PRACTICE EXAM 11: 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. In a new site-hazard exercise, use SMS = FaSs. With Fa = 1.25 and Ss = 1.10g, what value is obtained for SMS?

A. 0.880g
B. 1.100g
C. 1.375g
D. 2.350g

2. For a separate one-second hazard check, evaluate SM1 = FvS1 when Fv = 1.55 and S1 = 0.52g.

A. 0.335g
B. 0.806g
C. 1.070g
D. 2.070g

3. A study spectrum has SMS = 1.41g. Using SDS = (2/3)SMS, determine SDS to two decimals.

A. 0.71g
B. 1.41g
C. 2.12g
D. 0.94g

4. For this spectrum calculation, take SD1 = (2/3)SM1. If SM1 = 0.72g, what is SD1?

A. 0.48g
B. 0.36g
C. 0.72g
D. 1.08g

5. A design spectrum uses Ts = SD1/SDS. With SD1 = 0.48g and SDS = 0.94g, what is Ts to two decimals?

A. 0.45 s
B. 1.42 s
C. 1.96 s
D. 0.51 s

6. For an idealized spectrum, set T0 = 0.2Ts. If Ts = 0.51 s, what is T0 to three decimals?

A. 0.255 s
B. 0.510 s
C. 0.102 s
D. 2.550 s

7. Two sites have comparable mapped regional shaking, but one is underlain by stiff rock and the other by a thick soft-soil profile. Which statement best explains why their design spectra can differ?

A. Building occupancy changes the regional fault hazard
B. Local site conditions can modify shaking amplitudes across period ranges
C. Concrete compressive strength changes mapped motion
D. Roof drainage changes subsurface amplification

8. A proposed building footprint crosses a mapped active surface-fault trace. Which earthquake-related site concern is most directly associated with that condition?

A. Permanent ground offset across the fault trace
B. Long-period wind resonance
C. Corrosion of reinforcing steel
D. Thermal shortening of the roof

9. Two single-degree systems have equal mass, but System X has 1.96 times the lateral stiffness of System Y. Using T proportional to sqrt(m/k), what is TX/TY to two decimals?

A. 0.51
B. 1.40
C. 0.71
D. 1.96

10. At one level, lateral elements with stiffnesses 22 and 33 kips/in act in parallel under the same translation. What is their combined stiffness?

A. 11 kips/in
B. 55 kips/in
C. 27.5 kips/in
D. 726 kips/in

11. Near resonance, what is the principal dynamic effect of adding viscous damping to an otherwise unchanged structural system?

A. It doubles the seismic mass
B. It forces the natural period to zero
C. It removes all strength demand
D. It generally reduces the peak vibration response

12. A seismic frame can undergo substantial cyclic deformation after yielding without an abrupt loss of lateral resistance. Which system attribute does this behavior illustrate?

A. Ductility
B. Mass irregularity
C. Foundation settlement
D. Elastic brittleness

13. The center of floor mass is noticeably offset from the center of lateral stiffness. What response effect should an engineer expect under horizontal shaking?

A. Only uniform vertical shortening
B. No change in element force distribution
C. Translation coupled with torsional rotation
D. Elimination of story drift

14. Why is a weak, flexible ground story beneath substantially stiffer upper stories a serious seismic configuration?

A. It forces every story to develop the same drift demand
B. Drift and inelastic demand can concentrate in the weak story
C. It removes overturning effects from the lower-story columns
D. It prevents torsional response from developing in the floor system

15. A building uses several lateral lines that can continue sharing load if one line yields locally. What beneficial seismic characteristic is being provided?

A. Redundancy through alternate effective load paths
B. Zero diaphragm deformation
C. Automatic base isolation
D. Uniform member strength

16. Adjacent buildings have different periods and may move out of phase during strong shaking. Why is adequate separation between them important?

A. To increase their combined dead load
B. To eliminate foundation settlement
C. To make their periods identical
D. To reduce the risk of pounding between the structures

17. An older unreinforced-masonry building has a tall parapet with little positive anchorage back to the roof. Which retrofit most directly addresses the life-safety hazard?

A. Add roof insulation to reduce heat flow through the parapet
B. Increase interior finish thickness along the adjacent roof edge
C. Reduce plumbing fixture weight in rooms below the parapet
D. Brace or anchor the parapet to a reliable diaphragm load path

18. A wood apartment building has an open first-level parking area with few lateral walls and much stronger upper stories. Which retrofit concept most directly targets the vulnerability?

A. Remove upper-story shear walls
B. Increase roof dead load
C. Add lateral strength and stiffness at the open story
D. Make interior partitions more brittle

19. An older concrete frame has columns with sparse transverse reinforcement and short lap splices near likely hinge regions. What behavior is a principal retrofit concern?

A. Brittle loss of column or splice capacity before stable ductile response
B. Excessive roof drainage demand during seasonal storm loading only
C. Long-term timber shrinkage in unrelated nonconcrete framing members
D. Only cosmetic finish cracking with no structural consequence

20. An older precast building relies on small, discontinuous diaphragm-to-frame connections. Why are those connections a priority during seismic evaluation?

A. They mainly control interior acoustic separation between occupied spaces
B. They may interrupt transfer of diaphragm inertia into the vertical resisting system
C. They determine the regional seismic hazard assigned to the site
D. They make the diaphragm remain perfectly rigid during shaking

21. After a damaging earthquake, an engineer finds residual drift, fresh diagonal cracks, and several distressed beam-column connections. What should the immediate engineering evaluation emphasize?

A. Final paint selection
B. Long-term energy efficiency
C. Future landscaping loads
D. Current stability, load-path integrity, and hazards before reoccupancy

22. A retrofit is being developed for an older diaphragm whose connections are much weaker than the diaphragm sheathing itself. Which objective is most important?

A. Strengthen the connection force path so forces can reach the vertical system reliably
B. Increase diaphragm mass so larger inertia forces are generated
C. Reduce every vertical resisting element to negligible lateral stiffness
D. Remove edge anchorage so the diaphragm can slide freely

23. A new building has 1,280 kips of structural dead load, 95 kips of permanently attached equipment, and 45 kips of fixed partition weight included in the study case. If these are the only contributors, what effective seismic weight W is used?

A. 1,185 kips
B. 1,420 kips
C. 1,330 kips
D. 1,515 kips

24. For this practice ELF coefficient, use Cs = SDS/(R/Ie). With SDS = 0.84, R = 7, and Ie = 1.0, what is Cs?

A. 0.084
B. 0.147
C. 0.120
D. 5.880

25. A simplified ELF study gives Cs = 0.095 and W = 3,200 kips. What design base shear V = CsW results?

A. 30.4 kips
B. 337 kips
C. 3,295 kips
D. 304 kips

26. For this minimum-coefficient exercise, take Cs as the larger of 0.044SDSIe and 0.01. With SDS = 0.78 and Ie = 1.0, what value governs?

A. 0.0343
B. 0.0100
C. 0.0172
D. 0.0780

27. For vertical force distribution, let k vary linearly from 1.0 at T = 0.5 s to 2.0 at T = 2.5 s. What is k at T = 1.2 s?

A. 1.20
B. 1.50
C. 1.35

D. 1.70

28. A two-level building uses k = 1. Level 1 has w = 120 kips at h = 10 ft; Level 2 has w = 180 kips at h = 26 ft. What fraction Cvx of base shear is assigned to Level 2?

A. 0.204
B. 0.796
C. 0.661
D. 0.867

29. Applied floor forces are 45, 60, and 75 kips from the first occupied level to the roof. What is the story shear just below the second level?

A. 135 kips
B. 60 kips
C. 75 kips
D. 180 kips

30. During an overturning check, a single 110-kip inertia force is applied at roof elevation 32 ft above the foundation reference line. What moment about that reference line does this force contribute?

A. 1,760 kip-ft
B. 3,520 kip-ft
C. 3,410 kip-ft
D. 4,620 kip-ft

31. A diaphragm design force of 210 kips is spread uniformly across a 70-ft resisting width. What average unit shear is implied?

A. 2.1 kips/ft
B. 4.0 kips/ft

C. 14.7 kips/ft
D. 3.0 kips/ft

32. For this wall-anchorage study, use F = 0.4SDSIpWp. With SDS = 0.95, Ip = 1.0, and Wp = 68 kips, what force results?

A. 12.92 kips
B. 27.20 kips
C. 25.84 kips
D. 64.60 kips

33. For one foot of wall length, a 13-ft-tall wall panel is assigned a uniform horizontal inertial pressure of 20 psf. Convert that pressure into the equivalent diaphragm-level line force.

A. 260 lb/ft
B. 130 lb/ft
C. 240 lb/ft
D. 400 lb/ft

34. A floor lateral force of 175 kips acts with 6.5 ft eccentricity from the center of rigidity. What torsional moment is generated?

A. 568.8 kip-ft
B. 1,137.5 kip-ft
C. 1,105 kip-ft
D. 2,275 kip-ft

35. A 48-ft-wide diaphragm has a 3.6-ft offset between its mass and rigidity centers. Express that offset as a percentage of the diaphragm width.

A. 3.6%

B. 12.0%
C. 13.3%
D. 7.5%

36. Estimate an empirical period for a 70-ft structure from the expression Ta = Ct(hn)^x, taking Ct = 0.02 and x = 0.75. Report the period to two decimals.

A. 0.35 s
B. 0.70 s
C. 1.40 s
D. 0.48 s

37. A study period limit uses Cu = 1.30 and Ta = 0.78 s. What is the product CuTa?

A. 0.600 s
B. 0.780 s
C. 1.014 s
D. 1.300 s

38. A building has a study base-shear coefficient Cs = 0.105 and effective seismic weight W = 4,600 kips. What base shear V results?

A. 483 kips
B. 46 kips
C. 438 kips
D. 4,705 kips

39. For an orthogonal-combination exercise, use E = Ex + 0.30Ey. If Ex = 130 kips and Ey = 80 kips, what combined value is obtained?

A. 104 kips

B. 154 kips
C. 130 kips
D. 210 kips

40. A roof diaphragm delivers 108 kips to six identical collector lines that are assumed to share direct load equally. What axial force is assigned to each collector?

A. 12 kips
B. 54 kips
C. 18 kips
D. 108 kips

41. A diaphragm in-plane moment of 2,700 kip-ft is resisted by chord forces separated by 90 ft. What chord force magnitude is required?

A. 15 kips
B. 30 kips
C. 60 kips
D. 243 kips

42. Floor lateral forces are 30, 50, 70, and 95 kips from bottom to top. What total base shear is represented by these applied forces?

A. 245 kips
B. 165 kips
C. 215 kips
D. 315 kips

43. Level 4 moves 2.3 in laterally while the level immediately below moves 1.4 in in the same direction. What relative interstory displacement should be used as the elastic drift?

A. 1.4 in
B. 2.3 in
C. 3.7 in
D. 0.9 in

44. For this displacement exercise, use delta = (Cd/Ie)delta_e. With Cd = 5.5, Ie = 1.25, and delta_e = 0.75 in, what design displacement results?

A. 0.17 in
B. 1.88 in
C. 3.30 in
D. 4.40 in

45. A practice separation rule adds the absolute design displacements of two adjacent buildings. If the values are 2.1 in and 1.9 in, what separation does the rule require?

A. 4.0 in
B. 0.2 in
C. 2.1 in
D. 3.0 in

46. A 14-ft-high story has design drift of 1.56 in. What is the drift ratio as a percentage?

A. 0.56%
B. 1.11%
C. 0.93%
D. 9.29%

47. A diaphragm transfers 168 kips into a 56-ft wall line. What average line demand acts on that wall line?

A. 2.0 kips/ft
B. 3.0 kips/ft
C. 4.0 kips/ft
D. 9.4 kips/ft

48. A collector receives 4.2 kips/ft of diaphragm shear from an 18-ft tributary width. What axial force is accumulated in the collector?

A. 22.2 kips
B. 42.0 kips
C. 84.0 kips
D. 75.6 kips

49. For this component-force exercise, compute Fp = [0.4apSDSWp/(Rp/Ip)](1+2z/h). Use ap=1.0, SDS=0.80, Wp=5 kips, Rp=2.5, Ip=1.0, and z/h=0.25. What is Fp?

A. 0.96 kip
B. 0.64 kip
C. 1.28 kips
D. 2.40 kips

50. In the component height multiplier 1 + 2z/h, what value applies when z/h = 0.40?

A. 0.80
B. 1.40
C. 2.40
D. 1.80

51. A rooftop unit has a 1,200-lb horizontal design force resisted equally by four identical anchors. Ignoring eccentricity, what direct shear is assigned to each anchor?

A. 150 lb
B. 300 lb
C. 400 lb
D. 4,800 lb

52. A nonbuilding structure has effective seismic weight of 700 kips and a simplified design coefficient of 0.16. What base shear is obtained?

A. 70 kips
B. 140 kips
C. 112 kips
D. 716 kips

53. Why can a short, rigid piece of equipment experience substantial seismic acceleration even when its own deformation is small?

A. Small deformation means the equipment develops no inertia force
B. Rigid equipment can be treated as having no seismic mass
C. Its high stiffness can transmit floor acceleration with little internal flexibility
D. Acceleration is governed primarily by the equipment finish materials

54. Why are flexible joints or couplings important where piping crosses a building seismic separation?

A. They make the supported pipe weight negligible during shaking
B. They allow relative structural movement without forcing brittle pipe or connection failure
C. They prevent the supporting floors from accelerating during earthquakes
D. They eliminate the need for properly designed pipe supports

55. A suspended ceiling receives seismic bracing and perimeter detailing. What performance objective is primarily being addressed?

A. Limit hazardous ceiling movement and loss of support during shaking
B. Increase roof dead load to stabilize the ceiling grid
C. Amplify diaphragm torsion so ceiling braces engage earlier
D. Change the geotechnical site class assigned to the building

56. Why should seismic analysis of a partially filled liquid tank distinguish impulsive shell-following motion from convective sloshing motion?

A. Both motions are always identical
B. Sloshing occurs only in empty tanks
C. Liquid motion has no effect on anchorage
D. The two response components have different dynamic characteristics and force effects

57. A hospital component is required to remain functional immediately after an earthquake. Which design consideration becomes especially important beyond simple life safety?

A. Only architectural color selection
B. Anchorage, interaction, and deformation capacity sufficient to preserve operation
C. Reducing all equipment mass to zero
D. Ignoring utility connections

58. A cable tray weighs 35 lb/ft and the braced segment is 30 ft long. What total supported weight belongs to that segment?

A. 1,050 lb
B. 700 lb
C. 1,200 lb
D. 10,500 lb

59. Eight equally effective seismic braces resist a total horizontal component demand of 4.8 kips with no eccentric sharing effects. How much direct force belongs to one brace?

A. 0.40 kip
B. 0.80 kip
C. 38.4 kips
D. 0.60 kip

60. For this practice upper force, use Fmax = 1.6SDSIpWp. If SDS = 0.80, Ip = 1.0, and Wp = 3.0 kips, what is Fmax?

A. 2.40 kips
B. 4.80 kips
C. 3.84 kips
D. 6.00 kips

61. For a parapet check, multiply a 14-kip tributary seismic weight by a prescribed study coefficient of 0.45. What horizontal demand is produced?

A. 3.2 kips
B. 9.5 kips
C. 14.5 kips
D. 6.3 kips

62. Why must equipment anchorage design consider the supporting slab, curb, or framing as well as the anchor fastener itself?

A. The anchor fastener alone determines the site seismic classification used
B. Supporting-member stiffness and strength never influence anchorage force transfer
C. The complete force path can be governed by failure of the supporting material or attachment region
D. Concrete or framing around an anchor cannot govern connection failure

63. A rigid diaphragm translates without torsion while frames of 25 and 50 kips/in resist 210 kips. What direct shear is attracted by the 50-kips/in frame?

A. 70 kips
B. 140 kips
C. 105 kips
D. 160 kips

64. A rigid floor distributes 300 kips among three frames whose relative lateral stiffnesses are 4:6:2. Under pure translation, determine the share carried by the middle frame.

A. 150 kips
B. 75 kips
C. 100 kips
D. 180 kips

65. Two resisting lines lie at x = 0 and x = 40 ft, with stiffnesses 30 and 50 relative units. What is the stiffness-weighted center of rigidity coordinate from x = 0?

A. 15 ft
B. 20 ft
C. 25 ft
D. 31 ft

66. At one floor, the mass centroid is at x = 34 ft and the rigidity centroid is at x = 26 ft. What inherent plan eccentricity magnitude results?

A. 8 ft
B. 4 ft
C. 26 ft
D. 60 ft

67. A floor shear of 240 kips acts with 5.5 ft eccentricity from the center of rigidity. What torsional moment accompanies the direct shear?

A. 660 kip-ft
B. 1,205 kip-ft
C. 2,640 kip-ft
D. 1,320 kip-ft

68. A torsional floor moment of 600 kip-ft is resisted by two symmetric frames, each one relative stiffness unit and 15 ft from the center. Using Vi = M(ki ri)/sum(kj rj^2), find the torsional shear in either frame.

A. 10 kips
B. 20 kips
C. 30 kips
D. 40 kips

69. A flexible diaphragm carries 90 kips of uniformly distributed lateral load between two end wall lines. If tributary width gives equal reactions, what force reaches each wall line?

A. 30 kips
B. 60 kips
C. 45 kips
D. 90 kips

70. An in-plane diaphragm moment of 2,200 kip-ft is resisted by chord forces separated by 55 ft. What axial force magnitude must each chord develop?

A. 40 kips
B. 20 kips
C. 55 kips
D. 121 kips

71. A 24-ft tributary diaphragm strip delivers a uniform 3.6-kips/ft in-plane demand into a drag element. What accumulated axial force must that drag element transmit?

A. 27.6 kips
B. 72.0 kips
C. 96.0 kips
D. 86.4 kips

72. A lateral element resists 110 kips at an elastic displacement of 0.55 in. What secant stiffness k = F/delta is implied?

A. 60 kips/in
B. 110 kips/in
C. 200 kips/in
D. 242 kips/in

73. Model a member as a cantilever and evaluate its tip displacement from PL^3/(3EI). Use P = 15, L = 8, E = 1,200, and I = 1.5 in consistent units, rounding to two decimals.

A. 0.47
B. 1.42
C. 2.13
D. 4.27

74. At a diaphragm level, two independent lateral resisting elements of 42 and 28 kips/in undergo the same translation. What total restoring stiffness do they provide together?

A. 14 kips/in
B. 70 kips/in
C. 35 kips/in
D. 1,176 kips/in

75. A story resists 180 kips at an elastic story drift of 1.20 in. What effective story stiffness k = V/Delta results?

A. 150 kips/in
B. 120 kips/in
C. 180 kips/in
D. 216 kips/in

76. A floor has mass units 50 at x = 12 ft and 70 at x = 36 ft. At what x-coordinate is the combined mass centroid located?

A. 20 ft
B. 24 ft
C. 30 ft
D. 26 ft

77. For a torsion sensitivity study, the prescribed accidental offset is 0.05 times a 72-ft plan dimension. Calculate that offset.

A. 2.5 ft
B. 5.0 ft
C. 14.4 ft
D. 3.6 ft

78. A floor shear of 180 kips acts through 5.0 ft inherent eccentricity plus 3.6 ft accidental eccentricity on the same side. What torsional moment results?

A. 252 kip-ft
B. 900 kip-ft
C. 1,548 kip-ft
D. 1,800 kip-ft

79. For a stability exercise, use theta = PDelta/(Vh). If P = 1,000 kips, Delta = 1.2 in, V = 200 kips, and h = 156 in, what is theta to three decimals?

A. 0.038
B. 0.008
C. 0.077
D. 0.192

80. A 15-ft-high story has design drift of 1.80 in. What is the drift ratio as a percentage?

A. 0.50%
B. 1.00%
C. 1.20%
D. 10.0%

81. Two modal base-shear contributions are 90 and 120 kips. Using square-root-of-sum-of-squares combination, what response is obtained?

A. 105 kips
B. 150 kips
C. 210 kips
D. 250 kips

82. A dynamic model has two modes with very similar frequencies. Why might a correlation-sensitive combination procedure be preferable to treating their peak responses as independent?

A. Closely spaced modes always have negligible participating seismic mass
B. SRSS is intended only for gravity-load combinations in static analysis
C. Their peak responses may not be statistically independent when modal frequencies are close
D. Similar modal frequencies force all natural periods to become zero

83. Why may response-spectrum results be scaled to a specified minimum reference base shear before design forces are finalized?

A. To force every significant vibration mode to have the same period
B. To remove torsional response from the dynamic model entirely
C. To make the seismic mass identical at every floor level
D. To prevent an overly small dynamic result from falling below the required reference strength level

84. Which condition most strongly supports treating a diaphragm as rigid for in-plane distribution in an analytical model?

A. Its in-plane deformation is small relative to the deformation of the vertical resisting system
B. The diaphragm contains no penetrations or openings anywhere in plan
C. The gravity load happens to be uniform over the floor area
D. The building plan is approximately square and geometrically regular

85. Over a 24-ft simply supported strip, lateral line load varies linearly from zero at one end to 8 kips/ft at the other. Determine the resultant force represented by that load diagram.

A. 48 kips
B. 128 kips
C. 192 kips
D. 96 kips

86. For the triangular load that rises from zero at the left to a maximum at the right over 24 ft, where does the resultant act from the zero-load end?

A. 8 ft
B. 16 ft
C. 12 ft
D. 18 ft

87. A simply supported 35-ft diaphragm span carries a 140-kip lateral resultant located 10 ft from the left support. What is the right reaction?

A. 40 kips
B. 28 kips
C. 70 kips
D. 100 kips

88. Why must collectors and drag struts be modeled where diaphragm force paths turn, narrow, or bypass large openings?

A. They replace the need for all diaphragm chord force transfer
B. They support only ceiling finishes and other architectural dead loads
C. They gather and transfer concentrated in-plane forces into the intended vertical resisting elements
D. They eliminate the need to design collector-to-wall connections

89. Why is closely spaced transverse reinforcement provided in reinforced-concrete boundary or hinge regions expected to undergo large cyclic strains?

A. It eliminates axial force from the concrete member during shaking
B. It replaces the longitudinal reinforcement needed for flexural resistance
C. It confines the core and restrains longitudinal-bar buckling during repeated inelastic deformation
D. It removes development and anchorage requirements for longitudinal bars

90. In capacity design of a ductile seismic system, why are certain connections and collectors intentionally designed stronger than the expected yielding region?

A. To make every structural member remain elastic through any earthquake
B. To increase building seismic mass and therefore total inertia force
C. To eliminate all in-plane shear demand from the diaphragm system
D. So inelastic action occurs in the intended ductile mechanism rather than a brittle transfer element

91. A diaphragm chord splice must transfer cyclic axial force across a construction joint. What detailing objective is most important?

A. Use the shortest possible splice regardless of demand
B. Provide a developed, continuous force path for both tension and compression reversals
C. Rely on finish materials for force transfer
D. Allow the splice to separate freely

92. For a seismic steel connection using high-strength bolts, what is a key inspection objective during installation?

A. Confirm the specified bolt type, installation method, and required pretension or snug condition are achieved
B. Check only the beam paint finish and visible coating condition
C. Increase the number of bolts whenever field fit-up is difficult
D. Ignore faying-surface preparation because bolt installation controls everything

93. Why must edge distance, spacing, and concrete condition be checked for a post-installed seismic anchor rather than evaluating only the anchor steel strength?

A. Concrete breakout and group effects can govern before the steel fastener reaches its own strength
B. Anchor steel strength always governs regardless of surrounding concrete geometry
C. Concrete edge distance and spacing have no effect on anchorage
D. Reducing anchor spacing always increases the available seismic capacity

94. During inspection of a wood shear wall, why are nail spacing and edge distances important seismic details?

A. They determine the mapped spectral acceleration values for the site
B. They control panel-to-framing shear transfer and help avoid premature splitting or connection failure
C. They eliminate overturning tension at the ends of the wall
D. They control curing conditions for concrete used elsewhere in construction

95. Why is reinforcement position and lap-splice placement important in reinforced-masonry seismic construction?

A. Reinforcement location affects only wall appearance after construction is complete
B. Grout placement makes reinforcement splice length irrelevant to seismic behavior
C. Misplaced bars or inadequate splices can interrupt the intended tensile and flexural force path
D. Reinforced masonry never develops cyclic tensile demand during earthquake loading

96. A fire-sprinkler branch line crosses between building regions expected to experience relative seismic movement. What detailing principle is most important?

A. Rigidly lock the two moving building regions together through the pipe
B. Remove pipe supports so the branch line can move without restraint
C. Increase contained water weight so inertia stabilizes the piping system
D. Provide flexibility and clearance so imposed building drift does not rupture the piping system

97. A special inspector observes a seismic brace connection installed differently from the approved detail. What is the appropriate quality-control response?

A. Accept it because construction is already complete
B. Hide the deviation in the final report
C. Assume the substitute has equal capacity
D. Document the discrepancy and obtain evaluation or approved corrective direction before acceptance

98. Why is concrete placement and consolidation especially important around congested headed bars, couplers, and transverse reinforcement in seismic zones?

A. Honeycombing improves ductility in heavily reinforced concrete regions
B. Entrapped air can substitute for transverse reinforcement around anchors
C. Voids can impair bond, confinement, and the intended local load-transfer mechanism
D. Concrete consolidation changes the duration of the design earthquake

99. What is the principal role of structural observation on a seismic project during construction?

A. Provide focused professional review of significant structural work and important deviations from design intent
B. Replace every special inspection and testing requirement on the project
C. Guarantee that the completed building will never sustain earthquake damage
D. Eliminate the need for approved structural drawings and specifications

100. A collector connects a diaphragm to a concrete shear wall through embedded reinforcement. Why is continuity through the connection region essential?

A. The connection is needed mainly to support gravity finishes at the wall
B. The gathered diaphragm force must enter the wall without a weak link interrupting the seismic load path
C. The collector force disappears once the drag element reaches the wall face
D. Continuity is unnecessary because concrete self-weight provides adequate seismic transfer

Practice Exam 11: Answer Key and Explanations

1. C — Multiplying the supplied site coefficient by the mapped short-period value gives SMS = 1.25(1.10g) = 1.375g. The other values come from division, leaving the mapped value unchanged, or adding the two inputs instead of applying the stated product. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

2. B — The stated relationship requires multiplication: SM1 = 1.55(0.52g) = 0.806g. Dividing S1 by Fv, adding the inputs, or multiplying by an unrelated factor would not represent the supplied site modification for the one-second spectral ordinate. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

3. D — Applying the stated two-thirds reduction gives SDS = (2/3)(1.41g) = 0.94g. One-half of the input, leaving it unchanged, or increasing it by a factor of 1.5 are different operations and therefore do not satisfy the exercise definition. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

4. A — Two-thirds of 0.72g is 0.48g, so that is the design one-second ordinate under the stated rule. The distractors represent halving the value, omitting the reduction, or multiplying by 1.5 instead of applying the required two-thirds factor. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

5. D — The transition period is the ratio of the one-second and short-period design ordinates: 0.48/0.94 = 0.5106 second, which rounds to 0.51 second. Reversing the ratio, adding the ordinates, or multiplying them leads to different quantities. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

6. C — Multiplying the transition period by 0.2 gives T0 = 0.2(0.51) = 0.102 second. The alternative values correspond to halving, making no reduction, or dividing by 0.2, none of which follows the stated spectrum construction. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

7. B — Mapped hazard describes regional shaking, while near-surface geology can alter the motion reaching the foundation through amplification or deamplification over different period ranges. Occupancy, concrete strength, and roof drainage influence other design issues but do not explain the site-response difference described here. The other choices describe different mechanisms and do not address the seismic behavior identified in the scenario.

8. A — A surface-fault trace presents the possibility of permanent differential ground displacement directly across the site during fault rupture. That mechanism differs from shaking-induced structural vibration and from environmental durability effects such as corrosion or thermal movement. The design concern is the ground offset itself and its effect on foundations and connected systems.

9. C — With equal mass, period varies inversely with the square root of stiffness. Thus TX/TY = 1/sqrt(1.96) = 1/1.4 = 0.714, which rounds to 0.71. The alternatives use the stiffness ratio directly, its reciprocal, or an incorrect linear relationship. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

10. B — Parallel resisting elements experience the same story displacement, so their restoring forces add and the effective stiffness is 22 + 33 = 55 kips/in. Subtraction, averaging, or multiplication does not represent the force-displacement relation for springs that act in parallel. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

11. D — Damping dissipates vibration energy as the structure cycles and therefore generally reduces peak dynamic response, particularly around resonance. It does not automatically alter the seismic mass, collapse the natural period to zero, or eliminate the need for adequate strength and deformation capacity. The other choices describe different mechanisms and do not address the seismic behavior identified in the scenario.

12. A — Ductility is the ability to sustain significant inelastic deformation and repeated cyclic demand while retaining useful strength. Mass irregularity describes distribution of inertia, settlement is a geotechnical movement, and elastic brittleness is essentially the opposite of the stable post-yield behavior described in the stem. This is the governing result for the stated idealization.

13. C — An eccentricity between mass and stiffness creates a torsional moment when inertia forces act, so the floor tends to translate and rotate together. That rotation changes demand among resisting lines. The other choices ignore the plan geometry and do not represent the coupled lateral response of the system. This is the governing result for the stated idealization.

14. B — A sharp stiffness and strength discontinuity can concentrate lateral deformation and damage in the weak story, creating a soft-story mechanism and threatening stability. The configuration does not equalize drift, remove overturning, or guarantee freedom from torsion; instead it localizes demand where capacity may be limited. This is the governing result for the stated idealization.

15. A — Redundancy means that more than one effective path is available to carry earthquake forces, limiting the consequences of local yielding or damage. It does not imply a perfectly rigid diaphragm, base isolation, or identical member strengths. The benefit is reduced dependence on a single critical element or connection. This is the governing result for the stated idealization.

16. D — Neighboring structures can reach peak displacements at different times and in opposite directions. Adequate separation reduces the chance of collision, or pounding, as those displacements occur. Separation does not intentionally increase mass, prevent settlement, or force two different structures to share the same vibration period. This is the governing result for the stated idealization.

17. D — An inadequately anchored masonry parapet can fall outward during shaking because its out-of-plane inertia lacks a dependable load path. Bracing or positive anchorage back to the diaphragm directly addresses that hazard. Insulation, paint, and plumbing weight do not provide the required restraint to the masonry element. This is the governing result for the stated idealization.

18. C — The open parking level is vulnerable because its limited lateral system can attract concentrated drift and damage. Adding appropriately detailed walls, frames, or other lateral resistance at that level directly improves its strength and stiffness. Removing upper resistance or adding mass would generally worsen, not correct, the weak-story condition. This is the governing result for the stated idealization.

19. A — Sparse confinement and poorly located or short splices can cause brittle deterioration of column behavior before a stable ductile mechanism forms. Retrofit work therefore focuses on protecting critical regions and improving deformation capacity. Roof drainage, timber shrinkage, and finish cracking do not address the structural vulnerability described. This is the governing result for the stated idealization.

20. B — Precast seismic performance depends on reliable connection force transfer between floor or roof diaphragms and the vertical system. Small or discontinuous connections can fail before the primary members reach useful capacity, interrupting the load path. Acoustics, mapped hazard, and complete elimination of diaphragm deformation are unrelated to that connection issue.

21. D — Postearthquake evaluation first addresses whether the damaged structure can safely stand, transfer loads, and be occupied without exposing people to unstable components or compromised systems. Cosmetic finishes, energy efficiency, and landscaping are secondary. Residual drift and damaged connections are direct indicators that structural stability and load-path continuity require attention. This is the governing result for the stated idealization.

22. A — A diaphragm is only effective when its in-plane forces can be collected and delivered through connections into the vertical resisting system. Strengthening weak interfaces can prevent premature separation before the diaphragm material reaches its capacity. Adding mass, eliminating wall stiffness, or removing anchorage would undermine rather than improve seismic performance.

23. B — The stated effective weight is the sum of the three included permanent contributions: 1,280 + 95 + 45 = 1,420 kips. Omitting one component or adding a value twice produces the distractors. The exercise asks only for the listed contributors, so no additional load categories should be introduced. This is the governing result for the stated idealization.

24. C — The denominator R/I_e equals 7.0, so $C_s = 0.84/7 = 0.12$. The alternatives result from dividing by ten, multiplying by an unrelated ratio, or multiplying S_{DS} by R. Following the supplied expression directly gives the dimensionless coefficient used for this exercise. Because the problem supplies the governing expression directly, the calculation should follow that expression without importing unrelated code factors.

25. D — Base shear is the product of the coefficient and effective seismic weight: $V = 0.095(3{,}200) = 304$ kips. Moving the decimal, dividing instead of multiplying, or adding the inputs does not follow the stated equation. The answer should also be much smaller than the total seismic weight. This is the governing result for the stated idealization.

26. A — The first expression gives $0.044(0.78)(1.0) = 0.03432$, which exceeds the stated 0.01 floor. Rounded to four decimals, the governing value is 0.0343. The other choices reflect using the floor when it does not control or applying unrelated fractions of S_{DS}. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

27. C — The interval from 0.5 to 2.5 seconds is 2.0 seconds long. A period of 1.2 seconds is 0.7 second above the lower point, or 35 percent of the interval. Therefore $k = 1.0 + 0.35(1.0) = 1.35$. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

28. B — For $k = 1$, the distribution weight is wh. The lower contribution is 120(10) = 1,200 and the upper is 180(26) = 4,680. Thus C_{vx} at Level 2 is 4,680/(1,200 + 4,680) = 0.796. The distractors use incomplete or reversed ratios. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

29. A — Story shear at a cut equals the sum of the lateral forces acting above that cut. Just below the second level, the 60-kip second-level force and 75-kip roof force are included, giving 135 kips. Including the lowest-level force would instead give the base shear of 180 kips. This is the governing result for the stated idealization.

30. B — The moment about the base equals force times perpendicular height: 110 kips times 32 ft = 3,520 kip-ft. Halving the lever arm, subtracting the two numbers, or adding an unrelated force term does not satisfy basic moment equilibrium for the stated concentrated load. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

31. D — Average unit shear equals the total diaphragm force divided by the resisting width: 210/70 = 3.0 kips/ft. Multiplying instead of dividing or using an unrelated width ratio produces the distractors. The units also confirm that force divided by length is the needed quantity. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

32. C — Substituting the given values gives F = 0.4(0.95)(1.0)(68) = 25.84 kips. The alternatives arise from halving the result, omitting the 0.95 factor, or using the wall weight almost directly. The stated expression determines the answer for this exercise. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

33. A — For each foot of wall length, the tributary wall area is 13 square feet. Multiplying 20 psf by 13 ft gives 260 lb/ft of horizontal line force. The other values result from using half the height, the wrong pressure, or an incorrect multiplication. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

34. B — Torsional moment equals the lateral force times the eccentricity: 175(6.5) = 1,137.5 kip-ft. Halving the moment, subtracting the inputs, or doubling the lever arm does not satisfy moment equilibrium. The result represents the additional in-plane twisting demand on the diaphragm system. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

35. D — The percentage eccentricity is 3.6/48 times 100, which equals 7.5 percent. Using the offset alone as a percent, multiplying rather than dividing, or reversing the ratio gives the distractors. The comparison must use the offset divided by the relevant plan dimension. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

36. D — Substituting the supplied values gives Ta = 0.02(70^0.75) = about 0.484 second, which rounds to 0.48 second. Treating the exponent as a multiplier or using the height directly would give a different result and would not follow the stated period equation. Because the problem supplies the governing expression directly, the calculation should follow that expression without importing unrelated code factors.

37. C — Multiplying the two supplied factors gives CuTa = 1.30(0.78) = 1.014 seconds. Dividing, leaving Ta unchanged, or selecting Cu alone does not represent the stated limiting product. The calculation is direct because the problem defines the relationship explicitly. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

38. A — The base shear is V = CsW = 0.105(4,600) = 483 kips. The distractors represent a decimal-placement error, transposed digits, or addition rather than multiplication. The magnitude is also reasonable because the coefficient is about ten percent of the effective seismic weight. This is the governing result for the stated idealization.

39. B — Thirty percent of the secondary-direction effect is 0.30(80) = 24 kips. Adding that to 130 kips gives 154 kips. Subtracting the secondary contribution, ignoring it, or adding the full 80-kip effect does not follow the stated combination rule. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

40. C — Equal sharing among six identical collectors gives 108/6 = 18 kips per collector. Using the number of collectors as a multiplier, assigning half the total, or placing the full force in each line would violate the sharing assumption stated in the problem. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

41. B — The chord couple must reproduce the diaphragm moment, so the required axial force magnitude is 2,700/90 = 30 kips. Halving or doubling this value changes the resisting couple, while multiplying moment by spacing produces incorrect units. Moment equilibrium governs the chord demand. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

42. A — The base must resist the sum of all applied lateral floor forces: 30 + 50 + 70 + 95 = 245 kips. Omitting one floor or double-counting a force produces the distractors. This is simply horizontal force equilibrium for the complete building above the base. A quick independent check of both equilibrium and deformation compatibility helps confirm the selected result.

43. D — Story drift is the relative displacement between adjacent floors, so Delta = 2.3 - 1.4 = 0.9 inch. Using either absolute displacement alone or adding the two values does not measure the interstory deformation that distorts columns, walls, partitions, and attached components. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

44. C — The amplification factor is Cd/Ie = 5.5/1.25 = 4.4. Multiplying by the elastic displacement gives delta = 4.4(0.75) = 3.30 inches. The distractors reflect reversing the ratio, partial multiplication, or using the amplification factor alone instead of applying it to displacement. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

45. A — Under the stated rule, the required separation is the sum of the absolute design displacements: 2.1 + 1.9 = 4.0 inches. Subtracting the values or choosing only one building displacement does not provide the combined clearance specified by the exercise. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

46. C — The story height is 14(12) = 168 inches. Dividing 1.56 inches by 168 inches gives 0.009286, or about 0.93 percent. Using feet without unit conversion or moving the decimal incorrectly produces the distractors. Drift ratio must compare displacement and height in consistent units. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

47. B — Average line demand equals the transferred shear divided by the effective wall-line length: 168/56 = 3.0 kips/ft. The alternative values come from using different divisors or multiplying rather than dividing. Force per unit length is the correct dimensional form for this demand. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

48. D — Collector force is the accumulated line load times tributary width: 4.2(18) = 75.6 kips. Adding the quantities, multiplying by ten, or using a different width does not represent the stated load accumulation. The collector must carry the total force gathered from its tributary diaphragm region. A quick independent check of both equilibrium and deformation compatibility helps confirm the selected result.

49. A — The base factor is 0.4(1.0)(0.80)(5)/(2.5/1.0) = 0.64 kip. The height factor is 1 + 2(0.25) = 1.5, so Fp = 0.64(1.5) = 0.96 kip. The distractors omit or misapply one of these stated factors. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

50. D — Substituting z/h = 0.40 gives 1 + 2(0.40) = 1.80. The other choices omit the leading one, add rather than double the height ratio, or apply an excessive factor. The problem asks only for the stated dimensionless height multiplier. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

51. B — Equal direct sharing gives 1,200/4 = 300 lb per anchor. The alternatives represent dividing by eight, using three anchors, or multiplying the total force by the number of anchors. The stated idealization excludes eccentricity, so only simple equal force distribution is required. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

52. C — Multiplying the study coefficient by effective seismic weight gives V = 0.16(700) = 112 kips. Using ten percent of the weight, twenty percent, or adding the coefficient to the weight does not satisfy the stated relationship. The resulting force is a fraction of the total weight, as expected. This is the governing result for the stated idealization.

53. C — A rigid component may move nearly with its supporting floor, so limited component deformation does not imply limited acceleration. Its mass still creates inertia force as floor motion is transmitted through the anchorage. Zero deformation is therefore not the same as zero seismic demand, and finish properties are irrelevant. This is the governing result for the stated idealization.

54. B — Two sides of a seismic joint can move differently during shaking. Flexible piping details accommodate that relative displacement and reduce the chance of rupture, leakage, or damage at rigid connections. They do not remove pipe mass, stop floor motion, or eliminate the need for appropriately designed supports and bracing. This is the governing result for the stated idealization.

55. A — Ceiling bracing, clearances, and perimeter details are intended to control relative movement and maintain support during earthquake shaking so panels, grids, and attached elements do not create falling hazards. Those details do not intentionally increase structural mass, create torsion, or alter the geotechnical classification of the site. This is the governing result for the stated idealization.

56. D — Part of the liquid tends to move with the tank shell while another portion can participate in longer-period free-surface sloshing. Their effective masses, periods, elevations, and resulting forces differ, so separating them improves the dynamic idealization. Treating the motions as identical can misrepresent wall, anchorage, and freeboard demands. This is the governing result for the stated idealization.

57. B — Operational performance depends on more than preventing collapse of the component itself. Anchorage, support, utility connections, clearances, and deformation compatibility must remain functional through shaking and structural drift. Cosmetic finish choices do not establish operability, and neither eliminating mass nor ignoring connected services is a realistic design strategy. This is the governing result for the stated idealization.

58. A — The distributed weight is multiplied by the supported length: 35 lb/ft times 30 ft = 1,050 lb. Dividing, using an incorrect length, or moving the decimal produces the distractors. This total weight can then be used in whatever component-force relationship the design procedure requires. This is the governing result for the stated idealization.

59. D — Equal sharing among eight braces gives 4.8/8 = 0.60 kip per brace. The alternatives result from dividing by twelve, dividing by six, or multiplying by the number of braces. The stated idealization calls for simple direct force distribution with no eccentricity or unequal stiffness. A quick independent check of both equilibrium and deformation compatibility helps confirm the selected result.

60. C — Substituting the stated values gives Fmax = 1.6(0.80)(1.0)(3.0) = 3.84 kips. The other values omit a factor or substitute a different multiplier. Because the equation is supplied in the stem, no additional component coefficients should be introduced. The remaining choices reflect a reversed ratio, an omitted factor, or a simple arithmetic error rather than the stated relationship.

61. D — The lateral force is the stated coefficient times tributary weight: 0.45(14) = 6.3 kips. The alternatives represent halving the result, using a different coefficient, or adding instead of multiplying. The exercise defines a direct proportional relationship between parapet weight and lateral demand. This is the governing result for the stated idealization.

62. C — An anchor transfers force into surrounding concrete, steel, wood, or other support material, so local breakout, yielding, pryout, edge effects, or member failure can govern before the fastener itself reaches capacity. Seismic anchorage therefore requires evaluation of the entire connection and supporting load path, not the hardware in isolation. This is the governing result for the stated idealization.

63. B — For rigid translation without torsion, direct shear is distributed in proportion to stiffness. The 50-unit frame has 50/(25+50) = 2/3 of the total stiffness, so it attracts (2/3)(210) = 140 kips. Equal sharing would ignore the different frame stiffnesses. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

64. A — Total relative stiffness is 4 + 6 + 2 = 12. The 6-unit frame therefore receives 6/12 of the 300-kip direct shear, or 150 kips. Equal thirds or other fractions would ignore the stated stiffness distribution that controls rigid-diaphragm translation. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

65. C — The rigidity coordinate is the stiffness-weighted average: $xR = [30(0) + 50(40)]/(30+50) = 2{,}000/80 = 25$ ft. An unweighted midpoint or reversed weighting does not reflect the relative contribution of each resisting line to the floor stiffness. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

66. A — Inherent eccentricity is the separation between the mass and rigidity centers, so $|34 - 26| = 8$ ft. Choosing either coordinate alone or adding them does not describe the offset that creates torsional moment when floor inertia acts through the mass center. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

67. D — The torsional moment is V times eccentricity: $240(5.5) = 1{,}320$ kip-ft. Halving the lever arm, subtracting the numbers, or doubling the result does not satisfy moment equilibrium. The diaphragm must distribute this twisting demand in addition to the direct translational shear. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

68. B — The denominator is $1(15^2) + 1(15^2) = 450$. For either frame, $V_i = 600(1)(15)/450 = 20$ kips. Symmetry gives equal and opposite torsional shear magnitudes at the two frames. The other values do not satisfy the supplied distribution equation. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

69. C — With uniform loading and symmetric end supports, the total 90-kip diaphragm load is shared equally, giving 45 kips at each wall line. The reactions must sum to the total load. The other choices either fail equilibrium or assign the complete diaphragm force to one support. A quick independent check of both equilibrium and deformation compatibility helps confirm the selected result.

70. A — The chord force couple must create the diaphragm moment, so $F(55) = 2{,}200$ and $F = 40$ kips. Halving the result, using the spacing itself as force, or multiplying instead of dividing does not satisfy moment equilibrium. Equal tension and compression chord magnitudes form the resisting couple. This is the governing result for the stated idealization.

71. D — The collector accumulates the distributed diaphragm demand over its tributary width: $3.6(24) = 86.4$ kips. Adding the values or using a different tributary length produces the distractors. The axial force is the integral of the line demand over the contributing diaphragm region. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

72. C — Secant stiffness is force divided by displacement: $110/0.55 = 200$ kips/in. Using the force alone, adding force and displacement, or reversing the ratio does not produce stiffness units. The value represents the slope from the origin to the stated point on the force-displacement response. A quick independent check of both equilibrium and deformation compatibility helps confirm the selected result.

73. B — Substituting the values gives $\delta = 15(8^3)/[3(1{,}200)(1.5)] = 7{,}680/5{,}400 = 1.422$, which rounds to 1.42. The cubic length term is essential; using a linear or squared length, or omitting the factor of three, produces different values. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

74. B — Parallel springs undergo the same displacement, so the restoring forces add and the combined stiffness is 42 + 28 = 70 kips/in. Subtraction, averaging, or multiplication does not represent the stiffness of elements that share a common floor translation. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

75. A — Effective story stiffness is the story shear divided by the corresponding drift: 180/1.20 = 150 kips/in. Choosing the shear alone, multiplying instead of dividing, or subtracting the values does not produce the force-per-displacement units required for stiffness. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

76. D — The mass centroid is the weighted average x = [50(12) + 70(36)]/(50+70) = (600 + 2,520)/120 = 26 ft. A simple midpoint ignores the unequal masses, while the other choices result from incomplete or reversed weighting. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

77. D — Five percent of 72 ft is 0.05(72) = 3.6 ft. The other choices use unrelated percentages or place the decimal incorrectly. Because the problem explicitly provides the percentage, the calculation is simply the stated fraction of the plan dimension. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

78. C — The eccentricities act in the same direction, so the total lever arm is 5.0 + 3.6 = 8.6 ft. Multiplying by 180 kips gives M = 1,548 kip-ft. Subtracting the offsets or omitting one of them understates the stated torsional demand. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

79. A — Substitution gives theta = 1,000(1.2)/[200(156)] = 1,200/31,200 = 0.03846, which rounds to 0.038. The ratio is dimensionless because force and length units cancel. Omitting V or h, or reversing numerator and denominator, yields different values. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

80. B — The story height is 15(12) = 180 inches. Dividing 1.80 inches by 180 inches gives 0.01, or 1.00 percent. Using feet directly without converting to inches or shifting the decimal point produces the distractors. Drift ratio requires consistent displacement and height units. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

81. B — SRSS combination gives sqrt(90^2 + 120^2) = sqrt(8,100 + 14,400) = sqrt(22,500) = 150 kips. Arithmetic averaging or direct addition does not represent the stated modal combination method. The familiar 3-4-5 proportional relationship also provides a quick check. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

82. C — SRSS is most appropriate when modal responses are sufficiently separated to be treated as effectively uncorrelated. Closely spaced modes can respond with meaningful correlation, so a method that accounts for that relationship may better estimate combined demand. The issue is statistical dependence of modal response, not disappearance of mass or period.

83. D — A response-spectrum analysis can produce a base shear below a prescribed reference level depending on modeling and modal characteristics. Scaling preserves the distribution from the dynamic analysis while ensuring the design is not based on an unacceptably small overall force. It does not equalize modal periods, remove torsion, or alter floor masses.

84. A — Rigid-diaphragm idealization is appropriate when in-plane diaphragm deformation is small enough that floor points move approximately as a rigid body compared with deformation of the vertical system. Openings, gravity uniformity, and square geometry can influence behavior, but none alone establishes the relative stiffness condition that controls the modeling assumption. This is the governing result for the stated idealization.

85. D — The resultant of a triangular line load equals its area: one-half times base times peak intensity. Thus W = 0.5(24)(8) = 96 kips. Treating the entire span as loaded at the peak intensity would double the correct value and ignore the triangular variation. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

86. B — The centroid of a triangular load lies two-thirds of the base length from the zero-intensity end. Therefore the resultant acts at (2/3)(24) = 16 ft from the left. One-third from the zero end would place it too close to the small-load side. The distractors omit or misapply a needed force, moment, stiffness, or compatibility relationship for the stated idealization.

87. A — Taking moments about the left support gives Rright(35) = 140(10), so Rright = 40 kips. The left reaction is then 100 kips so vertical-equilibrium analog forces sum to 140. Equal sharing would be incorrect because the resultant is not at midspan. A sound seismic model must satisfy equilibrium while representing the stiffness, geometry, and deformation mechanism that control the response.

88. C — Collectors and drag struts provide axial transfer where diaphragm geometry or resisting-element location prevents simple direct shear flow. Their forces can become large around offsets and openings, so they must be represented in the analytical load path. They do not replace chords, serve only finishes, or eliminate connection design. This is the governing result for the stated idealization.

89. C — Transverse reinforcement helps confine core concrete and brace longitudinal bars when cyclic compression and tension reverse repeatedly in critical regions. Those functions support stable inelastic deformation and delay brittle deterioration. Ties do not eliminate axial load, replace primary flexural bars, or make anchorage and development requirements unnecessary. This is the governing result for the stated idealization.

90. D — Capacity design establishes a preferred hierarchy so predictable ductile regions yield while connections and force-transfer elements remain capable of carrying the associated amplified demands.

This reduces the chance that a brittle link interrupts the load path first. The approach does not require universal elasticity, added mass, or zero diaphragm shear.

91. B — Chord force can reverse with earthquake direction, so the splice must transfer axial demand reliably through both tension and compression cycles. Adequate development, connection strength, and continuity are essential. A deliberately short or separable splice would create a weak link, and architectural finishes cannot provide the required structural transfer. This is the governing result for the stated idealization.

92. A — Bolted seismic connections depend on the specified fasteners and installation condition being achieved in the field. Inspection verifies materials, installation procedure, and required tightening so the connection performs as designed. Paint appearance alone is not a structural acceptance criterion, and unreviewed bolt changes can alter the intended behavior. This is the governing result for the stated idealization.

93. A — Post-installed anchors transfer load into surrounding concrete, so nearby edges, anchor groups, cracking, and local geometry can limit concrete capacity before the steel element yields. Evaluating only fastener strength can therefore miss the governing failure mechanism. Reduced spacing does not automatically improve performance and may increase interaction among anchors. This is the governing result for the stated idealization.

94. B — Wood shear-wall capacity and ductility depend strongly on the sheathing-to-framing connection pattern. Incorrect nail spacing or poor edge distance can reduce strength, promote splitting, and change cyclic behavior. Those details do not establish seismic hazard, eliminate hold-down forces, or affect concrete materials elsewhere in the project. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

95. C — Reinforced masonry relies on properly located and developed steel to carry tension, flexure, and cyclic forces through the wall. Bars displaced from the design location or inadequately spliced can reduce capacity and continuity. Grout supports composite action but does not make reinforcement anchorage or placement irrelevant. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

96. D — Nonstructural distribution systems must accommodate the movement of the supporting structure. Flexible couplings, clearances, and appropriate support details prevent the pipe from becoming an unintended brace or rupturing under imposed drift. Rigidly tying moving regions together through the pipe or removing support would create additional hazards. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

97. D — A field deviation in a seismic connection can alter force transfer, stiffness, anchorage, and cyclic behavior. The discrepancy should be documented and referred for engineering evaluation or approved correction before acceptance. Completion of the work does not establish adequacy, and apparent similarity is not a substitute for verified capacity. This is the governing result for the stated idealization.

98. C — Congested reinforcement can obstruct concrete flow and trap voids around critical anchorage and confinement details. Proper placement and consolidation help the member develop the bond, bearing, and section integrity assumed in design. Honeycombing does not enhance ductility, air cannot substitute for steel, and construction quality does not change earthquake duration.

99. A — Structural observation gives the design professional selected opportunities to review significant seismic construction and identify deviations that may affect the intended structural behavior. It complements, rather than replaces, required inspection and testing. Observation cannot guarantee future earthquake performance and does not make approved construction documents unnecessary. Inspection should concentrate on details that govern repeated force transfer rather than appearance alone.

100. B — Collectors gather diaphragm inertia and must deliver it into the vertical resisting element through a connection capable of carrying the cyclic axial demand. A weak anchorage region can sever the load path before either major element reaches its intended capacity. Concrete weight alone does not provide this transfer mechanism. This is the governing result for the stated idealization.