

# PRACTICE EXAM 4: CONSTRUCTION CIVIL PE EXAM

## PREP (100 QUESTIONS)

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*This practice exam contains 100 questions and is an expanded simulation based on the currently effective NCEES PE Civil: Construction specification. The official PE Civil exam contains 80 questions within a 9-hour appointment, including 8 hours of exam time. Work all questions and use the same electronic-reference mindset you would use on exam day. NCEES does not publish a fixed passing score.*

1. A temporary retaining system supports level, dry granular backfill with friction angle 31 degrees. Assuming Rankine active conditions and a smooth vertical wall, what active earth pressure coefficient  $K_a$  should be used?

- A. 0.515
- B. 1.000
- C. 0.320
- D. 2.125

2. At a construction excavation, 5 ft of moist soil at 120 pcf overlies 9 ft of saturated soil at 130 pcf. The groundwater table is at the layer boundary. What vertical effective stress exists 14 ft below grade? Use water unit weight 62.4 pcf.

- A. 1770 psf
- B. 1208 psf
- C. 562 psf
- D. 1,170 psf

3. A 16-ft-high shoring wall is subjected to a uniform surface surcharge of 350 psf behind level backfill. If  $K_a=0.32$ , what lateral resultant per foot of wall is caused by the surcharge alone?

- A. 896 lb/ft

- B. 5,600 lb/ft
- C. 112 lb/ft
- D. 1,792 lb/ft

4. A centered service load of 240 kips acts on an 8-ft by 10-ft spread footing. Neglect footing self-weight. What average bearing pressure is transmitted to the supporting soil?

- A. 3.00 ksf
- B. 2.40 ksf
- C. 6.00 ksf
- D. 30.00 ksf

5. A 12-ft-thick normally consolidated clay has  $C_c=0.18$ , initial void ratio 0.68, initial effective stress 2.2 ksf, and a uniform stress increase of 1.1 ksf. Using one-dimensional consolidation, what settlement is estimated?

- A. 1.13 in.
- B. 2.72 in.
- C. 4.52 in.
- D. 0.19 in.

6. For a preliminary slope-stability check, available resisting force along a trial surface is 275 kips and driving force is 165 kips. What factor of safety corresponds to this force comparison?

- A. 0.60
- B. 1.10
- C. 2.75
- D. 1.67

7. A compacted fill sample has moist unit weight 129 pcf and water content 12%. What is the corresponding dry unit weight?

- A. 129.0 pcf
- B. 144.5 pcf
- C. 115.2 pcf
- D. 15.5 pcf

**8.** A piezometer indicates a point is 18 ft below the static groundwater surface. What hydrostatic pore water pressure acts at that point? Use  $\gamma_w=62.4$  pcf.

- A. 1,123 psf
- B. 936 psf
- C. 62 psf
- D. 2,246 psf

**9.** Field testing gives a dry density of 118 pcf for a lift whose laboratory maximum dry density is 124 pcf. What relative compaction has been achieved?

- A. 105.1%
- B. 6.0%
- C. 92.0%
- D. 95.2%

**10.** During differential leveling, a backsight of 4.25 ft is taken on a benchmark at elevation 315.60 ft, followed by a foresight of 7.10 ft to a new control point. What is the new point elevation?

- A. 319.85 ft
- B. 308.50 ft
- C. 312.75 ft
- D. 322.70 ft

**11.** A proposed storm-drain invert begins at elevation 522.40 ft and descends on a constant 1.75% grade for 480 ft. What is the downstream invert elevation?

- A. 530.80 ft
- B. 514.00 ft
- C. 518.00 ft
- D. 520.65 ft

**12.** A simple horizontal curve has radius 780 ft and central angle 36 degrees. What is the tangent length from PI to PC?

- A. 253.4 ft
- B. 490.1 ft
- C. 780.0 ft
- D. 126.7 ft

**13.** A circular construction baseline curve has radius 720 ft and central angle 28 degrees. What length is measured along the curve arc?

- A. 175.9 ft
- B. 351.9 ft
- C. 720.0 ft
- D. 703.7 ft

**14.** A simple circular curve used for site staking has radius 540 ft and central angle 30 degrees. What is its long chord length?

- A. 139.8 ft
- B. 282.7 ft
- C. 540.0 ft
- D. 279.5 ft

**15.** At the midpoint of a 360-ft parabolic vertical alignment, the PVC elevation is 610.00 ft, the entering grade is +2.0%, and the exiting grade is -1.5%. Determine the finished-grade elevation 180 ft beyond the PVC.

- A. 612.02 ft
- B. 613.60 ft
- C. 610.45 ft
- D. 607.75 ft

**16.** A survey crew measures coordinate offsets of 180 ft east-west and 240 ft north-south between two control monuments. What straight-line horizontal separation should be recorded?

- A. 420 ft
- B. 210 ft
- C. 300 ft
- D. 60 ft

**17.** A concrete batch contains 290 lb of mixing water and 580 lb of cementitious material. Ignoring aggregate moisture corrections, what water-cementitious materials ratio does the batch have by mass?

- A. 2.00
- B. 0.33
- C. 0.50
- D. 0.67

**18.** A steel brace is stressed to 24 ksi while remaining in the linear-elastic range. Using  $E=29,000$  ksi, what axial strain corresponds to that stress?

- A. 0.000828
- B. 0.000083
- C. 0.008276
- D. 1,208

**19.** A 40-ft steel member is installed at one temperature and later warms by 30 degrees F. Using a thermal-expansion coefficient of  $12 \times 10^{-6}$  per degree F, what free thermal elongation is expected?

- A. 0.144 in.
- B. 0.173 in.
- C. 1.728 in.
- D. 0.014 in.

**20.** A stockpile sample weighs 4,650 lb and occupies 30.0 ft<sup>3</sup> in its measured bulk condition. What is its bulk unit weight?

- A. 135 pcf
- B. 4,620 pcf
- C. 0.0065 pcf
- D. 155 pcf

**21.** A rough-sawn timber is nominally 2 in. thick, 10 in. wide, and 16 ft long. Using board-foot measure based on nominal dimensions, how many board feet does one piece contain?

- A. 20.0 board ft
- B. 320.0 board ft
- C. 26.7 board ft
- D. 13.3 board ft

**22.** A concrete cylinder fails under a compressive load of 78 kips. If its loaded cross-sectional area is 0.60 in.<sup>2</sup> for this simplified test specimen, what compressive stress is indicated?

- A. 46.8 ksi
- B. 130 ksi
- C. 78 ksi
- D. 0.13 ksi

**23.** Fresh concrete from a trial batch weighs 4,050 lb. If its measured fresh unit weight is 145 pcf, what yield volume does the batch represent?

- A. 27.93 ft<sup>3</sup>
- B. 27.00 ft<sup>3</sup>
- C. 13.97 ft<sup>3</sup>
- D. 587.25 ft<sup>3</sup>

**24.** A rectangular excavation is 160 ft long, 24 ft wide, and 6 ft deep. Ignoring side slopes and swell, what in-place excavation quantity is required?

- A. 640 yd<sup>3</sup>
- B. 23,040 yd<sup>3</sup>
- C. 5,120 yd<sup>3</sup>
- D. 853 yd<sup>3</sup>

**25.** Eight isolated square footings are each 12 ft by 12 ft by 1.5 ft thick. What total concrete quantity is required, before waste?

- A. 48.0 yd<sup>3</sup>
- B. 96.0 yd<sup>3</sup>
- C. 64.0 yd<sup>3</sup>
- D. 16.0 yd<sup>3</sup>

**26.** A reinforcing-steel takeoff contains 2,400 ft of #5 bar. Using a nominal weight of 1.502 lb/ft, what total bar weight should be estimated before waste?

- A. 1,598 lb
- B. 3,605 lb
- C. 4,800 lb
- D. 3,902 lb

**27.** A six-person crew works a 10-hour shift. If the fully burdened labor rate is \$42 per worker-hour, what direct labor cost is incurred for the shift?

- A. \$2,100
- B. \$420
- C. \$25,200
- D. \$2,520

**28.** A rented compactor costs \$1,800 for a productive shift and completes 120 compacted yd<sup>3</sup> during that shift. Ignoring other costs, what equipment cost per compacted cubic yard is represented?

- A. \$15.00/yd<sup>3</sup>
- B. \$12.00/yd<sup>3</sup>
- C. \$18.00/yd<sup>3</sup>
- D. \$216.00/yd<sup>3</sup>

**29.** A temporary batching setup has \$90,000 in fixed mobilization cost. It saves \$10 per cubic yard compared with the alternative method. At what production quantity does the fixed cost break even?

- A. 900 yd<sup>3</sup>
- B. 5,000 yd<sup>3</sup>
- C. 90,000 yd<sup>3</sup>
- D. 9,000 yd<sup>3</sup>

**30.** A maintenance expense of \$50,000 is expected three years from now. Using a 6% annual discount rate, what is its present worth?

- A. \$59,551
- B. \$47,170
- C. \$41,981
- D. \$33,333

**31.** A project reports earned value of \$180,000 and actual cost of \$200,000. What cost performance index, CPI, does this indicate?

- A. 1.11
- B. 0.90
- C. 0.10
- D. 1.90

**32.** A concrete crew places 720 yd<sup>3</sup> over nine productive hours. What average production rate should be used for that shift?

- A. 80 yd<sup>3</sup>/hr
- B. 90 yd<sup>3</sup>/hr
- C. 6,480 yd<sup>3</sup>/hr
- D. 8 yd<sup>3</sup>/hr

**33.** A network has three independent start-to-finish paths with total durations of 21, 26, and 24 days. If no resource constraints alter the logic, what is the project duration?

- A. 21 days
- B. 26 days
- C. 24 days
- D. 71 days

**34.** Activity B has an early start of day 7 and a duration of 9 days. Using finish equals start plus duration for this simplified schedule convention, what is its early finish?

- A. Day 9
- B. Day 15
- C. Day 16
- D. Day 63

**35.** An activity has early start day 14 and late start day 18. What total float does this imply?

- A. 4 days
- B. 32 days
- C. 14 days
- D. 18 days

**36.** An activity can be shortened from 12 days at \$80,000 to 9 days at \$98,000. Assuming linear crash cost, what is the crash cost slope per day saved?

- A. \$2,000/day
- B. \$18,000/day
- C. \$32,667/day
- D. \$6,000/day

**37.** For an activity, the optimistic duration is 5 days, most likely duration is 8 days, and pessimistic duration is 17 days. Using the PERT expected-time formula, what duration is expected?

- A. 9.0 days
- B. 10.0 days
- C. 8.0 days
- D. 7.5 days

**38.** Two noncritical activities require the same specialized crew at overlapping times, but both have available float. Which scheduling action best addresses the conflict without changing the project logic?

- A. Add a finish-to-finish dependency between every activity in the project.
- B. Shift one activity within its available float to level the shared crew demand.
- C. Declare both activities critical and remove their float.
- D. Shorten both activities regardless of cost or resource availability.

**39.** A linear earthwork operation advances at 75 ft/day. A following drainage crew must remain at least 600 ft behind the earthwork crew. What minimum start offset is needed before drainage begins?

- A. 6 days
- B. 10 days
- C. 45,000 days
- D. 8 days

**40.** An activity has 3 days of total float and experiences a 2-day delay with no other schedule changes. What is the immediate effect on the current project completion date?

- A. The project is delayed exactly 2 days.
- B. The project is accelerated by 1 day.
- C. The project completion date is unchanged, with 1 day of float remaining.
- D. The activity gains 5 days of total float.

**41.** Activity Y cannot start until Activity X is complete. Which precedence relationship directly represents this requirement?

- A. Start-to-start from X to Y.
- B. Finish-to-finish from X to Y.
- C. Start-to-finish from X to Y.
- D. Finish-to-start from X to Y.

**42.** A project has earned value of \$150,000 and planned value of \$165,000 at the status date. What schedule performance index, SPI, is indicated?

- A. 1.10
- B. 0.91
- C. 0.09
- D. 1.91

**43.** Three concrete strength test results are 4,120 psi, 3,980 psi, and 4,260 psi. What is their arithmetic average?

- A. 3,980 psi
- B. 4,260 psi
- C. 4120 psi
- D. 12,360 psi

**44.** During a concrete placement, slump is below the specified range. Which response is most appropriate before adding water at the truck?

- A. Evaluate the approved mix and project procedures, and make only an authorized adjustment within specified limits.
- B. Add enough water to reach any desired slump without documenting the change.
- C. Reject every low-slump load automatically regardless of specification provisions.
- D. Increase aggregate moisture assumptions in the batch ticket after placement is complete.

**45.** A compacted base course has field dry density 121 pcf and laboratory maximum dry density 126 pcf. What percent compaction is achieved?

- A. 104.1%
- B. 96.0%
- C. 5.0%
- D. 92.5%

**46.** An asphalt core has measured bulk density 148 pcf, and the project reference density is 153 pcf. What density percentage does the core represent?

- A. 96.7%
- B. 103.4%
- C. 5.0%
- D. 93.0%

**47.** Using a datum temperature of 32 degrees F, concrete is held 10 hours at 70 degrees F and then 8 hours at 80 degrees F. Using the simple temperature-time factor, what maturity index is accumulated?

- A. 684 degree-F-hours
- B. 1,340 degree-F-hours
- C. 576 degree-F-hours
- D. 764 degree-F-hours

**48.** A high-strength bolted connection is specified as pretensioned. Which field objective is central to installation quality control?

- A. Verify only that the bolt heads are visually flush with the connected plate.
- B. Measure plate thickness after tightening and infer bolt pretension from that value alone.
- C. Verify the approved installation method develops the required bolt pretension in the assembled connection.
- D. Apply the same arbitrary torque to every bolt regardless of the approved installation procedure.

**49.** Which nondestructive examination method is especially suited to detecting surface-breaking cracks in a clean, nonporous weld surface using a visible or fluorescent liquid?

- A. Radiographic testing only.
- B. Liquid penetrant testing.
- C. Concrete rebound-hammer testing.
- D. Soil nuclear-density testing.

**50.** A process-control chart has a centerline of 50 units and a process standard deviation of 4 units. If three-sigma limits are used, what is the upper control limit?

- A. 54 units
- B. 58 units
- C. 150 units
- D. 62 units

**51.** A concrete placement plan calls for continuous consolidation around congested reinforcing steel. What is the primary purpose of internal vibration when properly performed?

- A. Remove entrapped air and help the concrete fully surround reinforcement and fill the form.
- B. Increase the specified water-cementitious ratio after discharge.
- C. Create deliberate segregation so coarse aggregate settles below the paste.
- D. Replace the need for a stable formwork system during placement.

**52.** A standard 6-in.-diameter concrete cylinder fails at an axial load of 160 kips. What compressive strength does the test indicate?

- A. 4,244 psi
- B. 8,489 psi
- C. 5659 psi
- D. 28.3 psi

**53.** A simply supported 22-ft beam carries a 48-kip point load 11 ft from the left support. What reaction occurs at each support?

- A. 48 kips
- B. 24 kips
- C. 11 kips
- D. 96 kips

**54.** A temporary simply supported stringer spans 24 ft and carries 1.8 kip/ft uniformly along its entire length. Determine the peak positive bending moment in the stringer.

- A. 129.6 kip-ft
- B. 86.4 kip-ft
- C. 21.6 kip-ft

D. 259.2 kip-ft

**55.** A 9-ft cantilever supports an 18-kip point load at its free end. What fixed-end moment magnitude is produced?

- A. 18 kip-ft
- B. 81 kip-ft
- C. 162 kip-ft
- D. 324 kip-ft

**56.** A steel member carries 72 kips of axial tension through a gross area of 12 in.<sup>2</sup>. What average axial tensile stress is produced?

- A. 864.0 ksi
- B. 0.17 ksi
- C. 12.0 ksi
- D. 6.0 ksi

**57.** At a beam section, bending moment is 84 kip-ft, distance to the extreme fiber is 7 in., and moment of inertia is 1,764 in.<sup>4</sup>. What flexural stress magnitude is  $M c/I$ ?

- A. 4.0 ksi
- B. 0.33 ksi
- C. 33.6 ksi
- D. 2.0 ksi

**58.** A steel hanger is 14 ft long, has area 5.5 in.<sup>2</sup>, and carries 95 kips of axial tension. If  $E=29,000$  ksi, how much elastic lengthening occurs?

- A. 0.010 in.
- B. 1.001 in.

- C. 0.056 in.
- D. 0.100 in.

**59.** A column supports a tributary floor area 18 ft by 22 ft carrying a uniform construction load of 125 psf. What load from that area is delivered to the column?

- A. 39.6 kips
- B. 49.5 kips
- C. 9.9 kips
- D. 396.0 kips

**60.** At one extreme fiber of a member, axial loading produces 6.0 ksi compression and bending produces 4.5 ksi compression. What combined normal stress acts at that fiber?

- A. 1.5 ksi compression
- B. 27.0 ksi compression
- C. 10.5 ksi compression
- D. 10.5 ksi tension

**61.** A simply supported 28-ft beam carries a full-span uniform load of 2.2 kip/ft. What vertical reaction occurs at each support?

- A. 61.6 kips
- B. 15.4 kips
- C. 2.2 kips
- D. 30.8 kips

**62.** A temporary pin connection transfers 60 kips through a 3-in.-wide plate that is 0.75 in. thick. Using projected bearing area width times thickness, what average bearing stress is produced?

- A. 15.0 ksi

- B. 60.0 ksi
- C. 26.7 ksi
- D. 80.0 ksi

**63.** A paved laydown yard drains 8 acres. For a design storm, use  $C=0.78$  and rainfall intensity 3.5 in./hr. Under the customary Rational Method approximation  $Q=CiA$ , estimate the peak discharge in cfs.

- A. 21.8 cfs
- B. 28.0 cfs
- C. 9.8 cfs
- D. 2.7 cfs

**64.** A temporary bypass pipe conveys 18 cfs through a flowing cross-sectional area of  $6.0 \text{ ft}^2$ . What average velocity is present?

- A. 108.0 ft/s
- B. 3.0 ft/s
- C. 0.33 ft/s
- D. 12.0 ft/s

**65.** A rectangular drainage channel is 10 ft wide and carries water 2.5 ft deep. What hydraulic radius  $R=A/P$  applies to the wetted section?

- A. 1.67 ft
- B. 2.50 ft
- C. 25.00 ft
- D. 1.00 ft

**66.** A 7-acre disturbed area receives 4.0 in. of rainfall. If 65% of the rainfall becomes direct runoff, what runoff volume is produced?

- A. 2.33 acre-ft
- B. 0.65 acre-ft
- C. 1.52 acre-ft
- D. 18.20 acre-ft

**67.** A detention basin receives 42 cfs and releases 27 cfs for 45 minutes. Neglecting other gains and losses, how much storage accumulates during the interval?

- A. 113,400 ft<sup>3</sup>
- B. 40,500 ft<sup>3</sup>
- C. 72,900 ft<sup>3</sup>
- D. 675 ft<sup>3</sup>

**68.** A wellpoint system pump moves 750 gpm against 55 ft of total dynamic head. Ignoring inefficiency, determine the hydraulic horsepower transferred to the water. Use  $\gamma_w = 62.4$  pcf and 1 hp = 550 ft-lb/s.

- A. 7.5 hp
- B. 18.0 hp
- C. 62.4 hp
- D. 10.4 hp

**69.** An excavator has a 2.25-yd<sup>3</sup> bucket, 88% average fill, 26 cycles per hour, and 82% job efficiency. What expected loose-volume production rate results?

- A. 42.2 yd<sup>3</sup>/hr
- B. 51.5 yd<sup>3</sup>/hr
- C. 46.4 yd<sup>3</sup>/hr
- D. 21.1 yd<sup>3</sup>/hr

**70.** A haul-truck cycle requires 6 minutes loading, 16 minutes loaded travel, 4 minutes dumping, and 13 minutes return travel. What total cycle time should be used?

- A. 33 min
- B. 29 min
- C. 39 min
- D. 52 min

**71.** Five identical haul trucks each carry 12 yd<sup>3</sup> and have a 39-minute cycle time. Ignoring queuing and other delays, what is the fleet production rate?

- A. 18.5 yd<sup>3</sup>/hr
- B. 60.0 yd<sup>3</sup>/hr
- C. 120.0 yd<sup>3</sup>/hr
- D. 92.3 yd<sup>3</sup>/hr

**72.** A mass-haul plan assigns 5,250 yd<sup>3</sup> to a scraper fleet whose sustained production is 350 yd<sup>3</sup> per productive hour. Estimate the productive operating time needed for that quantity.

- A. 12 hr
- B. 15 hr
- C. 18 hr
- D. 1,837 hr

**73.** During lift planning, a 22-kip suspended load will be handled with its line of action 38 ft horizontally from the crane centerline. What overturning load moment is associated with the lifted load alone?

- A. 60 kip-ft
- B. 418 kip-ft
- C. 836 kip-ft
- D. 1,672 kip-ft

**74.** A rigging plan uses two identical sling legs to lift an 18-kip load symmetrically. Each leg forms a 50-degree angle from vertical. Neglecting sling weight, determine the tension in one leg.

- A. 9.0 kips
- B. 11.6 kips
- C. 28.0 kips
- D. 14.0 kips

**75.** A sump contains 180,000 gallons of water. A pump removes water at 900 gpm with no inflow. How many minutes are required to empty the sump?

- A. 200 min
- B. 150 min
- C. 300 min
- D. 162,000 min

**76.** A pile-driving crew averages 24 minutes per pile during productive time. If it has 8 productive hours available, approximately how many piles can it install?

- A. 8 piles
- B. 20 piles
- C. 12 piles
- D. 192 piles

**77.** An earthwork quantity is 3,200 bank yd<sup>3</sup>. If excavation produces a 22% swell from bank to loose condition, what loose volume must be hauled?

- A. 3,904 loose yd<sup>3</sup>
- B. 2,624 loose yd<sup>3</sup>
- C. 3,200 loose yd<sup>3</sup>
- D. 704 loose yd<sup>3</sup>

**78.** A loader produces 140 yd<sup>3</sup>/hr. Each truck carries 14 yd<sup>3</sup> and has a 46-minute round-trip cycle excluding loading overlap. Approximately how many trucks are needed to keep pace with the loader, rounding up to a whole truck?

- A. 5 trucks
- B. 6 trucks
- C. 9 trucks
- D. 8 trucks

**79.** A concrete placement contains 540 yd<sup>3</sup>, and the placing system can sustain 72 yd<sup>3</sup>/hr. Ignoring interruptions, how long will placement require?

- A. 6.0 hr
- B. 7.5 hr
- C. 8.5 hr
- D. 38,880 hr

**80.** A conveyor carries 3.5 yd<sup>3</sup> per minute at 75% effective utilization. What expected hourly production rate results?

- A. 210.0 yd<sup>3</sup>/hr
- B. 105.0 yd<sup>3</sup>/hr
- C. 157.5 yd<sup>3</sup>/hr
- D. 2.6 yd<sup>3</sup>/hr

**81.** A borrow material quantity of 2,600 loose yd<sup>3</sup> compacts to 88% of its loose volume in the embankment. What compacted volume is expected from that quantity?

- A. 2,288 compacted yd<sup>3</sup>
- B. 2,952 compacted yd<sup>3</sup>
- C. 2,600 compacted yd<sup>3</sup>
- D. 312 compacted yd<sup>3</sup>

**82.** Fresh-concrete form pressure is idealized as a uniform 900 psf over a 12-ft-high wall form. What horizontal resultant acts per foot of wall length?

- A. 5.4 kips/ft
- B. 10.8 kips/ft
- C. 0.9 kips/ft
- D. 108.0 kips/ft

**83.** Wall-form ties are spaced 2.5 ft vertically by 3.0 ft horizontally in a zone of uniform 850 psf concrete pressure. What tributary load acts on one tie?

- A. 2.13 kips
- B. 8.50 kips
- C. 18.75 kips
- D. 6.38 kips

**84.** A temporary shore supports a 6-ft by 6-ft tributary area carrying 150 psf of construction load. Neglect shore self-weight. What axial load is assigned to the shore?

- A. 0.9 kips
- B. 3.6 kips
- C. 5.4 kips
- D. 15.0 kips

**85.** A scaffold bay is 12 ft by 8 ft and carries a uniform platform load of 50 psf. If four legs share the load equally, what load from the platform acts on each leg?

- A. 2.40 kips
- B. 4.80 kips
- C. 1.20 kips

D. 0.30 kips

**86.** A temporary diagonal brace must provide a 14-kip horizontal resisting component. If the brace is oriented 35 degrees above horizontal, what axial force magnitude is required?

A. 11.5 kips

B. 17.1 kips

C. 24.4 kips

D. 14.0 kips

**87.** A braced excavation strut receives uniform lateral pressure of 620 psf over a tributary wall panel 9 ft high by 7 ft wide. What axial force is transferred to the strut under this simplified tributary-area model?

A. 19.5 kips

B. 31.0 kips

C. 86.8 kips

D. 39.1 kips

**88.** A temporary timber beam section has moment of inertia  $900 \text{ in.}^4$  and extreme-fiber distance 6 in. If bending moment is 42 kip-ft, what flexural stress magnitude is produced?

A. 3.36 ksi

B. 0.28 ksi

C. 33.60 ksi

D. 2.10 ksi

**89.** A falsework post carries 36 kips through a gross cross-sectional area of  $9 \text{ in.}^2$ . What average compressive stress is produced before considering buckling?

A. 4.0 ksi

B. 324.0 ksi

- C. 0.25 ksi
- D. 9.0 ksi

**90.** A temporary cantilever form bracket carries a concentrated 7.5-kip load 4 ft from its support. What support moment magnitude is produced by that load?

- A. 11.5 kip-ft
- B. 15.0 kip-ft
- C. 30.0 kip-ft
- D. 60.0 kip-ft

**91.** A simplified crane-support model has 100 kips of total vertical load shared by two outrigger lines 12 ft apart, plus a 60-kip-ft overturning moment. What larger outrigger-line reaction results?

- A. 35.0 kips
- B. 65.0 kips
- C. 80.0 kips
- D. 55.0 kips

**92.** A reshoring plan is being developed for a multistory concrete structure. What is the central structural purpose of reshoring?

- A. Permanently replace all columns in the completed building.
- B. Provide temporary support so construction loads are safely distributed while younger slabs continue gaining strength.
- C. Increase fresh-concrete slump by supporting form panels from below.
- D. Eliminate the need to evaluate construction loading on previously cast floors.

**93.** Before placing a heavy mobile crane on a completed floor, what temporary-works check is most important?

- A. Evaluate the crane wheel or outrigger loads and their distribution through the permanent floor system.
- B. Assume the floor can carry the crane because it supports normal occupancy loads.
- C. Check only the crane fuel level because structural capacity is unchanged by equipment position.
- D. Reduce the crane operating radius without evaluating the floor load path.

**94.** A temporary wall brace develops a 48-kip horizontal force acting 7 ft above its base. Two anchors form a resisting couple with 10 ft spacing. Neglecting other effects, what tension-compression couple force magnitude is required?

- A. 24.0 kips
- B. 48.0 kips
- C. 68.6 kips
- D. 33.6 kips

**95.** A temporary material platform is 10 ft by 10 ft and is rated for a uniform construction load of 110 psf. What total uniformly distributed load corresponds to that rating?

- A. 1.1 kips
- B. 10.0 kips
- C. 11.0 kips
- D. 110.0 kips

**96.** A trench is 6 ft deep in soil that is not stable rock. Under OSHA excavation requirements, what is generally required unless a permitted exception applies?

- A. No protective system is needed until the trench exceeds 10 ft deep.
- B. Use an adequate protective system designed for the excavation conditions.
- C. Only a warning line at the edge is required for employee protection.
- D. Protection is optional whenever the trench is less than 20 ft deep.

**97.** Employees are working in a trench that is 5 ft deep. Under OSHA excavation access rules, what arrangement is required for safe egress?

- A. Provide egress only when trench depth exceeds 10 ft.
- B. Place one ladder at any location regardless of lateral travel distance.
- C. Provide a stairway, ladder, ramp, or other safe means so employees need travel no more than 25 ft laterally.
- D. Use a rope only, provided it reaches the bottom of the trench.

**98.** A portable ladder is used to access an upper landing. When the ladder side rails do not otherwise provide equivalent support, how far should they extend above the landing surface under OSHA construction rules?

- A. At least 3 ft above the upper landing surface.
- B. At least 1 ft above the upper landing surface.
- C. Exactly 2 ft above the upper landing surface.
- D. At least 6 ft above the upper landing surface.

**99.** Employees are working on a scaffold platform 12 ft above a lower level. Under OSHA scaffold rules, what condition generally applies?

- A. Fall protection is generally triggered only above 20 ft on scaffolds.
- B. No fall protection is required if the scaffold is supported rather than suspended.
- C. Fall protection is optional whenever guardrails would interfere with production.
- D. Each employee more than 10 ft above a lower level must be protected from falling by the required protection system.

**100.** Excavated spoil is being stored beside a trench. Under OSHA excavation requirements, what minimum setback from the excavation edge is generally required unless retaining devices or another protective method is used?

- A. Keep spoil at least 6 in. from the edge.

- B. Keep excavated material and equipment at least 2 ft from the edge.
- C. Keep spoil at least 1 ft from the edge.
- D. Keep spoil at least 4 ft from the edge in every case.

## Practice Exam 4: Answer Key and Explanations

1. **C** — For level cohesionless backfill, Rankine active pressure uses  $K_a = (1 - \sin \phi) / (1 + \sin \phi)$ . With  $\phi = 31$  degrees,  $\sin \phi$  is about 0.515, giving  $K_a = 0.320$ . A coefficient below one is expected for active pressure; the larger alternatives correspond to omitted friction effects or passive-type behavior. The distractors reflect common unit, sign, or omitted-factor errors.
2. **B** — Total vertical stress is  $120(5) + 130(9) = 1770$  psf. Pore pressure 9 ft below the groundwater table is  $62.4(9) = 561.6$  psf. Effective stress equals total stress minus pore pressure, so  $\sigma' = 1208.4$  psf, reported as 1208 psf. The other choices isolate total stress, pore pressure, or one soil layer. The distractors reflect common unit, sign, or omitted-factor errors.
3. **D** — A uniform surcharge produces constant lateral pressure equal to  $K_a q$ . Here that pressure is  $0.32(350) = 112$  psf over the full 16-ft wall height. The surcharge resultant is therefore  $112(16) = 1792$  lb/ft. Halving the rectangle, omitting  $K_a$ , or reporting pressure instead of resultant produces the distractors. The distractors reflect common unit, sign, or omitted-factor errors.
4. **A** — The loaded footing area is  $8(10) = 80$  square feet. Average contact pressure for a centered axial load is  $P/A$ , so 240 kips divided by 80 square feet equals 3.00 ksf. The distractors result from using one footing dimension, dividing by an incorrect area, or confusing load magnitude with pressure. The distractors reflect common unit, sign, or omitted-factor errors.
5. **B** — For normally consolidated clay, settlement is  $H[C_c / (1 + e_0)] \log_{10}[(\sigma'_0 + \Delta \sigma) / \sigma'_0]$ . Substitution gives  $12[0.18 / 1.68] \log_{10}(3.3 / 2.2) = 0.2264$  ft. Converting feet to inches gives about 2.72 in. The alternatives reflect halving, doubling, or omitting major terms in the consolidation relationship. The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.
6. **D** — For this simplified stability comparison, factor of safety is resisting force divided by driving force. Dividing 275 kips by 165 kips gives 1.667, or 1.67. Reversing the ratio gives 0.60, while subtracting forces or moving a decimal does not produce the required dimensionless ratio of resistance to demand. The distractors reflect common unit, sign, or omitted-factor errors.
7. **C** — Moist and dry unit weights are related by  $\gamma = \gamma_d(1 + w)$ , with water content expressed as a decimal. Therefore  $\gamma_d = 129 / 1.12 = 115.18$  pcf, or 115.2 pcf. Keeping the moist weight unchanged ignores water, multiplying by 1.12 reverses the relationship, and 15.5 pcf treats water percentage as the dry weight. The distractors reflect common unit, sign, or omitted-factor errors.

**8. A** — Hydrostatic pore pressure below a static water surface is  $u = \gamma_w h$ . Multiplying 62.4 pcf by 18 ft gives 1123.2 psf, which rounds to 1123 psf. The smaller alternatives use the wrong depth or unit weight alone, while the larger value applies an unjustified multiplier to the hydrostatic head. The distractors reflect common unit, sign, or omitted-factor errors.

**9. D** — Relative compaction equals field dry density divided by laboratory maximum dry density times 100. The calculation  $118/124(100)$  gives 95.16%, reported as 95.2%. Reversing the ratio gives a value above 100%, subtracting densities gives a pcf difference rather than a percentage, and 92% uses an incorrect denominator. The distractors reflect common unit, sign, or omitted-factor errors.

**10. C** — Height of instrument is benchmark elevation plus backsight:  $315.60 + 4.25 = 319.85$  ft. Subtract the foresight to obtain the new elevation,  $319.85 - 7.10 = 312.75$  ft. The distractors either stop at height of instrument, subtract the foresight directly from the benchmark, or add the foresight instead of subtracting it. The distractors reflect common unit, sign, or omitted-factor errors.

**11. B** — A 1.75% descending grade drops 0.0175 ft per horizontal foot. Over 480 ft, the elevation change is  $0.0175(480) = 8.40$  ft downward. Subtracting from 522.40 ft gives 514.00 ft. Adding the change reverses the grade, while the other choices use an incomplete distance or percentage conversion. The distractors reflect common unit, sign, or omitted-factor errors.

**12. A** — Tangent length for a simple circular curve is  $T = R \tan(\Delta/2)$ . With  $R = 780$  ft and  $\Delta/2 = 18$  degrees,  $T = 780 \tan 18 \text{ degrees} = 253.44$  ft, or 253.4 ft. The distractors correspond to an arc-like calculation, the radius itself, or approximately one-half of the correct tangent length. The distractors reflect common unit, sign, or omitted-factor errors.

**13. B** — Arc length is  $L = \pi R \Delta/180$  when the central angle is in degrees. Substituting 720 ft and 28 degrees gives 351.86 ft, rounded to 351.9 ft. The alternatives represent half the arc, the radius, or a degree-to-radian error that greatly overstates the actual curved distance. The distractors reflect common unit, sign, or omitted-factor errors.

**14. D** — The long chord is  $C = 2R \sin(\Delta/2)$ . With  $R = 540$  ft and  $\Delta/2 = 15$  degrees,  $C = 1,080 \sin 15 \text{ degrees} = 279.52$  ft, or 279.5 ft. Omitting the factor of two gives the smallest choice, while the other distractors confuse chord length with an arc approximation or the radius. The distractors reflect common unit, sign, or omitted-factor errors.

**15. A** — Use  $E_x = E_{PVC} + g_1 x + [(g_2 - g_1)x^2]/(2L)$ . At  $x = 180$  ft, the tangent rise is  $0.02(180) = 3.60$  ft and the parabolic correction is  $-1.575$  ft. Therefore the curve elevation is  $610 + 3.60 - 1.575 = 612.025$  ft, reported as 612.02 ft. The alternatives omit or mis-sign one term. The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.

**16. C** — The coordinate differences are perpendicular components, so the horizontal distance follows the Pythagorean relation. Distance equals  $\sqrt{180^2 + 240^2} = \sqrt{90,000} = 300$  ft. Adding the coordinate differences gives 420 ft, averaging them gives 210 ft, and subtracting them gives 60 ft; none represents the straight-line distance. The distractors reflect common unit, sign, or omitted-factor errors.

**17. C** — The water-cementitious materials ratio is the mass of mixing water divided by the mass of cementitious material. Here  $w/cm = 290/580 = 0.50$ . A value of 2.00 reverses the ratio, while 0.33 and 0.67 result from unrelated proportions. This ratio is dimensionless because both numerator and denominator are masses. The distractors reflect common unit, sign, or omitted-factor errors.

**18. A** — Within the elastic range, Hooke law gives strain  $\epsilon = \sigma/E$ . Dividing 24 ksi by 29,000 ksi gives 0.00082759, reported as 0.000828. The stress units cancel, leaving dimensionless strain. The distractors reflect a decimal shift, reversing the ratio, or treating modulus as though it were a strain value. The distractors reflect common unit, sign, or omitted-factor errors.

**19. B** — Free thermal movement is  $\Delta L = \alpha L \Delta T$ . Convert 40 ft to 480 in., then multiply  $12 \times 10^{-6}$  per degree F by 480 in. by 30 degrees F. The result is 0.1728 in., or 0.173 in. The distractors omit the temperature change, shift a decimal, or mishandle the feet-to-inches conversion.

**20. D** — Bulk unit weight is weight divided by total bulk volume. Dividing 4,650 lb by 30.0 cubic feet gives 155 lb/ft<sup>3</sup>, or 155 pcf. The other choices subtract volume from weight, use an unrelated typical value, or reverse the weight-to-volume ratio and therefore have the wrong magnitude or dimensions. The distractors reflect common unit, sign, or omitted-factor errors.

**21. C** — Board feet equal thickness in inches times width in inches times length in feet divided by 12. Thus  $2(10)(16)/12 = 26.67$  board feet, or 26.7. The distractors omit the divisor, divide twice, or halve the correct quantity. Nominal dimensions are used because the question explicitly specifies rough-sawn board-foot measure. The distractors reflect common unit, sign, or omitted-factor errors.

**22. B** — Compressive stress equals axial load divided by loaded area. Using consistent kip and square-inch units, 78 kips divided by 0.60 in.<sup>2</sup> equals 130 ksi. Multiplying load by area gives 46.8 with incorrect dimensions, 78 ignores area, and 0.13 reverses the load-to-area relationship. The distractors reflect common unit, sign, or omitted-factor errors.

**23. A** — Concrete yield volume equals total batch weight divided by fresh unit weight. Dividing 4,050 lb by 145 lb/ft<sup>3</sup> gives 27.931 ft<sup>3</sup>, reported as 27.93 ft<sup>3</sup>. The 27-ft<sup>3</sup> option assumes exactly one cubic yard without calculation, while the other choices halve the result or multiply weight by unit weight. The distractors reflect common unit, sign, or omitted-factor errors.

**24. D** — Excavation volume is length times width times depth:  $160(24)(6) = 23,040$  ft<sup>3</sup>. Divide by 27 ft<sup>3</sup> per yd<sup>3</sup> to obtain 853.33333333333371228945907205343246 yd<sup>3</sup>, reported as 853 yd<sup>3</sup>. The distractors omit the cubic-foot conversion, use only part of the geometry, or leave the answer in cubic feet. The distractors reflect common unit, sign, or omitted-factor errors.

**25. C** — One footing contains  $12(12)(1.5) = 216$  ft<sup>3</sup>, or  $216/27 = 8.0$  yd<sup>3</sup>. For eight footings, total concrete is  $8(8.0) = 64.0$  yd<sup>3</sup>. The distractors reflect counting only six footings, applying an extra conversion factor, or using the volume of only two footings instead of the complete quantity. The distractors reflect common unit, sign, or omitted-factor errors.

**26. B** — Reinforcing-steel weight is bar length multiplied by unit weight. The calculation is 2,400 ft times 1.502 lb/ft = 3604.8 lb, or approximately 3605 lb. The feet cancel as expected. The distractors

divide instead of multiply, assume 2 lb/ft, or add length numerically to unit weight without preserving dimensions. The distractors reflect common unit, sign, or omitted-factor errors.

**27. D** — Total worker-hours equal crew size times shift duration:  $6(10)=60$  worker-hours. Multiplying by \$42 per worker-hour gives \$2,520. The \$2,100 choice uses only five workers, \$420 prices one worker for one shift hour count incorrectly, and \$25,200 introduces an extra factor of ten beyond the stated labor exposure. The distractors reflect common unit, sign, or omitted-factor errors.

**28. A** — Unit equipment cost equals total equipment cost divided by the quantity produced. Dividing \$1,800 by  $120 \text{ yd}^3$  gives \$15.00 per  $\text{yd}^3$ . The alternatives use unsupported production quantities, shift a decimal, or multiply cost by quantity rather than allocating the shift cost across the completed work. The distractors reflect common unit, sign, or omitted-factor errors.

**29. D** — Break-even quantity equals fixed cost divided by per-unit savings. The savings are \$10 per  $\text{yd}^3$ , so  $\$90,000/\$10=9,000 \text{ yd}^3$ . Below that quantity, the fixed setup cost is not fully recovered. The distractors use only one zero, an unrelated midpoint, or confuse fixed dollars directly with cubic yards. The distractors reflect common unit, sign, or omitted-factor errors.

**30. C** — Present worth of a single future cost is  $P=F/(1+i)^n$ . Substituting  $F=\$50,000$ ,  $i=0.06$ , and  $n=3$  gives  $\$50,000/(1.06)^3=\$41,980.96$ , or about \$41,981. The larger option compounds forward instead of discounting, while the other choices use incorrect discount periods or divide by years directly. The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.

**31. B** — Cost performance index is  $\text{CPI}=\text{EV}/\text{AC}$ . Dividing \$180,000 by \$200,000 gives 0.90. A CPI below 1.0 indicates cost inefficiency because the project earned less budgeted value than it spent. The 1.11 option reverses the ratio, 0.10 uses the cost difference, and 1.90 adds rather than compares the values. The distractors reflect common unit, sign, or omitted-factor errors.

**32. A** — Average production rate equals completed quantity divided by productive time. Dividing  $720 \text{ yd}^3$  by 9 hours gives  $80 \text{ yd}^3/\text{hr}$ . The  $90\text{-yd}^3/\text{hr}$  option assumes eight hours, 6,480 multiplies quantity by time, and 8 reverses the ratio. Rate units must be quantity per unit time, which confirms the calculation direction. The distractors reflect common unit, sign, or omitted-factor errors.

**33. B** — Project duration in a basic CPM network is governed by the longest start-to-finish path because that path has zero total float at the current logic. Among 21, 26, and 24 days, the 26-day path controls completion. Adding all path durations double-counts parallel work, while selecting a shorter path ignores the activity chain that finishes last.

**34. C** — Under the convention stated in the question, early finish equals early start plus duration. Therefore  $\text{EF}=7+9=16$ . The alternatives use the duration alone, apply an inclusive-day convention that the stem explicitly excludes, or multiply start and duration. Reading the schedule convention carefully prevents an otherwise common one-day ambiguity in CPM questions.

**35. A** — Total float may be computed as  $\text{LS}-\text{ES}$  when the schedule uses consistent date conventions. Here  $18-14=4$  days. That means the activity can slip four days without delaying the project completion

implied by the current network. Adding the dates, or reporting either start date by itself, does not measure schedule flexibility.

**36. D** — Crash cost slope is the increase in direct cost divided by the time reduction. Cost rises by \$18,000 and duration decreases by 3 days, so the slope is  $\$18,000/3 = \$6,000$  per day saved. The distractors use the total cost increase, an incorrect duration difference, or divide the crash cost itself by three.

**37. A** — PERT expected time is  $(a+4m+b)/6$ . Substituting 5, 8, and 17 gives  $(5+32+17)/6 = 54/6 = 9.0$  days. The 10-day value is a simple average of extremes, 8 days uses the most-likely estimate alone, and 7.5 days results from an incorrect weighting of the three estimates. The distractors reflect common unit, sign, or omitted-factor errors.

**38. B** — Resource leveling adjusts activity timing to reduce peaks or resolve conflicts while respecting logic and available float. Shifting one noncritical activity within its float can remove the crew overlap without necessarily extending project completion. The other actions either alter network logic unnecessarily, misclassify criticality, or add cost without first using the schedule flexibility already available.

**39. D** — The required time offset equals the required spatial separation divided by the leading crew production rate. Dividing 600 ft by 75 ft/day gives 8 days. Starting sooner would violate the specified 600-ft separation. The distractors use unsupported production rates or multiply distance by rate, producing units that are not days.

**40. C** — A delay that is smaller than available total float consumes float before it affects project completion. Starting with 3 days and using 2 days leaves 1 day of total float, so the current completion date remains unchanged. The other choices ignore float, reverse the direction of delay, or add the delay to float instead of subtracting it.

**41. D** — A finish-to-start relationship means the successor cannot begin until the predecessor finishes, which exactly matches the stated requirement. Start-to-start controls when activities may begin relative to one another, finish-to-finish controls completion timing, and start-to-finish is a less common relationship in which predecessor start constrains successor finish rather than successor start.

**42. B** — Schedule performance index is  $SPI = EV/PV$ . Dividing \$150,000 by \$165,000 gives 0.909, reported as 0.91. Because SPI is below 1.0, earned progress is behind the planned value at the status date. Reversing the ratio gives about 1.10, while the other choices use the difference or sum incorrectly. The distractors reflect common unit, sign, or omitted-factor errors.

**43. C** — The arithmetic average is the sum of the three results divided by three. Their sum is 12,360 psi, so the average is  $12,360/3 = 4120$  psi. The lower and upper alternatives are individual test values rather than the mean, and 12,360 psi is the unaveraged total. Averaging retains the same stress units.

**44. A** — Slump adjustment must remain within the approved mixture, specification, and project procedures because uncontrolled water addition changes the water-cementitious ratio and can affect strength and durability. Automatic rejection may be unnecessary if an authorized adjustment is allowed.

Post hoc moisture edits do not correct the delivered batch. Documentation and controlled adjustment protect both quality and traceability.

**45. B** — Percent compaction is field dry density divided by laboratory maximum dry density times 100. The calculation  $121/126(100)$  gives 96.03%, reported as 96.0%. Reversing the ratio produces a value above 100%, subtracting gives only a 5-pcf density difference, and 92.5% uses an incorrect reference maximum. The distractors reflect common unit, sign, or omitted-factor errors.

**46. A** — Density percentage is measured density divided by the reference density times 100. Thus  $148/153(100)=96.73\%$ , or 96.7%. Reversing the ratio gives a percentage above 100%, subtracting densities gives 5 pcf rather than a percentage, and 93.0% results from using a different reference value than the one stated. The distractors reflect common unit, sign, or omitted-factor errors.

**47. D** — The simple maturity index sums  $(T-T_{\text{datum}})\Delta t$  for each interval. The first interval contributes  $(70-32)(10)=380$  degree-F-hours and the second contributes  $(80-32)(8)=384$ . Their total is 764 degree-F-hours. The distractors omit one interval, use absolute temperatures without subtracting the datum, or multiply only one temperature difference by total time. The distractors reflect common unit, sign, or omitted-factor errors.

**48. C** — Pretensioned bolted connections require an installation method capable of producing the specified bolt tension, with inspection tied to that approved method. Head appearance alone does not establish tension, plate thickness does not measure bolt force, and arbitrary torque ignores method calibration and installation variables. Quality control therefore focuses on verified procedure execution rather than a superficial visual condition.

**49. B** — Liquid penetrant testing uses a low-viscosity penetrant that enters surface-breaking discontinuities and is then drawn out by developer for visual indication. Radiography can reveal internal weld features but is not defined by surface liquid action. Rebound-hammer and nuclear-density methods evaluate concrete and soil or asphalt properties, not weld surface discontinuities.

**50. D** — A three-sigma upper control limit is centerline plus three standard deviations. Therefore  $UCL=50+3(4)=62$  units. The 54-unit choice adds only one sigma, 58 adds two sigma, and 150 multiplies the centerline by three rather than applying statistical dispersion around the process mean. The distractors reflect common unit, sign, or omitted-factor errors.

**51. A** — Proper internal vibration consolidates fresh concrete by reducing entrapped air and helping the mixture flow around reinforcement and into form corners. It is not a means to add water, induce segregation, or substitute for structurally adequate forms. Excessive or improper vibration can cause defects, so the objective is controlled consolidation rather than simply maximizing vibration time.

**52. C** — Cylinder area is  $\pi d^2/4=\pi(6^2)/4=28.274333882308138043981671217 \text{ in.}^2$ . Convert 160 kips to 160,000 lb and divide by the area, giving 5658.8 psi, reported as 5659 psi. The distractors use half the load, double the stress, or report the cross-sectional area as though it were strength. The distractors reflect common unit, sign, or omitted-factor errors.

**53. B** — The load is centered because it acts 11 ft along a 22-ft span, so symmetry divides the 48-kip load equally between the two supports. Each reaction is 24 kips. The 48-kip choice is the total load, 11 kips confuses distance with force, and 96 kips doubles the applied load. The distractors reflect common unit, sign, or omitted-factor errors.

**54. A** — For a simply supported beam with full-span uniform load, maximum moment is  $wL^2/8$ . Substituting 1.8 kip/ft and 24 ft gives  $1.8(24^2)/8=129.6$  kip-ft. The distractors omit the division by eight, use total load times half-span incorrectly, or double the correct moment. The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.

**55. C** — A cantilever with a point load at the free end develops fixed-end moment  $PL$ . Multiplying 18 kips by 9 ft gives 162 kip-ft. The 18-kip-ft choice ignores the lever arm, 81 uses the span squared without the load, and 324 introduces an unnecessary factor of two beyond force times distance.

**56. D** — Average axial stress is  $P/A$ . With load in kips and area in square inches, the result is directly in ksi:  $72/12=6.0$  ksi. Multiplying load by area gives 864 with incorrect dimensions, reversing the ratio gives 0.17, and 12 ksi merely repeats the cross-sectional area numerically rather than computing stress. The distractors reflect common unit, sign, or omitted-factor errors.

**57. A** — Convert moment to kip-inches:  $84(12)=1,008$  kip-in. Then  $\sigma=Mc/I=1,008(7)/1,764=4.000$  ksi, reported as 4.0 ksi. The alternatives omit the feet-to-inches conversion, shift a decimal, or use an incorrect section-property combination. Consistent inch-based units are essential because  $I$  is given in  $\text{in.}^4$ . The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.

**58. D** — Axial deformation is  $\delta=PL/(AE)$ . Convert 14 ft to 168 in., then use 95 kips,  $5.5 \text{ in.}^2$ , and 29,000 ksi. The result is  $95(168)/[5.5(29,000)]=0.10006 \text{ in.}$ , or 0.100 in. The distractors reflect omitted length conversion, decimal shifts, or an incorrect area in the denominator. The distractors reflect common unit, sign, or omitted-factor errors.

**59. B** — Tributary area is  $18(22)=396 \text{ ft}^2$ . Multiplying by 125 psf gives 49,500 lb, which equals 49.5 kips. The 39.6-kip choice treats area as load after a scale change, 9.9 kips uses only a fraction of the tributary area, and 396 kips confuses square feet with kips. The distractors reflect common unit, sign, or omitted-factor errors.

**60. C** — Linear normal stresses superimpose algebraically. Because both stated contributions are compressive at the same fiber, their magnitudes add:  $6.0+4.5=10.5$  ksi compression. Subtraction would apply where bending opposes the axial stress. Multiplication is not a valid superposition rule, and changing the sign contradicts the stated compression directions. The distractors reflect common unit, sign, or omitted-factor errors.

**61. D** — Total uniform load is  $wL=2.2(28)=61.6$  kips. Symmetric loading divides that total equally between the two simple supports, so each reaction is  $61.6/2=30.8$  kips. The larger choice is total load,

15.4 divides by four, and 2.2 reports the load intensity rather than a support force. The distractors reflect common unit, sign, or omitted-factor errors.

**62. C** — The stated projected bearing area is  $3(0.75)=2.25 \text{ in.}^2$ . Average bearing stress is load divided by projected area, so  $60/2.25=26.67 \text{ ksi}$ , reported as 26.7 ksi. The distractors use width alone, ignore area completely, or divide only by thickness. The given simplified area definition controls this calculation. The distractors reflect common unit, sign, or omitted-factor errors.

**63. A** — Apply the Rational Method form stated in the question:  $Q=CiA$ . Multiplying  $0.78(3.5)(8)$  gives 21.84 cfs, reported as 21.8 cfs. The 28-cfs alternative omits the runoff coefficient, while the smaller choices omit the drainage area or combine the factors in the wrong order. The distractors reflect common unit, sign, or omitted-factor errors.

**64. B** — Continuity gives  $Q=VA$ , so average velocity is  $V=Q/A$ . Dividing  $18 \text{ ft}^3/\text{s}$  by  $6.0 \text{ ft}^2$  gives 3.0 ft/s. The units reduce correctly to feet per second. Multiplying flow by area gives 108 with incorrect dimensions, reversing the ratio gives 0.33, and 12 uses no valid continuity relationship. The distractors reflect common unit, sign, or omitted-factor errors.

**65. A** — Flow area is  $A=by=10(2.5)=25 \text{ ft}^2$ . Wetted perimeter is  $P=b+2y=10+5=15 \text{ ft}$ . Therefore hydraulic radius is  $R=A/P=25/15=1.667 \text{ ft}$ , or 1.67 ft. The alternatives report depth, area, or use an incorrect perimeter. Hydraulic radius is area divided by wetted perimeter, not geometric radius. The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.

**66. C** — Four inches equals  $4/12=0.3333 \text{ ft}$  of rainfall depth. Over 7 acres, rainfall volume is  $7(0.3333)=2.333 \text{ acre-ft}$ . Applying the 65% runoff fraction gives 1.5167 acre-ft, reported as 1.52 acre-ft. The distractors assume all rainfall runs off, use only the coefficient, or multiply inches and acres without converting depth. The distractors reflect common unit, sign, or omitted-factor errors.

**67. B** — Net storage rate is inflow minus outflow:  $42-27=15 \text{ cfs}$ . Forty-five minutes equals 2,700 seconds. Storage accumulation is therefore  $15 \text{ ft}^3/\text{s}$  times 2,700 s = 40,500  $\text{ft}^3$ . The distractors use inflow alone, outflow alone, or fail to convert minutes to seconds before multiplying by a cubic-foot-per-second rate. The distractors reflect common unit, sign, or omitted-factor errors.

**68. D** — Convert 750 gpm to about 1.671 cfs. Hydraulic power is  $\gamma QH=62.4(1.671)(55)$ , then divide by 550 ft-lb/s per horsepower. This gives about 10.43 hp, reported as 10.4 hp. The distractors use incorrect flow conversion, ignore the horsepower conversion, or report water unit weight rather than power. The distractors reflect common unit, sign, or omitted-factor errors.

**69. A** — Expected production equals bucket capacity times fill factor times cycles per hour times job efficiency. The calculation is  $2.25(0.88)(26)(0.82)=42.214 \text{ yd}^3/\text{hr}$ , reported as 42.2. Omitting job efficiency gives the larger alternative, misapplying fill gives another value, and halving the verified rate produces the smallest distractor. The distractors reflect common unit, sign, or omitted-factor errors.

**70. C** — Total truck cycle time is the sum of all recurring cycle components: loading, loaded travel, dumping, and return travel. Adding  $6+16+4+13$  gives 39 minutes. The 33-minute option omits loading,

29 minutes omits more than one component, and 52 minutes adds time not stated in the operating sequence. The distractors reflect common unit, sign, or omitted-factor errors.

**71. D** — One truck completes  $60/39=1.5385$  cycles per hour and moves  $12 \text{ yd}^3$  per cycle, or  $18.46 \text{ yd}^3/\text{hr}$ . Five trucks therefore move  $92.31 \text{ yd}^3/\text{hr}$ , reported as 92.3. The smallest option is one truck only, while 60 and 120 assume unsupported cycle rates rather than using the stated 39 minutes. The distractors reflect common unit, sign, or omitted-factor errors.

**72. B** — Required productive time equals total quantity divided by sustained production rate. Dividing  $5,250 \text{ yd}^3$  by  $350 \text{ yd}^3/\text{hr}$  gives 15 hours. The cubic-yard units cancel, leaving hours. The 12- and 18-hour choices imply different production rates, while multiplying quantity and rate produces a meaningless value with incompatible units. The distractors reflect common unit, sign, or omitted-factor errors.

**73. C** — Load moment equals lifted force multiplied by the horizontal operating radius. Therefore  $22 \text{ kips} \times 38 \text{ ft}=836 \text{ kip-ft}$ . Adding force and radius gives 60 with meaningless units, halving the radius effect gives  $418 \text{ kip-ft}$ , and 1,672 doubles the correct moment. The moment calculation uses the perpendicular horizontal lever arm. The distractors reflect common unit, sign, or omitted-factor errors.

**74. D** — For a symmetric two-leg sling, the vertical components of the two leg tensions support the load:  $2T \cos 50^\circ=18 \text{ kips}$ . Solving gives  $T=18/[2 \cos 50]=14.00 \text{ kips}$ , or 14.0 kips. Nine kips ignores sling angle, while the other choices use incorrect trigonometric relationships or component directions. The distractors reflect common unit, sign, or omitted-factor errors.

**75. A** — Pumping time equals stored volume divided by pump rate when inflow is zero. Dividing 180,000 gallons by 900 gallons per minute gives 200 minutes. The gallon units cancel. The 150- and 300-minute distractors use different effective pump rates, while 162,000 results from multiplication rather than dividing volume by discharge rate.

**76. B** — Eight productive hours equal 480 minutes. At 24 minutes per pile, expected production is  $480/24=20$  piles. The 8-pile alternative confuses hours with pile count, 12 assumes 40 minutes per pile, and 192 multiplies hours by minutes per pile. Time per unit must be inverted to obtain units per available time.

**77. A** — A 22% swell means loose volume is bank volume multiplied by 1.22. Thus  $3,200(1.22)=3,904$  loose  $\text{yd}^3$ . Multiplying by 0.82 would incorrectly shrink the material, keeping 3,200 ignores swell, and 704 is only the incremental swell volume rather than the total hauled loose quantity. The distractors reflect common unit, sign, or omitted-factor errors.

**78. D** — Each truck requires a fleet inventory equal to production rate times cycle time divided by truck capacity. During 46 minutes, the loader produces  $140(46/60)=107.33 \text{ yd}^3$ . Dividing by  $14 \text{ yd}^3$  per truck gives 7.67 trucks, so at least 8 whole trucks are needed. Rounding down would leave the loader waiting. The distractors reflect common unit, sign, or omitted-factor errors.

**79. B** — Placement duration equals total volume divided by sustained placing rate. Dividing  $540 \text{ yd}^3$  by  $72 \text{ yd}^3/\text{hr}$  gives 7.50 hours, or 7.5 hours. The 6.0- and 8.5-hour choices imply different production

rates, while multiplying volume by rate produces an extremely large number with units that are not time. The distractors reflect common unit, sign, or omitted-factor errors.

**80. C** — At continuous operation,  $3.5 \text{ yd}^3/\text{min}$  corresponds to  $3.5(60)=210 \text{ yd}^3/\text{hr}$ . Applying 75% effective utilization gives  $210(0.75)=157.5 \text{ yd}^3/\text{hr}$ . The 210 choice ignores utilization, 105 applies a 50% factor, and 2.6 multiplies by utilization without converting minutes to hours. The distractors reflect common unit, sign, or omitted-factor errors. Checking dimensions and expected magnitude provides a useful exam-day reasonableness check.

**81. A** — A compacted-volume factor of 0.88 means the final volume is 88% of the loose volume. Multiplying 2,600 by 0.88 gives 2,288 compacted  $\text{yd}^3$ . Dividing by 0.88 would increase volume instead of shrinking it, leaving 2,600 ignores compaction, and 312 represents only the volume reduction rather than the final compacted quantity.

**82. B** — For uniform pressure, resultant force per foot of wall equals pressure times height times one-foot tributary width. Thus  $900 \text{ psf}(12 \text{ ft})(1 \text{ ft})=10,800 \text{ lb/ft}=10.8 \text{ kips/ft}$ . The 5.4-kip choice incorrectly halves a rectangular pressure diagram, 0.9 reports pressure as force, and 108 shifts the unit conversion by a factor of ten. The distractors reflect common unit, sign, or omitted-factor errors.

**83. D** — One tie supports tributary area  $2.5(3.0)=7.5 \text{ ft}^2$ . Multiplying by 850 psf gives 6,375 lb, or 6.375 kips, reported as 6.38 kips. The distractors use only one spacing dimension, treat pressure as tie load directly, or multiply by an incorrect tributary area. The distractors reflect common unit, sign, or omitted-factor errors.

**84. C** — Tributary area is  $6(6)=36 \text{ ft}^2$ . Multiplying by 150 psf gives 5,400 lb, which equals 5.4 kips. The 0.9-kip choice uses one dimension only, 3.6 confuses area with load after scaling, and 15.0 kips moves the decimal. Tributary load follows area times pressure before unit conversion. The distractors reflect common unit, sign, or omitted-factor errors.

**85. C** — Total platform load is  $12(8)(50)=4,800 \text{ lb}$ , or 4.8 kips. With four equally loaded legs, each carries  $4.8/4=1.20 \text{ kips}$ . The 1.20-kip value would be correct only if the total were 4.8 and divided improperly after unit conversion, while 4.80 is the full bay load and 0.30 undercounts area. The distractors reflect common unit, sign, or omitted-factor errors.

**86. B** — The horizontal component of brace force is  $F \cos 35$  degrees. Setting  $F \cos 35=14 \text{ kips}$  gives  $F=14/\cos 35=17.09 \text{ kips}$ , or 17.1 kips. Multiplying by cosine gives the smaller choice, using sine gives the larger choice, and 14 kips ignores that only the horizontal component of the inclined brace resists the load. The distractors reflect common unit, sign, or omitted-factor errors.

**87. D** — Tributary wall area is  $9(7)=63 \text{ ft}^2$ . Multiplying by 620 psf gives 39,060 lb, or 39.06 kips, reported as 39.1 kips. The distractors halve the load as though pressure were triangular, round to the full wall pressure incorrectly, or multiply by an unsupported factor. The stem specifies uniform pressure. The distractors reflect common unit, sign, or omitted-factor errors.

**88. A** — Convert 42 kip-ft to 504 kip-in. Then apply  $\sigma=Mc/I=504(6)/900=3.360 \text{ ksi}$ , reported as 3.36 ksi. The smallest alternative omits the feet-to-inches conversion, the largest shifts the decimal, and

2.10 uses an incorrect section property. Consistent inch units are necessary because  $I$  is in  $\text{in.}^4$ . The distractors reflect common unit, sign, or omitted-factor errors.

**89. A** — Average axial compressive stress is  $P/A$ . Using 36 kips and  $9 \text{ in.}^2$  gives  $36/9=4.0$  ksi. Multiplication gives 324 with incorrect dimensions, reversing the ratio gives 0.25, and 9 ksi repeats the area numerically. The question asks only average stress; stability and buckling checks would be separate design considerations. The distractors reflect common unit, sign, or omitted-factor errors.

**90. C** — Cantilever support moment from a concentrated load is force times perpendicular lever arm. Multiplying 7.5 kips by 4 ft gives 30.0 kip-ft. Adding force and distance gives 11.5 with meaningless units, doubling only the load gives 15, and 60 doubles the correct moment. The support must resist the full PL moment.

**91. D** — For two support lines, the symmetric vertical load contributes  $100/2=50$  kips to each. The overturning moment changes reactions by  $M/s=60/12=5$  kips, so the larger reaction is  $50+5=55.0$  kips. The smaller line would carry 45 kips. The distractors omit or overstate the moment-induced reaction shift. The distractors reflect common unit, sign, or omitted-factor errors.

**92. B** — Reshoring supplies temporary vertical support after original shores or forms are removed, helping distribute construction loads through floors that may still be developing strength. It is not permanent framing, does not control concrete slump, and does not eliminate the need to evaluate load paths. A reshoring plan depends on construction sequence, slab strength, and load transfer.

**93. A** — Construction equipment can impose concentrated loads that differ greatly from normal occupancy loading, so the permanent floor must be checked for wheel or outrigger reactions and the resulting load path. Occupancy rating alone is not enough. Fuel level and operating radius may affect crane behavior, but neither substitutes for evaluating how temporary construction loads enter the structure.

**94. D** — Overturning moment is  $48(7)=336$  kip-ft. A resisting couple with 10-ft spacing requires force  $F$  such that  $F(10)=336$ , giving  $F=33.6$  kips. The 33.6-kip value would correspond to a slightly different spacing, 48 kips ignores the moment arm, and 68.6 kips overstates the required couple force. The distractors reflect common unit, sign, or omitted-factor errors.

**95. C** — Platform area is  $10(10)=100 \text{ ft}^2$ . Multiplying by 110 psf gives 11,000 lb, or 11.0 kips. The 1.1-kip choice loses a factor of ten, 10.0 kips assumes 100 psf instead of 110 psf, and 110 kips confuses the pressure number with total load after conversion. The distractors reflect common unit, sign, or omitted-factor errors.

**96. B** — OSHA 29 CFR 1926.652(a)(1) generally requires employees in excavations to be protected from cave-ins by an adequate protective system, except when the excavation is entirely in stable rock or is less than 5 ft deep and a competent person finds no cave-in indication. A 6-ft trench therefore exceeds that depth exception.

**97. C** — OSHA 29 CFR 1926.651(c)(2) requires a stairway, ladder, ramp, or other safe means of egress in trench excavations 4 ft or more deep, located so employees need no more than 25 ft of lateral travel.

A 5-ft trench therefore triggers the rule, and location matters rather than merely providing one distant ladder.

**98. A** — OSHA 29 CFR 1926.1053(b)(1) requires ladder side rails used for access to an upper landing to extend at least 3 ft above that landing. When such extension is not possible because of ladder length, the ladder must be secured and a grasping device provided. The rule therefore uses a 3-ft benchmark, not 1, 2, or 6 ft.

**99. D** — OSHA 29 CFR 1926.451(g)(1) generally requires each employee on a scaffold more than 10 ft above a lower level to be protected from falling to that lower level. The required system depends on scaffold type and circumstances. A 12-ft platform is above the threshold, so supported-scaffold status or production convenience does not remove the protection requirement.

**100. B** — OSHA 29 CFR 1926.651(j)(2) requires employees to be protected from excavated or other materials or equipment that could fall or roll into excavations. Protection includes placing and keeping such material or equipment at least 2 ft from the edge, or using retaining devices sufficient to prevent entry. The general setback is therefore 2 ft.