PRACTICE EXAM 6: 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. Mapped short-period acceleration at a site is Ss = 1.10g. With site coefficient Fa = 1.25, calculate the site-adjusted value SMS = FaSs.

A. 0.880g
B. 1.375g
C. 1.100g
D. 2.350g

2. A site-adjusted short-period ordinate SMS is 1.29g. Applying the stated design-spectrum conversion SDS = 2SMS/3, what design ordinate results?

A. 0.43g
B. 1.29g
C. 0.86g
D. 1.94g

3. A proposed structure straddles a mapped active fault trace. Which seismic hazard is most directly associated with that condition?

A. Permanent ground offset across the site
B. Only increased wind pressure on the roof
C. Only higher floor live-load demand

D. Only reduced concrete shrinkage strain

4. An existing warehouse is converted to a facility that must remain operational for emergency response. Which seismic design input is most directly reconsidered because of the occupancy change?

A. Mapped spectral acceleration at the site
B. Soil shear-wave velocity by itself
C. Nominal steel yield strength by itself
D. Risk category and importance provisions

5. Mapped one-second acceleration S1 = 0.44g is modified by site coefficient Fv = 1.70. Using SM1 = FvS1, determine the adjusted one-second ordinate.

A. 0.748g
B. 0.259g
C. 0.440g
D. 2.140g

6. Which subsurface profile is most susceptible to cyclic pore-pressure buildup and loss of effective stress during earthquake shaking?

A. Dense dry gravel above groundwater
B. Massive competent rock near the surface
C. Dry stiff clay with low saturation
D. Loose saturated granular soil with a high groundwater table

7. Why might a project require a site-specific ground-motion study rather than relying only on generalized mapped values?

A. To choose the architectural finish color
B. To eliminate structural load combinations

C. To better characterize unusual local hazard or site-response conditions
D. To replace all material testing requirements

8. Which two categories of information are fundamentally combined when assigning a seismic design category?

A. Roof slope and drainage area
B. Seismic demand and occupancy-related risk
C. Concrete slump and curing time
D. Column spacing and ceiling height

9. Two idealized buildings have the same mass. Building P has four times the lateral stiffness of Building Q. Using T proportional to sqrt(m/k), what is TP/TQ?

A. 0.25
B. 1.00
C. 2.00
D. 0.50

10. A diaphragm is very flexible in its own plane compared with the vertical lateral systems. How is direct lateral force commonly distributed conceptually?

A. Primarily by tributary area to the resisting lines
B. Only by the stiffness of every frame
C. Equally to all frames regardless of location
D. Only to the frame nearest the center of mass

11. What response is most likely when the center of mass is significantly offset from the center of rigidity?

A. Pure vertical vibration with no lateral drift

B. Elimination of member force redistribution
C. Translation accompanied by torsional rotation
D. Perfectly uniform drift at every plan location

12. What practical advantage does a redundant lateral system provide when earthquake damage reduces the capacity of one resisting element?

A. It eliminates all inelastic deformation
B. It provides alternate force paths if one element is damaged
C. It guarantees zero residual drift
D. It makes connection detailing unnecessary

13. For otherwise similar oscillators, what is the general effect of increasing viscous damping?

A. Reduced resonant response amplitude
B. Longer mass with unchanged dynamics
C. Automatic increase in seismic weight
D. Elimination of natural frequency

14. What is the intent of a strong-column, weak-beam philosophy in a ductile moment frame?

A. Force column hinging at every floor
B. Prevent all yielding in the frame
C. Concentrate damage in beam-column panel zones only
D. Favor beam yielding while reducing story-mechanism risk

15. A lateral system becomes substantially stiffer while mass stays approximately unchanged. What change is most directly expected?

A. Longer natural period
B. Shorter natural period

C. No change in natural period
D. Natural period becomes equal to damping ratio

16. Why can a sudden loss of lateral stiffness at one story be especially damaging during an earthquake?

A. It guarantees equal drift over the height
B. It reduces story shear to zero
C. It concentrates drift and inelastic demand at that level
D. It eliminates P-delta sensitivity

17. An existing open-front first story is much more flexible than the stories above. Which retrofit objective most directly addresses the vulnerability?

A. Add lateral stiffness and strength at the weak story
B. Add roof ballast to increase inertia
C. Remove diaphragm collectors above
D. Reduce foundation contact area

18. Which feature is a primary seismic vulnerability of an unreinforced masonry bearing wall building?

A. Excessive ductility of masonry walls
B. Brittle wall failure and poor out-of-plane anchorage
C. Too much reinforcing confinement
D. Automatic overstrength in all connections

19. A pre-1970 concrete frame has columns with widely spaced transverse reinforcement near potential plastic-hinge regions. What retrofit concern does this most directly indicate?

A. Excessive damping from too many ties
B. Unnecessary diaphragm flexibility
C. Inadequate confinement and shear resistance under cyclic loading

D. Excessive foundation embedment

20. A tilt-up building has adequate wall panels but weak wall-to-roof diaphragm connections. Which retrofit action most directly improves seismic performance?

A. Increase roof dead load
B. Reduce the number of roof collectors
C. Add architectural veneer to the panels
D. Strengthen the wall-to-diaphragm anchorage and continuity ties

21. Two adjacent buildings have little separation and noticeably different heights and periods. Which earthquake damage mechanism deserves specific evaluation?

A. Only long-term concrete creep
B. Pounding from incompatible lateral movement
C. Automatic phase synchronization
D. Only differential roof drainage

22. A shallow foundation bears on a potentially liquefiable layer. Which improvement strategy most directly addresses the geotechnical seismic vulnerability?

A. Add heavier suspended ceilings above the foundation
B. Reduce beam reinforcement in the superstructure
C. Remove diaphragm chords from the roof system
D. Improve the soil or bypass the weak layer

23. A building has effective seismic weight W = 5,250 kips and uses Cs = 0.082. Determine base shear from V = CsW.

A. 64.0 kips
B. 382.0 kips

C. 430.5 kips
D. 640.5 kips

24. A preliminary ELF check uses Cs = SDS Ie/R. With SDS = 1.05, Ie = 1.0, and R = 7.0, what coefficient results?

A. 0.150
B. 0.067
C. 0.540
D. 6.667

25. Vertical force distribution for a three-level building uses weighting terms of 2,400, 4,800, and 7,200 kip-ft. What fraction of base shear is assigned to the lowest level?

A. 0.250
B. 0.333
C. 0.167
D. 0.500

26. A 620-kip base shear is vertically distributed. One floor has distribution coefficient Cvx = 0.31. Determine that floor's lateral force contribution.

A. 124.0 kips
B. 200.0 kips
C. 427.8 kips
D. 192.2 kips

27. Floor forces from roof downward are 88, 72, 57, and 43 kips. What story shear acts immediately below the third level from the roof?

A. 88 kips

B. 217 kips
C. 160 kips
D. 260 kips

28. Lateral forces of 60, 90, and 130 kips act at elevations of 15, 30, and 45 ft. What base overturning moment results?

A. 9,450 kip-ft
B. 4,200 kip-ft
C. 7,650 kip-ft
D. 12,600 kip-ft

29. A story shear of 410 kips acts with a total eccentricity of 6.0 ft. What torsional moment is produced at that level?

A. 2,460 kip-ft
B. 68.3 kip-ft
C. 416 kip-ft
D. 4,920 kip-ft

30. For this problem, accidental eccentricity is 5% of the 84-ft plan dimension perpendicular to loading. What eccentricity is used?

A. 1.7 ft
B. 4.2 ft
C. 5.0 ft
D. 16.8 ft

31. A rigid diaphragm delivers 720 kips of direct shear to three frames with stiffnesses 18, 30, and 42 units. Neglect torsion. What direct shear goes to the 30-unit frame?

A. 144 kips
B. 336 kips
C. 400 kips
D. 240 kips

32. A diaphragm develops an in-plane bending moment of 1,800 kip-ft. If the effective chord spacing is 60 ft, what chord force follows from F = M/d?

A. 18 kips
B. 60 kips
C. 30 kips
D. 108 kips

33. A drag strut receives a uniform diaphragm transfer of 3.1 kips/ft from a 28-ft tributary strip. What axial force accumulates at the strut termination?

A. 9.0 kips
B. 31.1 kips
C. 86.8 kips
D. 112.0 kips

34. A vertical earthquake term is defined here by Ev = 0.2SDSD. For D = 1,100 kips and SDS = 0.75, determine Ev.

A. 165 kips
B. 82.5 kips
C. 220 kips
D. 825 kips

35. A load combination requires E = rhoQE + Ev. With QE = 115 kips, rho = 1.3, and Ev = 30 kips, evaluate E.

A. 145.0 kips
B. 149.5 kips
C. 188.5 kips
D. 179.5 kips

36. An overstrength load effect is evaluated as Em = Omega0QE + Ev. Use Omega0 = 2.5, QE = 72 kips, and Ev = 18 kips.

A. 162 kips
B. 198 kips
C. 180 kips
D. 252 kips

37. A 2,100 kip-ft overturning moment is resisted by two vertical reaction lines 35 ft apart. Neglect other effects. What equal tension/compression force couple is required?

A. 30 kips
B. 60 kips
C. 73.5 kips
D. 120 kips

38. A building has seismic weight W = 8,000 kips and base shear V = 560 kips. What is the ratio V/W?

A. 0.070
B. 0.007
C. 0.140
D. 14.286

39. For this problem, diaphragm design force is Fpx = 0.18wpx. If the tributary seismic weight wpx is 1,350 kips, what is Fpx?

A. 75 kips
B. 180 kips
C. 750 kips
D. 243 kips

40. For a simplified torsion check, use line force Ft = Mt r/J. If Mt = 3,000 kip-ft, r = 20 ft, and J = 1,500 ft^2, what is Ft?

A. 2.0 kips
B. 100 kips
C. 40 kips
D. 225 kips

41. A rigid diaphragm sends 500 kips of direct shear to two frames with lateral stiffnesses 35 and 65 units. Neglect torsion. What direct shear goes to the stiffer frame?

A. 175 kips
B. 250 kips
C. 325 kips
D. 465 kips

42. A story is 13 ft high. If the allowable drift for this problem is 0.020 times story height, what maximum drift is permitted?

A. 0.26 in.
B. 3.12 in.
C. 2.60 in.
D. 6.24 in.

43. A diaphragm carries 525 kips across an effective resisting width of 75 ft. What average unit shear V/L results?

A. 7.0 kips/ft
B. 0.14 kips/ft
C. 39.4 kips/ft
D. 450 kips/ft

44. Roof and floor forces above a selected story total 305 kips. An additional 55-kip floor force lies below the cut. What story shear acts at the selected story?

A. 55 kips
B. 250 kips
C. 360 kips
D. 305 kips

45. For this problem, the analytical period used in ELF design may not exceed CuTa. If Ta = 0.62 s and Cu = 1.40, what is the period cap?

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

46. For this problem, combine orthogonal effects as 100% of Ex plus 30% of Ey. If Ex = 140 kips and Ey = 80 kips act in the same sign, what combined effect is used?

A. 122 kips
B. 164 kips
C. 220 kips
D. 244 kips

47. Which building element primarily carries diaphragm in-plane bending through a tension-compression couple along opposite edges?

A. Interior gravity columns only
B. Roof membrane insulation
C. Diaphragm chords
D. Nonstructural partition tracks

48. What is the principal seismic purpose of a collector in a building diaphragm?

A. Increase floor live-load capacity throughout the building
B. Reduce mapped spectral acceleration at the site
C. Provide architectural fire separation between floor areas
D. Transfer diaphragm force to the vertical seismic system

49. A rooftop component is checked with Fp = [0.4apSDSWp/(Rp/Ip)](1+2z/h). Use ap=1.25, SDS=0.80, Wp=14 kips, Rp=3.5, Ip=1.0, and z/h=0.25. What is Fp before limits?

A. 2.40 kips
B. 1.60 kips
C. 3.20 kips
D. 4.80 kips

50. For this problem, the minimum component force is Fp,min = 0.3SDSIpWp. If SDS=1.0, Ip=1.5, and Wp=20 kips, what is the minimum?

A. 4.0 kips
B. 6.0 kips
C. 9.0 kips
D. 30.0 kips

51. For this problem, the maximum component force is Fp,max = 1.6SDSIpWp. If SDS=0.80, Ip=1.0, and Wp=15 kips, what is the maximum?

A. 7.5 kips
B. 12.0 kips
C. 30.0 kips
D. 19.2 kips

52. In the component-force expression given in the prior questions, what happens when z/h increases while all other inputs remain fixed?

A. The force decreases because component weight decreases
B. The calculated force increases because the height multiplier increases
C. The force is unchanged because elevation is ignored
D. The force becomes equal to the building base shear

53. All other component parameters remain unchanged. What is the direct effect of increasing the component importance factor Ip in the stated Fp equation?

A. It always decreases the component force
B. It removes the need for anchorage
C. It increases the component design force
D. It changes the geotechnical site class

54. What is the most important seismic function of equipment anchorage to a concrete support?

A. Transfer equipment inertia forces into the supporting structure
B. Increase the equipment operating speed
C. Reduce the mapped site hazard
D. Replace all gravity supports

55. For a tall liquid-storage tank, which dynamic behavior may require consideration in addition to the tank shell and support inertia?

A. Only steady hydrostatic pressure with no motion
B. Convective sloshing of the liquid
C. Automatic elimination of overturning
D. Only thermal expansion of the roof

56. A cantilevered sign support has a horizontal seismic force of 18 kips acting 22 ft above its base. What overturning moment does the force produce?

A. 40 kip-ft
B. 198 kip-ft
C. 792 kip-ft
D. 396 kip-ft

57. Why must a heavy roof-edge parapet have a positive structural attachment rather than relying on self-weight or friction?

A. To increase roof drainage capacity
B. To reduce foundation settlement directly
C. To prevent out-of-plane instability and transfer inertia forces
D. To eliminate diaphragm deformation

58. What is the principal seismic reason for providing flexible connections in piping that crosses a building seismic joint?

A. Increase fluid density during shaking
B. Make the joint structurally rigid
C. Eliminate pipe supports on both sides
D. Accommodate relative movement without rupturing the piping

59. What does lateral bracing of a suspended ceiling or overhead service primarily accomplish during an earthquake?

A. Limits lateral movement and transfers inertia forces to the structure
B. Changes the building risk category
C. Eliminates the need for vertical hangers
D. Reduces the site spectral acceleration

60. For this problem, a storage rack weighs 90 kips and is assigned a horizontal seismic coefficient of 0.22. What lateral force is used?

A. 4.1 kips
B. 19.8 kips
C. 20.2 kips
D. 112.0 kips

61. What is a primary earthquake vulnerability of heavy floor-mounted equipment that is not positively anchored?

A. Sliding or overturning that can damage the equipment and utilities
B. Automatic reduction of inertia force to zero
C. Permanent increase in floor stiffness
D. Guaranteed isolation from attached piping

62. Why are both bracing and flexible joints often important in distributed mechanical or piping systems?

A. Both are used only to increase gravity capacity
B. Bracing transfers inertia while flexibility accommodates differential movement
C. Bracing eliminates all support reactions
D. Flexible joints replace every anchor in the system

63. For this problem, use Ta = Ct hn^x with Ct = 0.03, hn = 64 ft, and x = 0.75. What approximate period Ta results?

A. 0.24 s
B. 1.92 s
C. 4.80 s
D. 0.68 s

64. For this problem, linearly interpolate spectral acceleration between Sa=1.0g at T=0.5 s and Sa=0.6g at T=1.0 s. What is Sa at T=0.75 s?

A. 0.40g
B. 0.60g
C. 0.80g
D. 1.20g

65. In modal response-spectrum analysis, what does a modal participation factor describe conceptually?

A. The concrete strength assigned to that mode
B. How strongly a vibration mode is excited by the ground-motion direction
C. The number of bolts in a modal connection
D. The soil bearing pressure under one column

66. Two well-separated modal responses to the same quantity are 30 and 40 units. Using SRSS, what combined response is obtained?

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

67. Why is CQC often preferred over simple SRSS when important modes have closely spaced natural frequencies?

A. It ignores damping entirely
B. It converts dynamic analysis into gravity design
C. It accounts for correlation between closely spaced modal responses
D. It forces all modal peaks to occur at zero time

68. Why must enough modes be included in a response-spectrum model to capture most of the participating mass?

A. To make every mode have the same period
B. To eliminate the need for a mass model
C. To guarantee zero torsional response
D. To represent the important dynamic response of the structure

69. For this problem, amplified displacement is delta = Cd deltae / Ie. If Cd = 5.0, deltae = 0.42 in., and Ie = 1.0, what is delta?

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

70. For this problem, use theta = Px Delta Ie/(Vx hsx Cd). If Px=1,800 kips, Delta=1.5 in., Ie=1.0, Vx=400 kips, hsx=144 in., and Cd=5.0, what is theta?

A. 0.0094
B. 0.0019
C. 0.0469
D. 0.0938

71. Why may response-spectrum results be scaled upward when their base shear is below a required minimum?

A. To make all mode shapes identical
B. To remove accidental torsion
C. To maintain a minimum overall design-force level while retaining dynamic distribution
D. To force the analytical period to zero

72. Which building is generally the best candidate for an equivalent lateral force procedure rather than a more advanced dynamic analysis?

A. A very tall irregular structure with strong higher modes
B. A regular low-rise structure within the procedure's applicability limits
C. A structure requiring nonlinear response-history analysis
D. A highly torsionally irregular tower outside simplified limits

73. Why is accidental torsion included in a three-dimensional seismic analysis even when calculated mass and stiffness centers coincide?

A. To eliminate all calculated torsional response
B. To replace the direct translational force
C. To simulate only construction dead load
D. To account for uncertainty in actual mass, stiffness, and loading distribution

74. How can a flexible diaphragm affect the analytical distribution of seismic forces compared with a rigid-diaphragm assumption?

A. It forces identical displacement at every plan point
B. It eliminates the need to model vertical frames
C. It permits greater in-plane deformation and more tributary-based force distribution
D. It automatically removes torsion from the building

75. For this problem, two seismic subsystems act in series with lateral stiffnesses k1=60 and k2=90 kips/in. Using 1/keq = 1/k1 + 1/k2, what is keq?

A. 60 kips/in.
B. 36 kips/in.
C. 75 kips/in.
D. 150 kips/in.

76. If R is increased while SDS, Ie, and all other inputs in Cs = SDS/(R/Ie) remain unchanged, what happens to the calculated elastic-design coefficient Cs?

A. Cs decreases
B. Cs increases
C. Cs remains unchanged
D. Cs becomes equal to R

77. If Ie is increased while SDS and R remain fixed in Cs = SDS/(R/Ie), what happens to Cs?

A. Cs decreases
B. Cs remains unchanged
C. Cs increases
D. Cs becomes zero

78. If Cd increases while elastic displacement deltae and Ie remain fixed in delta = Cd deltae/Ie, what happens to the amplified displacement?

A. It increases in direct proportion to Cd
B. It decreases in inverse proportion to Cd
C. It remains unchanged
D. It becomes equal to the base shear

79. What is a principal purpose of an overstrength factor Omega0 in seismic design?

A. Reduce ordinary member forces below design demand

B. Protect force-transfer elements for overstrength-level demand
C. Replace required ductile detailing in yielding members
D. Set the geotechnical site classification for analysis

80. What is the main analytical purpose of a redundancy factor rho when it is applicable?

A. Measure viscous damping directly
B. Calculate soil liquefaction resistance
C. Set the concrete modulus of elasticity
D. Reflect the reliability of having multiple seismic load paths

81. Why can a severe vertical or plan irregularity require a more rigorous seismic analysis procedure?

A. Because irregularity eliminates inertia forces
B. Because all irregular buildings have zero torsion
C. Because irregularity makes material strength irrelevant
D. Because simplified assumptions may not capture concentrated or coupled dynamic response

82. Under a flexible-diaphragm idealization, what primarily governs the direct force delivered to parallel wall lines?

A. Only their relative lateral stiffness
B. Only their distance from the center of rigidity
C. Their tributary diaphragm loading
D. An equal force split regardless of tributary area

83. What is the purpose of torsional amplification in a structure with pronounced torsional response?

A. Reduce direct story shear to zero
B. Increase design torsion to reflect amplified edge deformation and force concentration
C. Remove accidental eccentricity

D. Make all resisting lines carry equal force

84. A mode shape has large deformation in upper stories but little motion near the base. What does that observation suggest about higher-mode effects?

A. Higher modes may govern important upper-level forces and accelerations
B. Higher modes cannot significantly affect any building response
C. The building effectively has no meaningful natural period
D. Foundation settlement alone controls the upper-level response

85. For this problem, vertical seismic effect is taken as 0.2SDSD. If SDS doubles while D is unchanged, what happens to that effect?

A. It halves
B. It remains unchanged
C. It increases by a factor of four
D. It doubles

86. In nonlinear response-history analysis, why must the selected and scaled ground motions be compatible with the seismic hazard being evaluated?

A. So every record has identical acceleration values
B. So structural yielding is prevented
C. So the analyses represent an appropriate intensity and frequency-content range
D. So the building mass can be omitted

87. A structure has modal responses of 20, 30, and 60 units. Using SRSS for this problem, what combined response results?

A. 36.7 units
B. 70 units

C. 110 units
D. 3,600 units

88. For this problem, first-mode period is estimated from T = 2pi sqrt(m/k). If m/k = 0.010 s^2, what is T?

A. 0.063 s
B. 0.628 s
C. 0.100 s
D. 6.283 s

89. Why is special inspection important for designated seismic welds in a steel lateral system?

A. Verify materials, procedures, workmanship, and required weld execution
B. Replace the engineer of record
C. Eliminate the need for approved drawings
D. Allow unqualified welding procedures

90. For a bolted seismic connection, which field condition most directly deserves quality-control attention?

A. Architectural paint sheen only
B. Temporary office furniture layout
C. Required bolt type, installation, pretension, and connected-part condition
D. Roof drainage color coding

91. In a reinforced-concrete seismic boundary region, why is correct placement of transverse reinforcement especially important?

A. Provide confinement and resist cyclic shear and bar buckling
B. Increase the mapped ground acceleration used for design

C. Prevent all concrete cracking during strong earthquake response
D. Replace longitudinal reinforcement in the boundary region

92. What should an inspector verify in reinforced masonry that forms part of the seismic force-resisting system?

A. Verify only the exterior masonry paint and finish
B. Verify only the temporary scaffolding and access system
C. Verify only the architectural room numbering and signage
D. Verify reinforcement, grout placement, and required continuity

93. Why are edge nailing and boundary fastening important in a wood structural panel diaphragm or shear wall?

A. Transfer panel shear into framing along the load path
B. Determine mapped spectral values used for site hazard
C. Eliminate all need for overturning anchorage at boundaries
D. Make collector connections unnecessary in the diaphragm system

94. A hold-down anchor is installed with a different edge distance than shown on the approved structural drawings. What is the best seismic-quality-control response?

A. Assume the change has no effect
B. Cover the anchor and document it later
C. Remove adjacent shear-wall nailing instead
D. Have the design professional evaluate and approve the condition before concealment

95. A contractor proposes relocating a collector splice away from the location detailed on the drawings. What should occur before the change is made?

A. The splice may be moved anywhere without review

B. The engineer responsible for the design should evaluate the revised force-transfer condition
C. The collector may be omitted if the floor is level
D. Only the architectural consultant needs to approve it

96. Why can post-installed concrete anchors used for seismic bracing require special attention during installation?

A. They are unaffected by installation quality
B. They eliminate concrete breakout concerns
C. Performance depends on correct hole preparation, embedment, product, and installation procedure
D. They automatically develop the strength of the attached member

97. A nonstructural utility crosses a building seismic separation joint. What construction detail should be verified?

A. The utility is rigidly clamped across the gap
B. The joint is filled solid with grout
C. All supports on one side are removed
D. The installed joint connection can accommodate the required relative movement

98. For a special steel moment-frame connection, why is control of welding procedure and access-hole or connection geometry important?

A. Poor execution can reduce the intended ductile connection behavior
B. It changes the building site class
C. It removes the need for beam-column design
D. It guarantees perfectly elastic response

99. During inspection of a wood diaphragm, several boundary fasteners are missing near a collector connection. Why is this significant?

A. They only alter architectural appearance near the collector
B. They reduce the mapped earthquake hazard at the site
C. They can interrupt shear transfer into the collector
D. They automatically increase useful diaphragm ductility and strength

100. What is the seismic value of accurate as-built documentation for approved field changes to lateral-system connections?

A. It replaces all special-inspection and testing reports for construction
B. It records the final load path for future evaluation
C. It guarantees the structure cannot be damaged by earthquakes
D. It eliminates the need for future engineering review or judgment

Practice Exam 6: Answer Key and Explanations

1. B — Multiplying the mapped short-period value by the site coefficient gives SMS = 1.25(1.10g) = 1.375g. Dividing produces 0.880g, leaving Ss unchanged ignores the site adjustment, and adding the two inputs gives 2.350g without following the stated relation. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

2. C — The design short-period value is two-thirds of the stated maximum-considered value: SDS = (2/3)(1.29g) = 0.86g. One-third gives 0.43g, retaining 1.29g skips the conversion, and multiplying by 1.5 gives about 1.94g rather than applying the stated factor. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

3. A — A fault trace crossing the footprint raises concern for surface rupture and permanent differential ground displacement. That mechanism differs from ordinary inertial shaking because the ground itself may be offset beneath the foundation. Wind pressure, floor live load, and concrete shrinkage are unrelated to the mapped fault-crossing condition. This relationship is the controlling check for the seismic condition described.

4. D — The occupancy change affects the consequences of failure and the required reliability of the facility, so risk category and related importance provisions must be reconsidered. The geographic hazard, soil properties, and nominal material strengths do not change simply because the building use becomes more critical. A dimensional and physical check supports the same conclusion for the stated problem.

5. A — Applying the stated relation gives SM1 = 1.70(0.44g) = 0.748g. Dividing gives about 0.259g, leaving the mapped value unchanged ignores the site coefficient, and adding the two numbers gives 2.140g, which is not the operation specified in the stem. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

6. D — Liquefaction susceptibility is greatest when loose granular soil is saturated and subjected to cyclic shaking that can raise pore-water pressure and reduce effective stress. Dense dry gravel, competent rock, and dry stiff clay do not present the same classic combination of saturation, loose fabric, and contractive granular behavior. This relationship is the controlling check for the seismic condition described.

7. C — A site-specific study can refine ground-motion characterization when local geology, near-fault effects, unusual soil response, or other conditions are not adequately represented by generalized inputs. Architectural finishes, load combinations, and material testing are separate project decisions. The study addresses seismic hazard and site response rather than construction appearance or quality control.

8. B — Seismic design category links the severity of expected seismic demand with the consequences associated with the building occupancy or function. Roof drainage, concrete placement properties, and architectural dimensions may affect design elsewhere, but they do not form the fundamental hazard-and-risk combination used for seismic classification. This distinction is important when checking the intended seismic load path and response.

9. D — With equal mass, period varies inversely with the square root of stiffness. Therefore TP/TQ = sqrt(kQ/kP) = sqrt(1/4) = 0.50. A fourfold stiffness increase does not quarter the period; it reduces the period by the square root of four. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

10. A — A very flexible diaphragm does not enforce nearly rigid in-plane compatibility among all resisting lines. Direct force is therefore associated primarily with tributary loading rather than stiffness-proportional rigid-diaphragm distribution. Equal sharing or assigning force only by location ignores the diaphragm deformation that controls the load path. This relationship is the controlling check for the seismic condition described.

11. C — An offset between mass and stiffness creates an eccentric inertia-force path. Lateral translation then produces a torsional moment, causing different plan locations to experience different displacements and resisting-line demands. The system does not respond as a purely translating or purely vertical oscillator, and force distribution becomes less uniform. This relationship is the controlling check for the seismic condition described.

12. B — Redundancy allows earthquake forces to be redistributed through multiple elements or load paths when individual components yield or are damaged. It does not eliminate inelastic response or residual deformation, and it cannot substitute for proper connection detailing. The benefit is improved robustness rather than immunity from damage. This distinction is important when checking the intended seismic load path and response.

13. A — Greater damping dissipates more vibration energy per cycle and generally reduces response amplitude near resonance. It does not change the physical mass or eliminate the system's natural frequency. Damping modifies how strongly the structure responds to dynamic excitation rather than removing its basic stiffness-and-mass characteristics. This distinction is important when checking the intended seismic load path and response.

14. D — The philosophy seeks a distributed, ductile yielding mechanism in beams while reducing the chance that columns lose strength over a full story and form a dangerous sidesway mechanism. It does not prohibit all yielding, require column hinging, or intentionally concentrate damage in panel zones. Capacity hierarchy controls where inelastic action is preferred.

15. B — Natural period depends on both mass and stiffness. With mass essentially unchanged, increasing lateral stiffness increases the vibration frequency and therefore shortens the period. The period is not independent of stiffness, and it is not numerically equivalent to a damping ratio, which is a separate dimensionless response property. This relationship is the controlling check for the seismic condition described.

16. C — A soft or weak story attracts disproportionate deformation because neighboring levels are relatively stiffer or stronger. Concentrated drift can damage columns, walls, partitions, and connections and may amplify second-order effects. The condition does not equalize drift or remove story shear, and it can increase rather than eliminate P-delta sensitivity. This relationship is the controlling check for the seismic condition described.

17. A — The primary deficiency is concentration of deformation in the open first story. Adding appropriately detailed lateral elements can increase both stiffness and strength where they are lacking and reduce story-drift concentration. Added mass increases seismic inertia, removing collectors damages the load path, and reducing foundation area does not address the story mechanism.

18. B — Unreinforced masonry has limited tensile capacity and ductility, making brittle cracking and wall instability important concerns. Weak or missing wall-to-diaphragm anchorage can also permit out-of-plane wall failure. The system is not vulnerable because it has excessive reinforcement or ductility; the problem is insufficient ductile reinforcement and connection capacity. This relationship is the controlling check for the seismic condition described.

19. C — Sparse transverse reinforcement can lead to poor core confinement, bar buckling, and brittle shear degradation when columns experience cyclic inelastic demands. The issue is not excessive damping or diaphragm flexibility. Retrofit measures commonly target confinement and shear capacity so the column can sustain deformation without abrupt loss of gravity-load support.

20. D — When wall panels are adequate but their anchorage is weak, the critical load-path deficiency is force transfer between the walls and diaphragm. Strengthening anchorage and continuity ties directly addresses that vulnerability. Added roof mass increases inertia, fewer collectors reduce force-transfer reliability, and veneer does not restore the structural connection. This relationship is the controlling check for the seismic condition described.

21. B — Adjacent structures can move out of phase during strong shaking. If the separation gap is too small, floors or frames may impact, creating concentrated local forces and damage. Their differing periods and heights make compatible motion unlikely. Concrete creep and roof drainage are unrelated, while automatic synchronization should not be assumed.

22. D — Liquefaction can reduce soil stiffness and bearing resistance while causing settlement or lateral movement. Ground improvement can reduce susceptibility, and deep foundations may transfer loads to more competent strata when appropriate. Ceiling weight, beam reinforcement, and diaphragm chords do not change the weak soil mechanism that threatens foundation support and deformation compatibility.

23. C — Using the stated relation, V = 0.082(5,250) = 430.5 kips. The other choices reflect division, a different coefficient, or misplaced decimal arithmetic. Since Cs is dimensionless and W is a force, the product is a force representing the total design seismic shear at the base. This distinction is important when checking the intended seismic load path and response.

24. A — Writing the stated relation as Cs = SDS Ie/R gives Cs = 1.05(1.0)/7.0 = 0.150. The other choices represent an inverted ratio, an incorrect product, or a misplaced decimal. The coefficient is dimensionless and would next be multiplied by effective seismic weight to obtain base shear. The alternatives reflect common setup errors.

25. C — The total is 2,400 + 4,800 + 7,200 = 14,400 kip-ft. The lowest-level fraction is 2,400/14,400 = 1/6, or about 0.167. The other choices assign a larger share than the stated weighting permits. The common units cancel, leaving a dimensionless vertical-distribution coefficient. This relationship is the controlling check for the seismic condition described.

26. D — The assigned floor force is Fx = CvxV = 0.31(620) = 192.2 kips. The 427.8-kip choice is the remainder of the base shear rather than this floor's share. The other values use different fractions or rounding not supported by the stated coefficient. That reasoning also explains why the remaining choices do not fit the stated seismic mechanism.

27. B — Story shear at a cut equals the sum of the lateral forces at and above that cut. Immediately below the third level from the roof, the applicable forces are 88 + 72 + 57 = 217 kips. The smaller choices omit one or more upper-level forces, while 260 kips includes the force below the cut.

28. A — Summing moments about the base gives 60(15) + 90(30) + 130(45) = 900 + 2,700 + 5,850 = 9,450 kip-ft. Each floor force contributes according to its lever arm. The distractors omit a term, use an incorrect height, or apply an incorrect multiplier. This distinction is important when checking the intended seismic load path and response.

29. A — The torsional moment is story shear times eccentricity: 410 kips x 6.0 ft = 2,460 kip-ft. Dividing produces about 68.3, adding the inputs gives a dimensionally invalid result, and 4,920 doubles the correct value. This moment accompanies the direct translational shear and must be distributed to resisting lines. This relationship is the controlling check for the seismic condition described.

30. B — Applying the percentage stated in the problem gives e = 0.05(84 ft) = 4.2 ft. Five percent is a ratio, not a fixed five-foot offset. The 1.7-ft and 16.8-ft choices correspond to different percentages and do not follow the stated assumption. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

31. D — The total stiffness is 18 + 30 + 42 = 90 units. With rigid-diaphragm translation and torsion neglected, the 30-unit frame receives 30/90 of 720 kips, or 240 kips. The other choices correspond to different stiffness fractions or arithmetic. Direct shear is distributed in proportion to lateral stiffness under the stated idealization.

32. C — Using the diaphragm beam analogy, the chord couple resists the in-plane bending moment. F = M/d = 1,800/60 = 30 kips. The 60-kip option repeats the spacing numerically, while 18 and 108 kips do not satisfy the stated relation. Opposite chords develop tension and compression to form the resisting couple.

33. C — The accumulated axial force is the distributed transfer times its tributary length: 3.1 kips/ft x 28 ft = 86.8 kips. Adding or dividing the inputs does not give the correct units, and 112 kips uses an unrelated multiplier. The collector end connection must be capable of transferring the accumulated force into the vertical system.

34. A — Substitution gives Ev = 0.2(0.75)(1,100) = 165 kips. The 82.5-kip value uses half of the required factor, 220 kips omits SDS, and 825 kips omits the 0.2 coefficient. The stated relation produces a vertical earthquake load effect from the dead-load term. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

35. D — First apply the redundancy factor to the horizontal effect: 1.3(115) = 149.5 kips. Adding Ev gives E = 149.5 + 30 = 179.5 kips. The distractors omit a factor, stop at the intermediate value, or combine the terms incorrectly. Both terms are force effects, so they can be added directly.

36. B — The amplified horizontal effect is 2.5(72) = 180 kips. Adding the stated vertical effect gives Em = 180 + 18 = 198 kips. The 180-kip choice stops before adding Ev, while the other values use different combinations. The calculation illustrates how an overstrength-related horizontal demand is combined with the vertical seismic term.

37. B — A force couple separated by distance d resists moment M = Fd. Therefore F = 2,100/35 = 60 kips. The tension and compression reactions are equal and opposite in the simplified couple. The other values result from doubling, halving, or using an incorrect ratio. The result is consistent with the force path and deformation behavior described in the problem.

38. A — The ratio is V/W = 560/8,000 = 0.070. It is dimensionless because both numerator and denominator are forces. A misplaced decimal gives 0.007, doubling the correct ratio gives 0.140, and the inverse produces about 14.286. Multiplying 0.070 by 8,000 provides a quick check by recovering 560 kips. This distinction is important when checking the intended seismic load path and response.

39. D — Using the relation supplied in the stem, Fpx = 0.18(1,350) = 243 kips. The distractors use different percentages or confuse the coefficient with a force. Because 0.18 is dimensionless and wpx is a force, the result is a force that represents the stated diaphragm design demand. A dimensional and physical check supports the same conclusion for the stated problem.

40. C — Substitution gives Ft = 3,000(20)/1,500 = 40 kips. The units reduce to force because kip-ft times ft divided by ft squared leaves kips. The alternatives result from dividing by r, omitting J, or using an unrelated combination. The expression represents the torsional increment at the stated resisting line. This relationship is the controlling check for the seismic condition described.

41. C — The combined stiffness is 100 units, so the 65-unit frame takes 65 percent of the direct shear: 0.65(500) = 325 kips. The 175-kip value belongs to the 35-unit frame, 250 assumes equal stiffness, and 465 kips exceeds the stated stiffness proportion. Rigid-diaphragm translation gives stiffness-proportional direct distribution. This distinction is important when checking the intended seismic load path and response.

42. B — Convert the story height to inches: 13 ft x 12 = 156 in. The stated limit is 0.020(156) = 3.12 in. The 0.26-in. choice fails to convert units correctly, 2.60 uses a different ratio, and 6.24 doubles the permitted drift. Consistent units are essential when applying a drift ratio. This relationship is the controlling check for the seismic condition described.

43. A — Average unit shear equals total diaphragm shear divided by the resisting width: 525/75 = 7.0 kips/ft. The reciprocal is about 0.14, while multiplying or subtracting the inputs produces values with incorrect meaning. The force-per-length units confirm that division by the width is the appropriate operation. This distinction is important when checking the intended seismic load path and response.

44. D — Story shear at a horizontal cut is the sum of lateral inertia forces at and above that cut. The 55-kip force below the cut is not included, so the story shear remains 305 kips. Adding the lower force gives 360 kips, while 55 and 250 kips omit applicable upper-level demand.

45. A — The stated cap is CuTa = 1.40(0.62 s) = 0.868 s. Dividing by Cu gives about 0.443 s, keeping Ta unchanged ignores the cap multiplier, and adding the inputs gives 2.020 s. The result is a time because Cu is dimensionless and Ta is measured in seconds. This relationship is the controlling check for the seismic condition described.

46. B — The stated combination is 1.00(140) + 0.30(80) = 140 + 24 = 164 kips. The 122-kip choice subtracts the secondary effect, 220 adds both at 100 percent, and 244 effectively adds the 30 percent term twice. The procedure accounts for simultaneous response in perpendicular directions without simply summing both full values.

47. C — Diaphragm chords act analogously to beam flanges, developing tension and compression that resist in-plane bending moments. Interior gravity columns may receive lateral forces through other mechanisms, but they are not the primary chord couple. Roof insulation and partition tracks are not intended to provide the structural chord action required by the diaphragm load path.

48. D — Collectors, also called drag struts, gather distributed diaphragm shear and deliver it to walls, frames, or other vertical seismic-force-resisting elements when the load path requires concentrated transfer. They do not change site hazard or live-load capacity, and architectural fire separation is a different design function. Continuity and connection capacity are therefore critical.

49. A — The basic force term is 0.4(1.25)(0.80)(14)/(3.5/1.0) = 1.60 kips. The elevation multiplier is 1 + 2(0.25) = 1.50, so Fp = 1.60(1.50) = 2.40 kips. The distractors represent stopping before the height multiplier or applying an incorrect multiplier. Following each factor separately helps prevent denominator and elevation errors. The stated assumptions should be applied consistently when comparing the answer choices.

50. C — Substitution gives Fp,min = 0.3(1.0)(1.5)(20) = 9.0 kips. Omitting Ip gives 6.0 kips, using 0.2 instead of 0.3 gives 6.0 as well, while 30 kips incorrectly treats the importance factor as the entire coefficient. The minimum provides a floor on the component design force for the stated problem. This relationship is the controlling check for the seismic condition described.

51. D — The stated maximum is 1.6(0.80)(1.0)(15) = 19.2 kips. The smaller values omit or reduce one factor, while 30 kips uses a coefficient of 2.0 rather than 1.6. This upper limit caps the force obtained from the height-amplified component equation under the assumptions supplied in the problem. This distinction is important when checking the intended seismic load path and response.

52. B — The height term 1 + 2z/h increases as the component is located higher in the structure, so the calculated component force rises when other parameters remain unchanged. Component weight does not decrease automatically with elevation, and the equation explicitly includes z/h. The component force also does not become the entire building base shear.

53. C — Ip appears in the numerator through the Rp/Ip denominator, so increasing Ip increases the calculated component force when other terms remain unchanged. It reflects the greater consequence or required performance of certain components. The factor does not eliminate anchorage or alter soil classification, which are separate seismic design considerations. This relationship is the controlling check for the seismic condition described.

54. A — Anchorage provides the mechanical load path that transfers equipment inertia forces into the structural support while controlling sliding, overturning, or separation. It does not change the regional seismic hazard or equipment operating speed, and it supplements rather than replaces gravity support. Anchorage design must consider both the equipment and the supporting connection path.

55. B — Earthquake excitation can produce convective liquid motion, commonly called sloshing, in addition to impulsive response associated with the tank and attached liquid mass. Sloshing can affect freeboard, roof interaction, and forces. Treating the liquid as purely static hydrostatic pressure misses this dynamic mode, and overturning is not automatically eliminated. This relationship is the controlling check for the seismic condition described.

56. D — The overturning moment is force times lever arm: 18 kips x 22 ft = 396 kip-ft. The 198-kip-ft option halves the result, 792 doubles it, and 40 is essentially an addition rather than a moment calculation. The base and anchorage must transfer this moment along with shear and any other applicable load effects.

57. C — A heavy parapet develops inertia force during lateral shaking and can fail out of plane if its connection to the supporting structure is inadequate. Positive anchorage provides a defined load path and helps prevent falling hazards. Roof drainage, foundation settlement, and diaphragm flexibility are separate issues that the parapet anchorage does not directly solve.

58. D — A seismic joint permits portions of a building to move relative to one another. Piping that crosses the joint needs sufficient flexibility or a detailed connection so the relative displacement does not tear the pipe or its fittings. Making the crossing rigid can increase damage, while removing supports or changing fluid density does not address compatibility.

59. A — Bracing restrains lateral motion of the suspended system and transfers its inertia forces through a defined connection to the supporting structure. It does not change the regional hazard or occupancy classification, and gravity hangers remain necessary for vertical support. Proper detailing also helps control interaction with partitions, equipment, and other overhead components.

60. B — The stated lateral force is coefficient times weight: 0.22(90) = 19.8 kips. Dividing gives about 4.1 kips, adding the values gives 90.22 rather than a force relation, and 112 kips uses an unrelated combination. The rack frame and anchorage must provide a continuous path for this horizontal inertia force. This relationship is the controlling check for the seismic condition described.

61. A — Unanchored heavy equipment can slide, rock, or overturn when horizontal inertia forces exceed available friction and geometric stability. Movement can also rupture attached piping, conduits, or other services. Lack of anchorage does not reduce inertia to zero, stiffen the floor, or guarantee isolation from utility connections. The vulnerability is uncontrolled relative movement.

62. B — Distributed systems must both resist their own inertia and tolerate relative movement between supports, equipment, and building segments. Bracing provides the lateral force path, while flexible joints or loops reduce the risk of rupture from differential displacement. The two measures serve complementary functions and do not simply replace gravity supports or anchors.

63. D — Using the stated empirical relation gives Ta = 0.03(64^0.75) which is approximately 0.68 seconds. The other values result from using the height directly, applying the exponent incorrectly, or omitting the coefficient. The units and coefficients are defined by the supplied equation, so direct substitution is the required procedure. This relationship is the controlling check for the seismic condition described.

64. C — The target period is halfway between 0.5 and 1.0 seconds, so linear interpolation gives a value halfway between 1.0g and 0.6g: Sa = 0.80g. The 0.60g choice uses the endpoint, 0.40g subtracts too much, and 1.20g moves in the wrong direction. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

65. B — A modal participation factor indicates how effectively a particular mode couples with the applied ground-motion direction and contributes to overall response. It is a dynamic property related to mode shape and mass distribution, not material strength, connection hardware, or local soil pressure. Modes with little participation may contribute only modestly to global response quantities.

66. A — The square-root-of-sum-of-squares combination is sqrt(30^2 + 40^2) = sqrt(900 + 1,600) = sqrt(2,500) = 50. Simply averaging gives 35, direct addition gives 70, and multiplying gives 1,200.

SRSS is appropriate in the simplified condition stated because the modal peaks are not assumed to occur simultaneously. That reasoning also explains why the remaining choices do not fit the stated seismic mechanism.

67. C — Closely spaced modes can have correlated responses, so treating them as statistically independent may be inaccurate. Complete quadratic combination includes correlation terms that depend on modal properties and damping. It does not eliminate damping or turn the problem into gravity design, and it does not assume every modal peak occurs simultaneously at a prescribed instant.

68. D — A limited set of modes can miss significant inertia effects if too little participating mass is represented. Including enough modes helps capture the structural response that contributes materially in the excitation direction. It does not equalize modal periods, eliminate the mass model, or guarantee that torsional modes are absent. This relationship is the controlling check for the seismic condition described.

69. D — The amplified displacement is delta = 5.0(0.42)/1.0 = 2.10 inches. Dividing by Cd gives 0.084 inch, retaining 0.42 ignores the amplification factor, and adding the two inputs gives 5.42 inches without following the equation. The calculation converts elastic analysis displacement into the stated design displacement estimate. A dimensional and physical check supports the same conclusion for the stated problem.

70. A — Substitution gives theta = 1,800(1.5)(1.0) / [400(144)(5.0)] = 2,700/288,000 = 0.009375, or about 0.0094. The denominator must include story shear, story height, and Cd. The larger distractors omit one or more denominator factors or misplace the decimal. The alternatives represent common arithmetic errors such as reversing a ratio, omitting a factor, or using the wrong operation.

71. C — Dynamic analysis can produce a distribution of forces and deformations that is useful, yet design provisions may require a minimum overall lateral-force level. Scaling preserves the relative dynamic distribution while increasing response quantities consistently. It does not alter mode shapes, eliminate torsion, or force the period to zero. This relationship is the controlling check for the seismic condition described.

72. B — The equivalent lateral force procedure is best suited to structures whose height, regularity, and dynamic behavior fall within the method's assumptions and applicability limits. Tall or highly irregular buildings can have important higher-mode and torsional effects that simplified static distribution may not represent adequately, making more advanced dynamic procedures appropriate.

73. D — Accidental torsion represents uncertainty in the actual location of mass, stiffness, and applied inertia forces compared with the idealized analytical model. Even a nominally symmetric plan can experience torsional demand because real conditions are imperfect. The effect supplements rather than replaces direct translation and does not eliminate naturally occurring torsion.

74. C — A flexible diaphragm can deform significantly in its own plane, so it does not impose the nearly uniform translation and rotation associated with a rigid diaphragm. Force distribution may therefore depend more on tributary loading and local compatibility. The assumption does not remove the vertical systems or automatically eliminate torsional response.

75. B — For elements acting in series, 1/keq = 1/60 + 1/90 = 5/180 = 1/36, so keq = 36 kips/in. The equivalent stiffness is less than either individual stiffness because both deformations accumulate. Adding the stiffnesses would apply to parallel action rather than the series configuration stated in the problem. This relationship is the controlling check for the seismic condition described.

76. A — R appears in the denominator of the stated relation, so a larger R produces a smaller design coefficient when the other inputs are unchanged. The reduction reflects the assumed ductility and energy-dissipation capacity associated with the selected system. It does not make Cs equal to R, and the coefficient is not independent of the denominator.

77. C — Because R/Ie is the denominator, increasing Ie reduces that denominator and therefore increases Cs. The importance factor raises design demand for structures requiring greater reliability under the stated relation. It does not drive the coefficient to zero or leave it unchanged. Algebraically, the same expression can be written Cs = SDS Ie/R.

78. A — Cd multiplies the elastic displacement in the given relation, so increasing Cd increases the amplified displacement proportionally when deltae and Ie remain fixed. The factor is used to estimate larger inelastic-system deformation from elastic analysis results. It does not reduce displacement, leave it unchanged, or convert displacement into a force such as base shear.

79. B — Overstrength-related design forces are used where certain elements, collectors, connections, or anchorage should remain capable while other parts of the seismic system may yield. The factor does not remove all force, replace ductile detailing, or determine geotechnical site class. It supports a capacity-design hierarchy and a reliable force-transfer path. This relationship is the controlling check for the seismic condition described.

80. D — The redundancy factor addresses structural reliability associated with the distribution and availability of seismic-resisting elements and load paths. It is not a damping measure, geotechnical liquefaction parameter, or material-property equation. Where applicable, it modifies seismic demand to account for the consequences of limited redundancy in the lateral-force-resisting system. This relationship is the controlling check for the seismic condition described.

81. D — Irregular geometry, stiffness, strength, or mass can create concentrated drift, torsion, discontinuities, or higher-mode effects that simplified procedures may not represent adequately. More rigorous analysis can better capture those coupled responses. Irregularity does not eliminate inertia or torsion, and material strength remains essential to the final seismic design. This relationship is the controlling check for the seismic condition described.

82. C — A flexible diaphragm does not impose rigid-body in-plane compatibility, so direct forces are associated mainly with tributary diaphragm loading carried to each wall line. Stiffness and eccentricity can matter in more refined analyses, but a purely rigid-diaphragm stiffness distribution is inconsistent with the flexible idealization stated in the question. This relationship is the controlling check for the seismic condition described.

83. B — Pronounced torsional response can cause edge displacements and resisting-line forces to exceed those implied by a simple nominal eccentricity. Torsional amplification increases the design torsional effect where required to address that concentration. It does not eliminate direct shear, remove all eccentricity, or equalize the forces carried by every line. This relationship is the controlling check for the seismic condition described.

84. A — Higher modes can contribute substantially to upper-story accelerations, shears, and member forces even when the first mode dominates overall base shear or roof displacement. A mode shape with pronounced upper-level motion is a direct indication of that possibility. Dynamic response cannot be reduced to foundation settlement or a single mode in every structure.

85. D — The stated expression is linear in SDS. With D and the 0.2 coefficient unchanged, doubling SDS doubles the vertical seismic effect. There is no squared term that would produce a factor of four, and the relation is not inverse. Recognizing proportional relationships is useful for checking whether a computed result changes in the expected direction.

86. C — Response-history results depend strongly on the intensity, duration, and frequency content of the input motions. Records therefore need to represent the hazard level and spectral characteristics appropriate to the analysis objective. They need not be identical, and nonlinear analysis specifically allows yielding rather than preventing it or omitting the structural mass.

87. B — SRSS gives sqrt(20^2 + 30^2 + 60^2) = sqrt(400 + 900 + 3,600) = sqrt(4,900) = 70 units. Averaging gives about 36.7, direct addition gives 110, and 3,600 is only the square of the largest response. SRSS combines independent modal peaks without assuming simultaneous maxima. The result is consistent with the force path and deformation behavior described in the problem.

88. B — The period is T = 2pi sqrt(0.010) = 2pi(0.1) = approximately 0.628 seconds. The 0.100-second choice stops at the square root, 0.063 omits most of the 2pi factor, and 6.283 treats sqrt(0.010) as one. The given ratio already carries the time-squared units needed by the formula. This distinction is important when checking the intended seismic load path and response.

89. A — Special inspection provides independent confirmation that critical welding work follows the approved requirements, including materials, procedures, welder qualifications, and workmanship. It does not replace the design professional or construction documents, and it does not authorize unqualified procedures. Seismic connection performance depends on details actually being fabricated and installed as intended.

90. C — Bolted seismic connections depend on the specified fasteners, hole and faying-surface conditions, installation method, and any required pretension. Those items directly affect force transfer and connection behavior. Architectural paint, furniture, and drainage labeling do not verify the structural connection assumptions. Inspection should focus on features that govern strength, slip, and deformation capacity.

91. A — Closely spaced transverse reinforcement can confine the concrete core, support longitudinal bars against buckling, and contribute to shear resistance under cyclic inelastic demand. It does not alter the site hazard or prevent every crack, and it does not replace the longitudinal bars needed for flexural and axial resistance. Placement and anchorage are therefore critical.

92. D — Reinforced masonry performance depends on reinforcement being correctly located and developed and on grout adequately surrounding and bonding the reinforcement within the cells. Continuity at splices and connections is part of the load path. Paint, room numbers, and temporary scaffolding do not establish the final seismic strength or deformation capacity of the wall.

93. A — Panel-edge fasteners are a primary mechanism for transferring in-plane shear between the wood sheathing and supporting framing. Their spacing, size, and installation affect strength and stiffness. They do not determine seismic hazard, eliminate overturning forces, or substitute for collectors and hold-downs where those load-path elements are required. This distinction is important when checking the intended seismic load path and response.

94. D — Anchor edge distance can affect concrete breakout, splitting, installation tolerances, and the force-transfer assumptions used in design. A deviation should therefore be evaluated before it is concealed. Assuming equivalence or compensating by removing other load-path features is not appropriate. Timely review allows an engineered repair or acceptance based on the actual condition.

95. B — Collector splices carry concentrated seismic force along a defined load path, so their location and connection can be structurally significant. Relocating a splice should be evaluated by the responsible design professional before installation. Floor levelness and architectural approval do not establish that the revised splice has adequate force transfer, deformation capacity, and continuity.

96. C — Post-installed anchor capacity can be sensitive to drilling method, hole cleaning, embedment depth, adhesive or mechanical-anchor installation, spacing, edge distance, and substrate condition. Poor installation can undermine the design value. The anchor does not automatically match the attached member's strength or eliminate concrete failure modes, so inspection and documented procedures are important.

97. D — The structural joint exists so adjacent building segments can move relative to one another. Utilities crossing it need a flexible or otherwise detailed connection that can accommodate the expected movement without rupture or loss of function. Rigidly bridging or grouting the gap defeats that compatibility, while removing supports can create a different hazard.

98. A — Moment-frame connections rely on detailed geometry, material properties, and controlled welding to achieve the intended strength and inelastic deformation capacity. Deviations can create stress concentrations, defects, or brittle failure locations. These fabrication details do not change geotechnical site class, replace member design, or guarantee that the frame remains elastic during severe shaking.

99. C — Boundary fastening near a collector is part of the local shear-transfer mechanism that delivers diaphragm force into the collector and then to the vertical system. Missing fasteners can reduce capacity or alter force distribution at a critical interface. The defect does not change site hazard, and reduced fastening should not be assumed to increase useful ductility.

100. B — Accurate as-built records document what was actually installed, including approved deviations from the original drawings. That information is valuable for future repairs, renovations, damage evaluation, and verification of the seismic load path. Documentation does not replace inspection or engineering judgment, and it cannot guarantee that an earthquake will cause no damage.