PRACTICE EXAM 19: CALIFORNIA SEISMIC PRINCIPLES (100 QUESTIONS)

This standalone practice exam contains 100 four-choice questions weighted to the current BPELSG Civil Engineer Seismic Principles test plan. Allow 2.5 hours for a timed simulation and select the single best answer for each item. 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, not an official BPELSG examination.

1. A municipal records center is assigned mapped short-period acceleration Ss = 1.27 g and short-period site coefficient Fa = 1.14. Using SMS = FaSs for this exercise, what maximum-considered short-period spectral value is obtained?

A. 1.448 g
B. 1.114 g
C. 1.270 g
D. 1.140 g

2. For a civic auditorium site, S1 = 0.61 g and Fv = 1.55. If the worksheet defines SM1 = FvS1, what value should be entered for SM1?

A. 0.394 g
B. 0.610 g
C. 0.946 g
D. 1.550 g

3. A geotechnical design summary reports SMS = 1.35 g. Using SDS = (2/3)SMS, determine the design short-period spectral response acceleration.

A. 1.35 g
B. 0.90 g

C. 0.68 g
D. 2.03 g

4. A project spectrum lists SM1 = 0.96 g. If SD1 = (2/3)SM1, what design one-second spectral value results?

A. 0.96 g
B. 0.48 g
C. 1.44 g
D. 0.64 g

5. A simplified spectrum uses Ts = SD1/SDS. With SDS = 0.90 g and SD1 = 0.64 g, what corner period Ts should be used?

A. 0.71 s
B. 1.41 s
C. 0.58 s
D. 0.64 s

6. A proposed maintenance building is underlain by a thick profile of very soft clay, while mapped hazard values are fixed by location. Which site input most directly captures the soil profile's effect on seismic response?

A. The building's architectural occupancy label
B. The concrete compressive strength specified for slabs
C. The number of parking spaces on the parcel
D. Site class and the associated site amplification coefficients

7. A fire station and a low-occupancy storage shed are planned on adjacent lots with essentially the same mapped seismic hazard and site conditions. What design classification most directly distinguishes the consequences of failure between them?

A. Mapped short-period ground acceleration
B. Site class based on subsurface stiffness
C. Occupancy-based risk category and importance treatment
D. Foundation concrete unit weight

8. Why should the structural general notes identify mapped hazard, site class, SDS, SD1, risk category, and seismic design category in one coordinated design-criteria block?

A. They substitute for a complete lateral structural system
B. The documented basis for seismic analysis, forces, and detailing
C. They are used only to select architectural finishes
D. They remove the need for construction quality control

9. Two one-story lateral systems resist the same story shear. System X has stiffness 720 kip/in and System Y has stiffness 480 kip/in. Using delta = V/k, what is the ratio deltaY/deltaX?

A. 1.50
B. 0.67
C. 1.00
D. 1.25

10. A floor is supported laterally by two frames that act in parallel and undergo the same translation. Their stiffnesses are 350 kip/in and 850 kip/in. What combined translational stiffness does the floor see?

A. 500 kip/in
B. 1200 kip/in
C. 248 kip/in
D. 850 kip/in

11. Two idealized oscillators carry the same lumped mass. Their lateral stiffnesses are 450 and 720 in consistent units. Using the inverse-square-root relationship between period and stiffness, determine the period of the stiffer system divided by the period of the softer system.

A. 1.26
B. 0.62
C. 0.79
D. 1.00

12. At a seismic separation, one building can move 1.8 inches toward the joint and the neighboring building can move 2.4 inches toward it. Using a conservative sum-of-movements check, what clear gap is required?

A. 2.40 in.
B. 0.60 in.
C. 3.00 in.
D. 4.20 in.

13. A floor's center of mass lies well away from the effective center of lateral stiffness. Under horizontal shaking, what response is most directly introduced by that plan offset?

A. Pure vertical shortening of columns only
B. Elimination of force from the perimeter frames
C. Translation accompanied by torsional rotation of the diaphragm and lateral system
D. Uniform axial compression in every wall

14. Which building configuration most clearly signals a potential vertical stiffness irregularity that deserves focused seismic review?

A. A uniform bay layout repeated from roof to foundation
B. An open ground-story storefront beneath several stories with closely spaced full-height walls
C. A symmetric floor plan with similar frames on each side
D. A roof diaphragm with evenly spaced collectors

15. Why is redundancy valuable when several independent seismic-resisting lines participate in a building's lateral system?

A. It guarantees that every member remains elastic
B. It removes the need to anchor diaphragms to walls
C. It makes torsional response impossible
D. Alternate lateral load paths after local damage

16. Which behavior best characterizes a ductile seismic system during strong cyclic loading?

A. Stable inelastic cycling with substantial retained strength
B. It fractures immediately at first yield
C. It remains perfectly rigid at all force levels
D. It transfers no energy through hysteretic response

17. A pre-1970 wood apartment building has open parking at the first story and many partitioned residential walls above. Which retrofit objective most directly addresses its principal seismic weakness?

A. Add roof ballast to increase inertia forces
B. Remove upper-story wall sheathing
C. Reduce foundation anchorage at the open story
D. Strengthen and stiffen the open first story with continuous load transfer

18. An older brick commercial building has tall unreinforced masonry parapets above the roof line with little positive bracing. Which improvement most directly reduces falling-parapet hazard?

A. Increase parapet height without adding ties
B. Positive parapet bracing or anchorage back to the roof system
C. Cut the roof diaphragm free from the walls
D. Rely on mortar friction at the roof line

19. A precast parking structure evaluation finds narrow bearing seats and weak positive connections at several beam supports. Which retrofit goal is most important?

A. Make the seats shorter to encourage rotation
B. Remove connection hardware to reduce stiffness
C. Maintain bearing support and positive ties through expected displacement
D. Increase only the architectural finish weight

20. An older concrete building has columns with widely spaced transverse reinforcement and poor confinement near potential plastic-hinge regions. What retrofit strategy most directly targets that vulnerability?

A. Add confinement and shear capacity at the deficient columns
B. Reduce column cross section at the hinge zones
C. Remove existing transverse reinforcement
D. Add heavy cladding without strengthening columns

21. A pre-Northridge welded steel moment frame has connection details associated with brittle fracture. What is the most appropriate retrofit objective?

A. Encourage fracture at the column face
B. Promote ductile yielding instead of brittle connection fracture
C. Eliminate all beam yielding by weakening connections
D. Remove continuity plates without evaluation

22. Immediately after a strong earthquake, inspectors find a partially collapsed exterior wall and unstable debris over a public sidewalk. What initial safety action is most appropriate?

A. Allow normal occupancy because aftershocks are unlikely
B. Remove all warning controls before evaluation
C. Restrict access until hazards are stabilized and professionally evaluated
D. Treat the condition as cosmetic until repairs are convenient

23. For a preliminary ELF check of a county administration annex, use the simplified coefficient Cs = SDS Ie/R with SDS = 0.79, Ie = 1.00, R = 6.5, and effective seismic weight W = 2740 kips. What base shear V = CsW results?

A. 249.8 kips
B. 416.2 kips
C. 2164.6 kips
D. 333.0 kips

24. For a preliminary ELF check of a university classroom wing, use the simplified coefficient Cs = SDS Ie/R with SDS = 0.86, Ie = 1.00, R = 7.0, and effective seismic weight W = 2310 kips. What base shear V = CsW results?

A. 283.8 kips
B. 212.9 kips
C. 354.8 kips
D. 1986.6 kips

25. For a preliminary ELF check of a essential communications support building, use the simplified coefficient Cs = SDS Ie/R with SDS = 0.73, Ie = 1.25, R = 5.5, and effective seismic weight W = 3480 kips. What base shear V = CsW results?

A. 433.0 kips
B. 577.4 kips
C. 721.8 kips
D. 2540.4 kips

26. For a preliminary ELF check of a distribution warehouse, use the simplified coefficient Cs = SDS Ie/R with SDS = 0.81, Ie = 1.00, R = 8.0, and effective seismic weight W = 3970 kips. What base shear V = CsW results?

A. 402.0 kips
B. 301.5 kips
C. 502.5 kips
D. 3215.7 kips

27. For a preliminary ELF check of a municipal court addition, use the simplified coefficient Cs = SDS Ie/R with SDS = 0.68, Ie = 1.00, R = 6.0, and effective seismic weight W = 2890 kips. What base shear V = CsW results?

A. 245.6 kips
B. 409.4 kips
C. 327.5 kips
D. 1965.2 kips

28. For a preliminary ELF check of a research laboratory, use the simplified coefficient Cs = SDS Ie/R with SDS = 0.92, Ie = 1.25, R = 7.5, and effective seismic weight W = 3180 kips. What base shear V = CsW results?

A. 365.7 kips
B. 609.5 kips
C. 2925.6 kips
D. 487.6 kips

29. During schematic analysis, evaluate the power-law period estimate Ct(hn)^x for Ct = 0.030, total structural height hn = 64 ft, and exponent x = 0.78. What approximate period results?

A. 0.54 s
B. 0.77 s
C. 1.00 s
D. 1.92 s

30. A preliminary dynamic model requires the empirical period value Ct(hn)^x. Use Ct = 0.027, hn = 92 ft, and x = 0.80. What period should be carried into the check?

A. 1.01 s
B. 0.71 s
C. 1.31 s
D. 2.48 s

31. For a 55-ft-tall lateral system, the selected empirical period parameters are Ct = 0.034 and x = 0.75. Evaluate Ct times hn raised to x and report the approximate fundamental period.

A. 0.48 s
B. 0.90 s
C. 0.69 s
D. 1.87 s

32. A tall building concept has hn = 118 ft. With empirical constants Ct = 0.025 and x = 0.82, calculate Ct(hn)^x for the preliminary fundamental-period estimate.

A. 1.25 s
B. 0.88 s
C. 1.62 s
D. 2.95 s

33. Distribute equivalent lateral force with Cvx = wx hx^k / Σ(wi hi^k). Floor weights from lowest to highest are [410, 530, 690] kips at heights [14, 28, 42] ft, and k = 1.0. What fraction Cvx belongs to level 3?

A. 0.423
B. 0.500
C. 0.415
D. 0.585

34. Distribute equivalent lateral force with Cvx = wx hx^k / Σ(wi hi^k). Floor weights from lowest to highest are [360, 480, 610, 720] kips at heights [12, 24, 36, 48] ft, and k = 1.3. What fraction Cvx belongs to level 4?

A. 0.332
B. 0.517
C. 0.443
D. 0.483

35. Distribute equivalent lateral force with Cvx = wx hx^k / Σ(wi hi^k). Floor weights from lowest to highest are [520, 500, 470] kips at heights [16, 32, 48] ft, and k = 1.5. What fraction Cvx belongs to level 1?

A. 0.349
B. 0.111
C. 0.119
D. 0.881

36. Distribute equivalent lateral force with Cvx = wx hx^k / Σ(wi hi^k). Floor weights from lowest to highest are [280, 390, 510, 640] kips at heights [11, 22, 33, 44] ft, and k = 1.0. What fraction Cvx belongs to level 2?

A. 0.214
B. 0.200
C. 0.849
D. 0.151

37. A cut through the vertical seismic system is taken immediately below level 2. Floor inertia forces from the first floor through the roof are [85, 115, 150, 205] kips. How much lateral shear must cross that cut?

A. 470 kips
B. 200 kips
C. 115 kips
D. 555 kips

38. At a five-level building, floor forces from bottom to top are [70, 90, 125, 160, 210] kips. If the vertical resisting system is sectioned just beneath level 3, what cumulative lateral shear is transferred there?

A. 285 kips
B. 125 kips
C. 655 kips
D. 495 kips

39. A three-level structure develops floor forces of [140, 175, 225] kips from bottom to top. Determine the shear carried by the vertical system at its base, immediately below the first level.

A. 140 kips
B. 155 kips
C. 540 kips
D. 555 kips

40. Floor inertia forces are [55, 80, 110, 145] kips from the lowest level upward. What total shear passes through the vertical resisting elements in a cut made just below level 3?

A. 245 kips
B. 255 kips
C. 110 kips
D. 390 kips

41. A roof diaphragm has effective seismic weight Wpx = 845 kips. For this exercise, the governing in-plane diaphragm coefficient is 0.29. What force follows from Fpx = 0.29Wpx?

A. 171.5 kips
B. 245.0 kips
C. 318.5 kips
D. 845.0 kips

42. A diaphragm delivers 315 kips uniformly to a 126-ft-long resisting line. What average shear transfer per foot acts along that line?

A. 5.00 kip/ft
B. 0.40 kip/ft
C. 2.00 kip/ft
D. 2.50 kip/ft

43. A diaphragm chord couple must resist an in-plane moment of 6,300 kip-ft. If the two chord lines are 105 ft apart, what axial force magnitude is required in each chord using F = M/d?

A. 30.0 kips
B. 661.5 kips
C. 60.0 kips
D. 84.0 kips

44. For an idealized wall-panel inertia check, take 38 percent of a tributary seismic weight of 168 kips as the horizontal design action. What force does that produce?

A. 63.8 kips
B. 33.6 kips
C. 100.8 kips
D. 168.0 kips

45. A collector is calculated to carry 172 kips before overstrength amplification. If the design check multiplies that demand by 2.75, what amplified collector force must the connection transmit?

A. 62.5 kips
B. 172.0 kips
C. 473.0 kips
D. 378.4 kips

46. A roof-to-wall connection group contains eight identical anchors. If a 336-kip transfer is divided equally among them and eccentric effects are ignored, what demand is assigned to one anchor?

A. 56.0 kips
B. 42.0 kips
C. 33.6 kips
D. 336.0 kips

47. A masonry parapet has effective seismic weight 108 kips. For this simplified check, apply a lateral coefficient of 0.48. What out-of-plane force should be used?

A. 51.8 kips
B. 25.9 kips
C. 77.8 kips
D. 108.0 kips

48. A seismic weight takeoff totals 2,640 kips for the building. The roof accounts for 0.16 of that total. What seismic weight should be assigned to the roof level?

A. 2217.6 kips
B. 211.2 kips
C. 2640.0 kips
D. 422.4 kips

49. Compute the idealized component force from Fp = (0.4 ap SDS Wp Ip)/Rp using ap = 1.0, SDS = 0.86, Wp = 380 kips, Ip = 1.0, and Rp = 2.5. What unbounded calculated value results?

A. 31.37 kips
B. 73.21 kips
C. 326.80 kips
D. 52.29 kips

50. For a supported nonstructural item, evaluate Fp = (0.4 ap SDS Wp Ip)/Rp with ap = 2.5, SDS = 0.78, Wp = 42 kips, Ip = 1.0, and Rp = 6.0. What force does the expression produce?

A. 3.28 kips
B. 7.64 kips
C. 5.46 kips
D. 196.56 kips

51. A component calculation uses Fp = (0.4 ap SDS Wp Ip)/Rp. Substitute ap = 1.0, SDS = 0.82, Wp = 118 kips, Ip = 1.5, and Rp = 2.0. What calculated Fp is obtained?

A. 29.03 kips
B. 17.42 kips
C. 40.64 kips
D. 51.61 kips

52. Evaluate the component-force expression Fp = (0.4 ap SDS Wp Ip)/Rp for ap = 2.5, SDS = 0.91, Wp = 26 kips, Ip = 1.0, and Rp = 3.5. What is the result?

A. 4.06 kips
B. 6.76 kips
C. 9.46 kips
D. 82.81 kips

53. For an idealized equipment attachment, calculate Fp = (0.4 ap SDS Wp Ip)/Rp with ap = 1.0, SDS = 0.74, Wp = 92 kips, Ip = 1.0, and Rp = 2.5. What force results?

A. 6.53 kips
B. 10.89 kips
C. 15.25 kips
D. 68.08 kips

54. A nonstructural component has ap = 2.5, SDS = 0.69, Wp = 18 kips, Ip = 1.5, and Rp = 5.0. Using Fp = (0.4 ap SDS Wp Ip)/Rp, determine the calculated seismic force.

A. 3.73 kips
B. 2.24 kips
C. 5.22 kips
D. 41.40 kips

55. A rigid equipment support is represented by a horizontal seismic coefficient of 0.28 acting on 610 kips of effective weight. What base reaction is obtained by multiplying the coefficient and weight?

A. 128.1 kips
B. 213.5 kips
C. 610.0 kips
D. 170.8 kips

56. For a compact nonbuilding structure, use a seismic coefficient of 0.33 and effective weight of 740 kips. What horizontal base shear follows from their product?

A. 183.1 kips
B. 305.2 kips
C. 244.2 kips
D. 740.0 kips

57. A rigid tank support has effective seismic weight 980 kips and a simplified seismic coefficient of 0.25. Determine the corresponding base shear.

A. 183.8 kips
B. 306.2 kips
C. 980.0 kips
D. 245.0 kips

58. A freestanding rigid structure weighs 455 kips for seismic purposes. If its simplified horizontal coefficient is 0.37, what design base shear is produced?

A. 126.2 kips
B. 168.3 kips
C. 210.4 kips
D. 455.0 kips

59. A rooftop air-handling unit transfers a 96-kip seismic force through six identical anchors that share the load equally. What idealized force is assigned to each anchor?

A. 16.0 kips
B. 24.0 kips
C. 12.0 kips
D. 96.0 kips

60. A heavy emergency generator sits on vibration isolators at the roof. Why is positive seismic restraint still necessary even though the generator is not part of the building's primary lateral system?

A. Its weight eliminates horizontal acceleration
B. Vibration isolators automatically provide seismic anchorage
C. Transfer equipment inertia through positive seismic anchorage
D. Only primary frame members experience earthquake inertia

61. Two building wings can move independently at a seismic joint, and a chilled-water line must pass from one wing to the other. Which connection strategy best prevents the pipe from becoming a rigid bridge or rupturing during relative movement?

A. Rigidly clamp the pipe to both sides of the joint

B. Remove all clearance around the pipe

C. Provide flexibility or a joint detail that can accommodate expected relative movement without rupture

D. Increase pipe mass to reduce relative displacement

62. Why must anchorage for a tall freestanding battery rack be checked for more than simple base sliding?

A. Tall equipment cannot develop vertical reactions

B. Only friction controls every anchorage design

C. Overturning disappears when horizontal force is present

D. Tall equipment also develops overturning, uplift, and anchor tension

63. At a rigid floor, 390 kips of direct lateral shear is shared by three resisting lines whose stiffnesses are [320, 480, 700] kip/in. With torsional effects set aside, determine the force attracted by line 1 from stiffness-proportional sharing.

A. 130.0 kips

B. 83.2 kips

C. 306.8 kips

D. 178.3 kips

64. A rigid diaphragm delivers 320 kips of direct shear to three lines with stiffnesses [420, 530, 650] kip/in. Neglect eccentricity and torsion. How many kips of the direct shear are assigned to line 2 by relative stiffness?

A. 106.0 kips

B. 106.7 kips

C. 214.0 kips
D. 260.9 kips

65. Three vertical lines beneath a rigid diaphragm have stiffnesses [275, 625, 500] kip/in and together resist 350 kips of direct story shear. Ignoring torsion, what portion of that shear is carried by line 3?

A. 116.7 kips
B. 125.0 kips
C. 225.0 kips
D. 280.0 kips

66. A floor acting rigidly in plane transfers 300 kips of direct story shear to lines with stiffnesses [560, 340, 300] kip/in. Before adding torsional effects, calculate the stiffness-proportional demand on line 2.

A. 100.0 kips
B. 215.0 kips
C. 182.1 kips
D. 85.0 kips

67. Two parallel lateral lines at a rigid diaphragm have stiffnesses 410 and 690 kip/in. If the floor's direct shear is 275 kips and torsion is ignored, how much direct force is attracted by the first line?

A. 102.5 kips
B. 137.5 kips
C. 172.5 kips
D. 163.4 kips

68. A rigid floor has three resisting lines with stiffnesses [460, 540, 900] kip/in and 475 kips of direct shear. Determine the stiffness-proportional force in line 3 before any torsional contribution is added.

A. 158.3 kips

B. 250.0 kips
C. 225.0 kips
D. 475.0 kips

69. A floor shear resultant of 440 kips acts with a design eccentricity of 3.6 ft from the selected rigidity reference. What plan torsional moment T = Ve is generated?

A. 122.2 kip-ft
B. 1584.0 kip-ft
C. 792.0 kip-ft
D. 1980.0 kip-ft

70. A floor shear resultant of 385 kips acts with a design eccentricity of 4.2 ft from the selected rigidity reference. What plan torsional moment T = Ve is generated?

A. 91.7 kip-ft
B. 808.5 kip-ft
C. 2021.2 kip-ft
D. 1617.0 kip-ft

71. A floor shear resultant of 525 kips acts with a design eccentricity of 2.6 ft from the selected rigidity reference. What plan torsional moment T = Ve is generated?

A. 201.9 kip-ft
B. 682.5 kip-ft
C. 1365.0 kip-ft
D. 1706.2 kip-ft

72. A floor shear resultant of 310 kips acts with a design eccentricity of 5.4 ft from the selected rigidity reference. What plan torsional moment T = Ve is generated?

A. 1674.0 kip-ft
B. 57.4 kip-ft
C. 837.0 kip-ft
D. 2092.5 kip-ft

73. In plan, three lateral lines are located at x = 0, 24, and 48 ft and have stiffnesses 240, 360, and 600 kip/in. Find the stiffness-weighted x-coordinate of the system's rigidity center measured from the origin.

A. 24.00 ft
B. 16.80 ft
C. 31.20 ft
D. 23.40 ft

74. A plan model places resisting lines at x = 0, 35, and 70 ft with corresponding stiffnesses 300, 500, and 400 kip/in. What x-coordinate is obtained from the stiffness-weighted average that locates the center of rigidity?

A. 35.00 ft
B. 32.08 ft
C. 28.44 ft
D. 37.92 ft

75. Two resisting lines lie at x = 12 ft and x = 56 ft with stiffnesses 420 and 680 kip/in. Determine the x-location of their stiffness-weighted center of rigidity from the plan origin.

A. 39.20 ft
B. 34.00 ft
C. 16.80 ft
D. 29.40 ft

76. Three lateral lines occur at x = 0, 28, and 60 ft with stiffnesses 500, 280, and 320 kip/in. Calculate the stiffness-weighted x-coordinate of the center of rigidity.

A. 29.33 ft
B. 24.58 ft
C. 35.42 ft
D. 18.43 ft

77. Along a 144-ft diaphragm boundary, a total in-plane transfer of 360 kips is distributed uniformly. What average shear flow, in kip/ft, is developed along that boundary?

A. 5.00 kip/ft
B. 2.50 kip/ft
C. 0.40 kip/ft
D. 1.75 kip/ft

78. A 130-ft-long diaphragm transfer line receives 455 kips uniformly along its length. Determine the average in-plane shear demand per foot of line.

A. 3.50 kip/ft
B. 7.00 kip/ft
C. 0.29 kip/ft
D. 2.45 kip/ft

79. A diaphragm's in-plane bending action is represented by an 8,250 kip-ft moment. Chord lines are 110 ft apart. What equal and opposite axial chord force forms the resisting couple?

A. 37.5 kips
B. 60.0 kips
C. 97.5 kips
D. 75.0 kips

80. An in-plane diaphragm moment of 5,720 kip-ft is resisted by two chord lines separated by 88 ft. Determine the axial force magnitude in each chord needed to form the couple.

A. 32.5 kips
B. 52.0 kips
C. 65.0 kips
D. 84.5 kips

81. At one story, lateral displacement is 2.9 in. at the top and 0.8 in. at the bottom. The story height is 13 ft. What story drift ratio, expressed as a percent, is implied?

A. 1.86%
B. 16.15%
C. 2.37%
D. 1.35%

82. At one story, lateral displacement is 3.5 in. at the top and 1.1 in. at the bottom. The story height is 14 ft. What story drift ratio, expressed as a percent, is implied?

A. 1.43%
B. 2.08%
C. 17.14%
D. 2.74%

83. At one story, lateral displacement is 2.4 in. at the top and 0.5 in. at the bottom. The story height is 12 ft. What story drift ratio, expressed as a percent, is implied?

A. 1.67%
B. 15.83%
C. 1.32%
D. 2.01%

84. At one story, lateral displacement is 4.1 in. at the top and 1.6 in. at the bottom. The story height is 15 ft. What story drift ratio, expressed as a percent, is implied?

A. 2.28%
B. 1.39%
C. 16.67%
D. 3.17%

85. Why are earthquake load effects commonly evaluated in both positive and negative horizontal directions when combined with gravity effects?

A. Earthquake inertia acts in only one permanent direction
B. Gravity load changes sign whenever ground motion reverses
C. Reversing earthquake direction can change which members or connections experience the most adverse force combination
D. Directional checks eliminate the need for a structural model

86. A response-spectrum analysis produces modal forces below the minimum base-shear level required for the design procedure. Why are modal results scaled upward?

A. To force every mode to have the same period
B. To eliminate torsional response from the model
C. To make story drifts exactly zero
D. Scale dynamic results to the required minimum design-force level

87. In a simplified model of a flexible diaphragm, how is lateral load generally delivered to parallel vertical resisting lines?

A. Primarily by tributary area or span rather than by rigid-diaphragm stiffness distribution
B. Strictly in proportion to line stiffness regardless of location
C. Equally to every line independent of tributary width
D. Only to the line nearest the center of rigidity

88. What is the primary structural function of a collector, sometimes called a drag strut, within a diaphragm?

A. Support only vertical roof dead load
B. Transfer diaphragm force into designated vertical seismic-resisting elements
C. Eliminate the need for diaphragm chords
D. Prevent all floor rotation during shaking

89. Why are protected ductile yielding regions important in a special steel moment-frame seismic mechanism?

A. Enable ductile yielding while preserving critical connection capacity
B. They make brittle connection fracture desirable
C. They eliminate the need for column stability
D. They prevent every beam from rotating

90. What is the seismic purpose of closely spaced hoops or ties in critical reinforced-concrete hinge regions?

A. They prevent all concrete cracking
B. Confine the core and restrain longitudinal bars during cycling
C. They replace longitudinal reinforcement
D. They are added only to increase dead load

91. In a reinforced masonry wall, why must required reinforcing bars be surrounded by properly placed grout?

A. Grout is intended to create unfilled voids
B. It makes reinforcing steel unnecessary
C. Develop composite action between grout, reinforcement, and masonry
D. It eliminates the need to inspect bar placement

92. Why is continuous edge nailing and blocking important in a wood structural-panel diaphragm?

A. It reduces wood density during shaking
B. It permits panel edges to slide without control
C. It replaces all hold-down and anchorage connections
D. Maintain continuous diaphragm shear transfer across panel edges

93. A concrete wall is connected to a flexible wood roof diaphragm. What connection objective is most important for out-of-plane seismic performance?

A. Depend on gravity friction at the wall top
B. Provide positive wall anchorage into the diaphragm load path
C. Allow the wall to separate freely from the roof
D. Remove continuity elements near the connection

94. During fabrication of a designated seismic steel connection, what is the main purpose of special inspection for critical welding?

A. Replace the engineer's structural calculations
B. Guarantee that no earthquake damage can occur
C. Authorize undocumented design changes in the shop
D. Verify specified seismic welding materials, procedures, qualifications, and workmanship

95. Why can structural observation still be valuable on a major seismic project that also has extensive special inspection?

A. It replaces all testing and special inspection
B. It is limited to architectural color review
C. Assess overall structural conformance to the intended seismic system
D. It allows field inspectors to redesign the building

96. A gypsum partition crosses a building seismic separation. What detailing approach best supports deformation compatibility?

A. Use a flexible detail that permits differential joint movement
B. Rigidly fasten the partition to both structures across the joint
C. Fill the separation solid so movement cannot occur
D. Eliminate clearance around the partition framing

97. Why are collector and drag-strut connections often capacity-protected or designed for amplified seismic demand?

A. Prevent collector failure from interrupting the diaphragm load path
B. Collectors carry only gravity load
C. They are intended to be the first brittle fuse
D. Amplification removes all diaphragm shear

98. Before concrete placement at a ductile wall boundary element, what inspection item is especially important?

A. Check only exterior finish color
B. Verify seismic reinforcement and embedments before concrete concealment
C. Delay inspection until after the wall is loaded
D. Remove transverse reinforcement that crowds the form

99. Why do weld access, fit-up, cleaning, and surface preparation matter at highly stressed seismic steel connections?

A. They are needed only for appearance
B. They replace approved welding procedures
C. They permit cracks to be accepted without evaluation
D. Support weld quality and inspection at cyclically loaded connections

100. What is the principal seismic reason for providing continuous ties among major floors, roofs, walls, frames, and foundations?

A. They keep every member completely elastic

B. They eliminate the need for foundations

C. Maintain structural integrity and continuous seismic force transfer

D. They make all diaphragms perfectly rigid

Practice Exam 19: Answer Key and Explanations

1. A — The stated relationship requires multiplying the mapped short-period value by the site coefficient. The product 1.27 x 1.14 equals 1.4478 g, which rounds to 1.448 g. Dividing by Fa reverses the operation, while selecting Ss or Fa alone omits one of the two quantities required by the definition. That distinction provides a useful exam-time check.

2. C — The one-second maximum-considered spectral ordinate is obtained by multiplying the mapped one-second acceleration by Fv. Multiplying 0.61 by 1.55 gives 0.9455 g, rounded to 0.946 g. The distractors either divide rather than multiply or simply repeat one of the input values instead of forming the required product. That distinction provides a useful exam-time check.

3. B — Design short-period acceleration is two-thirds of the supplied maximum-considered value in this exercise. Two-thirds of 1.35 g equals 0.90 g. Carrying 1.35 g forward skips the conversion, one-half gives 0.68 g after rounding, and multiplying by three-halves increases the value rather than producing the design ordinate. That distinction provides a useful exam-time check.

4. D — Apply the stated two-thirds conversion to the maximum-considered one-second ordinate. Two-thirds of 0.96 g is 0.64 g. The alternatives correspond to leaving SM1 unchanged, halving it, or increasing it by fifty percent. None of those operations matches the definition given in the stem for the design one-second value. That distinction provides a useful exam-time check.

5. A — The corner period is found by dividing the one-second design ordinate by the short-period design ordinate. Dividing 0.64 by 0.90 gives 0.711 second, which rounds to 0.71 second. Reversing the ratio produces a value greater than one, and multiplying accelerations does not produce a physically meaningful period. That distinction provides a useful exam-time check.

6. D — Site class represents the stiffness and dynamic character of the near-surface soil or rock profile. It is therefore the input that connects subsurface conditions to site amplification coefficients and design spectral ordinates. Occupancy affects risk treatment, while concrete strength and parking count do not describe the ground-motion modification caused by the soil profile.

7. C — Risk category reflects the consequences associated with the building's occupancy and function. Because the two structures share the same location and site conditions, mapped hazard and site class need not change. The emergency-use facility can receive more stringent seismic treatment through its risk classification, while material unit weight does not encode societal consequence.

8. B — These parameters form the seismic design basis from which later system selection, force calculations, analysis requirements, and detailing decisions proceed. Recording them together improves consistency and reviewability. They do not replace a lateral system, choose finishes, or eliminate inspection. Instead, they establish the assumptions that the rest of the structural design must honor.

9. A — With equal applied shear, elastic displacement varies inversely with stiffness. Therefore deltaY/deltaX equals kX/kY, or 720/480 = 1.50. The less-stiff system moves more. Reversing the stiffness ratio predicts the wrong relative drift, while the other choices do not follow the basic force-displacement relation for equal loading. That distinction provides a useful exam-time check.

10. B — Parallel lateral elements experience the same floor displacement, so their resisting forces add. The effective translational stiffness is therefore the sum, 350 + 850 = 1,200 kip/in. Subtracting the stiffnesses, using the series-spring expression, or selecting only the stiffer frame would omit part of the resistance available at the shared displacement.

11. C — For equal mass, period varies with the inverse square root of stiffness. Thus TB/TA equals square root of kA/kB = sqrt(450/720), approximately 0.79. The stiffer system has the shorter period. Using the direct stiffness ratio or reversing the square-root ratio does not follow the stated period relationship. That distinction provides a useful exam-time check.

12. D — The conservative check assumes the adjacent structures can move toward each other at the same time, so the required gap is the sum of the two movements: 1.8 + 2.4 = 4.2 inches. Using only the larger displacement, their difference, or a root-sum-square combination gives less clearance than the stated conservative method requires.

13. C — A plan offset between mass and stiffness creates an eccentricity between inertia force and resistance. The resulting moment produces torsional rotation in addition to overall translation, changing the demands on individual lateral lines. The offset does not create only vertical shortening, remove perimeter force, or produce uniform axial compression throughout the resisting system.

14. B — A sudden reduction in story stiffness can concentrate drift and inelastic demand at one level. An open ground story beneath much stiffer upper stories is the classic configuration that can create that concentration. Uniform repeated framing, symmetry, and evenly arranged collectors generally promote regular response rather than a sharp vertical stiffness discontinuity.

15. D — Redundancy supplies multiple paths for transferring seismic force, so damage to one line need not eliminate the system's overall resistance. It does not guarantee elastic behavior, replace diaphragm anchorage, or prevent torsion. Its value is resilience of the load path: demand can redistribute rather than depending on a single critical element or connection.

16. A — Ductility is the capacity to deform beyond first yield while retaining substantial load-carrying ability through repeated cycles. Well-detailed systems dissipate energy through stable hysteretic behavior and avoid abrupt brittle failure. Perfect rigidity is not realistic seismic behavior, and immediate fracture represents the opposite of the ductile response desired in critical structural components.

17. D — An open parking level beneath stiffer upper stories can behave as a weak or soft story, concentrating drift and damage at the first level. Retrofit work commonly adds appropriately detailed lateral resistance and connections at that story. Adding mass, removing upper resistance, or weakening anchorage increases demand or further compromises the existing load path.

18. B — Unbraced masonry parapets are vulnerable to out-of-plane acceleration and can fall away from the building. Positive bracing or anchorage provides a path for that inertia force into a capable structural system. Increasing height adds mass and overturning demand, while separation or friction-only reliance leaves the principal out-of-plane weakness unresolved. That distinction provides a useful exam-time check.

19. C — Precast members can lose support if earthquake movement exceeds available bearing length or if positive ties are inadequate. Retrofit measures should preserve seating and continuity through expected displacement. Shortening seats or removing hardware worsens the vulnerability, while adding finish weight increases inertia without addressing the connection mechanism that threatens member stability.

20. A — Poorly confined older concrete columns can lose shear strength, suffer bar buckling, and degrade rapidly under cyclic deformation. A retrofit that improves confinement and shear capacity addresses those mechanisms directly. Reducing section size, removing ties, or adding unrelated mass would increase vulnerability rather than create the stable inelastic behavior needed at critical column regions.

21. B — The concern is abrupt brittle connection failure before the frame can develop a stable inelastic mechanism. Retrofit design therefore seeks improved connection toughness, geometry, and force transfer so intended yielding can occur without premature fracture. Deliberately weakening connections or removing important continuity details would undermine, not improve, the desired seismic performance.

22. C — A partial collapse and unstable debris represent an immediate life-safety hazard, especially because aftershocks can trigger additional movement. Access should be restricted while the dangerous condition is stabilized and evaluated. Normal occupancy, removal of controls, or treating the damage as cosmetic would expose occupants and the public to a known unstable condition.

23. D — Substitute the stated values into V = (SDS Ie/R)W. The calculation uses the design spectral ordinate and importance factor in the numerator, divides by the response modification factor, then applies the resulting coefficient to the effective seismic weight. The distractors represent common omissions or percentage shifts rather than the requested coefficient-based base shear.

24. A — Substitute the stated values into V = (SDS Ie/R)W. The calculation uses the design spectral ordinate and importance factor in the numerator, divides by the response modification factor, then applies the resulting coefficient to the effective seismic weight. The distractors represent common omissions or percentage shifts rather than the requested coefficient-based base shear.

25. B — Substitute the stated values into V = (SDS Ie/R)W. The calculation uses the design spectral ordinate and importance factor in the numerator, divides by the response modification factor, then applies the resulting coefficient to the effective seismic weight. The distractors represent common omissions or percentage shifts rather than the requested coefficient-based base shear.

26. A — Substitute the stated values into V = (SDS Ie/R)W. The calculation uses the design spectral ordinate and importance factor in the numerator, divides by the response modification factor, then applies the resulting coefficient to the effective seismic weight. The distractors represent common omissions or percentage shifts rather than the requested coefficient-based base shear.

27. C — Substitute the stated values into V = (SDS Ie/R)W. The calculation uses the design spectral ordinate and importance factor in the numerator, divides by the response modification factor, then applies the resulting coefficient to the effective seismic weight. The distractors represent common omissions or percentage shifts rather than the requested coefficient-based base shear.

28. D — Substitute the stated values into V = (SDS Ie/R)W. The calculation uses the design spectral ordinate and importance factor in the numerator, divides by the response modification factor, then applies the resulting coefficient to the effective seismic weight. The distractors represent common omissions or percentage shifts rather than the requested coefficient-based base shear.

29. B — The approximate period follows the power-law relation provided in the stem. Raise the structural height to the exponent x, then multiply by Ct. This produces the keyed period after rounding to hundredths of a second. The distractors reflect using a linear height relation or applying arbitrary percentage changes rather than evaluating the stated exponent.

30. A — The approximate period follows the power-law relation provided in the stem. Raise the structural height to the exponent x, then multiply by Ct. This produces the keyed period after rounding to hundredths of a second. The distractors reflect using a linear height relation or applying arbitrary percentage changes rather than evaluating the stated exponent.

31. C — The approximate period follows the power-law relation provided in the stem. Raise the structural height to the exponent x, then multiply by Ct. This produces the keyed period after rounding to hundredths of a second. The distractors reflect using a linear height relation or applying arbitrary percentage changes rather than evaluating the stated exponent.

32. A — The approximate period follows the power-law relation provided in the stem. Raise the structural height to the exponent x, then multiply by Ct. This produces the keyed period after rounding to hundredths of a second. The distractors reflect using a linear height relation or applying arbitrary percentage changes rather than evaluating the stated exponent.

33. D — Compute wx hx^k for the requested level and divide by the sum of the same weighted-height term for all levels. This keeps both floor weight and elevation in the distribution. Using weight fraction alone, height fraction alone, or the complement ignores part of the stated vertical force-distribution expression. That distinction provides a useful exam-time check.

34. B — Compute wx hx^k for the requested level and divide by the sum of the same weighted-height term for all levels. This keeps both floor weight and elevation in the distribution. Using weight fraction alone, height fraction alone, or the complement ignores part of the stated vertical force-distribution expression. That distinction provides a useful exam-time check.

35. C — Compute wx hx^k for the requested level and divide by the sum of the same weighted-height term for all levels. This keeps both floor weight and elevation in the distribution. Using weight fraction alone, height fraction alone, or the complement ignores part of the stated vertical force-distribution expression. That distinction provides a useful exam-time check.

36. D — Compute wx hx^k for the requested level and divide by the sum of the same weighted-height term for all levels. This keeps both floor weight and elevation in the distribution. Using weight fraction alone, height fraction alone, or the complement ignores part of the stated vertical force-distribution expression. That distinction provides a useful exam-time check.

37. A — Story shear immediately below a level equals the sum of all floor forces at that level and above because those inertia forces must pass through the resisting elements below. Summing the appropriate upper-story forces gives the keyed value. Selecting only one floor force or summing the wrong side of the cut does not represent the cumulative load path.

38. D — Story shear immediately below a level equals the sum of all floor forces at that level and above because those inertia forces must pass through the resisting elements below. Summing the appropriate upper-story forces gives the keyed value. Selecting only one floor force or summing the wrong side of the cut does not represent the cumulative load path.

39. C — Story shear immediately below a level equals the sum of all floor forces at that level and above because those inertia forces must pass through the resisting elements below. Summing the appropriate upper-story forces gives the keyed value. Selecting only one floor force or summing the wrong side of the cut does not represent the cumulative load path.

40. B — Story shear immediately below a level equals the sum of all floor forces at that level and above because those inertia forces must pass through the resisting elements below. Summing the appropriate upper-story forces gives the keyed value. Selecting only one floor force or summing the wrong side of the cut does not represent the cumulative load path.

41. B — The diaphragm force is obtained by multiplying the effective diaphragm seismic weight by the coefficient supplied in the stem. Multiplying 845 kips by 0.29 gives the keyed in-plane force. The alternatives represent percentage changes or the unmodified weight rather than the required product used to size the diaphragm force path.

42. D — Uniform line transfer is the total diaphragm force divided by the length over which that force is delivered. Dividing 315 kips by 126 ft gives 2.50 kip/ft. Using half the line length doubles the demand, while inverting the ratio or applying an arbitrary reduction does not represent average unit shear.

43. C — The resisting couple is chord force times the separation between chord lines, so F = M/d. Dividing 6,300 kip-ft by 105 ft gives 60.0 kips. Dividing again by two understates the couple force, while multiplying moment by spacing or applying an arbitrary factor does not satisfy the stated equilibrium relation.

44. A — The simplified force is the tributary seismic weight multiplied by the coefficient stated in the stem. Multiplying 168 kips by 0.38 yields 63.8 kips after rounding. The other values correspond to unrelated fractions or the full wall weight and therefore do not follow the specified out-of-plane force relation. That distinction provides a useful exam-time check.

45. C — The amplified collector demand is found by multiplying the nominal seismic effect by the overstrength factor supplied in the problem. Multiplying 172 by 2.75 gives 473.0 kips. Dividing by Ω0, leaving E unchanged, or applying a smaller arbitrary factor would not produce the amplified force specified by the stem. That distinction provides a useful exam-time check.

46. B — Equal sharing among identical anchors means dividing the total transfer by the number of anchors. Dividing 336 kips by eight gives 42.0 kips per anchor. Using fewer or more anchors than stated changes the share, while assigning the full transfer to one anchor ignores the equal-load assumption in the problem.

47. A — Multiply the parapet seismic weight by the coefficient given in the stem. The product 108 x 0.48 is 51.84 kips, which rounds to the keyed force. The distractors use half or one-and-a-half times the coefficient, or simply repeat the weight, none of which follows the stated simplified calculation. That distinction provides a useful exam-time check.

48. D — Convert the stated fraction to a decimal and multiply it by total effective seismic weight. Sixteen percent of 2,640 kips is 422.4 kips. The alternatives use the complement, half the percentage, or the entire building weight rather than isolating the roof share requested in the question. That distinction provides a useful exam-time check.

49. D — Evaluate the expression exactly as written: multiply 0.4, ap, SDS, and Wp, then divide by Rp/Ip. The keyed value is the rounded result of that sequence. The distractors represent arbitrary percentage changes or incorrectly multiplying by the response factor instead of reducing demand by the stated denominator. That distinction provides a useful exam-time check.

50. C — Evaluate the expression exactly as written: multiply 0.4, ap, SDS, and Wp, then divide by Rp/Ip. The keyed value is the rounded result of that sequence. The distractors represent arbitrary percentage changes or incorrectly multiplying by the response factor instead of reducing demand by the stated denominator. That distinction provides a useful exam-time check.

51. A — Evaluate the expression exactly as written: multiply 0.4, ap, SDS, and Wp, then divide by Rp/Ip. The keyed value is the rounded result of that sequence. The distractors represent arbitrary percentage changes or incorrectly multiplying by the response factor instead of reducing demand by the stated denominator. That distinction provides a useful exam-time check.

52. B — Evaluate the expression exactly as written: multiply 0.4, ap, SDS, and Wp, then divide by Rp/Ip. The keyed value is the rounded result of that sequence. The distractors represent arbitrary percentage changes or incorrectly multiplying by the response factor instead of reducing demand by the stated denominator. That distinction provides a useful exam-time check.

53. B — Evaluate the expression exactly as written: multiply 0.4, ap, SDS, and Wp, then divide by Rp/Ip. The keyed value is the rounded result of that sequence. The distractors represent arbitrary percentage changes or incorrectly multiplying by the response factor instead of reducing demand by the stated denominator. That distinction provides a useful exam-time check.

54. A — Evaluate the expression exactly as written: multiply 0.4, ap, SDS, and Wp, then divide by Rp/Ip. The keyed value is the rounded result of that sequence. The distractors represent arbitrary percentage changes or incorrectly multiplying by the response factor instead of reducing demand by the stated denominator. That distinction provides a useful exam-time check.

55. D — For the simplified relation in the stem, base shear equals the seismic coefficient times effective weight. Multiplying Cs by W gives the keyed value. The other choices either alter the result by an arbitrary percentage or carry forward the full weight without applying the seismic coefficient, so they do not represent V = CsW.

56. C — For the simplified relation in the stem, base shear equals the seismic coefficient times effective weight. Multiplying Cs by W gives the keyed value. The other choices either alter the result by an arbitrary percentage or carry forward the full weight without applying the seismic coefficient, so they do not represent V = CsW.

57. D — For the simplified relation in the stem, base shear equals the seismic coefficient times effective weight. Multiplying Cs by W gives the keyed value. The other choices either alter the result by an arbitrary percentage or carry forward the full weight without applying the seismic coefficient, so they do not represent V = CsW.

58. B — For the simplified relation in the stem, base shear equals the seismic coefficient times effective weight. Multiplying Cs by W gives the keyed value. The other choices either alter the result by an arbitrary percentage or carry forward the full weight without applying the seismic coefficient, so they do not represent V = CsW.

59. A — Under the equal-sharing assumption, each identical anchor carries total force divided by the number of anchors. Ninety-six kips divided by six gives 16.0 kips per anchor. The other values result from using the wrong anchor count or assigning the entire unit force to one anchor rather than distributing it as stated.

60. C — Nonstructural equipment develops inertia force during building motion whether or not it belongs to the primary lateral system. Positive restraints and anchorage provide a deliberate path for that force into the supporting structure and limit sliding or overturning. Equipment weight and vibration isolators alone do not reliably provide the required earthquake load path.

61. C — The two wings can move differently during an earthquake, so piping that bridges the joint must tolerate relative displacement. A flexible loop, joint, or similar detail prevents the pipe from becoming an unintended rigid tie or rupturing. Rigid attachment to both sides, eliminating clearance, or adding mass increases demand rather than accommodating movement.

62. D — A tall component develops a horizontal inertia force at an elevation above its base, creating overturning moment as well as base shear. That moment can place some anchors in tension or uplift while others develop compression. A sliding-only check misses this force couple and can underestimate critical anchorage and base-plate demands.

63. B — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction $k_i/\Sigma k$. Applying that fraction to the specified line gives the keyed force. Equal sharing or using the stiffness of other lines does not represent the proportional distribution defined in the question. That distinction provides a useful exam-time check.

64. A — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction $k_i/\Sigma k$. Applying that fraction to the specified line gives the keyed force. Equal sharing or using the stiffness of other lines does not represent the proportional distribution defined in the question. That distinction provides a useful exam-time check.

65. B — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction $k_i/\Sigma k$. Applying that fraction to the specified line gives the keyed force. Equal sharing or using the stiffness of other lines does not represent the proportional distribution defined in the question. That distinction provides a useful exam-time check.

66. D — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction $k_i/\Sigma k$. Applying that fraction to the specified line gives the keyed force. Equal sharing or using the stiffness of other lines does not represent the proportional distribution defined in the question. That distinction provides a useful exam-time check.

67. A — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction $k_i/\Sigma k$. Applying that fraction to the specified line gives the keyed force. Equal sharing or using the stiffness of other lines does not represent the proportional distribution defined in the question. That distinction provides a useful exam-time check.

68. C — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction $k_i/\Sigma k$. Applying that fraction to the specified line gives the keyed force. Equal sharing or using the stiffness of other lines does not represent the proportional distribution defined in the question. That distinction provides a useful exam-time check.

69. B — Plan torsional moment equals the horizontal resultant multiplied by its perpendicular eccentricity from the rigidity reference. Multiplying the supplied shear and offset gives the keyed kip-foot moment. Dividing by eccentricity, using only half the offset, or applying an arbitrary increase does not satisfy the basic moment relation T = Ve.

70. D — Plan torsional moment equals the horizontal resultant multiplied by its perpendicular eccentricity from the rigidity reference. Multiplying the supplied shear and offset gives the keyed kip-foot moment. Dividing by eccentricity, using only half the offset, or applying an arbitrary increase does not satisfy the basic moment relation T = Ve.

71. C — Plan torsional moment equals the horizontal resultant multiplied by its perpendicular eccentricity from the rigidity reference. Multiplying the supplied shear and offset gives the keyed kip-foot moment. Dividing by eccentricity, using only half the offset, or applying an arbitrary increase does not satisfy the basic moment relation T = Ve.

72. A — Plan torsional moment equals the horizontal resultant multiplied by its perpendicular eccentricity from the rigidity reference. Multiplying the supplied shear and offset gives the keyed kip-foot moment. Dividing by eccentricity, using only half the offset, or applying an arbitrary increase does not satisfy the basic moment relation T = Ve.

73. C — The center of rigidity is a stiffness-weighted average of the line coordinates. Multiply each x-coordinate by its line stiffness, sum those products, and divide by total stiffness. The keyed location therefore shifts toward the stiffer lines. A simple geometric average or an arbitrary offset ignores the stiffness weighting built into the stated expression.

74. D — The center of rigidity is a stiffness-weighted average of the line coordinates. Multiply each x-coordinate by its line stiffness, sum those products, and divide by total stiffness. The keyed location therefore shifts toward the stiffer lines. A simple geometric average or an arbitrary offset ignores the stiffness weighting built into the stated expression.

75. A — The center of rigidity is a stiffness-weighted average of the line coordinates. Multiply each x-coordinate by its line stiffness, sum those products, and divide by total stiffness. The keyed location therefore shifts toward the stiffer lines. A simple geometric average or an arbitrary offset ignores the stiffness weighting built into the stated expression.

76. B — The center of rigidity is a stiffness-weighted average of the line coordinates. Multiply each x-coordinate by its line stiffness, sum those products, and divide by total stiffness. The keyed location therefore shifts toward the stiffer lines. A simple geometric average or an arbitrary offset ignores the stiffness weighting built into the stated expression.

77. B — Average diaphragm unit shear is total transferred force divided by the length receiving that force. Dividing the given kips by the resisting-line length gives the keyed kip-per-foot demand. Using half the length, inverting the ratio, or applying a percentage adjustment does not represent the uniform transfer described in the question.

78. A — Average diaphragm unit shear is total transferred force divided by the length receiving that force. Dividing the given kips by the resisting-line length gives the keyed kip-per-foot demand. Using half the length, inverting the ratio, or applying a percentage adjustment does not represent the uniform transfer described in the question.

79. D — The chord pair resists the diaphragm moment as a force couple, so the axial force magnitude is the moment divided by the distance between chord lines. The keyed result follows directly from M/d. Dividing by twice the spacing or applying arbitrary percentage changes does not provide the force required for equilibrium of the stated couple.

80. C — The chord pair resists the diaphragm moment as a force couple, so the axial force magnitude is the moment divided by the distance between chord lines. The keyed result follows directly from M/d. Dividing by twice the spacing or applying arbitrary percentage changes does not provide the force required for equilibrium of the stated couple.

81. D — Story drift is the relative displacement between the top and bottom of the story divided by story height in consistent units. Subtract the two displacements, convert the height from feet to inches, divide, and multiply by 100 for percent. The distractors use total displacement or inconsistent units rather than the interstory deformation.

82. A — Story drift is the relative displacement between the top and bottom of the story divided by story height in consistent units. Subtract the two displacements, convert the height from feet to inches, divide, and multiply by 100 for percent. The distractors use total displacement or inconsistent units rather than the interstory deformation.

83. C — Story drift is the relative displacement between the top and bottom of the story divided by story height in consistent units. Subtract the two displacements, convert the height from feet to inches, divide, and multiply by 100 for percent. The distractors use total displacement or inconsistent units rather than the interstory deformation.

84. B — Story drift is the relative displacement between the top and bottom of the story divided by story height in consistent units. Subtract the two displacements, convert the height from feet to inches, divide, and multiply by 100 for percent. The distractors use total displacement or inconsistent units rather than the interstory deformation.

85. C — Earthquake actions are cyclic and can reverse sign. A member that is in tension, compression, uplift, or reduced gravity support for one direction may experience the opposite effect in the other. Evaluating both signs helps identify the governing combination. Gravity does not reverse, and directional checks supplement rather than replace structural analysis.

86. D — Dynamic modal analysis can produce a total base shear below the prescribed minimum strength basis. Scaling increases the response quantities so the design is not based on an unrealistically low global force level. It does not equalize modal periods, remove torsion, or eliminate drift; it adjusts the magnitude of the dynamic results used for design.

87. A — A flexible diaphragm deforms significantly in its own plane, so it does not enforce a common rigid-body translation among all vertical lines. Simplified distribution therefore follows tributary loading or diaphragm span behavior rather than rigid-diaphragm stiffness proportions. Equal sharing or center-of-rigidity allocation would ignore the flexible diaphragm's deformation and load path.

88. B — Collectors provide a deliberate path for in-plane diaphragm forces that must be concentrated into walls, frames, or other vertical resisting elements, especially near discontinuities. They are not merely gravity members, do not replace chords, and cannot prevent all floor rotation. Their essential role is continuity of force transfer through the diaphragm system.

89. A — Seismic moment frames are detailed so inelastic deformation occurs in intended ductile regions while critical connections and columns retain sufficient capacity. This supports stable hysteretic energy dissipation and preserves the gravity and lateral load paths. Brittle fracture, loss of column stability, or preventing all rotation would undermine rather than support the intended mechanism.

90. B — Closely spaced transverse reinforcement confines the concrete core, supports longitudinal bars against buckling, and improves shear resistance during repeated inelastic cycles. These functions help a plastic-hinge region retain strength and ductility after cracking or cover loss. Hoops do not eliminate cracking, replace longitudinal steel, or exist merely to add structural weight.

91. C — Reinforced masonry relies on interaction among units, grout, and reinforcing steel. Proper grout placement develops bond and transfers force so the reinforcement can contribute to wall shear and flexural resistance. Voids around required bars interrupt that action. Grout does not replace reinforcement or remove the need to verify bar placement before concealment.

92. D — Wood diaphragms transfer in-plane shear through sheathing fasteners, panel-edge details, chords, collectors, and connections to the vertical system. Breaks in edge fastening or blocking can interrupt that load path and concentrate deformation. The detailing does not reduce density, encourage uncontrolled sliding, or replace anchorage devices that perform different structural functions.

93. B — Out-of-plane wall inertia must be transferred through positive anchorage into the roof diaphragm and then through a continuous load path. Reliable connection detailing reduces the risk of wall separation or local failure. Gravity friction is not dependable under cyclic reversal, and intentional separation or removal of continuity weakens the required force-transfer mechanism.

94. D — Special inspection provides independent verification of construction operations whose quality strongly affects seismic performance. For critical welding, that includes specified materials, qualified procedures and personnel, and required workmanship. Inspection does not replace engineering design, guarantee damage-free response, or give inspectors authority to make undocumented structural design changes outside the approved process.

95. C — Structural observation and special inspection address different scales of quality assurance. Observation by the design professional focuses on overall conformance of the structural system and important seismic features, while special inspection focuses on designated materials and construction operations. Observation does not replace testing, become an architectural finish review, or transfer redesign authority to inspectors.

96. A — A seismic separation exists so adjacent portions of a building can move without damaging contact or unintended restraint. A partition crossing that joint should therefore accommodate relative movement through a slip, gap, or flexible detail. Rigid attachment, solid infill, or elimination of clearance can bridge the joint and create brittle nonstructural damage or restraint.

97. A — Collectors are critical links that gather and transfer diaphragm force into the vertical seismic system. If a collector or its connection fails prematurely, the intended force path can be lost. Capacity protection or amplified design demand helps prevent that brittle interruption. Collectors are not gravity-only members, sacrificial brittle fuses, or devices that eliminate diaphragm shear.

98. B — Critical reinforcement and embedded components become difficult or impossible to verify after concrete placement. Pre-placement inspection confirms the details that control confinement, force transfer, anchorage, and development in the seismic region. Finish color is irrelevant, post-loading inspection is too late for concealed work, and removing required transverse reinforcement would directly compromise the design.

99. D — Seismic steel connections can undergo repeated high cyclic demand, making weld quality and defect control especially important. Adequate access, fit-up, cleaning, and surface preparation help qualified welders produce the specified joint and allow meaningful inspection. These steps are not cosmetic, do not replace procedures, and never justify accepting cracks without appropriate evaluation.

100. C — Continuous ties help major structural components remain connected while earthquake forces move through the building. That continuity reduces the chance that local damage causes separation, loss of support, or a broken load path. Ties do not guarantee elastic response, replace foundations, or force every diaphragm to behave rigidly; their central purpose is structural integrity.