded cylinders.

60. B — The Charpy V-notch test measures the energy absorbed when a notched metal specimen fractures under impact loading, providing an indicator of notch toughness and susceptibility to brittle fracture at the test temperature. It is not a concrete compression, soil permeability, or masonry prism test. The test addresses fracture behavior rather than ordinary static yield strength or elastic stiffness.

61. C — Grout fills cells and surrounds the reinforcement, providing contact and force transfer so the bars and masonry can act as a reinforced structural assembly. It does not replace mortar joints, prevent steel from carrying tension, or serve only as finish material. Proper placement and consolidation are important because voids can interrupt the intended composite load path and development of reinforcement.

62. B — Prestressing introduces beneficial compression, often with eccentricity, so later service loads must first reduce that compression before creating substantial tensile stress. This can limit cracking and improve serviceability and span efficiency. It does not guarantee zero deflection, eliminate compression, or make steel unnecessary. Prestress losses, time-dependent behavior, geometry, and applied loading still require evaluation.

63. A — Using the stated values and the relationship given in the stem, the independent calculation gives 419.7 kip-ft. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

64. D — Using the stated values and the relationship given in the stem, the independent calculation gives 382.5 kip-ft. Design strength equals the nominal strength multiplied by the stated resistance factor. The distractors leave the nominal value unfactored, divide by phi, or apply an excessive reduction. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

65. B — Using the stated values and the relationship given in the stem, the independent calculation gives 44.0 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

66. D — Using the stated values and the relationship given in the stem, the independent calculation gives 33.9 in. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

67. C — Using the stated values and the relationship given in the stem, the independent calculation gives 1,428.8 kip. Apply the stated axial-strength model to the concrete and steel contributions separately. The concrete term uses the net concrete area, Ag - Ast, while the steel term uses Ast. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

68. A — Using the stated values and the relationship given in the stem, the independent calculation gives 19.84 kip-ft. Apply the simple-span uniform-load expression to the one-foot slab strip. The distractors halve or double the correct moment or omit the divisor of eight. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

69. D — Two-way action occurs when slab flexural stiffness in both principal directions contributes materially to carrying load. A nearly square panel with support along four sides commonly develops bending moments and load distribution in both directions. One-way action instead concentrates flexural response primarily across one span. Direct column support does not eliminate plate bending within the slab panel.

70. B — Using the stated values and the relationship given in the stem, the independent calculation gives 6.309 ksf. Average bearing pressure equals vertical load divided by footing area. The distractors divide by one footing dimension, halve the proper pressure, or use an incorrect area. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

71. A — Using the stated values and the relationship given in the stem, the independent calculation gives 79.635 ksf. The distractors report average pressure, overstate the eccentricity effect, or halve the maximum. The stated linear-pressure expression governs this idealized check. Units and magnitude are consistent with the stated model. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

72. C — Using the stated values and the relationship given in the stem, the independent calculation gives 688.8 kip. The distractors omit the efficiency factor, apply it to one pile only, or divide by efficiency. A factor below one should reduce the simple sum of individual capacities. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

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

74. D — Using the stated values and the relationship given in the stem, the independent calculation gives 1.80. The distractors double or halve the ratio or invert it. A factor of safety compares resisting capacity with driving demand using consistent force units. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

75. A — Using the stated values and the relationship given in the stem, the independent calculation gives 662.5 kip-ft. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

76. C — In major-axis flexure, an inadequately braced compression flange can move laterally while the cross-section twists, producing lateral-torsional buckling before the section reaches its full plastic moment. Bracing controls this stability mode but does not change steel chemistry or convert the member into an axial-only element. Cross-sectional strength and member stability are separate checks that can govern flexural capacity.

77. B — Using the stated values and the relationship given in the stem, the independent calculation gives 423.0 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

78. A — Using the stated values and the relationship given in the stem, the independent calculation gives 331.5 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

79. C — Using the stated values and the relationship given in the stem, the independent calculation gives 100 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

80. D — Using the stated values and the relationship given in the stem, the independent calculation gives 89.1 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

81. B — Using the stated values and the relationship given in the stem, the independent calculation gives 4,542 kip. The distractors halve or double the result or effectively omit part of the length-squared dependence. Column buckling capacity is highly sensitive to effective length and stiffness. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

82. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.973. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

83. C — Composite flexure requires the concrete slab and steel beam to develop compatible longitudinal deformation rather than sliding freely at their interface. Headed studs transfer the longitudinal interface shear needed to limit slip and develop composite action. They do not eliminate steel-web shear, change concrete chemistry, or replace the primary structural components. Connector strength, spacing, and detailing support the load path.

84. B — Using the stated values and the relationship given in the stem, the independent calculation gives 27.19 kip-ft. The distractors omit the unit conversion or halve or double the proper moment. Stress times section modulus produces a moment, so the dimensional path is straightforward to verify. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

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

86. D — Using the stated values and the relationship given in the stem, the independent calculation gives 5 fasteners. Because a connection cannot use a fraction of a fastener, round upward to five. Four fasteners provide insufficient stated resistance, while six or seven would exceed the minimum count. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

87. C — Using the stated values and the relationship given in the stem, the independent calculation gives 0.579 ksi. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

88. A — Using the stated values and the relationship given in the stem, the independent calculation gives 0.0602 ksi. The distractors halve or double the stress or divide by only one dimension. The calculation is an average stress idealization, not a complete wall design check. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

89. B — Using the stated values and the relationship given in the stem, the independent calculation gives 22.34 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

90. C — A collector, or drag strut, gathers diaphragm force and transfers it to a shear wall, braced frame, or moment frame when the force path is not direct. Openings and offsets create this need. Collectors do not change material strength, serve only gravity loads, or replace chords and vertical elements. Their connections must preserve continuity of the intended lateral load path.

91. A — Using the stated values and the relationship given in the stem, the independent calculation gives 132.4 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

92. D — Using the stated values and the relationship given in the stem, the independent calculation gives 64 kip. A tension-compression couple resists moment through force times separation. The distractors halve or double the correct force or report the moment magnitude as a force. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

93. A — Using the stated values and the relationship given in the stem, the independent calculation gives 1.516 ksi. The distractors double or halve the correct pressure or divide by only one plate dimension. The concentric-load assumption makes the idealized average pressure uniform across the plate area. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

94. B — Convert the 24-in. couple arm to 2 ft, then use F = M/d = 325/2 = 162.5 kip. The tension and compression resultants have equal magnitude under the stated no-axial-load assumption. The distractors omit the feet-to-inches relationship, report the moment as a force, or halve the correct force. Multiplying 162.5 kip by 2 ft reproduces 325 kip-ft.

95. C — Using the stated values and the relationship given in the stem, the independent calculation gives 9.20 ft. The distractors subtract eccentricity only once, subtract too much, or add it. The reduction on both sides of the resultant explains the factor of two and confirms the keyed answer. The remaining choices reflect common arithmetic, unit-conversion, or factor-application errors.

96. D — Using the stated values and the relationship given in the stem, the independent calculation gives 131 kip. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

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

98. C — Using the stated values and the relationship given in the stem, the independent calculation gives 35.69 ksf. The keyed option therefore matches the required result. The other choices represent plausible arithmetic, unit-conversion, or factor-application errors. Rechecking dimensions and the expected order of magnitude provides a final independent screen before accepting the answer.

99. D — Column transverse reinforcement serves several structural purposes. It confines the core concrete, restrains longitudinal bars against local buckling, helps maintain reinforcement geometry, and contributes to shear resistance where required. It does not replace longitudinal steel or prevent every form of concrete damage. Tie or spiral spacing and anchorage therefore influence strength, stability, and ductility of reinforced-concrete columns.

100. B — Ductile seismic design encourages controlled inelastic deformation in intended yielding regions while protecting brittle failure modes such as fracture, pullout, or abrupt connection rupture. This requires a clear force path, adequate deformation capacity, and an intentional strength hierarchy. Simply maximizing stiffness, relying on one unverified attachment, or making a brittle component weakest undermines dependable cyclic energy dissipation.