PRACTICE EXAM 11: 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 15 ft high retains a cohesionless backfill with unit weight $\gamma = 115$ pcf and angle of internal friction $\varphi = 32°$, 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. 3.98 kip/ft
B. 5.30 kip/ft
C. 2.65 kip/ft
D. 6.63 kip/ft

2. A normally consolidated clay layer 15 ft thick has an initial void ratio $e0 = 0.95$ and compression index $Cc = 0.25$. The effective overburden stress at mid-height is 2,500 psf, and a footing load increases the effective stress at mid-height by 1,500 psf. What is the primary consolidation settlement of the layer?

A. 3.20 in
B. 4.71 in
C. 6.05 in
D. 2.35 in

3. A soil profile consists of 6 ft of sand (moist unit weight 118 pcf) above the water table, underlain by 14 ft of saturated sand (saturated unit weight 128 pcf) below the water table. What is the effective vertical stress at a depth of 20 ft (bottom of the saturated layer)?

A. 2,500 psf
B. 708 psf
C. 1,792 psf
D. 1,626 psf

4. A strip footing 4 ft wide is founded at a depth of 5 ft in a cohesionless soil with unit weight 112 pcf. At this friction angle, Terzaghi's bearing capacity factors are $N_q = 18$ and $N_\gamma = 13$. What is the ultimate bearing capacity of the footing, neglecting the cohesion term?

A. 10,080 psf
B. 2,912 psf
C. 12,992 psf
D. 8,500 psf

5. An infinite slope in cohesionless sand is inclined at 18° to the horizontal. The sand has an effective friction angle of 30° 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. 1.45
B. 1.78
C. 1.20
D. 2.10

6. A retaining wall is deliberately pushed several inches horizontally into the retained soil mass, such as by a jacking operation. Which lateral earth pressure condition is being mobilized, and how does its magnitude compare to the active condition?

A. Active condition; lower than at-rest

B. At-rest condition; unrelated to wall movement
C. Passive condition; equal to the active pressure
D. Passive condition; substantially higher than the active pressure

7. In a saturated soil mass, what does 'total stress' at a given point represent?

A. The weight of all material above that point, without regard to sharing
B. Only the stress carried by the soil skeleton itself
C. Only the pore water pressure acting in the void spaces
D. The difference between overburden pressure and the pore pressure

8. For a shallow strip footing on cohesionless sand, if the footing width B is doubled while depth of embedment and soil properties remain unchanged, how does the contribution of the $N\gamma$ term ($0.5\gamma BN\gamma$) to ultimate bearing capacity change?

A. It quadruples in proportion to B squared
B. It stays exactly the same regardless of B
C. It doubles, since the term is directly proportional to B
D. It decreases by half as B increases

9. A horizontal curve has a radius of 650 ft and a deflection angle (Δ) of 42°. What is the length of the curve?

A. 381.1 ft
B. 476.4 ft
C. 550.0 ft
D. 610.9 ft

10. For a horizontal curve with radius 1,200 ft and a deflection angle of 30°, what is the middle ordinate (M) of the curve?

A. 25.6 ft
B. 33.2 ft
C. 48.7 ft
D. 40.9 ft

11. Before excavation begins near an active utility corridor with conflicting record drawings from two different utility owners, what is the most appropriate first step?

A. Rely on the older of the two record drawing sets
B. Proceed with excavation and stop if a utility is struck
C. Request a coordinated utility locate and verify critical crossings by potholing
D. Rely solely on ground-penetrating radar without physical verification

12. A grade stake is set where the existing ground elevation is 215.80 ft and the design subgrade elevation is 218.25 ft, requiring a fill. What is the magnitude of the fill, in feet, to be noted on the stake?

A. 2.45 ft
B. 1.45 ft
C. 3.45 ft
D. 0.45 ft

13. A sag vertical curve connects a −2.0% grade to a +3.0% grade, is 500 ft long, and begins (PVC) at station 20+00 with an elevation of 250.00 ft. What is the elevation of the lowest point on the curve?

A. 246.00 ft
B. 244.50 ft
C. 250.00 ft
D. 248.00 ft

14. On a large linear project such as a pipeline corridor spanning several miles, why are multiple redundant horizontal and vertical control points established along the alignment rather than relying on a single origin point?

A. Because a single point cannot legally be used for more than one property

B. Because GPS equipment cannot store more than one coordinate at a time

C. To allow independent verification and error detection along the alignment without referencing one distant point

D. Because local building codes require a minimum of three benchmarks per project regardless of size

15. During deep excavation adjacent to a sensitive existing structure, what is the primary purpose of installing survey monitoring points, such as optical or automated total station targets, on the adjacent building?

A. To establish the legal property line between the two parcels

B. To continuously measure movement and settlement of the adjacent structure as an early warning system

C. To calculate the new structure's excavation volume

D. To replace the need for a pre-construction condition survey

16. Based on the boring log figure shown, which soil layer would be expected to control both the allowable bearing pressure for a shallow foundation and the magnitude of long-term consolidation settlement?

Figure PQ-1: Vertical boring log profile diagram

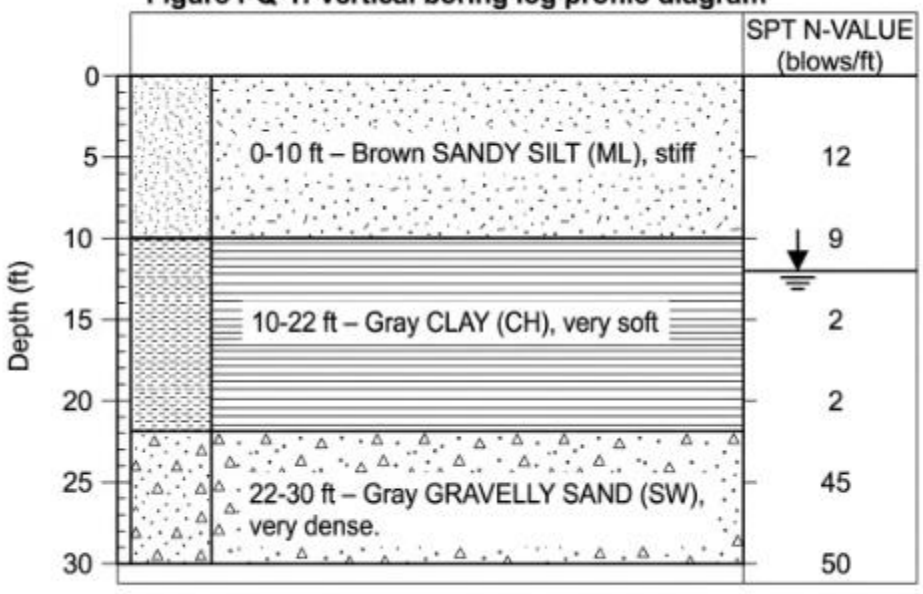


Figure PQ-1: Vertical boring log profile diagram

A. The gray CLAY (CH) layer from 10 to 22 ft

B. The brown SANDY SILT (ML) layer from 0 to 10 ft

C. The gray GRAVELLY SAND (SW) layer from 22 to 30 ft

D. The groundwater table zone at 12 ft depth

17. A concrete mix uses 520 lb of cement and 234 lb of water per cubic yard. What is the water-cement ratio (w/c) of this mix?

A. 0.55

B. 0.45

C. 0.40

D. 0.60

18. What is the primary structural purpose of providing adequate development length for a reinforcing bar embedded in concrete?

A. To increase the bar's cross-sectional area

B. To reduce the amount of required concrete cover

C. To transfer stress via bond so the bar develops its stress without slipping

D. To prevent corrosion of the reinforcing steel bar

19. Which engineered wood product consists of layers of dimension lumber boards stacked in alternating perpendicular orientations and glued together, producing a panel product used for structural walls and floors with strength in two directions?

A. Laminated veneer lumber (LVL)

B. Glued laminated timber (glulam)

C. Oriented strand board (OSB)

D. Cross-laminated timber (CLT)

20. A sieve analysis of a coarse aggregate sample shows 620 g retained cumulative on the No. 4 sieve out of a total sample mass of 800 g. What percent of the sample passes the No. 4 sieve?

A. 22.5%
B. 77.5%
C. 45.0%
D. 11.25%

21. Which concrete admixture is used to significantly increase workability and slump at a given water-cement ratio, without adding extra mixing water, primarily to facilitate placement in congested reinforcement or pumped concrete applications?

A. Air-entraining admixture
B. Accelerating admixture
C. Retarding admixture
D. High-range water-reducing admixture (superplasticizer)

22. A steel tension member has a cross-sectional area of 5.0 in^2 and is subjected to an axial tensile force of 140 kips. What is the axial stress in the member?

A. 28 ksi
B. 20 ksi
C. 35 ksi
D. 24 ksi

23. A rectangular concrete footing measures 5 ft by 5 ft by 2 ft thick. How many cubic yards of concrete are required for one footing, ignoring waste?

A. 1.23 cy
B. 1.85 cy
C. 2.47 cy
D. 0.93 cy

24. A contractor estimates that placing structural concrete costs $210 per cubic yard for materials and $110 per cubic yard for labor and equipment. What is the total estimated cost to place 180 cubic yards of concrete?

A. $37,800
B. $46,800
C. $57,600
D. $64,800

25. A contractor is deciding between purchasing equipment for $65,000 with annual operating savings of $13,000, versus continuing to rent. Ignoring the time value of money, how many years of use are required for the purchase to break even against the savings?

A. 3 years
B. 4 years
C. 4.5 years
D. 5 years

26. A project has a Budgeted Cost of Work Performed (earned value) of $380,000 and an Actual Cost of Work Performed of $400,000. What is the Cost Performance Index (CPI) for the project?

A. 1.05
B. 0.95
C. 0.80
D. 1.20

27. Two adjacent cross-sections along a roadway alignment, spaced 150 ft apart, have cut areas of 260 ft^2 and 300 ft^2, respectively. Using the average end area method, what is the cut volume, in cubic yards, between the two sections?

A. 1,555.6 cy
B. 1,244.4 cy

C. 1,866.7 cy
D. 933.3 cy

28. A contractor's direct cost estimate for a project totals $950,000. If the contractor applies a combined markup of 15% for overhead and profit, what is the total bid price?

A. $950,000
B. $1,045,000
C. $1,092,500
D. $1,140,000

29. A footing requires 60 pieces of No. 5 reinforcing bar, each 10 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. 501 lb
B. 626 lb
C. 751 lb
D. 876 lb

30. In a present-worth life-cycle cost comparison of two alternatives with different future maintenance schedules, what is the effect of using a higher discount rate on the present worth of costs occurring far in the future?

A. A higher discount rate reduces the present worth of distant future costs, making them contribute less to the total comparison
B. A higher discount rate has no effect on future cost present worth
C. A higher discount rate increases the present worth of distant future costs
D. Discount rate only affects the initial cost, not future costs

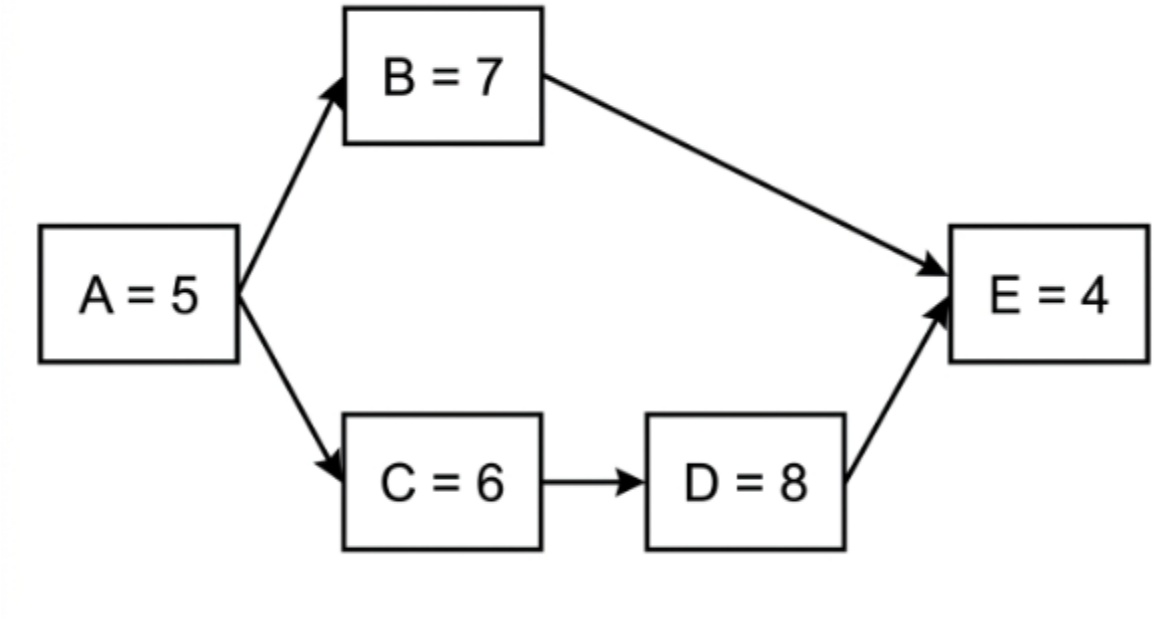
31. In a typical steel-framed building sequence, which activity must be completed before permanent roofing membrane installation can begin?

A. Interior drywall finishing
B. Final landscaping
C. Installation of the roof deck
D. Installation of interior floor finishes

32. An activity's duration estimates using PERT are: optimistic (a) = 4 days, most likely (m) = 7 days, pessimistic (b) = 16 days. What is the PERT expected duration (te) for this activity?

A. 7 days
B. 9 days
C. 6 days
D. 8 days

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



A. 16 days
B. 19 days
C. 23 days
D. 27 days

34. An activity has an Early Start of day 8, an Early Finish of day 15, and a Late Finish of day 19. What is the total float for this activity?

A. 8 days
B. 4 days
C. 6 days
D. 11 days

35. Which schedule compression technique shortens the project duration by overlapping activities that would normally be performed in sequence, accepting increased coordination risk rather than adding resources?

A. Fast-tracking
B. Crashing
C. Resource leveling
D. Resource smoothing

36. An activity has a normal duration of 12 days at a normal cost of $10,000, and a crash duration of 8 days at a crash cost of $16,000. What is the cost slope (cost per day) to crash this activity?

A. $750/day
B. $1,000/day
C. $2,000/day
D. $1,500/day

37. A high-rise building project with 40 nearly identical floors, each following the same repetitive construction cycle, would most benefit from which scheduling approach to visualize and manage crew production rates floor-to-floor?

A. A simple Gantt bar chart with no logic ties
B. PERT with three-point estimates only
C. Linear scheduling method (line-of-balance)

D. A fixed-price lump-sum milestone schedule

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 $1,200 per day, with enough crash days available. What is the minimum additional direct cost to achieve the required 5-day reduction?

A. $6,000
B. $4,800
C. $7,200
D. $9,000

39. Three activities are scheduled to run concurrently on a given day, each requiring one crew of electricians: Activity X needs 5 electricians, Activity Y needs 6 electricians, and Activity Z needs 4 electricians. If only 11 electricians are available that day, what is the resource shortfall?

A. 2 electricians
B. 4 electricians
C. 6 electricians
D. 15 electricians

40. What defines the critical path in a CPM schedule network?

A. The sequence of activities with the most total float
B. Any path containing the project's single most expensive activity
C. The shortest path from start to finish
D. The longest sequence of dependent activities, which determines the minimum project duration and has zero float

41. A 4-in. diameter concrete test cylinder fails in compression at a load of 50,265 lb. What is the measured compressive strength of the cylinder, in psi?

A. 3,000 psi

B. 3,500 psi

C. 4,500 psi

D. 4,000 psi

42. A direct tension indicator (DTI) washer used in a high-strength bolted connection has small protrusions on one face that flatten as the bolt is tightened. What does the gap remaining between the washer and the bolt head or nut indicate?

A. The amount of bolt pretension achieved, with a smaller remaining gap corresponding to higher achieved tension

B. The torque applied to the bolt, measured directly in ft-lb

C. The ultimate tensile strength of the bolt material

D. The number of full nut rotations completed

43. On a project with a third-party testing laboratory retained to perform concrete cylinder breaks and soil compaction tests, whose role does this testing activity primarily represent?

A. Quality assurance (QA) only

B. Neither QA nor QC; it is a legal requirement unrelated to quality

C. Quality control (QC), direct testing and inspection verifying conformance with specifications

D. Project management, unrelated to quality functions

44. During cold-weather concreting, what is the primary reason concrete must be protected and maintained above a minimum temperature for a specified curing period after placement?

A. To speed up the concrete's initial set time

B. To prevent freezing before adequate strength gain, which would permanently damage the concrete

C. To reduce the amount of cement required in the mix

D. To eliminate the need for air-entraining admixture

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 75°F for 36 hours accumulates how much maturity (temperature-time factor), in °F-hours?

A. 774 °F-hr
B. 1,161 °F-hr
C. 1,548 °F-hr
D. 1,935 °F-hr

46. A field density test on a compacted embankment fill shows a dry unit weight of 112 pcf. The laboratory maximum dry unit weight from a standard Proctor test is 120 pcf. What is the percent (relative) compaction achieved in the field?

A. 85.0%
B. 88.0%
C. 90.7%
D. 93.3%

47. A concrete delivery specified at 5 in. ± 1 in. slump tests at 2.5 in. upon arrival at the site. What action is appropriate for this load?

A. Reject the load; it falls below the lower tolerance limit of 4 in.
B. Accept the load, since lower slump indicates higher strength
C. Accept the load and add mixing water at the jobsite to increase slump
D. Accept the load without any further testing

48. A fillet weld connecting two steel plates has a leg size of 3/8 in. What is the effective throat thickness of this fillet weld?

A. 0.188 in
B. 0.265 in
C. 0.354 in

D. 0.442 in

49. In typical hot-mix asphalt compaction operations, what is the correct general sequence of roller types used to achieve final density?

A. Finish rolling first, then breakdown rolling, then intermediate rolling
B. Breakdown rolling, then intermediate rolling, then finish rolling
C. Intermediate rolling only, repeated until density is achieved
D. Rolling sequence does not matter as long as total passes are equal

50. Before a maturity method calibration curve can be reliably used to estimate in-place concrete strength on a project, what must first be established?

A. A single cylinder break at 28 days is sufficient to calibrate the curve
B. The calibration curve from a different concrete mix design can be reused directly
C. A strength-maturity relationship specific to the project's actual mix, developed from tested companion cylinders at multiple ages
D. No calibration is needed; the Nurse-Saul equation alone is sufficient without any testing

51. A structural member for a construction-stage condition is subjected to a dead load of 650 lb/ft and a construction live load of 400 lb/ft. Using an unfactored D + Lc service-level combination, what is the total line load on the member?

A. 650 lb/ft
B. 800 lb/ft
C. 925 lb/ft
D. 1,050 lb/ft

52. A rectangular timber beam is 8 in. wide by 14 in. deep and carries a maximum bending moment of 20 kip-ft. What is the maximum bending stress in the beam?

A. 918 psi
B. 765 psi
C. 1,050 psi
D. 1,225 psi

53. A short steel column with a cross-sectional area of 6.5 in^2 has an allowable compressive stress of 20 ksi. What is the allowable axial load capacity of the column, neglecting buckling effects?

A. 100 kips
B. 130 kips
C. 150 kips
D. 180 kips

54. A simply supported steel beam spans 24 ft and carries a concentrated load of 8 kips at midspan. The beam has a moment of inertia $I = 950\ in^4$ and modulus of elasticity $E = 29{,}000$ ksi. Using $\Delta = PL^3/48EI$, what is the maximum deflection at midspan?

A. 0.098 in
B. 0.120 in
C. 0.145 in
D. 0.175 in

55. Based on the triangular active earth pressure distribution shown in the figure, acting over a wall stem height of 12 ft, at what height above the base of the wall (Point O) does the resultant active earth pressure force act?

Figure PQ-3: Cross-section of a cantilever retaining wall with a 12-ft exposed stem height, level backfill above, and a triangular active earth pressure distribution starting at zero at the top of the wall and increasing linearly to a maximum value at the base of the stem. The base of the stem is labeled 'Point O.'

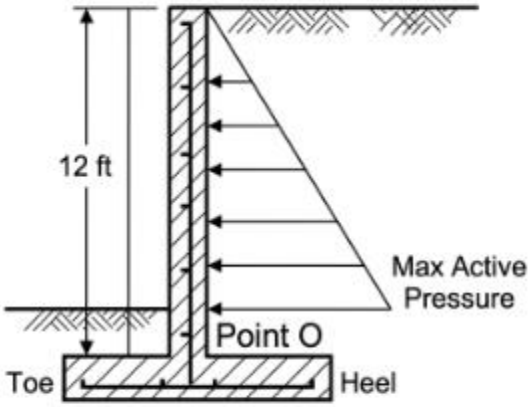


Figure PQ-3: Cross-section of a cantilever retaining wall with a 12-ft exposed stem height, level backfill above ill above, and a triangular active earth pressure distribution starting at zero at the top of the wall and increasing linearly to a maximun value at the base of the stem. The base of the stem is labeled 'Point O.'

A. 4.00 ft

B. 6.00 ft

C. 8.00 ft

D. 3.00 ft

56. A roof purlin has a tributary width of 6 ft and carries a uniform roof live load of 25 psf. What is the total uniform line load on the purlin from this live load?

A. 100 lb/ft

B. 120 lb/ft

C. 135 lb/ft

D. 150 lb/ft

57. A slab-on-grade exhibits a single, wide crack running diagonally across one corner of the slab several months after placement, with a visible vertical offset across the crack. What is the most likely cause?

A. Plastic shrinkage cracking from early moisture loss

B. Normal long-term drying shrinkage, with no vertical offset expected

C. Differential settlement of the subgrade beneath the slab corner

D. Excessive air entrainment in the concrete mix

58. A rectangular beam 10 in. wide by 18 in. deep carries a maximum shear force of 15 kips. Using Vmax = 1.5V/(bd) for a rectangular section, what is the maximum shear stress in the beam?

A. 125 psi

B. 104 psi

C. 150 psi

D. 167 psi

59. In a long, one-way spanning concrete slab restrained at its ends by stiff supporting walls, what is the main risk if transverse (perpendicular) shrinkage and temperature reinforcement is omitted or under-provided?

A. The slab will fail in flexure under normal service loads

B. Wide, poorly distributed shrinkage and thermal cracks can form, since restrained movement isn't controlled in that direction

C. The slab's fire rating will be reduced

D. The slab will experience excessive long-term deflection in the main span direction

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 9 ksi in the same direction. What is the maximum combined compressive stress at the extreme fiber?

A. 10 ksi

B. 9 ksi

C. 14.5 ksi

D. 19 ksi

61. A circular storm sewer pipe with a diameter of 30 in. flows full at a slope of 0.008 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. 20.5 cfs
B. 30.2 cfs
C. 39.8 cfs
D. 48.6 cfs

62. Using the Rational Method (Q = CiA), a drainage area of 22 acres has a runoff coefficient C = 0.35 and a design rainfall intensity of 2.5 in/hr. What is the peak runoff rate?

A. 19.25 cfs
B. 25.30 cfs
C. 15.40 cfs
D. 30.80 cfs

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

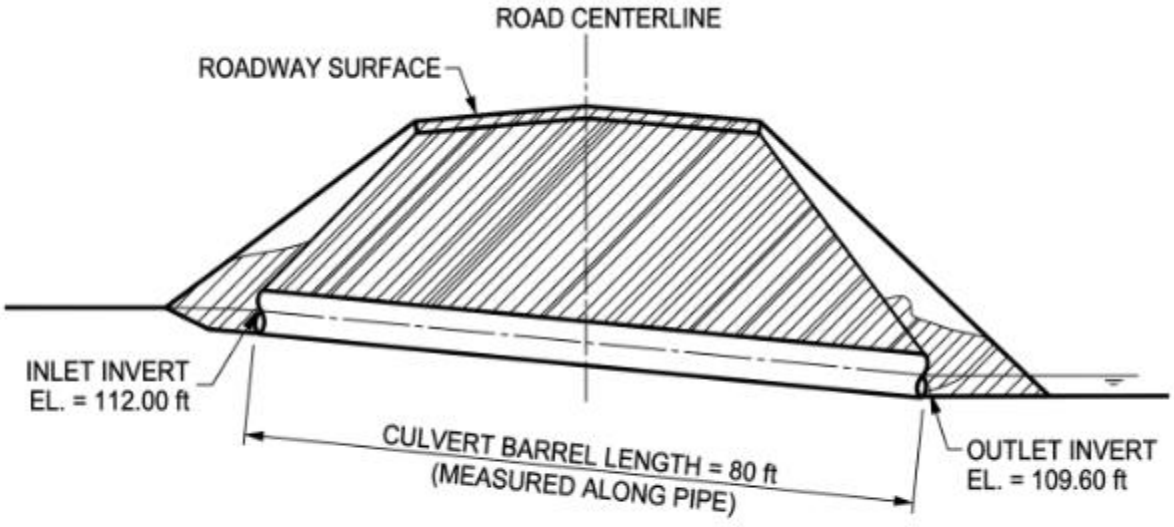


FIGURE PQ-4: LONGITUDINAL PROFILE DIAGRAM OF CULVERT CROSSING BENEATH ROADWAY

A. 1.0%

B. 1.5%

C. 2.0%

D. 3.0%

64. A proposed detention pond has a bottom area of 6,000 ft², a top area at the design water surface 5 ft above the bottom of 10,000 ft², and a mid-height area of 7,900 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. 30,000 ft³

B. 39,667 ft³

C. 45,500 ft³

D. 53,000 ft³

65. After initial sheet flow converges into small rills or swales but before reaching a well-defined open channel or pipe, which time-of-concentration segment describes this intermediate overland flow condition?

A. Sheet flow

B. Shallow concentrated flow

C. Open channel flow

D. Pipe (closed conduit) flow

66. A rapid transition from supercritical to subcritical flow in an open channel, accompanied by significant turbulence and energy dissipation, is known as what phenomenon?

A. Normal depth transition

B. Critical flow equilibrium

C. Laminar-to-turbulent transition

D. A hydraulic jump

67. A load of 10,000 lb is lifted using a two-leg sling with each leg inclined at 45° from the horizontal. What is the tension in each sling leg, assuming the load is shared equally?

A. 7,071 lb
B. 5,000 lb
C. 6,124 lb
D. 8,660 lb

68. A mobile crane's load chart lists a maximum capacity of 18,000 lb at a 35-ft operating radius. The rigging weighs 650 lb, and the load to be lifted weighs 15,200 lb. What is the remaining capacity margin at this radius after accounting for rigging weight?

A. 2,800 lb
B. 2,500 lb
C. 2,150 lb
D. 1,800 lb

69. An excavation requires dewatering at a rate of 380 gallons per minute (gpm) to maintain a dry work area. A pump is rated at 600 gpm capacity. What percentage of the pump's rated capacity is being utilized?

A. 50.0%
B. 63.3%
C. 70.0%
D. 80.0%

70. Based on the crane outrigger footprint shown, what does the offset load-line position relative to the base's geometric center primarily affect regarding the four outrigger reactions?

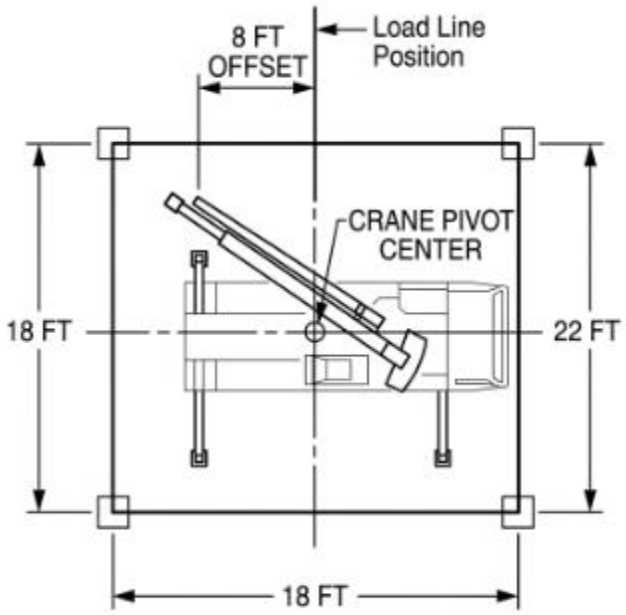


FIGURE PQ-5

A. It causes the reactions to become unequal, with the outrigger nearest the offset load line carrying a disproportionately larger share

B. It has no effect since crane weight is always distributed equally to all four outriggers

C. It only affects the boom's maximum reach, not outrigger loads

D. It eliminates the need to check ground bearing pressure since the load chart already accounts for it

71. For excavating a trench through hard, competent rock where conventional excavator buckets cannot effectively penetrate the material, which equipment or method is generally most appropriate?

A. A standard smooth-bucket excavator alone, unaided

B. A scraper in continuous push-pull operation

C. A wellpoint dewatering system installed nearby

D. A hydraulic hoe-ram/breaker or rock-specific equipment, possibly with blasting

72. A borrow pit excavation removes soil with an in-situ (bank) volume of 15,000 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. 17,045 cy

B. 15,000 cy
C. 13,200 cy
D. 11,000 cy

73. A driven pile is being installed using a hammer with a rated energy of 25,000 ft-lb per blow, and the pile advances 0.20 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. 25,000 lb
B. 41,667 lb
C. 50,000 lb
D. 20,833 lb

74. A dump truck hauls fill material a one-way distance of 3.0 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. 9.0 min
B. 12.5 min
C. 15.0 min
D. 18.0 min

75. What hazard is specifically created by a crawler crane's counterweight and rear structure rotating with the upper works during a swing, if the area behind the crane is not barricaded?

A. The crane's load chart capacity is reduced automatically
B. The crane's boom angle indicator becomes inaccurate
C. The crane must switch to a shorter boom
D. Workers behind the crane can be struck by the rotating tail swing

76. An excavator has a bucket capacity of 2.0 cy, a fill factor of 0.85, a cycle time of 22 seconds, and an efficiency (working-time) factor of 0.80. What is the estimated production rate in cy per hour?

A. 222.5 cy/hr

B. 278.2 cy/hr

C. 195.0 cy/hr

D. 250.0 cy/hr

77. A wellpoint dewatering system relying on surface-mounted vacuum pumps is generally limited to what maximum practical single-stage lift (drawdown depth), due to atmospheric vacuum limitations, before multiple stages or deep wells become necessary?

A. Approximately 15 to 18 ft per stage

B. Approximately 50 ft per stage

C. Approximately 100 ft per stage

D. No practical limit exists for a single stage

78. A cut excavation removes 8,000 cy of soil measured in its in-situ (bank) state. The soil has a swell factor of 1.30 when excavated and loaded loose into trucks. What is the loose (hauled) volume of this excavated material?

A. 6,154 cy

B. 10,400 cy

C. 9,000 cy

D. 11,200 cy

79. For a low-rise industrial facility erection project with a wide-open site providing ample room for crane travel and repositioning, and where relatively few, heavy lifts are required at moderate height, which crane type is typically most cost-effective?

A. A tower crane, permanently erected on site

B. A floating, barge-mounted crane

C. A monorail hoist system installed overhead

D. A mobile crane that can reposition around the open site

80. Concrete is placed in a wall form at a rate of 8 ft/hr, with a concrete temperature of 75°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. 980 psf
C. 1,110 psf
D. 1,250 psf

81. A scaffold frame leg has an allowable capacity of 3,800 lb. If four legs support a uniformly distributed platform load, and the total load on the scaffold bay is 13,000 lb, what is the utilization ratio of each leg, assuming equal load distribution?

A. 76.3%
B. 85.5%
C. 92.1%
D. 68.4%

82. A newly placed concrete slab imposes a construction load of 180 psf, distributed among one level of shores and two levels of reshores below it, all of similar stiffness. Assuming the load is shared equally among all three levels, what load does each level carry?

A. 180 psf
B. 120 psf
C. 90 psf
D. 60 psf

83. A temporary sign or windscreen attached to a construction hoist tower has an exposed area of 250 ft² and experiences a design wind pressure of 18 psf. What is the total design wind force acting on this exposed area?

A. 4,500 lb

B. 3,600 lb

C. 5,400 lb

D. 6,300 lb

84. A braced excavation in sand, 20 ft deep, uses an apparent earth pressure diagram per Peck's method with a maximum ordinate pa = 0.65·Ka·γ·H. Given Ka = 0.33, γ = 120 pcf, and H = 20 ft, what is the value of the maximum apparent pressure ordinate, pa?

A. 390 psf

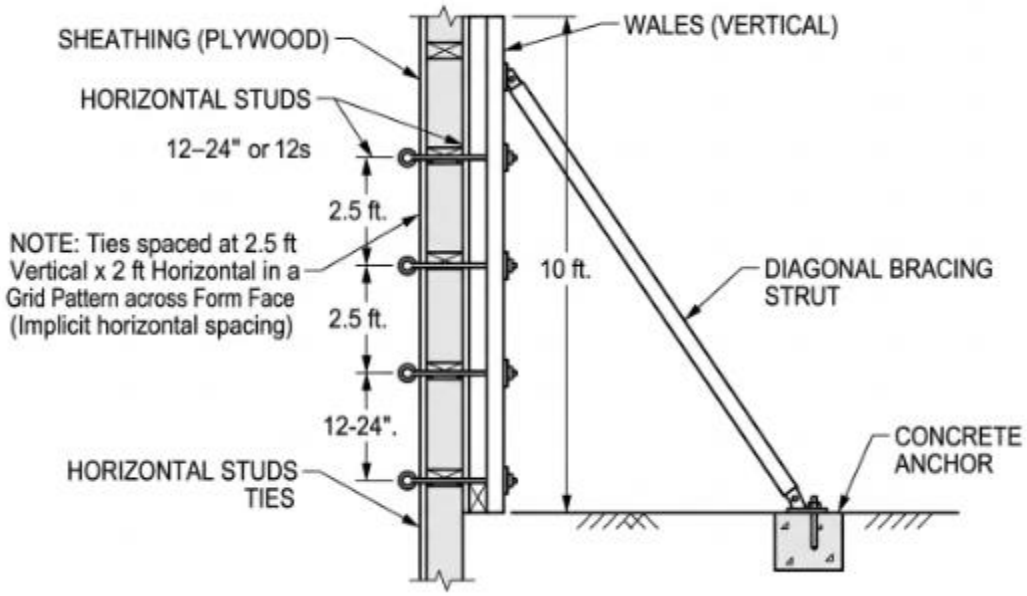
B. 450 psf

C. 515 psf

D. 580 psf

85. Based on the wall formwork cross-section shown, if the maximum lateral concrete pressure on the form is 700 psf and the tie spacing is 2.5 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. 3,500 lb

B. 2,800 lb

C. 4,200 lb

D. 5,600 lb

86. A guy wire bracing a temporary mast is anchored 9 ft horizontally from the base of the mast and attaches to the mast at a height of 12 ft, giving a wire length of 15 ft. If the horizontal force to be resisted at the attachment point is 1,200 lb, what tension in the guy wire is required to provide this horizontal resistance?

A. 1,200 lb
B. 1,500 lb
C. 2,000 lb
D. 2,400 lb

87. Immediately after a single steel column is set and plumbed, but before any beams or bracing connect it to adjacent columns, what is required to keep the column stable and plumb?

A. The column's own base plate and anchor bolts alone, with no additional bracing
B. Temporary guy wires or braces per the erection plan, until permanent connections are made
C. Welding the column directly to the foundation as the sole means of stability
D. No additional measures are needed if the column is plumbed correctly

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 210 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. 105.0 psf
B. 210.0 psf
C. 52.5 psf
D. 70.0 psf

89. A horizontal strut in a braced excavation supports a tributary height of 10 ft and a tributary width of 12 ft along the wall, with an apparent lateral earth pressure of 500 psf acting uniformly over the tributary height. What is the total axial load in the strut?

A. 45,000 lb
B. 50,000 lb
C. 60,000 lb
D. 72,000 lb

90. Per OSHA's scaffold standard, once a supported scaffold's height-to-base-width ratio exceeds 4:1 and restraint is therefore required, which of the following is an acceptable method of providing that restraint?

A. Guying, tying, or bracing to a structurally sound anchor point, per the standard
B. Adding additional scaffold planking only, without any guy, tie, or brace
C. Increasing the base width is the only acceptable OSHA-recognized method
D. No restraint method is recognized by OSHA beyond an engineered design

91. A partially cured elevated slab has a current allowable load capacity of 95 psf. A piece of construction equipment imposes an equivalent distributed load of 130 psf on the slab during a planned operation. By how much does the equipment load exceed the slab's current allowable capacity?

A. 15 psf
B. 20 psf
C. 25 psf
D. 35 psf

92. In a soldier pile and lagging excavation support system, what is the primary structural function of the vertical soldier piles themselves?

A. To directly retain the soil surface between the piles
B. To resist bending from earth pressure via the lagging and carry it to bearing strata below
C. To serve only as a visual guide for excavation limits
D. To support the lagging boards' self-weight only

93. A form tie rod has an ultimate tensile capacity of 18,000 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. 6,000 lb
B. 9,000 lb
C. 7,200 lb
D. 10,800 lb

94. Falsework supporting a concrete bridge girder segment during an extended construction schedule must also be checked for which environmental load that the permanent, completed structure's design may address differently?

A. Only dead load of the wet concrete, with wind ignored during construction
B. Only the seismic load combination used for the permanent structure
C. Only snow load, since wind cannot act on formwork
D. Wind load on the exposed falsework/formwork assembly, per ASCE 37 provisions for temporary structures

95. Per OSHA excavation standards, when a trench excavation is 4 ft or more in depth, what maximum lateral travel distance is permitted for employees to reach a means of egress, such as a ladder or ramp?

A. 15 ft
B. 25 ft
C. 50 ft
D. 100 ft

96. Under OSHA's steel erection standard (29 CFR 1926 Subpart R), 'connectors' working at what height range must have fall protection equipment available to be used, even though its use is not mandatory in that specific range?

A. Between 15 and 30 ft above a lower level
B. Between 6 and 15 ft above a lower level

C. Between 30 and 50 ft above a lower level

D. Above 50 ft only

97. Per MUTCD guidance, what device must a flagger use to control traffic through a temporary traffic control zone?

A. A STOP/SLOW paddle, or where authorized, a flag

B. A red flashlight only, during daytime operations

C. Hand signals alone, without any paddle or flag

D. A portable traffic signal exclusively, with no flagger paddle

98. How does OSHA's definition of a 'qualified person' primarily differ from its definition of a 'competent person'?

A. The two terms are legally identical under OSHA regulations

B. A competent person must be a licensed professional engineer, while a qualified person need not be

C. A qualified person only inspects excavations, while a competent person only inspects scaffolds

D. A qualified person has recognized credentials or extensive training, while a competent person is defined by hazard-identification ability and corrective authority

99. In the standard MUTCD temporary traffic control zone layout, which zone segment is the area where the actual construction or maintenance work takes place?

A. The advance warning area

B. The transition area

C. The activity area

D. The termination area

100. Under the OSH Act's General Duty Clause, an employer has an obligation to provide a workplace free from recognized hazards under which general condition?

A. Only when a specific OSHA standard already covers the hazard

B. When a recognized hazard is likely to cause death or serious harm and no standard applies

C. Only after a workplace fatality has occurred

D. Only for employers with more than 50 employees

Practice Exam 11: Answer Key and Explanations

1. A — The Rankine active coefficient is Ka = (1-sin32°)/(1+sin32°) = 0.307. The total active force per foot is the triangular pressure diagram's area: $0.5 \times Ka \times \gamma \times H^2 = 0.5 \times 0.307 \times 115 \times 15^2 \approx 3{,}975$ lb/ft, or 3.98 kip/ft. This resultant governs the 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 $Sc = [Cc \cdot H/(1+e0)] \cdot \log10[(p0+\Delta p)/p0]$. With H = 180 in, $Sc = (0.25 \times 180/1.95) \times \log10(1.6) = 23.08 \times 0.204 \approx 4.71$ in. This settlement accumulates gradually over time as excess pore pressure in the clay layer slowly dissipates through drainage. The distractors misapply the void-ratio term or the logarithmic stress ratio in the formula.

3. D — Total stress at 20 ft is $6 \times 118 + 14 \times 128 = 2{,}500$ psf. Pore pressure from the water table 14 ft above is $14 \times 62.4 = 873.6$ psf. Effective stress is total stress minus pore pressure: $2{,}500 - 874 \approx 1{,}626$ psf. Option A wrongly reports total stress without deducting pore pressure at all.

4. C — Terzaghi's equation gives $qu = q \cdot Nq + 0.5 \cdot \gamma \cdot B \cdot N\gamma$, with $q = \gamma \cdot Df = 112 \times 5 = 560$ psf. This gives $qu = 560 \times 18 + 0.5 \times 112 \times 4 \times 13 = 10{,}080 + 2{,}912 = 12{,}992$ 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. B — For a dry, cohesionless infinite slope, $FS = \tan\varphi/\tan\beta$. With $\varphi = 30°$ and $\beta = 18°$, $FS = \tan30°/\tan18° = 0.577/0.325 \approx 1.78$. Since FS exceeds 1.0, the slope is stable under fully drained conditions with no seepage forces; the other values come from swapping or mis-ratioing the two given angles.

6. D — Pushing a wall into the retained soil mobilizes the passive limit state, in which the soil resists compression along a failure surface. Passive pressure is substantially higher than active pressure, which instead develops when a wall moves away from the soil, allowing it to expand and mobilize its minimum resisting shear strength along a different failure surface.

7. A — Total stress is the weight of everything above a point, soil solids plus water, per unit area, without regard to how that load is shared. Effective stress and pore pressure are the two components total stress divides into ($\sigma = \sigma' + u$); options B and C each describe only one of those components.

8. C — In the term $0.5\gamma BN\gamma$, the footing width B appears to the first power only, so doubling B directly doubles this term's contribution, holding γ and $N\gamma$ constant. This differs from the $q \cdot Nq$ surcharge term,

which depends on embedment depth rather than width, so widening the footing affects only the $N\gamma$ contribution in this proportional way.

9. B — Curve length is $L = R \cdot \Delta$ with Δ in radians: $\Delta = 42 \times \pi / 180 = 0.7330$ rad. Multiplying by R = 650 ft gives $L = 650 \times 0.7330 \approx 476.4$ 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 $\Delta/2 = 15°$, $\cos 15° = 0.9659$, so $M = 1{,}200 \times (1 - 0.9659) \approx 40.9$ 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. C — Conflicting utility records mean neither set can be trusted on its own, so a coordinated locate request through the one-call system, followed by physical verification through potholing at critical crossing points, resolves the discrepancy before any excavation risk is taken. Waiting for a strike, or trusting an unverified record set or radar scan alone, all leave the conflict unresolved.

12. A — Fill is the difference between the higher design subgrade elevation and the lower existing ground elevation: 218.25 − 215.80 = 2.45 ft. Since the design grade sits above existing ground here, material must be added rather than removed, and the stake is marked with this fill amount for the grading crew.

13. D — The low point on a sag curve is at $x = g_1 L/(g_1 - g_2) = (-0.02 \times 500)/(-0.05) = 200$ ft from the PVC. Its elevation is $\text{elev}_{PVC} + g_1 x + [(g_2 - g_1)/2L]x^2 = 250 - 4 + 2 = 248.00$ ft. Omitting the parabolic correction term entirely would instead give the plain tangent elevation of 246.00 ft.

14. C — Redundant control points spaced along a long alignment let survey crews working at different locations independently check their layout against a nearby point rather than a single distant origin. This limits the distance over which small errors can accumulate and lets a discrepancy be caught locally, long before it propagates across miles of alignment and compounds into a significant error.

15. B — Monitoring points allow crews to continuously track any movement or settlement of the adjacent structure as excavation proceeds, comparing readings against predetermined threshold and limiting values so work can be paused or modified before damage occurs. This ongoing monitoring is a distinct, complementary measure to a one-time pre-construction condition survey, not a substitute for it.

16. A — The CH clay layer from 10 to 22 ft has very low N-values of only 2 blows/ft, indicating very soft, highly compressible clay with low undrained shear strength. This governs shallow foundation bearing capacity nearby and will also produce significant long-term settlement, unlike the stiffer silt above and dense sand below.

17. B — Water-cement ratio is the weight of water divided by the weight of cement: 234 lb / 520 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 stated in the problem.

18. C — Development length ensures enough embedded bar length exists for bond stress between the bar's surface and the surrounding concrete to transfer the bar's tensile force gradually, allowing it to

reach its design stress, often yield, without pulling out or slipping. It has no direct effect on cross-sectional area, required cover, or corrosion protection.

19. D — Cross-laminated timber is built from stacked layers of dimension lumber, with each layer's grain direction rotated 90 degrees from the layer beneath it before gluing. This cross-lamination gives CLT panels meaningful strength and stiffness in two directions, unlike LVL or glulam, which orient their laminations primarily along one axis for one-directional strength.

20. A — Percent passing is the complement of percent retained: 800 − 620 = 180 g passing, or 180/800×100 = 22.5%. Option B (77.5%) is simply the percent retained value, mistakenly reported directly as percent passing instead of first subtracting the retained mass from the total sample mass before dividing to get the true passing percentage.

21. D — High-range water-reducing admixtures, or superplasticizers, disperse cement particles to dramatically increase flowability and slump without increasing water content, preserving the mix's design water-cement ratio and strength. Air-entraining, accelerating, and retarding admixtures instead target freeze-thaw durability, setting speed, and setting delay, respectively, not workability at a fixed w/c ratio like this.

22. A — Axial stress equals force divided by area: $\sigma = P/A = 140 \text{ kips} / 5.0 \text{ in}^2 = 28 \text{ ksi}$. This stress is then compared against the steel's allowable or yield stress to check adequacy of the member. The other values would result only from using a different area or force than the ones given here.

23. B — Footing volume is $5\times5\times2 = 50 \text{ ft}^3$. Converting to cubic yards by dividing by 27 ft^3 per cy gives $50/27 \approx 1.85$ 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 linear plan dimensions on the drawings.

24. C — The combined unit cost is \$210 + \$110 = \$320 per cy. Multiplying by the 180 cy quantity gives \$320×180 = \$57,600. This is the standard method of summing all applicable unit-cost components before multiplying by total quantity, rather than using only one component in isolation as the other choices do.

25. D — Simple break-even analysis divides the purchase price by the annual savings: \$65,000/\$13,000 per year = 5 years. After this period, cumulative savings equal the initial purchase price, making continued use net-favorable versus renting going forward; this simplified approach ignores the time value of money that a full economic analysis would apply.

26. B — CPI equals earned value divided by actual cost: \$380,000/\$400,000 = 0.95. 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 the progress achieved. Option A inverts this ratio, producing a misleadingly favorable index reading.

27. A — The average end area method gives volume as $[(260+300)/2]\times150 = 280\times150 = 42{,}000 \text{ ft}^3$, or $42{,}000/27 \approx 1{,}555.6$ 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 15% markup multiplies the direct cost by 1.15: \$950,000×1.15 = \$1,092,500. This single multiplication correctly combines overhead and profit as one percentage applied to the direct cost base. Option A omits markup entirely, while B and D reflect different, incorrect markup percentages applied to that same cost base.

29. B — Total steel length is 60 bars × 10 ft each = 600 ft. Multiplying by the unit weight of 1.043 lb/ft gives 600×1.043 = 625.8 lb, which rounds to 626 lb. This length-times-unit-weight approach is the standard quantity takeoff method for estimating reinforcing steel tonnage directly from a bar schedule.

30. A — Present worth discounts future cash flows back to today's value, and a higher discount rate compounds this reduction more aggressively over time, so costs occurring far in the future contribute proportionally less to the total present-worth comparison. This is why alternatives with heavier long-term maintenance can appear more favorable as the assumed discount rate rises.

31. C — Roofing membrane is applied over a completed roof deck substrate, so the steel deck (or other structural roof substrate) must be installed and secured first before any membrane work can begin. Interior finishes, drywall, flooring, and landscaping are all separate, typically later, activities that do not need to precede roof deck installation.

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 = (4+28+16)/6 = 48/6 = 8 days. This weighting better reflects the skewed beta-distribution shape typically assumed for activity durations than a simple average of the three estimates would.

33. C — Two paths run from A to E: A-B-E totals 5+7+4 = 16 days, and A-C-D-E totals 5+6+8+4 = 23 days. The critical path is the longer of the two, since it determines the minimum project duration: 23 days. Path A-B-E carries 7 days of float relative to this longer, governing path.

34. B — Total float equals late finish minus early finish (equivalently, late start minus early start): 19 − 15 = 4 days. This is 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.

35. A — Fast-tracking compresses schedule duration by performing activities in parallel that were originally planned sequentially, such as starting design of a later phase before an earlier one is fully complete. This increases coordination and rework risk but adds no direct cost, distinguishing it from crashing, which shortens duration by adding resources at added cost instead.

36. D — Cost slope is (crash cost − normal cost)/(normal duration − crash duration) = (\$16,000−\$10,000)/(12−8) = \$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 given number of days on the critical path.

37. C — The linear scheduling method, or line-of-balance, plots each trade's production against floor level and time, making the repetitive floor-to-floor cycle and each crew's production rate directly visible. This reveals whether a faster crew might catch up to and interfere with a slower one ahead of it, something a plain bar chart or milestone schedule does not show.

38. A — The minimum additional cost to crash is the cost slope multiplied by the number of days shortened: \$1,200/day × 5 days = \$6,000. Since this is the only available critical activity, all 5 days of compression must come from it alone, leaving no cheaper alternative combination of activities to achieve the required deadline.

39. B — Total demand for that day is 5+6+4 = 15 electricians, while only 11 are available, leaving a shortfall of 15−11 = 4 electricians. This over-allocation must be resolved by delaying an activity within its available float, adding crew capacity, or extending the schedule before that day's work can proceed as originally planned.

40. D — The critical path is the longest sequence of dependent activities through the network, and its total duration sets the minimum time in which the project can be completed. Activities on this path have zero total float, meaning any delay to them delays the whole project, unlike paths with float or a path defined only by cost.

41. D — For a 4-in. diameter cylinder, area = $\pi \times 2^2 = 12.57$ in². Compressive strength is failure load divided by area: 50,265/12.57 ≈ 4,000 psi. This standard cylinder-break calculation confirms whether delivered concrete achieves its specified design strength, and here the result matches a 4,000 psi mix requirement closely, confirming the load's acceptance.

42. A — As a DTI washer's bumps compress under increasing bolt tension, the remaining gap between the washer and the bearing surface shrinks, and that gap is measured with a feeler gauge against a specified maximum value to confirm adequate pretension has been achieved. It does not directly report torque, rotation count, or material tensile strength.

43. C — Cylinder breaks and compaction tests are hands-on verification activities performed on the actual completed work to confirm it meets project specifications, which is precisely the definition of quality control. Quality assurance, by contrast, is the broader planned system of procedures intended to prevent defects, of which this testing lab's specific test results are one input.

44. B — Fresh concrete contains significant free water, and if it freezes before gaining sufficient strength, ice crystal formation can disrupt the cement paste's microstructure, causing permanent, irreversible strength loss. Cold-weather protection measures, insulation, heated enclosures, or heat-generating admixtures, are specifically intended to prevent this freezing until the concrete has cured enough to resist it.

45. C — The Nurse-Saul maturity factor is $M = \Sigma(T - T0) \cdot \Delta t = (75 - 32) \times 36 = 43 \times 36 = 1{,}548$ °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 tested, cured, and formally reported back to the field.

46. D — Percent compaction compares field dry unit weight to the laboratory maximum: 112/120×100 ≈ 93.3%. Specifications commonly require 95% or greater relative compaction for structural fill, so this result would likely fall just short of a 95% minimum requirement and should be checked carefully against the project's actual compaction specification value.

47. A — The acceptable slump range here is 4 to 6 in., and a measured 2.5 in. falls well below the lower limit, indicating stiffer, less workable concrete than specified, likely complicating placement. The load should be rejected; adding water at the jobsite is never acceptable, since it alters the approved water-cement ratio.

48. B — The effective throat of an equal-leg fillet weld equals the leg size times 0.707 (cos45°), the shortest distance through the weld's triangular cross-section: 0.375 in × 0.707 ≈ 0.265 in. This throat dimension, rather than the leg size directly, is what is used to compute the weld's effective strength in design calculations.

49. B — Breakdown rolling, typically with a vibratory steel-wheel roller, is performed first on the hottest mat to achieve the majority of density gain. Intermediate rolling, often with a pneumatic-tired roller, follows to further densify and seal the surface, and finish rolling with a static steel-wheel roller removes remaining roller marks last, while the mat is still workable.

50. C — The maturity method only estimates strength reliably when it is calibrated to the specific concrete mix actually being used on the project, which requires testing companion cylinders of that exact mix at multiple ages to build a strength-versus-maturity curve. A curve from a different mix, or the Nurse-Saul equation alone, cannot be assumed to apply without this project-specific calibration testing.

51. D — An unfactored service-level combination sums the applicable loads directly: D + Lc = 650 + 400 = 1,050 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. A — Section modulus for a rectangular section is $S = bd^2/6 = 8\times196/6 \approx 261.3$ in³. Converting the moment, M = 20 kip-ft × 12 in/ft × 1,000 = 240,000 lb-in. Bending stress is $\sigma = M/S = 240{,}000/261.3 \approx$ 918 psi, the maximum fiber stress at the top and bottom of the beam's cross-section.

53. B — For a short column not governed by buckling, allowable capacity is the allowable stress multiplied by the cross-sectional area: 20 ksi × 6.5 in² = 130 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 case.

54. C — Converting the 24-ft span to 288 in, $\Delta = PL^3/48EI = (8\times288^3)/(48\times29{,}000\times950) \approx 0.145$ 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: 12 ft/3 = 4.00 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.

56. D — A uniform area load converts to a line load by multiplying by the tributary width the member collects: 25 psf × 6 ft = 150 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.

57. C — A vertical offset across a crack indicates that one side of the slab has physically moved relative to the other, which is characteristic of differential settlement of the underlying subgrade rather than shrinkage. Plastic shrinkage and normal drying shrinkage cracks are typically flush, without vertical offset, since they result from volume change rather than support movement.

58. A — For a rectangular section, maximum shear stress occurs at the neutral axis and equals 1.5 times the average shear stress: $\tau_{max} = 1.5V/(bd) = 1.5\times15{,}000/(10\times18) = 22{,}500/180 = 125$ psi. The 1.5 factor reflects the parabolic shear stress distribution that develops across the depth of a rectangular cross-section under transverse loading.

59. B — The transverse direction of a one-way slab carries no significant flexural demand, so without adequate temperature and shrinkage steel, restrained shrinkage and thermal movement in that direction can produce a few wide, poorly distributed cracks rather than many small, well-controlled ones. This is a serviceability and durability concern distinct from flexural capacity, fire rating, or main-span deflection.

60. D — When axial and bending stresses act in the same sense at an extreme fiber, they superimpose directly: combined stress = axial + bending = 10 + 9 = 19 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 frame.

61. C — For a 2.5-ft diameter pipe, area = $\pi r^2 \approx 4.91$ ft² and hydraulic radius R = D/4 = 0.625 ft. Manning's equation gives Q = (1.486/n)AR^(2/3)S^(1/2) ≈ (1.486/0.012)×4.91×0.625^0.667×0.008^0.5 ≈ 39.8 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 = 0.35×2.5×22 = 19.25 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. D — Culvert slope equals the drop in invert elevation divided by the barrel length: (112.00−109.60)/80×100 = 2.40/80×100 = 3.0%. Maintaining adequate barrel slope helps sustain self-cleansing velocity through the culvert, preventing sediment accumulation, and this computed value would be checked against a minimum design velocity or slope criterion for the project.

64. B — The prismoidal formula gives V = (h/6)(Abottom+4Amid+Atop) = (5/6)×(6,000+4×7,900+10,000) = 0.833×47,600 ≈ 39,667 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

more accurately reflects the pond's actual sloped-wall geometry throughout its full depth than a plain average would.

65. B — Time of concentration is typically built from a sequence of flow segments: sheet flow across the initial unchanneled ground, followed by shallow concentrated flow once water gathers into small rills or swales, and finally channel or pipe flow once it reaches a defined conveyance. Shallow concentrated flow is specifically this intermediate segment between sheet flow and a defined channel.

66. D — A hydraulic jump is the abrupt, turbulent transition that occurs when fast, shallow supercritical flow encounters conditions requiring slower, deeper subcritical flow, dissipating significant kinetic energy in the process. It is distinct from normal depth, which is a uniform-flow condition set by channel slope and roughness, and unrelated to the general laminar-to-turbulent flow classification.

67. A — Each leg supports half the vertical load, but because the leg is inclined, its tension exceeds that vertical component: $T = (\text{load}/2)/\sin 45° = 5{,}000/0.707 \approx 7{,}071$ 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. C — The total weight the crane must support at this radius is the load plus all rigging: 15,200+650 = 15,850 lb. Subtracting this from the rated capacity of 18,000 lb gives a margin of 18,000−15,850 = 2,150 lb. Rigging weight must always be included; 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: 380/600×100 ≈ 63.3%. Running at roughly two-thirds of rated capacity leaves reasonable reserve margin to absorb surges in inflow or gradual performance degradation, which is generally preferable to selecting a pump expected to run continuously near its maximum rating.

70. A — As the load line shifts off the crane's geometric center, the reaction each outrigger pad carries redistributes, with the pad nearest the offset load and boom position picking up more than an even one-quarter share of the total reaction. This concentrated reaction, not an assumed equal split, is what must be checked against the soil's allowable bearing capacity.

71. D — Hard, competent rock exceeds what a standard smooth excavator bucket can penetrate, so rock-specific methods, a hydraulic hoe-ram or breaker attachment, a rock wheel or ripper, or controlled blasting where permitted by local regulation, are required instead. Scrapers and wellpoint dewatering address soil-moving and groundwater control, not rock breakage, and are not relevant to this rock condition.

72. C — Shrinkage factor accounts for the volume reduction when loose, excavated soil is recompacted into denser fill: compacted fill volume = bank volume × shrinkage factor = 15,000×0.88 = 13,200 cy. Ignoring this shrinkage and simply using the bank volume, as in option B, would overstate the actual compacted fill volume the borrow source can produce.

73. B — Substituting into the Engineering News formula gives $Ru = 2\times25{,}000/(0.20+1.0) = 50{,}000/1.2 \approx 41{,}667$ 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 3.0 mi/20 mph = 0.15 hr, and empty return time is 3.0 mi/30 mph = 0.10 hr, for a combined travel time of 0.25 hr, or 15.0 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. D — As a crane's upper works rotate during a swing, the counterweight and rear structure sweep through an arc behind the machine, the tail swing radius, and anyone or anything caught in that arc risks being struck or crushed. Barricading this area is a standard, required precaution and is unrelated to load chart capacity, boom angle accuracy, or boom length selection.

76. A — Cycles per hour equal 3,600 seconds divided by the 22-second cycle time, about 163.6 cycles/hr. Each cycle effectively moves 2.0×0.85 = 1.7 cy, giving 163.6×1.7 ≈ 278.2 cy/hr before accounting for downtime. Applying the 0.80 efficiency factor for non-productive time reduces this to 278.2×0.80 ≈ 222.5 cy/hr, the realistic estimated rate.

77. A — A surface-mounted vacuum wellpoint system is fundamentally limited by atmospheric pressure, which restricts practical single-stage lift to roughly 15 to 18 ft in typical field conditions. Deeper drawdown requirements call for multiple stacked wellpoint stages or an entirely different method, such as deep wells with submersible pumps, which are not limited by atmospheric vacuum in the same way.

78. B — Swell factor accounts for the volume increase when compact, in-situ soil is excavated and loosened: loose volume = bank volume × swell factor = 8,000×1.30 = 10,400 cy. This loose, not bank, volume is what actually determines how many truckloads are required to haul the excavated material off the site.

79. D — A wide-open site with room for repositioning, combined with relatively few heavy lifts at moderate height, favors a mobile crane, crawler or truck-mounted, that can be moved between lift locations as needed without the cost and setup time of a fixed tower crane. A tower crane is instead better justified by sustained, repetitive high-reach lifting on a confined footprint.

80. C — Substituting the given values: Pmax = 150 + 9,000×(8/75) = 150 + 960 = 1,110 psf. Placement rate and concrete temperature are the two dominant variables in this simplified pressure 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.

81. B — With four legs sharing the load equally, each leg carries 13,000/4 = 3,250 lb. Comparing this to the leg's allowable capacity of 3,800 lb gives a utilization ratio of 3,250/3,800×100 ≈ 85.5%. Since this is below 100%, the legs have adequate capacity for the stated load, provided load distribution in the field is reasonably even.

82. D — Multi-level shoring analysis typically assumes the total construction load distributes among all supporting levels roughly in proportion to their stiffness. With three levels of comparable stiffness

sharing the load equally, each carries one-third of the 180 psf total: 180/3 = 60 psf, a value each supported level below must be checked against.

83. A — Total wind force equals design wind pressure multiplied by the exposed area subject to it: F = 18 psf × 250 ft² = 4,500 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. C — Substituting into Peck's apparent pressure formula: pa = 0.65×0.33×120×20 ≈ 515 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. A — Each tie's tributary area is its vertical spacing times its horizontal spacing: 2.5 ft × 2 ft = 5 ft². Multiplying by the maximum lateral concrete pressure gives the design tension load on each tie: 700 psf × 5 ft² = 3,500 lb. This tributary-area method is standard for distributing lateral pressure to discrete form ties across a wall face.

86. C — The 9-12-15 geometry is a 3-4-5 right triangle scaled up, where horizontal force = tension × (horizontal leg / hypotenuse). Solving for tension: tension = 1,200×(15/9) ≈ 2,000 lb, the wire force needed to provide the required 1,200-lb horizontal resistance at the mast's attachment point on the structure above the anchor.

87. B — A single, unconnected column has no lateral stability system of its own beyond its base connection, which alone is generally insufficient to resist construction loads such as wind or impact. Temporary guy wires or braces, specified in the erection plan, hold the column plumb and stable until permanent beam connections and bracing are installed and can take over that role.

88. D — Distributing the 210 psf construction load equally across 3 supporting levels gives 210/3 = 70 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 × 12 ft = 120 ft². Multiplying by the uniform apparent pressure of 500 psf gives the total axial strut load: 500×120 = 60,000 lb. This tributary-area method converts the wall's distributed earth pressure into a discrete design load for the individual strut.

90. A — OSHA's scaffold standard specifically identifies guying, tying, bracing, or an equivalent means to a structurally sound anchor as acceptable restraint once the 4:1 height-to-base-width ratio is exceeded. Increasing base width would avoid triggering the requirement in the first place but is not itself the restraint method the standard describes for an already-tall scaffold configuration.

91. D — The excess load is the imposed equipment load minus the slab's current allowable capacity: 130−95 = 35 psf. 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.

92. B — The soldier piles are the primary structural elements: they resist the bending moment generated by lateral earth pressure that the horizontal lagging boards transfer to them, and they carry that load down to a stable bearing stratum below the excavation's subgrade. Retaining the soil surface directly between piles is instead the lagging's function, not the piles'.

93. C — Allowable working load is the ultimate tensile capacity divided by the specified safety factor: 18,000/2.5 = 7,200 lb. 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.

94. D — Falsework presents a different exposed profile than the finished structure and is often in place for an extended duration, so ASCE 37 requires an explicit wind load check on the temporary assembly itself. This construction-stage wind check is separate from, and often governed differently than, the permanent structure's own design combinations.

95. B — OSHA's excavation standard requires that a means of egress, such as a ladder, ramp, or other safe exit, be located so that no employee in a trench 4 ft or more in depth must travel more than 25 ft laterally to reach it. This ensures workers can exit quickly if a hazardous condition, such as a potential cave-in, develops.

96. A — The steel erection standard sets a distinct threshold for connectors: between 15 and 30 ft above a lower level, fall protection equipment must be provided and available for use, though its actual use is not mandatory in that specific range given the nature of connecting work. Above 30 ft, fall protection must be worn and used at all times.

97. A — MUTCD guidance specifies that a flagger's primary means of controlling traffic is a STOP/SLOW paddle, with a flag permitted only where specifically authorized as an alternative. Hand signals alone or a portable signal in place of a flagger paddle do not meet this standard requirement for clearly, visibly directing traffic through a work zone.

98. D — A qualified person is defined by possessing a recognized degree, certificate, or extensive knowledge, training, and experience in a subject, demonstrating the ability to solve problems in that area. A competent person, by contrast, is defined functionally: the ability to identify existing and predictable hazards and the authorization to take prompt corrective action, without a specific credential requirement.

99. C — The activity area is the segment of a temporary traffic control zone where the actual work occurs, and it typically contains the work space, a buffer space, and sometimes a traffic space. The advance warning, transition, and termination areas are the segments before, at the taper into, and after the activity area, respectively, guiding traffic around it.

100. B — The General Duty Clause requires employers to keep their workplace free of recognized hazards likely to cause death or serious physical harm, specifically filling gaps where no specific OSHA

standard directly addresses the hazard in question. It applies regardless of employer size and does not require a fatality to have already occurred before the obligation exists.