PRACTICE EXAM 8: PE CIVIL–CONSTRUCTION DEPTH SIMULATION (100 QUESTIONS)

This practice exam contains 100 questions modeled on the NCEES Principles and Practice of Engineering (PE) Civil–Construction depth exam. The actual NCEES exam contains 80 questions and allows 9 hours to complete, including a tutorial and an optional scheduled break; examinees must answer every question. The exam is computer-based, closed-book, with electronic references (the NCEES PE Civil Reference Handbook and listed design standards) provided on-screen. NCEES does not publish a fixed passing percentage; results are scaled for form difficulty. Select the best answer for each question.

1. A retaining wall 14 ft high retains a cohesionless backfill with unit weight $\gamma = 118$ pcf and angle of internal friction $\varphi = 27°$, with a level backfill surface and no surcharge. Using Rankine theory, what is the total active lateral force per foot of wall length acting on the wall?

A. 4.34 kip/ft
B. 6.51 kip/ft
C. 3.26 kip/ft
D. 8.68 kip/ft

2. A normally consolidated clay layer 18 ft thick has an initial void ratio $e0 = 0.85$ and compression index $Cc = 0.34$. The effective overburden stress at mid-height is 2,600 psf, and a footing load increases the effective stress at mid-height by 1,700 psf. What is the primary consolidation settlement of the layer?

A. 6.20 in
B. 10.50 in
C. 4.80 in
D. 8.67 in

3. A soil profile consists of 9 ft of sand (moist unit weight 118 pcf) above the water table, underlain by 13 ft of saturated sand (saturated unit weight 130 pcf) below the water table. What is the effective vertical stress at a depth of 22 ft (bottom of the saturated layer)?

A. 2,752 psf
B. 1,941 psf
C. 1,062 psf
D. 1,600 psf

4. A strip footing 4.2 ft wide is founded at a depth of 5 ft in a cohesionless soil with unit weight 118 pcf. At this friction angle, Terzaghi's bearing capacity factors are $N_q = 19$ and $N_\gamma = 13$. What is the ultimate bearing capacity of the footing, neglecting the cohesion term?

A. 11,210 psf
B. 3,221 psf
C. 14,431 psf
D. 16,200 psf

5. An infinite slope in cohesionless sand is inclined at 21° to the horizontal. The sand has an effective friction angle of 35° and no cohesion, with the slope fully drained. What is the factor of safety against sliding along a plane parallel to the slope surface?

A. 1.82
B. 1.40
C. 1.60
D. 2.15

6. A soil sample tested in a direct shear box shows a linear relationship between applied normal stress and peak shear stress at failure, passing through the origin. What does this result indicate about the soil's shear strength parameters?

A. The soil has very high cohesion and negligible internal friction angle

B. The test result is invalid, since real soils never show a linear relationship

C. The soil has essentially zero cohesion, with shear strength derived almost entirely from internal friction proportional to normal stress

D. The soil's permeability can be directly determined from this same test result

7. Which best describes the relationship between a soil's plasticity index (PI) and its expected volume change behavior when exposed to moisture fluctuations?

A. Plasticity index has no relationship whatsoever to shrink-swell behavior

B. Higher plasticity index soils generally exhibit greater potential for shrink-swell behavior as moisture content changes

C. Lower plasticity index soils always exhibit greater shrink-swell potential than higher PI soils

D. Plasticity index only describes a soil's permeability, not its volume change behavior

8. A footing is being designed on a slope rather than level ground, with the ground surface sloping away from one side of the footing. How does this sloping ground condition typically affect the footing's ultimate bearing capacity compared to an identical footing on level ground?

A. Bearing capacity is typically increased, since the slope adds extra soil weight above the footing

B. Sloping ground has no effect on bearing capacity, only on settlement

C. Bearing capacity depends only on the footing width, never on the surrounding ground surface shape

D. Bearing capacity is typically reduced, since the sloping ground provides less lateral confinement and a shorter failure surface on the downslope side

9. A horizontal curve has a radius of 950 ft and a deflection angle (Δ) of 35°. What is the length of the curve?

A. 580.3 ft

B. 464.3 ft

C. 638.4 ft

D. 696.6 ft

10. For a horizontal curve with radius 1,200 ft and a deflection angle of 22°, what is the middle ordinate (M) of the curve?

A. 16.5 ft
B. 27.5 ft
C. 33.0 ft
D. 22.0 ft

11. During construction layout of a large building, why does a surveyor typically establish a rectangular control grid of permanent points around the building footprint, rather than laying out each column line independently from a single instrument setup?

A. A control grid is purely a cosmetic convention with no functional layout benefit
B. Column lines can only legally be laid out from a single fixed instrument position
C. A control grid provides multiple redundant reference points from which any column line can be checked and re-established if a single point is disturbed
D. A control grid is required only for buildings taller than a specified number of stories

12. A grade stake is set where the existing ground elevation is 280.10 ft and the design subgrade elevation is 283.55 ft, requiring a fill. What is the magnitude of the fill, in feet, to be noted on the stake?

A. 2.45 ft
B. 3.45 ft
C. 4.45 ft
D. 1.45 ft

13. A crest vertical curve connects a +3.0% grade to a −2.0% grade, is 500 ft long, and begins (PVC) at station 10+00 with an elevation of 145.00 ft. What is the elevation of the highest point on the curve?

A. 152.00 ft
B. 149.50 ft
C. 147.25 ft

D. 154.75 ft

14. Why does a survey crew typically establish both horizontal and vertical control before beginning construction layout on a project, rather than establishing only one type of control?

A. Vertical control is only needed on projects with significant earthwork quantities

B. Horizontal control alone is always sufficient to fully define any construction layout point

C. Establishing both types of control is a purely redundant, unnecessary practice

D. Construction elements need correct plan location and elevation, so both control types are needed to define a point in space

15. An extensometer installed within a borehole through an embankment or slope is used to measure which specific condition?

A. The magnitude and distribution of internal ground movement or deformation along the length of the borehole

B. The ambient air temperature at various depths within the borehole

C. The concentration of dissolved oxygen in groundwater at that location

D. The exact bearing capacity of the soil at the borehole's bottom

16. Based on the boring log figure shown, which soil layer is most likely to govern the design of a mat foundation intended to distribute building loads over a wide area?

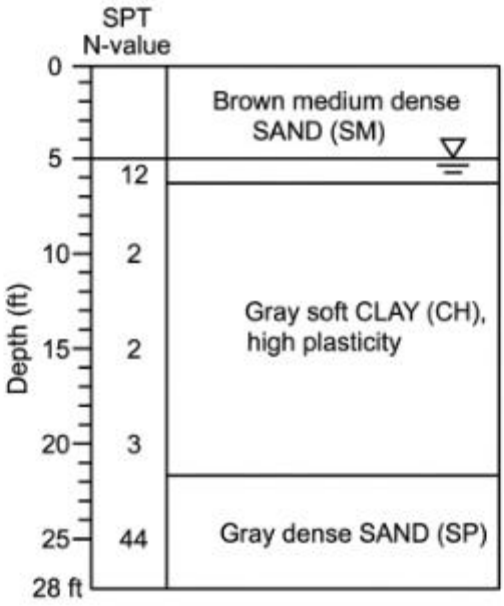


Figure PQ-1

A. The brown SAND (SM) layer from 0 to 6 ft

B. The gray dense SAND (SP) layer from 22 to 28 ft

C. The gray soft CLAY (CH) layer from 6 to 22 ft, given its very low blow counts and high compressibility

D. No single layer governs, since mat foundations are unaffected by underlying soil conditions

17. A concrete mix uses 460 lb of cement and 207 lb of water per cubic yard. What is the water-cement ratio (w/c) of this mix?

A. 0.45

B. 0.55

C. 0.40

D. 0.50

18. Which structural steel property describes its resistance to plastic deformation, typically defined as the stress at which a material begins to deform permanently rather than elastically?

A. Ultimate tensile strength

B. Modulus of elasticity

C. Yield strength
D. Poisson's ratio

19. A sieve analysis of a coarse aggregate sample shows 350 g retained cumulative on the No. 4 sieve out of a total sample mass of 700 g. What percent of the sample passes the No. 4 sieve?

A. 60%
B. 50%
C. 40%
D. 35%

20. Why is ground granulated blast-furnace slag (GGBFS) commonly used as a partial cement replacement in mass concrete pours, such as large dam or foundation elements?

A. GGBFS accelerates the concrete's setting time significantly compared to portland cement alone
B. GGBFS functions purely as an inert filler with no chemical reaction with the cement paste
C. GGBFS eliminates the need for any reinforcing steel in mass concrete elements
D. GGBFS reacts more slowly than portland cement, generating less heat of hydration and reducing the risk of thermal cracking in large concrete masses

21. In a pretensioned prestressed concrete member, why is the prestressing force typically applied to the strands before the concrete is cast, rather than after?

A. Pretensioning anchors strand against fixed abutments in an open bed before casting, transferring force via bond once cured
B. Pretensioning is always cheaper than post-tensioning regardless of project scale
C. Applying force before casting eliminates the need for any concrete curing period
D. Pretensioning is only used for members shorter than 20 ft in length

22. A steel tension member has a cross-sectional area of 4.6 in^2 and is subjected to an axial tensile force of 138 kips. What is the axial stress in the member?

A. 24 ksi
B. 34 ksi
C. 30 ksi
D. 20 ksi

23. A rectangular concrete footing measures 7 ft by 4 ft by 2 ft thick. How many cubic yards of concrete are required for one footing, ignoring waste?

A. 1.55 cy
B. 2.07 cy
C. 2.59 cy
D. 1.04 cy

24. A contractor estimates that placing structural concrete costs $215 per cubic yard for materials and $95 per cubic yard for labor and equipment. What is the total estimated cost to place 210 cubic yards of concrete?

A. $45,150
B. $65,100
C. $19,950
D. $52,500

25. A contractor is deciding between purchasing equipment for $78,000 with annual operating savings of $13,000, versus continuing to rent. Ignoring the time value of money, how many years of use are required for the purchase to break even against the savings?

A. 5 years
B. 7 years
C. 4 years
D. 6 years

26. A project has a Budgeted Cost of Work Performed (earned value) of $410,000 and an Actual Cost of Work Performed of $450,000. What is the Cost Performance Index (CPI) for the project?

A. 1.10
B. 0.85
C. 1.20
D. 0.91

27. Two adjacent cross-sections along a roadway alignment, spaced 105 ft apart, have cut areas of 250 ft² and 290 ft², respectively. Using the average end area method, what is the cut volume, in cubic yards, between the two sections?

A. 840.0 cy
B. 1,260.0 cy
C. 1,050.0 cy
D. 630.0 cy

28. A contractor's direct cost estimate for a project totals $1,020,000. If the contractor applies a combined markup of 9% for overhead and profit, what is the total bid price?

A. $1,111,800
B. $1,020,000
C. $1,071,000
D. $1,153,600

29. A footing requires 35 pieces of No. 6 reinforcing bar, each 13 ft long. The unit weight of No. 6 rebar is 1.502 lb/ft. What is the total weight of reinforcing steel required, rounded to the nearest pound?

A. 683 lb
B. 570 lb
C. 796 lb
D. 910 lb

30. Why does a contractor's cost estimate typically distinguish between direct costs, such as labor, material, and equipment for the work itself, and indirect costs, such as project overhead and general conditions?

A. Direct and indirect costs are always numerically identical on every project regardless of scope
B. This separation exists purely as a bookkeeping formality with no bearing on estimate accuracy
C. Only indirect costs are ever included in a contractor's final bid price to the owner
D. Separating costs allows better cost control, since direct costs vary with quantity of work while indirect costs are largely time-dependent

31. In a typical multi-story building sequence, which activity generally must be substantially complete on a given floor before interior partition wall framing begins on that same floor?

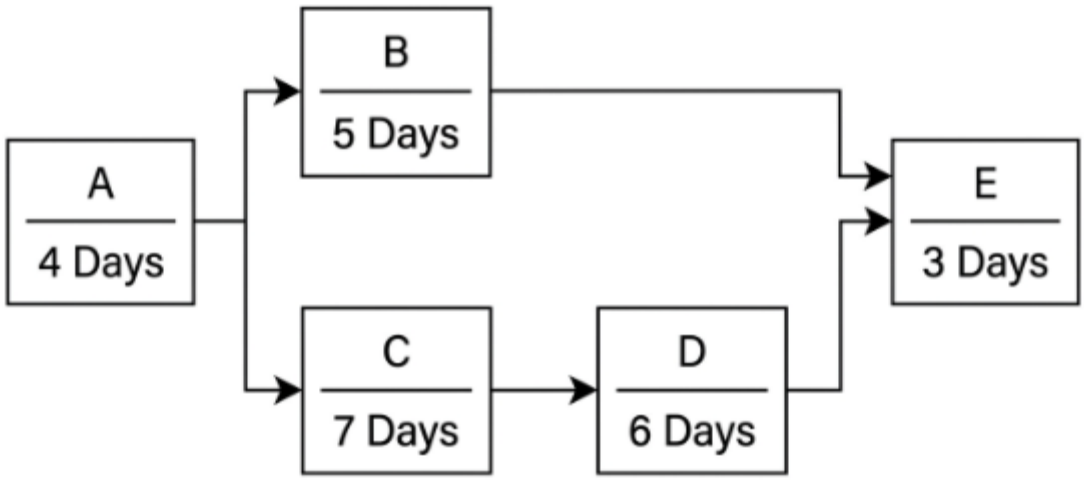
A. Installation of finished flooring throughout the building
B. Structural floor slab placement and curing to adequate strength on that floor
C. Final interior painting of completed walls
D. Installation of the building's permanent elevator cab

32. An activity's duration estimates using PERT are: optimistic (a) = 4 days, most likely (m) = 9 days, pessimistic (b) = 20 days. What is the PERT expected duration (te) for this activity?

A. 9 days
B. 11 days
C. 10 days
D. 12 days

33. Based on the CPM network diagram shown, what is the length of the critical path through the project, in days?

Figure PQ-2: CPM Network Diagram



A. 16 days
B. 14 days
C. 20 days
D. 24 days

34. An activity has an Early Start of day 11, an Early Finish of day 17, and a Late Finish of day 25. What is the total float for this activity?

A. 14 days
B. 6 days
C. 11 days
D. 8 days

35. What distinguishes a 'finish-to-finish' precedence relationship from a standard 'finish-to-start' relationship in a CPM schedule?

A. Finish-to-finish and finish-to-start are functionally identical relationships with different names
B. Finish-to-finish requires the predecessor to finish before the successor finishes, letting the successor's work overlap concurrently

C. Finish-to-finish relationships can only be used for the very last activity in a project

D. Finish-to-finish always requires a longer overall project duration than finish-to-start

36. An activity has a normal duration of 11 days at a normal cost of $8,000, and a crash duration of 7 days at a crash cost of $13,600. What is the cost slope (cost per day) to crash this activity?

A. $1,400/day

B. $1,000/day

C. $1,800/day

D. $800/day

37. A wastewater treatment plant expansion with several nearly identical treatment basins, each following the same construction sequence, would most benefit from which scheduling technique to compare crew progress across the basins?

A. PERT with three-point estimates alone

B. A simple, unlinked bar chart with no logic ties

C. Linear scheduling method (line-of-balance)

D. A milestone-only schedule with no intermediate detail

38. A project's critical path must be shortened by 4 days to meet a contractual deadline. The only critical activity available to crash has a cost slope of $1,250 per day, with enough crash days available. What is the minimum additional direct cost to achieve the required 4-day reduction?

A. $4,000

B. $6,000

C. $3,000

D. $5,000

39. Three activities are scheduled to run concurrently on a given day, each requiring one crew of pipefitters: Activity X needs 4 pipefitters, Activity Y needs 8 pipefitters, and Activity Z needs 7 pipefitters. If only 15 pipefitters are available that day, what is the resource shortfall?

A. 2 pipefitters

B. 4 pipefitters

C. 6 pipefitters

D. 19 pipefitters

40. What is the primary function of a 'schedule of values' submitted by a contractor for a lump-sum construction contract?

A. It establishes the contractor's internal profit margin on each individual line item

B. It replaces the need for a detailed CPM schedule on the project

C. It applies only to unit-price contracts, never to lump-sum contracts

D. It breaks the lump-sum price into line items by activity or system, supporting progress payments tied to completed work

41. A 6-in. diameter concrete test cylinder fails in compression at a load of 101,788 lb. What is the measured compressive strength of the cylinder, in psi?

A. 3,600 psi

B. 3,200 psi

C. 4,000 psi

D. 2,900 psi

42. A welding inspector performs a visual inspection of a completed structural weld and notices undercut, a groove melted into the base metal at the weld toe, exceeding the allowable depth in the applicable welding code. What is the appropriate response?

A. Accept the weld as-is, since undercut is a purely cosmetic defect with no effect on strength

B. Grind the entire weld off and leave the connection unwelded

C. Reject the weld and require repair per the applicable welding code's procedures before the connection is accepted

D. Accept the weld only if it is painted over to conceal the defect

43. What is the primary purpose of documenting concrete placement conditions, such as ambient temperature, concrete temperature, and weather, in a daily field report during placement?

A. This documentation creates a record supporting later evaluation of test results and troubleshooting if strength or durability concerns arise

B. This documentation is purely a formality required for the contractor's internal filing system

C. This documentation replaces the need for any cylinder testing on that day's placement

D. This documentation is used solely to determine the concrete supplier's delivery fee

44. During compaction of an asphalt pavement lift, why is it important to complete breakdown, intermediate, and finish rolling before the mat cools below a critical temperature threshold?

A. Rolling below the critical temperature threshold causes the asphalt binder to permanently liquefy

B. Once the mat cools sufficiently, the asphalt binder stiffens enough that further rolling cannot meaningfully increase the pavement's density

C. Temperature has no actual effect on how effectively rolling can densify the asphalt mat

D. The critical temperature threshold applies only to rolling performed at night, never during daytime paving

45. Using the Nurse-Saul maturity method with a datum temperature of 32°F (0°C), a concrete cylinder cured at an average temperature of 66°F for 44 hours accumulates how much maturity (temperature-time factor), in °F-hours?

A. 1,122 °F-hr

B. 1,870 °F-hr

C. 748 °F-hr

D. 1,496 °F-hr

46. A field density test on a compacted embankment fill shows a dry unit weight of 114 pcf. The laboratory maximum dry unit weight from a standard Proctor test is 122 pcf. What is the percent (relative) compaction achieved in the field?

A. 89.0%
B. 96.5%
C. 93.4%
D. 86.0%

47. What is the primary purpose of retaining sealed, uncracked concrete cube or cylinder specimens for extended archival storage after standard 28-day testing has already been completed and reported?

A. Archived specimens allow later re-examination, such as petrographic analysis, if a durability or performance concern arises well after the original test results were reported
B. Archived specimens are required solely to satisfy a fixed calendar storage duration with no analytical purpose
C. Archived specimens replace the need for testing any additional specimens on future, unrelated projects
D. Archived specimens are kept only to demonstrate compliance with a specific paint color requirement

48. A fillet weld connecting two steel plates has a leg size of 9/16 in. What is the effective throat thickness of this fillet weld?

A. 0.281 in
B. 0.398 in
C. 0.475 in
D. 0.353 in

49. Why do specifications for structural bolted connections typically require a specific bolt installation sequence, such as tightening from the center of a bolt group outward?

A. The sequence exists purely to make inspection paperwork easier to complete
B. A specified tightening sequence helps ensure uniform clamping force develops across the joint and prevents localized gaps or distortion from uneven, out-of-order tightening
C. Bolt tightening sequence has no actual effect on the joint's clamping force or performance
D. A specific sequence is required only for bolts larger than 1 inch in diameter

50. What is the primary purpose of a concrete mix design's slump specification range, rather than a single fixed target slump value?

A. A range acknowledges normal, acceptable batch-to-batch variability in workability while still ensuring the concrete remains placeable and within limits supporting adequate strength and finishing
B. A range exists purely because slump cannot be measured with any real precision
C. A single fixed slump value would always be achievable with perfect consistency on every batch
D. The range applies only to concrete delivered by pump, never by direct chute discharge

51. A structural member for a construction-stage condition is subjected to a dead load of 610 lb/ft and a construction live load of 300 lb/ft. Using an unfactored D + Lc service-level combination, what is the total line load on the member?

A. 760 lb/ft
B. 800 lb/ft
C. 910 lb/ft
D. 1,000 lb/ft

52. A rectangular timber beam is 10 in. wide by 15 in. deep and carries a maximum bending moment of 17 kip-ft. What is the maximum bending stress in the beam?

A. 480 psi
B. 610 psi
C. 670 psi
D. 544 psi

53. A short steel column with a cross-sectional area of 5.8 in^2 has an allowable compressive stress of 26 ksi. What is the allowable axial load capacity of the column, neglecting buckling effects?

A. 150.8 kips
B. 130.0 kips
C. 165.0 kips

D. 140.0 kips

54. A simply supported steel beam spans 17 ft and carries a concentrated load of 8 kips at midspan. The beam has a moment of inertia I = 790 in⁴ and modulus of elasticity E = 29,000 ksi. Using $\Delta = PL^3/48EI$, what is the maximum deflection at midspan?

A. 0.048 in
B. 0.075 in
C. 0.090 in
D. 0.062 in

55. Based on the triangular active earth pressure distribution shown in the figure, acting over a wall stem height of 17 ft, at what height above the base of the wall (Point O) does the resultant active earth pressure force act?

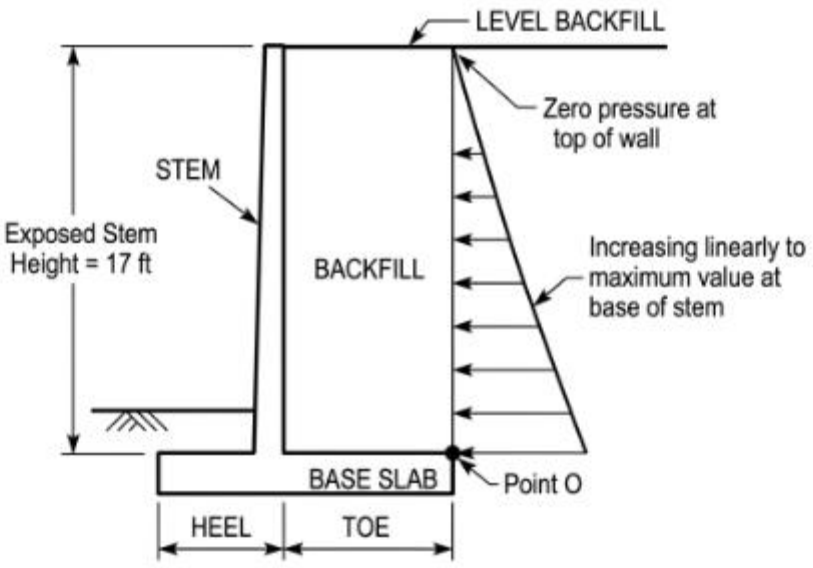


Figure PQ-3: Cross-section of a cantilever retaining wall

A. 8.50 ft
B. 4.25 ft
C. 5.67 ft
D. 11.33 ft

56. A roof purlin has a tributary width of 6.5 ft and carries a uniform roof live load of 21 psf. What is the total uniform line load on the purlin from this live load?

A. 120 lb/ft
B. 136.5 lb/ft
C. 150 lb/ft
D. 105 lb/ft

57. A structural steel beam in an exposed exterior application shows a uniform, dull reddish-brown surface coating developing evenly across its entire exposed surface, several months after erection, without flaking or section loss. What does this finish most likely indicate?

A. The beam is suffering from active, ongoing corrosion that will progressively reduce its structural capacity
B. The beam's original shop-applied primer coating has completely failed and must be immediately reapplied
C. The beam is fabricated from weathering steel, which is intentionally designed to develop a stable, protective oxide layer through initial exposure
D. The coating indicates a fabrication defect requiring the member to be rejected and replaced

58. A rectangular beam 10 in. wide by 19 in. deep carries a maximum shear force of 15 kips. Using $V_{max} = 1.5V/(bd)$ for a rectangular section, what is the maximum shear stress in the beam?

A. 100 psi
B. 118 psi
C. 135 psi
D. 150 psi

59. In a composite steel-concrete beam design, what is the primary structural function of shear studs welded to the top flange of the steel beam?

A. Shear studs exist purely to hold the metal deck formwork in place during concrete placement

B. Shear studs are required only in beams shorter than 20 ft in span

C. Shear studs primarily resist the beam's vertical shear force, not horizontal shear

D. Shear studs transfer horizontal shear between the steel beam and concrete slab, allowing them to act as one composite section

60. A column carries an axial load producing a uniform stress of 13 ksi and a bending moment producing an extreme fiber bending stress of 7 ksi in the same direction. What is the maximum combined compressive stress at the extreme fiber?

A. 20 ksi

B. 13 ksi

C. 16 ksi

D. 7 ksi

61. A circular storm sewer pipe with a diameter of 30 in. flows full at a slope of 0.0075 ft/ft. Using Manning's equation with n = 0.013 and R = D/4 for a full circular pipe, what is the approximate full-flow capacity of the pipe, in cfs?

A. 28.0 cfs

B. 31.5 cfs

C. 42.0 cfs

D. 35.5 cfs

62. Using the Rational Method (Q = CiA), a drainage area of 19 acres has a runoff coefficient C = 0.40 and a design rainfall intensity of 3.4 in/hr. What is the peak runoff rate?

A. 25.8 cfs

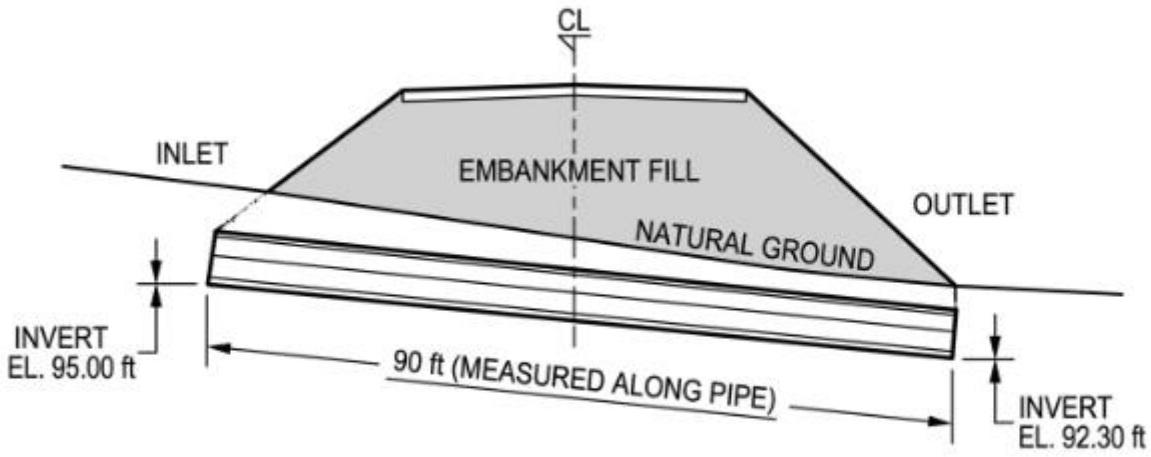
B. 20.6 cfs

C. 31.0 cfs

D. 15.5 cfs

63. Based on the culvert profile shown, what is the slope of the culvert barrel, expressed as a percentage?

Figure PQ-4



A. 2.0%

B. 2.5%

C. 3.0%

D. 3.5%

64. A proposed detention pond has a bottom area of 6,800 ft², a top area at the design water surface 4.4 ft above the bottom of 10,800 ft², and a mid-height area of 8,750 ft². Using the prismoidal formula $V = (h/6)(A_{bottom}+4\times A_{mid}+A_{top})$, what is the storage volume of the pond?

A. 34,000 ft³

B. 38,573 ft³

C. 42,000 ft³

D. 31,500 ft³

65. Which best describes how urbanization of a previously undeveloped watershed typically affects peak runoff rate and time of concentration for the same rainfall event?

A. Urbanization has no measurable effect on either peak runoff rate or time of concentration

B. Urbanization always decreases peak runoff rate while increasing time of concentration

C. Urbanization generally increases peak runoff rate and shortens time of concentration, due to increased impervious surface and more efficient drainage conveyance

D. Peak runoff rate depends only on rainfall intensity, never on land development conditions

66. In open channel flow, what generally happens to flow depth as a channel transitions from a mild slope to a steep slope, assuming subcritical flow upstream of the transition?

A. Flow depth always increases regardless of the change in channel slope

B. Flow depth remains completely unchanged regardless of any change in channel slope

C. Channel slope has no relationship to flow depth in open channel hydraulics

D. Flow depth generally decreases as the channel transitions from mild to steep slope, potentially passing through critical depth at the transition

67. A load of 15,000 lb is lifted using a two-leg sling with each leg inclined at 42° from the horizontal. What is the tension in each sling leg, assuming the load is shared equally?

A. 11,209 lb

B. 7,500 lb

C. 10,050 lb

D. 13,375 lb

68. A mobile crane's load chart lists a maximum capacity of 19,000 lb at a 32-ft operating radius. The rigging weighs 680 lb, and the load to be lifted weighs 16,200 lb. What is the remaining capacity margin at this radius after accounting for rigging weight?

A. 2,800 lb

B. 2,120 lb

C. 1,500 lb

D. 2,450 lb

69. An excavation requires dewatering at a rate of 460 gallons per minute (gpm) to maintain a dry work area. A pump is rated at 850 gpm capacity. What percentage of the pump's rated capacity is being utilized?

A. 48.0%

B. 54.1%

C. 60.0%

D. 65.0%

70. Based on the crane outrigger footprint shown, why would a crane operator choose to fully extend all four outriggers rather than a partial extension, even when the lift itself appears well within the crane's capacity?

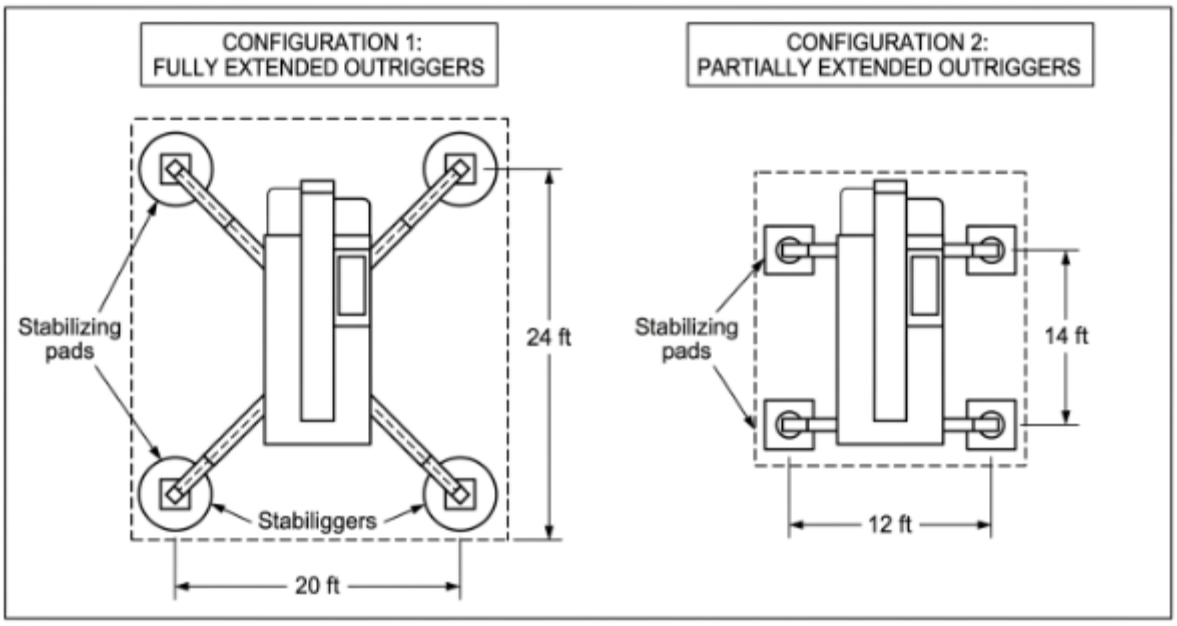


Figure PQ-5. Plan-view diagram of a mobile crane setup showing two configurations side by side.

A. Full extension is purely a cosmetic industry convention with no effect on crane capacity

B. Partial extension always provides greater stability than full extension for any given lift

C. Outrigger extension distance has no bearing on the crane's rated lifting capacity

D. Full extension gives the crane its maximum rated stability and capacity for a given radius, since load charts assume full extension

71. For placing structural steel members at height on a high-rise building under construction, which type of crane is generally selected over a mobile crane operating from the ground?

A. A tower crane, able to reach the building's full height and footprint from a fixed or climbing position

B. A rough-terrain crane operating from an adjacent parking area

C. A truck-mounted crane positioned on the nearest public roadway

D. A crawler crane relocated to a new position for every single lift

72. A borrow pit excavation removes soil with an in-situ (bank) volume of 14,000 cy. If the soil has a shrinkage factor of 0.91 when placed and compacted as fill, what compacted fill volume will this borrow material yield?

A. 14,000 cy

B. 15,400 cy

C. 12,740 cy

D. 11,200 cy

73. A driven pile is being installed using a hammer with a rated energy of 26,000 ft-lb per blow, and the pile advances 0.30 in. per blow at final set. Using the simplified Engineering News formula, Ru = 2E/(s+1.0), with E in ft-lb and s in inches, what is the estimated ultimate pile capacity?

A. 40,000 lb

B. 26,000 lb

C. 52,000 lb

D. 20,000 lb

74. A dump truck hauls fill material a one-way distance of 3.0 miles at an average haul speed of 21 mph, and returns empty at an average speed of 31 mph over the same distance. Ignoring loading and dumping time, what is the total round-trip travel time for one cycle?

A. 12.0 min

B. 14.4 min

C. 16.5 min

D. 10.5 min

75. What is the primary purpose of a written excavation competent-person inspection log maintained on a jobsite, beyond simply performing the required daily inspections themselves?

A. The written log replaces the need for the competent person to actually visit the excavation

B. The written log is used solely to calculate the excavation crew's daily wages

C. The written log creates a documented, verifiable record confirming when inspections occurred and what conditions were observed, supporting accountability and later review

D. The written log is required only on excavations deeper than 25 ft

76. An excavator has a bucket capacity of 2.1 cy, a fill factor of 0.89, a cycle time of 19 seconds, and an efficiency (working-time) factor of 0.81. What is the estimated production rate in cy per hour?

A. 354.1 cy/hr

B. 236.6 cy/hr

C. 310.0 cy/hr

D. 286.8 cy/hr

77. What is the primary purpose of conducting a pre-construction survey of adjacent properties before beginning pile driving operations that could generate significant ground vibration?

A. The survey documents existing conditions of nearby structures, establishing a baseline to compare against if vibration-related damage is later claimed

B. The survey is required solely to obtain the pile driving equipment rental permit

C. The survey replaces the need for vibration monitoring during the actual pile driving operations

D. The survey is only required if the adjacent properties are owned by the same client

78. A cut excavation removes 8,500 cy of soil measured in its in-situ (bank) state. The soil has a swell factor of 1.23 when excavated and loaded loose into trucks. What is the loose (hauled) volume of this excavated material?

A. 8,500 cy

B. 9,500 cy

C. 10,455 cy
D. 11,500 cy

79. For a project requiring a large volume of structural fill delivered from a distant borrow source over an extended period, why might a contractor establish a dedicated haul road rather than relying on existing public roads for the entire route?

A. A dedicated haul road is purely an aesthetic feature with no effect on hauling efficiency
B. Public roads are always faster than any dedicated haul road regardless of distance or condition
C. Dedicated haul roads are required only when the total haul distance exceeds 50 miles
D. A dedicated haul road can be built for heavy, repetitive traffic, reducing travel time and wear compared to existing infrastructure

80. Concrete is placed in a wall form at a rate of 7.5 ft/hr, with a concrete temperature of 75°F. Using a simplified maximum lateral pressure formula for walls, $P_{max} = 150 + 9{,}000(R/T)$, where R is placement rate in ft/hr and T is temperature in °F, what is the maximum lateral pressure on the formwork?

A. 950 psf
B. 1,050 psf
C. 1,150 psf
D. 850 psf

81. A scaffold frame leg has an allowable capacity of 4,100 lb. If four legs support a uniformly distributed platform load, and the total load on the scaffold bay is 16,000 lb, what is the utilization ratio of each leg, assuming equal load distribution?

A. 85.0%
B. 90.0%
C. 97.6%
D. 80.0%

82. A newly placed concrete slab imposes a construction load of 225 psf, distributed among three levels of shores and reshores of similar stiffness below it. Assuming the load is shared equally among all three levels, what load does each level carry?

A. 75 psf
B. 112.5 psf
C. 56.25 psf
D. 150 psf

83. A temporary sign or windscreen attached to a construction hoist tower has an exposed area of 300 ft² and experiences a design wind pressure of 15 psf. What is the total design wind force acting on this exposed area?

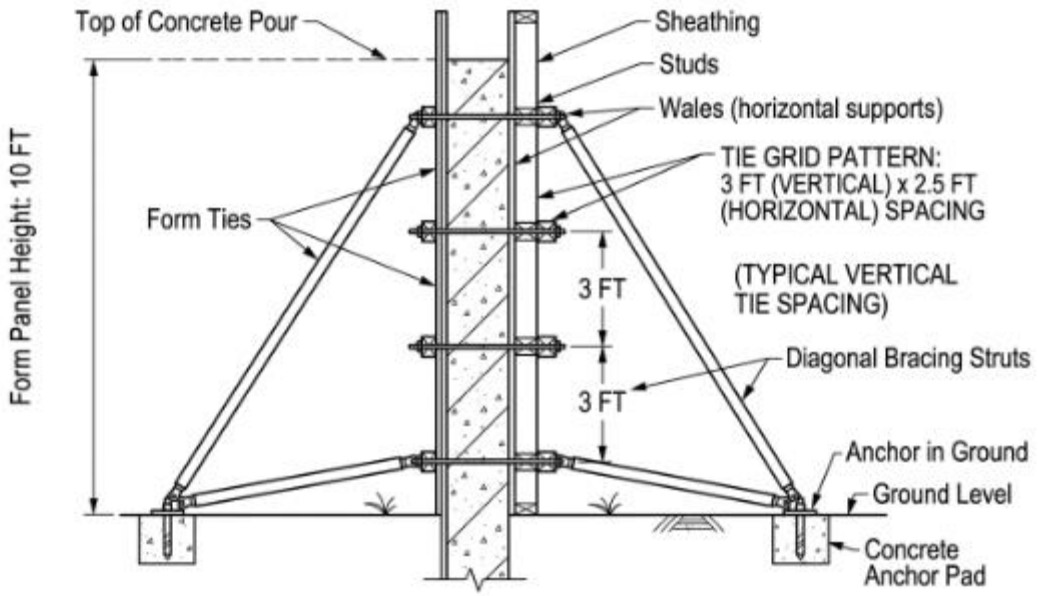
A. 4,000 lb
B. 5,000 lb
C. 3,750 lb
D. 4,500 lb

84. A braced excavation in sand, 24 ft deep, uses an apparent earth pressure diagram per Peck's method with a maximum ordinate pa = 0.65·Ka·γ·H. Given Ka = 0.28, γ = 114 pcf, and H = 24 ft, what is the value of the maximum apparent pressure ordinate, pa?

A. 450 psf
B. 498 psf
C. 550 psf
D. 400 psf

85. Based on the wall formwork cross-section shown, if the maximum lateral concrete pressure on the form is 820 psf and the tie spacing is 3 ft vertical by 2.5 ft horizontal, what is the design tension load on each individual form tie?

Figure PQ-6: Cross-section diagram of a wall formwork system



A. 4,920 lb

B. 7,380 lb

C. 6,150 lb

D. 3,690 lb

86. A guy wire bracing a temporary mast is anchored 9 ft horizontally from the base of the mast and attaches to the mast at a height of 12 ft, giving a wire length of 15 ft. If the horizontal force to be resisted at the attachment point is 1,800 lb, what tension in the guy wire is required to provide this horizontal resistance?

A. 1,800 lb

B. 2,400 lb

C. 3,600 lb

D. 3,000 lb

87. Why does a falsework design for a highway bridge girder segment typically need to account for the possibility of differential settlement between individual falsework support towers?

A. Differential settlement between towers is structurally impossible if the towers are all the same height

B. Uneven settlement between towers can introduce unintended stresses into the girder or formwork that a design assuming perfectly rigid, unyielding supports would not capture

C. Falsework towers never settle under load regardless of the bearing soil conditions beneath them

D. Differential settlement only matters for towers spaced more than 100 ft apart

88. A structure's typical floor construction load capacity (allowable) is 100 psf once the concrete reaches adequate strength, and each freshly poured slab imposes a construction load of 230 psf that must be distributed among the shore/reshore levels below it. Assuming the load distributes equally among 3 supporting levels, what is the load imposed on each level, in psf?

A. 76.7 psf

B. 115.0 psf

C. 57.5 psf

D. 230.0 psf

89. A horizontal strut in a braced excavation supports a tributary height of 8 ft and a tributary width of 17 ft along the wall, with an apparent lateral earth pressure of 500 psf acting uniformly over the tributary height. What is the total axial load in the strut?

A. 60,000 lb

B. 75,000 lb

C. 68,000 lb

D. 56,000 lb

90. Why must a construction hoist's mast tie-in connections to the building structure be specifically engineered and verified as the hoist climbs to increasing heights during construction?

A. Tie-in connections resist significant lateral wind and operational loads on the mast, and their required spacing and capacity are re-verified as the hoist's height and exposure increase

B. Tie-in connections only matter for hoists used to carry personnel, never for materials-only hoists

C. Once installed at the base, tie-in connections never need re-verification regardless of the hoist's final height

D. Tie-in connections exist purely to provide a walking platform for hoist maintenance personnel

91. A partially cured elevated slab has a current allowable load capacity of 95 psf. A piece of construction equipment imposes an equivalent distributed load of 140 psf on the slab during a planned operation. By how much does the equipment load exceed the slab's current allowable capacity?

A. 35 psf
B. 45 psf
C. 55 psf
D. 25 psf

92. In a braced excavation, why are waler beams typically installed horizontally along the excavation wall, spanning between vertical soldier piles or sheeting, before the horizontal struts are connected?

A. Walers exist purely to provide a walking surface for workers along the excavation wall
B. Walers are required only when the excavation exceeds 40 ft in depth
C. Walers primarily resist vertical settlement of the excavation wall, not lateral pressure
D. Walers collect the lateral earth pressure from the wall and concentrate it into point loads that struts can resist as discrete members

93. A form tie rod has an ultimate tensile capacity of 21,000 lb, and the project specifies a safety factor of 3.0 for formwork ties. What is the maximum allowable working load for this tie?

A. 10,500 lb
B. 6,000 lb
C. 7,000 lb
D. 8,400 lb

94. Why is it important to check a crane's outrigger float, or pad, penetration into the ground surface before and during a lift, rather than only checking it once at initial setup?

A. Outrigger penetration only matters for cranes lifting loads over 50 tons
B. Soft or marginal ground can allow gradual outrigger penetration during the lift, changing the crane's level and effective stability from what was verified at initial setup

C. Once verified at setup, ground conditions beneath an outrigger pad can never change during a lift

D. Outrigger float penetration has no bearing on the crane's actual level or stability

95. Under OSHA's steel erection standard (29 CFR 1926 Subpart R), what is generally required before a multi-story structural steel frame may have more than a specified number of floors erected above the most recent permanently connected floor?

A. No limit exists on how many floors may be erected above the most recent permanent floor

B. The limit applies only to buildings taller than 20 total stories

C. A limit applies only when fewer than five ironworkers are performing the erection work

D. Permanent floors or temporary flooring meeting specific criteria must be installed within a limited number of floors of the erection front, per the standard's specific floor-limit provisions

96. Under OSHA's fall protection requirements for residential construction (29 CFR 1926.501), what is generally required for employees working at heights of 6 ft or more above a lower level?

A. Conventional fall protection, unless the employer shows it is infeasible and uses a written fall protection plan instead

B. No fall protection is required in residential construction regardless of height

C. Fall protection is required only above 15 ft in residential construction specifically

D. A verbal safety briefing alone satisfies the fall protection requirement in residential work

97. Under OSHA excavation standards, when may a professional engineer's tabulated data be used instead of a site-specific engineered design for a sloping, shoring, or shielding system?

A. Tabulated data may be used regardless of whether actual site conditions match what the data covers

B. Tabulated data eliminates the need for any competent person inspection of the excavation

C. Tabulated data may only be used for excavations shallower than 5 ft in depth

D. When the data was prepared or approved by a registered professional engineer and site conditions fall within what the data covers

98. Under OSHA's general safety and health provisions for construction, what is the primary purpose of requiring an accident prevention program tailored to the specific hazards of a jobsite, rather than relying on a single generic company-wide program?

A. A jobsite-specific program is required purely to satisfy an administrative filing requirement with no safety function

B. A generic company-wide program is always more effective than any jobsite-specific tailoring

C. A jobsite-specific program addresses the hazards and activities actually present on that project, which a generic company-wide program might not adequately capture

D. Jobsite-specific programs are required only for projects lasting longer than one year

99. In a temporary traffic control zone, what is the primary function of the transition area, located between the advance warning area and the activity area?

A. The transition area is where all construction materials and equipment must be stored

B. The transition area guides traffic out of its normal path, via a tapered lane closure, into the alignment needed around the work area

C. The transition area marks the exact legal boundary of the contractor's work area

D. The transition area is the only zone where flaggers may be positioned

100. Which statement best describes the relationship between an OSHA standard's requirements and a more stringent state or local requirement that may also apply to a construction project?

A. Employers generally must comply with whichever requirement, OSHA or the applicable state or local one, is more protective or stringent for that specific situation

B. OSHA standards always completely preempt and override any state or local safety requirement

C. State and local safety requirements are never legally enforceable on a construction project

D. Only the requirement that is easiest and least costly to comply with actually applies

Practice Exam 8: Answer Key and Explanations

1. A — The Rankine active coefficient is Ka = (1-sin27°)/(1+sin27°) ≈ 0.376. The total active force per foot is the triangular pressure diagram's area: 0.5×Ka×γ×H² = 0.5×0.376×118×14² ≈ 4,343 lb/ft, or 4.34 kip/ft. This resultant governs design of the wall stem and base. The other options use the wrong coefficient or omit the 0.5 area factor.

2. D — Primary settlement uses Sc = [Cc·H/(1+e0)]·log10[(p0+Δp)/p0]. With H = 216 in, Sc = (0.34×216/1.85)×log10(1.654) ≈ 39.7×0.219 ≈ 8.67 in. This settlement develops gradually as excess pore pressure in the clay dissipates through drainage over time, unlike an immediate elastic response. The distractors misapply the void-ratio term or the logarithmic stress ratio.

3. B — Total stress at 22 ft is 9×118 + 13×130 = 2,752 psf. Pore pressure from the water table 13 ft above is 13×62.4 = 811.2 psf. Effective stress is total stress minus pore pressure: 2,752 − 811 ≈ 1,941 psf. Option B wrongly reports total stress without deducting any pore pressure contribution at all.

4. C — Terzaghi's equation gives qu = q·Nq + 0.5·γ·B·Nγ, with q = γ·Df = 118×5 = 590 psf. This gives qu = 590×19 + 0.5×118×4.2×13 ≈ 11,210 + 3,221 = 14,431 psf. The distractors isolate only one of the two additive terms, the surcharge term or the width term, rather than summing both together.

5. A — For a dry, cohesionless infinite slope, FS = tanφ/tanβ. With φ = 35° and β = 21°, FS = tan35°/tan21° ≈ 0.700/0.384 ≈ 1.82. Since FS exceeds 1.0, the slope is stable under fully drained conditions; the other values come from swapping or mis-ratioing the two given angles in the formula.

6. C — A linear shear-versus-normal-stress relationship passing through the origin, with zero shear strength at zero normal stress, indicates the soil has essentially no cohesion, behaving as a purely frictional material where strength scales directly with confining normal stress. A soil with real cohesion would instead show a positive shear-stress intercept even at zero normal stress.

7. B — Plasticity index, the range of moisture content over which a soil behaves plastically, correlates with clay mineral content and activity, and higher PI soils, especially those containing expansive clay minerals, generally exhibit greater shrink-swell potential as moisture fluctuates. Lower PI soils, such as silts and sands, typically show much less volume change behavior from moisture alone.

8. D — A footing near a slope has reduced confinement on the downslope side, where the failure surface has a shorter path to daylight through the slope face, weakening resistance to punching or general shear failure. This typically reduces ultimate bearing capacity versus level ground, and published reduction factors account for this slope proximity effect.

9. A — Curve length is L = R·Δ with Δ in radians: Δ = 35×π/180 ≈ 0.6109 rad. Multiplying by R = 950 ft gives L ≈ 950×0.6109 ≈ 580.3 ft. This arc-length relationship only holds once the deflection angle is converted from degrees, which is where the other, incorrect choices go wrong.

10. D — The middle ordinate is M = R(1−cos(Δ/2)). With Δ/2 = 11°, cos11° ≈ 0.9816, so M = 1,200×(1−0.9816) ≈ 22.0 ft. This is distinct from the external distance, which offsets from the PI rather than the long chord. Using the full deflection angle instead of half of it produces the other values.

11. C — A rectangular control grid establishes multiple permanent, redundant reference points, so if any single point is disturbed or destroyed, column lines can still be re-established by checking against other grid points. Relying on only one instrument setup for the entire layout would leave the project vulnerable to a single point of failure.

12. B — Fill is the difference between the higher design subgrade elevation and the lower existing ground elevation: 283.55 − 280.10 = 3.45 ft. Since the design grade sits above existing ground here, material must be added rather than removed, and the stake is marked with this fill amount so the grading crew knows how much material to place at that point.

13. B — The high point on a crest curve is at $x = g_1L/(g_1-g_2) = 0.030\times500/0.05 = 300$ ft from the PVC. Its elevation is $\text{elev}_{PVC} + g_1x - [(g_1-g_2)/2L]x^2 = 145 + 9.00 - 4.50 = 149.50$ ft exactly. Option B omits the parabolic curve correction entirely, giving a distorted, higher elevation instead.

14. D — Every point on a construction project has both a horizontal position and a vertical elevation, and both must be correctly established for the work to be built as designed. Horizontal control alone would leave elevations undefined, and vertical control alone would leave plan position undefined, so both types together are needed to fully locate points in three-dimensional space.

15. A — An extensometer measures the relative movement or deformation between fixed points anchored at different depths along a borehole, revealing where and how much internal ground movement is occurring within the monitored embankment or slope. This differs from instruments measuring temperature, groundwater chemistry, or bearing capacity, which serve entirely different monitoring purposes on a project.

16. C — The gray soft clay layer from 6 to 22 ft shows very low N-values of only 2 to 3 blows/ft across a thick 16-ft interval, indicating soft, highly compressible material with low shear strength. A mat foundation over this area would have settlement and bearing behavior governed by this weak clay, not the denser sand.

17. A — Water-cement ratio is the weight of water divided by the weight of cement: 207 lb / 460 lb = 0.45 exactly. This ratio strongly influences both strength and permeability, with lower w/c ratios generally producing stronger, more durable concrete. The other options would require different water or cement quantities than the ones actually given in this problem.

18. C — Yield strength marks the stress level at which a material transitions from elastic, fully recoverable deformation to plastic, permanent deformation, a critical design parameter for structural steel. Ultimate tensile strength instead describes the maximum stress before fracture, modulus of elasticity describes stiffness within the elastic range, and Poisson's ratio describes lateral-to-axial strain, none of which describe this specific yield transition.

19. B — Percent passing is the complement of percent retained: 700 − 350 = 350 g passing, or 350/700×100 = 50% exactly. This particular sample happens to have an equal split between retained and passing mass. Option B (60%) would only result from a different retained mass than the 350 g actually reported in this problem.

20. D — GGBFS hydrates more slowly than portland cement, spreading out heat generation over a longer period and reducing the peak temperature rise within a large concrete mass. This lower heat of hydration significantly reduces the risk of thermal cracking that can occur when the concrete's interior heats up much more than its surface, a common concern in large-volume mass concrete pours.

21. A — In pretensioning, strands are tensioned against fixed abutments in an open bed before concrete is placed, and once cured, the strands are cut, transferring force into the member through bond along their length. Post-tensioning, by contrast, tensions strands only after the concrete has already cured and gained adequate strength on its own.

22. C — Axial stress equals force divided by area: $\sigma = P/A = 138 \text{ kips} / 4.6 \text{ in}^2 = 30 \text{ ksi}$ exactly. This stress is then compared against the steel's allowable or yield stress to check whether the member is adequate for the applied load. The other values would only result from using a different area or force than the ones given.

23. B — Footing volume is $7 \times 4 \times 2 = 56 \text{ ft}^3$. Converting to cubic yards by dividing by 27 ft^3 per cy gives $56/27 \approx 2.07$ cy. This same volume-to-cy conversion applies to any rectangular concrete element and is the standard basis for estimating concrete quantities directly from a footing's plan dimensions and thickness.

24. B — The combined unit cost is \$215 + \$95 = \$310 per cy. Multiplying by the 210 cy quantity gives \$310×210 = \$65,100. This is the standard method of summing all applicable unit-cost components together before multiplying by total quantity, rather than using only one component in isolation as several of the other choices reflect.

25. D — Simple break-even analysis divides the purchase price by the annual savings: \$78,000/\$13,000 per year = 6 years exactly. After this period, cumulative savings equal the initial purchase price, making continued use net-favorable versus renting from that point forward; this simplified approach ignores the time value of money a full analysis would apply.

26. D — CPI equals earned value divided by actual cost: \$410,000/\$450,000 ≈ 0.91. A CPI below 1.0 indicates the project has spent more than the value of work actually accomplished so far, signaling a cost overrun relative to progress achieved. Option B inverts this ratio, producing a misleadingly favorable index reading for the project.

27. C — The average end area method gives volume as $[(250+290)/2] \times 105 = 270 \times 105 = 28{,}350 \text{ ft}^3$, or 28,350/27 = 1,050.0 cy exactly after converting to cubic yards. The distractors result from using only one section's area alone, or from omitting the ft^3-to-cy unit conversion step entirely at the very end of the calculation.

28. A — Applying a 9% markup multiplies the direct cost by 1.09: \$1,020,000×1.09 = \$1,111,800. This single multiplication correctly combines overhead and profit as one percentage applied to the direct cost base. Option B omits markup entirely, while C and D reflect different, incorrect markup percentages applied to that same direct cost base.

29. A — Total steel length is 35 bars × 13 ft each = 455 ft. Multiplying by the unit weight of 1.502 lb/ft gives 455×1.502 ≈ 683.4 lb, which rounds to 683 lb. This length-times-unit-weight approach is the standard quantity takeoff method for estimating reinforcing steel tonnage directly from a bar schedule listing.

30. D — Direct costs generally scale with the quantity of work performed, while indirect costs like project overhead and general conditions are largely a function of project duration rather than work quantity. Separating these two cost categories allows more accurate cost control and forecasting, since a schedule delay affects indirect costs very differently than a quantity change affects direct costs.

31. B — Interior partition walls on a floor are typically anchored to the structural slab below, so that slab must be placed and cured to adequate strength before wall framing begins. Finished flooring, painting, and elevator cab installation are all later activities occurring well after the frame and walls are in place.

32. C — PERT expected duration weights the most likely estimate four times as heavily as the optimistic and pessimistic estimates: te = (a+4m+b)/6 = (4+36+20)/6 = 60/6 = 10 days exactly. This weighting better reflects the skewed beta-distribution shape typically assumed for activity durations than a simple average of the three raw estimates would produce.

33. C — Two paths run from A to E: A-B-E totals 4+5+3 = 12 days, and A-C-D-E totals 4+7+6+3 = 20 days. The critical path is the longer of the two, since it determines the minimum project duration: 20 days. Path A-B-E carries substantial float relative to this longer, governing path through the network.

34. D — Total float equals late finish minus early finish (equivalently, late start minus early start): 25 − 17 = 8 days. This represents the amount of slack the activity can absorb without delaying the overall project completion date. The other choices would require different combinations of the given early and late dates than provided.

35. B — A finish-to-finish relationship ties the completion of the successor to the completion of the predecessor, allowing the successor's actual work to start and proceed concurrently, overlapping with the predecessor's ongoing work. A standard finish-to-start relationship instead requires the predecessor to fully finish before the successor can even begin, a stricter, fully sequential logic type.

36. A — Cost slope is (crash cost − normal cost)/(normal duration − crash duration) = ($13,600−$8,000)/(11−7) = $5,600/4 = $1,400 per day. This marginal cost figure lets a scheduler compare which activities are cheapest to compress when the overall project duration needs shortening by some number of days on the critical path.

37. C — The linear scheduling method, or line-of-balance, plots production against location, each treatment basin, and time, making the repetitive construction cycle across basins directly visible in one view. This reveals whether a faster crew on one basin might catch up to and interfere with a slower crew working the basin ahead of it in the sequence.

38. D — The minimum added cost to crash an activity is its cost slope multiplied by the number of days shortened: $1,250/day × 4 days = $5,000. Since this is the only available critical activity, all 4 days of

compression must come from it alone, leaving no cheaper combination of activities to achieve the required deadline reduction.

39. B — Total demand for that day is 4+8+7 = 19 pipefitters, while only 15 are available, leaving a shortfall of 19−15 = 4 pipefitters. This over-allocation must be resolved by delaying one activity within its available float, bringing in additional crew capacity, or extending the schedule before all three activities can proceed as originally planned that day.

40. D — A schedule of values allocates the total lump-sum contract price across individual line items by system or activity, providing the basis for monthly progress payment applications tied to the percentage of each line item actually completed. This financial breakdown is a distinct document from the project's CPM schedule and is specifically used for lump-sum, not unit-price, contract payment applications.

41. A — For a 6-in. diameter cylinder, area = $\pi \times 3^2 \approx 28.27$ in². Compressive strength is failure load divided by area: 101,788/28.27 ≈ 3,600 psi. This standard cylinder-break calculation confirms whether delivered concrete achieves its specified design strength, and here the result closely matches a 3,600 psi mix requirement, confirming acceptance of the load.

42. C — Undercut reduces the effective cross-section of the base metal at the weld toe, creating a stress concentration that can significantly reduce the connection's fatigue life and static strength if it exceeds code-allowable limits. An undercut weld exceeding those limits must be rejected and repaired per the applicable welding code's specified procedures, not simply accepted, ground away entirely, or cosmetically concealed.

43. A — Recording placement conditions such as ambient and concrete temperature and weather creates a documented record that can later be reviewed if strength or durability concerns arise, helping determine whether adverse conditions, such as extreme heat or cold, may have contributed to a problem. This record supports troubleshooting and evaluation of test results well after the placement itself is complete.

44. B — As a hot-mix asphalt lift cools, the asphalt binder progressively stiffens, and once the mat drops below a critical temperature, roughly 175°F depending on the binder grade, further rolling can no longer meaningfully increase density regardless of additional passes. All required rolling stages must therefore be completed while the mat remains above this threshold to achieve the specified compaction.

45. D — The Nurse-Saul maturity factor is $M = \Sigma(T - T0) \cdot \Delta t = (66 - 32) \times 44 = 34 \times 44 = 1{,}496$ °F-hours. This accumulated value is compared against a project-specific calibration curve relating maturity to compressive strength, giving an early strength estimate well before a companion cylinder break could even be cured, tested, and formally reported back to the field crew.

46. C — Percent compaction compares field dry unit weight to the laboratory maximum: $114/122 \times 100 \approx 93.4\%$. Specifications commonly require 95% or greater relative compaction for structural fill, so this result would fall just short of a typical 95% minimum requirement and should be checked against the project's actual compaction specification value before acceptance.

47. A — Retaining archived specimens beyond the standard 28-day test provides a physical record that can later be re-examined, through petrographic analysis or additional testing, if a durability, cracking, or performance concern surfaces well after the original results were reported and accepted. This provides a valuable investigative resource that would otherwise be unavailable once specimens are discarded shortly after routine testing.

48. B — The effective throat of an equal-leg fillet weld equals the leg size times 0.707 (cos45°), the shortest distance through the weld's triangular cross-section: 0.5625 in × 0.707 ≈ 0.398 in. This throat dimension, rather than the leg size directly, is what governs the weld's effective strength in structural design calculations for the connection.

49. B — Tightening bolts in a specified sequence, typically from the center of the group outward, helps the connected plates draw together evenly, preventing localized gaps, distortion, or uneven clamping force that could result from tightening in a random or out-of-order sequence. This systematic approach helps ensure the joint achieves the uniform clamping performance the connection design assumes.

50. A — A slump range, rather than one exact target value, acknowledges that some normal batch-to-batch variability in workability is expected and acceptable, while still bounding the concrete within limits that support proper placement, consolidation, and finishing without compromising strength or durability. This practical tolerance avoids rejecting acceptable concrete over minor, insignificant variation from a single fixed value.

51. C — An unfactored service-level combination sums the applicable loads directly: D + Lc = 610 + 300 = 910 lb/ft. This combined demand is what the member must be checked against for the temporary construction-stage condition, which can differ meaningfully from whatever load combinations govern the structure's later, final permanent-service condition.

52. D — Section modulus for a rectangular section is $S = bd^2/6 = 10 \times 225/6 = 375$ in³. Converting the moment, M = 17 kip-ft × 12 in/ft × 1,000 = 204,000 lb-in. Bending stress is $\sigma = M/S = 204{,}000/375 = 544$ psi exactly, the maximum fiber stress at the top and bottom of the beam.

53. A — For a short column not governed by buckling, allowable capacity is the allowable stress multiplied by the cross-sectional area: 26 ksi × 5.8 in² = 150.8 kips. A longer, more slender column carrying this same load would instead need a reduced allowable stress to account for buckling, which is not a governing concern in this short-column scenario.

54. D — Converting the 17-ft span to 204 in, $\Delta = PL^3/48EI = (8 \times 204^3)/(48 \times 29{,}000 \times 790) \approx 0.062$ in. This is the standard midspan deflection formula for a simply supported beam under a central point load, used to check serviceability against an allowable limit such as span/360, a common criterion for many floor framing members.

55. C — For a triangular pressure distribution, the resultant force acts at the centroid of the triangle, one-third of the height up from the base: 17 ft/3 ≈ 5.67 ft above Point O. This one-third rule is a standard statics result for any triangular loading, distinct from a uniform (rectangular) distribution, whose resultant instead acts at mid-height above the base.

56. B — A uniform area load converts to a line load by multiplying by the tributary width the member collects: 21 psf × 6.5 ft = 136.5 lb/ft. The purlin's span length does not enter into this unit conversion; it instead determines the total load and bending moment the member must resist along its full length once this line load is established.

57. C — Weathering steel, such as ASTM A588, is designed to develop a stable, adherent protective oxide patina through initial weather exposure, which then significantly slows further corrosion compared to ordinary carbon steel. A uniform reddish-brown finish without flaking or measurable section loss is the expected appearance of this material, not a defect.

58. B — For a rectangular section, maximum shear stress occurs at the neutral axis and equals 1.5 times the average shear stress: $\tau_{max} = 1.5V/(bd) = 1.5\times15{,}000/(10\times19) = 22{,}500/190 \approx 118$ psi. The 1.5 factor reflects the parabolic shear stress distribution that develops across the depth of a rectangular cross-section under this loading.

59. D — Shear studs welded to the beam's top flange and embedded in the slab transfer horizontal shear at the steel-concrete interface, forcing the two materials to act as one composite section rather than bending independently. This composite action significantly increases stiffness and capacity over the steel section acting alone without studs.

60. A — When axial and bending stresses act in the same sense at an extreme fiber, they superimpose directly: combined stress = axial + bending = 13 + 7 = 20 ksi exactly. This combined-stress check at the governing fiber is central to designing members subject to both axial compression and bending, such as beam-columns in a braced or unbraced building frame.

61. D — For a 2.5-ft diameter pipe, area = $\pi r^2 \approx 4.91$ ft² and hydraulic radius R = D/4 = 0.625 ft. Manning's equation gives Q = (1.486/n)AR^(2/3)S^(1/2) ≈ (1.486/0.013)×4.91×0.625^0.667×0.0075^0.5 ≈ 35.5 cfs. This full-flow capacity check confirms whether the pipe size can convey the design peak flow it is required to carry.

62. A — The Rational Method computes peak runoff as Q = CiA = 0.40×3.4×19 ≈ 25.8 cfs, with drainage area in acres and rainfall intensity in in/hr conveniently combining to give cfs directly. This simplified method remains widely used for preliminary sizing of storm drainage systems on relatively small drainage areas such as this one.

63. C — Culvert slope equals the drop in invert elevation divided by the barrel length: (95.00−92.30)/90×100 = 2.70/90×100 = 3.0% exactly. Maintaining adequate barrel slope helps sustain self-cleansing velocity through the culvert, preventing sediment accumulation, and this value would be checked against a minimum design velocity or slope criterion for the project.

64. B — The prismoidal formula gives V = (h/6)(Abottom+4Amid+Atop) = (4.4/6)×(6,800+4×8,750+10,800) = 0.733×52,600 ≈ 38,573 ft³. This method accounts for the changing cross-sectional area with depth in a sloped-side pond, weighting the mid-height area heavily so the result better reflects the pond's true sloped-wall geometry throughout its depth than a plain average would.

65. C — Urbanization replaces natural, permeable ground cover with impervious surfaces like pavement and rooftops, reducing infiltration, while also introducing efficient conveyance systems like curbs, gutters, and storm sewers that move runoff more quickly to the outlet. Together, these changes typically increase peak runoff rate and shorten time of concentration compared to the same watershed in its undeveloped condition.

66. D — As a channel transitions from a mild slope, where normal depth is subcritical, to a steep slope, where normal depth would be supercritical, the flow depth generally decreases through the transition, often passing through critical depth near that point. This behavior reflects the flow adjusting from one normal-depth condition toward another as the governing channel slope changes.

67. A — Each leg supports half the vertical load, but because the leg is inclined, its tension exceeds that vertical component: $T = (\text{load}/2)/\sin 42° = 7{,}500/0.669 \approx 11{,}209$ lb. Sling leg tension increases sharply as the angle from horizontal decreases, which is why shallow sling angles are avoided in rigging practice to limit excessive leg tension.

68. B — The total weight the crane must support at this radius is the load plus all rigging: 16,200+680 = 16,880 lb. Subtracting this from the rated capacity of 19,000 lb gives a margin of 19,000−16,880 = 2,120 lb. Rigging weight must always be included in this check; the chart's rated capacity is not the payload weight alone.

69. B — Percent utilization compares the required flow rate to the pump's rated capacity: $460/850 \times 100 \approx 54.1\%$. Operating at this level leaves substantial reserve margin for surges in inflow or gradual performance degradation over time, generally preferable to selecting a pump expected to run continuously near its maximum rated capacity on site.

70. D — Crane load charts are typically developed and rated with outriggers fully extended, since this configuration provides the widest, most stable base and highest rated capacity for a given radius. Operating with partial extension, unless a specific reduced-capacity chart is used instead, could mean the crane actually exceeds its true capacity for that setup.

71. A — A tower crane, fixed or climbing internally within the building core, can reach a high-rise structure's full height and entire footprint from essentially one single setup position throughout construction. A ground-based mobile crane's reach and capacity both diminish at greater heights and radii, making it far less practical for this application.

72. C — Shrinkage factor accounts for the volume reduction when loose, excavated soil is recompacted into denser fill: compacted fill volume = bank volume × shrinkage factor = $14{,}000 \times 0.91 = 12{,}740$ cy exactly. Ignoring this shrinkage and simply using the bank volume, as in option B, would overstate the actual compacted fill volume this borrow source can produce.

73. A — Substituting into the Engineering News formula gives $Ru = 2 \times 26{,}000/(0.30+1.0) = 52{,}000/1.30 = 40{,}000$ lb exactly. This dynamic formula relates hammer energy and pile penetration per blow to an estimated ultimate capacity, offering a quick field check during driving, though it is generally considered less reliable than a wave-equation analysis or a static load test.

74. B — Loaded travel time is 3.0 mi/21 mph ≈ 0.1429 hr, and empty return time is 3.0 mi/31 mph ≈ 0.0968 hr, for a combined travel time of about 0.2397 hr, or roughly 14.4 minutes. This travel-time component is then added to loading and dumping time, excluded here, to build the truck's complete production cycle time estimate.

75. C — While OSHA requires the inspections themselves, maintaining a written log of when each occurred and what conditions were observed creates a documented, verifiable record supporting accountability and later review. This written record is a valuable practice beyond simply performing the inspection, though it does not substitute for actually walking the excavation.

76. D — Cycles per hour equal 3,600 seconds divided by the 19-second cycle time, or about 189.5 cycles/hr. Each cycle effectively moves 2.1×0.89 = 1.869 cy, giving 189.5×1.869 ≈ 354.1 cy/hr before accounting for downtime. Applying the 0.81 efficiency factor for non-productive time reduces this to 354.1×0.81 ≈ 286.8 cy/hr, the realistic estimated rate.

77. A — A pre-construction survey documents existing cracks, settlement, and physical conditions of nearby structures before vibration-inducing work like pile driving begins, establishing a documented baseline for comparison if damage is later claimed against the contractor. This record distinguishes pre-existing conditions from new damage, and complements rather than replaces ongoing vibration monitoring.

78. C — Swell factor accounts for the volume increase when compact, in-situ soil is excavated and loosened: loose volume = bank volume × swell factor = 8,500×1.23 = 10,455 cy exactly. This loose, not bank, volume is what actually determines how many truckloads are required to haul the excavated material off the site once it has been loosened.

79. D — A dedicated haul road, built for the project's heavy, repetitive truck traffic, can provide a shorter, more direct route than existing public roads, which weren't designed for this level of sustained loading. This reduces travel time, equipment wear, and the impact and liability of heavy truck traffic on public infrastructure.

80. B — Substituting the given values: Pmax = 150 + 9,000×(7.5/75) = 150 + 900 = 1,050 psf exactly. Placement rate and concrete temperature are the two dominant variables in this simplified formula, since a faster placement rate or colder concrete both increase the hydrostatic-like pressure buildup before the concrete gains enough strength to become self-supporting in the form.

81. C — With four legs sharing the load equally, each leg carries 16,000/4 = 4,000 lb. Comparing this to the leg's allowable capacity of 4,100 lb gives a utilization ratio of 4,000/4,100×100 ≈ 97.6%. Since this is below 100%, the legs have adequate capacity for the stated load, though the margin here is notably tighter than in many other configurations.

82. A — Multi-level shoring analysis typically assumes the total construction load distributes among all supporting levels roughly in proportion to their relative stiffness. With three levels of comparable stiffness sharing the load equally, each carries one-third of the 225 psf total: 225/3 = 75 psf exactly, a value each supported level below must be checked against for adequacy.

83. D — Total wind force equals design wind pressure multiplied by the exposed area subject to it: F = 15 psf × 300 ft² = 4,500 lb exactly. This resultant force is then resisted by the hoist tower's bracing and anchorage system, along with wind acting on the tower and hoist structure itself, not the windscreen area alone.

84. B — Substituting into Peck's apparent pressure formula: pa = 0.65×0.28×114×24 ≈ 498 psf. This apparent pressure envelope, rather than a simple triangular active pressure diagram, is used specifically for designing struts and walers in braced excavations, since it better reflects redistributed pressures observed in staged, braced excavation construction over the full depth.

85. C — Each tie's tributary area is its vertical spacing times its horizontal spacing: 3 ft × 2.5 ft = 7.5 ft². Multiplying by the maximum lateral pressure gives the design tension load on each tie: 820 psf × 7.5 ft² = 6,150 lb exactly. This tributary-area method is standard for distributing lateral pressure to discrete form ties across a wall face.

86. D — The 9-12-15 geometry is a scaled 3-4-5 Pythagorean right triangle, where horizontal force = tension × (horizontal leg / hypotenuse). Solving for tension: tension = 1,800×(15/9) = 3,000 lb exactly, the wire force needed to provide the required 1,800-lb horizontal resistance at the mast's attachment point on the structure above.

87. B — Individual falsework towers can settle by different amounts depending on local bearing soil variability, foundation preparation, or load distribution, and this uneven settlement can introduce unintended stresses or misalignment into the girder or formwork above. A design assuming perfectly rigid, unyielding supports would fail to capture these real, differential settlement effects, which is why this possibility must be specifically considered.

88. A — Distributing the 230 psf construction load equally across 3 supporting levels gives 230/3 ≈ 76.7 psf per level. Since this is below the 100 psf allowable floor capacity per level, the 3-level shoring and reshoring scheme is adequate for this load; fewer levels would concentrate more load onto each remaining level and could exceed that allowable capacity.

89. C — The strut's tributary area is its tributary height times tributary width: 8 ft × 17 ft = 136 ft². Multiplying by the uniform apparent pressure of 500 psf gives the total axial strut load: 500×136 = 68,000 lb exactly. This tributary-area method converts the wall's distributed earth pressure into a discrete design load for the individual strut member.

90. A — As a hoist climbs higher, its mast becomes taller and more exposed to lateral wind and operational forces, and the tie-in connections anchoring it to the building must resist these growing demands. Their required spacing and capacity are engineered and re-verified as height increases, since a scheme adequate lower down may not remain adequate further up.

91. B — The excess load is the imposed equipment load minus the slab's current allowable capacity: 140−95 = 45 psf exactly. This overload indicates the planned operation should not proceed on the slab in its current condition without allowing further curing and strength gain, adding temporary shoring beneath, or reducing the equipment loading before the work proceeds as planned.

92. D — Waler beams run horizontally along the wall face, collecting the distributed lateral earth pressure over their tributary length and concentrating it into discrete point loads at each individual strut location. This lets the struts, spaced at intervals rather than continuously along the wall, resist that collected load as simple axial compression members instead.

93. C — Allowable working load is the ultimate tensile capacity divided by the specified safety factor: 21,000/3.0 = 7,000 lb exactly. This safety factor provides margin against uncertainties in material variability, installation quality, and unanticipated load increases, so the tie is never designed to operate close to its actual breaking capacity during normal formwork use on the project.

94. B — Soft or unevenly compacted ground beneath an outrigger pad can allow gradual, progressive penetration during the lift itself, not just at setup, potentially making the crane unlevel and altering its stability from what was originally verified. Continued monitoring during the lift helps catch this developing condition before it becomes hazardous.

95. D — OSHA's steel erection standard limits how many floors of erected steel may exist above the most recent permanently connected floor or qualifying temporary flooring, requiring such flooring within a limited number of floors of the erection front. This provision helps ensure a reasonably close, complete working surface exists beneath ironworkers as erection proceeds upward.

96. A — OSHA generally requires conventional fall protection, guardrails, safety nets, or personal fall arrest systems, for residential employees at 6 ft or more above a lower level, matching the general construction trigger height. Where infeasible, a written, site-specific plan meeting specific criteria may be used instead, not a verbal briefing alone.

97. D — OSHA permits using tabulated data, protective system designs prepared or approved by a registered professional engineer, as an alternative to a fully site-specific design, but only when the excavation's actual soil and conditions genuinely fall within what the data covers. Using it outside that applicability, or skipping required inspections, does not satisfy the standard.

98. C — Different jobsites present different hazards depending on the work performed, site conditions, and surrounding environment, and a program tailored to those specific conditions addresses them more effectively than a generic program applied uniformly across all company projects. This tailoring keeps the program's content actually relevant to workers on that site.

99. B — The transition area redirects traffic out of its normal path, typically through a tapered lane closure or shift, into the alignment needed to proceed safely around the work area. This differs from the advance warning area before it, which only alerts drivers, and the activity area after it, where work occurs.

100. A — Where a state or local jurisdiction imposes a safety requirement more stringent than the corresponding OSHA standard, and its authority to do so is valid, employers generally must comply with whichever requirement is more protective. OSHA standards do not automatically preempt all stricter state requirements, and choosing the easiest one to comply with is not how this works.