PRACTICE EXAM 9: 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 12 ft high retains a cohesionless backfill with unit weight $\gamma = 120$ pcf and angle of internal friction $\varphi = 29°$, 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. 3.00 kip/ft
B. 4.50 kip/ft
C. 2.25 kip/ft
D. 6.00 kip/ft

2. A normally consolidated clay layer 15 ft thick has an initial void ratio $e0 = 0.72$ and compression index $Cc = 0.26$. The effective overburden stress at mid-height is 2,100 psf, and a footing load increases the effective stress at mid-height by 1,300 psf. What is the primary consolidation settlement of the layer?

A. 3.90 in
B. 5.69 in
C. 7.40 in
D. 2.85 in

3. A soil profile consists of 7 ft of sand (moist unit weight 115 pcf) above the water table, underlain by 11 ft of saturated sand (saturated unit weight 128 pcf) below the water table. What is the effective vertical stress at a depth of 18 ft (bottom of the saturated layer)?

A. 2,213 psf
B. 805 psf
C. 1,410 psf
D. 1,527 psf

4. A strip footing 3.8 ft wide is founded at a depth of 4.5 ft in a cohesionless soil with unit weight 112 pcf. At this friction angle, Terzaghi's bearing capacity factors are $N_q = 17$ and $N_\gamma = 12$. What is the ultimate bearing capacity of the footing, neglecting the cohesion term?

A. 8,568 psf
B. 2,554 psf
C. 11,122 psf
D. 12,800 psf

5. An infinite slope in cohesionless sand is inclined at 19° to the horizontal. The sand has an effective friction angle of 32° 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. 1.35
B. 1.55
C. 1.81
D. 2.05

6. A saturated clay sample is loaded rapidly in a laboratory consolidation test, and the excess pore pressure generated is measured immediately after load application, before any drainage occurs. What does this measured excess pore pressure represent?

A. The portion of the applied stress increment initially carried by the pore water rather than the soil skeleton

B. The final, long-term effective stress increase after full consolidation is complete

C. The soil's permeability coefficient at that specific stress level

D. The total stress that existed in the sample before the load was applied

7. A soil's effective friction angle, φ', is generally considered which of the following?

A. A parameter that applies exclusively to undrained, short-term loading conditions

B. A value that changes depending only on the applied total stress, never on soil type

C. A parameter used solely to compute a soil's unit weight for settlement analysis

D. A fundamental shear strength parameter governing long-term, drained soil behavior, distinct from total stress parameters used for short-term analysis

8. A shallow foundation is being designed on a soil profile where the water table is anticipated to fluctuate seasonally between 3 ft and 8 ft below the footing base. For a conservative bearing capacity design, which water table position should generally be assumed?

A. The lowest anticipated water table position, since it simplifies the calculation

B. The highest anticipated water table, since it gives the lowest effective unit weight and most conservative capacity

C. The average of the seasonal high and low water table positions

D. Water table position has no effect on bearing capacity calculations

9. A horizontal curve has a radius of 700 ft and a deflection angle (Δ) of 42°. What is the length of the curve?

A. 410.5 ft

B. 565.8 ft

C. 620.3 ft

D. 513.1 ft

10. For a horizontal curve with radius 1,050 ft and a deflection angle of 26°, what is the middle ordinate (M) of the curve?

A. 19.8 ft
B. 33.5 ft
C. 26.9 ft
D. 40.2 ft

11. Why does a licensed land surveyor typically research and review prior recorded deeds, plats, and survey records for a parcel before beginning a new boundary survey?

A. To establish the history of how the boundary was previously described, monumented, and possibly divided, informing where evidence of the true boundary is likely to be found
B. Because reviewing prior records is purely an optional courtesy with no bearing on the new survey's accuracy
C. Because current GPS technology makes historical deed research entirely unnecessary
D. Because state law requires review only when the parcel exceeds a specified minimum acreage

12. A grade stake is set where the existing ground elevation is 615.75 ft and the design subgrade elevation is 612.30 ft, requiring a cut. What is the magnitude of the cut, 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 +2.8% grade to a −3.2% grade, is 480 ft long, and begins (PVC) at station 9+00 with an elevation of 175.00 ft. What is the elevation of the highest point on the curve?

A. 178.14 ft
B. 180.50 ft
C. 176.20 ft

D. 182.75 ft

14. During construction staking of a curved roadway, why does the survey crew set stakes at even, closely spaced stations, such as every 25 or 50 ft, along the curve rather than only at the beginning and end points?

A. Closely spaced stakes are purely an aesthetic preference with no functional benefit

B. Closely spaced stakes reproduce the curved alignment accurately, since a curve cannot be defined by only its two endpoints

C. Only the beginning and end points of a curve carry any legal significance

D. Additional stakes are set only when the curve radius exceeds a specific minimum value

15. A tiltmeter installed on an existing building adjacent to a deep excavation is used to monitor which specific condition during construction?

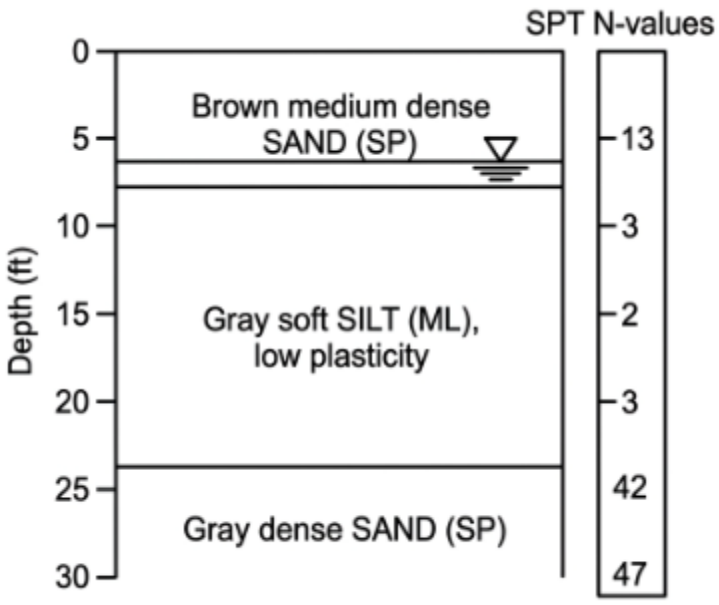
A. The excavation's own groundwater level over time

B. The ambient temperature at the building's foundation level

C. The building's inclination or rotation, giving early warning of tilting from nearby excavation-induced ground movement

D. The compressive strength of the building's existing foundation concrete

16. Based on the boring log figure shown, which soil layer would most likely require a deep foundation or ground improvement to support a heavily loaded structure, rather than a conventional shallow spread footing?



[Figure PQ-1: Vertical boring log profile diagram.]

A. The brown SAND (SP) layer from 0 to 8 ft

B. The gray SAND (SP) layer from 24 to 30 ft

C. No layer in this profile would require anything beyond a standard shallow footing

D. The gray SILT (ML) layer from 8 to 24 ft, given its very low blow counts throughout

17. A concrete mix uses 470 lb of cement and 212 lb of water per cubic yard. What is the water-cement ratio (w/c) of this mix?

A. 0.55

B. 0.40

C. 0.45

D. 0.50

18. Which property of structural steel describes its ability to undergo significant plastic deformation before fracturing, an important characteristic for seismic and impact resistance?

A. Hardness

B. Ductility

C. Brittleness

D. Elastic modulus

19. A sieve analysis of a coarse aggregate sample shows 410 g retained cumulative on the No. 4 sieve out of a total sample mass of 820 g. What percent of the sample passes the No. 4 sieve?

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

20. Why does concrete exposed to repeated cycles of freezing and thawing benefit significantly from an adequate air-void system created by air-entraining admixture?

A. Air voids increase the concrete's compressive strength directly
B. Air voids reduce the total amount of cement required in the mix design
C. Air voids eliminate the need for any curing after placement
D. Tiny air voids give relief space for water expanding as it freezes, relieving pressure that would crack the concrete

21. In a prestressed concrete member, what does the term 'transfer' specifically refer to?

A. The process of pouring concrete into the prestressing bed forms
B. The delivery of prestressing strand from the manufacturer to the precast plant
C. The final placement of the completed prestressed member onto its supports
D. The point at which the prestressing force is released from the tensioning device and transferred into the concrete member itself

22. A steel tension member has a cross-sectional area of 5.2 in^2 and is subjected to an axial tensile force of 143 kips. What is the axial stress in the member?

A. 22 ksi

B. 27.5 ksi

C. 32 ksi

D. 18 ksi

23. A rectangular concrete footing measures 6 ft by 5 ft by 1.5 ft thick. How many cubic yards of concrete are required for one footing, ignoring waste?

A. 1.25 cy

B. 2.08 cy

C. 1.67 cy

D. 0.83 cy

24. A contractor estimates that placing structural concrete costs $205 per cubic yard for materials and $90 per cubic yard for labor and equipment. What is the total estimated cost to place 230 cubic yards of concrete?

A. $67,850

B. $47,150

C. $20,700

D. $54,000

25. A contractor is deciding between purchasing equipment for $84,000 with annual operating savings of $14,000, 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 $440,000 and an Actual Cost of Work Performed of $480,000. What is the Cost Performance Index (CPI) for the project?

A. 1.09
B. 0.85
C. 0.92
D. 1.15

27. Two adjacent cross-sections along a roadway alignment, spaced 130 ft apart, have cut areas of 260 ft² and 300 ft², respectively. Using the average end area method, what is the cut volume, in cubic yards, between the two sections?

A. 1,078.5 cy
B. 1,348.1 cy
C. 1,617.8 cy
D. 808.9 cy

28. A contractor's direct cost estimate for a project totals $990,000. If the contractor applies a combined markup of 11% for overhead and profit, what is the total bid price?

A. $1,098,900
B. $990,000
C. $1,049,400
D. $1,148,400

29. A footing requires 45 pieces of No. 5 reinforcing bar, each 11 ft long. The unit weight of No. 5 rebar is 1.043 lb/ft. What is the total weight of reinforcing steel required, rounded to the nearest pound?

A. 430 lb
B. 602 lb
C. 688 lb
D. 516 lb

30. In a cost estimate, why are indirect (overhead) costs, such as project supervision, temporary facilities, and insurance, typically allocated across the project's direct cost items rather than tracked as a single lump-sum line item alone?

A. Indirect costs cannot legally be included in a bid price under any circumstances

B. Allocating indirect costs proportionally provides a more accurate unit cost for each work item and supports better cost control and comparison during construction

C. Indirect costs are always identical in amount to direct costs on every project

D. Allocating indirect costs is purely a bookkeeping formality with no effect on bid accuracy

31. In a typical bridge construction sequence, which activity generally must be complete before the bridge deck concrete can be placed?

A. Installation and bracing of the deck formwork and reinforcing steel

B. Installation of the bridge's final railing and lighting fixtures

C. Application of the final wearing surface or overlay

D. Removal of the falsework supporting the completed structure

32. An activity's duration estimates using PERT are: optimistic (a) = 5 days, most likely (m) = 10 days, pessimistic (b) = 15 days. What is the PERT expected duration (te) for this activity?

A. 11 days

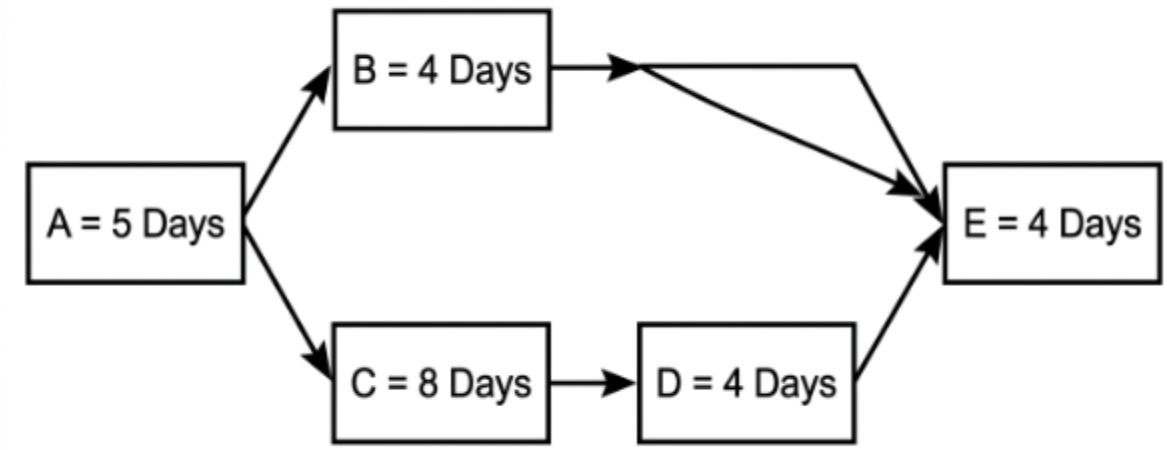
B. 9 days

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



A. 16 days
B. 18 days
C. 24 days
D. 21 days

34. An activity has an Early Start of day 9, an Early Finish of day 16, and a Late Finish of day 23. What is the total float for this activity?

A. 7 days
B. 14 days
C. 5 days
D. 9 days

35. What is the primary purpose of assigning a 'calendar' to individual activities in scheduling software, distinct from the project's overall default calendar?

A. Calendars exist purely for cosmetic color-coding of the schedule with no scheduling effect
B. Every activity must always use the exact same calendar as the overall project

C. To account for activity-specific non-working days, such as a concrete pour that cannot occur on weekends

D. Activity-specific calendars are only used for activities performed by union labor

36. An activity has a normal duration of 13 days at a normal cost of $9,500, and a crash duration of 9 days at a crash cost of $15,500. What is the cost slope (cost per day) to crash this activity?

A. $1,000/day

B. $1,500/day

C. $2,000/day

D. $750/day

37. A pipeline rehabilitation project with many nearly identical manhole segments, each following the same repetitive lining and testing cycle, would most benefit from which scheduling technique to compare crew progress across segments?

A. PERT with three-point estimates alone

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

C. A milestone-only schedule with no intermediate detail

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

38. A project's critical path must be shortened by 5 days to meet a contractual deadline. The only critical activity available to crash has a cost slope of $1,150 per day, with enough crash days available. What is the minimum additional direct cost to achieve the required 5-day reduction?

A. $5,750

B. $4,600

C. $6,900

D. $3,450

39. Three activities are scheduled to run concurrently on a given day, each requiring one crew of laborers: Activity X needs 5 laborers, Activity Y needs 6 laborers, and Activity Z needs 8 laborers. If only 14 laborers are available that day, what is the resource shortfall?

A. 3 laborers
B. 5 laborers
C. 7 laborers
D. 19 laborers

40. What is the defining characteristic of the 'critical chain' scheduling method, as distinct from traditional CPM scheduling?

A. It ignores all resource availability and schedules purely on logic, identically to basic CPM
B. It requires that every activity in the network have exactly zero float
C. It accounts for resource constraints and inserts time buffers to protect the completion date, rather than relying on float alone
D. It is only applicable to projects with fewer than ten total activities

41. A 6-in. diameter concrete test cylinder fails in compression at a load of 115,925 lb. What is the measured compressive strength of the cylinder, in psi?

A. 3,700 psi
B. 4,500 psi
C. 4,100 psi
D. 3,300 psi

42. A steel reinforcing bar delivered to the jobsite has mill certification paperwork showing a different heat number than what is stamped on the actual bars in the bundle. What is the appropriate response to this discrepancy?

A. Use the bars anyway, since heat number discrepancies never affect actual bar strength

B. Hold the shipment and resolve the discrepancy with the supplier before using the material, since the certification must correctly correspond to the actual delivered bars

C. Discard the mill certification paperwork and proceed with installation without it

D. Accept the material only if the bars are visually similar in color to prior deliveries

43. What is the primary purpose of a submittal review process, in which a contractor submits shop drawings and product data for the engineer or architect's review before fabrication or installation?

A. To confirm the proposed materials, equipment, and details conform to the design intent and specifications before they are fabricated or installed

B. To finalize the contractor's payment schedule for the submitted item

C. To satisfy a purely ceremonial requirement with no bearing on the actual work

D. To replace the need for any field inspection once the item is installed

44. During placement of a large concrete slab, why do specifications typically limit the maximum distance concrete can be pumped or conveyed horizontally before requiring intermediate re-mixing or verification of consistency?

A. Pumping distance limits exist purely to control the contractor's equipment rental costs

B. Longer pumping distances always increase the concrete's final compressive strength

C. Distance limits apply only to concrete containing no admixtures whatsoever

D. Extended pumping distances can cause segregation or slump and air content changes by final placement

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 72°F for 36 hours accumulates how much maturity (temperature-time factor), in °F-hours?

A. 1,080 °F-hr

B. 1,800 °F-hr

C. 720 °F-hr

D. 1,440 °F-hr

46. A field density test on a compacted embankment fill shows a dry unit weight of 116 pcf. The laboratory maximum dry unit weight from a standard Proctor test is 124 pcf. What is the percent (relative) compaction achieved in the field?

A. 89.0%
B. 96.8%
C. 93.5%
D. 86.5%

47. What is the primary function of a batch plant's automated recording system, which logs the actual weights of each material dispensed into a concrete batch?

A. To calculate the delivery driver's total hours for payroll purposes
B. To provide a verifiable record confirming the batch was proportioned according to the approved mix design, supporting quality control and dispute resolution
C. To determine the retail sale price charged to the customer for that load
D. To replace the need for any slump or air content testing at the jobsite

48. A fillet weld connecting two steel plates has a leg size of 7/16 in. What is the effective throat thickness of this fillet weld?

A. 0.309 in
B. 0.219 in
C. 0.375 in
D. 0.263 in

49. What is the primary reason a project specification might require a 'pre-pour checklist' to be completed and signed off before concrete placement begins on a critical structural element?

A. To determine the exact volume of concrete that will be ordered for the pour
B. To satisfy a purely administrative filing requirement with no bearing on quality
C. To replace the need for a structural engineer's periodic site visits entirely

D. To formally verify that reinforcement, formwork, and embeds have been inspected and are correct before they become inaccessible

50. A concrete supplier's quality control lab tests aggregate samples for gradation on a regular schedule throughout the production season. What is the primary purpose of this ongoing testing, rather than testing only once at the start of the season?

A. Ongoing testing is required purely to satisfy a fixed calendar schedule regardless of any actual variability

B. Aggregate gradation never changes once a source is initially approved for use

C. Gradation can vary over time due to source material or stockpile segregation, so ongoing testing verifies the mix design's assumptions stay valid

D. Ongoing testing exists solely to generate paperwork for the project's final closeout documents

51. A structural member for a construction-stage condition is subjected to a dead load of 660 lb/ft and a construction live load of 340 lb/ft. Using an unfactored D + Lc service-level combination, what is the total line load on the member?

A. 1,000 lb/ft

B. 820 lb/ft

C. 900 lb/ft

D. 1,100 lb/ft

52. A rectangular timber beam is 8 in. wide by 16 in. deep and carries a maximum bending moment of 19 kip-ft. What is the maximum bending stress in the beam?

A. 590 psi

B. 668 psi

C. 740 psi

D. 810 psi

53. A short steel column with a cross-sectional area of 6.6 in^2 has an allowable compressive stress of 24 ksi. What is the allowable axial load capacity of the column, neglecting buckling effects?

A. 158.4 kips
B. 135.0 kips
C. 175.0 kips
D. 145.0 kips

54. A simply supported steel beam spans 19 ft and carries a concentrated load of 9 kips at midspan. The beam has a moment of inertia $I = 860\ in^4$ and modulus of elasticity $E = 29{,}000$ ksi. Using $\Delta = PL^3/48EI$, what is the maximum deflection at midspan?

A. 0.070 in
B. 0.108 in
C. 0.089 in
D. 0.125 in

55. Based on the triangular active earth pressure distribution shown in the figure, acting over a wall stem height of 15 ft, at what height above the base of the wall (Point O) does the resultant active earth pressure force act?

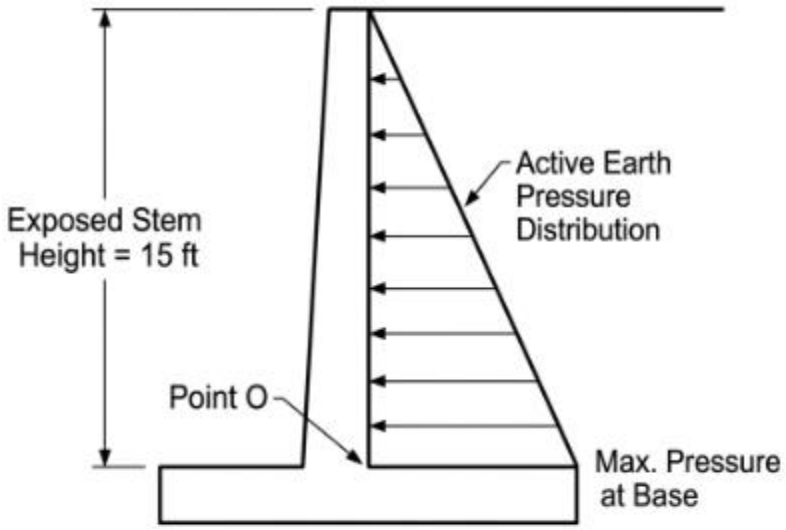


Figure PQ-3: Cross-section of Cantilever Retaining Wall

A. 7.50 ft
B. 5.00 ft
C. 3.75 ft

D. 10.00 ft

56. A roof purlin has a tributary width of 7.5 ft and carries a uniform roof live load of 19 psf. What is the total uniform line load on the purlin from this live load?

A. 125 lb/ft
B. 160 lb/ft
C. 110 lb/ft
D. 142.5 lb/ft

57. A precast concrete panel develops a diagonal crack extending from a corner shortly after being lifted from the casting bed using lifting inserts positioned according to the shop drawings. What is the most likely cause of this cracking?

A. Handling stresses from the lifting configuration exceeding the panel's tensile capacity at that stage of strength gain
B. Alkali-silica reaction between reactive aggregate and cement paste alkalis
C. Long-term drying shrinkage occurring after the panel has fully cured
D. Corrosion-induced spalling above embedded reinforcing steel

58. A rectangular beam 8 in. wide by 17 in. deep carries a maximum shear force of 12 kips. Using Vmax = 1.5V/(bd) for a rectangular section, what is the maximum shear stress in the beam?

A. 110 psi
B. 150 psi
C. 132 psi
D. 170 psi

59. In seismic design of reinforced concrete moment frames, why are beam-column joints typically detailed with closely spaced transverse reinforcement, in addition to what the joint's shear demand alone might suggest?

A. Closely spaced transverse reinforcement exists purely to hold the longitudinal bars in place during concrete placement

B. Transverse reinforcement in joints is required only in buildings under three stories tall

C. Transverse reinforcement in joints primarily improves the joint's appearance, not its structural performance

D. Closely spaced transverse reinforcement confines the joint's concrete core, improving its ability to maintain integrity under the large, reversing forces expected during a seismic event

60. A column carries an axial load producing a uniform stress of 10 ksi and a bending moment producing an extreme fiber bending stress of 8 ksi in the same direction. What is the maximum combined compressive stress at the extreme fiber?

A. 10 ksi

B. 18 ksi

C. 14 ksi

D. 8 ksi

61. A circular storm sewer pipe with a diameter of 27 in. flows full at a slope of 0.0055 ft/ft. Using Manning's equation with n = 0.012 and R = D/4 for a full circular pipe, what is the approximate full-flow capacity of the pipe, in cfs?

A. 19.5 cfs

B. 29.0 cfs

C. 34.0 cfs

D. 24.9 cfs

62. Using the Rational Method (Q = CiA), a drainage area of 22 acres has a runoff coefficient C = 0.36 and a design rainfall intensity of 2.6 in/hr. What is the peak runoff rate?

A. 16.5 cfs

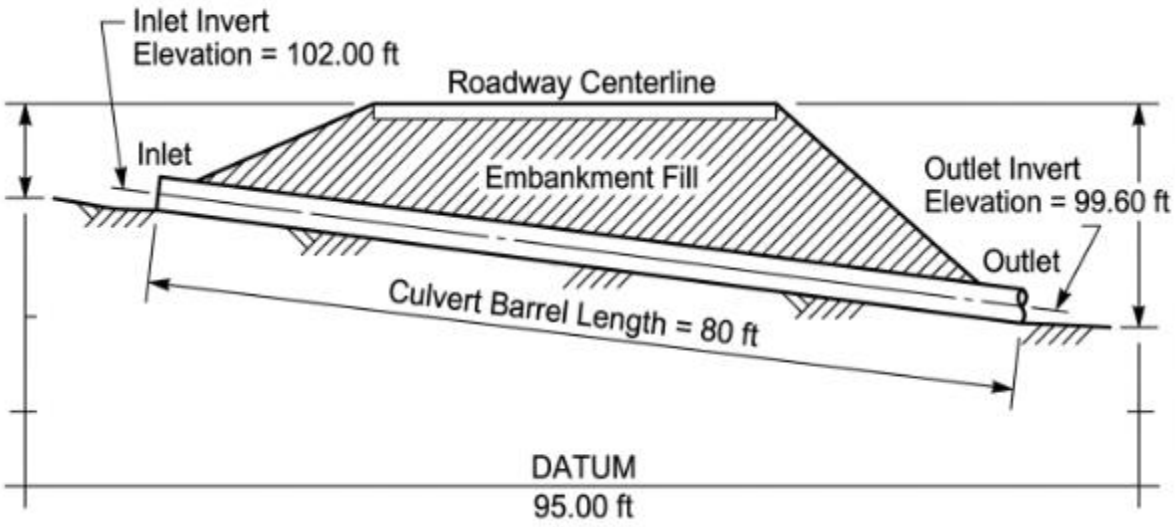
B. 24.7 cfs

C. 20.6 cfs

D. 13.2 cfs

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

Figure PQ-4: Longitudinal Profile



A. 3.0%

B. 2.0%

C. 2.5%

D. 3.5%

64. A proposed detention pond has a bottom area of 7,500 ft², a top area at the design water surface 4.2 ft above the bottom of 11,500 ft², and a mid-height area of 9,600 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. 35,000 ft³

B. 40,180 ft³

C. 45,600 ft³

D. 33,300 ft³

65. Which best describes the relationship between a watershed's time of concentration and the resulting peak discharge for a given total rainfall volume, all else being equal?

A. Time of concentration has no relationship whatsoever to peak discharge magnitude

B. A shorter time of concentration generally produces a higher peak discharge, since runoff arrives more quickly and is less spread out

C. A longer time of concentration always produces a higher peak discharge regardless of other factors

D. Peak discharge depends only on total rainfall volume, never on travel time

66. In a storm sewer system design, why is it generally undesirable for pipe velocity to be either too low or too high across the range of expected flows?

A. Low velocity always increases pipe cost, while high velocity always decreases pipe cost

B. Pipe velocity has no bearing on either sediment transport or pipe durability

C. Velocities too low risk sediment deposition and clogging, while velocities too high risk erosion and joint separation

D. Velocity only matters for open channels, never for closed conduit storm sewers

67. A load of 13,000 lb is lifted using a two-leg sling with each leg inclined at 48° from the horizontal. What is the tension in each sling leg, assuming the load is shared equally?

A. 8,747 lb

B. 6,500 lb

C. 9,750 lb

D. 11,555 lb

68. A mobile crane's load chart lists a maximum capacity of 22,000 lb at a 35-ft operating radius. The rigging weighs 750 lb, and the load to be lifted weighs 18,800 lb. What is the remaining capacity margin at this radius after accounting for rigging weight?

A. 3,200 lb

B. 1,800 lb

C. 2,950 lb

D. 2,450 lb

69. An excavation requires dewatering at a rate of 480 gallons per minute (gpm) to maintain a dry work area. A pump is rated at 760 gpm capacity. What percentage of the pump's rated capacity is being utilized?

A. 55.0%

B. 63.2%

C. 70.0%

D. 50.0%

70. Based on the crane outrigger footprint shown, why would placing timber cribbing or steel mats beneath each outrigger pad be necessary on a site with soft, uncompacted fill soil?

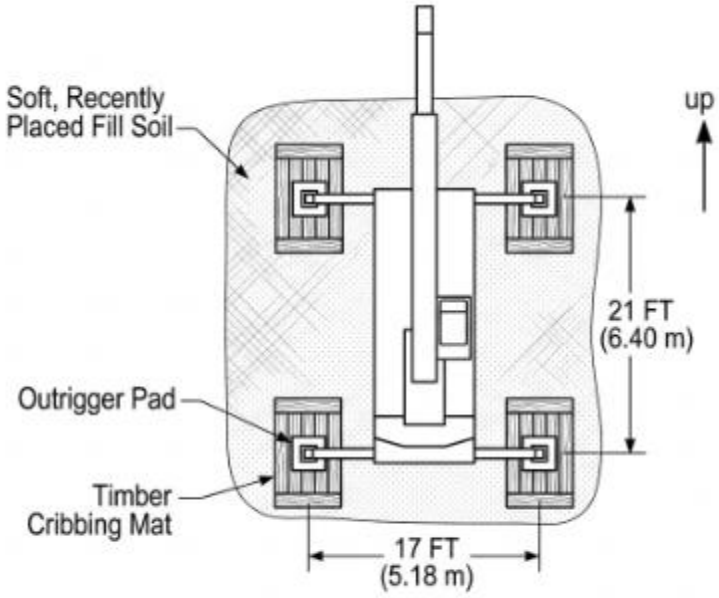


Figure PQ-5: Plan-view of Mobile Crane Outrigger and Cribbing

A. Cribbing or mats are purely decorative and have no effect on ground bearing pressure

B. Cribbing is only required when the crane's total weight exceeds 100 tons

C. Mats are needed only to protect the appearance of finished pavement surfaces

D. Cribbing or mats spread the outrigger's reaction over a larger area, reducing bearing pressure on the soft soil below allowable capacity

71. For excavating and loading blasted rock in a quarry or large rock cut, which piece of equipment is typically most efficient for high-volume loading into haul trucks?

A. A small skid-steer loader working alone

B. A backhoe-loader combination unit designed for utility trenching

C. A large hydraulic excavator or loader sized to match the haul truck fleet

D. A motor grader equipped with a front-mounted blade

72. A borrow pit excavation removes soil with an in-situ (bank) volume of 16,000 cy. If the soil has a shrinkage factor of 0.88 when placed and compacted as fill, what compacted fill volume will this borrow material yield?

A. 14,080 cy

B. 16,000 cy

C. 18,200 cy

D. 12,500 cy

73. A driven pile is being installed using a hammer with a rated energy of 27,000 ft-lb per blow, and the pile advances 0.26 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. 27,000 lb

B. 54,000 lb

C. 42,857 lb

D. 21,429 lb

74. A dump truck hauls fill material a one-way distance of 2.6 miles at an average haul speed of 20 mph, and returns empty at an average speed of 30 mph over the same distance. Ignoring loading and dumping time, what is the total round-trip travel time for one cycle?

A. 10.5 min

B. 13.0 min

C. 15.5 min

D. 9.0 min

75. What is the primary purpose of a job hazard analysis (JHA) prepared for a specific, non-routine construction task before work begins?

A. To break the task into steps, identify hazards for each step, and specify the controls needed to perform it safely

B. To calculate the total labor cost of performing the task

C. To satisfy a purely administrative filing requirement with no bearing on actual safety

D. To replace the need for any personal protective equipment during the task

76. An excavator has a bucket capacity of 2.0 cy, a fill factor of 0.87, a cycle time of 21 seconds, and an efficiency (working-time) factor of 0.83. What is the estimated production rate in cy per hour?

A. 298.3 cy/hr

B. 217.4 cy/hr

C. 270.0 cy/hr

D. 247.6 cy/hr

77. What is the primary purpose of a signal person on a construction site during a crane lift where the operator's view of the load or landing area is obstructed?

A. To calculate the load's exact weight before the lift begins

B. To operate the crane's controls directly in place of the crane operator

C. To give clear, standardized hand or radio signals directing crane movements when the load cannot be seen directly

D. To serve purely as a decorative safety requirement with no functional role

78. A cut excavation removes 9,500 cy of soil measured in its in-situ (bank) state. The soil has a swell factor of 1.26 when excavated and loaded loose into trucks. What is the loose (hauled) volume of this excavated material?

A. 9,500 cy

B. 11,970 cy

C. 10,500 cy
D. 13,000 cy

79. For a project requiring frequent, small-quantity concrete pours spread across a large site over many months, such as isolated footings at scattered locations, which concrete delivery method is often most practical compared to ready-mix truck delivery for every pour?

A. A single large batch plant delivery scheduled once for the entire project's total concrete quantity
B. Hand-mixing all concrete on-site using only bagged cement and a wheelbarrow
C. Ordering the maximum truck-mixer load for every pour regardless of the actual quantity needed
D. A dedicated small volumetric mixer truck that mixes concrete on-site to the exact quantity needed for each small pour, reducing waste from minimum-load charges

80. Concrete is placed in a wall form at a rate of 5.5 ft/hr, with a concrete temperature of 65°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. 912 psf
B. 820 psf
C. 1,000 psf
D. 750 psf

81. A scaffold frame leg has an allowable capacity of 3,900 lb. If four legs support a uniformly distributed platform load, and the total load on the scaffold bay is 14,000 lb, what is the utilization ratio of each leg, assuming equal load distribution?

A. 80.0%
B. 89.7%
C. 95.0%
D. 75.0%

82. A newly placed concrete slab imposes a construction load of 185 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. 92.5 psf
B. 46.25 psf
C. 123.3 psf
D. 61.7 psf

83. A temporary sign or windscreen attached to a construction hoist tower has an exposed area of 240 ft² and experiences a design wind pressure of 18 psf. What is the total design wind force acting on this exposed area?

A. 3,800 lb
B. 4,800 lb
C. 4,320 lb
D. 3,500 lb

84. A braced excavation in sand, 21 ft deep, uses an apparent earth pressure diagram per Peck's method with a maximum ordinate pa = 0.65·Ka·γ·H. Given Ka = 0.32, γ = 116 pcf, and H = 21 ft, what is the value of the maximum apparent pressure ordinate, pa?

A. 507 psf
B. 450 psf
C. 560 psf
D. 400 psf

85. Based on the wall formwork cross-section shown, if the maximum lateral concrete pressure on the form is 780 psf and the tie spacing is 2.5 ft vertical by 2.5 ft horizontal, what is the design tension load on each individual form tie?

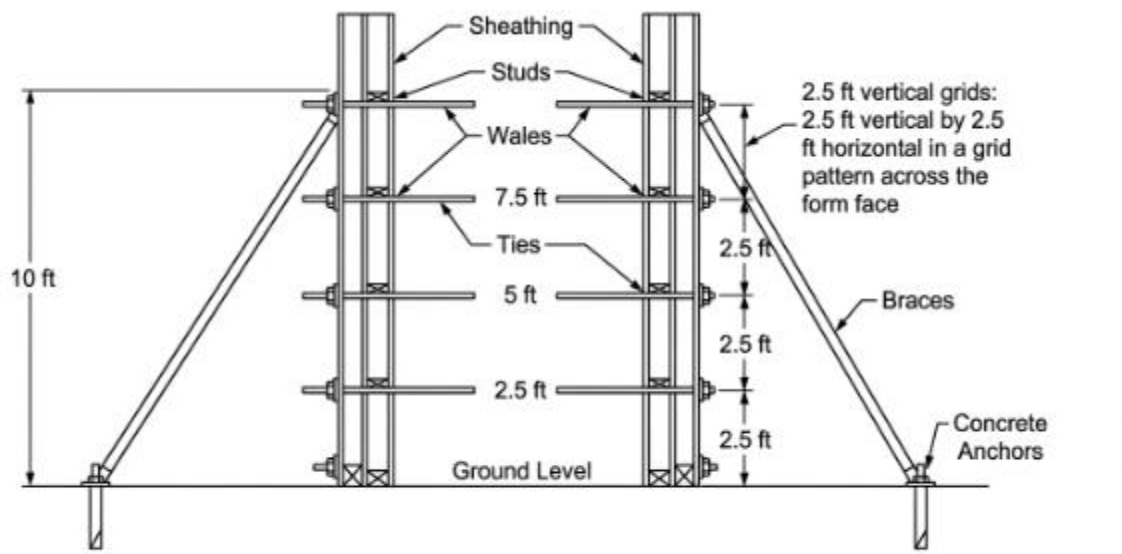


Figure PQ-6: Cross-section diagram of a wall formwork system showing vertical wales, horizontal form ties spaced at regular intervals, and diagonal bracing struts extending from the top of the form down to concrete anchors in the ground.

A. 3,900 lb

B. 5,850 lb

C. 4,875 lb

D. 3,000 lb

86. A guy wire bracing a temporary mast is anchored 6 ft horizontally from the base of the mast and attaches to the mast at a height of 8 ft, giving a wire length of 10 ft. If the horizontal force to be resisted at the attachment point is 1,500 lb, what tension in the guy wire is required to provide this horizontal resistance?

A. 2,500 lb

B. 1,500 lb

C. 2,000 lb

D. 3,000 lb

87. Why is a licensed structural engineer typically required to design and stamp the falsework and shoring plans for a complex, heavily loaded temporary support system, rather than leaving the design entirely to the contractor's field judgment?

A. Field judgment is always more accurate than engineering analysis for temporary structures

B. Engineering review is required only for falsework supporting structures shorter than 10 ft in height

C. Stamped engineering drawings are purely a formality with no bearing on actual system safety

D. Falsework failures can cause serious injury or collapse, and an engineered design ensures the system is properly analyzed for actual loads

88. A structure's typical floor construction load capacity (allowable) is 95 psf once the concrete reaches adequate strength, and each freshly poured slab imposes a construction load of 215 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. 107.5 psf

B. 71.7 psf

C. 53.75 psf

D. 215.0 psf

89. A horizontal strut in a braced excavation supports a tributary height of 9 ft and a tributary width of 13 ft along the wall, with an apparent lateral earth pressure of 440 psf acting uniformly over the tributary height. What is the total axial load in the strut?

A. 45,000 lb

B. 51,480 lb

C. 58,000 lb

D. 40,000 lb

90. Why must a formwork system for a wall pour account for the impact and vibration loads of a concrete bucket or pump discharge, in addition to the static lateral pressure of the fresh concrete itself?

A. Impact and vibration loads are always negligible compared to static concrete pressure and can be safely ignored in every case

B. Only pump discharge, never bucket discharge, produces any impact load worth considering

C. Formwork is designed only for the concrete's final weight after it has fully cured

D. Concrete discharge from a bucket, pump, or chute delivers localized dynamic impact loads at the point of placement that a static-only pressure analysis would not capture

91. A partially cured elevated slab has a current allowable load capacity of 88 psf. A piece of construction equipment imposes an equivalent distributed load of 125 psf on the slab during a planned operation. By how much does the equipment load exceed the slab's current allowable capacity?

A. 27 psf
B. 47 psf
C. 37 psf
D. 20 psf

92. In an internally braced excavation, why must struts be checked not only for axial compression but also for buckling, particularly when they span a long unbraced length between walers or bracing points?

A. A long, slender strut under high compression can buckle laterally before reaching full material strength, so buckling capacity often governs its design
B. Struts are never subject to buckling regardless of their length-to-cross-section ratio
C. Buckling only needs to be checked for struts made of timber, never for steel struts
D. Axial compression alone always governs strut design, making a buckling check unnecessary

93. A form tie rod has an ultimate tensile capacity of 16,500 lb, and the project specifies a safety factor of 2.5 for formwork ties. What is the maximum allowable working load for this tie?

A. 8,250 lb
B. 5,500 lb
C. 6,600 lb
D. 7,150 lb

94. Why is it important to verify that a crane's outrigger pads are set on a level, stable surface before beginning a lift, rather than on a sloped or uncompacted grade?

A. Level ground has no actual effect on a crane's rated lifting capacity or stability

B. Outrigger leveling is required only for cranes with a capacity above 200 tons

C. Sloped ground only affects the crane operator's personal comfort, not the lift's safety

D. An unlevel or unstable surface can cause uneven outrigger loading and reduced effective capacity, raising the risk of tipping

95. Under OSHA construction standards, what is required before an employee enters a permit-required confined space that has been reclassified as a non-permit space due to elimination of all hazards?

A. No documentation or verification of any kind is required for a reclassified space

B. Documentation supporting the reclassification, verifying that all hazards have actually been eliminated, must be made available to entrants

C. Reclassification is automatic after any single atmospheric test, regardless of the result

D. Reclassification requires only a verbal statement from any employee present at the space

96. Under OSHA's respiratory protection standard, what must an employer establish before requiring employees to wear tight-fitting respirators for protection against a workplace hazard?

A. A written respiratory protection program, including medical evaluation and fit testing requirements for affected employees

B. A verbal instruction that employees should simply wear a respirator when they feel it is needed

C. No program is required as long as respirators are made available somewhere on site

D. A program is required only for respirators rated for use in immediately dangerous atmospheres

97. Under OSHA construction standards, when must a written excavation-specific protective system design be prepared by a registered professional engineer, rather than relying on the standard's tabulated data options?

A. A professional engineer's design is never required for any excavation protective system

B. Only when the excavation is being performed in a state without any local building code

C. Only when more than 10 employees are working in the excavation at the same time

D. When the excavation is more than 20 ft deep, or when site-specific conditions fall outside the tabulated data's applicability

98. Under OSHA's control of hazardous energy (lockout/tagout) standard, what must occur before an employee begins servicing or maintenance work on equipment that could unexpectedly energize, start up, or release stored energy?

A. The employee may proceed with maintenance as long as a coworker is standing nearby to watch

B. Lockout/tagout is required only for equipment powered by electricity, never for other energy sources

C. The equipment must be de-energized and locked out, or tagged out where lockout is infeasible, following the employer's established energy control procedure

D. A verbal warning to other workers in the area is sufficient without any lockout or tagout device

99. In a temporary traffic control zone, what is the primary function of the termination area, the final segment before traffic returns to its normal condition?

A. To store construction materials and equipment for the duration of the project

B. To provide a clear transition allowing traffic to safely resume its normal path and speed after passing through the activity area

C. To mark the exact legal boundary of the contractor's work area

D. To serve as the only location where positive protection barriers may be installed

100. Which of the following best describes the general relationship between OSHA's general industry standards (29 CFR 1910) and its construction standards (29 CFR 1926)?

A. Construction work is generally governed by the construction standards, which take precedence over general industry standards for construction activities where both might otherwise apply

B. General industry standards always take precedence over construction standards on every construction site

C. The two sets of standards are completely identical, with no differences in their specific requirements

D. Only general industry standards apply to any site where construction work is being performed

Practice Exam 9: Answer Key and Explanations

1. A — The Rankine active coefficient is Ka = (1-sin29°)/(1+sin29°) ≈ 0.347. The total active force per foot is the triangular pressure diagram's area: 0.5×Ka×γ×H² = 0.5×0.347×120×12² ≈ 3,000 lb/ft, or 3.00 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. B — Primary settlement uses Sc = [Cc·H/(1+e0)]·log10[(p0+Δp)/p0]. With H = 180 in, Sc = (0.26×180/1.72)×log10(1.619) ≈ 27.2×0.209 ≈ 5.69 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 in the formula.

3. D — Total stress at 18 ft is 7×115 + 11×128 = 2,213 psf. Pore pressure from the water table 11 ft above is 11×62.4 = 686.4 psf. Effective stress is total stress minus pore pressure: 2,213 − 686 ≈ 1,527 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 = 112×4.5 = 504 psf. This gives qu = 504×17 + 0.5×112×3.8×12 ≈ 8,568 + 2,554 = 11,122 psf. The distractors isolate only one of the two additive terms, the surcharge term or the width term, instead of correctly summing both contributions together.

5. C — For a dry, cohesionless infinite slope, FS = tanφ/tanβ. With φ = 32° and β = 19°, FS = tan32°/tan19° ≈ 0.625/0.344 ≈ 1.81. 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. A — When a saturated clay is loaded rapidly and drainage cannot yet occur, the applied stress increment is initially carried almost entirely by the incompressible pore water, generating excess pore pressure, rather than by the more compressible soil skeleton. Over time, as drainage occurs, this excess pressure dissipates and the load gradually transfers to the soil skeleton as effective stress.

7. D — The effective friction angle, φ', characterizes shear strength in terms of effective stress, governing long-term, drained behavior once excess pore pressure has fully dissipated. This is distinct from total stress parameters like undrained shear strength, which instead govern short-term, undrained conditions immediately after loading, before drainage has had time to occur.

8. B — Bearing capacity depends on the effective unit weight of soil within the zone of influence, and submergence reduces that effective unit weight to roughly half the dry value. Assuming the highest anticipated water table position produces the lowest, most conservative bearing capacity estimate, appropriately accounting for the worst-case seasonal groundwater condition the foundation may actually experience.

9. D — Curve length is L = R·Δ with Δ in radians: Δ = 42×π/180 ≈ 0.7330 rad. Multiplying by R = 700 ft gives L ≈ 700×0.7330 ≈ 513.1 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. C — The middle ordinate is $M = R(1-\cos(\Delta/2))$. With $\Delta/2 = 13°$, $\cos 13° \approx 0.9744$, so $M = 1{,}050\times(1-0.9744) \approx 26.9$ 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. A — Prior deeds, plats, and survey records document how a boundary has been previously described, monumented, and possibly divided over time, giving the surveyor crucial context for interpreting ambiguous calls and locating physical evidence of the boundary in the field. Skipping this research risks missing evidence or misinterpreting a boundary that later research would have clarified.

12. B — Cut is the difference between the higher existing ground elevation and the lower design subgrade elevation: 615.75 − 612.30 = 3.45 ft. Since existing ground sits above the design grade here, material must be removed rather than added, and the stake is marked with this cut amount for the grading crew to follow accordingly.

13. A — The high point on a crest curve is at $x = g1L/(g1-g2) = 0.028\times480/0.06 \approx 224.0$ ft from the PVC. Its elevation is $\text{elevPVC} + g1x - [(g1-g2)/2L]x^2 \approx 175 + 6.27 - 3.14 \approx 178.14$ ft. Option B omits the parabolic curve correction entirely, giving a distorted, higher elevation instead.

14. B — A curve is a continuously changing alignment, and its true path cannot be reproduced in the field from just its beginning and end points, which are connected by a straight chord rather than the actual curved path. Closely spaced intermediate stakes at regular stations let the construction crew accurately follow and construct the curve's true geometric path throughout its length.

15. C — A tiltmeter directly measures small changes in a structure's inclination or rotation over time, providing an early warning if the building begins to tilt due to ground movement, settlement, or lateral soil displacement caused by nearby excavation activity. This differs from piezometers, which measure groundwater or pore pressure, or from testing methods used to evaluate existing concrete strength.

16. D — The gray silt layer from 8 to 24 ft shows very low N-values, only 2 to 3 blows/ft, indicating soft, weak material with low bearing capacity and high compressibility across a thick 16-ft interval. A heavily loaded structure would likely need deep foundations reaching the dense sand below 24 ft, or ground improvement, rather than this weak silt.

17. C — Water-cement ratio is the weight of water divided by the weight of cement: 212 lb / 470 lb ≈ 0.45. 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. B — Ductility describes a material's capacity to undergo substantial plastic deformation before it actually fractures, allowing structural steel to absorb energy and redistribute load during extreme events like earthquakes or impacts. Hardness measures resistance to surface indentation, brittleness describes the opposite of ductility, and elastic modulus describes stiffness within the elastic range, not deformation capacity before fracture.

19. A — Percent passing is the complement of percent retained: 820 − 410 = 410 g passing, or $410/820\times100 = 50\%$. 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 410 g actually reported in this problem.

20. D — As pore water in concrete freezes, it expands by roughly 9%, generating internal hydraulic pressure within the concrete's capillary pore structure. A well-distributed system of tiny, closely spaced air voids provides nearby relief space for this expanding water, relieving the pressure before it can crack the surrounding paste, which is why air entrainment specifically improves freeze-thaw durability.

21. D — Transfer is the specific moment when the tensioning force held in the prestressing strands is released from the jacking equipment and transferred into the concrete member through bond or end anchorage, inducing the intended compressive stress in the concrete. This is a distinct, critical stage from concrete placement, strand delivery, or the member's eventual erection onto its final supports.

22. B — Axial stress equals force divided by area: $\sigma = P/A = 143 \text{ kips} / 5.2 \text{ in}^2 = 27.5 \text{ ksi}$. 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. C — Footing volume is $6 \times 5 \times 1.5 = 45 \text{ ft}^3$. Converting to cubic yards by dividing by 27 ft^3 per cy gives $45/27 \approx 1.67$ 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. A — The combined unit cost is \$205 + \$90 = \$295 per cy. Multiplying by the 230 cy quantity gives \$295×230 = \$67,850. 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: \$84,000/\$14,000 per year = 6 years. 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. C — CPI equals earned value divided by actual cost: \$440,000/\$480,000 ≈ 0.92. 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. B — The average end area method gives volume as $[(260+300)/2] \times 130 = 280 \times 130 = 36{,}400 \text{ ft}^3$, or $36{,}400/27 \approx 1{,}348.1$ cy 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 an 11% markup multiplies the direct cost by 1.11: \$990,000×1.11 = \$1,098,900. 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. D — Total steel length is 45 bars × 11 ft each = 495 ft. Multiplying by the unit weight of 1.043 lb/ft gives 495×1.043 ≈ 516.3 lb, which rounds to 516 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. B — Distributing indirect costs across individual work items, rather than lumping them into one unallocated total, produces a more realistic all-in unit cost for each item, which supports better cost tracking, change order pricing, and comparison against actual field costs during construction. A single undistributed lump sum would obscure how overhead actually relates to the work being performed.

31. A — Deck concrete is placed onto formwork that has already received its reinforcing steel, so both the formwork installation and rebar placement must be complete and inspected before concrete placement begins. Railing, lighting, wearing surface, and falsework removal are all later activities that occur only after the deck concrete has been placed and gained adequate strength.

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 = (5+40+15)/6 = 60/6 = 10 days. 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. D — Two paths run from A to E: A-B-E totals 5+4+4 = 13 days, and A-C-D-E totals 5+8+4+4 = 21 days. The critical path is the longer of the two, since it determines the minimum project duration: 21 days. Path A-B-E carries substantial float relative to this longer, governing path through the network.

34. A — Total float equals late finish minus early finish (equivalently, late start minus early start): 23 − 16 = 7 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. C — An activity-specific calendar lets the software correctly account for that activity's actual working pattern, such as a concrete pour restricted to weekdays only, differing from the project's general default calendar which might include weekend work for other trades. Without this distinction, the software could calculate dates that ignore real constraints specific to certain activities.

36. B — Cost slope is (crash cost − normal cost)/(normal duration − crash duration) = ($15,500−$9,500)/(13−9) = $6,000/4 = $1,500 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. D — The linear scheduling method, or line-of-balance, plots production against location, each manhole segment, and time, making the repetitive lining and testing cycle across segments directly visible in one view. This reveals whether a faster crew on one segment might catch up to and interfere with a slower crew working the segment ahead of it in the sequence.

38. A — The minimum added cost to crash an activity is its cost slope multiplied by the number of days shortened: $1,150/day × 5 days = $5,750. Since this is the only available critical activity, all 5 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 5+6+8 = 19 laborers, while only 14 are available, leaving a shortfall of 19−14 = 5 laborers. 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. C — Critical chain scheduling explicitly incorporates resource constraints into the schedule, identifying the resource-constrained critical path, and inserts strategically placed time buffers, such as a project buffer at the end, to protect the overall completion date from variability. This differs from traditional CPM, which typically calculates float per activity without this resource-driven buffering approach.

41. C — For a 6-in. diameter cylinder, area = $\pi \times 3^2 \approx 28.27$ in². Compressive strength is failure load divided by area: 115,925/28.27 ≈ 4,100 psi. This standard cylinder-break calculation confirms whether delivered concrete achieves its specified design strength, and here the result closely matches a 4,100 psi mix requirement, confirming acceptance of the load.

42. B — Mill certification paperwork documents the specific chemical and mechanical properties of the actual steel delivered, so a mismatched heat number breaks the chain of traceability between the certification and the physical bars. The shipment should be held and the discrepancy resolved with the supplier before use; visual similarity does not restore traceability.

43. A — Submittal review lets the design team confirm that a contractor's proposed materials, equipment, and shop drawing details actually conform to the design intent and specifications before fabrication or installation begins. Catching a nonconforming submittal early avoids the far greater cost and schedule impact of discovering the same problem much later.

44. D — As concrete travels a longer distance through a pump line or conveyor, vibration, pressure changes, and time in transit can cause aggregate segregation or changes in slump and air content from what was originally batched. Limiting conveying distance helps ensure properties at final placement still match what was approved at the plant.

45. D — The Nurse-Saul maturity factor is $M = \Sigma(T - T0) \cdot \Delta t = (72 - 32) \times 36 = 40 \times 36 = 1{,}440$ °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 reported back to the field.

46. C — Percent compaction compares field dry unit weight to the laboratory maximum: 116/124×100 ≈ 93.5%. 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. B — An automated batch recording system creates a verifiable, time-stamped record of the actual quantities of cement, aggregate, water, and admixtures dispensed into each batch, confirming it was proportioned according to the approved mix design. This record supports quality control and can help resolve later disputes about whether a specific load was batched correctly, independent of any jobsite testing performed afterward.

48. A — 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: 0.4375 in × 0.707 ≈ 0.309 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. D — A pre-pour checklist formally documents that reinforcement placement, formwork dimensions, embedded items, and other critical details have been inspected and confirmed correct while they are still visible and accessible. Since these items become permanently hidden once concrete is placed, catching an error at this checklist stage is far less costly than discovering it after the concrete has already cured.

50. C — Aggregate gradation can drift over a production season due to changes at the quarry source, weathering, handling, or segregation within stockpiles, potentially shifting away from what the mix design originally assumed. Regular ongoing testing catches this drift early, allowing mix adjustments before an out-of-specification gradation affects delivered concrete's workability or strength on the project.

51. A — An unfactored service-level combination sums the applicable loads directly: D + Lc = 660 + 340 = 1,000 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. B — Section modulus for a rectangular section is $S = bd^2/6 = 8 \times 256/6 \approx 341.3$ in³. Converting the moment, M = 19 kip-ft × 12 in/ft × 1,000 = 228,000 lb-in. Bending stress is $\sigma = M/S = 228{,}000/341.3 \approx$ 668 psi, 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: 24 ksi × 6.6 in² = 158.4 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. C — Converting the 19-ft span to 228 in, $\Delta = PL^3/48EI = (9 \times 228^3)/(48 \times 29{,}000 \times 860) \approx 0.089$ 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. B — For a triangular pressure distribution, the resultant force acts at the centroid of the triangle, one-third of the height up from the base: 15 ft/3 = 5.00 ft above Point O exactly. 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. D — A uniform area load converts to a line load by multiplying by the tributary width the member collects: 19 psf × 7.5 ft = 142.5 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. A — Lifting a precast panel introduces bending and handling stresses differing substantially from its final in-service loading, and if the concrete hasn't yet gained adequate strength, or the lift point configuration was miscalculated, tensile stresses during the lift can exceed capacity and crack the panel. ASR, drying shrinkage, and corrosion spalling all develop over a much longer timeframe.

58. C — For a rectangular section, maximum shear stress occurs at the neutral axis and equals 1.5 times the average shear stress: $\tau_{max} = 1.5V/(bd) = 1.5\times12{,}000/(8\times17) = 18{,}000/136 \approx 132$ 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 — Beam-column joints experience large, reversing shear forces during an earthquake, and confining the joint's concrete core with closely spaced transverse reinforcement helps it maintain structural integrity and ductility under this demanding, cyclic loading. This confinement requirement goes beyond what a simple static shear calculation alone would suggest, reflecting the joint's critical role in the frame's overall seismic performance.

60. B — When axial and bending stresses act in the same sense at an extreme fiber, they superimpose directly: combined stress = axial + bending = 10 + 8 = 18 ksi. 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 2.25-ft diameter pipe, area = $\pi r^2 \approx 3.98$ ft² and hydraulic radius R = D/4 = 0.5625 ft. Manning's equation gives $Q = (1.486/n)AR^{(2/3)}S^{(1/2)} \approx (1.486/0.012)\times3.98\times0.5625^{0.667}\times0.0055^{0.5} \approx 24.9$ cfs. This full-flow capacity check confirms whether the pipe size can convey the design peak flow it is required to carry.

62. C — The Rational Method computes peak runoff as $Q = CiA = 0.36\times2.6\times22 \approx 20.6$ 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. A — Culvert slope equals the drop in invert elevation divided by the barrel length: $(102.00-99.60)/80\times100 = 2.40/80\times100 = 3.0\%$ 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 $V = (h/6)(A_{bottom}+4A_{mid}+A_{top}) = (4.2/6)\times(7{,}500+4\times9{,}600+11{,}500) = 0.7\times57{,}400 \approx 40{,}180$ 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 than a plain average would, especially for a pond this deep.

65. B — A shorter time of concentration means runoff from across the watershed arrives at the outlet more quickly and is concentrated over a shorter period, producing a sharper, higher peak discharge for the same total rainfall volume. A longer time of concentration instead spreads that same volume of runoff over a longer period, generally producing a lower, more attenuated peak.

66. C — Storm sewer design targets a velocity range avoiding both extremes: too low a velocity lets sediment settle and gradually clog the pipe, while too high a velocity erodes the pipe interior, stresses joints, and causes turbulence at manholes. Both extremes create real maintenance and performance problems over the system's service life.

67. A — Each leg supports half the vertical load, but because the leg is inclined, its tension exceeds that vertical component: $T = (\text{load}/2)/\sin 48° = 6{,}500/0.743 \approx 8{,}747$ 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. D — The total weight the crane must support at this radius is the load plus all rigging: 18,800+750 = 19,550 lb. Subtracting this from the rated capacity of 22,000 lb gives a margin of 22,000−19,550 = 2,450 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: 480/760×100 ≈ 63.2%. Operating at this level leaves meaningful 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 — An outrigger pad alone concentrates the crane's reaction over a relatively small contact area, which can produce bearing pressure exceeding soft, uncompacted fill soil's allowable capacity and risk punch-through or tipping. Cribbing or steel mats spread that same reaction over a much larger footprint, reducing the actual bearing pressure transmitted to the soil below to within its safe allowable range.

71. C — Large-volume rock loading operations require equipment sized to efficiently fill haul trucks in a small number of passes, which a properly sized hydraulic excavator or large front-end loader provides. A small skid-steer, a utility backhoe-loader, or a motor grader are all designed for different, smaller-scale or finishing tasks and would be far less efficient for high-volume rock loading.

72. A — Shrinkage factor accounts for the volume reduction when loose, excavated soil is recompacted into denser fill: compacted fill volume = bank volume × shrinkage factor = 16,000×0.88 = 14,080 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. C — Substituting into the Engineering News formula gives $Ru = 2\times27{,}000/(0.26+1.0) = 54{,}000/1.26 \approx 42{,}857$ lb. 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 2.6 mi/20 mph = 0.13 hr, and empty return time is 2.6 mi/30 mph ≈ 0.0867 hr, for a combined travel time of about 0.2167 hr, or exactly 13.0 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. A — A job hazard analysis systematically breaks a task into its individual steps, identifies the specific hazards associated with each step, and specifies the controls, procedures, PPE, or equipment needed to perform that step safely. This structured, step-by-step approach is particularly valuable for non-routine tasks, where workers may not already have well-established safe habits from repeated experience.

76. D — Cycles per hour equal 3,600 seconds divided by the 21-second cycle time, or about 171.4 cycles/hr. Each cycle effectively moves 2.0×0.87 = 1.74 cy, giving 171.4×1.74 ≈ 298.3 cy/hr before accounting for downtime. Applying the 0.83 efficiency factor for non-productive time reduces this to 298.3×0.83 ≈ 247.6 cy/hr, the realistic estimated rate.

77. C — A signal person gives the crane operator standardized hand signals or radio communication conveying information the operator cannot obtain through direct line of sight, such as the load's position relative to obstructions or the exact landing point. This link is essential when the operator's view of the load or landing area is blocked.

78. B — Swell factor accounts for the volume increase when compact, in-situ soil is excavated and loosened: loose volume = bank volume × swell factor = 9,500×1.26 = 11,970 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 volumetric mixer truck carries dry, unmixed materials and combines them on-site in the exact quantity needed for each small pour, avoiding the minimum-load charges and waste that would result from ordering a full ready-mix truck for every scattered footing. This makes it more practical for frequent, small-quantity pours across a large site.

80. A — Substituting the given values: Pmax = 150 + 9,000×(5.5/65) ≈ 150 + 762 ≈ 912 psf. 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. B — With four legs sharing the load equally, each leg carries 14,000/4 = 3,500 lb. Comparing this to the leg's allowable capacity of 3,900 lb gives a utilization ratio of 3,500/3,900×100 ≈ 89.7%. Since this is below 100%, the legs have adequate capacity for the stated load, provided load distribution in the field is reasonably even across all four legs.

82. D — 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 185 psf total: 185/3 ≈ 61.7 psf, a value each supported level below must be checked against for adequacy.

83. C — Total wind force equals design wind pressure multiplied by the exposed area subject to it: F = 18 psf × 240 ft² = 4,320 lb. 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. A — Substituting into Peck's apparent pressure formula: pa = 0.65×0.32×116×21 ≈ 507 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: 2.5 ft × 2.5 ft = 6.25 ft². Multiplying by the maximum lateral pressure gives the design tension load on each tie: 780 psf × 6.25 ft² ≈ 4,875 lb. This tributary-area method is standard for distributing lateral pressure to discrete form ties across a wall face.

86. A — The 6-8-10 geometry is a scaled 3-4-5 Pythagorean right triangle, where horizontal force = tension × (horizontal leg / hypotenuse). Solving for tension: tension = 1,500×(10/6) ≈ 2,500 lb exactly, the wire force needed to provide the required 1,500-lb horizontal resistance at the mast's attachment point on the structure above.

87. D — Falsework and shoring failures can cause serious injuries or a structural collapse, since they temporarily support significant loads, sometimes the full weight of wet concrete, before the permanent structure can support itself. An engineered design, properly analyzed for actual anticipated loads, gives far more assurance than relying solely on field judgment.

88. B — Distributing the 215 psf construction load equally across 3 supporting levels gives 215/3 ≈ 71.7 psf per level. Since this is below the 95 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. B — The strut's tributary area is its tributary height times tributary width: 9 ft × 13 ft = 117 ft². Multiplying by the uniform apparent pressure of 440 psf gives the total axial strut load: 440×117 = 51,480 lb exactly. This tributary-area method converts the wall's distributed earth pressure into a discrete design load for the individual strut member.

90. D — As concrete is discharged from a bucket, pump line, or chute into the form, it delivers a localized dynamic impact load at the point of placement, superimposed on the static lateral pressure from concrete already in the form. A design considering only static pressure would understate actual peak loading during active placement.

91. C — The excess load is the imposed equipment load minus the slab's current allowable capacity: 125−88 = 37 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. A — A long, slender strut carrying high axial compression can buckle laterally well before the material reaches its full compressive strength, especially as unbraced length between walers increases significantly. This is why strut design checks both axial stress and buckling capacity carefully, since buckling often governs over material crushing in practice.

93. C — Allowable working load is the ultimate tensile capacity divided by the specified safety factor: 16,500/2.5 = 6,600 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. D — A crane set on unlevel or unstable ground can develop uneven outrigger loading, with some pads carrying disproportionately more reaction than others, reducing the crane's effective stability and capacity from what the load chart assumes. This raises the risk of tipping, which is why a level, stable setup is required before any lift begins.

95. B — OSHA permits reclassifying a permit-required confined space as a non-permit space only when all hazards have actually been eliminated, and this reclassification must be supported by documentation available to entrants confirming that determination. A single test, a verbal statement, or an automatic reclassification without this documented verification does not satisfy the standard's requirement for this specific hazard-elimination determination.

96. A — OSHA's respiratory protection standard requires a written program addressing key elements including medical evaluation of employees before respirator use and fit testing to confirm a tight-fitting respirator actually seals properly on that individual. Simply making respirators available, or leaving use to individual judgment without this structured program, does not satisfy the standard's specific written-program requirement.

97. D — OSHA's excavation standard allows tabulated data for many common sloping and shoring configurations, but requires a design by a registered professional engineer when the excavation exceeds 20 ft in depth or actual site conditions, such as unusual soil or surcharge loads, fall outside what the tabulated data covers. Neither employee count nor building code status determines this requirement.

98. C — OSHA's lockout/tagout standard requires equipment be de-energized and locked out, or tagged out with equivalent protection where lockout is infeasible, following the employer's established procedure, before service begins. This applies to unexpected energization, startup, or stored energy release from any source, not electrical alone, and a coworker watching does not substitute.

99. B — The termination area is the final segment of a temporary traffic control zone, providing a clear transition that allows traffic to safely resume its normal path and speed after the activity area. This distinguishes it from the advance warning, transition, and activity areas that precede it earlier in the layout.

100. A — OSHA structured 29 CFR 1926 as the standards specifically governing construction work, and these construction-specific standards generally take precedence over the general industry standards in 29 CFR 1910 for construction activities where both might otherwise seem to apply. The two standard sets are not identical, and general industry standards do not simply override construction-specific requirements on a construction site.