PRACTICE EXAM 7: CALIFORNIA CIVIL SEISMIC PRINCIPLES (100 QUESTIONS)

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

1. For this problem, the site-adjusted short-period value is SMS = FaSs. If Ss = 1.18g and Fa = 1.15, what is SMS?

A. 1.026g
B. 1.357g
C. 1.180g
D. 2.330g

2. A design-spectrum one-second ordinate is defined here as SD1 = (2/3)SM1. If SM1 = 0.87g, what value is obtained?

A. 0.58g
B. 0.29g
C. 0.87g
D. 1.31g

3. A geotechnical report identifies loose saturated sand beneath a gently sloping site near a free face. Which earthquake-related ground problem deserves the most direct attention?

A. Long-term concrete creep
B. Roof ponding from rainfall
C. Liquefaction with possible lateral spreading

D. Thermal expansion of steel

4. A conventional office building is repurposed as an emergency operations center. Which project classification should be revisited because the consequences of earthquake failure have changed?

A. Mapped fault location
B. Measured soil shear-wave velocity
C. Specified reinforcing-bar yield strength
D. Risk category and associated importance provisions

5. For this problem, use SM1 = FvS1. If S1 = 0.51g and Fv = 1.60, determine SM1.

A. 0.319g
B. 0.510g
C. 0.816g
D. 2.110g

6. Which site profile would generally be expected to modify incoming earthquake shaking more strongly than competent shallow rock?

A. A shallow massive rock outcrop
B. A thin architectural topping slab
C. A dry roof membrane assembly
D. A deep deposit of relatively soft soil

7. Why can near-fault directivity or unusual basin effects justify more detailed ground-motion characterization for a particular project?

A. Generalized mapped parameters may not capture important local response features
B. The study sets the building paint system
C. It removes the need for structural analysis

D. It determines the contractor bidding sequence

8. What two broad considerations are brought together when a project is assigned a seismic design category?

A. Roof drainage and snow accumulation
B. Expected seismic demand and occupancy-related risk
C. Concrete curing and form removal
D. Ceiling height and room area

9. Two single-degree oscillators have equal stiffness. Oscillator X has nine times the mass of Oscillator Y. Using T proportional to sqrt(m/k), what is TX/TY?

A. 0.33
B. 1.0
C. 9.0
D. 3.0

10. A floor diaphragm is much stiffer in-plane than the vertical frames and walls it connects. What behavior is most consistent with a rigid-diaphragm idealization?

A. Each frame moves independently with no diaphragm interaction
B. The floor constrains attached vertical lines to compatible in-plane translation and rotation
C. Only tributary area controls all frame forces
D. The floor carries no in-plane shear

11. A building has substantial eccentricity between its mass center and stiffness center. What global response should the lateral-system designer expect in addition to translation?

A. Uniform vertical settlement only
B. Pure axial shortening of all columns

C. Torsional rotation of the floor system
D. Elimination of diaphragm shear

12. What is the principal seismic benefit of providing several independent lateral resisting lines instead of relying on a single critical line?

A. Greater redundancy and alternate paths for earthquake force
B. Guaranteed zero structural damage
C. Elimination of drift calculations
D. Removal of all torsional response

13. For otherwise similar linear oscillators subjected to the same excitation, increasing damping generally has what effect near resonance?

A. It always doubles the natural period
B. It makes stiffness equal to zero
C. It reduces the peak dynamic response
D. It guarantees no residual displacement

14. Why is a strong-column, weak-beam hierarchy desirable in a ductile moment-resisting frame?

A. It forces every beam to remain elastic
B. It promotes beam yielding instead of a column story mechanism
C. It removes the need for joint detailing
D. It makes the frame insensitive to drift

15. Two adjacent buildings are separated by only a small gap and have substantially different dynamic characteristics. What design concern is most directly associated with the limited separation?

A. Liquefaction inside the floor diaphragm
B. Loss of concrete curing water

C. Wind uplift on interior partitions
D. Pounding as the buildings move out of phase

16. A structure develops a pronounced decrease in lateral stiffness at one story while the stories above remain much stiffer. Why is this configuration unfavorable?

A. Drift and inelastic demand can concentrate in the weak story
B. It automatically reduces base shear to zero
C. It prevents any torsional response
D. It guarantees uniform yielding over height

17. An older unreinforced masonry building has heavy parapets with weak positive attachment to the roof or wall system. Which retrofit action most directly addresses the falling-hazard vulnerability?

A. Increase interior floor live load
B. Reduce concrete slab curing time
C. Change exterior paint color
D. Provide engineered positive bracing and anchorage for the parapets

18. A nonductile concrete frame has columns with poor transverse confinement in likely plastic-hinge regions. What retrofit objective is most important?

A. Increase roof dead load
B. Improve column confinement and shear resistance
C. Reduce beam reinforcement continuity
D. Remove diaphragm collectors

19. An older welded steel moment frame contains connection details associated with brittle fracture concerns. Which evaluation focus is most appropriate?

A. Assess beam-column connection toughness, geometry, and deformation capacity

B. Verify only interior paint adhesion
C. Increase partition wall weight
D. Ignore connections and check roof drainage only

20. A precast concrete building relies on narrow bearing seats and limited positive connection between floor units and supports. What seismic vulnerability should be prioritized?

A. Excessive landscape irrigation
B. Long-term carpet wear
C. Loss of support or connection during relative movement
D. Thermal expansion of glazing only

21. A tilt-up warehouse has strong wall panels but inadequate anchorage from the roof diaphragm into the wall. What retrofit priority most directly improves performance?

A. Add roof finish weight
B. Strengthen the diaphragm-to-wall anchorage and continuity
C. Decrease connection inspection
D. Remove wall bracing during construction

22. An existing building retrofit adds new shear walls but leaves a weak collector connection between the diaphragm and the new walls. What remains the controlling concern?

A. The building automatically becomes torsion-free
B. The new walls eliminate all diaphragm demand
C. A weak collector can block force transfer into the new walls
D. Collector strength is unrelated to seismic performance

23. During a preliminary lateral-force check, the effective seismic weight is 4,800 kips and the selected dimensionless seismic coefficient is 0.094. Using $V = C_sW$ for this exercise, compute the total design base shear.

A. 451.2 kips
B. 45.12 kips
C. 510.6 kips
D. 4,894 kips

24. A simplified coefficient is defined here as Cs = SDS Ie/R. With SDS = 0.96, Ie = 1.25, and R = 6.0, determine Cs.

A. 0.128
B. 0.160
C. 0.312
D. 0.200

25. A four-level vertical force distribution has weighting terms 2,100, 4,200, 6,300, and 8,400. What fraction of total base shear is assigned to the second level?

A. 0.10
B. 0.20
C. 0.30
D. 0.40

26. A base shear of 690 kips is distributed vertically. If one floor has Cvx = 0.27, what lateral force is assigned to that floor?

A. 69.0 kips
B. 255.6 kips
C. 717.0 kips
D. 186.3 kips

27. Floor lateral forces from the roof downward are 95, 78, 62, and 41 kips. What story shear acts just below the second level from the roof?

A. 173 kips
B. 78 kips
C. 157 kips
D. 276 kips

28. Lateral forces of 55, 85, and 125 kips act at elevations of 14, 28, and 42 ft. What base overturning moment do they produce?

A. 3,710 kip-ft
B. 7,630 kip-ft
C. 8,400 kip-ft
D. 11,130 kip-ft

29. A story shear of 465 kips acts with a total diaphragm eccentricity of 5.5 ft. What torsional moment is associated with that eccentricity?

A. 84.5 kip-ft
B. 470.5 kip-ft
C. 2,557.5 kip-ft
D. 3,022.5 kip-ft

30. For this exercise, accidental eccentricity is 5% of a 96-ft diaphragm plan dimension perpendicular to loading. What eccentricity is used?

A. 1.92 ft
B. 4.8 ft
C. 5.0 ft
D. 9.6 ft

31. A rigid diaphragm transfers 840 kips of direct shear to three parallel frames having stiffnesses 24, 36, and 60 units. Neglect torsion. What direct shear goes to the 36-unit frame?

A. 168 kips
B. 360 kips
C. 504 kips
D. 252 kips

32. A diaphragm has an in-plane bending moment of 2,240 kip-ft and an effective chord spacing of 56 ft. Using F = M/d, what chord force is required?

A. 40 kips
B. 28 kips
C. 56 kips
D. 125.4 kips

33. A collector accumulates a uniform diaphragm transfer of 2.8 kips/ft over a 34-ft tributary length. What axial force reaches the collector end?

A. 31.2 kips
B. 68.0 kips
C. 120.4 kips
D. 95.2 kips

34. For this problem, define the vertical seismic term as Ev = 0.2SDSD. If SDS = 0.68 and D = 1,250 kips, what is Ev?

A. 170 kips
B. 85 kips
C. 250 kips
D. 850 kips

35. A seismic load effect is defined here as E = rhoQE + Ev. If QE = 128 kips, rho = 1.2, and Ev = 24 kips, what is E?

A. 153.6 kips
B. 177.6 kips
C. 152.0 kips
D. 184.0 kips

36. For this exercise, overstrength load effect is Em = Omega0QE + Ev. Use Omega0 = 3.0, QE = 64 kips, and Ev = 16 kips. What is Em?

A. 192 kips
B. 80 kips
C. 208 kips
D. 240 kips

37. An overturning moment of 2,640 kip-ft is resisted by a tension-compression couple acting at vertical reaction lines 44 ft apart. What magnitude of force is required at each line?

A. 30 kips
B. 44 kips
C. 116.2 kips
D. 60 kips

38. A floor diaphragm has tributary seismic weight of 1,120 kips and is assigned a force coefficient of 0.21 for this exercise. Applying Fpx = 0.21wpx, determine the diaphragm design force.

A. 112.0 kips
B. 213.3 kips
C. 235.2 kips
D. 1,120.21 kips

39. A simplified torsional line force is Ft = Mtr/J. If Mt = 3,600 kip-ft, r = 18 ft, and J = 1,620 ft^2, what is Ft?

A. 22.2 kips
B. 40 kips
C. 72 kips
D. 200 kips

40. Two parallel frames support a rigid diaphragm. Their lateral stiffnesses are 45 and 75 units, and the diaphragm carries 640 kips of direct translational shear. Ignoring torsion, how much shear is attracted by the 75-unit frame?

A. 400 kips
B. 240 kips
C. 320 kips
D. 480 kips

41. A story height is 12.5 ft. If the drift limit for this exercise is 0.018 times story height, what maximum interstory drift is permitted?

A. 0.225 in.
B. 2.70 in.
C. 1.80 in.
D. 4.50 in.

42. A diaphragm transfers 612 kips across an effective resisting width of 68 ft. What average diaphragm unit shear V/L results?

A. 9.0 kips/ft
B. 6.8 kips/ft
C. 10.2 kips/ft
D. 41.6 kips/ft

43. At a selected story, lateral floor forces at and above the cut are 110, 82, and 64 kips. A 48-kip force occurs below the cut. What story shear acts at the selected story?

A. 208 kips
B. 304 kips
C. 256 kips
D. 48 kips

44. For this exercise, the period used in an ELF calculation may not exceed CuTa. If Ta = 0.58 s and Cu = 1.50, what period cap results?

A. 0.39 s
B. 0.58 s
C. 2.08 s
D. 0.87 s

45. For this problem, orthogonal seismic effects are combined as 100% of Ex plus 30% of Ey. If Ex = 165 kips and Ey = 70 kips act with the same sign, what combined force is used?

A. 165 kips
B. 214.5 kips
C. 235 kips
D. 186 kips

46. A wall panel is loaded out of its plane by earthquake inertia. What structural action must its anchorage and supporting diaphragm be able to transfer?

A. Only gravity load parallel to the wall
B. Only thermal strain in wall finishes
C. The wall out-of-plane inertial force into the building load path
D. Only roof drainage reactions

47. What is the principal structural function of a diaphragm chord under in-plane seismic loading?

A. Carry only vertical plumbing weight
B. Resist tension and compression associated with diaphragm bending
C. Eliminate every collector force
D. Prevent all floor acceleration

48. Why are collectors or drag struts provided where diaphragm force must be delivered to a wall or frame that is not aligned with the distributed diaphragm shear?

A. They transfer gathered diaphragm force into the vertical system
B. They eliminate the need for diaphragm shear
C. They reduce mapped ground motion
D. They carry only architectural partition loads

49. An 18-kip rooftop component has ap = 1.0, SDS = 0.90, Rp = 3.0, Ip = 1.0, and z/h = 0.50. For this exercise use Fp = [0.4apSDSWp/(Rp/Ip)](1+2z/h). Determine Fp before applying limits.

A. 2.16 kips
B. 6.48 kips
C. 12.96 kips
D. 4.32 kips

50. For this exercise, the minimum component force is Fp,min = 0.3SDSIpWp. If SDS = 0.85, Ip = 1.5, and Wp = 24 kips, what is the minimum force?

A. 9.18 kips
B. 6.12 kips
C. 10.80 kips
D. 30.60 kips

51. For this problem, the maximum component force is Fp,max = 1.6SDSIpWp. With SDS = 0.72, Ip = 1.0, and Wp = 22 kips, what value results?

A. 15.84 kips
B. 25.344 kips
C. 22.72 kips
D. 35.20 kips

52. In the component-force expression containing the factor (1 + 2z/h), what is the direct effect of moving an otherwise identical component from a low elevation toward the roof?

A. The force becomes independent of component weight
B. The importance factor automatically becomes zero
C. The calculated component force increases before limits are applied
D. The component no longer requires anchorage

53. What is the primary seismic purpose of positively anchoring a heavy mechanical unit to its concrete housekeeping pad or support?

A. Transfer inertial force and prevent sliding or overturning
B. Increase the mapped spectral acceleration
C. Eliminate all vibration during operation
D. Replace the need for equipment supports

54. A large liquid-storage tank is evaluated for earthquake response. Which behavior may need to be considered in addition to rigid-body support inertia?

A. Only paint thickness variation
B. Only atmospheric humidity
C. Only floor finish abrasion
D. Sloshing or convective motion of the contained liquid

55. A freestanding sign experiences a 21-kip horizontal seismic force acting 19 ft above its base. What overturning moment does the force produce at the base?

A. 40 kip-ft
B. 210 kip-ft
C. 399 kip-ft
D. 798 kip-ft

56. Why should a heavy masonry or precast parapet at a roof edge have a positive seismic attachment to the supporting structure?

A. To increase roof rainwater storage
B. To prevent out-of-plane instability and falling during strong shaking
C. To eliminate all thermal movement
D. To reduce the building occupancy category

57. A piping run crosses a seismic separation joint between two building segments. Why is flexibility or a movement-accommodating detail important at the crossing?

A. The segments can move differently without rupturing the pipe
B. The pipe must prevent all building movement
C. The joint should be rigidly locked by the pipe
D. Flexibility eliminates the need for pipe supports

58. What is the main earthquake-resistance function of lateral bracing for suspended overhead services?

A. Increase the service operating pressure
B. Eliminate gravity hangers
C. Control sway and transfer inertia to the supporting structure
D. Change the building site class

59. For this problem, a storage rack has seismic weight of 105 kips and uses a horizontal coefficient of 0.24. What lateral force is obtained?

A. 4.38 kips
B. 25.2 kips
C. 24.0 kips
D. 129 kips

60. A tall floor-mounted cabinet is heavy and has a high center of mass but no positive anchorage. Which seismic behavior is the most immediate concern?

A. Reduction of mapped ground motion
B. Automatic increase in structural damping
C. Elimination of component acceleration
D. Sliding or overturning under inertial loading

61. A nonbuilding structure is idealized with seismic coefficient $C_s = 0.19$ and effective seismic weight $W = 260$ kips. Using $V = C_sW$ for this exercise, what base shear results?

A. 13.7 kips
B. 49.4 kips
C. 45.6 kips
D. 260.19 kips

62. Why are both bracing and flexible connections often used in long distributed piping or duct systems?

A. Both features are used only for thermal insulation
B. Flexibility alone carries all gravity load
C. Bracing eliminates every need for movement capacity
D. Bracing controls inertial movement while flexible details accommodate relative displacement

63. For this exercise, approximate period is Ta = Ct hn^x. If Ct = 0.028, hn = 72 ft, and x = 0.75, what is Ta to two decimals?

A. 0.69 s
B. 0.28 s
C. 0.52 s
D. 2.02 s

64. Spectral acceleration varies linearly from 1.10g at T = 0.4 s to 0.70g at T = 0.8 s for this exercise. What is Sa at T = 0.6 s?

A. 0.80g
B. 1.00g
C. 0.90g
D. 1.40g

65. In a response-spectrum analysis, what does the effective modal mass associated with a mode indicate?

A. The physical mass of only one beam
B. How strongly that mode participates in the selected excitation direction
C. The concrete density used in every element
D. The total gravity load regardless of mode shape

66. Two sufficiently separated modal responses are 24 and 32 units. Using SRSS, what combined response is obtained?

A. 28 units
B. 56 units
C. 40 units
D. 768 units

67. Why can complete quadratic combination be more appropriate than SRSS when two important modes have close natural frequencies?

A. CQC forces all mode shapes to be identical
B. SRSS is only valid for static gravity loads
C. CQC eliminates the need to calculate modes
D. CQC accounts for correlation between closely spaced modal responses

68. Why should a response-spectrum model include enough modes to capture a large portion of participating mass in each important direction?

A. Omitted modes can leave significant dynamic response unrepresented
B. Additional modes always reduce base shear to zero
C. Only the first mode contains structural mass
D. Modal mass has no relationship to response completeness

69. An elastic analysis gives deltae = 0.48 in. at a story. For this exercise amplify it using delta = Cd deltae/Ie with Cd = 4.5 and Ie = 1.2. What displacement results?

A. 0.13 in.
B. 1.80 in.
C. 2.16 in.
D. 2.59 in.

70. For this exercise, theta = Px Delta Ie/(Vx hsx Cd). Use Px = 1,650 kips, Delta = 1.2 in., Ie = 1.0, Vx = 360 kips, hsx = 150 in., and Cd = 5.5. What is theta?

A. 0.00667
B. 0.00333
C. 0.0367
D. 0.0667

71. A response-spectrum analysis produces a design base shear lower than a required benchmark. Why may the modal results be scaled upward?

A. To make every modal period identical
B. To remove all accidental torsion
C. To convert the building into a rigid diaphragm
D. To raise dynamic results to the required minimum force level

72. Which structure is most naturally suited to a simplified equivalent lateral force analysis rather than a more sophisticated dynamic procedure?

A. A very tall irregular tower with strong higher-mode effects
B. A highly torsionally irregular building with setbacks
C. A regular low-rise building with straightforward dynamic behavior
D. A complex structure with several closely spaced dominant modes

73. Why is an accidental eccentricity commonly included in diaphragm torsion evaluation even if the calculated mass and rigidity centers line up exactly?

A. It guarantees zero torsional response
B. It replaces the computed eccentricity in every case
C. It represents uncertainty in actual mass, stiffness, and force application
D. It accounts only for vertical gravity settlement

74. Compared with a rigid-diaphragm model, what can a flexible-diaphragm idealization change most directly in lateral-force distribution?

A. All vertical elements must receive equal force
B. Direct forces may follow tributary loading rather than stiffness-proportional compatibility
C. Torsion can never occur
D. The diaphragm has infinite in-plane stiffness

75. Two lateral springs act in series with stiffnesses 48 and 80 kips/in. Using $1/k_{eq} = 1/k_1 + 1/k_2$, what is the equivalent stiffness?

A. 32 kips/in.
B. 64 kips/in.
C. 128 kips/in.
D. 30 kips/in.

76. In the simplified relation Cs = SDS/(R/Ie), what happens to Cs if R increases while SDS and Ie remain fixed?

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

77. What is the main reason an overstrength factor is applied to selected seismic load-path elements or connections?

A. It reduces all member forces below gravity levels
B. It eliminates the need for connection design
C. Keep selected load-path elements stronger than intended yielding regions
D. It changes the mapped seismic hazard

78. Why can a pronounced plan or vertical irregularity trigger the need for a more rigorous analysis model?

A. Irregularity can invalidate simple force-distribution assumptions
B. Irregularity always reduces earthquake demand
C. Irregularity guarantees first-mode dominance
D. Irregularity removes diaphragm deformation

79. What is the purpose of torsional amplification when a building shows pronounced torsional response?

A. Suppress all translational shear
B. Increase design torsional effects to account for sensitivity to eccentric response
C. Convert the diaphragm to a flexible model
D. Reduce stiffness eccentricity to zero in the real building

80. A computed mode shape has several reversals over the building height and substantial upper-story deformation. What does that pattern most strongly indicate?

A. The structure has no dynamic behavior
B. Only rigid-body translation is possible
C. The first mode must contain all participating mass
D. Higher-mode response is significant

81. For this problem, the vertical seismic effect is Ev = 0.2SDSD. If SDS is increased by 50% while D is unchanged, how does Ev change?

A. Ev increases by 50%
B. Ev decreases by 50%
C. Ev doubles
D. Ev remains unchanged

82. Why must ground-motion records used for nonlinear response-history analysis be selected and scaled to represent the target seismic hazard?

A. Any arbitrary motion produces the same nonlinear response
B. The analysis response depends on the amplitude and frequency content of the input motions
C. Scaling is used only to change gravity load
D. Record selection removes the need for a structural model

83. Modal responses to a quantity are 18, 24, and 45 units. Using SRSS for this exercise, what combined response is obtained?

A. 29.0 units
B. 87.0 units
C. 54.08 units
D. 19,125 units

84. For this problem, estimate period from T = 2pi sqrt(m/k). If m/k = 0.0144 s^2, what period results?

A. 0.120 s
B. 0.377 s
C. 1.508 s
D. 0.754 s

85. A rigid diaphragm has its center of rigidity offset 7 ft east of its center of mass. A 300-kip story shear acts through the mass center. What nominal torsional moment results from this eccentricity?

A. 42.9 kip-ft
B. 307 kip-ft
C. 4,200 kip-ft
D. 2,100 kip-ft

86. Three parallel lateral lines in a rigid diaphragm have stiffnesses 20, 30, and 50 units. If direct story shear is 600 kips and torsion is neglected, what force goes to the 20-unit line?

A. 100 kips
B. 120 kips
C. 180 kips
D. 300 kips

87. Why can a semi-rigid diaphragm model be useful when neither the rigid nor flexible idealization adequately represents floor behavior?

A. It assumes zero in-plane stiffness
B. It forces tributary distribution regardless of stiffness
C. It explicitly represents diaphragm deformation together with interaction among vertical resisting elements
D. It removes the need to model diaphragm forces

88. What is the main analytical reason to model collectors and diaphragm discontinuities explicitly rather than applying story forces only at vertical frames and walls?

A. Concentrated transfer forces and compatibility demands can govern the load path
B. Collectors carry no seismic force
C. Diaphragm discontinuities eliminate inertia
D. Vertical frames automatically receive every force without transfer elements

89. During special inspection of a designated seismic weld, what should be verified most directly?

A. Only the architectural finish color
B. Required materials, welding procedure, welder qualifications, and workmanship
C. Only temporary lighting levels
D. Only the building mailing address

90. For a pretensioned structural bolted connection in the seismic load path, which field issue is most important to inspect?

A. Furniture placement near the connection
B. Wall paint sheen
C. Temporary parking layout
D. Bolt type, installation, pretension, and connected-surface condition

91. Why is closely spaced transverse reinforcement critical near expected plastic-hinge regions of reinforced-concrete seismic members?

A. It changes the site spectral acceleration
B. It prevents every possible crack
C. It confines concrete, restrains bars, and resists cyclic shear
D. It replaces all longitudinal reinforcement

92. When reinforced masonry is part of the seismic force-resisting system, what construction feature should special inspection verify?

A. Reinforcement, development, grout placement, and continuity
B. Only room signage
C. Only exterior landscaping
D. Only temporary scaffolding color

93. Why is fastener spacing along wood structural panel edges important in a diaphragm or shear wall?

A. It determines mapped ground motion
B. It transfers in-plane shear between sheathing and framing
C. It eliminates overturning forces
D. It makes collectors unnecessary

94. A concrete hold-down anchor is installed closer to an edge than shown on the approved structural drawings. What should occur before the work is concealed?

A. The responsible design professional should evaluate the actual installed condition
B. The condition should be assumed acceptable
C. The anchor should be covered and ignored
D. Adjacent shear-wall nailing should be removed

95. A contractor wants to move a collector splice several feet from the approved location. What is the appropriate seismic construction-control action?

A. Move it without review because collectors are nonstructural
B. Delete the splice entirely
C. Seek only interior-design approval
D. Obtain engineering approval before relocating the splice

96. Why can post-installed anchors used for seismic bracing require close installation inspection?

A. Their capacity is independent of workmanship
B. They cannot experience concrete failure
C. Anchor capacity depends strongly on correct installation conditions
D. They automatically match the attached member strength

97. A sprinkler main crosses a building seismic separation joint. What should an inspector verify at the crossing?

A. The pipe rigidly locks the two building segments together
B. The installed detail can accommodate the required relative structural movement
C. The joint is filled solid with grout
D. All pipe supports are removed near the joint

98. Why is control of weld access-hole geometry, joint preparation, and welding procedure important in a special steel moment-frame connection?

A. Those details set the geotechnical site class
B. They eliminate beam-column design
C. Poor execution can reduce ductile cyclic connection performance
D. They guarantee perfectly elastic behavior

99. What is the principal purpose of seismic structural observation during construction when it is required?

A. Periodic professional review for general conformance with approved documents
B. Replace all continuous special inspection
C. Direct the contractor means and methods
D. Guarantee that no earthquake damage will occur

100. Why are accurate records of approved field changes valuable for future seismic evaluation or renovation?

A. They eliminate the need for engineering judgment
B. They replace all material test reports
C. They prove the building cannot be damaged
D. They document the final constructed load path, connections, and accepted deviations

Practice Exam 7: Answer Key and Explanations

1. B — Using the equation given in the stem, SMS = 1.15(1.18g) = 1.357g. Dividing Ss by Fa gives about 1.026g, leaving Ss unchanged omits the site adjustment, and adding the two numerical inputs produces 2.330g without applying the stated multiplication. The units remain consistent with the quantity requested in the stem.

2. A — The stated conversion requires two-thirds of the maximum-considered one-second value. Thus SD1 = (2/3)(0.87g) = 0.58g. One-third gives 0.29g, retaining 0.87g skips the conversion, and multiplying by 1.5 gives about 1.31g instead of reducing the ordinate. The units remain consistent with the quantity requested in the stem. This also distinguishes the correct operation from the common distractor calculations.

3. C — Loose saturated granular soil can develop excess pore-water pressure during cyclic shaking, reducing effective stress and triggering liquefaction. Near a free face or slope, the weakened ground may also move laterally. Concrete creep, roof ponding, and thermal expansion are separate design issues and do not arise from the described subsurface earthquake mechanism.

4. D — Changing the building to an emergency operations function changes the consequences of failure and the expected reliability of the facility. That makes risk category and related importance provisions a direct design consideration. The geographic hazard, measured soil profile, and specified material strength do not automatically change because the occupancy becomes more critical.

5. C — Applying the relation in the question gives SM1 = 1.60(0.51g) = 0.816g. Dividing 0.51 by 1.60 gives about 0.319g, keeping 0.510g ignores the site coefficient, and adding 1.60 and 0.51 gives 2.110 rather than the required product. The units remain consistent with the quantity requested in the stem. This also distinguishes the correct operation from the common distractor calculations.

6. D — A deep soft-soil profile can alter ground-motion amplitude and frequency content through site response, so it can meaningfully modify the motion transmitted to a structure. Competent shallow rock generally has less soil amplification. Architectural topping and roof membrane materials are building components, not subsurface profiles controlling seismic site response. Seismic design follows the load path and the expected deformation mechanism.

7. A — Near-fault effects, basin response, and unusual local geology can shape ground-motion intensity or spectral content in ways that generalized mapped parameters may not fully represent. A more detailed study addresses seismic hazard and site response. It does not choose finishes, eliminate structural analysis, or control the administrative sequence used for construction bidding.

8. B — Seismic design category reflects both the level of earthquake demand and the significance of the building occupancy or function. Combining those considerations helps establish appropriate seismic requirements. Roof drainage, concrete curing, and room geometry may matter elsewhere in design and construction, but they are not the fundamental hazard-and-risk basis for seismic classification.

9. D — With stiffness unchanged, period varies with the square root of mass. Therefore TX/TY = sqrt(9/1) = 3.0. Taking the reciprocal gives 0.33, assuming no period change gives 1.0, and using the mass ratio directly gives 9.0 rather than applying the square-root relationship. The units remain consistent with the quantity requested in the stem.

10. B — A rigid diaphragm is idealized as having very small in-plane deformation relative to the vertical resisting elements. It therefore enforces compatible translation and rotation at attached lines, causing force distribution to depend on stiffness and torsion. Independent frame movement, purely tributary distribution, and zero diaphragm shear are inconsistent with that idealization.

11. C — When the resultant inertia force does not pass through the center of rigidity, it creates a torsional moment in addition to translational shear. The diaphragm and vertical elements therefore experience rotational response and uneven line forces. Uniform settlement, pure axial shortening, and elimination of diaphragm shear do not describe this eccentric lateral response.

12. A — Multiple effective resisting lines can provide redundancy, so the structure is less dependent on one element or connection for the entire lateral load path. This can improve robustness when damage occurs. Redundancy does not guarantee zero damage, remove drift evaluation, or eliminate torsional effects caused by mass and stiffness distribution.

13. C — Damping dissipates vibrational energy, so greater damping generally reduces peak resonant response for otherwise comparable systems. Damping can influence response amplitude without automatically doubling the natural period or eliminating stiffness. It also does not guarantee that a real structure will have no residual displacement after strong inelastic earthquake response. Seismic design follows the load path and the expected deformation mechanism.

14. B — A strong-column, weak-beam hierarchy is intended to concentrate ductile yielding in beam regions while reducing the chance that columns form a dangerous story mechanism. The concept does not require every beam to remain elastic, eliminate connection detailing, or make drift irrelevant. Controlled inelastic behavior is the central seismic objective. Seismic design follows the load path and the expected deformation mechanism.

15. D — Adjacent buildings can move with different amplitudes and timing during an earthquake. If the separation is inadequate, their structures may impact, producing pounding damage at floors, columns, or walls. That concern is distinct from soil liquefaction, curing moisture, or wind uplift. Dynamic incompatibility between neighboring structures is the governing issue.

16. A — A sharp stiffness discontinuity can cause earthquake deformation to concentrate in the flexible story rather than being distributed over the building height. That concentration increases local drift and inelastic demand and can produce a story mechanism. It does not eliminate base shear, prevent torsion, or guarantee uniform yielding throughout the structure.

17. D — Unreinforced masonry parapets can fail out of plane during shaking when they lack reliable positive attachment and bracing. Adding engineered anchorage and bracing directly addresses that instability and falling hazard. Increasing live load, changing curing procedures, or altering finishes does not establish a dependable seismic load path for the parapet.

18. B — Poorly confined columns can lose shear and axial capacity after cyclic flexural cracking and bar buckling. A retrofit should improve confinement, shear resistance, and deformation capacity in critical regions. Adding roof mass increases seismic inertia, while reducing reinforcement continuity or removing collectors would weaken the lateral load path rather than address the column vulnerability.

19. A — Older welded moment connections may have details, material characteristics, or stress concentrations that limit ductile cyclic performance. Evaluation should focus on connection toughness, geometry, weld quality, and expected deformation demand. Paint adhesion, added partition weight, and roof drainage do not address the brittle connection mechanism that can compromise the seismic frame.

20. C — Precast elements can experience significant relative movement during strong shaking. Inadequate bearing length or weak positive connections can allow units to lose support or separate from their intended load path. Landscape irrigation, carpet wear, and ordinary glazing expansion do not represent the primary life-safety mechanism created by limited precast support and connection capacity.

21. B — Tilt-up walls depend on positive anchorage to the roof diaphragm for out-of-plane stability and for a continuous seismic load path. Strengthening that interface directly addresses a well-known vulnerability. Adding roof weight increases inertia, reducing inspection weakens quality control, and removing temporary bracing does not improve the completed wall-to-diaphragm connection. Seismic design follows the load path and the expected deformation mechanism.

22. C — New lateral elements are effective only if earthquake inertia forces can reach them through a continuous load path. A weak collector connection can prevent the diaphragm from transferring the intended force to the new walls. Added walls do not automatically eliminate torsion or diaphragm demand, and collector capacity is directly relevant to retrofit effectiveness.

23. A — The base shear follows directly from V = CsW = 0.094(4,800) = 451.2 kips. Moving the decimal one place gives 45.12 kips, 510.6 kips uses the wrong coefficient, and adding the weight and coefficient does not produce a force consistent with the stated equation. The units remain consistent with the quantity requested in the stem.

24. D — Using the relation given, Cs = 0.96(1.25)/6.0 = 0.200. Dividing SDS by R without the importance factor gives 0.160, while the other numerical choices result from rearranging the factors incorrectly. Keeping the coefficient dimensionless is also consistent with its later use in multiplying seismic weight. The units remain consistent with the quantity requested in the stem.

25. B — The total weighting is 2,100 + 4,200 + 6,300 + 8,400 = 21,000. The second-level coefficient is therefore 4,200/21,000 = 0.20. The other fractions correspond to the first, third, and fourth weighting terms rather than the second level requested in the question. The units remain consistent with the quantity requested in the stem.

26. D — The floor force is Fx = CvxV = 0.27(690) = 186.3 kips. Ten percent of the base shear gives 69.0 kips, 255.6 kips corresponds to a different coefficient, and adding 0.27 to 690 has no physical meaning for a force-distribution calculation. The units remain consistent with the quantity requested in the stem.

27. A — Story shear at a cut equals the sum of lateral forces at and above that level. Just below the second level from the roof, the 95-kip roof force and 78-kip second-level force are included, giving 173 kips. The remaining choices omit a force, use a different cut, or sum all floors.

28. C — The base overturning moment is the sum of each force times its elevation: 55(14) + 85(28) + 125(42) = 770 + 2,380 + 5,250 = 8,400 kip-ft. The other values result from omitting or misplacing one of the force-height products. The units remain consistent with the quantity requested in the stem.

29. C — Torsional moment equals story shear times eccentricity, so Mt = 465(5.5) = 2,557.5 kip-ft. Dividing produces about 84.5, simple addition gives 470.5, and the larger value does not follow the stated force-times-distance relationship. Moment units confirm that multiplication is the correct operation. The units remain consistent with the quantity requested in the stem.

30. B — Five percent of the stated plan dimension is 0.05(96 ft) = 4.8 ft. The 1.92-ft option uses 2%, 5.0 ft treats the percentage as a fixed distance, and 9.6 ft uses 10%. Applying the percentage to the dimension is the operation explicitly required in the stem. The units remain consistent with the quantity requested in the stem.

31. D — For rigid-diaphragm direct shear without torsion, force is proportional to line stiffness. Total stiffness is 24 + 36 + 60 = 120 units, so the 36-unit frame receives 36/120 of 840 kips, or 252 kips. The other choices correspond to different stiffness fractions. The units remain consistent with the quantity requested in the stem.

32. A — The chord couple force is F = M/d = 2,240/56 = 40 kips. The 28-kip and 56-kip choices reflect unrelated numerical manipulations, while 125.4 kips does not satisfy the moment-over-depth relation. Multiplying the 40-kip force by the 56-ft spacing recovers the original diaphragm moment. The units remain consistent with the quantity requested in the stem.

33. D — For a uniform transfer along the tributary length, the accumulated collector force is 2.8 kips/ft times 34 ft, which equals 95.2 kips. The other values result from addition or incorrect multiplication. The feet cancel, leaving kips, which is appropriate for the axial force requested. The units remain consistent with the quantity requested in the stem.

34. A — Substitution into the stated expression gives Ev = 0.2(0.68)(1,250) = 170 kips. The alternatives result from using only part of the factor or multiplying by the wrong decimal. Because SDS and 0.2 are dimensionless, the result retains the force units of the dead load. The units remain consistent with the quantity requested in the stem.

35. B — First amplify QE by rho: 1.2(128) = 153.6 kips. Adding Ev gives E = 153.6 + 24 = 177.6 kips. The 153.6-kip choice omits Ev, while the other choices combine the values incorrectly. The sequence follows the equation exactly and keeps all terms in force units. The units remain consistent with the quantity requested in the stem.

36. C — The overstrength term is Omega0QE = 3.0(64) = 192 kips. Adding the 16-kip vertical term gives Em = 208 kips. The 192-kip option omits Ev, 80 kips simply adds QE and Ev, and 240 kips applies an incorrect factor to the combined quantities. The units remain consistent with the quantity requested in the stem.

37. D — A force couple produces moment Fd, so F = M/d = 2,640/44 = 60 kips. The 30-kip option halves the required force, 44 kips confuses spacing with force, and 116.2 kips does not reproduce the stated moment. Checking 60(44) returns 2,640 kip-ft. The units remain consistent with the quantity requested in the stem.

38. C — Using the specified coefficient, Fpx = 0.21(1,120) = 235.2 kips. Ten percent of the weight gives 112.0 kips, 213.3 kips corresponds to a different coefficient, and adding 0.21 to the weight is not a valid force calculation. The result scales directly with diaphragm weight. The units remain consistent with the quantity requested in the stem.

39. B — Substituting into Ft = Mtr/J gives 3,600(18)/1,620 = 40 kips. The other values arise from dividing or multiplying the parameters in a different order. Dimensional cancellation also works: kip-ft times ft divided by ft squared leaves kips, the requested line force. The units remain consistent with the quantity requested in the stem.

40. A — The total stiffness is 45 + 75 = 120 units. The 75-unit frame receives 75/120 of the 640-kip direct shear, which equals 400 kips. The remaining 240 kips goes to the 45-unit frame. Equal sharing or other fractions would ignore the stipulated stiffness-proportional rigid-diaphragm distribution. The units remain consistent with the quantity requested in the stem.

41. B — Convert the story height to inches: 12.5 ft = 150 in. The permitted drift is 0.018(150) = 2.70 in. The 0.225-in. value applies the decimal to feet without conversion, and the other choices correspond to different drift ratios rather than the one stated. The units remain consistent with the quantity requested in the stem.

42. A — Average unit shear is the total shear divided by effective width: 612/68 = 9.0 kips/ft. The other choices use incorrect division or multiplication. The force divided by length naturally produces force per unit length, which matches the units requested for diaphragm unit shear. The units remain consistent with the quantity requested in the stem.

43. C — Story shear at the selected cut is the sum of lateral forces at and above that cut: 110 + 82 + 64 = 256 kips. The 48-kip force below the cut is not included. The alternatives either omit an upper force, include the lower force, or use only the lower-level force.

44. D — The stated cap is C_uT_a = 1.50(0.58 s) = 0.87 s. Dividing gives about 0.39 s, retaining 0.58 s ignores C_u, and adding the two inputs gives 2.08 rather than applying the required product. The coefficient is dimensionless, so the result remains in seconds. The units remain consistent with the quantity requested in the stem.

45. D — The specified combination is 165 + 0.30(70) = 165 + 21 = 186 kips. Using 165 alone omits the orthogonal contribution, 214.5 kips applies 30% to the wrong quantity, and 235 kips adds 100% of both directions rather than following the stated rule. The units remain consistent with the quantity requested in the stem.

46. C — A wall has mass, so earthquake acceleration perpendicular to its plane creates out-of-plane inertial force. Positive anchorage and the supporting diaphragm must transfer that force into the seismic load path while maintaining wall stability. Gravity parallel to the wall, finish temperature effects, and roof drainage do not represent the stated seismic action.

47. B — A diaphragm subjected to in-plane bending develops a tension-compression couple near its boundaries, analogous to flange forces in a beam. Chords provide that axial resistance. They do not merely support plumbing, eliminate collector demands, or prevent floor acceleration. Their role is part of the diaphragm force-resisting mechanism and load path.

48. A — Collectors gather diaphragm shear over a tributary region and transfer the resulting axial force to a vertical resisting element when direct distributed transfer is not available. They are therefore critical load-path elements. They do not eliminate diaphragm shear, change the seismic hazard, or exist primarily to support architectural partition loads.

49. D — The bracketed term is 0.4(1.0)(0.90)(18)/(3.0) = 2.16 kips. With z/h = 0.50, the height multiplier is 1 + 2(0.50) = 2. Therefore F_p = 2.16(2) = 4.32 kips. The other choices omit, triple, or otherwise misapply the height factor. The units remain consistent with the quantity requested in the stem.

50. A — Substitution gives Fp,min = 0.3(0.85)(1.5)(24) = 9.18 kips. Omitting the importance factor gives 6.12 kips, using 0.3(1.5)(24) gives 10.80 kips, and simply adding or miscombining the inputs produces the larger distractor rather than the specified product. The units remain consistent with the quantity requested in the stem. This also distinguishes the correct operation from the common distractor calculations.

51. B — Using the stated maximum expression, Fp,max = 1.6(0.72)(1.0)(22) = 25.344 kips. The distractors omit a factor, add values, or use a different coefficient. Since the spectral and importance terms are dimensionless, multiplying by component weight correctly leaves the final result in kips. The units remain consistent with the quantity requested in the stem.

52. C — As z/h increases, the multiplier 1 + 2z/h increases, so the calculated component force rises when all other parameters stay fixed. Elevation does not remove the dependence on component weight, set the importance factor to zero, or eliminate anchorage. The expression represents greater amplified response higher in the structure. Seismic design follows the load path and the expected deformation mechanism.

53. A — Positive anchorage provides a designed path for earthquake inertia forces from the equipment into the supporting structure and helps prevent sliding, rocking, or overturning. It does not alter the site hazard or eliminate normal operating vibration. The anchor system works with, rather than replaces, the equipment support and structural load path.

54. D — Liquid in a tank can oscillate relative to the container, producing convective or sloshing response in addition to impulsive inertia associated with the tank and a portion of the fluid. That dynamic behavior can affect forces and freeboard. Paint thickness, humidity, and finish abrasion are unrelated to the principal seismic response of stored liquid.

55. C — Base overturning moment equals horizontal force times its height of application: 21 kips times 19 ft = 399 kip-ft. Adding the numbers gives 40, multiplying by 10 gives 210, and doubling the correct moment gives 798. Force times perpendicular distance is the required moment relationship. The units remain consistent with the quantity requested in the stem.

56. B — A heavy parapet develops significant out-of-plane inertia during earthquake shaking. Positive attachment and bracing transfer that force into the structure and reduce the risk of overturning or falling debris. The attachment does not manage rainwater, eliminate thermal movement, or change occupancy classification. Its purpose is seismic stability and life-safety load transfer.

57. A — A seismic joint permits adjacent structural segments to move relative to one another. A piping crossing must accommodate that movement without tearing the pipe, fittings, or supports. Rigidly bridging the joint can transfer unintended forces and cause rupture. Flexible detailing does not eliminate ordinary support requirements or restrain the buildings from moving as designed.

58. C — Lateral bracing limits excessive horizontal movement of suspended services and provides a force path for their earthquake inertia into the supporting structure. Gravity hangers primarily carry vertical weight and are not automatically replaced. Bracing does not change operating pressure or geotechnical site class. It addresses seismic stability and collision or connection damage risk.

59. B — The specified lateral force is the coefficient times rack weight: 0.24(105) = 25.2 kips. Dividing gives about 4.38 kips, using 0.24 as if the weight were 100 gives 24.0 kips, and adding coefficient and weight does not produce a physically meaningful force. The units remain consistent with the quantity requested in the stem.

60. D — A heavy unanchored component develops inertia as the floor accelerates. With a high center of mass, that force can produce significant overturning moment as well as sliding demand. Lack of anchorage therefore creates a stability hazard. It does not reduce site motion, automatically add damping, or eliminate the component acceleration that creates the force.

61. B — Using the stated relation gives V = 0.19(260) = 49.4 kips. Dividing the weight by an unrelated factor or using a nearby coefficient produces the other force values, while adding 0.19 to 260 is not the required operation. The coefficient is dimensionless, leaving the result in kips. The units remain consistent with the quantity requested in the stem.

62. D — Distributed systems experience their own inertia while also crossing supports or structural regions that may move differently. Bracing controls excessive sway and transfers force, while flexible joints or connections accommodate relative displacement where needed. These functions are complementary. Neither feature is simply insulation, and flexibility or bracing alone does not address every seismic demand.

63. A — Substituting the stated values gives Ta = 0.028(72^0.75), which is approximately 0.69 seconds. The other choices result from ignoring the exponent, using a different exponent, or multiplying the inputs incorrectly. The formula is empirical, so following its stated powers and coefficient is essential. The units remain consistent with the quantity requested in the stem.

64. C — The target period lies halfway between 0.4 and 0.8 seconds, so linear interpolation gives the midpoint between 1.10g and 0.70g. That midpoint is (1.10 + 0.70)/2 = 0.90g. The alternatives do not represent the halfway value on the specified straight-line segment. The units remain consistent with the quantity requested in the stem.

65. B — Effective modal mass measures how much of the structure mass participates through a particular mode in a selected excitation direction. It depends on the mode shape and mass distribution. It is not simply the mass of one member, material density, or total gravity load independent of the dynamic characteristics of the mode.

66. C — The SRSS combination is sqrt(24^2 + 32^2) = sqrt(576 + 1,024) = sqrt(1,600) = 40 units. Direct averaging gives 28, direct addition gives 56, and multiplication gives 768. SRSS combines modal peaks statistically rather than assuming they occur simultaneously with the same sign. The units remain consistent with the quantity requested in the stem.

67. D — Closely spaced modes can have correlated responses, violating the assumption that modal peaks are statistically independent. CQC includes correlation terms and can therefore combine such modes more appropriately. It does not make mode shapes identical, restrict SRSS to gravity analysis, or eliminate the need to determine the dynamic modes in the first place.

68. A — A modal solution represents the structure by superimposing selected vibration modes. If important participating mass lies in omitted modes, the combined response may miss relevant forces, accelerations, or deformations. Including enough effective modal mass improves completeness. Additional modes do not automatically reduce response, and the first mode does not contain all structural participation.

69. B — Using the stated relation, delta = 4.5(0.48)/1.2 = 1.80 inches. Dividing the elastic displacement by the product gives the small distractor, omitting Ie gives 2.16 inches, and multiplying by Ie instead of dividing gives about 2.59 inches. The equation directly controls the calculation. The units remain consistent with the quantity requested in the stem.

70. A — Substitution gives theta = 1,650(1.2)(1.0)/[360(150)(5.5)] = 1,980/297,000 = about 0.00667. The denominator includes story shear, story height, and Cd, so omitting any major factor produces a much larger value. The ratio is dimensionless after force and displacement units cancel appropriately. The units remain consistent with the quantity requested in the stem.

71. D — Dynamic analysis can distribute forces and capture modal behavior well while still producing an overall base shear below a prescribed minimum benchmark. Scaling raises the combined response to the required force level without discarding the modal distribution. It does not make periods identical, remove torsion, or change the physical diaphragm classification.

72. C — Equivalent lateral force methods are most appropriate when structural height, regularity, and dynamic behavior are sufficiently simple for a static representation to capture the important response. Tall, torsionally irregular, or dynamically complex structures are more likely to require procedures that explicitly represent multiple modes and three-dimensional behavior. The analytical idealization must remain consistent with the structural response being evaluated.

73. C — Accidental eccentricity introduces a nominal offset to represent uncertainties in the actual location of mass, stiffness, and applied inertia force that are not captured perfectly by the analytical model. It can therefore create design torsion even when calculated centers coincide. It does not guarantee zero torsion or represent gravity settlement.

74. B — A flexible diaphragm can deform enough that it does not enforce nearly rigid translation and rotation among the vertical resisting lines. Direct lateral force may therefore be distributed primarily by tributary loading instead of stiffness compatibility. Equal sharing, zero torsion, and infinite in-plane stiffness are not consequences of the flexible-diaphragm assumption.

75. D — For springs in series, keq = 1/(1/48 + 1/80). The reciprocal sum is 1/30, so keq = 30 kips/in. An equivalent series stiffness must be less than either individual stiffness, which also rules out 64 and 128. The 32-kip option is close but does not satisfy the equation. The units remain consistent with the quantity requested in the stem.

76. A — The relation can be written Cs = SDS Ie/R, so R appears in the denominator. Increasing R with SDS and Ie fixed therefore reduces Cs. The coefficient does not increase, stay unchanged, or become numerically equal to R. The relationship represents reduced design force associated with greater ductile response modification.

77. C — Selected collectors, connections, and other load-path elements may need sufficient strength to transmit forces associated with yielding of the intended ductile system rather than fail prematurely. An overstrength factor addresses that demand. It does not reduce all forces, eliminate connection design, or modify the site seismic hazard itself. The analytical idealization must remain consistent with the structural response being evaluated.

78. A — Strong irregularity can cause torsion, localized deformation, discontinuous force paths, or significant modal effects that a simplified analysis may not represent adequately. A more rigorous model can capture those behaviors. Irregularity does not inherently reduce demand, guarantee first-mode dominance, or eliminate diaphragm deformation; it often makes response less uniform and predictable.

79. B — A torsionally sensitive structure can experience larger edge displacements and line forces than a nominal eccentricity calculation suggests. Torsional amplification increases the design torsional effect to address that sensitivity. It does not remove translational shear, change the physical diaphragm flexibility, or make the actual centers of mass and rigidity coincide.

80. D — Mode shapes with multiple curvature or displacement reversals over height are characteristic of higher vibration modes rather than simple first-mode sway. Significant upper-story deformation can therefore indicate important higher-mode contribution. The observation does not imply an absence of dynamics, pure rigid translation, or complete participating mass in the first mode.

81. A — The stated equation is directly proportional to SDS when D is fixed. Multiplying SDS by 1.50 therefore multiplies Ev by 1.50, which is a 50% increase. The effect does not decrease, double, or remain constant. No additional nonlinear relationship is present in the simplified expression used for this question. This preserves compatibility between the model assumptions and the calculated response.

82. B — Nonlinear response-history results depend strongly on the amplitude, duration, frequency content, and other characteristics of the applied ground motions. Records should therefore be compatible with the hazard being evaluated so the structural demands are meaningful. Arbitrary motions are not equivalent, scaling does not change gravity load, and a structural model is still required.

83. C — SRSS gives sqrt(18^2 + 24^2 + 45^2) = sqrt(324 + 576 + 2,025) = sqrt(2,925), which is about 54.08 units. The other answers use averaging, direct addition, or multiplication. SRSS is specifically the square root of the sum of squared modal responses. The units remain consistent with the quantity requested in the stem.

84. D — The square root of 0.0144 s^2 is 0.12 s. Multiplying by 2pi gives T = 2pi(0.12) = about 0.754 s. The 0.120-s choice stops before the 2pi factor, 0.377 s uses pi, and 1.508 s doubles the correct result. The units remain consistent with the quantity requested in the stem.

85. D — The nominal torsional moment is story shear times eccentricity: 300 kips times 7 ft = 2,100 kip-ft. Dividing gives about 42.9, adding gives 307, and doubling gives 4,200. The offset between mass and rigidity centers creates a force-times-distance moment in addition to translation. The units remain consistent with the quantity requested in the stem.

86. B — Total stiffness is 20 + 30 + 50 = 100 units. The 20-unit line therefore receives 20/100 of the 600-kip direct shear, or 120 kips. The other values correspond to different fractions. Under the stated rigid-diaphragm assumption, direct translation is distributed in proportion to lateral stiffness. The units remain consistent with the quantity requested in the stem.

87. C — A semi-rigid model represents finite diaphragm stiffness, allowing in-plane diaphragm deformation and its interaction with frames or walls to influence force distribution and torsion. It does not assume zero stiffness, force a purely tributary distribution, or eliminate diaphragm forces. The model is useful when floor flexibility materially affects structural response.

88. A — Diaphragm discontinuities, offsets, and collectors can create concentrated axial, shear, and connection demands that are not visible if story forces are placed only at vertical elements. Explicit modeling helps trace how inertia reaches the resisting system. Collectors do carry seismic force, and discontinuities do not eliminate the need for a continuous load path.

89. B — Critical seismic weld performance depends on the specified base and filler materials, qualified procedures and personnel, joint preparation, and acceptable workmanship. Special inspection verifies those requirements against the approved documents. Finish color, temporary lighting, and mailing information do not establish the strength, toughness, or deformation capacity of the structural welded connection.

90. D — Bolted seismic connection behavior depends on the correct fastener assembly, hole and faying-surface condition, installation method, and any required pretension. Those features directly affect force transfer and slip behavior. Furniture, paint, and parking arrangements do not verify that the structural connection was installed consistently with the approved seismic design. Field deviations require evaluation because connection behavior can change materially.

91. C — Transverse reinforcement in plastic-hinge regions confines the concrete core, supports longitudinal bars against buckling, and contributes to cyclic shear resistance. These functions help members sustain inelastic deformation without losing strength abruptly. The reinforcement does not change seismic hazard, prevent all cracking, or replace the longitudinal steel required for flexural and axial resistance.

92. A — Reinforced masonry relies on correctly located and developed reinforcement, adequate grout placement around the bars, and continuity through connections and splices. These details establish the intended strength and deformation capacity. Signage, landscaping, and scaffolding color do not verify the permanent seismic load path or the integrity of the reinforced masonry system.

93. B — Panel-edge fasteners transfer shear between the wood sheathing and its framing, so size, spacing, edge distance, and installation affect both strength and stiffness. They do not determine the site hazard, eliminate overturning, or replace collectors where concentrated force transfer is required. Proper fastening is therefore a central seismic detailing and inspection item.

94. A — Anchor edge distance can affect concrete breakout, splitting, installation tolerances, and the force-transfer assumptions used in design. A field deviation should therefore be evaluated before concealment, with an engineered repair or acceptance documented as appropriate. Assuming equivalence or weakening adjacent load-path components is not a sound quality-control response. Seismic quality control verifies that the intended load path is actually constructed.

95. D — Collector splices can carry substantial axial seismic force and may be located to coordinate force transfer, development, and connection capacity. Relocation can therefore change structural demand or detailing assumptions. The responsible engineer should evaluate and approve the revision before installation. Collectors are structural load-path elements, so architectural approval alone is not sufficient.

96. C — Post-installed anchor performance can be sensitive to drilling, hole cleaning, embedment depth, adhesive or mechanical installation, spacing, edge distance, and substrate condition. Inspection helps confirm that the installed condition matches the qualified design assumptions. Workmanship is not irrelevant, concrete failure modes remain possible, and anchor strength does not automatically equal attached-member strength.

97. B — A building seismic joint permits adjacent structural segments to move relative to one another. The sprinkler crossing must therefore use a detail capable of accommodating expected movement without rupture or loss of support. Rigidly bridging or grouting the joint can defeat that purpose, while removing supports can create a separate stability problem.

98. C — Special moment-frame connections depend on controlled geometry, material properties, and welding to develop the intended strength and inelastic deformation capacity. Poor access-hole details, preparation, or welding can introduce defects and stress concentrations. These fabrication features do not determine site class, eliminate member design, or keep the frame perfectly elastic during severe shaking.

99. A — Structural observation provides periodic review by the design professional or qualified observer of significant structural construction for general conformance with the approved documents. It complements, rather than replaces, required inspection and testing. Observation does not control contractor means and methods and cannot guarantee that a completed structure will suffer no earthquake damage.

100. D — Accurate as-built records show how the seismic system was actually constructed, including approved deviations, repairs, and connection changes. That information can be critical during future alterations, damage assessment, or retrofit planning. Documentation does not replace engineering judgment or testing and cannot prove that earthquake damage will never occur. Seismic quality control verifies that the intended load path is actually constructed.