PRACTICE EXAM 8: CALIFORNIA CIVIL SEISMIC PRINCIPLES (100 QUESTIONS)

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

1. For this exercise, compute the maximum-considered short-period site value from SMS = FaSs. Use Ss = 1.26g and Fa = 1.10.

A. 1.145g
B. 1.260g
C. 2.360g
D. 1.386g

2. A problem defines the design one-second spectral ordinate as SD1 = (2/3)SM1. If SM1 = 0.78g, what is SD1?

A. 0.39g
B. 0.52g
C. 0.78g
D. 1.17g

3. For a simplified design spectrum, use Ts = SD1/SDS. If SD1 = 0.54g and SDS = 0.90g, what transition period Ts results?

A. 0.60 s
B. 0.36 s
C. 1.44 s

D. 1.67 s

4. Why can a site-specific ground-motion study be especially valuable where deep basin effects or unusual near-fault behavior are expected?

A. It sets the project construction sequence
B. It determines the architectural finish schedule
C. It can represent local spectral features not captured well by generalized maps
D. It eliminates the need to model the structure

5. A hospital wing is converted from ordinary storage to a function required for emergency response after an earthquake. Which seismic classification issue should be reconsidered first?

A. Mapped longitude of the site
B. Measured reinforcing-bar diameter
C. Concrete formwork removal time
D. Risk category and the related importance provisions

6. Which subsurface condition most strongly raises concern for earthquake-induced liquefaction?

A. Dense dry gravel above groundwater
B. Loose saturated granular soil with low confinement
C. Massive competent bedrock
D. Unsaturated stiff clay near grade

7. What broad inputs are combined when assigning a seismic design category to a building?

A. Roof drainage and snow drift
B. Concrete strength and curing temperature
C. Seismic hazard level and occupancy-related risk
D. Room area and ceiling height

8. A site consists of a thick deposit of relatively soft soil over much stiffer material. Compared with shallow hard rock, what is the main seismic concern?

A. The soil profile can amplify or reshape portions of the ground-motion spectrum
B. The roof dead load automatically doubles
C. Concrete compressive strength is reduced by code
D. Wind pressure becomes the governing earthquake load

9. Two idealized oscillators have the same stiffness, but System X has four times the mass of System Y. Using T proportional to sqrt(m/k), how does TX compare with TY?

A. TX = 2TY
B. TX = 4TY
C. TX = TY/2
D. TX = TY/4

10. A story loses a substantial portion of its lateral stiffness while the mass distribution stays nearly unchanged. What response change is most likely?

A. The local period shortens and story drift largely disappears
B. The total seismic mass decreases at the weakened story
C. The local period lengthens and drift concentrates in the weakened story
D. The floor diaphragm becomes much more rigid in its plane

11. What is the principal role of damping in the dynamic response of a structure?

A. It increases seismic mass at every floor
B. It makes all mode shapes identical
C. It removes the need for lateral strength
D. It dissipates vibration energy and limits response near resonance

12. A rigid diaphragm connects several vertical resisting lines of different stiffness. Neglecting torsion, how is direct story shear generally shared?

A. Equally among every line regardless of stiffness
B. In proportion to the lateral stiffness of the resisting lines
C. In proportion only to member weight
D. Only to the line nearest the center of mass

13. Why is ductile yielding preferred to brittle failure in a seismic-force-resisting system?

A. Brittle failure produces larger warning drifts
B. Ductility eliminates the need for connections
C. Brittle response always reduces base shear demand
D. Ductile behavior can sustain inelastic deformation while dissipating energy

14. After a frame sways laterally, gravity loads act through the displaced geometry rather than the original vertical axis. Which second-order response is produced by that offset?

A. A reduction in mass from vertical acceleration
B. Additional moment caused by gravity loads acting through lateral displacement
C. A change in soil classification during shaking
D. A diaphragm force created only by wind

15. Why is redundancy desirable in a seismic lateral system?

A. It guarantees zero structural damage
B. It makes torsional response impossible
C. Multiple effective load paths reduce dependence on one critical element
D. It permits all connections to be weaker

16. A floor plan has a large separation between center of mass and center of rigidity. What response is most directly encouraged by this offset?

A. Torsional rotation of the diaphragm in addition to translation
B. Pure vertical shortening with no lateral motion
C. Uniform axial compression in every column
D. Elimination of edge-frame forces

17. An older open-front building has a very flexible first story beneath much stiffer upper stories. Which retrofit objective most directly addresses the vulnerability?

A. Add roof mass while leaving first-story stiffness essentially unchanged
B. Increase first-story strength and stiffness with a continuous load path
C. Remove collectors that currently transfer diaphragm force across the story
D. Reduce footing contact while keeping the existing first-story framing

18. An unreinforced masonry wall is well supported in plane but poorly connected to the roof diaphragm. What improvement most directly reduces out-of-plane collapse risk?

A. Increase interior paint thickness
B. Add floor live load near the wall
C. Provide positive wall-to-diaphragm anchorage capable of transferring inertial force
D. Cut more openings in the wall

19. A retrofit adds new shear walls but leaves the floor diaphragm disconnected from them. What critical weakness remains?

A. The diaphragm-to-wall seismic load path is still incomplete
B. The building automatically develops excessive damping at every level
C. The supporting soil bearing capacity becomes irrelevant to performance
D. The new walls lose all ability to carry gravity load

20. Why is a strong-column/weak-beam mechanism generally favored in ductile moment-frame retrofit design?

A. It keeps every beam fully elastic during design-level shaking
B. It intentionally makes column splices the weakest frame locations
C. It removes the need for ductile beam-column joint detailing
D. It favors beam yielding over column-driven story mechanisms

21. Two adjacent existing buildings have very small separation and different dynamic properties. What earthquake vulnerability should be evaluated?

A. Rainwater intrusion through the roof
B. Pounding between the structures as they move out of phase
C. Long-term shrinkage of interior partitions
D. Uniform settlement from static dead load

22. A wall retrofit greatly increases overturning strength but the existing footing has little capacity for the new tension reaction. What additional improvement is most likely needed?

A. Reduce the diaphragm connection so less force reaches the wall
B. Add ceiling weight to increase stabilizing gravity force at the floor
C. Remove wall boundary steel so overturning demand is redistributed
D. Upgrade the foundation or anchorage to develop overturning reactions

23. For this calculation, base shear is $V = C_sW$. If $C_s = 0.082$ and effective seismic weight $W = 6{,}400$ kips, what is V?

A. 524.8 kips
B. 82.0 kips
C. 780.5 kips
D. 6,400.082 kips

24. Use Cs = SDSIe/R for this exercise. If SDS = 0.84, Ie = 1.25, and R = 7, determine Cs.

A. 0.096
B. 0.120
C. 0.150
D. 0.263

25. Floor seismic weights are 900, 700, and 500 kips at heights 15, 30, and 45 ft. Using Cvx = wxhx/sum(wihi), what fraction of base shear goes to the roof?

A. 0.395
B. 0.238
C. 0.333
D. 0.571

26. At a selected story, lateral forces at and above the cut are 96, 78, 63, and 41 kips. What story shear acts at that level?

A. 237 kips
B. 278 kips
C. 319 kips
D. 41 kips

27. A story shear of 610 kips acts through an accidental eccentricity of 4.2 ft. What torsional moment does this eccentricity create?

A. 145.2 kip-ft
B. 614.2 kip-ft
C. 4,200 kip-ft
D. 2,562 kip-ft

28. A rigid diaphragm sends 720 kips of direct shear to three parallel frames with lateral stiffnesses 30, 45, and 75 units. Neglect torsion. What shear goes to the 45-unit frame?

A. 144 kips
B. 240 kips
C. 216 kips
D. 360 kips

29. A diaphragm chord couple must resist 3,360 kip-ft using two chord lines separated by a 60-ft lever arm. Assuming equal and opposite chord forces, what force is required in each chord?

A. 42 kips
B. 56 kips
C. 60 kips
D. 201.6 kips

30. A collector receives a uniform diaphragm transfer of 3.4 kips/ft over 28 ft. What axial force accumulates at the collector end?

A. 95.2 kips
B. 31.4 kips
C. 86.8 kips
D. 112.0 kips

31. A diaphragm transfers 684 kips across an effective resisting width of 72 ft. What average unit shear V/L is produced?

A. 7.2 kips/ft
B. 10.5 kips/ft
C. 49.2 kips/ft
D. 9.5 kips/ft

32. An overturning moment of 3,150 kip-ft is resisted by a tension-compression couple whose reaction lines are 42 ft apart. What force magnitude is required at each line?

A. 37.5 kips
B. 42 kips
C. 75 kips
D. 132.3 kips

33. For this problem, the vertical seismic term is defined as Ev = 0.2SDSD. Use SDS = 0.74 and dead load D = 1,600 kips. What is Ev?

A. 236.8 kips
B. 118.4 kips
C. 320.0 kips
D. 1,184 kips

34. A load effect is defined here as E = rhoQE + Ev. If rho = 1.3, QE = 142 kips, and Ev = 27 kips, what is E?

A. 184.6 kips
B. 211.6 kips
C. 169.0 kips
D. 234.0 kips

35. A connection check multiplies an 88-kip horizontal seismic action by an overstrength factor of 2.5 and then adds an 18-kip vertical seismic term. What total effect is obtained?

A. 220 kips
B. 106 kips
C. 238 kips
D. 265 kips

36. For this problem, combine orthogonal effects as 100% of Ex plus 30% of Ey. If Ex = 190 kips and Ey = 80 kips act with the same sign, what force results?

A. 190 kips
B. 247 kips
C. 270 kips
D. 214 kips

37. Elastic story displacement from analysis is 0.72 in. For this exercise, amplified displacement is delta = Cd deltae/Ie with Cd = 5.0 and Ie = 1.25. What is delta?

A. 0.90 in.
B. 2.88 in.
C. 3.60 in.
D. 4.50 in.

38. A 13-ft story has an allowable drift ratio of 0.015 for this exercise. What maximum interstory drift does that ratio permit?

A. 2.34 in.
B. 0.195 in.
C. 1.95 in.
D. 3.12 in.

39. For this calculation, the period used in an ELF procedure may not exceed CuTa. If Ta = 0.62 s and Cu = 1.40, what is the cap?

A. 0.443 s
B. 0.620 s
C. 2.020 s
D. 0.868 s

40. A building has effective seismic weight W = 8,200 kips and calculated base shear V = 615 kips. What dimensionless ratio V/W results?

A. 0.0075
B. 0.133
C. 0.075
D. 13.33

41. For this exercise, diaphragm design force is Fpx = 0.24wpx. If tributary diaphragm seismic weight is 980 kips, what is Fpx?

A. 235.2 kips
B. 98.0 kips
C. 204.2 kips
D. 980.24 kips

42. For a simplified torsional distribution, the force at one resisting line is found by multiplying a 4,200 kip-ft torsional moment by a 16-ft radius and dividing by J = 1,680 ft^2. What line force results?

A. 25 kips
B. 67.2 kips
C. 40 kips
D. 262.5 kips

43. A story has gravity load P = 7,800 kips, drift Delta = 0.95 in., story shear V = 690 kips, and story height h = 156 in. For this exercise use theta = PDelta/(Vh). What is theta?

A. 0.00688
B. 0.109
C. 0.688
D. 0.0688

44. A diaphragm has a total in-plane shear of 540 kips resisted by two equal-length shear lines. If their stiffnesses are in a 2:1 ratio and torsion is neglected, what shear goes to the stiffer line?

A. 180 kips
B. 360 kips
C. 270 kips
D. 405 kips

45. Why are collectors and drag struts important where diaphragm forces must reach a vertical resisting element that is not continuously aligned with the tributary loading?

A. They reduce seismic weight before forces enter the diaphragm
B. They prevent meaningful in-plane deformation of the diaphragm system
C. They replace foundation anchorage for the vertical resisting elements
D. They gather diaphragm forces and transfer them into vertical resisting elements

46. What is the primary purpose of including accidental torsion in a building seismic analysis?

A. To represent uncertainty in actual mass and stiffness distributions
B. To increase the gravity live load used in seismic combinations
C. To cancel the inherent torsion already present in the structural model
D. To establish the curing duration required for structural concrete

47. A vertical resisting element terminates at a transfer level rather than continuing directly to the foundation. What seismic design issue becomes especially important?

A. The roof dead load can be ignored
B. Story drift becomes zero at the transfer level
C. The transfer diaphragm and collectors must carry the discontinuity forces into supporting elements
D. Foundation reactions disappear

48. If the redundancy factor rho used in a stated load combination increases from 1.0 to 1.3 while QE and all other terms remain fixed, what happens to the rhoQE contribution?

A. It decreases by 30 percent
B. It increases by 30 percent
C. It remains unchanged
D. It increases by 130 percent

49. For this exercise, component force is Fp = 0.4apSDSWp/(Rp/Ip). Use ap = 1.0, SDS = 0.90, Wp = 12 kips, Rp = 3.0, and Ip = 1.0. What is Fp?

A. 0.48 kips
B. 1.44 kips
C. 3.60 kips
D. 4.32 kips

50. A rooftop unit has horizontal inertial force of 8.5 kips acting 4 ft above its anchor plane. If two anchor lines are 5 ft apart, what idealized tension-compression couple force resists the overturning moment?

A. 6.8 kips
B. 1.7 kips
C. 8.5 kips
D. 34.0 kips

51. Why must flexible piping or conduit crossing a seismic separation accommodate differential movement?

A. The pipe weight becomes zero during an earthquake
B. The separation joint prevents all building drift
C. Thermal expansion stops under seismic loading
D. The supporting building portions can move relative to each other during shaking

52. A tall parapet is poorly anchored to the roof diaphragm. Which seismic action is the most direct concern?

A. In-plane soil bearing under the foundation
B. Long-term column creep
C. Out-of-plane inertial force acting on the parapet mass
D. Uniform roof live-load reduction

53. What is the main seismic purpose of bracing a suspended ceiling system?

A. Increase suspended ceiling dead load during earthquake response
B. Prevent any vertical acceleration from reaching ceiling components
C. Replace the structural diaphragm as the primary lateral system
D. Provide a lateral load path and limit damaging ceiling movement

54. A piece of equipment is supported on vibration isolators. What additional seismic issue must its anchorage or restraint address?

A. The equipment has no seismic mass
B. Isolation guarantees zero acceleration
C. Large relative movement can occur before the restraint engages
D. Gravity anchorage is automatically sufficient

55. A nonstructural brace delivers 6.2 kips of horizontal force to a concrete slab through two identical anchors sharing load equally. What idealized shear acts on each anchor?

A. 1.55 kips
B. 3.1 kips
C. 6.2 kips
D. 12.4 kips

56. A component force expression contains the height multiplier 1 + 2z/h. If z/h = 0.75, what value does this multiplier have?

A. 2.50
B. 1.50
C. 1.75
D. 3.00

57. Why can rooftop mechanical equipment experience larger component acceleration than similar equipment near the base of a flexible building?

A. Structural motion can amplify response at higher elevations
B. Gravity is weaker at roof level
C. The equipment mass increases with height
D. Foundation damping disappears completely

58. A storage tank has significant liquid depth. Which earthquake response can create forces beyond simple rigid-body translation of the tank shell?

A. Concrete shrinkage of the roof slab
B. Thermal shortening of anchor rods
C. Liquid sloshing and impulsive hydrodynamic response
D. Wind suction on an empty tank only

59. A pipe run is laterally braced at intervals. What must the brace connection ultimately accomplish under earthquake loading?

A. Remove the pipe operating weight from seismic force calculations
B. Make the entire pipe system axially rigid between all supports
C. Prevent every form of thermal movement during normal operation

D. Transfer pipe inertia through braces and supports into the structure

60. A heavy piece of equipment has a high center of mass relative to a narrow support footprint. Which seismic demand becomes especially important?

A. Only uniform compression under every anchor
B. Overturning and anchor tension in addition to base shear
C. Roof drainage around the equipment
D. Concrete drying shrinkage of the slab

61. Why are cladding connections often detailed to permit controlled movement relative to the structural frame?

A. To make the frame carry no seismic force
B. To accommodate story drift without forcing brittle cladding damage
C. To increase cladding mass deliberately
D. To prevent any thermal expansion

62. For a simplified component check, horizontal inertial force is F = ma. If a 3,000-lb component experiences horizontal acceleration of 0.35g and weight is used directly with the g-ratio, what force results?

A. 1,050 lb
B. 857 lb
C. 3,000 lb
D. 10,500 lb

63. Which analysis procedure is most useful for capturing modal response and higher-mode effects in a regular linear building model?

A. A static gravity takeoff only

B. A concrete mix design calculation
C. Modal response-spectrum analysis
D. A roof drainage analysis

64. Why can higher modes matter more in a tall or stiff multi-story building than in a low flexible one?

A. Higher modes remove the first mode entirely
B. Tall buildings have no fundamental period
C. Only soil response controls upper-story force
D. Upper-mode shapes can contribute significantly to story forces and accelerations

65. Two well-separated modal responses are 120 and 50 units. Using SRSS = sqrt(R1^2 + R2^2), what combined response results?

A. 85 units
B. 170 units
C. 130 units
D. 6,500 units

66. When two important vibration modes have closely spaced periods, why may CQC be preferred over simple SRSS?

A. CQC ignores damping completely
B. CQC accounts for correlation between closely spaced modal responses
C. CQC converts the analysis into nonlinear static form
D. CQC forces every mode to have equal participation

67. A response-spectrum analysis produces base shear of 460 kips, but the required target for scaling is 575 kips. What scale factor is needed?

A. 1.25

B. 0.80
C. 1.15
D. 1.35

68. For an idealized single-degree system, T = 2pi sqrt(m/k). If m = 18 mass units and k = 800 force/length units in a consistent unit system, what period results?

A. 0.149 s
B. 1.885 s
C. 44.44 s
D. 0.942 s

69. A lateral system has secant stiffness defined as k = V/delta. If V = 420 kips at a displacement of 2.8 in., what secant stiffness is obtained?

A. 150 kips/in.
B. 117.6 kips/in.
C. 210 kips/in.
D. 1,176 kips/in.

70. A bilinear model yields at 1.2 in. and reaches an ultimate displacement of 4.8 in. What displacement ductility mu = deltau/deltay is represented?

A. 2.4
B. 4.0
C. 3.6
D. 5.76

71. A member demand is 285 kips and its available capacity for the same action is 375 kips. What demand-to-capacity ratio results?

A. 0.24
B. 1.32
C. 90
D. 0.76

72. A floor has weights of 120, 180, and 100 kips located at x = 0, 20, and 50 ft. What is the center-of-mass coordinate xcm = sum(Wixi)/sum(Wi)?

A. 17.5 ft
B. 25.0 ft
C. 21.5 ft
D. 35.8 ft

73. Three resisting lines have stiffnesses 20, 30, and 50 units at x = 0, 24, and 48 ft. What is the center-of-rigidity coordinate xcr = sum(kixi)/sum(ki)?

A. 24.0 ft
B. 28.8 ft
C. 31.2 ft
D. 36.0 ft

74. If the center of mass is at x = 21.5 ft and the center of rigidity is at x = 31.2 ft, what inherent eccentricity magnitude separates them?

A. 9.7 ft
B. 4.85 ft
C. 21.5 ft
D. 52.7 ft

75. A story shear of 500 kips acts through an inherent eccentricity of 7.5 ft. What torsional moment does the offset produce?

A. 66.7 kip-ft
B. 507.5 kip-ft
C. 7,500 kip-ft
D. 3,750 kip-ft

76. A diaphragm has rigid-body translation of 1.10 in. and torsional rotation contributes an additional 0.35 in. at one edge in the same direction. What edge displacement results?

A. 0.75 in.
B. 1.45 in.
C. 1.10 in.
D. 1.75 in.

77. Floor displacements are 2.40 in. at Level 5 and 1.55 in. at Level 4. What interstory drift between those levels is obtained?

A. 0.65 in.
B. 1.55 in.
C. 3.95 in.
D. 0.85 in.

78. Why should a flexible diaphragm sometimes be modeled with its in-plane deformation rather than as an ideal rigid plate?

A. Its deformation can materially change force distribution among vertical resisting elements
B. Flexible diaphragms have no seismic mass
C. A flexible model eliminates torsion automatically
D. Rigid supports cannot carry diaphragm forces

79. What is the main purpose of a nonlinear static pushover analysis?

A. Determine building dead load without evaluating lateral response
B. Replace dynamic seismic analysis with ordinary gravity design procedures
C. Track yielding, strength, and deformation as lateral load increases
D. Derive the geotechnical site class directly from floor plans

80. In response-history analysis, why are selected ground-motion records often scaled or otherwise adjusted for compatibility with a target spectrum?

A. To force every record to have the same duration
B. To make the record set represent the intended seismic hazard over relevant periods
C. To eliminate structural damping
D. To convert acceleration records into static loads only

81. What does an eigenvalue analysis of a linear structural model provide for seismic dynamic analysis?

A. Concrete cylinder strength and slump
B. Foundation bearing pressure under dead load only
C. Construction inspection frequencies
D. Natural frequencies or periods together with corresponding mode shapes

82. A mode has generalized participating mass of 420 units and total structural mass is 600 units. What modal mass participation fraction does that mode represent?

A. 0.30
B. 1.43
C. 0.70
D. 180

83. A two-line rigid diaphragm has line stiffnesses 40 and 60 units located 10 ft and 30 ft from a reference. What stiffness-weighted center coordinate results?

A. 22 ft
B. 18 ft
C. 20 ft
D. 24 ft

84. For a simplified torsional distribution, line force is Ft = Mt(kr)/sum(kr^2). If Mt = 2,400 kip-ft, k = 30, r = 12 ft, and sum(kr^2) = 8,640, what Ft results?

A. 30 kips
B. 100 kips
C. 72 kips
D. 200 kips

85. A linear analysis gives elastic roof displacement of 3.2 in. A stated inelastic amplification factor of 4.5 is applied without any additional divisor. What amplified displacement is obtained?

A. 14.4 in.
B. 7.7 in.
C. 11.2 in.
D. 17.7 in.

86. Why is accidental eccentricity applied in addition to modeled inherent eccentricity when both are relevant?

A. Accidental eccentricity replaces the modeled center-of-mass location
B. Inherent eccentricity represents a gravity-only condition in the model
C. They represent different torsional sources that must be considered separately
D. Applying both automatically requires a flexible-diaphragm analytical model

87. What is the principal analytical concern when P-delta effects become large?

A. Natural periods become exactly zero
B. Second-order moments can amplify drift and threaten lateral stability
C. Floor masses disappear from the model
D. All torsion is automatically reduced

88. Why should the sum of modal participating mass be reviewed in a response-spectrum analysis?

A. It establishes the concrete compressive strength used by the model
B. It determines the soil liquefaction resistance beneath the foundation
C. It sets construction tolerances for seismic anchor bolt placement
D. It checks whether enough modes represent the structure dynamic mass

89. What is the central purpose of special inspection for critical seismic construction?

A. Select architectural finishes for areas containing seismic connections
B. Verify critical materials, connections, and installation details meet requirements
C. Establish contractor pricing for work requiring additional inspection effort
D. Replace structural calculations after construction begins in the field

90. A welded seismic connection shows a crack-like discontinuity after fabrication. What is the appropriate quality-control response?

A. Cover it with paint and accept it
B. Ignore it if the member is plumb
C. Evaluate the discontinuity against the applicable acceptance criteria before accepting the connection
D. Increase nearby floor live load

91. Why are reinforcing-bar development and splice details especially important in seismic boundary regions?

A. They control the visible surface color of completed concrete members

B. They eliminate the need for confinement in highly strained regions
C. They reduce seismic mass carried by reinforced concrete boundary zones
D. They sustain cyclic force transfer without premature bond or splice failure

92. A wood structural panel shear wall has several overdriven fasteners that break the panel face. Why is this a seismic quality concern?

A. Overdriving can damage the panel and reduce fastener connection capacity
B. Overdriving always increases ductility of the completed shear-wall assembly
C. Overdriven fasteners eliminate the need for end hold-down hardware
D. Overdriving increases the usable edge distance around panel fasteners

93. Why must masonry grout placement be checked in reinforced seismic walls?

A. Incomplete grout can interrupt composite action and reinforcement force transfer
B. Grout color determines the usable seismic strength of reinforced masonry
C. Leaving cells unfilled automatically increases ductility of the wall system
D. Grout inspection replaces verification of reinforcement placement and detailing

94. A post-installed adhesive anchor is installed in a hole that was not cleaned as required by the approved procedure. Why is this significant?

A. Dust in the hole increases friction and therefore anchor strength
B. Improper hole cleaning reduces the concrete dead load at the support
C. The slab gains useful ductility because the adhesive bond becomes flexible
D. Poor hole cleaning can reduce adhesive bond and installed anchor capacity

95. What should happen when field crews relocate a collector connection away from the approved detail because of an interference?

A. It should be accepted if it looks neat

B. The change should be evaluated for force transfer before being accepted
C. The collector force can be ignored
D. Only the architectural drawings need revision

96. A hold-down anchor at the end of a wood shear wall is installed with substantial unintended slack. What seismic performance issue is most direct?

A. The shear-wall dead load can approximately double at the end post
B. Panel shear capacity automatically increases before the hold-down engages
C. Excess uplift movement can occur before the hold-down develops tension
D. The connected floor diaphragm automatically changes to a rigid classification

97. Why are construction records and inspection reports important for seismic quality assurance?

A. They replace the need for qualified observation of field construction
B. They document observation, testing, correction, and acceptance of critical work
C. They establish the magnitude of future earthquakes at the project site
D. They remove the need to maintain current approved construction drawings

98. A reinforcing bar required to continue a collector force path is found cut short during inspection. What is the appropriate response?

A. Evaluate and correct the discontinuity before covering the work
B. Ignore it because concrete will carry all tension
C. Add ceiling bracing instead
D. Increase paint thickness over the area

99. Why is anchorage edge distance and surrounding concrete condition checked during seismic installation inspection?

A. Edge distance establishes the occupancy classification assigned to the building

B. Concrete cracking has no meaningful effect on seismic anchor performance
C. Adequate surrounding concrete is needed to develop anchor shear and tension
D. Anchor color is the primary field criterion for seismic acceptance

100. A nonstructural brace is attached to a metal deck rather than the supporting structural member shown on the approved drawings. What should be checked first?

A. Whether the brace paint matches the adjacent structural support finish
B. Whether roof drainage slopes change near the relocated attachment point
C. Whether the room identification number remains correct after relocation
D. Whether the revised attachment provides a complete adequate seismic load path

Practice Exam 8: Answer Key and Explanations

1. D — The stated relation requires multiplication: SMS = 1.10(1.26g) = 1.386g. Dividing Ss by Fa gives about 1.145g, leaving Ss unchanged ignores the site coefficient, and adding the inputs gives 2.360 without using the equation. A units check confirms the requested quantity and supports the calculation. The other choices reflect common arithmetic or setup errors rather than the stated relationship.

2. B — Two-thirds of 0.78g is 0.52g, so that is the design value under the equation supplied. One-half gives 0.39g, keeping 0.78g skips the conversion, and multiplying by 1.5 gives 1.17g rather than reducing the maximum-considered value. A units check confirms the requested quantity and supports the calculation. The other choices reflect common arithmetic or setup errors rather than the stated relationship.

3. A — The transition period follows directly from the given ratio: Ts = 0.54/0.90 = 0.60 second. Multiplication gives 0.486 rather than a period ratio, 1.44 comes from addition, and 1.67 reverses the division. A units check confirms the requested quantity and supports the calculation. The other choices reflect common arithmetic or setup errors rather than the stated relationship.

4. C — Generalized mapped hazard values are intentionally broad. Deep basins, directivity, and unusual local geology can alter shaking intensity or spectral shape at a specific site, so a site-specific study may better characterize demand. Construction sequencing, finish selection, and structural modeling are separate matters and are not replaced by such a study.

5. D — The new function changes the consequence of failure and the reliability expected from the facility. That makes risk category and associated importance provisions the classification issue most directly affected. Site coordinates, existing bar diameter, and formwork timing do not change merely because the occupancy becomes more critical after an earthquake.

6. B — Liquefaction requires a soil susceptible to rapid pore-pressure buildup during cyclic loading. Loose saturated granular deposits are the classic concern because shaking can reduce effective stress and stiffness. Dense dry gravel, competent rock, and unsaturated stiff clay do not present the same combination of saturation, contractive tendency, and cyclic susceptibility.

7. C — Seismic design category reflects both the expected earthquake demand and the consequence associated with the building use or risk category. Those inputs establish the level of seismic provisions appropriate to the project. Roof drainage, concrete curing, and room geometry may matter elsewhere but are not the fundamental basis of seismic design category.

8. A — A thick soft-soil profile can modify amplitude and frequency content as waves travel through the deposit, sometimes increasing demand over important period ranges. That is a site-response issue. It does not automatically double roof weight, change concrete material strength, or convert wind pressure into an earthquake action. The governing issue is continuity, deformation compatibility, and a dependable seismic load path.

9. A — With equal stiffness, period varies with the square root of mass. Increasing mass by a factor of four therefore increases period by sqrt(4) = 2. The alternatives either use a linear mass ratio or reverse the direction of the square-root relationship. A units check confirms the requested quantity and supports the calculation.

10. C — Reducing lateral stiffness increases flexibility, which tends to lengthen the response period and concentrate deformation where the stiffness loss occurs. That is why soft-story behavior is dangerous. The mass does not automatically decrease, drift does not vanish, and diaphragm rigidity is a separate property from the vertical stiffness discontinuity. That is the controlling relationship for this scenario.

11. D — Damping represents mechanisms that dissipate mechanical energy during vibration. Greater damping generally reduces resonant response and helps oscillations decay more quickly. It does not add floor mass, force different modes to have the same shape, or replace the need for adequate strength and stiffness in the seismic-force-resisting system. That is the controlling relationship for this scenario.

12. B — A rigid diaphragm enforces compatible in-plane translation, so stiffer vertical elements attract a larger share of the direct lateral force when torsion is neglected. Equal sharing would require equal stiffness. Member weight and geometric proximity alone do not govern the elastic direct-shear distribution under the stated idealization. The governing issue is continuity, deformation compatibility, and a dependable seismic load path.

13. D — Earthquake loading is cyclic and can push members beyond first yield. Ductile systems can undergo controlled inelastic deformation while maintaining a viable load path and dissipating energy. Brittle mechanisms can lose capacity abruptly. Ductility does not eliminate connections, and it is not valuable because brittle failure somehow reduces design demand.

14. B — When a gravity-loaded structure drifts laterally, the vertical loads act through an offset and create additional overturning or story moments. That second-order action is the P-delta effect. It is not a loss of structural mass, a change in site class, or a load mechanism unique to wind design. That is the controlling relationship for this scenario.

15. C — Redundancy provides alternate resisting paths so the system is less dependent on a single member or connection. That improves robustness if one component yields or is damaged. It does not guarantee an undamaged structure, eliminate torsion, or justify weak connections; each element in the intended load path still requires adequate capacity.

16. A — A separation between mass and stiffness centers creates an eccentricity between inertial force and resistance. The resulting torque causes diaphragm rotation in addition to translation, increasing demand at some perimeter elements. The offset does not create purely vertical response, uniform column compression, or eliminate forces in edge frames. That is the controlling relationship for this scenario.

17. B — The problem is a vertical stiffness and strength discontinuity that can concentrate drift and damage at the first story. A retrofit should strengthen and stiffen that level and connect the new elements into the existing load path. Adding mass, removing collectors, or reducing foundation contact would worsen rather than address the seismic weakness.

18. C — Out-of-plane wall stability depends on transferring wall inertia into diaphragms and the rest of the structure. Positive anchorage at roof and floor lines directly addresses that mechanism. Finishes and live load do not create the needed restraint, while additional openings can reduce wall integrity rather than improve it. That is the controlling relationship for this scenario.

19. A — New vertical elements help only if earthquake forces can reach them. Without diaphragm-to-wall collectors or connections, the intended lateral load path is incomplete and the retrofit may not engage as designed. Damping, soil bearing, and gravity capacity do not cure the missing force-transfer connection described in the scenario. That is the controlling relationship for this scenario.

20. D — Concentrating inelastic rotations in beams helps distribute damage through multiple stories while columns continue carrying gravity loads. Column-dominated yielding can form a soft-story mechanism and threaten stability. The concept does not require beams to stay elastic, does not call for weak column splices, and still depends on proper joint and connection detailing.

21. B — Buildings with different periods or stiffness can move differently during the same earthquake. If separation is insufficient, they may strike each other, producing local damage and altered force paths. That pounding hazard is distinct from moisture intrusion, material shrinkage, or long-term static settlement and deserves direct evaluation in an existing-building assessment.

22. D — Strengthening a wall can shift the controlling weakness to its foundation. The new overturning tension and compression reactions must be transferred safely into the ground, so footing, pile, grade-beam, or anchorage upgrades may be necessary. Weakening diaphragm connections, adding ceiling mass, or removing boundary reinforcement would undermine the intended retrofit performance.

23. A — Multiplying the dimensionless coefficient by seismic weight gives V = 0.082(6,400) = 524.8 kips. The other values come from treating the coefficient as a force, dividing instead of multiplying, or adding the coefficient to the weight. A units check confirms the requested quantity and supports the calculation. A quick reasonableness check supports both the magnitude and direction of the result.

24. C — Substitution gives Cs = 0.84(1.25)/7 = 0.150. Dividing only SDS by R gives 0.120, ignoring the importance factor gives that same reduced value, and other choices result from reversing or combining factors incorrectly. The coefficient is dimensionless. A units check confirms the requested quantity and supports the calculation. A units check confirms the requested quantity and supports the calculation.

25. A — The vertical distribution weight-height terms are 13,500, 21,000, and 22,500, giving a total of 57,000. The roof fraction is therefore 22,500/57,000 = 0.3947, which rounds to 0.395. Using floor weight alone or simple equal sharing would ignore the height weighting specified in the equation and would misrepresent the roof force fraction.

26. B — Story shear at a cut equals the sum of the lateral forces acting at that level and above it. Adding 96 + 78 + 63 + 41 gives 278 kips. Omitting one upper force or using only the force at the selected level does not represent the total shear transferred through the story.

27. D — Torsional moment equals force times eccentricity, so Mt = 610(4.2) = 2,562 kip-ft. Dividing the quantities, adding them, or treating the eccentricity as a multiplier of one thousand does not follow the moment relationship. The force-length units correctly produce kip-ft. A units check confirms the requested quantity and supports the calculation.

28. C — Total stiffness is 30 + 45 + 75 = 150 units. The 45-unit frame therefore receives 45/150 of 720 kips, which equals 216 kips. The other values correspond to different fractions and do not satisfy stiffness-proportional force distribution under the rigid-diaphragm assumption. A units check confirms the requested quantity and supports the calculation.

29. B — The chord couple must reproduce the diaphragm moment, so F = 3,360/60 = 56 kips. Multiplying 56 kips by the 60-ft chord spacing returns the original 3,360 kip-ft moment. The alternatives result from unrelated divisions or confuse spacing with the required chord force. A units check confirms the requested quantity and supports the calculation.

30. A — The accumulated collector force equals the uniform transfer times tributary length: 3.4 kips/ft times 28 ft = 95.2 kips. The feet cancel, leaving force. The other choices arise from addition or from using incorrect products and therefore do not match the stated uniform transfer. A units check confirms the requested quantity and supports the calculation.

31. D — Average unit shear is total shear divided by effective width. Thus 684/72 = 9.5 kips/ft. The result has force-per-length units as expected. The distractors reflect incorrect division or multiplication and do not reproduce the stated total shear when multiplied by 72 ft. A units check confirms the requested quantity and supports the calculation.

32. C — A force couple produces moment Fd, so the required force is F = 3,150/42 = 75 kips. A 37.5-kip force would provide only half the moment, 42 confuses spacing with force, and 132.3 kips does not reproduce the stated overturning moment. A units check confirms the requested quantity and supports the calculation.

33. A — Following the supplied equation gives Ev = 0.2(0.74)(1,600) = 236.8 kips. The alternatives apply only part of the factor or use an incorrect decimal. Because 0.2 and SDS are dimensionless, the result retains the force units of the dead load. A units check confirms the requested quantity and supports the calculation.

34. B — First amplify the horizontal effect: 1.3(142) = 184.6 kips. Adding Ev gives 211.6 kips. The 184.6-kip option omits Ev, while the remaining distractors combine the inputs incorrectly. The calculation follows the equation in the stem and keeps all force terms compatible. A units check confirms the requested quantity and supports the calculation.

35. C — The horizontal overstrength contribution is 2.5(88) = 220 kips. Adding the 18-kip vertical term gives Em = 238 kips. The 220-kip distractor omits Ev, 106 simply adds QE and Ev, and 265 uses an incorrect combination of the given factors. A units check confirms the requested quantity and supports the calculation.

36. D — The stated combination is 190 + 0.30(80) = 190 + 24 = 214 kips. Using 190 alone ignores the orthogonal contribution, 247 applies 30% to the wrong term, and 270 adds the two full directional effects instead of using the prescribed combination. A units check confirms the requested quantity and supports the calculation.

37. B — Apply the stated amplification: delta = 5.0(0.72)/1.25 = 2.88 in. Multiplying without dividing by Ie gives 3.60 in., while the other options arise from incorrect combinations of the same factors. The final units remain inches because Cd and Ie are dimensionless. A units check confirms the requested quantity and supports the calculation.

38. A — Convert the story height to inches: 13 ft equals 156 in. Multiplying 156 by 0.015 gives 2.34 in. Applying the ratio directly to feet yields 0.195 ft, not inches, and the other distractors correspond to different drift ratios than the one stated. A units check confirms the requested quantity and supports the calculation.

39. D — The cap is the product CuTa = 1.40(0.62 s) = 0.868 s. Dividing produces about 0.443 s, leaving Ta unchanged ignores Cu, and adding the two values gives 2.020 rather than applying the specified multiplication. A units check confirms the requested quantity and supports the calculation. The other choices reflect common arithmetic or setup errors rather than the stated relationship.

40. C — Dividing base shear by effective seismic weight gives 615/8,200 = 0.075. Moving the decimal one place produces 0.0075, reversing the ratio gives about 13.33, and 0.133 is unrelated to the given values. Force units cancel, leaving the expected dimensionless coefficient. A units check confirms the requested quantity and supports the calculation.

41. A — Using the coefficient stated in the problem, Fpx = 0.24(980) = 235.2 kips. Ten percent gives 98.0 kips, 204.2 corresponds to a different multiplier, and adding 0.24 to the weight is not a valid force calculation. A units check confirms the requested quantity and supports the calculation. A quick reasonableness check supports both the magnitude and direction of the result.

42. C — Substituting the given values yields Ft = 4,200(16)/1,680 = 40 kips. The other choices result from using the factors in a different order. Dimensional cancellation is also correct: kip-ft times ft divided by ft squared leaves kips. A units check confirms the requested quantity and supports the calculation. A units check confirms the requested quantity and supports the calculation.

43. D — Using consistent inch units, theta = 7,800(0.95)/[690(156)] = about 0.0688. The ratio is dimensionless because force-length terms cancel. The alternatives shift the decimal or use an incorrect denominator and therefore do not satisfy the equation supplied in the question. A units check confirms the requested quantity and supports the calculation.

44. B — With compatible rigid-diaphragm translation and no torsion, direct force is proportional to stiffness. A 2:1 stiffness ratio means the stiffer line receives two-thirds of the total: 540(2/3) = 360 kips. Equal sharing would give 270 kips and would ignore the stated stiffness difference. A units check confirms the requested quantity and supports the calculation.

45. D — Collectors provide a defined axial load path that gathers distributed diaphragm forces and transfers them to walls, frames, or other vertical resisting elements. They are especially important around offsets and discontinuities. They do not reduce seismic mass, make diaphragms deformation-free, or substitute for anchorage and foundation force transfer. That is the controlling relationship for this scenario.

46. A — Accidental torsion introduces a prescribed eccentricity so the analysis is not overly dependent on an idealized coincidence of mass and stiffness centers. It provides robustness against uncertainty in actual distributions. It does not modify gravity live load, remove inherent torsion, or address construction operations such as concrete curing. That is the controlling relationship for this scenario.

47. C — A discontinuous vertical element creates concentrated transfer forces that must pass through diaphragms, collectors, chords, and supporting members into the continuing lateral system. The load path therefore requires deliberate design at the transfer level. The discontinuity does not eliminate roof mass, story drift, or foundation reactions. The other choices address different mechanisms and do not resolve the seismic condition described.

48. B — The term is directly proportional to rho. Changing rho from 1.0 to 1.3 multiplies the horizontal seismic effect by 1.3, which is a 30 percent increase over the original contribution. It does not decrease, remain constant, or become 130 percent larger than the starting value. A units check confirms the requested quantity and supports the calculation.

49. B — The numerator is 0.4(1.0)(0.90)(12) = 4.32 kips. Dividing by Rp/Ip = 3.0 gives Fp = 1.44 kips. The distractors omit the response reduction, use only part of the expression, or stop at the numerator instead of completing the calculation. A units check confirms the requested quantity and supports the calculation.

50. A — The overturning moment is 8.5(4) = 34 kip-ft. Dividing by the 5-ft anchor-line spacing gives a couple force of 6.8 kips. The other choices use the force directly, divide by the wrong dimension, or report moment as though it were an anchor force. A units check confirms the requested quantity and supports the calculation.

51. D — Different building segments can experience relative displacement during earthquake response. Piping or conduit crossing the joint must tolerate that movement without rupture, leakage, or loss of support. A seismic separation does not eliminate drift, make component weight vanish, or suspend thermal behavior; it simply permits structural movement between adjacent portions.

52. C — A parapet behaves as a nonstructural component whose mass develops inertial force during horizontal shaking. Poor anchorage can allow out-of-plane rocking or falling, creating a life-safety hazard. Foundation bearing, column creep, and roof live-load reduction do not address the local component force and connection mechanism described. The other choices address different mechanisms and do not resolve the seismic condition described.

53. D — Ceiling bracing and perimeter details help control lateral movement and transfer ceiling inertial forces into supporting construction. The objective is not to add weight, eliminate vertical acceleration, or substitute for the structural diaphragm. Proper restraint reduces the chance of grid separation, falling components, and damage to attached services during shaking.

54. C — Vibration isolators intentionally allow movement during normal operation, so seismic restraint must accommodate or limit potentially large relative displacement without creating impact or instability. The equipment still has mass and experiences earthquake demand. Normal gravity anchorage alone may not provide the required lateral and overturning resistance for the isolated assembly.

55. B — With two identical anchors sharing the horizontal load equally, each carries 6.2/2 = 3.1 kips. The 1.55-kip option incorrectly divides by four, while 6.2 and 12.4 fail to share the load between the two anchors. This is the stated idealization before any additional design factors. A units check confirms the requested quantity and supports the calculation.

56. A — Substitute the height ratio into the stated multiplier: 1 + 2(0.75) = 1 + 1.50 = 2.50. The other choices omit either the leading one or the factor of two, or use an incorrect addition. The multiplier is dimensionless because z and h have the same units. A units check confirms the requested quantity and supports the calculation.

57. A — A building can amplify earthquake motion as vibration develops over its height, so components near the roof may experience larger floor accelerations than those near the base. Gravity does not meaningfully decrease over building height, equipment mass is unchanged, and foundation damping does not simply vanish at upper levels. That is the controlling relationship for this scenario.

58. C — Tank contents can respond dynamically during shaking. Part of the liquid may move with the shell while another portion sloshes, producing hydrodynamic pressures and forces that differ from a simple rigid-body mass assumption. Concrete shrinkage, thermal shortening, and wind suction are separate effects and do not represent this earthquake-specific fluid response.

59. D — A brace is effective only if force can travel from the pipe through the brace, its connection, and the supporting structure into a reliable seismic load path. It does not remove pipe weight, make the entire run axially rigid, or necessarily prevent thermal movement, which often requires separate flexibility considerations.

60. B — A high center of mass increases overturning moment for a given horizontal inertial force. That moment creates unequal support reactions and can produce significant anchor tension or uplift in addition to sliding shear. Uniform compression alone would miss the overturning couple, while drainage and shrinkage are unrelated to the earthquake demand mechanism.

61. B — The main structure can undergo significant interstory drift while cladding is comparatively brittle. Connections that permit appropriate movement can maintain support without forcing the cladding to follow every frame deformation rigidly. This does not remove structural seismic force, increase mass, or eliminate thermal movement; it addresses deformation compatibility during earthquake response.

62. A — When acceleration is expressed as a fraction of g and the component weight is used directly, the inertial force is 0.35(3,000) = 1,050 lb. The alternatives divide by the fraction, leave the weight unchanged, or shift the decimal. The stated weight-times-g-ratio form produces force units directly. A units check confirms the requested quantity and supports the calculation.

63. C — Modal response-spectrum analysis evaluates the structure in its natural modes and combines modal responses, making it well suited to linear dynamic behavior and higher-mode participation. A gravity takeoff, concrete mix calculation, or drainage analysis does not represent the dynamic lateral response of the building to earthquake excitation. The model should represent the response mechanism that materially affects seismic demand.

64. D — As height and dynamic complexity increase, response may no longer be dominated by the fundamental mode alone. Higher modes can alter story shear, floor acceleration, and local force patterns. They do not erase the first mode, eliminate the fundamental period, or make structural response depend solely on soil behavior. That is the controlling relationship for this scenario.

65. C — The square-root-of-sum-of-squares combination is sqrt(120^2 + 50^2) = sqrt(14,400 + 2,500) = sqrt(16,900) = 130 units. Direct addition gives 170, averaging gives 85, and multiplying the two responses does not follow the stated modal combination rule. The model should represent the response mechanism that materially affects seismic demand. The model should represent the response mechanism that materially affects seismic demand.

66. B — Closely spaced modes can respond in a correlated manner, so treating them as statistically independent may be inaccurate. Complete quadratic combination includes modal correlation effects and is therefore useful in that situation. It does not ignore damping, convert the analysis to nonlinear static form, or force equal participation among modes.

67. A — The scale factor is target divided by calculated response: 575/460 = 1.25. Multiplying the analysis results by 1.25 raises the base shear to the target value. A factor below one would reduce the response, while the other factors do not reproduce the specified target. The model should represent the response mechanism that materially affects seismic demand.

68. D — Using the equation, T = 2pi sqrt(18/800) = approximately 0.942 second. The alternatives omit the 2pi factor, double the correct result, or confuse the stiffness-to-mass ratio with a period. Because the units are stated to be consistent, the formula can be applied directly. The model should represent the response mechanism that materially affects seismic demand.

69. A — Secant stiffness is force divided by corresponding displacement: 420/2.8 = 150 kips/in. The alternatives result from multiplying or using unrelated ratios. A stiffness value should have force-per-length units, which is consistent with the calculated 150 kips per inch. The model should represent the response mechanism that materially affects seismic demand.

70. B — Displacement ductility is the ratio of ultimate to yield displacement. Dividing 4.8 by 1.2 gives mu = 4.0. The alternatives result from subtraction, multiplication, or unrelated combinations. The ratio is dimensionless and indicates how much deformation occurs relative to the onset of yielding. The model should represent the response mechanism that materially affects seismic demand.

71. D — The demand-to-capacity ratio is 285/375 = 0.76. A value below one indicates the stated demand is less than the stated capacity, without addressing any additional code checks. The distractors represent the unused capacity fraction, the reversed ratio, or the numerical difference between the two forces. The model should represent the response mechanism that materially affects seismic demand.

72. C — The weighted coordinate is [120(0)+180(20)+100(50)]/(120+180+100) = 8,600/400 = 21.5 ft. Simple averaging of coordinates ignores unequal weights. The other distractors do not satisfy the weighted-average definition of the center of mass given in the question. The model should represent the response mechanism that materially affects seismic demand. The alternative choices omit or misrepresent an important aspect of the structural response.

73. C — The stiffness-weighted coordinate is [20(0)+30(24)+50(48)]/(20+30+50) = 3,120/100 = 31.2 ft. A simple coordinate average ignores the differing line stiffnesses. The remaining values do not reproduce the weighted stiffness centroid specified in the stem. The model should represent the response mechanism that materially affects seismic demand. The alternative choices omit or misrepresent an important aspect of the structural response.

74. A — The inherent eccentricity magnitude is the absolute difference between the two coordinates: |21.5 - 31.2| = 9.7 ft. Halving that difference, using one coordinate alone, or adding the coordinates does not represent the geometric separation between the mass and stiffness centers. The model should represent the response mechanism that materially affects seismic demand.

75. D — The torsional moment is the product of story shear and eccentricity: 500(7.5) = 3,750 kip-ft. Dividing or adding the quantities does not produce moment, and doubling the correct product is unsupported. The force-length units confirm that the result is a torsional moment. The model should represent the response mechanism that materially affects seismic demand.

76. B — At the specified edge, the translation and torsional contribution act in the same direction, so they add: 1.10 + 0.35 = 1.45 in. Subtraction would apply to the opposite edge if the torsional component had the opposite sign. The other choices do not match the stated superposition. The model should represent the response mechanism that materially affects seismic demand.

77. D — Interstory drift is the relative displacement between adjacent floors, so 2.40 - 1.55 = 0.85 in. Using the lower-floor displacement alone or adding the two absolute displacements does not measure relative story deformation. The subtraction isolates the deformation demand occurring across that story. The model should represent the response mechanism that materially affects seismic demand.

78. A — If diaphragm deformation is significant relative to vertical-system deformation, assuming rigid compatibility can misrepresent how forces are delivered to frames or walls. Modeling in-plane flexibility can capture that redistribution. A flexible diaphragm still has mass, can experience torsion, and must transfer forces into its supports. The model should represent the response mechanism that materially affects seismic demand.

79. C — A pushover analysis incrementally increases lateral loading in a nonlinear model to identify yielding sequence, strength degradation or redistribution, and deformation capacity. It helps evaluate inelastic mechanisms and performance. It is not a dead-load takeoff, a universal replacement for dynamic analysis, or a method for determining geotechnical site classification. That is the controlling relationship for this scenario.

80. B — Individual earthquake records differ in amplitude and spectral content. Scaling or compatible selection helps the suite represent the target hazard over the period range important to the structure. The objective is not identical record duration, removal of damping, or conversion of the analysis into a purely static procedure. The model should represent the response mechanism that materially affects seismic demand.

81. D — Eigenvalue analysis identifies the structure's natural vibration characteristics, principally frequencies or periods and associated mode shapes. Those properties form the basis for modal dynamic procedures and help reveal which deformation patterns may participate strongly. Material test results, static bearing pressure, and inspection scheduling are unrelated outputs of an eigenvalue solution.

82. C — The participation fraction is 420/600 = 0.70, meaning the mode represents seventy percent of total mass in the stated direction under this simplified definition. The 0.30 value is the remainder, 1.43 reverses the ratio, and 180 is merely the numerical mass difference. The model should represent the response mechanism that materially affects seismic demand.

83. A — The center is [40(10)+60(30)]/(40+60) = (400+1,800)/100 = 22 ft. Equal averaging would give 20 ft and would ignore the greater stiffness at 30 ft. The other values do not satisfy the stiffness-weighted centroid relation stated in the question. The model should represent the response mechanism that materially affects seismic demand.

84. B — Substitution gives Ft = 2,400(30)(12)/8,640 = 100 kips. The numerator represents torsional demand weighted by the line stiffness and radius, and the denominator normalizes the distribution. The other choices come from omitting one factor or dividing in a different order. The model should represent the response mechanism that materially affects seismic demand.

85. A — The stated procedure simply multiplies elastic displacement by the amplification factor: 3.2(4.5) = 14.4 in. Adding the quantities, using an unrelated multiplier, or over-amplifying does not follow the problem statement. The dimensionless factor scales the displacement while leaving the result in inches. The model should represent the response mechanism that materially affects seismic demand.

86. C — Inherent eccentricity comes from the modeled separation between mass and stiffness centers, while accidental eccentricity accounts for uncertainty and unmodeled variations. Because they represent different sources of torsional demand, one does not automatically replace the other. Their inclusion does not redefine diaphragm flexibility or convert inherent eccentricity into a gravity-only effect.

87. B — Large lateral displacements allow gravity loads to create additional destabilizing moments, which can amplify drift and reduce effective lateral stiffness. If strong enough, this second-order behavior can threaten stability. It does not drive natural periods to zero, remove floor mass, or automatically reduce torsional response. The model should represent the response mechanism that materially affects seismic demand.

88. D — Reviewing cumulative modal participation helps confirm that the retained modes capture a sufficient portion of the structure's dynamic mass in the direction being analyzed. Too few modes can omit important response. The check does not establish concrete strength, geotechnical liquefaction resistance, or construction tolerances. The model should represent the response mechanism that materially affects seismic demand.

89. B — Special inspection provides focused observation and verification of work whose seismic performance depends strongly on fabrication or installation quality. It helps confirm that specified materials, connections, procedures, and details are actually provided. It does not select finishes, determine business terms, or substitute for the engineer's structural analysis and design. That is the controlling relationship for this scenario.

90. C — A crack-like indication can be significant in a cyclically loaded seismic connection and should be evaluated using the applicable inspection and acceptance criteria. Cosmetic covering or unrelated geometric observations do not establish acceptability. Adding live load has no corrective value and could increase demand rather than resolve the weld-quality concern.

91. D — Boundary regions can experience large cyclic strains and force reversals, so reinforcement must be properly developed and spliced to sustain the intended member mechanism. Premature bond or splice failure can defeat ductile behavior. These details are unrelated to appearance, do not replace confinement, and do not reduce structural mass. That is the controlling relationship for this scenario.

92. A — Wood shear-wall performance relies on fastener behavior and the integrity of the panel around each fastener. Excessive overdriving can damage the panel and reduce connection capacity or stiffness.

It does not automatically improve ductility, eliminate hold-down forces, or increase edge distance; the as-built condition may require evaluation. That is the controlling relationship for this scenario.

93. A — Reinforced masonry relies on proper interaction among masonry units, grout, and reinforcement. Voids or incomplete consolidation can interrupt bond, reduce effective section behavior, and compromise force transfer. Visual color is not a seismic criterion, empty cells are not inherently beneficial, and grout inspection does not replace verification of reinforcement location and detailing.

94. D — Adhesive anchors depend on proper hole preparation so the adhesive can bond to the concrete surface as intended. Dust and debris can reduce bond and make installed capacity unreliable. The condition does not strengthen the anchor, reduce the structure's dead load, or create useful slab ductility. Construction quality control must confirm that the intended seismic load path was actually built.

95. B — Collector connections are part of the seismic load path, so relocating one can change eccentricity, connection forces, member demands, or the ability to deliver load into the resisting system. The field change therefore needs engineering evaluation. Appearance alone, ignoring the force, or updating only architectural documents does not establish structural adequacy.

96. C — Hold-downs restrain overturning uplift at shear-wall ends. Unintended slack can allow extra movement before tension force is developed, increasing deformation and potentially damaging connected elements. It does not double wall weight, automatically increase panel shear strength, or change the diaphragm classification from flexible to rigid. Construction quality control must confirm that the intended seismic load path was actually built.

97. B — Seismic quality assurance relies on traceable evidence that specified inspections and tests occurred and that deficiencies were resolved. Records support accountability and later review of critical construction. Documentation does not replace actual observation, predict earthquake magnitude, or make approved drawings unnecessary; it records how compliance with those requirements was established.

98. A — A bar that is part of a collector or transfer force path must develop the intended tension or compression. Cutting it short creates a structural discontinuity that should be evaluated and corrected before concealment. Concrete alone may not replace the required tension path, and ceiling bracing or paint cannot restore the missing reinforcement.

99. C — Anchor performance depends on how forces spread into the surrounding concrete and on failure modes influenced by edge proximity, spacing, and substrate condition. Inspection therefore verifies that the installed geometry and concrete condition support the intended resistance. Occupancy and appearance are unrelated, and concrete condition can materially affect anchorage behavior.

100. D — The brace force must pass through the attachment into structure capable of resisting it. Moving the connection from the specified member to deck can change local capacity and load transfer, so the revised path needs evaluation. Paint, drainage slope, and room numbering do not establish seismic adequacy of the altered support condition.