PRACTICE EXAM 21: 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. For a new municipal records center, the seismic worksheet must form the site-adjusted short-period MCE ordinate. With Ss = 1.27 g and Fa = 1.14, calculate SMS from the stated product SMS = Fa Ss.

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

2. A transit maintenance office has S1 = 0.61 g and Fv = 1.55. The design-basis worksheet defines the one-second MCE spectral ordinate as SM1 = Fv S1. Which value belongs on that line?

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

3. The hazard summary for a courthouse annex lists SMS = 1.35 g. Using the stated design conversion SDS = (2/3)SMS, determine the short-period design spectral acceleration.

A. 0.68 g
B. 0.90 g
C. 2.03 g

D. 1.35 g

4. A library addition has a maximum-considered one-second spectral value SM1 = 0.96 g. Apply the stated relation SD1 = (2/3)SM1. What design one-second ordinate results?

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

5. A simplified response spectrum is being laid out with SDS = 0.90 g and SD1 = 0.64 g. Compute the transition period from Ts = SD1/SDS.

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

6. A proposed operations building sits over a thick profile of very soft clay even though the mapped hazard values are unchanged. Which seismic-design input accounts for the influence of those subsurface conditions on spectral response?

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

7. A hospital support facility and a low-occupancy storage building are planned on the same soil profile with the same mapped hazard. Which classification most directly captures the different consequences associated with failure?

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

8. The general notes for a seismic design identify the mapped spectral values, site class, SDS, SD1, risk category, and seismic design category in one block. What is the principal purpose of recording these items together?

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

9. Two elastic single-story test frames carry the same lateral shear. Frame X has stiffness 720 kip/in and frame Y has stiffness 480 kip/in. Using delta = V/k, determine the ratio deltaY/deltaX.

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

10. At one floor, two lateral frames undergo the same translation and therefore behave as parallel springs. Their stiffnesses are 350 kip/in and 850 kip/in. What combined lateral stiffness represents the pair?

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

11. Two idealized SDOF systems have identical mass. One has stiffness 450 and the other 720 in consistent units. Since T is proportional to 1/sqrt(k), determine Tstiff/Tsoft.

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

12. Two adjacent building wings can close toward a seismic separation by 1.8 in. and 2.4 in., respectively. For a preliminary check that adds the possible closing movements, what joint clearance is needed?

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

13. At a rigid diaphragm, the center of mass is offset in plan from the effective center of lateral resistance. Under horizontal seismic inertia, what additional motion should be expected because of that offset?

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. Which building configuration is the strongest warning sign of a vertical stiffness irregularity during an initial seismic configuration review?

A. An open ground-story storefront beneath several stories with closely spaced full-height walls
B. A roof diaphragm with evenly spaced collectors
C. A uniform bay layout repeated from roof to foundation

D. A symmetric floor plan with similar frames on each side

15. A lateral system provides several separate resisting lines in each principal direction rather than relying on one line. What resilience benefit does this arrangement provide during earthquake loading?

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

16. A ductile seismic system is intentionally detailed to yield during severe cyclic loading. Which post-yield response best represents the intended behavior?

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 three-story wood residential building has open parking at grade and much stiffer, stronger wall lines above. Which retrofit objective most directly addresses the vulnerable first-story mechanism?

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

18. An older brick commercial building has unbraced parapets above the roof edge. Which retrofit measure most directly limits the falling-hazard risk during strong ground motion?

A. Positive parapet bracing or anchorage back to the roof system
B. Cut the roof diaphragm free from the walls

C. Rely on mortar friction at the roof line
D. Increase parapet height without adding ties

19. A precast parking structure has narrow support seats and inadequate positive ties at beam ends. What retrofit objective most directly reduces the chance that members lose bearing during earthquake displacement?

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

20. An older reinforced-concrete frame has sparse transverse reinforcement in column regions expected to undergo large cyclic rotations. Which retrofit strategy best improves that deficiency?

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

21. A pre-Northridge welded steel moment connection is judged susceptible to brittle fracture under repeated seismic cycles. Which retrofit goal most directly improves the intended connection behavior?

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

22. After an earthquake, masonry and façade debris is unstable above a sidewalk next to a damaged building. What is the most appropriate first life-safety action?

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

23. A civic administration building is checked with the simplified ELF relation V = (SDS Ie/R)W. Use SDS = 0.79, Ie = 1.00, R = 6.5, and W = 2,740 kips. What base shear results?

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

24. For a school classroom wing, calculate the simplified equivalent lateral base shear from V = (SDS Ie/R)W using SDS = 0.86, Ie = 1.00, R = 7.0, and W = 2,310 kips.

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

25. An essential radio facility has SDS = 0.73, Ie = 1.25, R = 5.5, and effective seismic weight W = 3,480 kips. Using V = (SDS Ie/R)W, determine the base shear.

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

26. A warehouse concept model uses SDS = 0.81, Ie = 1.00, R = 8.0, and W = 3,970 kips. What base shear follows from the simplified expression V = (SDS Ie/R)W?

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

27. For a county justice-building expansion, use SDS = 0.68, Ie = 1.00, R = 6.0, and W = 2,890 kips in V = (SDS Ie/R)W. What value of V is obtained?

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

28. A research building has SDS = 0.92, Ie = 1.25, R = 7.5, and W = 3,180 kips. Evaluate the simplified ELF base shear V = (SDS Ie/R)W.

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

29. A 64-ft building is being screened before detailed modeling. With Ct = 0.030 and x = 0.78, estimate the empirical period using Ta = Ct(hn)^x.

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

30. For a 92-ft structural system, the selected empirical-period constants are Ct = 0.027 and x = 0.80. What preliminary period follows from Ta = Ct(hn)^x?

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

31. A 55-ft lateral-force-resisting system uses Ct = 0.034 and x = 0.75 for the approximate-period expression. Evaluate Ta = Ct(hn)^x.

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

32. A preliminary study of a 118-ft tower uses Ct = 0.025 and x = 0.82. What empirical fundamental period is obtained from Ta = Ct(hn)^x?

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

33. For a three-level ELF distribution, the floor weights from bottom to top are [410, 530, 690] kips and the heights are [14, 28, 42] ft. With k = 1.0, use Cvx = wx hx^k / sum(wi hi^k). What is Cvx at level 3?

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

34. A four-story force distribution uses weights [360, 480, 610, 720] kips at elevations [12, 24, 36, 48] ft with k = 1.3. From Cvx = wx hx^k / sum(wi hi^k), what fraction of base shear is assigned to level 4?

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

35. Three floor levels have weights [520, 500, 470] kips at heights [16, 32, 48] ft. If k = 1.5, determine the first-level coefficient Cvx from wx hx^k / sum(wi hi^k).

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

36. An ELF model has floor weights [280, 390, 510, 640] kips at heights [11, 22, 33, 44] ft, listed from bottom upward. With k = 1.0, what Cvx value belongs to level 2?

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

37. The lateral inertia forces at levels 1 through roof are [85, 115, 150, 205] kips. If the vertical resisting system is cut immediately below level 2, what story shear crosses that cut?

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

38. A five-level building has floor forces [70, 90, 125, 160, 210] kips from the lowest floor to the roof. What cumulative story shear acts just below level 3?

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

39. Floor forces in a three-story structure are 140, 175, and 225 kips from bottom to top. What base shear is transferred into the foundation?

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

40. A four-level building develops floor forces of [55, 80, 110, 145] kips from low to high. What story shear is present immediately below level 3?

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

41. A roof diaphragm has effective seismic weight Wpx = 845 kips. For this simplified check, the in-plane coefficient is 0.29. Calculate Fpx = 0.29Wpx.

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

42. A diaphragm transfers 315 kips uniformly along a 126-ft collector line. What average shear flow, in kip/ft, acts along that line?

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

43. A diaphragm must resist 6,300 kip-ft of in-plane moment using two chord lines 105 ft apart. If the chords form a force couple, what axial force magnitude is required in each chord?

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

44. A wall panel has 168 kips of tributary seismic weight. A simplified inertia check takes the horizontal action as 0.38 times that weight. What force is obtained?

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

45. A collector connection has an unamplified seismic demand of 172 kips. If the design check multiplies that force by 2.75, what amplified connection demand results?

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

46. Eight identical anchors are assumed to share a 336-kip roof-to-wall transfer equally, with eccentric effects neglected. What idealized force acts on one anchor?

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

47. A parapet anchorage calculation uses an effective seismic weight of 108 kips and the simplified horizontal coefficient stated in the problem. What design anchorage force follows from that coefficient-weight calculation?

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

48. The effective seismic weight of a building is 2,640 kips. If the roof accounts for 16 percent of that total, what roof-level seismic weight is assigned?

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

49. A mechanical penthouse item is being checked without applying the code force caps. Insert ap = 1.0, SDS = 0.86, Wp = 380 kips, Ip = 1.0, and Rp = 2.5 into 0.4(ap)(SDS)(Wp)(Ip)/Rp. Which calculated force is obtained?

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

50. A supported component has ap = 2.5, SDS = 0.78, Wp = 42 kips, Ip = 1.0, and Rp = 6.0. Using Fp = (0.4 ap SDS Wp Ip)/Rp without minimum or maximum limits, calculate the force.

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

51. A nonstructural item is checked with ap = 1.0, SDS = 0.82, Wp = 118 kips, Ip = 1.5, and Rp = 2.0. Evaluate Fp = (0.4 ap SDS Wp Ip)/Rp.

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

52. A suspended service module has Wp = 26 kips, ap = 2.5, SDS = 0.91, Ip = 1.0, and Rp = 3.5. What unbounded value is produced by 0.4(ap)(SDS)(Wp)(Ip)/Rp?

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

53. A floor-mounted equipment item weighs 92 kips for seismic design. Using ap = 1.0, SDS = 0.74, Ip = 1.0, and Rp = 2.5, what force follows from 0.4(ap)(SDS)(Wp)(Ip)/Rp?

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

54. For a suspended component, use Wp = 18 kips, Ip = 1.5, ap = 2.5, SDS = 0.69, and Rp = 5.0. Calculate the simplified component force from 0.4(ap)(SDS)(Wp)(Ip)/Rp.

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

55. For a screening calculation, multiply a 610-kip equipment-support seismic weight by 0.28. Which horizontal reaction is produced by that simplified coefficient method?

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

56. A compact nonbuilding system has seismic weight 740 kips. If its simplified horizontal coefficient is 0.33, what horizontal base shear results?

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

57. A rigid tank support is idealized with 980 kips of seismic weight and a horizontal coefficient of 0.25. Determine the resulting base shear.

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

58. A rigid freestanding installation is assigned 455 kips of seismic weight for a conceptual check. The prescribed simplified coefficient is 0.37. What lateral base action follows from multiplying these two values?

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

59. A rooftop air-handling unit develops a 96-kip horizontal earthquake force. If six identical anchors share that force equally, what idealized demand is assigned to each anchor?

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

60. A vibration-isolated emergency generator is installed on the roof but is not part of the building's primary lateral system. Why is positive seismic restraint still required at its support?

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

61. A hydronic pipe passes across a seismic separation between two building wings. Which connection/detailing approach best prevents the pipe from restraining the joint while still accommodating expected 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. A tall battery rack is anchored to the floor. Why is checking only resistance to horizontal sliding insufficient for the seismic anchorage design?

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

63. A rigid diaphragm delivers 390 kips of direct shear to three lines having stiffnesses [320, 480, 700] kip/in. Before torsional effects are added, what direct force goes to line 1 if distribution is proportional to stiffness?

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

64. Three resisting lines beneath a rigid floor have stiffnesses [420, 530, 650] kip/in and share 320 kips of direct lateral shear. Ignoring torsion, what force is attracted by the 530-kip/in line?

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

65. A rigid diaphragm transfers 350 kips of direct story shear to lines with stiffnesses [275, 625, 500] kip/in. With no torsional component, what force goes to the 500-kip/in line?

A. 280.0 kips

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

66. Lines with stiffnesses [560, 340, 300] kip/in resist 300 kips of direct floor shear. Before considering eccentricity, how much of that direct shear is assigned to the 340-kip/in line?

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

67. A floor model has only two vertical resisting lines, with lateral stiffnesses of 410 and 690 kip/in. The direct diaphragm shear is 275 kips. Before any eccentricity effect is added, determine the share carried by the 410-kip/in line using stiffness proportioning.

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

68. Direct diaphragm shear of 475 kips is shared by three vertical elements whose stiffnesses are 460, 540, and 900 kip/in. Disregard torsional redistribution. How much of the direct force is allocated to the stiffest element?

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

69. A 440-kip floor-shear resultant acts 3.6 ft away from the chosen rigidity reference. What torsional moment follows from T = Ve?

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

70. The design floor shear is 385 kips and its eccentricity from the rigidity reference is 4.2 ft. Calculate the plan torsional moment using T = Ve.

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

71. A floor-level resultant of 525 kips acts with a 2.6-ft design eccentricity. What torsional moment is generated?

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

72. For a floor shear of 310 kips acting 5.4 ft from the rigidity reference, determine the torsional moment T = Ve.

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

73. Three resisting lines are located at x = 0, 24, and 48 ft and have stiffnesses 240, 360, and 600 kip/in. Using xR = sum(kixi)/sum(ki), find the x-coordinate of the center of rigidity.

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

74. Lateral lines at x = 0, 35, and 70 ft have stiffnesses 300, 500, and 400 kip/in. What center-of-rigidity coordinate results from the stiffness-weighted average?

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

75. A plan contains two lateral elements: k = 420 kip/in at x = 12 ft and k = 680 kip/in at x = 56 ft. Using the stiffness-weighted coordinate definition, determine the location xR from the datum.

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

76. A plan has lateral lines at x = 0, 28, and 60 ft with stiffnesses 500, 280, and 320 kip/in. Compute xR = sum(kixi)/sum(ki).

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

77. Uniform diaphragm transfer along a 144-ft boundary totals 360 kips. Express the corresponding average in-plane transfer intensity in kip/ft.

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

78. A diaphragm transfer of 455 kips is spread uniformly over a 130-ft line. Determine the average shear demand per foot.

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

79. Two diaphragm chord lines 110 ft apart resist an in-plane moment of 8,250 kip-ft. What axial force magnitude in each chord forms the resisting couple?

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

80. A diaphragm has 5,720 kip-ft of in-plane moment and chord lines separated by 88 ft. What equal-and-opposite axial force magnitude is required in the chords?

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

81. A 13-ft story has lateral displacement 0.8 in. at the lower level and 2.9 in. at the upper level. Using relative displacement divided by story height, what is the interstory drift ratio in percent?

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

82. Across one 14-ft story, the measured upper-floor translation is 3.5 in. and the measured lower-floor translation is 1.1 in. Convert their difference into a percent drift ratio using the full story height.

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

83. A 12-ft story moves 0.5 in. at its lower level and 2.4 in. at its upper level. What percent story drift is represented by that relative movement?

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

84. For a 15-ft story, the lower-level displacement is 1.6 in. and the upper-level displacement is 4.1 in. What interstory drift ratio, in percent, results?

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

85. When seismic effects are combined with gravity actions for member or connection design, why is the horizontal earthquake effect commonly evaluated with both positive and negative signs?

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

86. A response-spectrum model produces a total modal base shear below the minimum design level required by the procedure. Why are the modal response quantities scaled upward before they are used for design?

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

87. Suppose in-plane diaphragm flexibility is large enough that rigid-body floor action is not assumed. Under that idealization, how is lateral force generally apportioned to the parallel vertical resisting lines?

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

88. In a diaphragm system, what is the defining force-transfer role of a collector or drag strut?

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

89. Why are intended yielding zones in a special steel moment frame detailed so brittle connection or stability failures do not occur first?

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

90. In reinforced-concrete plastic-hinge regions, what performance benefit is provided by closely spaced transverse hoops or ties during repeated cyclic deformation?

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

91. Why must grout fully surround required reinforcing bars in reinforced masonry where the wall is expected to transfer seismic forces and deform inelastically?

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. For a wood structural-panel diaphragm, what seismic function is served by continuous panel-edge fastening together with adequate blocking?

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

93. A concrete wall receives out-of-plane support from a flexible wood roof diaphragm. What connection objective is essential at the wall-to-roof interface during earthquake motion?

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

94. What is special inspection of critical seismic welding intended to confirm while a designated steel connection is fabricated and erected?

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

95. Even with extensive special inspection, why can structural observation by the design professional add value on a major seismic project?

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

96. A gypsum partition crosses a seismic separation joint between two building segments. What detailing concept best prevents the partition from bridging the joint rigidly?

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

97. A drag-strut connection is part of a critical diaphragm force path. Why may its seismic design demand be amplified, or the connection otherwise protected by capacity-design principles?

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

98. Forms are ready to close around a ductile concrete wall boundary zone. Before the reinforcement and embeds become concealed, what should the seismic inspection specifically confirm?

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

99. At a seismic steel connection, why are fit-up, access, cleaning, and surface preparation important before final weld acceptance?

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

100. Why are continuous positive ties provided among diaphragms, walls, frames, and foundations as part of the seismic load path?

A. Maintain structural integrity and continuous seismic force transfer
B. They keep every member completely elastic
C. They eliminate the need for foundations
D. They make all diaphragms perfectly rigid

Practice Exam 21: 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. D — 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. C — 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. C — 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. B — 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. A — 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. 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. 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. A — 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. B — 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. A — 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. D — 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. C — 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. C — 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. D — 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. 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.

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. 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.

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. 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.

29. 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.

30. 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.

31. 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.

32. 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.

33. 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.

34. 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.

35. 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.

36. 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.

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. 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.

39. 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.

40. 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.

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. 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. A — 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. D — 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. A — 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. 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.

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. 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.

52. 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.

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. 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.

55. A — 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. 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.

58. 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.

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. A — 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. C — For rigid-diaphragm direct distribution without torsion, each line receives the total story shear multiplied by its stiffness fraction ki/Σk. 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. 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.

65. 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.

66. 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.

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. 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.

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. 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.

74. 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.

75. 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.

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. 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.

78. 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.

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. 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.

82. 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.

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