PRACTICE EXAM 12: CALIFORNIA CIVIL SEISMIC PRINCIPLES (100 QUESTIONS)

This standalone practice exam contains 100 four-choice questions weighted to the current BPELSG Civil Engineer Seismic Principles test plan. Use a 2.5-hour time limit for realistic practice. For the remainder of 2026, BPELSG continues testing to the 2022 California Building Code and ASCE/SEI 7-16. This is independently created study material and is not an official BPELSG examination.

1. For a site-response exercise, use $S_{MS} = F_aS_s$. If $F_a = 1.18$ and $S_s = 1.06g$, what is SMS to three decimals?

A. 0.898g
B. 1.060g
C. 1.251g
D. 2.240g

2. For a one-second site coefficient calculation, evaluate $S_{M1} = F_vS_1$ when $F_v = 1.70$ and $S_1 = 0.44g$.

A. 0.748g
B. 0.259g
C. 1.140g
D. 2.140g

3. A design-spectrum exercise gives $S_{MS} = 1.32g$ and specifies $S_{DS} = (2/3)S_{MS}$. What is SDS?

A. 0.66g
B. 0.88g
C. 1.32g
D. 1.98g

4. If SM1 = 0.69g and SD1 = (2/3)SM1 for this exercise, determine SD1.

A. 0.35g
B. 0.69g
C. 1.04g
D. 0.46g

5. During spectrum calibration, an engineer has design ordinates SD1 = 0.46g and SDS = 0.88g. The transition period is defined as Ts = SD1/SDS. What is Ts to three decimals?

A. 0.523 s
B. 0.404 s
C. 1.340 s
D. 1.913 s

6. The lower corner period for the same idealized spectrum is defined as T0 = 0.2Ts. Taking Ts = 0.523 s, compute T0 to three decimals.

A. 0.262 s
B. 0.523 s
C. 2.615 s
D. 0.105 s

7. A level site is underlain by loose, saturated sand with a shallow groundwater table. Which seismic site hazard should receive particular geotechnical attention?

A. Long-term timber shrinkage
B. Thermal roof expansion
C. Liquefaction and associated ground deformation
D. Steel coating deterioration

8. Why can two buildings with similar structural systems require different seismic design criteria when one has a much higher consequence of failure?

A. Roof color changes mapped shaking
B. Risk category can change the required design performance level
C. Concrete slump sets the regional hazard
D. Window area controls site classification

9. A vibration study compares two equal-mass oscillators. Oscillator A is 2.25 times as stiff laterally as Oscillator B. From T proportional to sqrt(m/k), determine the ratio TA/TB.

A. 0.444
B. 0.667
C. 1.500
D. 2.250

10. A story restores lateral force through two parallel lines rated at 26 and 44 kips/in. Because both undergo the same translation, what total story stiffness do they provide?

A. 70 kips/in
B. 18 kips/in
C. 35 kips/in
D. 1,144 kips/in

11. A structure keeps the same stiffness but its effective seismic mass increases by a factor of 1.44. Using T proportional to sqrt(m/k), by what factor does its period change?

A. 0.69
B. 1.44
C. 2.07

D. 1.20

12. Near resonance, what is the principal effect of increasing viscous damping while leaving mass and stiffness essentially unchanged?

A. Seismic mass doubles immediately
B. Natural period becomes zero
C. Peak dynamic response generally decreases
D. All strength demand disappears

13. A story carries a sustained gravity load of 620 kips and experiences a lateral drift of 0.75 in. Using the simple secondary moment estimate M = PDelta, what is the P-Delta moment?

A. 82.7 kip-in
B. 465 kip-in
C. 620 kip-in
D. 826.7 kip-in

14. Why does redundancy generally improve seismic performance of a lateral-force-resisting system?

A. It supplies alternate paths for redistributed seismic force
B. It forces every story drift to zero
C. It prevents all diaphragm torsion from developing
D. It removes all seismic demand from foundations

15. A floor plan has the center of mass far from the center of rigidity. What response characteristic should the engineer expect to become more important?

A. Only vertical settlement
B. Uniform axial shortening only
C. Elimination of diaphragm shear

D. Torsional rotation and uneven element demand

16. Two adjacent buildings can move toward each other during the same earthquake. If their maximum expected lateral movements toward the joint are 1.8 in and 1.2 in, what minimum relative movement should the joint accommodate in this simplified check?

A. 3.0 in
B. 0.6 in
C. 1.5 in
D. 2.2 in

17. An older unreinforced masonry bearing-wall building has timber diaphragms with weak wall-to-diaphragm ties. Which retrofit most directly addresses a common life-safety vulnerability?

A. Add heavier roofing without new anchorage
B. Remove interior partitions only
C. Provide positive diaphragm-to-wall anchorage and continuity
D. Increase wall paint thickness

18. A tilt-up concrete building has heavy wall panels but inadequate roof-diaphragm anchorage. What failure mode is the retrofit primarily intended to prevent?

A. Elastic shortening of columns
B. Foundation corrosion
C. Out-of-plane wall separation from the diaphragm
D. Roof membrane wrinkling

19. An older building places an open parking level beneath several much stiffer occupied floors, causing deformation to concentrate at the bottom. Which retrofit objective best addresses that weakness?

A. Add extra mass only at the roof level

B. Reduce diaphragm connections at the upper stories
C. Remove remaining lateral elements from the first story
D. Strengthen and stiffen the weak first story

20. An older flat-slab building shows limited punching-shear capacity around columns. Why is this a seismic concern?

A. The slab will remain elastic under every earthquake
B. Drift and gravity load can trigger brittle slab-column failure
C. Punching shear influences architectural finishes but not structure
D. Column gravity load disappears whenever lateral shaking begins

21. A steel braced-frame retrofit review identifies a gusset connection likely to fracture before the brace can develop stable inelastic behavior. What is the preferred objective?

A. Intentionally weaken the gusset before strengthening the brace
B. Re-detail the connection so the ductile brace mechanism develops
C. Remove all brace connections from the resisting system
D. Increase building mass to reduce connection force demand

22. After an earthquake, a reinforced-concrete column has wide diagonal cracks, crushed cover concrete, and visibly buckled longitudinal bars. What should a rapid safety evaluation infer?

A. The observed damage is cosmetic and needs no restriction
B. The damaged column has gained reliable cyclic ductility
C. No follow-up is needed if nearby glazing remains intact
D. The column may have severe capacity loss requiring restricted use

23. A four-level building has effective seismic weights of 800, 780, 760, and 720 kips. If the exercise specifies $C_s = 0.12$ and $V = C_sW$, what is the base shear?

A. 367.2 kips
B. 306.0 kips
C. 410.4 kips
D. 3,060 kips

24. For another building, the effective seismic weight is 4,100 kips and the stated seismic coefficient is 0.085. Using V = CsW, determine V.

A. 287.0 kips
B. 410.0 kips
C. 348.5 kips
D. 4,185 kips

25. In a vertical-force distribution, the weighted term wxhx^k for one level is 18,900 and the sum of all weighted terms is 62,000. If V = 920 kips, what force Fx acts at that level?

A. 153.3 kips
B. 304.8 kips
C. 639.5 kips
D. 280.5 kips

26. A roof level is assigned 42 percent of an 860-kip base shear by the specified vertical-distribution calculation. What lateral force acts at the roof?

A. 206.4 kips
B. 420.0 kips
C. 361.2 kips
D. 498.8 kips

27. At the second story, the lateral forces applied at that level and above are 135, 150, and 165 kips. What is the story shear immediately below that level?

A. 450 kips
B. 165 kips
C. 315 kips
D. 495 kips

28. A diaphragm-force exercise gives an average acceleration ratio of 0.16 for a floor with seismic weight 650 kips. Using Fpx = 0.16wpx, what is Fpx?

A. 65 kips
B. 104 kips
C. 81.3 kips
D. 156 kips

29. A wall anchorage check uses a specified out-of-plane coefficient of 0.40 on a tributary wall weight of 90 kips. What anchorage force results?

A. 36 kips
B. 22.5 kips
C. 40 kips
D. 54 kips

30. An out-of-plane wall-force exercise specifies F = 0.25W for a wall segment weighing 120 kips. What is the design force?

A. 24 kips
B. 48 kips
C. 30 kips
D. 90 kips

31. A preliminary period model is prescribed as Ta = Ct hn^x. Insert Ct = 0.020, hn = 64 ft, and x = 0.75 and report Ta to three decimals.

A. 0.320 s
B. 0.512 s
C. 1.280 s
D. 0.453 s

32. A period limit for an exercise is defined as CuTa. If Cu = 1.40 and Ta = 0.46 s, what is the limit?

A. 0.329 s
B. 0.644 s
C. 0.460 s
D. 1.860 s

33. Use Cs = SDS/(R/Ie) for a simplified base-shear exercise. If SDS = 1.00, R = 5.0, and Ie = 1.0, what is Cs?

A. 0.10
B. 0.20
C. 0.50
D. 5.00

34. A building has floor seismic weights of 980, 960, 940, and 920 kips. The exercise also includes 25 percent of a 400-kip storage load. What effective seismic weight is used?

A. 3,800 kips
B. 4,000 kips
C. 4,200 kips
D. 3,900 kips

35. Two parallel frame lines have lateral stiffnesses of 60 and 40 kips/in and share a 500-kip story force in proportion to stiffness. What force goes to the 60-kip/in line?

A. 200 kips
B. 250 kips
C. 300 kips
D. 360 kips

36. Using the same two frame lines with stiffnesses 60 and 40 kips/in and a 500-kip story force, what force goes to the 40-kip/in line?

A. 200 kips
B. 140 kips
C. 250 kips
D. 300 kips

37. A flexible diaphragm transfers 360 kips to two parallel resisting lines according to tributary widths. One line supports 48 ft of a total 120-ft width. What force does it receive?

A. 144 kips
B. 96 kips
C. 180 kips
D. 216 kips

38. A parapet segment has seismic weight 18 kips and the exercise specifies a lateral coefficient of 0.80. What force acts on the parapet?

A. 9.0 kips
B. 18.0 kips
C. 22.5 kips
D. 14.4 kips

39. A collector must carry a 170-kip floor force plus 65 kips transferred from an adjacent diaphragm segment. What axial collector force is required in this simplified equilibrium check?

A. 105 kips
B. 170 kips
C. 235 kips
D. 255 kips

40. Three floor forces of 120, 150, and 170 kips act at heights of 12, 24, and 36 ft above the base. What is the total overturning moment about the base?

A. 7,920 kip-ft
B. 11,160 kip-ft
C. 10,080 kip-ft
D. 15,840 kip-ft

41. If the 11,160 kip-ft overturning moment in a simplified foundation model is resisted by a vertical force couple separated by 50 ft, what couple force is required?

A. 111.6 kips
B. 279.0 kips
C. 223.2 kips
D. 558.0 kips

42. For accidental torsion, this exercise uses an eccentricity equal to 5 percent of a 120-ft diaphragm dimension. What eccentricity is applied?

A. 3 ft
B. 6 ft
C. 5 ft
D. 12 ft

43. A 480-kip diaphragm force acts with the 6-ft accidental eccentricity from the exercise. What torsional moment does that eccentricity create?

A. 2,880 kip-ft
B. 480 kip-ft
C. 2,400 kip-ft
D. 3,360 kip-ft

44. A 60-ft-deep diaphragm must resist an in-plane moment of 3,600 kip-ft by a tension-compression chord couple. What axial force magnitude is required in each chord?

A. 30 kips
B. 90 kips
C. 216 kips
D. 60 kips

45. At a 140-ft-long diaphragm transfer interface, the total shear crossing the line is 420 kips. Assuming uniform average transfer, what unit shear acts along the interface?

A. 3.0 kips/ft
B. 1.5 kips/ft
C. 2.8 kips/ft
D. 6.0 kips/ft

46. A story force of 520 kips is shared by two wall lines with stiffnesses 35 and 45 units. What direct force goes to the 35-unit line?

A. 195.0 kips
B. 260.0 kips
C. 227.5 kips
D. 292.5 kips

47. For a simplified orthogonal response combination, the exercise specifies SRSS = sqrt(Fx^2 + Fy^2). If Fx = 320 kips and Fy = 240 kips, what is the combined value?

A. 280 kips
B. 360 kips
C. 560 kips
D. 400 kips

48. A top-story force of 98 kips and two forces below it of 112 and 126 kips all lie above a section cut. What story shear acts at the cut?

A. 224 kips
B. 336 kips
C. 238 kips
D. 294 kips

49. A mechanical component weighs 12 kips and a simplified component-force coefficient of 0.44 is specified. What lateral component force results?

A. 3.00 kips
B. 6.60 kips
C. 12.44 kips
D. 5.28 kips

50. A rooftop component weighs 8.5 kips and the stated seismic coefficient for the exercise is 0.62. What force acts on the component?

A. 5.27 kips
B. 3.23 kips
C. 8.50 kips
D. 13.77 kips

51. A nonbuilding tank has effective seismic weight 260 kips and the exercise specifies V = 0.18W. What base shear is obtained?

A. 36.4 kips
B. 46.8 kips
C. 52.0 kips
D. 78.0 kips

52. The 46.8-kip tank base shear acts at an effective height of 14 ft. What overturning moment does it create at the base?

A. 327.6 kip-ft
B. 468.0 kip-ft
C. 655.2 kip-ft
D. 842.4 kip-ft

53. An equipment item is modeled as a single mass with m = 2.4 consistent mass units and lateral stiffness k = 240 consistent force/length units. Using T = 2pi sqrt(m/k), what is T to three decimals?

A. 0.100 s
B. 0.314 s
C. 0.628 s
D. 1.257 s

54. A suspended component has a total lateral design force of 28 kips resisted equally by two identical braces. What force does each brace carry in the symmetric idealization?

A. 14 kips
B. 7 kips
C. 28 kips
D. 56 kips

55. A masonry parapet strip contributes 40 kips of tributary seismic weight. A simplified lateral coefficient of 0.75 applies to the strip. Determine the resulting line force.

A. 10 kips
B. 20 kips
C. 53.3 kips
D. 30 kips

56. An equipment anchorage couple must resist 180 kip-in of overturning moment with tension and compression anchors separated by 36 in. What force is required in the couple?

A. 2.5 kips
B. 5.0 kips
C. 6.5 kips
D. 10.0 kips

57. A nonbuilding structure weighs 340 kips and the exercise gives a seismic coefficient of 0.22. What design base shear is used?

A. 74.8 kips
B. 57.8 kips
C. 68.0 kips
D. 102.0 kips

58. A rigid vessel weighs 95 kips and a simplified lateral coefficient of 0.30 is specified. What lateral force acts at its center of mass?

A. 19.0 kips
B. 31.7 kips
C. 66.5 kips
D. 28.5 kips

59. A piping run has a total seismic brace force of 20 kips shared equally by four identical braces. What force is assigned to each brace?

A. 4 kips
B. 10 kips
C. 5 kips
D. 20 kips

60. For a rooftop unit, use the supplied relation Fp = 0.4apSDSWp/(Rp/Ip). Taking ap = 1.0, SDS = 1.0, Wp = 10 kips, Rp = 2.5, and Ip = 1.0, calculate Fp.

A. 0.8 kips
B. 1.6 kips
C. 4.0 kips
D. 10.0 kips

61. Use the same supplied component equation Fp = 0.4apSDSWp/(Rp/Ip). For ap = 2.5, SDS = 0.9, Wp = 6 kips, Rp = 3.0, and Ip = 1.5, what is Fp?

A. 1.35 kips
B. 2.7 kips
C. 4.05 kips
D. 5.4 kips

62. A mounted component keeps the same mass but its support stiffness is reduced to one-quarter of its original value. Using T proportional to sqrt(m/k), how does its natural period change?

A. The period halves
B. The period stays unchanged
C. The period doubles
D. The period becomes four times larger

63. At a floor treated as rigid in plane, a 600-kip direct shear is resisted by three lines having stiffness indices 30, 45, and 25. With torsion omitted, find the share carried by the 30-index line.

A. 180 kips
B. 150 kips
C. 200 kips
D. 270 kips

64. For the same 600-kip rigid-diaphragm force and stiffnesses 30, 45, and 25 units, what direct force goes to the 45-unit line?

A. 150 kips
B. 180 kips
C. 300 kips
D. 270 kips

65. For the same diaphragm and stiffnesses 30, 45, and 25 units, what direct force goes to the 25-unit line?

A. 120 kips
B. 180 kips
C. 270 kips
D. 150 kips

66. In plan, three resisting lines lie at x = 0, 30, and 60 ft and have stiffness indices 20, 30, and 50. Determine the stiffness-weighted x location of the rigidity center.

A. 39 ft
B. 30 ft
C. 45 ft
D. 52 ft

67. The floor mass centroid lies at x = 48 ft, while the stiffness-weighted rigidity center lies at x = 39 ft. What plan eccentricity separates these two points?

A. 4.5 ft
B. 39 ft
C. 9 ft
D. 87 ft

68. A 600-kip diaphragm force acts through the center of mass with 9 ft of eccentricity from the center of rigidity. What torsional moment results?

A. 1,800 kip-ft
B. 5,400 kip-ft
C. 3,600 kip-ft
D. 6,600 kip-ft

69. For one rigid-diaphragm line, use the torsional-force expression Ft = Mkr/Sigma(kr^2). If M = 5,400 kip-ft, kr = 1,200, and Sigma(kr^2) = 540,000, what is Ft?

A. 6 kips
B. 12 kips
C. 18 kips
D. 45 kips

70. If a resisting line has 180 kips of direct shear and 12 kips of torsional shear acting in the same direction, what total line shear is used?

A. 168 kips
B. 180 kips
C. 192 kips
D. 216 kips

71. A flexible diaphragm transfers 450 kips by tributary width. One wall line supports 36 ft of a total 90-ft diaphragm width. What force does that wall receive?

A. 135 kips
B. 225 kips
C. 270 kips
D. 180 kips

72. At adjacent levels j and j+1, the elastic lateral displacements are 1.1 in and 2.9 in, respectively. What relative elastic drift occurs across that story?

A. 1.8 in
B. 1.1 in
C. 2.0 in
D. 4.0 in

73. Normalize a relative story movement of 1.8 in by a story height of 144 in. What dimensionless drift ratio results?

A. 0.0125
B. 0.0083
C. 0.0180
D. 0.0800

74. A displacement-amplification exercise specifies Delta = Cd deltae/Ie. If Cd = 5.5, deltae = 0.80 in, and Ie = 1.0, what is Delta?

A. 0.15 in
B. 4.4 in
C. 1.45 in
D. 6.3 in

75. A story carries 800 kips of gravity load and has a lateral drift of 0.35 ft. Using M = PDelta, what secondary moment is produced?

A. 140 kip-ft
B. 228.6 kip-ft
C. 280 kip-ft
D. 800 kip-ft

76. For a cantilever wall idealized with lateral stiffness k = 3EI/h^3, what happens to k if EI doubles while height stays unchanged?

A. The stiffness halves
B. The stiffness quadruples
C. The stiffness stays unchanged
D. The stiffness doubles

77. For a cantilever with top displacement proportional to h^3 when load and EI are unchanged, by what factor does displacement increase if height increases by 20 percent?

A. 1.728
B. 1.200
C. 1.440
D. 2.000

78. A diaphragm moment is 4,800 kip-ft and the effective chord spacing is 80 ft. What axial chord force is required by the force couple?

A. 40 kips
B. 60 kips
C. 80 kips
D. 120 kips

79. A collector must carry 110 kips from one diaphragm region and 75 kips transferred from another. What collector force results from equilibrium?

A. 35 kips
B. 110 kips
C. 225 kips
D. 185 kips

80. A diaphragm shear of 350 kips is transferred along a 100-ft resisting line. What average unit shear acts along the line?

A. 2.5 kips/ft
B. 3.0 kips/ft
C. 3.5 kips/ft
D. 7.0 kips/ft

81. Three floor masses expressed as weights are 100, 200, and 300 units at x = 0, 20, and 50 ft. What is the x-coordinate of the center of mass?

A. 31.67 ft
B. 23.33 ft
C. 30.00 ft
D. 41.67 ft

82. A calculated mass center lies at x = 31.67 ft and the rigidity center lies at x = 27.00 ft. Determine the magnitude of their plan offset.

A. 2.34 ft
B. 27.00 ft
C. 58.67 ft
D. 4.67 ft

83. For a 100-ft diaphragm dimension, an analysis exercise specifies accidental eccentricity of 5 percent of the dimension. What accidental eccentricity is used?

A. 2.5 ft
B. 10 ft
C. 5 ft
D. 20 ft

84. For one loading direction, the inherent eccentricity is 4.67 ft and accidental eccentricity adds 5.00 ft in the same sense. What total design eccentricity is used in this simplified check?

A. 0.33 ft
B. 9.67 ft
C. 4.84 ft
D. 23.35 ft

85. A modal-response exercise specifies SRSS = sqrt(R1^2 + R2^2). If R1 = 150 and R2 = 200, what combined response is obtained?

A. 175
B. 225
C. 250
D. 350

86. For another SRSS check, modal responses are 90 and 120. What combined response is obtained?

A. 150
B. 105
C. 135
D. 210

87. Two wall lines with stiffnesses 40 and 60 units resist a 300-kip direct diaphragm force. What force goes to the 40-unit line?

A. 90 kips
B. 120 kips
C. 150 kips
D. 180 kips

88. For the same two wall lines with stiffnesses 40 and 60 units resisting 300 kips, what direct force goes to the 60-unit line?

A. 120 kips
B. 150 kips
C. 240 kips
D. 180 kips

89. In a concrete frame hinge zone expected to cycle well beyond first yield, what function is provided by closely spaced hoops or ties?

A. It removes axial load from the hinge region
B. It confines concrete and restrains longitudinal-bar buckling during cycling
C. It replaces the main flexural reinforcement at hinges
D. It eliminates bar anchorage and development requirements entirely

90. Why are lap splices generally undesirable in the most highly strained portion of an intended reinforced-concrete plastic hinge?

A. Bond deterioration can undermine the intended ductile hinge mechanism
B. Lap splices always increase plastic-hinge curvature capacity substantially
C. Splices prevent the reinforcing bars from yielding in tension
D. Concrete cover alone fully develops the longitudinal reinforcement

91. During fabrication of a seismic steel moment connection, what is a key quality-control objective for critical welds?

A. Judge weld acceptance primarily from the final paint color
B. Change electrode type whenever field fit-up becomes difficult
C. Verify specified weld procedures, materials, fit-up, and inspection
D. Skip required inspection when finished welds appear visually smooth

92. A steel brace connection uses a gusset plate intended to permit stable brace deformation. Why is connection geometry important?

A. Gusset geometry changes only the architectural appearance of braces
B. A thicker gusset automatically resolves every seismic connection concern
C. Brace axial force disappears once it reaches the gusset plate
D. Bad geometry can cause restraint, buckling, or premature fracture

93. In reinforced-masonry construction, why should grout placement and reinforcement position be inspected carefully?

A. They ensure the intended reinforced-masonry seismic load path develops
B. They matter mainly for the finished wall color and texture
C. Grout placement makes reinforcing-bar location unimportant for performance
D. Masonry walls never experience cyclic tension during earthquake response

94. Why are sheathing nail spacing and edge distance important in a wood structural panel shear wall?

A. They establish the mapped spectral acceleration values for the site
B. They eliminate overturning tension from wood shear-wall end posts
C. They govern connection strength, ductility, and splitting risk under cycling
D. They determine how quickly unrelated concrete elements finish curing

95. A diaphragm collector crosses a construction joint before entering a shear wall. What is the essential detailing objective?

A. Allow the collector to terminate freely at the construction joint
B. Provide developed continuity for cyclic axial force across the joint
C. Rely on architectural finish materials to transfer collector forces
D. Detail the collector for force acting in only one direction

96. Why is positive anchorage between a concrete or masonry wall and a diaphragm a critical seismic detail?

A. It intentionally increases roof dead load to improve stability
B. It removes every in-plane shear force from the wall
C. It prevents all possible forms of foundation settlement below walls
D. It transfers wall inertia to the diaphragm and preserves support

97. For a post-installed anchor carrying seismic tension near a concrete edge, why must edge distance and concrete condition be evaluated in addition to anchor steel strength?

A. The steel fastener always governs every seismic anchor design
B. Concrete edge geometry has no effect on anchorage resistance
C. Concrete breakout can govern before the steel fastener reaches strength
D. Placing anchors closer to edges always increases their capacity

98. Mechanical piping bridges a seismic joint where two building wings can move independently. Which detailing approach best protects the piping from imposed relative displacement?

A. Provide flexibility and clearance so relative building movement does not rupture the piping
B. Rigidly use the pipe to tie the buildings together
C. Remove all supports near the joint
D. Add water weight to resist drift

99. Field inspection reveals that a seismic brace connection does not match the approved construction detail. What action should occur before that connection is accepted?

A. Accept the connection because the physical installation is complete
B. Leave the deviation out of the final inspection documentation
C. Assume the changed detail has equal capacity without review
D. Document it and obtain approved engineering evaluation before acceptance

100. Which activity best describes structural observation during construction of a seismic-force-resisting system?

A. Replace every special inspection required for seismic construction
B. Provide focused professional review of significant work and deviations
C. Guarantee that the completed building will suffer zero damage
D. Eliminate the need for approved structural construction documents

Practice Exam 12: Answer Key and Explanations

1. C — The supplied relationship is a direct product: SMS = 1.18(1.06g) = 1.2508g, which rounds to 1.251g. Dividing by Fa, leaving Ss unchanged, or adding the inputs does not follow the stated site-modification expression. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

2. A — Multiplying the one-second mapped value by the supplied site coefficient gives SM1 = 1.70(0.44g) = 0.748g. The alternatives result from division, addition, or inserting an unrelated multiplier rather than using the stated product. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

3. B — Applying the stated two-thirds factor gives SDS = (2/3)(1.32g) = 0.88g. Halving the value, leaving it unchanged, or multiplying by 1.5 produces different quantities and does not satisfy the spectrum definition provided in the stem. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

4. D — Two-thirds of 0.69g equals 0.46g, so that is the design one-second spectral value under the rule given. The distractors correspond to approximately one-half, no reduction, or a 1.5 multiplier rather than the required two-thirds factor. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

5. A — The transition period is the ratio 0.46/0.88 = 0.5227 second, which rounds to 0.523 second. Reversing the ratio, adding the ordinates, or multiplying them would create quantities with different meanings and would not satisfy the supplied equation. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

6. D — Multiplying 0.523 second by 0.2 gives 0.1046 second, which rounds to 0.105 second. Halving the transition period, leaving it unchanged, or dividing by 0.2 are different operations and do not follow the stated spectrum construction. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

7. C — Loose saturated granular soil can lose substantial effective stress and stiffness during strong shaking, producing liquefaction, settlement, lateral spreading, or related ground deformation. Those mechanisms are geotechnical seismic hazards, unlike timber shrinkage, thermal movement, or coating deterioration, which are durability or environmental issues rather than earthquake-induced soil response. That relationship governs the stated idealization.

8. B — Seismic design criteria reflect not only the regional hazard and site response but also the consequences associated with occupancy and function. A higher risk category can increase required reliability or performance through the governing design framework. Roof color, concrete slump, and window area do not define regional seismic hazard or geotechnical site classification.

9. B — With equal mass, period varies inversely with the square root of stiffness. Therefore TA/TB = 1/sqrt(2.25) = 1/1.5 = 0.667. The other choices use the stiffness ratio directly, its reciprocal, or an incorrect linear relationship. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

10. A — Parallel resisting lines undergo the same story displacement, so their restoring forces add. The effective stiffness is therefore 26 + 44 = 70 kips/in. Subtracting, averaging, or multiplying the two stiffnesses does not represent the force-displacement relation for elements acting in parallel. That relationship governs the stated idealization. That relationship governs the stated idealization.

11. D — With stiffness unchanged, the period scales with the square root of mass. The factor is sqrt(1.44) = 1.20, so the period increases by twenty percent. The distractors use the mass factor directly, its reciprocal, or an unrelated combined factor. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

12. C — Damping dissipates vibration energy during cyclic motion and generally reduces peak dynamic response, especially near resonance. Increasing damping does not double mass, drive the natural period to zero, or eliminate the need for adequate strength and deformation capacity. The structure still must carry inertia forces and sustain the resulting cyclic demands.

13. B — The secondary moment estimate is the axial gravity load multiplied by the lateral offset: 620 kips times 0.75 inch = 465 kip-in. The other values come from dividing by the drift, omitting the drift, or combining the inputs incorrectly. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

14. A — Redundancy provides multiple participating elements or load paths so loss of strength in one location is less likely to cause immediate system failure. It does not guarantee zero deformation, eliminate torsion, or remove foundation demand. Instead, it improves the ability of the structural system to redistribute cyclic forces after local yielding or damage.

15. D — Eccentricity between the centers of mass and rigidity creates torsional moment when lateral inertia forces act through the mass center. That rotation can increase demand on perimeter elements and produce uneven force distribution. The condition does not imply only settlement, uniform axial shortening, or the disappearance of diaphragm shear. That relationship governs the stated idealization.

16. A — For the stated simplified check, the critical relative closing movement is the sum of the two movements toward the joint: 1.8 + 1.2 = 3.0 inches. Subtracting or averaging the movements would underestimate the possible relative displacement when the structures move toward one another. That relationship governs the stated idealization.

17. C — Unreinforced masonry walls can separate from flexible diaphragms and fall out of plane when anchorage is weak. Positive wall-to-diaphragm ties and a continuous load path directly address that vulnerability. Added roof weight can increase seismic demand, while partition removal or paint thickness does not provide the needed structural anchorage. That relationship governs the stated idealization.

18. C — Heavy concrete wall panels require reliable out-of-plane anchorage to the roof diaphragm so inertia forces can be transferred without separation. Weak ties can permit panels to pull away and lose support. Column shortening, corrosion, and roofing behavior are different mechanisms and do not represent the primary seismic vulnerability described. That relationship governs the stated idealization.

19. D — A weak, flexible first story can concentrate drift and inelastic demand at one level, creating a soft-story collapse mechanism. Strengthening or stiffening that story while preserving compatible force transfer reduces the concentration. Adding roof mass raises demand, and removing upper connections or first-story resistance would worsen rather than improve the condition.

20. B — Flat-slab connections may experience gravity shear together with unbalanced moment and cyclic drift during an earthquake. Limited punching-shear capacity can produce a brittle local failure with little warning and can jeopardize vertical-load support. The connection is therefore a seismic vulnerability even though the slab may appear adequate under ordinary service conditions.

21. B — A brittle gusset or connection can interrupt the load path before the brace develops the deformation mechanism assumed for seismic response. Retrofit should shift the hierarchy toward stable, ductile behavior by strengthening or re-detailing the connection as appropriate. Intentionally weakening the joint, removing connections, or adding mass would not achieve that objective.

22. D — Wide diagonal cracking, concrete crushing, and bar buckling indicate substantial inelastic damage and possible loss of shear strength, confinement, or axial-load stability. Those signs should not be treated as cosmetic. A rapid evaluation should recognize the potential hazard and trigger appropriate restriction, shoring, or detailed engineering assessment rather than assuming the member remains reliable.

23. A — The effective seismic weight is 800 + 780 + 760 + 720 = 3,060 kips. Applying the supplied coefficient gives V = 0.12(3,060) = 367.2 kips. The distractors reflect omitting the coefficient, using a different coefficient, or reporting weight instead of shear. That relationship governs the stated idealization. That relationship governs the stated idealization.

24. C — The base shear follows directly from the stated coefficient and seismic weight: V = 0.085(4,100) = 348.5 kips. The other choices result from using a different percentage, multiplying by 0.10, or adding the coefficient numerically to the weight rather than applying it as a multiplier. That relationship governs the stated idealization.

25. D — The level coefficient is 18,900/62,000 = 0.30484. Multiplying by the base shear gives Fx = 0.30484(920) = 280.45 kips, or 280.5 kips. The alternatives confuse the coefficient with a force or use the complement or another incorrect ratio. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

26. C — The assigned roof force is simply 0.42 times the total base shear: 0.42(860) = 361.2 kips. The distractors represent an unrelated percentage, confusing percent with kips, or using the remaining 58 percent instead of the stated 42 percent share. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

27. A — Story shear equals the sum of the lateral forces at and above the level being cut. Adding 135 + 150 + 165 gives 450 kips. Using only the top force, omitting one contribution, or adding an extra value would not satisfy equilibrium of the portion of the building above the cut.

28. B — The diaphragm force is the stated acceleration ratio times the floor seismic weight: 0.16(650) = 104 kips. The alternatives correspond to ten percent, an incorrect division, or twenty-four percent of the floor weight rather than the supplied sixteen percent. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

29. A — Multiplying the tributary wall weight by the specified coefficient gives 0.40(90) = 36 kips. The other values reflect a different coefficient, confusing forty percent with forty kips, or using sixty percent instead of the stated forty percent. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

30. C — The design force is one quarter of the stated wall weight: 0.25(120) = 30 kips. The other options use twenty percent, forty percent, or the remaining seventy-five percent instead of the supplied coefficient. No additional factor is required by the problem statement. That relationship governs the stated idealization. That relationship governs the stated idealization.

31. D — Substituting the supplied values gives Ta = 0.020(64^0.75) = 0.45255 second, which rounds to 0.453 second. The distractors use simpler linear or square-root treatments that do not follow the exponent in the stated empirical expression. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

32. B — The specified upper period is the product 1.40(0.46) = 0.644 second. Dividing by Cu, leaving Ta unchanged, or adding the two numbers does not represent the supplied limit expression. The units remain seconds because Cu is dimensionless. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

33. B — The denominator R/Ie is 5.0/1.0 = 5.0, so Cs = 1.00/5.0 = 0.20. The distractors result from dividing by ten, halving the spectral value, or reporting the response modification coefficient itself instead of the calculated seismic coefficient. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

34. D — The floor weights total 3,800 kips. The included storage contribution is 0.25(400) = 100 kips, giving W = 3,900 kips. Ignoring the storage share, including half of it, or including the entire 400 kips leads to the other values. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

35. C — The 60-kip/in line provides 60/(60 + 40) = 0.60 of the total stiffness. Its direct share is therefore 0.60(500) = 300 kips. Equal sharing, assigning the smaller-line fraction, or using seventy-two percent would not reflect stiffness-proportional distribution. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

36. A — The 40-kip/in line provides 40 percent of the combined 100-kip/in stiffness. Its direct share is therefore 0.40(500) = 200 kips. The other choices represent an unrelated percentage, equal sharing, or the force assigned to the stiffer line. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

37. A — For a flexible-diaphragm tributary idealization, the line receives 48/120 = 0.40 of the total force. Thus its share is 0.40(360) = 144 kips. The distractors use different fractions, equal sharing, or the complementary tributary width. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

38. D — The lateral force is 0.80(18) = 14.4 kips. The alternative values use one-half of the weight, the full weight without the coefficient, or divide by 0.80. Applying the stated coefficient directly gives the only result consistent with the exercise. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

39. C — The collector must transmit both contributions through the load path, so the axial force is 170 + 65 = 235 kips. Ignoring the transferred diaphragm force, subtracting it, or adding an unrelated amount would not satisfy equilibrium at the collector connection. Because the governing expression is supplied in the stem, unrelated code coefficients should not be introduced into the calculation.

40. B — The overturning moment is the sum of each lateral force times its height: 120(12) + 150(24) + 170(36) = 1,440 + 3,600 + 6,120 = 11,160 kip-ft. The alternatives omit or misplace one of the force-height products. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

41. C — A force couple produces moment Fd, so F = M/d = 11,160/50 = 223.2 kips. Using twice the lever arm, forty feet, or twenty feet gives the other values and does not match the stated fifty-foot separation. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

42. B — Five percent of the stated diaphragm dimension is 0.05(120) = 6 ft. The distractors represent 2.5 percent, confusing the percentage number with feet, or using ten percent. The exercise asks only for the stated accidental eccentricity calculation. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

43. A — Torsional moment is force times eccentricity, so M = 480(6) = 2,880 kip-ft. The other values omit the eccentricity, use five feet, or use seven feet. Multiplication by the stated six-foot lever arm gives the required moment. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

44. D — The chord force pair resists the diaphragm moment through the couple Fd. Thus F = 3,600/60 = 60 kips. The distractors use a doubled lever arm, a forty-foot lever arm, or multiply instead of divide. The chord pair must provide the stated moment through its separation. That relationship governs the stated idealization.

45. A — Average unit shear is total shear divided by resisting length: 420/140 = 3.0 kips/ft. The alternatives correspond to doubling the length, using a nearby rounded divisor, or halving the length. The stated average assumes uniform distribution over the full 140 feet. Because the governing expression is supplied in the stem, unrelated code coefficients should not be introduced into the calculation.

46. C — The 35-unit line has 35/(35 + 45) = 35/80 of the total lateral stiffness. Its direct share is therefore 520(35/80) = 227.5 kips. Equal sharing or use of another fraction would not represent the stated stiffness-proportional distribution. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

47. D — Using the supplied square-root-of-sum-of-squares expression gives sqrt(320^2 + 240^2) = sqrt(160,000) = 400 kips. The alternatives come from averaging, using another linear combination, or simply adding the two forces. SRSS is not ordinary arithmetic addition. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

48. B — The story shear at the section cut equals the sum of all lateral forces acting above it: 98 + 112 + 126 = 336 kips. Omitting one contribution or combining only two floors would violate equilibrium of the free body above the cut. That relationship governs the stated idealization. That relationship governs the stated idealization.

49. D — The lateral force is 0.44(12) = 5.28 kips. The other values use twenty-five percent, fifty-five percent, or add the coefficient numerically to the weight. The exercise supplies the governing coefficient directly, so no additional amplification factor is needed. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

50. A — Multiplying the component weight by the stated coefficient gives 0.62(8.5) = 5.27 kips. The alternatives use the complementary fraction, omit the coefficient, or add the force to the weight. The calculation is a direct force coefficient times component weight. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

51. B — The stated base-shear relation gives V = 0.18(260) = 46.8 kips. The distractors correspond to fourteen, twenty, or thirty percent of the weight. Since the coefficient is given, the task is a direct multiplication without importing additional tank parameters. Checking units and the expected order of magnitude provides a useful independent screen on the arithmetic before selecting an option.

52. C — The overturning moment is force times height: 46.8(14) = 655.2 kip-ft. The other values use a seven-foot, ten-foot, or eighteen-foot lever arm. The stated fourteen-foot effective height is the moment arm for this simplified tank model. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

53. C — The mass-to-stiffness ratio is 2.4/240 = 0.01, whose square root is 0.1. Multiplying by 2pi gives T = 0.6283 second, or 0.628 second. The distractors omit 2pi, use pi only, or double the correct result. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

54. A — Equal sharing between two identical braces gives 28/2 = 14 kips per brace. Seven kips would imply four equal braces, while twenty-eight and fifty-six kips ignore or reverse the load-sharing relationship. The symmetric idealization assumes both braces have equal stiffness and participate equally. That relationship governs the stated idealization. That relationship governs the stated idealization.

55. D — The lateral force is 0.75(40) = 30 kips. The distractors correspond to twenty-five or fifty percent of the weight, or divide by the coefficient rather than multiply. The exercise provides the coefficient directly for the parapet tributary weight. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

56. B — A force couple produces moment Fd, so F = 180/36 = 5.0 kips. Using twice the lever arm gives 2.5 kips, while the other values correspond to different separations. The calculation assumes the simplified couple carries the entire stated overturning moment. Because the governing expression is supplied in the stem, unrelated code coefficients should not be introduced into the calculation.

57. A — The base shear follows from 0.22(340) = 74.8 kips. The distractors correspond to seventeen, twenty, or thirty percent of the weight. Because the coefficient is explicitly supplied, the correct calculation is direct multiplication with no additional adjustment. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

58. D — Applying the stated coefficient gives F = 0.30(95) = 28.5 kips. The other values use twenty percent, divide by three, or use the complementary seventy percent. The problem requires only the direct coefficient-times-weight calculation. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

59. C — Equal distribution among four identical braces gives 20/4 = 5 kips per brace. Four kips would imply five braces, ten kips would imply two, and twenty kips assigns the entire force to one brace. The stated idealization assumes equal stiffness and symmetric participation. That relationship governs the stated idealization. That relationship governs the stated idealization.

60. B — The denominator is Rp/Ip = 2.5. The numerator is 0.4(1.0)(1.0)(10) = 4.0, so Fp = 4.0/2.5 = 1.6 kips. The alternatives omit the denominator, halve the result, or report the component weight instead of the force. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

61. B — Here Rp/Ip = 3.0/1.5 = 2.0. The numerator is 0.4(2.5)(0.9)(6) = 5.4, giving Fp = 5.4/2.0 = 2.7 kips. The distractors represent halving again, using a different denominator, or omitting the denominator entirely. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

62. C — With mass unchanged, period varies inversely with the square root of stiffness. Reducing stiffness to one-quarter multiplies the period by 1/sqrt(1/4) = 2. The period therefore doubles, not halves, remains unchanged, or increases by a factor of four. The remaining choices correspond to reversing the ratio, omitting a stated factor, or making a simple arithmetic error in the supplied relationship.

63. A — The total stiffness is 30 + 45 + 25 = 100 units. The 30-unit line therefore receives 30 percent of the 600-kip force, or 180 kips. The other values correspond to different stiffness fractions or to another line. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

64. D — The 45-unit line provides 45 percent of the total 100-unit stiffness. Its direct share is therefore 0.45(600) = 270 kips. The distractors represent the 25-unit line, the 30-unit line, or an even fifty-percent allocation rather than stiffness-proportional distribution. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

65. D — The 25-unit line contributes one-quarter of the total 100-unit stiffness, so it receives 0.25(600) = 150 kips. The other choices use twenty percent or the shares belonging to the 30-unit and 45-unit lines. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

66. A — The center of rigidity is the stiffness-weighted coordinate: xR = [20(0) + 30(30) + 50(60)]/(20 + 30 + 50) = 3,900/100 = 39 ft. The alternatives are an unweighted average or other coordinates not supported by the stiffness weighting. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

67. C — The inherent eccentricity is the distance between the two centers: |48 - 39| = 9 ft. Dividing the difference, reporting one coordinate, or adding the coordinates does not represent the offset that creates torsional moment under lateral inertia force. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

68. B — The torsional moment is the diaphragm force times the eccentricity: 600(9) = 5,400 kip-ft. The alternatives correspond to three-, six-, or eleven-foot lever arms. The nine-foot offset is the correct moment arm for the simplified torsional equilibrium calculation. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

69. B — Substitution gives Ft = 5,400(1,200)/540,000 = 12 kips. The distractors result from doubling or halving the numerator contribution or using an incorrect divisor. The expression supplied in the stem already contains the needed stiffness and radius terms. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

70. C — When direct and torsional components act in the same direction at the line, they add algebraically: 180 + 12 = 192 kips. Subtracting the torsional component, ignoring it, or doubling it would not represent the stated combination. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

71. D — The tributary fraction is 36/90 = 0.40, so the wall receives 0.40(450) = 180 kips. The alternatives use thirty, fifty, or sixty percent. This result follows the stated flexible-diaphragm tributary idealization rather than stiffness-based rigid-diaphragm distribution. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

72. A — Story drift is the relative lateral displacement between adjacent floors. Subtracting gives 2.9 - 1.1 = 1.8 inches. The other choices report one absolute displacement, use an incorrect difference, or add the two displacements rather than taking their relative movement. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

73. A — The drift ratio is relative displacement divided by story height: 1.8/144 = 0.0125. The alternatives come from using a different displacement, treating inches as feet, or moving the decimal incorrectly. Both numerator and denominator are already in consistent inch units. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

74. B — Substituting the stated values gives Delta = 5.5(0.80)/1.0 = 4.4 inches. The alternatives divide instead of multiply, use another factor, or add the inputs. The importance factor is one, so it does not change the numerator. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

75. C — The secondary P-Delta moment equals the gravity load times lateral offset: 800(0.35) = 280 kip-ft. Halving the drift, dividing by it, or omitting it does not follow the stated expression. The units are consistent because the offset is given in feet. The distractors omit or misapply a required force, moment, stiffness, eccentricity, or deformation relationship for the stated model.

76. D — In the supplied expression, stiffness is directly proportional to EI when height is fixed. Doubling EI therefore doubles k. A halving, fourfold increase, or no change would require a different functional relationship than the stated linear dependence on flexural rigidity. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

77. A — The new height is 1.20 times the original, and displacement varies with the cube of height. Therefore the factor is 1.20^3 = 1.728. The other choices use linear, squared, or doubled scaling instead of the cubic dependence stated in the stem. The distractors omit or misapply a required force, moment, stiffness, eccentricity, or deformation relationship for the stated model.

78. B — The chord force couple satisfies M = Fd, so F = 4,800/80 = 60 kips. The distractors correspond to different lever arms or multiplication rather than division. The pair of chord forces develops the stated diaphragm moment through the eighty-foot separation. The distractors omit or misapply a required force, moment, stiffness, eccentricity, or deformation relationship for the stated model.

79. D — The collector transmits both forces through the same load path, so the axial demand is 110 + 75 = 185 kips. Subtracting the contributions, ignoring one, or adding an unrelated amount would not satisfy equilibrium at the transfer region. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

80. C — Average unit shear equals total shear divided by resisting length: 350/100 = 3.5 kips/ft. The distractors use different divisors or halve the resisting length. The calculation assumes the stated uniform average over the entire one-hundred-foot line. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

81. A — The center of mass is the weight-weighted coordinate: [100(0) + 200(20) + 300(50)]/(100 + 200 + 300) = 19,000/600 = 31.67 ft. The alternatives are unweighted or incorrectly weighted averages and do not place the center according to the stated mass distribution. The distractors omit or misapply a required force, moment, stiffness, eccentricity, or deformation relationship for the stated model.

82. D — The inherent eccentricity is the absolute coordinate difference: |31.67 - 27.00| = 4.67 ft. Halving that difference, reporting the rigidity coordinate, or adding the coordinates does not represent the offset that produces torsional response. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

83. C — Five percent of 100 ft is 0.05(100) = 5 ft. The other options represent 2.5, 10, or 20 percent. This is a direct application of the percentage stated in the analysis exercise and requires no additional torsional amplification. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

84. B — When the two eccentricities act in the same sense, they add algebraically: 4.67 + 5.00 = 9.67 ft. Subtracting, averaging, or multiplying them would not represent the combined lever arm used for the stated torsional load case. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

85. C — Applying the supplied SRSS expression gives sqrt(150^2 + 200^2) = sqrt(62,500) = 250. Averaging, using an intermediate linear combination, or simply adding the responses does not reproduce square-root-of-sum-of-squares combination. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response. That relationship governs the stated idealization.

86. A — The SRSS combination is sqrt(90^2 + 120^2) = sqrt(22,500) = 150. The distractors correspond to an average, another linear blend, or direct addition. SRSS combines squared modal effects and therefore differs from simple arithmetic summation. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

87. B — The total stiffness is 100 units, so the 40-unit line attracts forty percent of the direct force: 0.40(300) = 120 kips. The alternatives represent thirty percent, equal sharing, or the force carried by the stiffer sixty-unit line. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

88. D — The 60-unit line provides sixty percent of the combined stiffness, so its direct force is 0.60(300) = 180 kips. The other values correspond to the flexible line, equal sharing, or an eighty-percent assumption not supported by the given stiffnesses. A sound seismic idealization must satisfy equilibrium while representing the stiffness, geometry, and compatibility relationships that actually control the response.

89. B — Closely spaced transverse reinforcement improves confinement of the concrete core and braces longitudinal bars against buckling when compression and tension reverse during large inelastic cycles. Those functions support stable ductility. The ties do not remove axial load, replace the primary flexural bars, or eliminate anchorage and development requirements. That relationship governs the stated idealization.

90. A — Plastic-hinge regions undergo large cyclic strains and repeated bond demand. Locating a lap splice there can promote slip, splitting, or bond deterioration before the intended flexural mechanism develops fully. Detailing seeks reliable bar continuity through the critical region rather than relying on cover concrete or assuming the splice automatically improves ductility.

91. C — Critical seismic welds depend on qualified procedures, compatible materials, proper fit-up, execution, and the inspection specified by the project requirements. Surface appearance alone cannot demonstrate acceptable toughness or internal quality. Unreviewed changes to electrodes or omission of required inspection can undermine the intended cyclic connection performance. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

92. D — Gusset geometry influences force transfer, brace end rotation, buckling clearance, and local stress concentration. An unfavorable detail can shift damage into the connection and cause brittle fracture before the intended brace mechanism develops. Simply increasing thickness does not automatically correct every geometry problem, and brace force must still pass through the joint.

93. A — Reinforced masonry relies on correctly positioned and developed steel working with fully grouted cells or regions to transfer tension, shear, and flexure. Misplaced bars or incomplete grout can reduce bond, strength, and continuity. Grout does not make reinforcement location irrelevant, and seismic masonry can experience significant cyclic tension demand. That relationship governs the stated idealization.

94. C — Wood shear-wall behavior is governed largely by the sheathing-to-framing connections. Nail spacing and edge distance affect load transfer, cyclic slip, splitting risk, and achievable ductility. These details do not define the seismic hazard, remove overturning tension, or control concrete curing elsewhere in the building. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

95. B — A collector is part of the seismic load path and must transmit gathered diaphragm force through joints into the vertical resisting element. Development, anchorage, and continuity must work for force reversals. Stopping the collector, relying on finishes, or detailing for only one direction can create a weak link under cyclic loading.

96. D — Wall anchorage provides a direct load path for out-of-plane inertia forces from heavy walls into the diaphragm. Without reliable ties, the wall can separate, lose support, or fall outward. The anchorage does not exist to add roof weight, eliminate in-plane shear, or address every possible foundation movement. That relationship governs the stated idealization.

97. C — Post-installed anchors transfer load into surrounding concrete, so edge distance, spacing, cracking, and embedment influence breakout and splitting resistance. The steel fastener may be stronger than the concrete failure mechanism around it. Assuming steel always governs or that a nearby edge increases capacity can produce an unsafe anchorage assessment. That relationship governs the stated idealization.

98. A — Nonstructural piping crossing a separation must accommodate relative movement of the supporting structures. Flexible couplings, loops, or clearance prevent the pipe from becoming an unintended structural tie or rupturing during drift. Removing support or increasing fluid weight would not provide reliable deformation compatibility. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

99. D — A field deviation in a seismic connection can change force transfer, stiffness, anchorage, and cyclic behavior. The inspector should document the condition and obtain evaluation or approved correction before acceptance. Completion of the work or visual similarity does not demonstrate that the substituted detail provides the intended seismic performance. That relationship governs the stated idealization.

100. B — Structural observation gives the responsible design professional selected opportunities to review significant structural construction and identify deviations that may affect intended seismic behavior. It complements rather than replaces special inspection and testing. Observation cannot guarantee future earthquake performance and does not eliminate the need for approved construction documents. That relationship governs the stated idealization.