PRACTICE EXAM 14: 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 13 ft high retains a cohesionless backfill with unit weight $\gamma = 122$ pcf and angle of internal friction $\varphi = 31°$, 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. 4.95 kip/ft
B. 3.30 kip/ft
C. 2.48 kip/ft
D. 6.60 kip/ft

2. A normally consolidated clay layer 16 ft thick has an initial void ratio $e0 = 0.68$ and compression index $Cc = 0.30$. The effective overburden stress at mid-height is 2,400 psf, and a footing load increases the effective stress at mid-height by 1,600 psf. What is the primary consolidation settlement of the layer?

A. 7.61 in
B. 5.20 in
C. 9.40 in
D. 3.80 in

3. A soil profile consists of 8 ft of sand (moist unit weight 112 pcf) above the water table, underlain by 12 ft of saturated sand (saturated unit weight 126 pcf) below the water table. What is the effective vertical stress at a depth of 20 ft (bottom of the saturated layer)?

A. 2,408 psf
B. 896 psf
C. 1,512 psf
D. 1,659 psf

4. A strip footing 3.5 ft wide is founded at a depth of 4 ft in a cohesionless soil with unit weight 114 pcf. At this friction angle, Terzaghi's bearing capacity factors are $N_q = 15$ and $N_\gamma = 11$. What is the ultimate bearing capacity of the footing, neglecting the cohesion term?

A. 6,840 psf
B. 2,195 psf
C. 9,035 psf
D. 10,500 psf

5. An infinite slope in cohesionless sand is inclined at 20° to the horizontal. The sand has an effective friction angle of 33° 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. 1.30
B. 1.50
C. 1.78
D. 2.10

6. A cohesive soil sample is sheared under undrained conditions in a triaxial test, with no volume change permitted and no time for pore pressure to dissipate. What type of shear strength parameter does this test most directly measure?

A. The fully drained, long-term effective friction angle of the soil

B. The soil's permeability coefficient under the applied confining pressure

C. The soil's compression index for long-term settlement estimation

D. The undrained shear strength, denoted Su or cu, representing the soil's short-term strength before consolidation occurs

7. In a saturated soil mass at rest, why does the coefficient of lateral earth pressure at rest, K0, generally fall between the active and passive coefficients rather than equaling either one?

A. Because no wall movement has occurred to mobilize the soil's full shear strength in either the active or passive direction

B. Because the water table always sits exactly at the ground surface in this condition

C. Because K0 is calculated using only the soil's unit weight, ignoring friction angle entirely

D. Because at-rest conditions only apply to soils with zero cohesion and zero friction angle

8. A footing bears on a two-layer soil profile: a stiff clay near the surface underlain by a much softer, more compressible clay layer at depth. Compared to a uniform stiff clay profile of the same total thickness, how is total settlement typically affected?

A. Total settlement decreases, since the stiff upper layer fully shields the softer layer below

B. Total settlement increases, because the softer layer beneath compresses more under the same applied stress increment

C. Total settlement is unaffected, since only the uppermost layer contributes to settlement

D. Total settlement only affects bearing capacity, never the settlement magnitude itself

9. A horizontal curve has a radius of 850 ft and a deflection angle (Δ) of 38°. What is the length of the curve?

A. 563.7 ft

B. 450.9 ft

C. 620.4 ft

D. 678.2 ft

10. For a horizontal curve with radius 1,300 ft and a deflection angle of 24°, what is the middle ordinate (M) of the curve?

A. 20.5 ft
B. 35.6 ft
C. 42.1 ft
D. 28.4 ft

11. During a boundary and topographic survey, why does a surveyor typically use both a total station and GPS/GNSS equipment on the same project rather than relying on just one method?

A. Total stations are now obsolete and are only kept as a legal backup requirement
B. Each method has complementary strengths; GPS excels in open areas, a total station works well under tree canopy or near structures
C. GPS equipment cannot measure horizontal angles under any circumstances whatsoever
D. Combining methods is required by state licensing law regardless of site conditions

12. A grade stake is set where the existing ground elevation is 550.40 ft and the design subgrade elevation is 547.90 ft, requiring a cut. What is the magnitude of the cut, in feet, to be noted on the stake?

A. 1.50 ft
B. 3.50 ft
C. 2.50 ft
D. 0.50 ft

13. A crest vertical curve connects a +2.5% grade to a −3.5% grade, is 550 ft long, and begins (PVC) at station 12+00 with an elevation of 210.00 ft. What is the elevation of the highest point on the curve?

A. 212.86 ft
B. 215.50 ft
C. 209.20 ft
D. 217.75 ft

14. Before setting final grade stakes for a large parking lot, why does a survey crew typically establish an offset stake a fixed distance from the actual proposed edge of pavement, rather than staking the edge directly?

A. Offset stakes are required only when the pavement edge curves rather than running straight

B. The offset stake survives construction equipment traffic and earthwork that would otherwise destroy a stake set directly on the finished edge line

C. Offset stakes allow the crew to skip computing the actual edge-of-pavement elevation entirely

D. Offset staking is purely a cost-saving measure that skips the design elevation calculation

15. A settlement plate is installed at the base of a planned embankment before fill placement begins. What does this instrument measure over the course of construction?

A. The lateral movement of the embankment's side slopes during construction

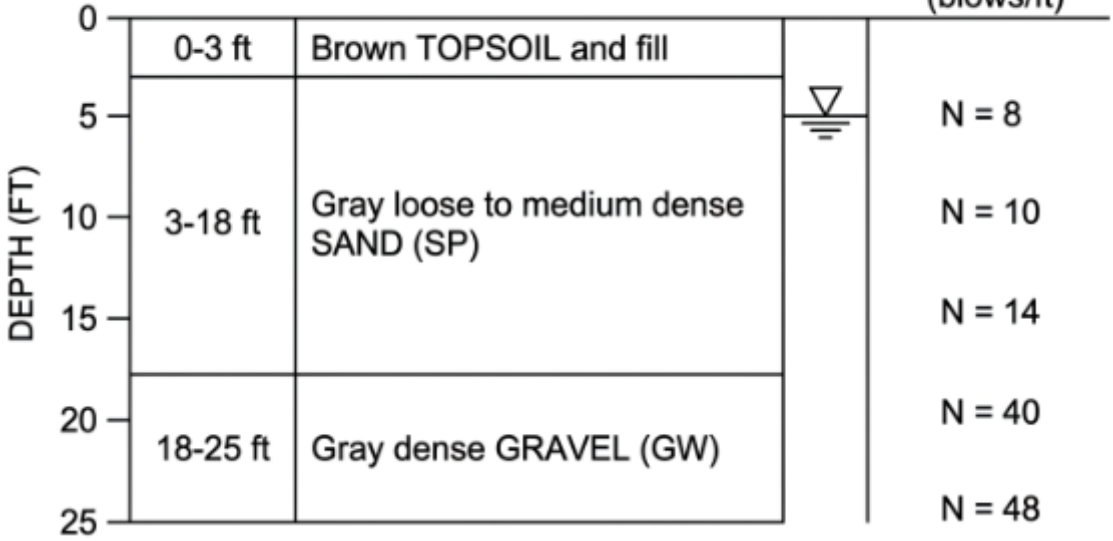
B. The pore water pressure within the embankment fill material itself

C. The moisture content of the fill material as it is placed in lifts

D. The vertical settlement of the ground surface beneath the embankment as fill is placed and the underlying soil consolidates

16. Based on the boring log figure shown, at what depth does the profile first indicate soil conditions likely to cause significant difficulty for open-cut excavation without dewatering?

Figure PQ-1: Vertical boring log profile diagram



A. At 20 ft, within the dense gravel layer

B. At the ground surface, within the topsoil layer

C. At approximately 5 ft, where the groundwater table intersects the loose sand layer

D. There is no depth in this profile where dewatering would be needed

17. A concrete mix uses 490 lb of cement and 220 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 mechanical test is most commonly used to evaluate a structural steel member's toughness, its ability to absorb energy during rapid impact loading at a specified temperature?

A. The standard tension test to failure

B. The Brinell hardness test

C. The Charpy V-notch impact test

D. The standard bend test around a mandrel

19. A sieve analysis of a coarse aggregate sample shows 380 g retained cumulative on the No. 4 sieve out of a total sample mass of 760 g. What percent of the sample passes the No. 4 sieve?

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

20. Why does the addition of silica fume to a concrete mix typically produce a significant increase in strength and a dramatic reduction in permeability compared to an ordinary portland cement mix?

A. It functions purely as an inert filler with no chemical reaction with the cement paste
B. It replaces the need for any coarse aggregate in the mix design entirely
C. It primarily works by significantly slowing the concrete's initial setting time
D. Its extremely fine particle size fills voids between cement grains while its high reactivity refines the paste's pore structure

21. What is the primary reason ready-mix concrete specifications commonly limit the maximum elapsed time between batching at the plant and discharge at the jobsite?

A. Regulatory agencies impose the limit purely for traffic safety reasons unrelated to the concrete itself
B. Beyond that time, hydration has progressed enough that workability and placement quality can no longer be reliably assured
C. The limit exists only to control the driver's total hours behind the wheel
D. Concrete becomes structurally unsound and unusable immediately after the time limit passes

22. A steel tension member has a cross-sectional area of 4.8 in^2 and is subjected to an axial tensile force of 156 kips. What is the axial stress in the member?

A. 28 ksi
B. 36 ksi
C. 32.5 ksi
D. 24 ksi

23. A rectangular concrete footing measures 8 ft by 4 ft by 2 ft thick. How many cubic yards of concrete are required for one footing, ignoring waste?

A. 2.37 cy
B. 1.78 cy
C. 2.96 cy
D. 1.19 cy

24. A contractor estimates that placing structural concrete costs $220 per cubic yard for materials and $95 per cubic yard for labor and equipment. What is the total estimated cost to place 200 cubic yards of concrete?

A. $44,000
B. $19,000
C. $50,000
D. $63,000

25. A contractor is deciding between purchasing equipment for $90,000 with annual operating savings of $15,000, 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. 6 years
B. 5 years
C. 7 years
D. 9 years

26. A project has a Budgeted Cost of Work Performed (earned value) of $460,000 and an Actual Cost of Work Performed of $500,000. What is the Cost Performance Index (CPI) for the project?

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

27. Two adjacent cross-sections along a roadway alignment, spaced 110 ft apart, have cut areas of 280 ft^2 and 320 ft^2, respectively. Using the average end area method, what is the cut volume, in cubic yards, between the two sections?

A. 977.8 cy
B. 1,466.7 cy
C. 733.3 cy
D. 1,222.2 cy

28. A contractor's direct cost estimate for a project totals $1,050,000. If the contractor applies a combined markup of 12% for overhead and profit, what is the total bid price?

A. $1,050,000
B. $1,113,000
C. $1,176,000
D. $1,239,000

29. A footing requires 40 pieces of No. 6 reinforcing bar, each 12 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. 601 lb
B. 721 lb
C. 841 lb
D. 962 lb

30. In an engineering economic analysis, why must all cash flows being compared between alternatives first be converted to a common point in time, whether present worth, future worth, or annual worth?

A. Money has time value, so amounts occurring at different times are not directly comparable until brought to the same time basis
B. Cash flows are always assumed equal in value regardless of when they occur
C. Converting to a common time basis is only a bookkeeping convenience with no analytical necessity
D. This conversion is required only when comparing more than three alternatives at once

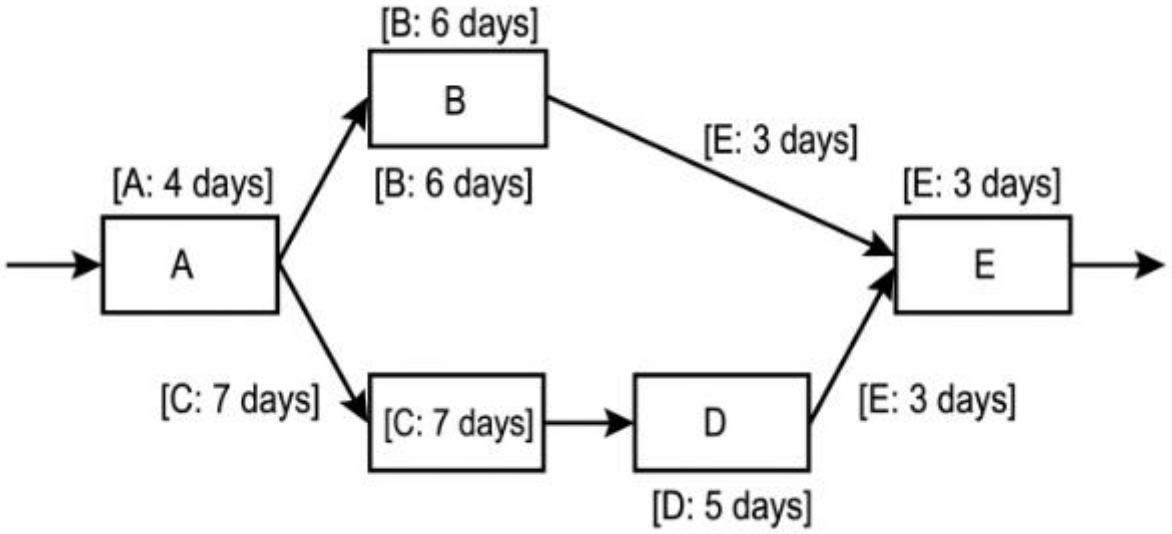
31. In a typical highway construction sequence, which activity generally must be complete before final pavement striping and signage installation can begin?

A. Initial site clearing and grubbing operations
B. Rough grading of the roadway subgrade
C. Placement of the final wearing course of asphalt or concrete pavement
D. Installation of the underlying storm drainage pipe network

32. An activity's duration estimates using PERT are: optimistic (a) = 7 days, most likely (m) = 11 days, pessimistic (b) = 21 days. What is the PERT expected duration (te) for this activity?

A. 13 days
B. 11 days
C. 14 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?



A. 19 days
B. 15 days
C. 23 days
D. 27 days

34. An activity has an Early Start of day 16, an Early Finish of day 24, and a Late Finish of day 33. What is the total float for this activity?

A. 17 days
B. 8 days
C. 13 days
D. 9 days

35. What is the primary difference between a 'finish-to-start' and a 'start-to-start' precedence relationship in a CPM schedule?

A. Finish-to-start and start-to-start are functionally identical relationships with different names
B. Finish-to-start requires the predecessor to finish before the successor starts, while start-to-start only requires the predecessor to start before the successor starts

C. Start-to-start relationships can only be used for the very first activity in a schedule

D. Finish-to-start relationships are always used for milestones, never for activities with duration

36. An activity has a normal duration of 15 days at a normal cost of $10,000, and a crash duration of 10 days at a crash cost of $17,000. What is the cost slope (cost per day) to crash this activity?

A. $1,000/day

B. $1,700/day

C. $1,400/day

D. $700/day

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

A. PERT with three-point estimates alone

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

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

D. A milestone-only schedule with no intermediate detail

38. A project's critical path must be shortened by 6 days to meet a contractual deadline. The only critical activity available to crash has a cost slope of $1,300 per day, with enough crash days available. What is the minimum additional direct cost to achieve the required 6-day reduction?

A. $6,500

B. $9,100

C. $5,200

D. $7,800

39. Three activities are scheduled to run concurrently on a given day, each requiring one crew of masons: Activity X needs 6 masons, Activity Y needs 7 masons, and Activity Z needs 9 masons. If only 16 masons are available that day, what is the resource shortfall?

A. 6 masons

B. 4 masons

C. 8 masons

D. 22 masons

40. What does 'resource-constrained scheduling' mean when applied to a CPM network?

A. Resources are ignored entirely, and only logical activity sequencing determines the schedule

B. The schedule is fixed first, and resource quantities are increased without limit to meet it

C. The schedule is adjusted so that resource demand never exceeds available resource supply, potentially extending activity dates beyond pure logic-based scheduling

D. Resource-constrained scheduling applies only to activities with zero float in the network

41. A 6-in. diameter concrete test cylinder fails in compression at a load of 107,442 lb. What is the measured compressive strength of the cylinder, in psi?

A. 3,400 psi

B. 4,200 psi

C. 3,000 psi

D. 3,800 psi

42. During a concrete pour, a quality control inspector notices the delivered concrete's actual air content, measured by a pressure meter test, is significantly below the specified minimum for freeze-thaw exposure. What is the most appropriate immediate action?

A. Reject the load or have additional air-entraining admixture added and re-tested before placement, per the mix design and specification

B. Accept the load as-is, since air content is a minor property with no durability consequence

C. Add extra water to the mix to compensate for the low air content reading

D. Proceed with placement and address the air content deficiency only after curing is complete

43. What is the primary purpose of a pre-installation conference held before a major, specialized trade begins work, such as waterproofing or curtain wall installation?

A. To finalize the trade's contract price after work has already started

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

C. To review the approved installation procedures, sequencing, and quality expectations among all relevant parties before work begins, catching potential issues early

D. To replace the need for any subsequent field inspection of the completed work

44. What does a 'mock-up' panel or sample installation, required before full-scale production begins on a specialized finish such as an exterior cladding system, primarily serve to establish?

A. The final contract price for the entire cladding scope of work

B. An approved visual and performance standard against which all subsequent production installation will be judged and compared

C. A replacement for the manufacturer's standard installation instructions

D. The project's overall construction schedule and sequencing plan

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 70°F for 40 hours accumulates how much maturity (temperature-time factor), in °F-hours?

A. 1,140 °F-hr

B. 1,520 °F-hr

C. 1,900 °F-hr

D. 760 °F-hr

46. A field density test on a compacted embankment fill shows a dry unit weight of 118 pcf. The laboratory maximum dry unit weight from a standard Proctor test is 125 pcf. What is the percent (relative) compaction achieved in the field?

A. 90.0%

B. 97.6%

C. 94.4%

D. 88.0%

47. Why do concrete specifications typically require test cylinders to be cured under standard laboratory conditions, separate from field-cured cylinders taken from the same batch?

A. Standard-cured cylinders establish potential strength under ideal conditions; field-cured ones indicate actual in-place strength

B. Standard-cured cylinders are only used when field-cured cylinders are physically unavailable

C. Field-cured cylinders are always discarded and never actually tested for strength

D. Standard curing exists solely to reduce the total number of cylinders a project requires

48. A fillet weld connecting two steel plates has a leg size of 5/8 in. What is the effective throat thickness of this fillet weld?

A. 0.313 in

B. 0.530 in

C. 0.375 in

D. 0.442 in

49. What is the primary purpose of performing a trial batch of a new concrete mix design in a laboratory before it is approved for use on a project?

A. To determine the exact retail price of the concrete for billing purposes

B. To verify the mix achieves its required strength, workability, and other specified properties before committing to full-scale production use

C. To satisfy a purely administrative filing requirement with no technical function

D. To replace the need for any field testing once the mix is placed on the project

50. A maturity method calibration curve was developed using a specific cement source and mix proportions. If the concrete supplier later changes to a different cement source for the same nominal mix, what must happen before the maturity method can continue to be used reliably?

A. The calibration curve must be redeveloped using the new cement source, since strength-maturity relationships are specific to the actual materials used

B. The existing calibration curve remains valid indefinitely regardless of any material changes

C. No recalibration is needed as long as the mix's nominal design strength stays the same

D. The maturity method becomes permanently invalid and cannot be used again on the project

51. A structural member for a construction-stage condition is subjected to a dead load of 700 lb/ft and a construction live load of 380 lb/ft. Using an unfactored D + Lc service-level combination, what is the total line load on the member?

A. 900 lb/ft

B. 950 lb/ft

C. 1,080 lb/ft

D. 1,200 lb/ft

52. A rectangular timber beam is 9 in. wide by 17 in. deep and carries a maximum bending moment of 20 kip-ft. What is the maximum bending stress in the beam?

A. 480 psi

B. 620 psi

C. 690 psi

D. 554 psi

53. A short steel column with a cross-sectional area of 7.0 in^2 has an allowable compressive stress of 23 ksi. What is the allowable axial load capacity of the column, neglecting buckling effects?

A. 140 kips

B. 175 kips

C. 150 kips
D. 161 kips

54. A simply supported steel beam spans 20 ft and carries a concentrated load of 10 kips at midspan. The beam has a moment of inertia I = 880 in⁴ and modulus of elasticity E = 29,000 ksi. Using $\Delta = PL^3/48EI$, what is the maximum deflection at midspan?

A. 0.089 in
B. 0.135 in
C. 0.113 in
D. 0.160 in

55. Based on the triangular active earth pressure distribution shown in the figure, acting over a wall stem height of 13 ft, at what height above the base of the wall (Point O) does the resultant active earth pressure force act?

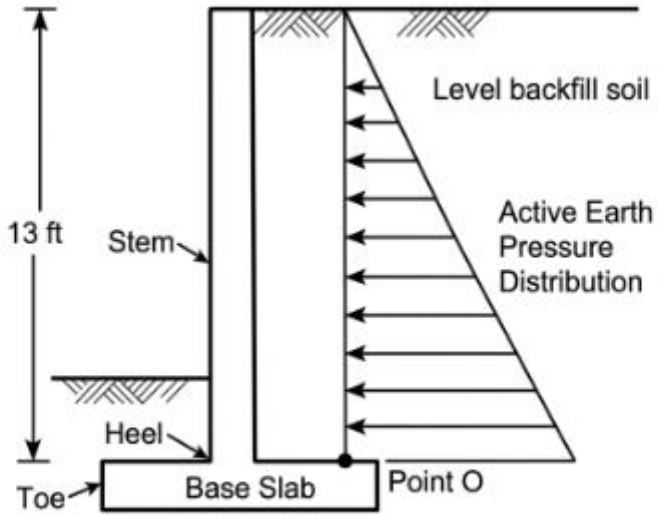


Figure PQ-3: Cantilever Retaining Wall Cross-section

A. 4.33 ft
B. 6.50 ft
C. 3.25 ft
D. 8.67 ft

56. A roof purlin has a tributary width of 8 ft and carries a uniform roof live load of 20 psf. What is the total uniform line load on the purlin from this live load?

A. 140 lb/ft
B. 160 lb/ft
C. 180 lb/ft
D. 120 lb/ft

57. A newly poured concrete floor slab develops a network of shallow, closely spaced parallel cracks running perpendicular to the direction of finishing trowel passes, appearing within the first hour after placement on a hot, windy day. What is the most likely cause?

A. Plastic shrinkage cracking from rapid surface moisture evaporation exceeding the bleed water rate
B. Alkali-silica reaction between reactive aggregate and cement paste alkalis
C. Corrosion-induced spalling above embedded reinforcing steel
D. Long-term drying shrinkage occurring after the concrete has fully cured

58. A rectangular beam 9 in. wide by 18 in. deep carries a maximum shear force of 14 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. 130 psi
D. 170 psi

59. Why does a reinforced concrete column design typically require both longitudinal reinforcement and transverse ties or spirals, rather than longitudinal bars alone?

A. Ties or spirals exist purely to hold the longitudinal bars in position during concrete placement, with no structural function afterward
B. Ties or spirals restrain the longitudinal bars against buckling and confine the concrete core, both of which increase the column's usable capacity and ductility

C. Ties or spirals are required only in columns taller than a specified minimum height

D. Ties or spirals primarily resist the column's flexural bending moment, not its axial load

60. A column carries an axial load producing a uniform stress of 11 ksi and a bending moment producing an extreme fiber bending stress of 9 ksi in the same direction. What is the maximum combined compressive stress at the extreme fiber?

A. 11 ksi

B. 16 ksi

C. 9 ksi

D. 20 ksi

61. A circular storm sewer pipe with a diameter of 33 in. flows full at a slope of 0.0065 ft/ft. Using Manning's equation with n = 0.0115 and R = D/4 for a full circular pipe, what is the approximate full-flow capacity of the pipe, in cfs?

A. 38.0 cfs

B. 42.5 cfs

C. 55.0 cfs

D. 48.2 cfs

62. Using the Rational Method (Q = CiA), a drainage area of 25 acres has a runoff coefficient C = 0.42 and a design rainfall intensity of 3.0 in/hr. What is the peak runoff rate?

A. 31.5 cfs

B. 26.3 cfs

C. 37.8 cfs

D. 21.0 cfs

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

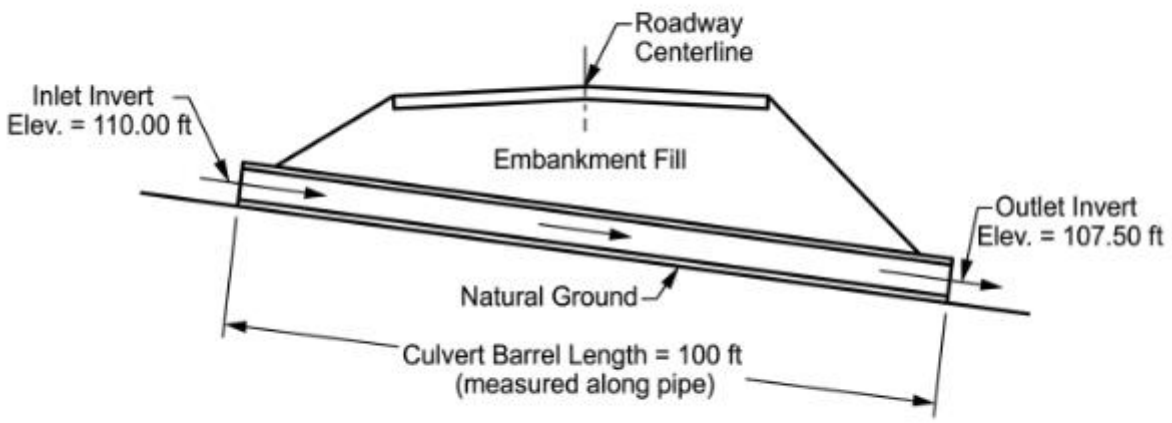


Figure PQ-4

A. 1.5%

B. 2.5%

C. 3.0%

D. 4.0%

64. A proposed detention pond has a bottom area of 8,500 ft², a top area at the design water surface 4.8 ft above the bottom of 12,500 ft², and a mid-height area of 10,450 ft². Using the prismoidal formula V = (h/6)(Abottom+4×Amid+Atop), what is the storage volume of the pond?

A. 44,000 ft³

B. 58,000 ft³

C. 50,240 ft³

D. 42,500 ft³

65. Which watershed characteristic has the most direct effect on shortening the time of concentration, all else being equal?

A. A larger total drainage area alone, regardless of slope or flow path length

B. A higher assigned SCS curve number, independent of any slope consideration

C. A longer overall flow path length from the hydraulically most distant point

D. A steeper overland and channel slope, which increases flow velocity and shortens travel time along the flow path

66. In open channel flow, what does the term 'normal depth' refer to?

A. The average depth measured across the entire length of the channel regardless of flow conditions

B. The depth at which uniform flow occurs for a given discharge, slope, roughness, and channel shape, where gravity and friction forces balance

C. The depth at which specific energy is at its minimum value for a given discharge

D. The depth measured only at the channel's downstream outlet structure

67. A load of 16,000 lb is lifted using a two-leg sling with each leg inclined at 55° from the horizontal. What is the tension in each sling leg, assuming the load is shared equally?

A. 8,000 lb

B. 10,875 lb

C. 9,766 lb

D. 13,912 lb

68. A mobile crane's load chart lists a maximum capacity of 26,000 lb at a 40-ft operating radius. The rigging weighs 900 lb, and the load to be lifted weighs 22,500 lb. What is the remaining capacity margin at this radius after accounting for rigging weight?

A. 2,600 lb

B. 3,500 lb

C. 2,000 lb

D. 3,100 lb

69. An excavation requires dewatering at a rate of 550 gallons per minute (gpm) to maintain a dry work area. A pump is rated at 900 gpm capacity. What percentage of the pump's rated capacity is being utilized?

A. 55.0%

B. 70.0%

C. 61.1%

D. 50.0%

70. Based on the crane outrigger footprint shown, if the boom slews to a new position 90 degrees from where it was initially set, what should the operator verify before continuing the lift?

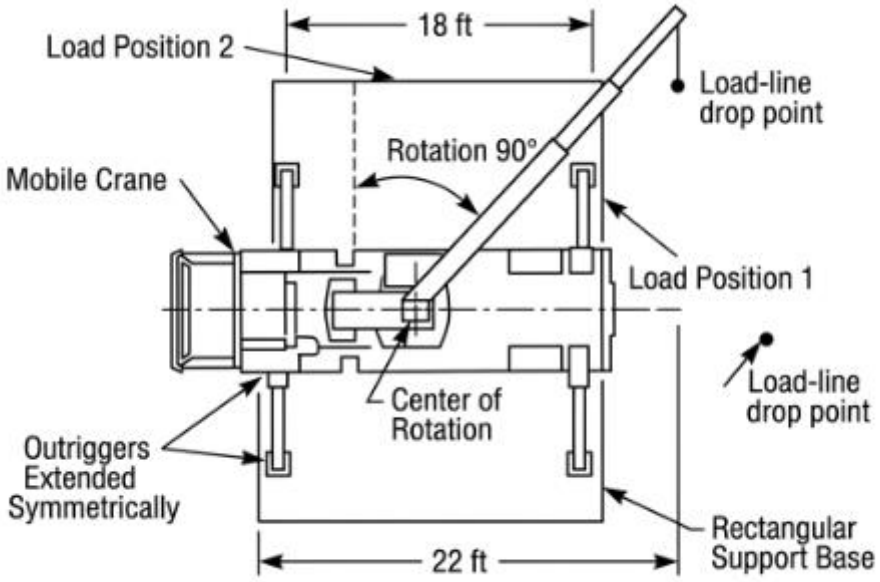


Figure PQ-5

A. Nothing further, since outrigger loads never change once the crane is initially set up

B. That the outrigger reactions and ground bearing pressure at the new boom position remain within allowable limits, since they can differ from the original position

C. Only that the boom length remains unchanged from the original position

D. Only that the wind speed has not changed since the crane was set up

71. For hoisting workers to an elevated work platform on a building under construction where no permanent elevator is yet operational, which piece of equipment is typically used, distinct from a materials-only hoist?

A. A materials-only construction hoist rated for supplies alone

B. A standard forklift equipped with an aftermarket work platform attachment

C. A crane bucket suspended from the main hook block

D. A personnel hoist specifically designed, tested, and certified for carrying workers

72. A borrow pit excavation removes soil with an in-situ (bank) volume of 22,000 cy. If the soil has a shrinkage factor of 0.85 when placed and compacted as fill, what compacted fill volume will this borrow material yield?

A. 18,700 cy
B. 22,000 cy
C. 25,900 cy
D. 16,500 cy

73. A driven pile is being installed using a hammer with a rated energy of 30,000 ft-lb per blow, and the pile advances 0.22 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. 30,000 lb
B. 60,000 lb
C. 24,590 lb
D. 49,180 lb

74. A dump truck hauls fill material a one-way distance of 2.8 miles at an average haul speed of 19 mph, and returns empty at an average speed of 29 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. 16.5 min
C. 14.6 min
D. 10.5 min

75. What is the primary purpose of a rigging plan, prepared in advance for a heavy or critical lift?

A. To document the load weight, rigging configuration, crane position, and capacity checks in advance, ensuring the lift is planned safely before it is attempted

B. To determine the final billing amount the crane rental company will charge

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

D. To replace the need for a qualified rigger or signal person during the actual lift

76. An excavator has a bucket capacity of 2.4 cy, a fill factor of 0.90, a cycle time of 24 seconds, and an efficiency (working-time) factor of 0.80. What is the estimated production rate in cy per hour?

A. 324.0 cy/hr

B. 259.2 cy/hr

C. 216.0 cy/hr

D. 290.0 cy/hr

77. What is the primary purpose of a competent person's daily inspection of rigging equipment, such as slings and shackles, before use on a jobsite?

A. To identify wear, damage, or deformation that could compromise the equipment's rated capacity before it is placed into service that day

B. To calculate the exact remaining service life of each piece of equipment in years

C. To satisfy a purely administrative recordkeeping requirement with no safety function

D. To replace the manufacturer's periodic certified inspection requirement entirely

78. A cut excavation removes 10,500 cy of soil measured in its in-situ (bank) state. The soil has a swell factor of 1.24 when excavated and loaded loose into trucks. What is the loose (hauled) volume of this excavated material?

A. 10,500 cy

B. 11,500 cy

C. 14,500 cy

D. 13,020 cy

79. For a remote bridge project site with no nearby utility power source and a need for continuous, reliable electricity to run pumps, lighting, and small tools throughout construction, what is typically provided?

A. A temporary connection to the nearest residential utility meter

B. Battery-powered hand tools exclusively, eliminating any need for generated power

C. One or more portable diesel or gas generators sized for the site's total connected electrical load

D. Solar panels alone, sized only for daytime lighting needs

80. Concrete is placed in a wall form at a rate of 6 ft/hr, with a concrete temperature of 70°F. Using a simplified maximum lateral pressure formula for walls, Pmax = 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. 850 psf

B. 921 psf

C. 1,000 psf

D. 780 psf

81. A scaffold frame leg has an allowable capacity of 4,200 lb. If four legs support a uniformly distributed platform load, and the total load on the scaffold bay is 15,000 lb, what is the utilization ratio of each leg, assuming equal load distribution?

A. 89.3%

B. 80.0%

C. 95.0%

D. 75.0%

82. A newly placed concrete slab imposes a construction load of 195 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. 97.5 psf

B. 65 psf
C. 48.75 psf
D. 130 psf

83. A temporary sign or windscreen attached to a construction hoist tower has an exposed area of 260 ft² and experiences a design wind pressure of 17 psf. What is the total design wind force acting on this exposed area?

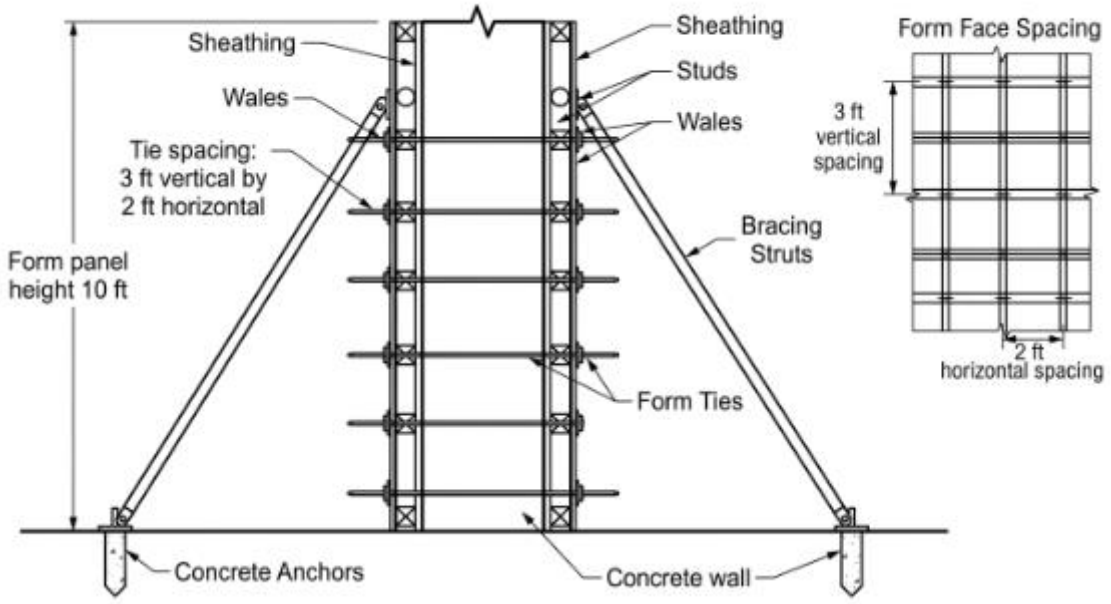
A. 3,900 lb
B. 4,900 lb
C. 4,420 lb
D. 3,600 lb

84. A braced excavation in sand, 23 ft deep, uses an apparent earth pressure diagram per Peck's method with a maximum ordinate pa = 0.65·Ka·γ·H. Given Ka = 0.30, γ = 120 pcf, and H = 23 ft, what is the value of the maximum apparent pressure ordinate, pa?

A. 480 psf
B. 600 psf
C. 420 psf
D. 538 psf

85. Based on the wall formwork cross-section shown, if the maximum lateral concrete pressure on the form is 800 psf and the tie spacing is 3 ft vertical by 2 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. 3,600 lb

B. 6,000 lb

C. 4,800 lb

D. 2,400 lb

86. A guy wire bracing a temporary mast is anchored 7 ft horizontally from the base of the mast and attaches to the mast at a height of 24 ft, giving a wire length of 25 ft. If the horizontal force to be resisted at the attachment point is 1,300 lb, what tension in the guy wire is required to provide this horizontal resistance?

A. 1,300 lb

B. 4,643 lb

C. 3,900 lb

D. 5,200 lb

87. During the initial erection of a multi-story steel frame, why is a specific, engineered erection sequence and bracing plan required rather than simply following the final structural drawings' member layout?

A. The final structural drawings never show enough detail to determine member sizes

B. An erection sequence is only needed for buildings over a specified height threshold

C. Steel erectors are legally required to develop their own sequence regardless of stability

D. The partially erected frame lacks the full lateral bracing the completed structure will have, so temporary measures must be engineered per stage

88. A structure's typical floor construction load capacity (allowable) is 90 psf once the concrete reaches adequate strength, and each freshly poured slab imposes a construction load of 200 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. 66.7 psf

B. 100.0 psf

C. 50.0 psf

D. 200.0 psf

89. A horizontal strut in a braced excavation supports a tributary height of 10 ft and a tributary width of 15 ft along the wall, with an apparent lateral earth pressure of 470 psf acting uniformly over the tributary height. What is the total axial load in the strut?

A. 60,000 lb

B. 80,000 lb

C. 70,500 lb

D. 65,000 lb

90. Why must temporary shoring and reshoring beneath a newly placed elevated concrete slab remain in place for a specified minimum duration, rather than being removed as soon as the concrete surface appears hard?

A. Shoring removal timing is based solely on the project's overall schedule, not concrete strength

B. The concrete must gain sufficient measured strength to support its own weight and imposed loads, which takes time beyond surface hardening

C. Surface hardness is itself a reliable, sufficient indicator of load-bearing strength

D. Shoring must remain in place permanently and is never actually removed

91. A partially cured elevated slab has a current allowable load capacity of 90 psf. A piece of construction equipment imposes an equivalent distributed load of 135 psf on the slab during a planned operation. By how much does the equipment load exceed the slab's current allowable capacity?

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

92. In a soldier pile and lagging excavation support system installed in stratified soil with an intermittently caving sandy layer, what modification to the standard lagging installation sequence is typically necessary?

A. Installing all lagging for the full depth only after excavation is fully complete
B. Omitting lagging entirely in any layer that shows a tendency to cave
C. Increasing the horizontal spacing between soldier piles to speed up the work
D. Installing lagging promptly, in short vertical increments just ahead of continued excavation to limit exposure time

93. A form tie rod has an ultimate tensile capacity of 19,000 lb, and the project specifies a safety factor of 2.0 for formwork ties. What is the maximum allowable working load for this tie?

A. 8,000 lb
B. 9,500 lb
C. 10,500 lb
D. 7,600 lb

94. Why does falsework supporting a curved, cantilevered segment of an elevated highway ramp require more detailed engineering analysis than falsework supporting a simple, straight, simply supported span?

A. Curved falsework always requires twice as many vertical support posts as straight falsework

B. Curved falsework is exempt from the wind load checks required for straight spans

C. Falsework for curved segments is never engineered and instead follows a fixed standard detail

D. The curved, cantilevered geometry introduces torsional and unbalanced loading effects that a simple straight-span falsework analysis would not capture

95. Under OSHA's hazard communication standard, what document must be readily accessible to employees for each hazardous chemical present at a worksite?

A. A material cost estimate sheet

B. A vendor delivery receipt

C. A safety data sheet (SDS)

D. A daily weather report

96. Per OSHA requirements, what must be provided at a construction site where employees may be exposed to a fall hazard and conventional fall protection is determined to be infeasible or to create a greater hazard?

A. A documented, site-specific fall protection plan meeting the specific criteria in the applicable standard

B. No fall protection or plan is required under this exception

C. A verbal instruction to employees to simply be careful near the edge

D. A generic, company-wide fall protection plan with no site-specific content

97. Under OSHA's electrical safety-related work practices standard, what must be established before employees work on or near exposed energized electrical conductors or circuit parts, unless de-energizing creates a greater hazard or is infeasible?

A. The conductors or circuit parts must be de-energized and a lockout/tagout procedure applied before work begins

B. Employees may work on energized parts at any time as long as they wear insulated gloves

C. No specific precaution is required if the voltage is below 50 volts

D. A verbal warning to nearby workers is sufficient without any de-energizing procedure

98. Under current OSHA recordkeeping rules (29 CFR 1904.39), within what time frame must an employer report a work-related fatality to OSHA, and within what time frame must an employer report a work-related in-patient hospitalization of even a single employee?

A. Both a fatality and a hospitalization must be reported within 8 hours

B. Both a fatality and a hospitalization must be reported within 24 hours

C. A fatality must be reported within 8 hours; an in-patient hospitalization must be reported within 24 hours

D. Reporting is required only if three or more employees are hospitalized from the same incident

99. In a temporary traffic control zone, what is the primary purpose of the advance warning area, the first segment a driver encounters approaching the work zone?

A. To provide additional parking space for construction vehicles and equipment

B. To inform drivers a work zone lies ahead, giving advance notice to adjust speed and attention

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

D. To serve as the location where all flaggers must be stationed at all times

100. Which federal agency is responsible for developing and enforcing workplace safety and health regulations under the Occupational Safety and Health Act?

A. The Environmental Protection Agency (EPA)

B. The Federal Highway Administration (FHWA)

C. The National Institute of Standards and Technology (NIST)

D. The Occupational Safety and Health Administration (OSHA)

Practice Exam 14: Answer Key and Explanations

1. B — The Rankine active coefficient is Ka = (1-sin31°)/(1+sin31°) ≈ 0.320. The total active force per foot is the triangular pressure diagram's area: $0.5 \times Ka \times \gamma \times H^2 = 0.5 \times 0.320 \times 122 \times 13^2 \approx 3{,}300$ lb/ft, or 3.30

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. A — Primary settlement uses $S_c = [C_c \cdot H/(1+e_0)] \cdot \log_{10}[(p_0+\Delta p)/p_0]$. With H = 192 in, $S_c = (0.30 \times 192/1.68) \times \log_{10}(1.667) \approx 34.29 \times 0.222 \approx 7.61$ 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. D — Total stress at 20 ft is 8×112 + 12×126 = 2,408 psf. Pore pressure from the water table 12 ft above is 12×62.4 = 748.8 psf. Effective stress is total stress minus pore pressure: 2,408 − 749 ≈ 1,659 psf. Option B wrongly reports total stress without deducting any pore pressure at all.

4. C — Terzaghi's equation gives $q_u = q \cdot N_q + 0.5 \cdot \gamma \cdot B \cdot N_\gamma$, with $q = \gamma \cdot D_f = 114 \times 4 = 456$ psf. This gives $q_u = 456 \times 15 + 0.5 \times 114 \times 3.5 \times 11 = 6{,}840 + 2{,}195 \approx 9{,}035$ 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, $FS = \tan\varphi/\tan\beta$. With $\varphi = 33°$ and $\beta = 20°$, $FS = \tan 33°/\tan 20° \approx 0.649/0.364 \approx 1.78$. 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. D — An undrained triaxial test prevents drainage during shearing, so the measured strength reflects the soil's condition immediately after loading, before any pore pressure dissipation or consolidation occurs. This undrained shear strength, Su, governs short-term stability problems, such as the end of construction, distinct from the drained effective friction angle governing long-term conditions.

7. A — The active and passive coefficients represent two opposite limit states, each requiring the wall to yield away from or into the soil to fully mobilize shear strength along a failure surface. With no wall movement at all, neither limit state is reached, so the soil remains at an intermediate at-rest stress state between these two bounds.

8. B — Settlement analysis must consider every compressible layer within the significant stress zone beneath a footing, not just the uppermost layer. A softer, more compressible clay at depth will compress more under the same stress increment than an equally thick stiff layer would, increasing total settlement compared to a uniform stiff profile of the same overall thickness.

9. A — Curve length is $L = R \cdot \Delta$ with Δ in radians: $\Delta = 38 \times \pi/180 \approx 0.6632$ rad. Multiplying by R = 850 ft gives $L \approx 850 \times 0.6632 \approx 563.7$ 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 $M = R(1-\cos(\Delta/2))$. With $\Delta/2 = 12°$, $\cos 12° \approx 0.9781$, so $M = 1{,}300 \times (1-0.9781) \approx 28.4$ 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. B — GPS/GNSS receivers work best with a clear, unobstructed view of the sky, losing accuracy or signal entirely under dense tree canopy, near tall structures, or indoors. A total station has no such

limitation, since it measures angles and distances optically, so combining both lets a surveyor cover the full range of site conditions efficiently.

12. C — Cut is the difference between the higher existing ground elevation and the lower design subgrade elevation: 550.40 − 547.90 = 2.50 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.

13. A — The high point on a crest curve is at $x = g_1L/(g_1-g_2) = 0.025\times550/0.06 \approx 229.2$ ft from the PVC. Its elevation is $\text{elev}_{PVC} + g_1x - [(g_1-g_2)/2L]x^2 \approx 210 + 5.73 - 2.87 \approx 212.86$ ft. Option D omits the parabolic curve correction entirely, giving only the plain tangent elevation instead.

14. B — A stake set directly on the finished edge-of-pavement line would almost certainly be disturbed or destroyed by the very earthwork, grading, or paving equipment operating right at that location. Offsetting the stake a known, fixed distance away keeps it intact and usable throughout construction, while still letting the crew measure back to the true design line.

15. D — A settlement plate consists of a rigid plate at the original ground surface connected to a riser pipe extending up through the fill, allowing surveyors to measure the plate's elevation over time as construction proceeds. This directly tracks vertical settlement of the ground beneath the embankment as the underlying soil consolidates under the growing fill load.

16. C — The groundwater table is shown at 5 ft depth, right within the loose to medium dense sand layer, meaning any open-cut excavation deeper than about 5 ft would encounter groundwater inflow through this relatively permeable sand. This combination of shallow groundwater and permeable sand is exactly the condition that typically necessitates dewatering before or during excavation.

17. A — Water-cement ratio is the weight of water divided by the weight of cement: 220 lb / 490 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. C — The Charpy V-notch impact test strikes a notched steel specimen with a swinging pendulum at a controlled temperature, measuring the energy absorbed during fracture. This directly evaluates toughness and brittle-fracture resistance, a property distinct from what tension, hardness, or bend tests measure, which instead assess strength, surface hardness, or ductility under slow bending.

19. B — Percent passing is the complement of percent retained: 760 − 380 = 380 g passing, or 380/760×100 = 50%. This particular sample happens to have equal mass retained and passing, an even split. Option B (60%) would only result from a different retained mass than the 380 g actually reported in this problem.

20. D — Silica fume particles are extremely fine, far smaller than cement grains, so they physically pack into voids between cement particles while also reacting pozzolanically with calcium hydroxide from hydration. Together these effects densify and refine the paste's microstructure, producing higher strength and much lower permeability than an ordinary portland cement mix of the same proportions.

21. B — As cement hydration proceeds during transit, the mix progressively loses workability and begins to stiffen, so a maximum elapsed-time limit ensures the concrete is placed and consolidated while it can still be properly worked into place. Beyond that window, added water or extended mixing to restore workability would compromise the approved mix design and final quality.

22. C — Axial stress equals force divided by area: $\sigma = P/A = 156 \text{ kips} / 4.8 \text{ in}^2 = 32.5 \text{ ksi}$. 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 given.

23. A — Footing volume is $8 \times 4 \times 2 = 64 \text{ ft}^3$. Converting to cubic yards by dividing by 27 ft^3 per cy gives $64/27 \approx 2.37$ 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. D — The combined unit cost is \$220 + \$95 = \$315 per cy. Multiplying by the 200 cy quantity gives \$315×200 = \$63,000. 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. A — Simple break-even analysis divides the purchase price by the annual savings: \$90,000/\$15,000 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. B — CPI equals earned value divided by actual cost: \$460,000/\$500,000 = 0.92 exactly. 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. D — The average end area method gives volume as $[(280+320)/2] \times 110 = 300 \times 110 = 33{,}000 \text{ ft}^3$, or $33{,}000/27 \approx 1{,}222.2$ 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. C — Applying a 12% markup multiplies the direct cost by 1.12: \$1,050,000×1.12 = \$1,176,000. 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. B — Total steel length is 40 bars × 12 ft each = 480 ft. Multiplying by the unit weight of 1.502 lb/ft gives $480 \times 1.502 \approx 720.96$ lb, which rounds to 721 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. A — Because money has time value, a dollar today is not equivalent to a dollar several years from now, due to the opportunity to earn or pay interest in the interim. Converting all cash flows to a common

time basis makes them genuinely comparable, which is why this step is necessary in any valid economic analysis.

31. C — Striping and signage are applied directly onto the finished pavement surface, so the final wearing course must be placed and cured before this work can begin. Clearing, rough grading, and storm drainage installation are all much earlier activities in the sequence, occurring well before the pavement structure itself is complete.

32. D — PERT expected duration weights the most likely estimate four times as heavily as the optimistic and pessimistic estimates: te = (a+4m+b)/6 = (7+44+21)/6 = 72/6 = 12 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. A — Two paths run from A to E: A-B-E totals 4+6+3 = 13 days, and A-C-D-E totals 4+7+5+3 = 19 days. The critical path is the longer of the two, since it determines the minimum project duration: 19 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): 33 − 24 = 9 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-start relationship requires the predecessor activity to fully finish before its successor can begin, the most common and restrictive logic type. A start-to-start relationship instead only requires the predecessor to have started, allowing the successor to begin in parallel, useful for modeling overlapping work like excavation and concrete placement progressing together.

36. C — Cost slope is (crash cost − normal cost)/(normal duration − crash duration) = ($17,000−$10,000)/(15−10) = $7,000/5 = $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. B — The linear scheduling method, or line-of-balance, plots production against location, in this case each process train, and time, making the repetitive construction cycle across trains directly visible in one view. This reveals whether a faster crew on one train might catch up to and interfere with a slower crew working the train ahead of it.

38. D — The minimum added cost to crash an activity is its cost slope multiplied by the number of days shortened: $1,300/day × 6 days = $7,800. Since this is the only available critical activity, all 6 days of compression must come from it alone, leaving no cheaper combination of activities to achieve the required deadline reduction.

39. A — Total demand for that day is 6+7+9 = 22 masons, while only 16 are available, leaving a shortfall of 22−16 = 6 masons. 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 — Pure CPM logic-based scheduling determines the earliest possible dates based only on activity dependencies, ignoring whether enough resources actually exist to perform concurrent work. Resource-constrained scheduling instead adjusts activity timing so that resource demand on any given day never exceeds the actual available supply, which can push some activities later than their pure logic-based dates.

41. D — For a 6-in. diameter cylinder, area = $\pi \times 3^2 \approx 28.27$ in². Compressive strength is failure load divided by area: 107,442/28.27 ≈ 3,800 psi. This standard cylinder-break calculation confirms whether delivered concrete achieves its specified design strength, and here the result closely matches a 3,800 psi mix requirement, confirming acceptance of the load.

42. A — Air content directly governs the concrete's resistance to internal damage from freeze-thaw cycling, so a reading significantly below the specified minimum is a real durability concern, not a minor issue. The appropriate response is to reject the load or add approved air-entraining admixture and re-test before placement, never to add water, which does not address air content at all.

43. C — A pre-installation conference brings together the installer, general contractor, and relevant design or owner representatives to review approved procedures, sequencing, substrate conditions, and quality expectations before the specialized work begins. Catching potential coordination issues, incompatible materials, or unclear expectations at this early stage is far less costly than discovering them after installation is underway.

44. B — A mock-up is a physical, full-scale sample of the finished work, built and reviewed before production installation begins, establishing an approved benchmark for appearance, workmanship, and often performance testing. All subsequent production work is then judged against this approved standard, catching quality or coordination issues before they are repeated across the full scope of installation.

45. B — The Nurse-Saul maturity factor is $M = \Sigma(T - T0) \cdot \Delta t = (70 - 32) \times 40 = 38 \times 40 = 1{,}520$ °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.

46. C — Percent compaction compares field dry unit weight to the laboratory maximum: 118/125×100 = 94.4%. 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 — Standard laboratory curing, at controlled temperature and full moisture, isolates the mix design's inherent strength potential from jobsite variables, confirming the concrete supplied meets specification under ideal conditions. Field-cured cylinders, by contrast, experience the same temperature and moisture history as the actual structure, indicating the real in-place strength under whatever conditions the jobsite provides.

48. D — 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: 0.625 in × 0.707 ≈ 0.442 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 — A trial batch, mixed and tested under controlled laboratory conditions, confirms that a proposed mix design actually achieves its required compressive strength, workability, air content, and other specified properties before it is approved for full-scale project use. This upfront verification catches mix design problems early, rather than discovering a deficiency only after concrete has already been placed on the project.

50. A — A strength-maturity relationship is specific to the exact materials and proportions used to develop it, since different cement sources can hydrate at different rates even within a nominally identical mix design. Changing the cement source therefore requires redeveloping the calibration curve with the new material before the maturity method can continue to be relied upon for strength estimates.

51. C — An unfactored service-level combination sums the applicable loads directly: D + Lc = 700 + 380 = 1,080 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 $S = bd^2/6 = 9 \times 289/6 \approx 433.5$ in³. Converting the moment, M = 20 kip-ft × 12 in/ft × 1,000 = 240,000 lb-in. Bending stress is $\sigma = M/S = 240{,}000/433.5 \approx$ 554 psi, the maximum fiber stress at the top and bottom of the beam.

53. D — For a short column not governed by buckling, allowable capacity is the allowable stress multiplied by the cross-sectional area: 23 ksi × 7.0 in² = 161 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 20-ft span to 240 in, $\Delta = PL^3/48EI = (10 \times 240^3)/(48 \times 29{,}000 \times 880) \approx 0.113$ 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. A — For a triangular pressure distribution, the resultant force acts at the centroid of the triangle, one-third of the height up from the base: 13 ft/3 ≈ 4.33 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: 20 psf × 8 ft = 160 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 — Hot, windy conditions dramatically accelerate surface moisture evaporation, and when that rate exceeds the rate bleed water rises to the surface, the surface layer shrinks and cracks while the concrete is still plastic, within the first hour of placement. ASR, corrosion spalling, and long-term drying shrinkage all develop over months or years, not within the first hour after placement.

58. C — For a rectangular section, maximum shear stress occurs at the neutral axis and equals 1.5 times the average shear stress: $\tau_{max} = 1.5V/(bd) = 1.5\times14{,}000/(9\times18) = 21{,}000/162 \approx 130$ 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. B — Transverse ties or spirals brace the longitudinal bars against premature buckling under compression and confine the concrete core, both of which meaningfully increase the column's effective axial capacity and, particularly for spirals, its ductility under load. Without this restraint, longitudinal bars alone could buckle outward before reaching their full compressive capacity, reducing overall column strength.

60. D — When axial and bending stresses act in the same sense at an extreme fiber, they superimpose directly: combined stress = axial + bending = 11 + 9 = 20 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 2.75-ft diameter pipe, area = $\pi r^2 \approx 5.94$ ft² and hydraulic radius R = D/4 = 0.6875 ft. Manning's equation gives Q = (1.486/n)AR^(2/3)S^(1/2) ≈ (1.486/0.0115)×5.94×0.6875^0.667×0.0065^0.5 ≈ 48.2 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 = 0.42×3.0×25 = 31.5 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. B — Culvert slope equals the drop in invert elevation divided by the barrel length: (110.00−107.50)/100×100 = 2.50/100×100 = 2.5% 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. C — The prismoidal formula gives V = (h/6)(Abottom+4Amid+Atop) = (4.8/6)×(8,500+4×10,450+12,500) = 0.8×62,800 ≈ 50,240 ft³. This method accounts for the changing cross-sectional area with depth in a sloped-side pond, weighting the mid-height area quite heavily so the final result better reflects the pond's true sloped-wall geometry than a plain average would.

65. D — Steeper slopes increase flow velocity along both the overland and channel segments of the flow path, directly shortening the travel time from the hydraulically most distant point to the outlet. A longer flow path instead lengthens time of concentration, while drainage area size and curve number affect runoff volume and rate rather than travel time directly.

66. B — Normal depth is the equilibrium depth at which uniform flow occurs in a channel of constant slope, roughness, and cross-section, where the gravitational force driving the flow exactly balances frictional resistance. This is distinct from critical depth, which minimizes specific energy for a given discharge regardless of the channel's actual slope or roughness characteristics.

67. C — Each leg supports half the vertical load, but because the leg is inclined, its tension exceeds that vertical component: $T = (\text{load}/2)/\sin 55° = 8{,}000/0.819 \approx 9{,}766$ 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. A — The total weight the crane must support at this radius is the load plus all rigging: 22,500+900 = 23,400 lb. Subtracting this from the rated capacity of 26,000 lb gives a margin of 26,000−23,400 = 2,600 lb. Rigging weight must always be included in this check; the chart's rated capacity is not the payload weight alone.

69. C — Percent utilization compares the required flow rate to the pump's rated capacity: $550/900 \times 100 \approx 61.1\%$. 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. B — As the boom slews to a new position, the load and boom weight act on a different side of the outrigger base, redistributing the reaction each outrigger pad carries in a way that can differ substantially from the original setup position. The operator must reverify that ground bearing pressure at this new configuration still falls within allowable limits before lifting.

71. D — A personnel hoist is specifically designed, inspected, and certified to safely carry workers, with safety features such as overspeed governors and emergency brakes that a materials-only hoist lacks. Using a materials hoist, forklift attachment, or suspended crane bucket to carry personnel instead of a certified personnel hoist would bypass these required worker-specific safety protections.

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 = $22{,}000 \times 0.85 = 18{,}700$ 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. D — Substituting into the Engineering News formula gives $Ru = 2 \times 30{,}000/(0.22+1.0) = 60{,}000/1.22 \approx 49{,}180$ 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. C — Loaded travel time is 2.8 mi/19 mph ≈ 0.1474 hr, and empty return time is 2.8 mi/29 mph ≈ 0.0966 hr, for a combined travel time of about 0.2440 hr, or roughly 14.6 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 rigging plan documents the load's weight and center of gravity, the chosen rigging configuration, the crane's position and configuration, and the capacity checks confirming the lift is within the crane's rated capacity for that setup. Preparing this in advance catches potential problems before the lift is attempted, rather than discovering an issue mid-lift with a suspended load.

76. B — Cycles per hour equal 3,600 seconds divided by the 24-second cycle time, or 150 cycles/hr. Each cycle effectively moves 2.4×0.90 = 2.16 cy, giving 150×2.16 = 324 cy/hr before accounting for downtime. Applying the 0.80 efficiency factor for non-productive time reduces this to 324×0.80 ≈ 259.2 cy/hr, the realistic estimated rate.

77. A — Rigging equipment such as slings, shackles, and hooks can develop wear, cuts, corrosion, or deformation through repeated use that reduces their actual capacity below the rated value. A daily visual inspection by a competent person before use catches this kind of damage early, removing compromised equipment from service before it is loaded and potentially fails during a lift.

78. D — Swell factor accounts for the volume increase when compact, in-situ soil is excavated and loosened: loose volume = bank volume × swell factor = 10,500×1.24 = 13,020 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 loosened.

79. C — A remote site without nearby utility power typically relies on one or more portable generators, sized to meet the total connected electrical load of pumps, lighting, tools, and other equipment running simultaneously. Residential utility connections are not designed for construction site loads, and battery tools or daytime-only solar panels alone cannot reliably support continuous site power needs.

80. B — Substituting the given values: Pmax = 150 + 9,000×(6/70) ≈ 150 + 771 ≈ 921 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. A — With four legs sharing the load equally, each leg carries 15,000/4 = 3,750 lb. Comparing this to the leg's allowable capacity of 4,200 lb gives a utilization ratio of 3,750/4,200×100 ≈ 89.3%. 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. B — 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 195 psf total: 195/3 = 65 psf exactly, 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 = 17 psf × 260 ft² = 4,420 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. D — Substituting into Peck's apparent pressure formula: pa = 0.65×0.30×120×23 ≈ 538 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 ft = 6 ft². Multiplying by the maximum lateral pressure gives the design tension load on each tie: 800 psf × 6 ft² = 4,800 lb exactly. This tributary-area method is standard for distributing lateral pressure to form ties.

86. B — The 7-24-25 geometry is a Pythagorean right triangle, where horizontal force = tension × (horizontal leg / hypotenuse). Solving for tension: tension = 1,300×(25/7) ≈ 4,643 lb, the wire force needed to provide the required 1,300-lb horizontal resistance at the mast's attachment point on the structure above the anchor point.

87. D — The final structural drawings describe the completed, fully braced building, but during erection the partially assembled frame lacks that full lateral bracing system and can be vulnerable to wind, seismic, or construction loads at intermediate stages. An engineered erection sequence and temporary bracing plan specifically addresses the frame's stability at each stage of construction, not just its final condition.

88. A — Distributing the 200 psf construction load equally across 3 supporting levels gives 200/3 ≈ 66.7 psf per level. Since this is below the 90 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 capacity.

89. C — The strut's tributary area is its tributary height times tributary width: 10 ft × 15 ft = 150 ft². Multiplying by the uniform apparent pressure of 470 psf gives the total axial strut load: 470×150 = 70,500 lb exactly. This tributary-area method converts the wall's distributed earth pressure into a discrete design load for the individual strut member.

90. B — Surface hardness is not a reliable indicator of a slab's actual load-bearing strength, since curing and strength gain continue well after the surface feels firm. Shoring must remain until verified testing, cylinder breaks, cores, or an approved method like maturity, confirms the concrete has reached the strength needed to support itself and any imposed loads.

91. A — The excess load is the imposed equipment load minus the slab's current allowable capacity: 135−90 = 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 — A caving sandy layer can lose material and destabilize quickly once exposed, so lagging must be installed promptly in short vertical increments just ahead of continued excavation. Waiting until full-depth excavation is complete, omitting lagging in the caving zone, or widening pile spacing would all increase the risk of collapse.

93. B — Allowable working load is the ultimate tensile capacity divided by the specified safety factor: 19,000/2.0 = 9,500 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 curved, cantilevered segment introduces torsional loading and an unbalanced load distribution that a simple straight, simply supported span does not experience, requiring falsework designed specifically to resist these additional effects. Treating curved, cantilevered falsework the same as a standard straight-span detail would risk overlooking torsion and eccentric loading that could compromise stability during construction.

95. C — OSHA's Hazard Communication Standard requires that a safety data sheet be maintained and readily accessible to employees for every hazardous chemical present at the worksite, detailing its properties, hazards, and safe handling and emergency procedures. This is distinct from purely administrative or unrelated documents like cost estimates, delivery receipts, or weather reports, none of which serve this specific safety function.

96. A — When conventional fall protection is genuinely infeasible or would create a greater hazard, OSHA still requires a documented, site-specific fall protection plan meeting the specific criteria set out in the applicable standard, rather than no protection at all. A vague verbal warning or a generic company-wide plan lacking site-specific analysis does not satisfy this documented, site-specific requirement.

97. A — OSHA's electrical safety standard requires that exposed energized conductors or circuit parts be de-energized and a lockout/tagout procedure applied before employees work on or near them, unless de-energizing is infeasible or would create a greater hazard than working energized. Insulated gloves alone, a low-voltage exception, or a verbal warning do not satisfy this de-energization requirement where it applies.

98. C — Current OSHA rules require a fatality to be reported within 8 hours of a work-related incident, while an in-patient hospitalization, amputation, or loss of an eye affecting even a single employee must be reported within 24 hours. The older three-or-more hospitalization threshold in option D no longer applies; a single hospitalization is now reportable.

99. B — The advance warning area is the first segment of a temporary traffic control zone, using signs to inform approaching drivers that a work zone lies ahead well before they reach it. This gives drivers time to adjust speed and attention, distinct from the transition, activity, and termination areas that follow.

100. D — The Occupational Safety and Health Administration, a division of the U.S. Department of Labor, was created by the OSH Act to develop and enforce workplace safety and health regulations across covered industries, including construction. The EPA, FHWA, and NIST each have distinct federal missions, environmental protection, highway infrastructure, and technical standards, respectively, none of which is workplace safety enforcement.