PRACTICE EXAM 20: 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 peer reviewer checks the seismic criteria sheet for a public archives building. The sheet lists Ss = 1.27 g and Fa = 1.14. If the intermediate maximum-considered short-period ordinate is defined here by SMS = Fa x Ss, what value should the reviewer obtain?

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

2. During a design-basis audit for a performing-arts facility, the site values are S1 = 0.61 g and Fv = 1.55. The audit worksheet forms SM1 by multiplying Fv and S1. What one-second maximum-considered spectral value belongs in the worksheet?

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

3. A spectrum-preparation note already gives SMS = 1.35 g. The next line converts that ordinate to the design level by taking two-thirds of SMS. What value should be reported as SDS?

A. 1.35 g

B. 0.68 g
C. 0.90 g
D. 2.03 g

4. An engineer is checking the one-second branch of a design spectrum. The maximum-considered ordinate is SM1 = 0.96 g, and the worksheet defines SD1 as two-thirds of that value. What is the resulting SD1?

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

5. A reviewer wants the transition period between the constant-acceleration and descending portions of a simplified spectrum. With SDS = 0.90 g and SD1 = 0.64 g, use Ts = SD1/SDS. What transition period results?

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

6. Mapped hazard is unchanged, but a site investigation finds a deep deposit of very soft clay beneath a planned utility building. Which design input is intended to translate that subsurface condition into the seismic response used for design?

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

7. Two buildings share essentially the same site hazard and soil profile: one is an emergency-response facility and the other is ordinary storage. Which classification is used most directly to reflect the different consequences of failure?

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

8. A plan checker asks why the structural drawings list site class, mapped spectral values, SDS, SD1, risk category, and seismic design category together in the general notes. What is the best reason for documenting that information as one coordinated seismic basis?

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

9. A testing engineer applies the same lateral story force to two single-story systems. Their stiffnesses are 720 kip/in for X and 480 kip/in for Y. From delta = V/k, what is the displacement ratio deltaY/deltaX?

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

10. At one diaphragm level, two frames translate together and therefore act as parallel lateral springs. Their individual stiffnesses are 350 kip/in and 850 kip/in. What effective translational stiffness should be used for the combined pair?

A. 500 kip/in

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

11. Two SDOF idealizations have equal mass, but their lateral stiffnesses are 450 and 720 in consistent units. Because period varies inversely with the square root of stiffness, what is Tstiff/Tsoft?

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

12. A seismic joint separates two wings. At the joint line, one wing may approach by 1.8 in. and the other by 2.4 in. If the preliminary clearance check simply adds the two possible closing movements, what gap is required?

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

13. In a rigid-floor plan, the resultant mass force acts noticeably away from the effective center of lateral resistance. What additional response should the analyst expect from this eccentricity under horizontal earthquake loading?

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

14. During configuration review, which arrangement should most strongly alert the engineer to a possible vertical stiffness irregularity rather than a relatively uniform lateral system?

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. A building uses several independent lateral-resisting lines in each principal direction. What seismic advantage is obtained by avoiding dependence on only one line of resistance?

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

16. When a deliberately ductile seismic system is pushed through repeated strong cycles beyond first yield, which response is most desirable?

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

17. A wood apartment building has a wide open first-story parking level beneath heavily partitioned residential floors. In retrofit planning, which objective most directly addresses the weakness created by that abrupt change in lateral stiffness and strength?

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

18. An older unreinforced brick storefront has tall parapets extending above the roof with little positive anchorage. Which retrofit action most directly reduces the life-safety hazard from those parapets during strong shaking?

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

19. A seismic evaluation of a precast garage identifies short bearing lengths and weak positive ties at beam supports. Which retrofit objective most directly reduces the risk of loss of support?

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

20. A concrete frame from an older era has widely spaced column ties near locations expected to undergo large cyclic rotations. Which retrofit approach most directly improves the deficient confinement behavior?

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

21. A welded steel moment frame uses older connection details known to be vulnerable to brittle fracture under cyclic demand. What retrofit objective best addresses the connection-level weakness?

A. Encourage fracture at the column face
B. Eliminate all beam yielding by weakening connections
C. Remove continuity plates without evaluation

D. Promote ductile yielding instead of brittle connection fracture

22. Following a damaging earthquake, an exterior wall has partially collapsed and unstable debris hangs over a public walkway. What should the initial safety response prioritize?

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

23. A checker is asked to verify the simplified ELF base shear for a county annex. Use Cs = SDS Ie/R with SDS = 0.79, Ie = 1.00, R = 6.5, and W = 2,740 kips, then compute V = CsW. What base shear is obtained?

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

24. For a classroom building, a design-review spreadsheet uses Cs = SDS Ie/R. With SDS = 0.86, Ie = 1.00, R = 7.0, and effective seismic weight W = 2,310 kips, what value of V = CsW should appear?

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

25. An essential communications support building is checked with the simplified relation Cs = SDS Ie/R. Given SDS = 0.73, Ie = 1.25, R = 5.5, and W = 3,480 kips, what base shear follows from V = CsW?

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

26. During schematic review of a distribution warehouse, use Cs = SDS Ie/R with SDS = 0.81, Ie = 1.00, R = 8.0. If W = 3,970 kips, what equivalent lateral base shear does V = CsW produce?

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

27. A municipal court addition has SDS = 0.68, Ie = 1.00, R = 6.0, and effective seismic weight W = 2,890 kips. For this exercise, determine base shear from Cs = SDS Ie/R and V = CsW.

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

28. A research laboratory uses the simplified ELF relation Cs = SDS Ie/R. With SDS = 0.92, Ie = 1.25, R = 7.5, and W = 3,180 kips, what base shear is calculated from V = CsW?

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

29. Before refining a dynamic model, an engineer estimates period from Ta = Ct(hn)^x. Using Ct = 0.030, hn = 64 ft, and x = 0.78, what approximate period does the empirical expression give?

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

30. A preliminary model needs an empirical fundamental period. Evaluate Ta = Ct(hn)^x using Ct = 0.027, total height hn = 92 ft, and exponent x = 0.80. What period should be entered?

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

31. For a 55-ft lateral system, the selected empirical constants are Ct = 0.034 and x = 0.75. What approximate fundamental period is obtained from Ta = Ct(hn)^x?

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

32. A conceptual tower is 118 ft tall. Its empirical period parameters are Ct = 0.025 and x = 0.82. Evaluate Ta = Ct(hn)^x for the preliminary period check.

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

33. An ELF force-distribution audit uses Cvx = wx hx^k / sum(wi hi^k). From lowest floor upward, weights are [410, 530, 690] kips at heights [14, 28, 42] ft, with k = 1.0. What share Cvx belongs to the third level?

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

34. For a four-level ELF distribution, use Cvx = wx hx^k / sum(wi hi^k). The floor weights are [360, 480, 610, 720] kips at heights [12, 24, 36, 48] ft, and k = 1.3. What fraction of V goes to level 4?

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

35. A three-level vertical distribution uses Cvx = wx hx^k / sum(wi hi^k). Level weights are [520, 500, 470] kips at heights [16, 32, 48] ft, with k = 1.5. What fraction is assigned to level 1?

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

36. An analyst distributes ELF forces with Cvx = wx hx^k / sum(wi hi^k). From bottom to top, weights are [280, 390, 510, 640] kips and heights are [11, 22, 33, 44] ft, with k = 1.0. Find Cvx for level 2.

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

37. Floor inertia forces from level 1 through the roof are [85, 115, 150, 205] kips. A free-body cut is made in the vertical lateral system immediately below level 2. What total lateral shear must cross that cut?

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

38. At a five-level building, lateral floor forces from bottom to top are [70, 90, 125, 160, 210] kips. If a story free body is cut just below level 3, what cumulative shear is carried across the cut?

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

39. A three-story structure develops floor forces of [140, 175, 225] kips from the first floor to the roof. What is the base story shear obtained by summing all floor forces above the foundation?

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

40. The floor forces of a four-level building are [55, 80, 110, 145] kips from bottom upward. Determine the story shear in the vertical system immediately below level 3 by summing the forces at and above that level.

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

D. 255 kips

41. A roof diaphragm has effective seismic weight Wpx = 845 kips. A simplified check uses an in-plane force coefficient of 0.29. What diaphragm force is obtained from Fpx = 0.29Wpx?

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

42. A 126-ft-long diaphragm transfer line receives a total of 315 kips distributed uniformly along its length. What average line shear, in kip/ft, corresponds to that transfer?

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

43. An in-plane diaphragm moment of 6,300 kip-ft is resisted by a pair of chords 105 ft apart. Treating the chords as an equal-and-opposite couple, what axial force magnitude is required in each chord from F = M/d?

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

44. For a wall-panel inertia screening calculation, the horizontal design action is taken as 38 percent of a 168-kip tributary seismic weight. What force results from that coefficient-weight product?

A. 33.6 kips

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

45. A collector connection sees a calculated seismic demand of 172 kips before amplification. The design check applies a factor of 2.75 to that demand. What amplified force must the connection be capable of transmitting?

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

46. A roof-to-wall load path uses eight identical anchors. If a 336-kip transfer is assumed to divide equally and eccentricity is ignored, what idealized force is assigned to each anchor?

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

47. During a parapet anchorage check, the effective seismic weight carried by the parapet is 108 kips. The simplified procedure in this problem takes 0.48 times that weight as the horizontal out-of-plane action. What design force follows from that multiplication?

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

48. The building seismic-weight takeoff totals 2,640 kips. If 16 percent of that total is assigned to the roof level, what roof seismic weight should be used?

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

49. For an idealized component check, evaluate Fp = (0.4 ap SDS Wp Ip)/Rp with ap = 1.0, SDS = 0.86, Wp = 380 kips, Ip = 1.0, and Rp = 2.5. Ignoring any upper or lower bounds, what value does the expression give?

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

50. A supported nonstructural component is checked using Fp = (0.4 ap SDS Wp Ip)/Rp. Substitute ap = 2.5, SDS = 0.78, Wp = 42 kips, Ip = 1.0, and Rp = 6.0. What force is calculated?

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

51. A component design worksheet uses Fp = (0.4 ap SDS Wp Ip)/Rp. With ap = 1.0, SDS = 0.82, Wp = 118 kips, Ip = 1.5, and Rp = 2.0, what force does the expression produce?

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

52. A ceiling-supported service module weighs 26 kips for seismic design. Its worksheet uses ap = 2.5, SDS = 0.91, Ip = 1.0, and Rp = 3.5 in the relation 0.4(ap)(SDS)(Wp)(Ip)/Rp. What unbounded component-force value does the worksheet produce?

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

53. A floor-mounted equipment item has Wp = 92 kips. For a simplified attachment check, use ap = 1.0, SDS = 0.74, Ip = 1.0, and Rp = 2.5 in 0.4(ap)(SDS)(Wp)(Ip)/Rp. What horizontal component force is calculated?

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

54. A suspended component has Wp = 18 kips and importance factor Ip = 1.5. With ap = 2.5, SDS = 0.69, and Rp = 5.0, evaluate 0.4(ap)(SDS)(Wp)(Ip)/Rp. What seismic component force does this simplified calculation yield?

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

55. A rigid equipment support has 610 kips of effective seismic weight. A simplified horizontal coefficient of 0.28 is applied directly to that weight. What base reaction results?

A. 128.1 kips
B. 213.5 kips

C. 170.8 kips
D. 610.0 kips

56. A compact nonbuilding structure has effective seismic weight of 740 kips and a simplified horizontal coefficient of 0.33. What horizontal base shear is obtained from the coefficient-weight product?

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

57. A rigid tank support is represented by 980 kips of seismic weight and a simplified horizontal coefficient of 0.25. What base shear does that idealization produce?

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

58. A freestanding rigid structure has seismic weight of 455 kips. If a simplified horizontal coefficient of 0.37 is used, what design base shear results?

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

59. A rooftop air-handling unit develops a 96-kip horizontal seismic force. Six identical anchors are assumed to share that force equally. What idealized anchor demand follows from that assumption?

A. 16.0 kips

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

60. A roof-mounted emergency generator is isolated for vibration in normal service. Why must its support still include positive seismic restraint even though the generator is not part of the primary building lateral-force-resisting system?

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

61. A chilled-water line crosses a seismic separation between two wings that can translate relative to one another. Which detailing strategy best allows the pipe to survive the joint movement without becoming a rigid link between the structures?

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. A tall freestanding battery rack is anchored at its base. Why is a seismic anchorage check that considers only horizontal sliding incomplete?

A. Tall equipment cannot develop vertical reactions
B. Tall equipment also develops overturning, uplift, and anchor tension
C. Only friction controls every anchorage design
D. Overturning disappears when horizontal force is present

63. Before torsion is introduced, a rigid diaphragm carries 390 kips of direct story shear to three resisting lines with stiffnesses [320, 480, 700] kip/in. If load is shared in proportion to stiffness, how much direct shear goes to line 1?

A. 83.2 kips
B. 130.0 kips
C. 306.8 kips
D. 178.3 kips

64. A rigid floor distributes 320 kips of direct lateral shear among three lines with stiffnesses [420, 530, 650] kip/in. Neglect plan eccentricity. What stiffness-proportional force is assigned to line 2?

A. 106.7 kips
B. 214.0 kips
C. 260.9 kips
D. 106.0 kips

65. Three vertical lateral lines have stiffnesses [275, 625, 500] kip/in and together resist 350 kips of direct story shear. With torsional effects excluded, what share of the direct force is attracted by line 3?

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

66. At a rigid diaphragm, 300 kips of direct shear is distributed among lines with stiffnesses [560, 340, 300] kip/in. Before any torsional component is added, what force goes to line 2 by relative stiffness?

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

67. Two parallel lateral lines have stiffnesses 410 and 690 kip/in. A rigid floor applies 275 kips of direct shear and torsion is neglected. What direct force is attracted by the 410-kip/in line?

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

68. A rigid floor sends 475 kips of direct story shear to three lines with stiffnesses [460, 540, 900] kip/in. Ignoring torsion, determine the stiffness-proportional force assigned to the 900-kip/in line.

A. 158.3 kips
B. 250.0 kips
C. 475.0 kips
D. 225.0 kips

69. At one floor, the horizontal shear resultant is 440 kips and its line of action is offset 3.6 ft from the selected rigidity reference. What torsional moment is generated from T = V e?

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

70. A 385-kip floor shear acts with a design eccentricity of 4.2 ft relative to the rigidity reference. Using T = V e, what plan torsional moment must be considered?

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

D. 1617.0 kip-ft

71. The resultant floor shear is 525 kips and its design eccentricity is 2.6 ft. What torsional moment follows from multiplying the shear by the eccentricity?

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

72. A 310-kip floor shear resultant is assumed to act 5.4 ft from the rigidity reference. What plan torsional moment is produced by T = V e?

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

73. Using xR = sum(kixi)/sum(ki), locate the rigidity center for three resisting lines at x = 0, 24, and 48 ft with stiffnesses 240, 360, and 600 kip/in. What x-coordinate results?

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

74. Three lateral lines are located at x = 0, 35, and 70 ft. Their stiffnesses are 300, 500, and 400 kip/in. What plan coordinate is obtained for the center of rigidity from the stiffness-weighted average?

A. 35.00 ft
B. 32.08 ft

C. 28.44 ft
D. 37.92 ft

75. Two resisting lines are positioned at x = 12 ft and 56 ft with stiffnesses 420 and 680 kip/in. Using a stiffness-weighted average, where is the center of rigidity measured from the origin?

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

76. A plan model has lateral lines at x = 0, 28, and 60 ft with stiffnesses 500, 280, and 320 kip/in. Calculate the x-coordinate of the center of rigidity using xR = sum(kixi)/sum(ki).

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

77. A diaphragm boundary is 144 ft long and transfers 360 kips uniformly along its length. What average in-plane shear flow, in kip/ft, corresponds to that total transfer?

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

78. A diaphragm load path transfers 455 kips uniformly along a 130-ft line. Determine the average in-plane shear demand per foot along that line.

A. 7.00 kip/ft

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

79. An in-plane diaphragm moment of 8,250 kip-ft is resisted by chord lines spaced 110 ft apart. What axial force magnitude in each chord forms the required equal-and-opposite couple?

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

80. A diaphragm in-plane moment is 5,720 kip-ft, and the two chord lines are separated by 88 ft. What axial chord force magnitude is required to create the resisting couple?

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

81. At a 13-ft-tall story, measured lateral displacement is 0.8 in. at the bottom and 2.9 in. at the top. What interstory drift ratio, expressed as a percent, follows from the displacement difference divided by story height?

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

82. A 14-ft story has lateral displacement readings of 1.1 in. at its base and 3.5 in. at its top. What story drift ratio, in percent, is obtained from the relative displacement?

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

83. At a story 12 ft high, lateral displacement is 0.5 in. at the bottom and 2.4 in. at the top. Compute the interstory drift ratio as a percentage.

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

84. A 15-ft story has measured lateral displacements of 1.6 in. at the lower level and 4.1 in. at the upper level. What drift ratio, expressed as a percent, does the relative translation imply?

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

85. Why are horizontal earthquake effects commonly checked with both signs when they are combined with gravity-load effects in member and connection design?

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

86. A response-spectrum analysis produces a total modal base shear below the minimum level required by the governing design procedure. What is the purpose of scaling the modal results upward before design forces are used?

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. When a diaphragm is idealized as flexible in its own plane, what general principle is used to distribute lateral load to parallel vertical resisting elements?

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

88. Within a diaphragm load path, what job is performed by a collector or drag strut that distinguishes it from an ordinary chord or boundary member?

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

89. In a special steel moment frame, why are designated ductile yielding regions protected from unintended brittle failure modes?

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

90. What seismic behavior is promoted by closely spaced transverse hoops or ties in reinforced-concrete regions expected to undergo large cyclic hinge rotations?

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

91. In reinforced masonry construction, why is proper grout placement around required reinforcing bars important to the wall's seismic load path and deformation capacity?

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

92. What is the principal seismic benefit of continuous edge nailing together with adequate blocking in a wood structural-panel diaphragm?

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

93. A concrete wall relies on a flexible wood roof diaphragm for out-of-plane restraint. What connection objective is most important so the wall remains tied to the roof during earthquake motion?

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. For a designated seismic steel connection, what is special inspection of critical welding primarily intended to verify during fabrication and erection?

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

95. On a major seismic project, why can structural observation provide useful oversight even when extensive special inspection is already being performed?

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

96. A nonstructural gypsum partition crosses a seismic separation between building segments. Which detailing concept best accommodates the expected differential movement?

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

97. Why are collector and drag-strut connections often designed for amplified seismic demand or otherwise capacity-protected relative to ordinary force levels?

A. Collectors carry only gravity load
B. They are intended to be the first brittle fuse

C. Amplification removes all diaphragm shear

D. Prevent collector failure from interrupting the diaphragm load path

98. Before concrete is placed around a ductile wall boundary element, which inspection focus is especially important to confirm the intended confinement and bar arrangement?

A. Verify seismic reinforcement and embedments before concrete concealment

B. Check only exterior finish color

C. Delay inspection until after the wall is loaded

D. Remove transverse reinforcement that crowds the form

99. At a highly stressed seismic steel connection, why do weld access, fit-up, cleanliness, and surface preparation matter before the final weld is accepted?

A. They are needed only for appearance

B. Support weld quality and inspection at cyclically loaded connections

C. They replace approved welding procedures

D. They permit cracks to be accepted without evaluation

100. What is the main earthquake-resistance reason for providing continuous positive ties among roofs, floors, walls, frames, and foundations throughout a building?

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 20: Answer Key and Explanations

1. B — 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. A — 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. C — 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. C — 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. B — 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. D — 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. D — 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. B — 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. D — 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. A — 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. C — 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. B — 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. C — 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. A — 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. D — 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. D — 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. A — 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. 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.

24. 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.

25. 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.

26. 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.

27. 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.

28. 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.

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. D — 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. A — 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. 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.

38. 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.

39. 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.

40. 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.

41. A — 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. C — 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. B — 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. D — 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. A — 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. D — 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. B — 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. C — 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. 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.

50. 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.

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. 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.

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. 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.

56. 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.

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. 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.

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. B — 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. B — 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. 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.

64. 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.

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. 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.

67. 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.

68. 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.

69. 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 $T = Ve$.

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. 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 $T = Ve$.

72. 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 $T = Ve$.

73. 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.

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. 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.

77. C — 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. D — 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. B — 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. A — 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. 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.

82. 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.

83. 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.

84. 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.

85. A — 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. B — 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. C — 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. B — 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. C — 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. D — 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. A — 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. C — 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. A — 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. D — 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. D — 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. A — 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. B — 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.