PRACTICE EXAM 9: 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. At a site, mapped Ss = 1.18g is modified by Fa = 1.25. Applying the stated product relation SMS = FaSs, determine SMS.

A. 1.475g
B. 0.944g
C. 1.180g
D. 2.430g

2. A simplified spectrum defines SDS = (2/3)SMS. If SMS = 1.14g, what is SDS?

A. 0.57g
B. 1.14g
C. 1.71g
D. 0.76g

3. For this exercise, compute the transition period using Ts = SD1/SDS. Take SD1 = 0.63g and SDS = 1.05g.

A. 0.42 s
B. 0.60 s
C. 1.68 s

D. 1.67 s

4. A geotechnical report identifies loose saturated sand below the groundwater table. Which earthquake-related site hazard deserves the most direct attention?

A. Long-term concrete shrinkage
B. Snow accumulation on the roof
C. Potential liquefaction and associated ground deformation
D. Thermal expansion of cladding

5. A new emergency operations center must remain functional after a major earthquake. Which project classification decision most directly reflects that consequence of failure?

A. The paint sheen specification
B. The occupancy-related risk category
C. The concrete slump target
D. The roof drain diameter

6. Why can two sites in the same city have different design spectral response even when the regional mapped hazard is similar?

A. Building height changes the regional fault
B. Concrete cover changes mapped acceleration
C. Different soil profiles can amplify and reshape shaking differently
D. Roof live load alters the geologic hazard

7. Which site condition is most associated with permanent ground displacement rather than only inertial building response?

A. A symmetric floor plan
B. A regular column grid

C. A lightweight roof diaphragm
D. A mapped active fault trace crossing the site

8. A design team is deciding whether a site-specific response analysis is warranted. Which condition provides the strongest reason to consider one?

A. Unusual basin or near-fault spectral effects
B. A change in interior paint color
C. A revised furniture layout
D. A smaller plumbing fixture count

9. Two idealized single-degree systems have equal mass. System P has four times the lateral stiffness of System Q. Using T proportional to sqrt(m/k), how does TP compare with TQ?

A. TP = 0.25TQ
B. TP = 2TQ
C. TP = 0.5TQ
D. TP = 4TQ

10. A building gains substantial roof equipment mass without changing its lateral stiffness. What general dynamic trend should be expected?

A. The period becomes exactly zero
B. The stiffness automatically doubles
C. The damping ratio must become 100%
D. The fundamental period tends to increase

11. What does increased damping generally do to the peak response of a structure near resonance?

A. It reduces the amplitude by dissipating vibration energy
B. It doubles the seismic mass

C. It forces every floor to move identically
D. It eliminates the need for strength

12. A rigid diaphragm connects lateral-resisting lines with different stiffnesses. What primarily controls how diaphragm shear is distributed among those lines in an elastic analysis?

A. Their paint colors and finishes
B. Their relative lateral stiffnesses and geometry
C. The order in which walls were framed
D. The number of ceiling tiles

13. What is the main structural significance of a large separation between a floor center of mass and center of rigidity?

A. It removes all story shear
B. It increases torsional response under lateral loading
C. It guarantees zero drift
D. It makes the diaphragm flexible by definition

14. A very flexible diaphragm spans between widely spaced shear walls. Compared with an ideal rigid diaphragm, what behavior becomes more important?

A. Perfectly uniform floor translation
B. Automatic elimination of torsion
C. In-plane diaphragm deformation and local tributary load paths
D. Zero collector demand

15. Why are higher vibration modes often more important in a tall building than in a very low-rise building?

A. Tall buildings have no fundamental mode

B. Low-rise buildings cannot vibrate
C. Higher modes change gravity load into wind
D. Multiple mode shapes can contribute materially to story forces and accelerations

16. A story is much weaker and more flexible than the stories above and below. During strong shaking, where is inelastic deformation most likely to concentrate?

A. At the weak, flexible story
B. Uniformly at every floor
C. Only in the foundation soil
D. Only in nonstructural finishes

17. An older unreinforced masonry building has wood diaphragms that are poorly connected to the exterior walls. Which retrofit objective is most fundamental?

A. Increase interior paint thickness
B. Reduce window cleaning frequency
C. Provide positive wall-to-diaphragm anchorage and a continuous load path
D. Replace all floor finishes

18. A soft-story apartment building has open parking at the ground level. Which strengthening concept most directly addresses the principal vulnerability?

A. Strengthen lateral resistance at the weak ground story
B. Add heavier roofing at the top floor
C. Remove diaphragm connections
D. Reduce concrete cover at columns

19. A retrofit adds new shear walls but does not strengthen the collectors that deliver diaphragm forces to them. What is the main concern?

A. The walls automatically become too flexible
B. Collectors may not deliver force into the new walls
C. The building loses all gravity capacity
D. The roof live load becomes zero

20. A post-earthquake rapid evaluation finds obvious partial collapse and falling-hazard conditions. Which immediate action is most appropriate?

A. Reopen immediately because shaking stopped
B. Hide the damage with temporary finishes
C. Increase occupancy to test the structure
D. Restrict entry and obtain a more detailed safety evaluation

21. Why can adding stiffness to only one side of an existing building create a new seismic problem?

A. It always eliminates base shear
B. It makes every column stronger
C. It can shift rigidity and increase torsional response
D. It removes the need for diaphragm chords

22. A retrofit scheme strengthens individual columns but leaves brittle beam-column joints unchanged. What is the principal weakness of that approach?

A. The original joint mechanism may still govern under cyclic frame deformation
B. The new columns eliminate all joint forces
C. Brittle joints become ductile automatically
D. Gravity loads no longer reach the foundation

23. Define the seismic coefficient for this exercise as Cs = SDS Ie/R. With SDS = 0.96, Ie = 1.0, and R = 6, calculate Cs.

A. 0.096
B. 0.576
C. 6.250
D. 0.160

24. A building has effective seismic weight W = 8,400 kips and Cs = 0.125. Using V = CsW, what base shear V results?

A. 672 kips
B. 1,050 kips
C. 1,175 kips
D. 8,525 kips

25. An approximate period expression is Ta = 0.02(hn)^0.75. For hn = 64 ft, what value is obtained?

A. 0.45 s
B. 0.32 s
C. 0.75 s
D. 1.28 s

26. A three-level building has story weights 120, 120, and 80 kips at heights 12, 24, and 36 ft. For k = 1, what fraction of V is assigned to the roof using Cvx = wxhx / sum(wihi)?

A. 0.222
B. 0.333
C. 0.400
D. 0.500

27. A particular level receives 22% of a 900-kip base shear under the vertical force distribution. What floor force does that represent?

A. 110 kips
B. 220 kips
C. 1,122 kips
D. 198 kips

28. A diaphragm resists 420 kip-ft of in-plane flexure through boundary chords separated by 35 ft. What axial chord force is M/d?

A. 7 kips
B. 12 kips
C. 35 kips
D. 14,700 kips

29. A collector must transfer 260 kips into a shear wall. If two identical connections share the force equally, what demand is assigned to each connection before other factors?

A. 65 kips
B. 260 kips
C. 130 kips
D. 520 kips

30. A wall line has design shear 360 kips distributed uniformly along 30 ft. What average shear demand per foot results?

A. 8 kip/ft
B. 30 kip/ft
C. 10,800 kip/ft
D. 12 kip/ft

31. An elastic analysis gives a relative story displacement of 0.42 in. Use Delta = Cd*deltae/Ie with Cd = 5.0 and Ie = 1.0. What amplified drift Delta results?

A. 0.084 in.
B. 2.10 in.
C. 0.42 in.
D. 5.42 in.

32. Two adjacent floors have amplified lateral displacements of 3.7 in. and 2.2 in. in the same direction. What story drift is the difference between them?

A. 1.5 in.
B. 0.8 in.
C. 2.2 in.
D. 5.9 in.

33. A torsional analysis uses floor force F = 180 kips acting at an eccentricity e = 6 ft. What torsional moment Fe is produced?

A. 30 kip-ft
B. 1,080 kip-ft
C. 186 kip-ft
D. 3,600 kip-ft

34. A rectangular diaphragm has uniform in-plane shear of 9 kip/ft along a 40-ft collector segment. What total collector force is transferred over that segment?

A. 49 kips
B. 4.44 kips
C. 360 kips
D. 90 kips

35. A line of resistance contains two elastic shear walls with stiffnesses 3k and 2k that share a 500-kip force. Ignoring torsion, how much goes to the 3k wall?

A. 200 kips
B. 250 kips
C. 333 kips
D. 300 kips

36. A floor has seismic weight 1,600 kips and experiences horizontal acceleration of 0.18g in a simplified inertial calculation. What horizontal inertial force is 0.18W?

A. 288 kips
B. 160 kips
C. 178 kips
D. 1,888 kips

37. A cantilever wall carries an overturning moment of 9,600 kip-ft. If the compression-tension couple acts over 24 ft, what axial couple force is M/d?

A. 400 kips
B. 200 kips
C. 576 kips
D. 9,624 kips

38. A diaphragm opening interrupts a straight load path between two wall lines. What should the designer identify first?

A. Only the floor finish pattern
B. Only the building paint scheme
C. Only the plumbing fixture count
D. Collectors, chords, and local force paths around the opening

39. What is the principal reason accidental eccentricity is included in torsional seismic analysis?

A. To eliminate inherent torsion
B. To reduce building weight
C. To account for uncertainty in mass and stiffness locations
D. To replace story-drift checks

40. A transfer diaphragm delivers upper-story forces into a different lower-story lateral system. What is the main design concern?

A. Matching interior finishes above and below
B. A complete and adequately detailed force-transfer path through the discontinuity
C. Keeping every column the same color
D. Making the roof drainage symmetric

41. Why is a weak-story condition particularly dangerous even when total building base shear is not unusually high?

A. It causes earthquake duration to double
B. It removes all diaphragm forces
C. It prevents any torsional motion
D. Deformation and inelastic demand can concentrate in one story

42. What is the purpose of a diaphragm chord in a floor or roof seismic system?

A. Carry only vertical plumbing loads
B. Eliminate all collector forces
C. Resist diaphragm flexural tension and compression near its boundaries
D. Increase soil bearing capacity

43. A collector force enters a wall through a connection that is much weaker than the collector member. What is the likely seismic consequence?

A. The weak connection can fail before the collector
B. The collector automatically becomes stronger
C. The diaphragm force disappears
D. The wall stiffness becomes infinite

44. Why should floor mass from heavy permanent equipment be included in seismic weight when appropriate?

A. Permanent equipment reduces inertia to zero
B. Earthquake inertia is proportional to the mass that must be accelerated
C. Only exterior walls create seismic mass
D. Equipment weight is always treated as wind load

45. A story shear of 540 kips is resisted by three identical frames acting in parallel with equal stiffness. Ignoring torsion, what elastic shear is assigned to each frame?

A. 135 kips
B. 270 kips
C. 1,620 kips
D. 180 kips

46. A floor force of 210 kips acts 8 ft from the center of rigidity. What torsional moment is generated by that eccentricity?

A. 26.25 kip-ft
B. 218 kip-ft
C. 1,680 kip-ft
D. 2,100 kip-ft

47. Why can adding a very stiff new wall to an otherwise regular floor plan increase forces in nearby diaphragm collectors?

A. The wall removes all seismic mass
B. The stiff wall attracts more lateral force
C. The collector force must become zero
D. The earthquake magnitude increases locally

48. What is the main reason story drift is checked separately from member strength?

A. Excessive drift can cause damage despite adequate member strength
B. Drift is another name for base shear
C. Strength automatically guarantees zero displacement
D. Drift affects only building paint

49. For a component-force exercise, evaluate 0.4 ap SDS Wp(1+2z/h) divided by (Rp/Ip). Use ap=1.0, SDS=0.80, Wp=10 kips, z/h=0.5, Rp=2.5, and Ip=1.0.

A. 2.56 kips
B. 1.28 kips
C. 3.20 kips
D. 6.40 kips

50. A rooftop component weighs 18 kips. If a simplified component check uses F = 0.24Wp, what force results?

A. 2.40 kips
B. 4.32 kips
C. 7.50 kips
D. 18.24 kips

51. A suspended mechanical unit is braced by four identical rods sharing a 12-kip lateral force equally. What force is assigned to each rod?

A. 2 kips
B. 4 kips
C. 3 kips
D. 48 kips

52. Why are flexible utility connections often provided at seismically restrained equipment?

A. To increase the equipment mass
B. To make anchorage unnecessary
C. To eliminate all floor acceleration
D. To accommodate relative movement without rupturing the service line

53. A parapet is anchored only by gravity friction at its base. What seismic vulnerability is most direct?

A. The parapet becomes a rigid diaphragm
B. Out-of-plane inertial force can overturn or dislodge the parapet
C. Roof mass becomes zero
D. The foundation soil liquefies automatically

54. A tank is supported on a narrow pedestal. Which additional effect is especially important beyond simple horizontal shear?

A. Overturning moment and anchorage tension at the support
B. Interior paint adhesion
C. Roof drainage slope
D. Concrete curing temperature only

55. A component brace attaches to lightweight deck instead of the structural framing shown in the design. What should be checked first?

A. Whether the deck color matches the brace

B. Whether the room number is correct
C. Whether the deck can transfer brace force to structure
D. Whether ceiling tiles remain centered

56. A piece of floor-mounted equipment has a lateral design force of 24 kips resisted by six identical anchors. Assuming equal elastic sharing, what shear is assigned to each anchor?

A. 3 kips
B. 6 kips
C. 144 kips
D. 4 kips

57. Why can a component near the roof experience larger seismic acceleration than the same component near the base?

A. Structural motion can amplify acceleration with elevation
B. Gravity reverses direction near the roof
C. Concrete strength always doubles aloft
D. The component weight becomes zero

58. Two structural wings move independently at a seismic separation, and a partition spans the gap. Which detail best preserves the purpose of the separation?

A. Make the partition heavier
B. Allow relative movement without creating a brittle bridge
C. Rigidly lock both wings together through the finish
D. Remove all nearby ceiling bracing

59. A horizontal equipment force of 15 kips acts 3 ft above an anchor group. What overturning moment reaches the anchor group?

A. 5 kip-ft
B. 18 kip-ft
C. 45 kip-ft
D. 225 kip-ft

60. A suspended ceiling has perimeter clearance but rigid utility penetrations tie it to the structure. What is the key seismic concern?

A. The ceiling mass disappears
B. The floor diaphragm becomes flexible automatically
C. The roof period becomes zero
D. Penetrations may restrain movement and transfer unintended forces

61. A rigid equipment skid weighs 30 kips and a simplified check requires a lateral force equal to 0.30Wp. What force should be used?

A. 3 kips
B. 9 kips
C. 10 kips
D. 30.3 kips

62. Why are equipment anchorage forces checked independently of the strength of the equipment cabinet itself?

A. Anchors must transfer component inertia into supporting structure
B. A strong cabinet guarantees perfect anchors
C. Anchors carry only gravity load
D. Cabinet strength determines soil class

63. Two lateral resisting lines have elastic stiffnesses 4k and 6k and share a 700-kip story shear. Ignoring torsion, how much shear goes to the 6k line?

A. 280 kips
B. 350 kips
C. 525 kips
D. 420 kips

64. A response-spectrum analysis gives modal responses of 80 and 60 units that are statistically independent. Using SRSS = sqrt(r1^2+r2^2), what combined response results?

A. 20 units
B. 70 units
C. 100 units
D. 140 units

65. Three independent modal responses are 30, 40, and 0. Using SRSS, what combined value results?

A. 50 units
B. 35 units
C. 70 units
D. 1,200 units

66. An analysis model assigns a lateral stiffness of 24 kip/in to a story and applies 120 kips of shear. Using delta = V/k, what elastic story displacement results?

A. 0.20 in.
B. 24 in.
C. 2,880 in.
D. 5 in.

67. A single-degree system has mass parameter m = 9 and stiffness parameter k = 36 in consistent units. Using omega = sqrt(k/m), what circular frequency results?

A. 0.5 rad/s
B. 2 rad/s
C. 4 rad/s
D. 6 rad/s

68. Using T = 2pi/omega, what period corresponds to omega = 5 rad/s?

A. 0.200 s
B. 5.000 s
C. 1.257 s
D. 31.416 s

69. A two-story shear building has story drifts 0.9 in. and 1.4 in. Which story controls a drift-based review?

A. The first story because it is lower
B. Both always control equally
C. The second story with 1.4 in. drift
D. Neither because drift is not a seismic response

70. Why is a P-Delta check important when gravity load acts through large lateral story displacement?

A. It eliminates all first-order forces
B. It reduces gravity load to zero
C. It makes stiffness independent of deformation
D. Gravity load through drift creates secondary seismic effects

71. A floor has center-of-mass eccentricity of 4 ft from the center of rigidity and 250 kips of lateral force. What inherent torsional moment results?

A. 62.5 kip-ft

B. 1,000 kip-ft
C. 254 kip-ft
D. 4,000 kip-ft

72. A modal analysis captures 72% of the participating mass in the modes included so far. What is the clearest analytical implication?

A. Additional modes may be needed to capture response
B. The model is automatically exact
C. No more modes can exist
D. The building has zero higher-mode response

73. Why can CQC modal combination be preferable to simple SRSS when modes have closely spaced frequencies?

A. It assumes every mode is identical
B. It accounts for correlation between modal responses
C. It removes the need for mode shapes
D. It converts dynamic analysis into static gravity analysis

74. A pushover analysis is most useful for examining which aspect of structural behavior?

A. Only the architectural finish schedule
B. Only the elastic gravity deflection
C. Only the soil classification letter
D. The sequence and distribution of nonlinear yielding

75. Why must an analytical model include major stiffness discontinuities such as a transfer level?

A. They can change force distribution and deformation concentration
B. They only affect paint cracking

C. They eliminate higher modes

D. They make seismic mass irrelevant

76. A lateral load of 96 kips causes 0.8 in. of elastic displacement in a model. What secant stiffness V/delta does that point imply?

A. 76.8 kip/in.

B. 95.2 kip/in.

C. 120 kip/in.

D. 0.0083 kip/in.

77. A two-bay diaphragm model assigns tributary seismic forces of 140 and 220 kips to adjacent collector regions. What total force reaches the common support if both act in the same direction?

A. 80 kips

B. 360 kips

C. 180 kips

D. 30,800 kips

78. A story has total lateral stiffness 50 kip/in. After cracking, the effective stiffness is estimated as 60% of that value. What effective stiffness is used?

A. 20 kip/in.

B. 60 kip/in.

C. 30 kip/in.

D. 110 kip/in.

79. A model predicts floor displacements of +2.6 in. and -1.1 in. at opposite diaphragm edges. What total edge-to-edge differential displacement is implied?

A. 3.7 in.

B. 1.5 in.
C. 2.6 in.
D. 2.86 in.

80. Why should diaphragm flexibility be represented when its in-plane deformation is not negligible?

A. It guarantees zero torsion
B. It removes all chord forces
C. It changes earthquake magnitude
D. It can change force distribution to vertical elements

81. What is a key purpose of checking mode shapes in a dynamic model rather than only reading numerical periods?

A. Mode shapes determine paint color
B. They replace mass participation checks
C. They reveal whether modeled deformation patterns are reasonable
D. They eliminate the need for boundary conditions

82. A brace model carries 200 kips at an axial deformation of 0.50 in. in an elastic range. What axial stiffness F/delta is implied?

A. 100 kip/in.
B. 200.5 kip/in.
C. 0.0025 kip/in.
D. 400 kip/in.

83. A nonlinear analysis shows plastic hinges forming in columns before beams throughout a moment frame. Why is that result concerning?

A. It may indicate an undesirable column-yielding mechanism

B. Column yielding always improves stability
C. It proves the diaphragm is rigid
D. It eliminates P-Delta effects

84. Why is mass eccentricity sensitivity useful when reviewing a torsionally irregular floor?

A. It removes inherent torsion from the model
B. Small mass shifts can amplify edge-element demand
C. It changes the soil profile
D. It guarantees equal wall forces

85. A response-history analysis produces peak story shears of 410, 455, and 438 kips in three selected records. What arithmetic mean is obtained for this exercise?

A. 410.0 kips
B. 455.0 kips
C. 434.3 kips
D. 1,303 kips

86. Why is it important to model collector and diaphragm transfer forces rather than applying story shear only to vertical elements?

A. Horizontal transfer elements can govern local seismic demand
B. Collectors carry only gravity load
C. Story shear automatically bypasses diaphragms
D. Vertical elements make horizontal continuity irrelevant

87. A first-mode period is 0.8 s and a second-mode period is 0.25 s. Which mode has the higher natural frequency?

A. The first mode because its period is longer

B. The second mode with the shorter period
C. Both have identical frequency
D. Frequency cannot be related to period

88. Why should a seismic model be checked for unintended diaphragm releases or disconnected nodes before trusting results?

A. They only affect drawing appearance
B. They always increase concrete strength
C. They make earthquake input unnecessary
D. They can create artificial flexibility and false force paths

89. Why are closely spaced transverse ties used in highly ductile reinforced-concrete seismic regions?

A. They reduce concrete weight to zero
B. They confine concrete and restrain longitudinal-bar buckling
C. They replace all longitudinal reinforcement
D. They eliminate the need for anchorage

90. A welded seismic connection receives an unapproved field modification that removes part of a reinforcing plate. What should happen before acceptance?

A. It should be accepted if paint covers the cut
B. The change can be ignored if gravity loads are small
C. Only the architectural drawings need revision
D. The altered connection should be evaluated against the intended seismic force path and capacity

91. Why is proper development length important where reinforcing bars anchor a collector into a concrete wall?

A. Development length controls paint color

B. Shorter anchorage always increases ductility
C. They must develop collector force without bond failure
D. Collectors do not transfer tension

92. A wood shear wall has missing edge nails along a panel boundary. Why is that a seismic quality-control concern?

A. Missing fasteners can interrupt panel-to-framing shear transfer
B. The wall automatically becomes stronger
C. Hold-down forces disappear
D. The foundation soil class changes

93. Why must masonry wall grout and reinforcement placement be inspected before the work becomes inaccessible?

A. Masonry color determines wall ductility
B. Grout eliminates the need for reinforcement
C. Hidden voids or misplaced bars can compromise seismic behavior
D. Inspection changes earthquake duration

94. A post-installed anchor hole contains drilling dust when adhesive is placed, contrary to the approved installation procedure. What is the main concern?

A. Poor hole preparation can reduce adhesive-anchor bond
B. Dust always increases bond strength
C. The anchor loses all gravity load
D. The slab becomes more ductile automatically

95. Why are hold-down nuts and anchorage details checked carefully at wood shear-wall ends?

A. They carry only ceiling weight

B. They transfer overturning tension and limit wall uplift
C. They eliminate diaphragm shear
D. They determine concrete site class

96. A special inspector finds reinforcing congestion preventing proper concrete placement in a seismic joint. What is the best response?

A. Remove bars until concrete flows easily
B. Ignore voiding if the forms look straight
C. Add paint after stripping forms
D. Resolve the constructability problem without compromising required reinforcement, confinement, or development

97. Why are structural-observation notes and special-inspection reports valuable on seismic projects?

A. They replace the engineer of record
B. They document seismic observations, deficiencies, and corrections
C. They predict the next earthquake magnitude
D. They make approved drawings unnecessary

98. A collector reinforcing bar is cut short in the field to avoid an opening. What must be verified before the work is covered?

A. The opening trim color matches
B. The remaining bar is visually straight
C. The revised detail must restore collector force transfer
D. The ceiling grid is centered

99. Why is anchor edge distance checked during seismic installation inspection?

A. Insufficient edge distance can reduce concrete breakout resistance

B. Edge distance changes the building risk category
C. It only affects paint coverage
D. It makes all anchors flexible

100. A braced nonstructural component is installed with a field-drilled connection into a member not shown on the approved drawings. What should be confirmed first?

A. The new hole is visually centered
B. The brace and member have matching finishes
C. The component label is facing outward
D. The revised connection must complete the seismic load path

Practice Exam 9: Answer Key and Explanations

1. A — Multiplying the site coefficient by the mapped short-period value gives SMS = 1.25(1.18g) = 1.475g. Dividing produces 0.944g, keeping Ss unchanged omits the site effect, and adding the numbers produces 2.430 without using the stated relationship. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

2. D — The design short-period value is two-thirds of the maximum-considered value, so SDS = (2/3)(1.14g) = 0.76g. The other numerical choices correspond to one-half, no reduction, or multiplying by 1.5 instead of applying the stated two-thirds factor. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

3. B — The transition period is the ratio of the one-second design ordinate to the short-period design ordinate: 0.63/1.05 = 0.60 second. The distractors come from multiplication, addition, or reversing the ratio, none of which matches the supplied equation. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

4. C — Loose saturated sand can develop excess pore-water pressure under cyclic shaking, reducing effective stress and potentially causing liquefaction, settlement, or lateral deformation. The other choices are unrelated environmental or material effects and do not arise from the identified subsurface condition during earthquake loading. The other choices describe different mechanisms and do not address the seismic behavior stated in the problem.

5. B — Risk category captures the consequences associated with occupancy and the importance of continued function. An emergency operations center has a more critical post-earthquake role than ordinary occupancies, so its classification affects seismic design expectations. Paint, slump, and drain size may matter elsewhere but do not establish seismic consequence classification. That is the controlling relationship for this scenario.

6. C — Local soil conditions influence how seismic waves are amplified and filtered before reaching the ground surface. Therefore, two nearby sites can experience different spectral shapes even under similar regional hazard. Structural geometry and material detailing affect building response, but they do not change the underlying mapped geologic hazard. That is the controlling relationship for this scenario.

7. D — Surface fault rupture can produce permanent differential ground displacement across a site, directly affecting foundations and utilities. A symmetric plan, regular grid, or lightweight diaphragm influences structural response but does not itself create permanent tectonic ground offset. The distinction is important when evaluating site-specific seismic hazards. That is the controlling relationship for this scenario.

8. A — Site-specific response analysis is most useful when generalized mapped and site-class procedures may not capture important local spectral effects, such as deep-basin amplification or unusual near-fault behavior. Interior finishes, furniture arrangement, and plumbing fixture counts do not materially alter the seismic ground-motion characterization for the site. That is the controlling relationship for this scenario.

9. C — With equal mass, period varies inversely with the square root of stiffness. Increasing stiffness by four reduces period by sqrt(4), giving TP = 0.5TQ. The other choices either use a direct stiffness ratio or reverse the physical relationship between stiffness and vibration period. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

10. D — For an idealized system, increasing mass while keeping stiffness approximately unchanged increases the natural period because T is proportional to the square root of m/k. The other responses are not implied by added mass. Stiffness and damping are separate physical properties and do not automatically change in those ways. That is the controlling relationship for this scenario.

11. A — Damping dissipates vibrational energy and typically reduces resonant response amplitude compared with an otherwise similar lightly damped system. It does not add mass, impose a rigid-body floor shape, or replace strength. Seismic design still requires adequate capacity and a stable load path even when damping is significant. That is the controlling relationship for this scenario.

12. B — A rigid diaphragm constrains in-plane deformation so the connected vertical elements participate according to their stiffness and location, including torsional effects. Architectural finishes, construction sequence, and ceiling tile count do not govern elastic force distribution. The analysis should reflect the relative stiffness and geometry of the resisting elements. That is the controlling relationship for this scenario.

13. B — An offset between the center of mass and center of rigidity creates an eccentricity between inertial force and lateral resistance, producing torsional rotation in addition to translation. The offset does not eliminate story shear or drift, and it does not by itself classify the diaphragm as flexible. That is the controlling relationship for this scenario.

14. C — A flexible diaphragm can deform appreciably in its own plane, so forces may follow more local tributary paths rather than rigid-diaphragm distribution assumptions. This deformation can affect collectors, chords, and wall demands. It does not guarantee uniform translation, remove torsional considerations, or eliminate collector forces. That is the controlling relationship for this scenario.

15. D — Tall structures usually have several closely spaced dynamic modes that can contribute to response, especially upper-story accelerations and force distributions. Low-rise buildings are often dominated more strongly by the first mode. Every structure has a fundamental mode, and higher modes do not convert one load type into another. That is the controlling relationship for this scenario.

16. A — A pronounced strength and stiffness discontinuity attracts deformation because the weak story reaches nonlinear response earlier than adjacent stories. This concentration can lead to instability or collapse mechanisms. Deformation is not necessarily uniform, and although soil and finishes may respond, the structural weakness specifically concentrates story drift at that level.

17. C — Poor wall-to-diaphragm anchorage can permit out-of-plane wall failure and interrupt the transfer of seismic forces. A retrofit should establish positive connections and continuity between walls, diaphragms, and resisting elements. Architectural maintenance or finishes do not address the structural load-path deficiency that controls this vulnerability. The controlling idea is a continuous load path together with compatible strength, stiffness, and deformation capacity.

18. A — The open ground story commonly has reduced stiffness and strength, causing drift concentration. Adding appropriately designed frames, walls, or other resisting elements at that story can reduce the discontinuity while maintaining a continuous seismic path. Heavier roofing increases mass, and removing connections or cover does not solve the weakness. That is the controlling relationship for this scenario.

19. B — Adding strong vertical elements is not sufficient if diaphragm forces cannot reach them. Collectors and their connections must transfer load into the new walls; otherwise the retrofit can leave a critical discontinuity. The issue is not automatic flexibility, loss of all gravity capacity, or elimination of roof live load. That is the controlling relationship for this scenario.

20. D — Visible partial collapse and falling hazards indicate potentially unsafe conditions. Entry should be restricted and the building should receive a more detailed evaluation before normal use. The end of shaking does not prove stability, cosmetic concealment does not restore safety, and increasing occupancy would expose more people to risk. That is the controlling relationship for this scenario.

21. C — An asymmetric retrofit changes how lateral resistance is distributed. Concentrating stiffness on one side can increase eccentricity between mass and rigidity, amplifying torsional response even while overall strength increases. Base shear remains, column strength is not automatically improved, and diaphragm chords may still be required for force transfer. That is the controlling relationship for this scenario.

22. A — A seismic retrofit must address the mechanism that controls inelastic performance. Stronger columns do not automatically repair inadequate joint confinement, anchorage, or shear capacity. If the joints remain brittle, cyclic frame deformation can still trigger premature failure there, preventing the intended ductile response despite improvements to individual column strength. That is the controlling relationship for this scenario.

23. D — The supplied equation gives Cs = 0.96/(6/1.0) = 0.160. Multiplying SDS by 0.1, multiplying SDS by R, or reversing the division produces the distractors. The coefficient is dimensionless and should be smaller than SDS when R exceeds the importance factor. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

24. B — Base shear is the coefficient times effective seismic weight: V = 0.125(8,400) = 1,050 kips. The other values reflect unrelated percentages or addition rather than multiplication. Because Cs is much less than one, the base shear should be a fraction of W, providing a useful reasonableness check. That is the controlling relationship for this scenario.

25. A — Substituting the supplied values gives Ta = 0.02(64^0.75), which is approximately 0.45 second. The distractors come from using the height linearly, confusing the exponent with the result, or applying an inverse relationship. The calculation is based entirely on the equation stated in the stem. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

26. C — For k = 1, the roof numerator is 80(36) = 2,880. The denominator is 120(12)+120(24)+80(36)=7,200, so the roof fraction is 2,880/7,200 = 0.400. The other choices result from using weight or height alone, reversing a ratio, or using an incorrect denominator in the stated vertical-distribution equation. Its elevated location partly offsets the smaller roof weight in the numerator.

27. D — The vertical distribution relation is Fx = CvxV. Multiplying 0.22 by 900 gives 198 kips. The distractors correspond to dividing or adding rather than using the distribution coefficient correctly. Since Cvx is 22 percent, the floor force should be 22 percent of the base shear. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

28. B — The chord couple resists diaphragm bending, so the force equals moment divided by the separation between chord lines: 420/35 = 12 kips. The distractors use unrelated ratios, the spacing itself, or multiplication. Checking units also confirms that kip-ft divided by feet gives kips. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

29. C — Equal sharing between two identical connections gives 260/2 = 130 kips per connection. The alternatives correspond to dividing twice, assigning the full collector force to each, or doubling the total. The calculation assumes the problem statement permits equal distribution and does not introduce additional amplification factors. A quick reasonableness check supports both the magnitude and direction of the computed result.

30. D — Average unit shear is total shear divided by resisting length: 360 kips/30 ft = 12 kip/ft. The other choices arise from using an unrelated divisor, confusing the wall length with demand, or multiplying instead of dividing. Units provide an immediate check because the result must be force per length. That is the controlling relationship for this scenario.

31. B — The stated amplification gives Delta = 5.0(0.42)/1.0 = 2.10 inches. Dividing by Cd, leaving the elastic displacement unchanged, or adding Cd to the displacement does not follow the equation. The amplified drift should exceed the elastic analysis value when Cd is greater than one. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

32. A — Story drift is the relative displacement between adjacent levels, so 3.7 - 2.2 = 1.5 inches. The other values use one floor displacement alone, an unrelated difference, or addition. Seismic drift checks focus on interstory deformation rather than absolute floor movement by itself. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

33. B — Torsional moment equals force times eccentricity, so 180(6) = 1,080 kip-ft. The distractors come from division, addition, or multiplying by an unrelated factor. Units also verify the operation: kips multiplied by feet must produce kip-ft rather than force alone. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

34. C — Total force equals unit shear times tributary length: 9 kip/ft times 40 ft = 360 kips. Adding, dividing, or using only one input creates the distractors. The resulting units are kips because the length cancels the per-foot dimension in the distributed shear. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

35. D — Elastic force sharing is proportional to stiffness. The 3k wall takes 3/(3+2) of 500, which is 300 kips. The 2k wall takes 200 kips. Equal splitting would give 250 kips, while 333 kips does not match the stated stiffness ratio. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

36. A — Using the stated simplified relation, the inertial force is 0.18(1,600) = 288 kips. Ten percent gives 160, adding the coefficient as if it were kips is meaningless, and adding 288 to the weight gives 1,888 rather than the horizontal force itself. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

37. A — The axial couple needed to resist overturning is moment divided by lever arm: 9,600/24 = 400 kips. The distractors use half the result, a product with an unrelated ratio, or simple addition. The units confirm that kip-ft divided by feet yields kips. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

38. D — A large diaphragm opening can interrupt direct in-plane shear flow and change chord forces, collector demands, and local stress concentrations. The designer must establish how forces pass around the opening and reconnect to the resisting system. Finishes and plumbing fixtures do not define the structural seismic load path. That is the controlling relationship for this scenario.

39. C — Accidental eccentricity represents unavoidable uncertainty in the true locations of mass, stiffness, and force application. It is added to inherent eccentricity effects rather than replacing them. The provision does not reduce seismic weight or eliminate drift checks; it intentionally tests sensitivity to torsional response. The controlling idea is a continuous load path together with compatible strength, stiffness, and deformation capacity.

40. B — A transfer condition changes where and how seismic forces enter the lower resisting system. The diaphragm, collectors, connections, and supporting elements must carry the resulting transfer forces and deformations. Architectural appearance and drainage symmetry do not establish structural continuity through the vertical discontinuity. The other choices describe different mechanisms and do not address the seismic behavior stated in the problem.

41. D — A weak story can yield substantially before adjacent stories, concentrating drift and inelastic demand into a limited height. Collapse risk can therefore increase even without an unusually large total base shear. The condition does not control earthquake duration, eliminate diaphragm forces, or prevent torsional response. That is the controlling relationship for this scenario.

42. C — A diaphragm behaves like a deep horizontal beam. Chords near its edges resist the tension-compression couple associated with diaphragm bending, while collectors transfer shear into vertical resisting elements. Plumbing loads and soil bearing are unrelated, and chord action does not eliminate the need for collectors. That is the controlling relationship for this scenario.

43. A — A seismic load path is only as reliable as its weakest critical link. If the connection cannot transfer the collector force, failure can occur there even when the collector member itself is strong. Force does not disappear, member strength is not increased by a weak joint, and wall stiffness remains finite.

44. B — Seismic inertial force develops when the building mass is accelerated during ground motion. Heavy permanent equipment contributes to that mass and can therefore affect story forces, base shear, and dynamic characteristics. It does not eliminate inertia, and seismic mass is not limited to exterior walls or converted into wind loading.

45. D — Equal stiffness and parallel action imply equal force sharing, so 540/3 = 180 kips per frame. The distractors represent division by four, division by two, or multiplication by three. The result depends on the explicit assumption that the three frames have equal stiffness and compatible deformation. A quick reasonableness check supports both the magnitude and direction of the computed result.

46. C — The torsional moment is force times eccentricity: 210 kips times 8 ft = 1,680 kip-ft. Dividing, adding, or multiplying by ten produces the distractors. The units again confirm that the result must be a moment, not a force or dimensionless quantity. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

47. B — A stiffer vertical element tends to attract a larger share of lateral load, which can increase the forces that diaphragms and collectors must deliver to it. The new wall does not remove mass, force collectors to zero, or change the earthquake magnitude. The effect arises from redistribution of structural stiffness and load path.

48. A — Strength and deformation are distinct performance measures. A structure can have sufficient force capacity yet experience damaging relative floor movement that affects partitions, cladding, stairs, piping, or stability. Story drift therefore requires its own evaluation. It is not synonymous with base shear and is not eliminated by adequate strength alone.

49. A — The height factor is 1+2(0.5)=2.0. The numerator is 0.4(1.0)(0.80)(10)(2.0)=6.4, and dividing by 2.5 gives 2.56 kips. The distractors reflect omitting the height factor, omitting Rp, or using an incorrect divisor. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship. A quick reasonableness check supports both the magnitude and direction of the computed result.

50. B — The stated simplified check requires multiplying the component weight by 0.24: 0.24(18) = 4.32 kips. The alternatives use ten percent, divide by 2.4, or add the coefficient numerically to the weight. The result should be a fraction of component weight under the given relationship. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

51. C — Equal sharing among four identical braces gives 12/4 = 3 kips per rod. The distractors correspond to division by six, division by three, or multiplication by four. The calculation assumes the geometry and stiffness permit equal sharing as explicitly stated in the problem. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

52. D — Anchored equipment and connected piping or conduit may move differently during shaking. Flexible connections provide deformation capacity so the utility can accommodate relative displacement without tearing, leaking, or imposing unintended loads. They do not increase useful seismic mass, replace anchorage, or eliminate floor acceleration demands. That is the controlling relationship for this scenario.

53. B — A parapet above the roof experiences out-of-plane inertial force during shaking. Without positive anchorage, gravity friction alone may be inadequate to prevent sliding or overturning, creating a falling hazard. The condition does not make the parapet a diaphragm, remove roof mass, or cause soil liquefaction by itself. That is the controlling relationship for this scenario.

54. A — A tall or elevated tank develops significant overturning because horizontal inertial force acts above the support. The pedestal and anchors must therefore resist both shear and a tension-compression couple. Paint, drainage, and curing may matter in other contexts but do not replace evaluation of the seismic overturning load path. That is the controlling relationship for this scenario.

55. C — A brace is useful only if its force reaches structure capable of resisting it. Attaching to lightweight deck can introduce local deck failure or an incomplete load path unless specifically designed. Cosmetic or administrative details do not establish the structural capacity of the revised attachment. That is the controlling relationship for this scenario.

56. D — With six identical anchors sharing the force equally, each anchor carries 24/6 = 4 kips of shear. The other choices use different divisors or multiplication. Actual anchorage design may also consider tension, eccentricity, and interaction, but those effects are intentionally excluded by the simplified problem statement. A quick reasonableness check supports both the magnitude and direction of the computed result.

57. A — The building itself filters and amplifies ground motion, and upper floors can experience accelerations larger than those near the base. Component force procedures account for this elevation effect. Gravity does not reverse, concrete strength does not automatically change with elevation, and component mass remains present during shaking. That is the controlling relationship for this scenario.

58. B — A seismic separation joint exists to permit independent movement of adjacent building portions. A partition crossing the joint needs a detail that accommodates that displacement without binding or transferring unintended force. Increasing mass or rigidly bridging the joint defeats the purpose, while unrelated ceiling bracing does not solve the compatibility issue.

59. C — Moment equals force times lever arm, so 15 kips times 3 ft = 45 kip-ft. The other values come from division, addition, or squaring the force relationship. The result must have moment units, which immediately rules out any answer stated only as force. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

60. D — Perimeter clearance is useful only if other penetrations and attachments do not prevent the intended relative movement. Rigid piping or conduit can act as unintended braces, causing impact or transferring forces into the ceiling system. The condition does not eliminate mass, redefine diaphragm flexibility, or make the structural period zero.

61. B — The simplified requirement is 0.30 times the equipment weight: 0.30(30) = 9 kips. The distractors reflect ten percent, division by three, or adding 0.30 to the weight. Because the coefficient is less than one, the result should be a fraction of Wp. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

62. A — Seismic performance depends on the complete path from component mass through the cabinet, anchorage, and supporting structure. A strong cabinet can still detach if anchors or the substrate are inadequate. Anchors can resist lateral and tension forces, and cabinet strength has no role in determining geotechnical site classification. That is the controlling relationship for this scenario.

63. D — Elastic sharing is proportional to stiffness. The 6k line receives 6/(4+6) of 700, which equals 420 kips, while the 4k line receives 280 kips. Equal sharing gives 350, and 525 does not correspond to the stated stiffness ratio. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

64. C — The square-root-of-sum-of-squares combination gives sqrt(80^2+60^2)=sqrt(10,000)=100. Direct subtraction, averaging, or linear addition produces the distractors. SRSS is appropriate in this simplified problem because the modes are explicitly treated as statistically independent. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship. A quick reasonableness check supports both the magnitude and direction of the computed result.

65. A — Applying SRSS gives sqrt(30^2+40^2+0^2)=sqrt(2,500)=50. The familiar 3-4-5 relationship provides a quick check. The distractors come from averaging, linearly adding the nonzero modes, or multiplying them, none of which matches the stated combination rule. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship. That is the controlling relationship for this scenario.

66. D — The elastic displacement is force divided by stiffness: 120 kips/(24 kip/in) = 5 inches. The other choices reverse the ratio, select the stiffness value itself, or multiply force and stiffness. Unit cancellation confirms that the result must be inches. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

67. B — The circular frequency is sqrt(36/9) = sqrt(4) = 2 rad/s. The distractors correspond to reversing the ratio, taking only the square root of stiffness, or using a linear ratio. The calculation follows directly from the equation provided in the stem. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

68. C — The period is T = 2pi/5, which is approximately 1.257 seconds. The alternatives use the reciprocal without 2pi, copy omega as if it were a period, or multiply by 2pi. Units and the inverse relationship between period and frequency provide a useful check. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

69. C — A drift-based review focuses on the largest interstory deformation relative to the applicable limit. With the stated values, the second story has the larger demand and therefore controls. Being lower in the building does not automatically govern, and drift is a central seismic response quantity rather than something that can be ignored.

70. D — P-Delta effects arise because gravity loads acting through lateral displacement create secondary moments and can amplify deformation or destabilize a flexible story. The phenomenon adds to first-order response rather than eliminating it. Gravity remains present, and geometric nonlinearity means response can become more sensitive to deformation, not less. That is the controlling relationship for this scenario.

71. B — Inherent torsional moment equals floor force times eccentricity: 250(4) = 1,000 kip-ft. The other options come from division, addition, or multiplying by an incorrect factor. Because the effect is a moment, the units must be force times distance. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

72. A — If only 72 percent of participating mass is represented, a meaningful portion of dynamic response may remain in omitted modes. Additional modes should be included until the analysis captures an adequate level of participation for the method being used. The current model is therefore not automatically complete or exact. That is the controlling relationship for this scenario.

73. B — Closely spaced modes can have correlated peak responses, violating the independence assumption behind simple SRSS. Complete quadratic combination accounts for modal correlation and can therefore provide a better combination estimate. It does not make modes identical, eliminate mode shapes, or transform the problem into a gravity-only analysis. That is the controlling relationship for this scenario.

74. D — A nonlinear static pushover incrementally increases lateral demand to reveal where hinges or other inelastic actions form and how capacity evolves. It can help identify weak mechanisms and deformation concentration. It is not an architectural tool, is not limited to elastic gravity deflection, and does not determine geotechnical site class.

75. A — A major stiffness discontinuity can alter the dynamic characteristics and redistribute story forces and drifts, so it must be represented in the model. Omitting it can hide demand concentration or transfer effects. The discontinuity is not merely cosmetic, does not remove higher modes, and does not make structural mass unimportant.

76. C — Secant stiffness at the stated point is 96/0.8 = 120 kip/in. The distractors come from multiplication, subtraction, or reversing the ratio. Force divided by displacement must produce force per unit displacement, which is the correct stiffness dimension. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

77. B — For forces acting in the same direction, the support receives the sum: 140 + 220 = 360 kips. Subtraction, averaging, or multiplication creates the distractors. The problem states a common support and concurrent same-direction action, so simple addition is the appropriate equilibrium operation. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

78. C — Sixty percent of 50 kip/in is 0.60(50) = 30 kip/in. The other choices correspond to forty percent, confusing the percentage with a stiffness value, or adding instead of multiplying. Reduced effective stiffness generally increases calculated periods and deformations relative to an uncracked model. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

79. A — Opposite signs indicate movement in different directions, so the edge-to-edge differential is 2.6 - (-1.1) = 3.7 inches. The distractors use simple magnitude subtraction, one edge alone, or multiplication. This differential is relevant when evaluating diaphragm rotation and torsional deformation. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

80. D — A deformable diaphragm does not enforce identical floor translation, so its in-plane stiffness affects the path and proportion of force delivered to resisting lines and collectors. Treating it as rigid can misrepresent demand. Flexibility does not eliminate torsion or chord action, and it cannot alter the regional earthquake magnitude. That is the controlling relationship for this scenario.

81. C — Reasonable periods alone do not prove a correct model. Mode shapes help identify disconnected nodes, unintended rigid links, missing restraints, or unrealistic deformation patterns. They complement rather than replace participation and boundary-condition checks. Visual review of modal behavior is therefore a useful model-verification step in seismic analysis. That is the controlling relationship for this scenario.

82. D — Axial stiffness is force divided by deformation: 200/0.50 = 400 kip/in. The distractors use multiplication, addition, or reverse division. The stiffness dimension must be force per unit displacement, which confirms the required operation and helps screen out implausible answers. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

83. A — Widespread column hinging can concentrate inelastic deformation into a story mechanism and compromise gravity-load stability. Seismic detailing often seeks a more favorable hierarchy of yielding. The observed pattern does not automatically improve stability, prove diaphragm behavior, or eliminate geometric second-order effects such as P-Delta response. That is the controlling relationship for this scenario.

84. B — Torsionally sensitive floors can experience large changes in edge-element demand from modest shifts in mass or stiffness. Sensitivity checks help reveal that vulnerability and test robustness of the model. They do not eliminate inherent torsion, change site geology, or force equal load sharing among unequal resisting elements. That is the controlling relationship for this scenario.

85. C — The arithmetic mean is (410+455+438)/3 = 1,303/3 = 434.3 kips. The other answers select an individual record or the unaveraged sum. The problem specifically asks for a simple mean, so no envelope, scaling, or statistical combination beyond averaging is required. The remaining choices reflect common arithmetic, unit, or setup errors rather than the stated relationship.

86. A — Seismic force reaches vertical resisting systems through diaphragms, chords, collectors, and connections. Local transfer actions can be large, especially near openings, discontinuities, or changes in system alignment. Applying story shear only to walls or frames can therefore miss critical horizontal load-path demands that govern design and detailing. That is the controlling relationship for this scenario.

87. B — Frequency is the inverse of period, so the 0.25-second second mode has a higher natural frequency than the 0.8-second first mode. Longer period means lower frequency. The relationship is fundamental to vibration analysis and does not require additional information for this qualitative comparison. The other choices describe different mechanisms and do not address the seismic behavior stated in the problem.

88. D — Unintended releases or disconnected nodes can prevent force transfer that should exist, producing unrealistic periods, drifts, and member forces. Numerical output may still look orderly, so connectivity checks are essential. These errors are structural-model issues, not appearance problems, and they do not improve material strength or eliminate seismic excitation. That is the controlling relationship for this scenario.

89. B — Closely spaced transverse reinforcement improves confinement of the concrete core and braces longitudinal bars against buckling during repeated tension-compression cycles. That supports ductile deformation after cracking and yielding. Ties do not remove concrete mass, replace longitudinal flexural reinforcement, or eliminate the need for adequate development and anchorage. That is the controlling relationship for this scenario.

90. D — A field modification to a seismic connection can change strength, stiffness, stress flow, and ductility. The altered detail should therefore be evaluated against the design intent before acceptance. Cosmetic covering, low gravity load, or architectural documentation alone cannot establish that the modified connection still performs adequately under cyclic seismic demand.

91. C — Collector reinforcement can carry significant cyclic tension or compression, so the bars must be developed sufficiently to transfer that force into the wall. Inadequate embedment can cause bond failure before the intended mechanism develops. Development length is unrelated to appearance, and collectors can indeed carry substantial tension demand. That is the controlling relationship for this scenario.

92. A — Wood shear-wall capacity and stiffness depend strongly on the fastener pattern that transfers shear between sheathing and framing. Missing edge nails can reduce capacity and alter load distribution. The deficiency does not strengthen the wall, eliminate overturning hold-down demand, or affect the geotechnical classification of the site. That is the controlling relationship for this scenario.

93. C — Reinforced masonry relies on correct placement of bars, grout, and units so forces transfer through the intended composite section. Once the work is concealed, voids or misplaced reinforcement may be difficult to detect. Appearance does not define ductility, grout does not replace reinforcement, and inspection cannot change the earthquake itself.

94. A — Adhesive-anchor capacity depends on proper hole preparation so the adhesive bonds to sound concrete as intended. Residual dust can reduce bond and make capacity unreliable. The condition does not strengthen the bond, remove gravity effects, or create beneficial slab ductility, so the installation should be evaluated under the approved procedure.

95. B — Shear-wall overturning produces tension at one end and compression at the other. Hold-downs and their anchorage provide the tension path and control uplift deformation so the wall can develop its intended response. They do not serve only ceiling loads, eliminate diaphragm shear, or determine site classification. That is the controlling relationship for this scenario.

96. D — Congestion can lead to honeycombing or incomplete consolidation, but removing required seismic reinforcement is not an acceptable shortcut. The condition should be resolved through an approved detail or construction method that preserves confinement, anchorage, and force transfer. Straight forms or later paint do not correct hidden structural deficiencies. That is the controlling relationship for this scenario.

97. B — Seismic quality assurance depends on traceable documentation that critical work was observed, deficiencies were identified, and corrective actions were completed. Reports provide that record for the project team and authorities. They do not replace engineering responsibility, forecast earthquakes, or eliminate the need for approved construction documents. That is the controlling relationship for this scenario.

98. C — Cutting a collector bar can interrupt a critical seismic force path and reduce development capacity. Before concealment, an engineered revision should demonstrate how the required force is transferred around the opening and properly anchored. Appearance of the bar or ceiling has no bearing on restoring the missing structural continuity. That is the controlling relationship for this scenario.

99. A — Anchor forces must spread into surrounding concrete, and proximity to an edge can reduce the available breakout surface and resistance. Verifying edge distance therefore helps confirm that the installed anchor matches the design assumptions. It does not alter occupancy risk category, control finish coverage, or make every anchor flexible. That is the controlling relationship for this scenario.

100. D — Changing the attachment point can alter local member demand, connection strength, and the path by which seismic force reaches the structure. The revised support therefore needs engineering evaluation before acceptance. Visual centering, matching finishes, and label orientation do not establish structural adequacy under earthquake loading. Inspection should focus on details that govern continuity and cyclic performance rather than appearance alone.