

PRACTICE EXAM 7: CONSTRUCTION CIVIL PE SIMULATION (100 QUESTIONS)

This extended practice exam contains 100 questions for Construction Civil PE preparation. The current NCEES PE Civil: Construction exam is computer-based, contains 80 questions, and has a 9-hour appointment including tutorial and optional scheduled break. NCEES does not publish a fixed passing score. Work every question and use the answer explanations for review after completing the simulation.

1. A temporary working pad consists of 4 ft of soil weighing 118 pcf over 6 ft of soil weighing 124 pcf. Ignoring pore-water effects, what is the total vertical stress at the bottom of the 10-ft profile?

- A. 0.744 ksf
- B. 1.240 ksf
- C. 2.432 ksf
- D. 1.216 ksf

2. At a site, the groundwater table is 5 ft below grade. Soil above the water table weighs 115 pcf, and saturated soil below it weighs 120 pcf. What is the effective vertical stress 12 ft below grade? Use the unit weight of water as 62.4 pcf.

- A. 0.806 ksf
- B. 0.978 ksf
- C. 1.415 ksf
- D. 0.403 ksf

3. A vertical retaining wall supports level, drained sand with an effective friction angle of 32 degrees. Using Rankine theory with zero wall friction, what active earth-pressure coefficient K_a should be used?

- A. 0.307
- B. 0.438

- C. 0.529
- D. 0.694

4. A 14-ft-high temporary retaining wall is designed with $K_a = 0.33$ and soil unit weight 120 pcf. Neglect surcharge and water. What is the resultant active soil force per foot of wall?

- A. 1.940 kip/ft
- B. 7.762 kip/ft
- C. 3.881 kip/ft
- D. 4.620 kip/ft

5. An 8-ft clay layer has $e_0 = 0.82$ and $C_c = 0.22$. The initial effective stress is 1.5 ksf, and a new fill increases stress by 1.0 ksf. Using one-dimensional primary consolidation, what settlement is estimated?

- A. 1.287 in.
- B. 4.162 in.
- C. 6.522 in.
- D. 2.574 in.

6. A footing analysis gives an ultimate bearing capacity of 9.6 ksf. If the required factor of safety against bearing failure is 3.0, what allowable bearing pressure should be used?

- A. 3.2 ksf
- B. 2.4 ksf
- C. 6.6 ksf
- D. 28.8 ksf

7. For a trial slope surface, the summed resisting moment is 425 kip-ft and the summed driving moment is 285 kip-ft. What factor of safety against rotational sliding does this trial surface have?

- A. 0.671

- B. 1.491
- C. 1.140
- D. 2.982

8. A 10-ft wall retains soil with $\gamma = 115$ pcf and $K_a = 0.30$. A uniform surface surcharge of 250 psf acts behind the wall. What total active resultant per foot of wall includes both soil and surcharge?

- A. 1.725 kip/ft
- B. 0.750 kip/ft
- C. 2.475 kip/ft
- D. 3.225 kip/ft

9. A field density test gives a dry density of 116.5 pcf. The laboratory maximum dry density for the same material is 121.0 pcf. What relative compaction was achieved?

- A. 96.28%
- B. 92.45%
- C. 103.86%
- D. 4.50%

10. A temporary haul-road centerline begins at elevation 642.35 ft and falls at a constant 2.2% grade for 180 ft. What is the centerline elevation at the end of the run?

- A. 646.31 ft
- B. 638.75 ft
- C. 638.39 ft
- D. 641.95 ft

11. A simple circular horizontal curve has radius 650 ft and central angle 38 degrees. What is the tangent length T from the point of intersection to the PC or PT?

- A. 205.86 ft
- B. 223.81 ft
- C. 430.00 ft
- D. 111.94 ft

12. A simple circular curve has radius 720 ft and central angle 46 degrees. What is the arc length of the curve?

- A. 289.03 ft
- B. 920.00 ft
- C. 462.22 ft
- D. 578.05 ft

13. For a simple circular curve with radius 500 ft and central angle 32 degrees, what is the long chord between the PC and PT?

- A. 551.27 ft
- B. 275.64 ft
- C. 137.82 ft
- D. 279.25 ft

14. Two control points are 520 ft apart horizontally. The second point is 7.8 ft higher than the first. What is the average grade between the points?

- A. 0.67%
- B. 6.67%
- C. 15.00%
- D. 1.50%

15. A survey line is 240 ft long on a bearing of N35 degrees E. What is the eastward departure of the line?

- A. 137.66 ft
- B. 196.60 ft
- C. 84.00 ft
- D. 240.00 ft

16. A survey crew sets up over a benchmark at elevation 388.62 ft and reads a 5.14-ft backsight. The next point must be set at elevation 390.08 ft. What foresight rod reading will establish that elevation?

- A. 2.46 ft
- B. 4.60 ft
- C. 3.68 ft
- D. 8.82 ft

17. A concrete mix will contain 312 lb of mixing water per batch. The specified maximum water-cementitious materials ratio is 0.48. What minimum cementitious-material mass is required if all 312 lb of water is counted?

- A. 624 lb
- B. 150 lb
- C. 650 lb
- D. 792 lb

18. A concrete batch has a total batched mass of 14,850 lb and a measured fresh unit weight of 148.5 pcf. What concrete yield does the batch produce?

- A. 3.704 yd³
- B. 2.694 yd³
- C. 4.000 yd³
- D. 100.000 yd³

19. A 3.00-yd³ concrete sample volume includes 0.135 yd³ of entrained air. What is the air content by volume?

- A. 0.45%
- B. 13.50%
- C. 22.22%
- D. 4.50%

20. A pile cap contains nine reinforcing bars, each with a specified cross-sectional area of 0.79 in^2 . What is the total steel area provided by the bars?

- A. 6.32 in^2
- B. 7.11 in^2
- C. 8.90 in^2
- D. 0.09 in^2

21. A steel tie rod carries 42 kips in tension. The rod is 12 ft long, has area 2.4 in^2 , and $E = 29,000 \text{ ksi}$. What elastic elongation is expected?

- A. 0.043 in.
- B. 0.174 in.
- C. 0.087 in.
- D. 1.043 in.

22. A wood specimen weighs 57 lb before oven drying and 50 lb after oven drying. What is its moisture content based on oven-dry mass?

- A. 12.28%
- B. 14.00%
- C. 7.00%
- D. 114.00%

23. An aggregate sample weighs 100.0 g oven dry and 102.4 g in saturated-surface-dry condition. What is the aggregate absorption?

- A. 2.34%
- B. 0.24%
- C. 102.40%
- D. 2.40%

24. A utility trench is 420 ft long, 5.5 ft wide, and 8 ft deep with vertical sides. What is the in-place excavation quantity, neglecting swell?

- A. 684.44 yd³
- B. 228.15 yd³
- C. 2053.33 yd³
- D. 739.20 yd³

25. Twelve isolated equipment pads are each 8 ft by 8 ft by 1.75 ft thick. What total concrete volume is required before adding waste?

- A. 4.15 yd³
- B. 597.33 yd³
- C. 56.89 yd³
- D. 49.78 yd³

26. A paving area is 1,800 yd². Asphalt will be placed 4 in. thick at a compacted density of 145 pcf. What asphalt tonnage is required, neglecting waste?

- A. 130.50 tons
- B. 783.00 tons
- C. 391.50 tons
- D. 435.00 tons

27. An earthwork crew costs \$1,860 per working day and averages 155 bank cubic yards of accepted excavation per day. What is the direct crew cost per bank cubic yard?

- A. \$12.00/BCY
- B. \$8.33/BCY
- C. \$15.50/BCY
- D. \$288.30/BCY

28. A bid includes 325 linear feet of pipe at \$18.00 per installed foot. The estimator adds 7% for waste and cutting loss to the quantity. What material-and-installation cost is carried for this item?

- A. \$5,850.00
- B. \$6,259.50
- C. \$6,697.67
- D. \$438.50

29. A rehabilitation alternative will require a single \$125,000 expenditure four years from now. Using a 6% annual discount rate, what is the present value of that future cost?

- A. \$125,000
- B. \$74,250
- C. \$157,812
- D. \$99,012

30. Method A has a \$18,000 mobilization cost plus \$85 per operating hour. Method B has a \$30,000 mobilization cost plus \$65 per hour. At how many operating hours are the total costs equal?

- A. 600 hr
- B. 400 hr
- C. 750 hr
- D. 240 hr

31. At the status date, earned value is \$540,000. Management wants a cost performance index of exactly 0.90. What actual cost would correspond to that CPI at the same earned value?

- A. \$486,000
- B. \$594,000
- C. \$600,000
- D. \$60,000

32. A four-person crew installs 960 linear feet of conduit during a 10-hour shift. What labor productivity was achieved in linear feet per labor-hour?

- A. 96.0 LF/labor-hr
- B. 24.0 LF/labor-hr
- C. 2.4 LF/labor-hr
- D. 240.0 LF/labor-hr

33. A CPM network has three start-to-finish paths with activity durations: A-D-F = 3 + 6 + 4 days, B-E-F = 5 + 5 + 4 days, and C-E-F = 4 + 5 + 4 days. What is the project duration?

- A. 13 days
- B. 12 days
- C. 14 days
- D. 18 days

34. An activity has ES = day 8, EF = day 14, LS = day 11, and LF = day 17. What is its total float?

- A. 6 days
- B. 3 days
- C. 9 days
- D. 0 days

35. An activity finishes early on day 9. Its two immediate successors have early starts on days 12 and 15. What is the activity's free float?

- A. 3 days
- B. 6 days
- C. 12 days
- D. 0 days

36. A scheduler models a weather-sensitive activity with optimistic time 5 days, most-likely time 8 days, and pessimistic time 17 days. Using the PERT weighted estimate, what duration should be carried in the network?

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

37. For a PERT activity, the optimistic duration is 3 days and the pessimistic duration is 15 days. What is the activity variance?

- A. 2.0 days²
- B. 4.0 days²
- C. 12.0 days²
- D. 144.0 days²

38. A scheduler is evaluating acceleration of a concrete-deck activity. Direct cost rises from \$31,500 to \$38,700 when duration is reduced from 9 days to 6 days. What incremental direct cost is paid for each day saved?

- A. \$800/day
- B. \$1,050/day
- C. \$7,200/day
- D. \$2,400/day

39. A critical activity can be shortened by up to 2 days at \$1,000 per day. Another critical activity can be shortened by 1 day at \$1,800 per day. If the project must be shortened exactly 2 days, what is the minimum added direct cost?

- A. \$1,800
- B. \$2,800
- C. \$2,000
- D. \$3,600

40. Crew demand is 5 workers for Activity A on days 1-4, 4 workers for Activity B on days 3-6, and 3 workers for Activity C on days 5-7. What is the peak simultaneous crew demand?

- A. 9 workers
- B. 12 workers
- C. 8 workers
- D. 7 workers

41. A 20-day activity is planned to progress linearly. After 8 days, field measurement shows 35% complete. By how many percentage points is actual progress behind the linear plan?

- A. 35.0 percentage points
- B. 40.0 percentage points
- C. 12.5 percentage points
- D. 5.0 percentage points

42. A linear paving operation must place 3,600 ft of pavement. The planned production rate is 450 ft per working day. What planned duration is required?

- A. 6.0 days
- B. 9.0 days
- C. 8.0 days
- D. 16.0 days

43. Four concrete cylinders from one placement test at 4,250, 4,410, 4,330, and 4,370 psi. What is the arithmetic mean compressive strength?

- A. 4,340 psi
- B. 4,250 psi
- C. 4,370 psi
- D. 17,360 psi

44. A production process has mean test strength 4,500 psi and standard deviation 225 psi. What is the coefficient of variation?

- A. 20.00%
- B. 5.00%
- C. 4.72%
- D. 0.05%

45. A field density test gives 124.2 pcf dry density where the laboratory maximum dry density is 130.0 pcf. What percent compaction is indicated?

- A. 104.67%
- B. 95.54%
- C. 92.00%
- D. 5.80%

46. A concrete truck contains 27,000 lb of fresh concrete. The measured fresh unit weight is 150 pcf. What batch yield does this represent?

- A. 6.667 yd³
- B. 180.000 yd³
- C. 5.556 yd³

D. 7.407 yd³

47. Using a datum temperature of -10 C, concrete is at 12 C for 6 hr, 18 C for 8 hr, and 22 C for 10 hr. What Nurse-Saul maturity index is accumulated?

- A. 436 C-hr
- B. 516 C-hr
- C. 676 C-hr
- D. 916 C-hr

48. A compacted asphalt specimen has bulk density 142.5 pcf and theoretical maximum density 150.0 pcf. What percent of theoretical maximum density was achieved?

- A. 105.26%
- B. 5.00%
- C. 92.50%
- D. 95.00%

49. A bolt is tightened to 250 ft-lb. Using $T = KFd$ with $K = 0.20$ and nominal bolt diameter $d = 0.75$ in., what approximate bolt tension F results?

- A. 20.00 kip
- B. 16.67 kip
- C. 25.00 kip
- D. 4.00 kip

50. A welding operation deposits 72 lb of weld metal during 9 arc-hours of productive welding time. What is the average deposition rate?

- A. 6.0 lb/hr
- B. 9.0 lb/hr

- C. 8.0 lb/hr
- D. 648.0 lb/hr

51. A paving-production measurement process has standard deviation 1.1 units. If control limits are placed three standard deviations above and below the process mean, what is the total width from the lower control limit to the upper control limit?

- A. 3.3 units
- B. 6.6 units
- C. 2.2 units
- D. 7.7 units

52. A sieve test starts with 200 g of aggregate, and 186 g passes a specified sieve. What percent passing should be reported for that sieve?

- A. 7.0%
- B. 107.5%
- C. 186.0%
- D. 93.0%

53. A simply supported 20-ft beam carries a 30-kip point load 7 ft from the left support. What is the vertical reaction at the left support?

- A. 10.5 kip
- B. 30.0 kip
- C. 9.0 kip
- D. 19.5 kip

54. A simply supported temporary beam spans 18 ft. The design limits its maximum positive moment under a full-span uniform load to 72.9 kip-ft. What uniform load intensity produces that moment?

- A. 0.90 kip/ft
- B. 3.60 kip/ft
- C. 1.80 kip/ft
- D. 2.25 kip/ft

55. A temporary beam section has $I = 1,800 \text{ in}^4$ and extreme-fiber distance $c = 10 \text{ in}$. If allowable bending stress is 6.0 ksi, what bending moment reaches that stress?

- A. 50 kip-ft
- B. 90 kip-ft
- C. 108 kip-ft
- D. 180 kip-ft

56. A rectangular temporary beam is 8 in. wide and 14 in. deep. It carries a bending moment of 54 kip-ft. Using $S = bh^2/6$, what maximum bending stress occurs?

- A. 2.480 ksi
- B. 1.240 ksi
- C. 4.960 ksi
- D. 9.450 ksi

57. A member carries 42 kips of shear across a gross shear area of 18 in^2 . Using average shear stress V/A , what stress is indicated?

- A. 0.429 ksi
- B. 7.560 ksi
- C. 1.167 ksi
- D. 2.333 ksi

58. A compression member carries 210 kips over a gross cross-sectional area of 32 in^2 . What average axial compressive stress is developed?

- A. 6.563 ksi
- B. 3.281 ksi
- C. 0.152 ksi
- D. 6720.000 ksi

59. A steel member carries 95 kips in tension, is 15 ft long, has area 4.8 in^2 , and $E = 29,000 \text{ ksi}$. What elastic axial elongation occurs?

- A. 0.010 in.
- B. 0.123 in.
- C. 0.246 in.
- D. 1.475 in.

60. A cantilever has a 4.2-kip point load at its free end. The cantilever is 10 ft long with $E = 29,000 \text{ ksi}$ and $I = 520 \text{ in}^4$. What is the free-end deflection?

- A. 0.053 in.
- B. 0.320 in.
- C. 0.160 in.
- D. 1.920 in.

61. A member has $P = 160 \text{ kips}$, area $A = 40 \text{ in}^2$, bending moment $M = 35 \text{ kip-ft}$, and section modulus $S = 140 \text{ in}^3$. What maximum combined normal stress $P/A + M/S$ occurs?

- A. 4.00 ksi
- B. 7.00 ksi
- C. 3.00 ksi
- D. 1.00 ksi

62. A rectangular footing 10 ft by 12 ft carries a centered service load of 640 kips. Neglect footing self-weight. What average soil bearing pressure acts beneath the footing?

- A. 6.400 ksf
- B. 2.667 ksf
- C. 5.333 ksf
- D. 53.333 ksf

63. A temporary drainage design must convey a Rational Method peak flow of 52.25 cfs. With runoff coefficient $C = 0.75$ and design intensity $I = 2.8$ in/hr, what contributing area corresponds to that flow? Use $Q = 1.008CIA$.

- A. 18.50 acres
- B. 34.84 acres
- C. 13.88 acres
- D. 24.68 acres

64. A 2.4-in. runoff depth is generated uniformly over a 6-acre construction site. What runoff volume does that depth represent?

- A. 52,272 ft³
- B. 43,560 ft³
- C. 13,068 ft³
- D. 627,264 ft³

65. A rectangular drainage channel is 5 ft wide with 2 ft flow depth. Manning $n = 0.015$ and channel slope $S = 0.004$. Using $Q = (1.49/n)AR^{(2/3)}S^{(1/2)}$, what discharge is conveyed?

- A. 35.11 cfs
- B. 67.40 cfs
- C. 88.18 cfs
- D. 44.09 cfs

66. A 30-in.-diameter circular pipe carries 8.5 cfs while flowing full. What is the average flow velocity?

- A. 1.732 ft/s
- B. 4.330 ft/s
- C. 0.866 ft/s
- D. 10.625 ft/s

67. During a 25-minute storm interval, inflow to a detention basin averages 14 cfs while controlled outflow averages 9 cfs. Neglect other losses. What storage increase occurs during the interval?

- A. 3,750 ft³
- B. 21,000 ft³
- C. 7,500 ft³
- D. 34,500 ft³

68. A pump delivers 900 gpm against 65 ft of total dynamic head at 78% overall efficiency. Using brake horsepower = $QH/(3960 \text{ eta})$, what brake horsepower is required?

- A. 14.77 hp
- B. 24.28 hp
- C. 11.08 hp
- D. 18.94 hp

69. An excavator averages a 32-second cycle. Effective working time is 50 minutes per clock hour. Approximately how many production cycles are completed per hour?

- A. 112.50 cycles/hr
- B. 93.75 cycles/hr
- C. 50.00 cycles/hr
- D. 75.00 cycles/hr

70. A haul truck carries 18 loose yd³ per trip. Its cycle time is 24 minutes and job efficiency is 0.85. What average hourly production does one truck provide?

- A. 38.25 LCY/hr
- B. 45.00 LCY/hr
- C. 31.88 LCY/hr
- D. 64.80 LCY/hr

71. An excavator loads a truck in 5 minutes. The truck's complete cycle, including loading, haul, dump, return, and spotting, is 25 minutes. How many identical trucks are needed to keep the excavator continuously supplied under ideal balance?

- A. 4 trucks
- B. 6 trucks
- C. 5 trucks
- D. 20 trucks

72. A dozer moves 6.5 loose yd³ per productive cycle. Average cycle time is 4 minutes and job efficiency is 0.80. What average production rate is expected?

- A. 97.5 LCY/hr
- B. 78.0 LCY/hr
- C. 62.4 LCY/hr
- D. 52.0 LCY/hr

73. A borrow excavation contains 10,800 bank yd³ of soil. The material swells 22% when excavated. What loose volume must be hauled?

- A. 8,852 LCY
- B. 10,822 LCY
- C. 2,376 LCY
- D. 13,176 LCY

74. An embankment soil experiences 12% shrinkage from bank volume to compacted volume. If 14,000 bank yd³ are excavated, what compacted volume results?

- A. 15,680 CCY
- B. 14,012 CCY
- C. 12,320 CCY
- D. 1,680 CCY

75. An earthmoving spread costs \$240 per operating hour and produces 60 bank yd³ per hour. What is the equipment cost per bank cubic yard?

- A. \$2.50/BCY
- B. \$14.40/BCY
- C. \$300.00/BCY
- D. \$4.00/BCY

76. A crane chart permits 38,000 lb gross suspended load at the planned radius. The hook block weighs 1,200 lb and rigging weighs 800 lb. What is the maximum net payload that can be lifted without exceeding the chart value?

- A. 36,000 lb
- B. 38,000 lb
- C. 37,200 lb
- D. 34,800 lb

77. A symmetric two-leg sling lifts an 18,000-lb load. Each sling leg is 50 degrees above horizontal. Neglect sling weight. What tension acts in each leg?

- A. 11,749 lb
- B. 9,000 lb
- C. 14,001 lb
- D. 23,496 lb

78. A sump contains 48,000 gal that must be pumped out. A 320-gpm pump is expected to operate effectively at 80% of rated flow because of intermittent cycling. How long will pumping require?

- A. 2.500 hr
- B. 4.688 hr
- C. 150.000 hr
- D. 3.125 hr

79. During pile driving, average penetration is 0.75 in. per hammer blow over a representative interval. At that rate, how many blows are required for 1 ft of penetration?

- A. 9.0 blows/ft
- B. 12.0 blows/ft
- C. 16.0 blows/ft
- D. 0.1 blows/ft

80. A four-point support system carries a crane plus lifted-load vertical force of 180 kips. Apply a 1.15 dynamic factor and assume equal distribution to the four supports. What design reaction acts at each support?

- A. 45.00 kip
- B. 51.75 kip
- C. 207.00 kip
- D. 57.50 kip

81. An excavator bucket has 2.8 yd³ heaped capacity, a 0.90 fill factor, and excavated soil unit weight 2,900 lb/loose yd³. What average payload is carried per bucket?

- A. 7,308 lb
- B. 8,120 lb
- C. 5,220 lb
- D. 2,610 lb

82. A wall form is designed for a uniform lateral concrete pressure of 950 psf over a 12-ft height. What total horizontal form load acts per foot of wall length?

- A. 5.70 kip/ft
- B. 11.40 kip/ft
- C. 0.95 kip/ft
- D. 22.80 kip/ft

83. Form ties are spaced 2.0 ft horizontally and 2.5 ft vertically. The design lateral concrete pressure is 900 psf. What tributary lateral load is assigned to one interior tie?

- A. 2.25 kip
- B. 5.40 kip
- C. 4.50 kip
- D. 9.00 kip

84. A slab shore supports a 6-ft by 6-ft tributary area. Wet concrete plus formwork weighs 170 psf and construction live load is 50 psf. What unfactored vertical load is carried by the shore?

- A. 6.12 kip
- B. 1.80 kip
- C. 15.84 kip
- D. 7.92 kip

85. Forty-eight identical shores are assumed to share a 360-kip construction load equally. What average axial load is assigned to each shore?

- A. 6.00 kip
- B. 17.28 kip
- C. 7.50 kip

D. 17280.00 kip

86. A scaffold platform is 20 ft by 5 ft. The specified platform load is 75 psf, and scaffold self-weight contributing to four legs is 1,000 lb. Assuming equal reactions, what load acts at each leg?

A. 1,875 lb

B. 8,500 lb

C. 250 lb

D. 2,125 lb

87. A temporary diagonal brace resists a 12-kip horizontal force. The brace is oriented 40 degrees above horizontal. Neglect other load paths. What axial force must the brace develop?

A. 9.193 kip

B. 15.665 kip

C. 18.668 kip

D. 12.000 kip

88. A temporary anchorage transfers 72 kips of direct shear through six identical bolts. If load is shared equally and eccentricity is neglected, what shear is assigned to each bolt?

A. 12.0 kip

B. 6.0 kip

C. 18.0 kip

D. 432.0 kip

89. A temporary simply supported lagging member spans 8 ft and carries a uniform line load of 3.2 kip/ft. What maximum bending moment is produced?

A. 25.60 kip-ft

B. 12.80 kip-ft

- C. 51.20 kip-ft
- D. 20.48 kip-ft

90. A trench strut supports a wall strip 12 ft long with an 8-ft tributary height. Average lateral earth pressure over that tributary area is 600 psf. What axial strut load results?

- A. 28.8 kip
- B. 7.2 kip
- C. 115.2 kip
- D. 57.6 kip

91. Average excavation pressure on a braced wall is 750 psf. Vertical strut spacing is 6 ft. What equivalent uniform line load is delivered to the wale, per foot of wall length?

- A. 0.75 kip/ft
- B. 2.25 kip/ft
- C. 4.50 kip/ft
- D. 9.00 kip/ft

92. A crane outrigger reaction of 145 kips is spread uniformly over a 6-ft by 8-ft timber mat. What average ground bearing pressure does the mat apply?

- A. 2.417 ksf
- B. 3.021 ksf
- C. 6.042 ksf
- D. 17.400 ksf

93. A temporary simply supported beam spans 16 ft under a uniform construction load of 2.4 kip/ft. What maximum positive bending moment must the beam resist?

- A. 38.4 kip-ft

- B. 153.6 kip-ft
- C. 61.4 kip-ft
- D. 76.8 kip-ft

94. A pin-ended temporary steel column has $E = 29,000$ ksi, $I = 150$ in⁴, effective-length factor $K = 1.0$, and unsupported length 12 ft. What Euler elastic buckling load is predicted?

- A. 1,035.1 kip
- B. 4,140.3 kip
- C. 2,070.4 kip
- D. 172.5 kip

95. A scissor lift weighs 11,200 lb total. Its four tires share load equally, and each tire has a 7-in. by 9-in. contact patch. What average contact pressure is applied to the slab?

- A. 44.44 psi
- B. 177.78 psi
- C. 11.11 psi
- D. 62.22 psi

96. A worker is installing edge forms on a walking/working surface 6.5 ft above the level below, with an unprotected side and no task-specific exception. Under OSHA construction fall-protection rules, what is required?

- A. No fall protection is required until the height exceeds 10 ft.
- B. Provide a guardrail system, safety net system, or personal fall arrest system.
- C. Use only a warning line placed 6 ft back from the edge.
- D. Allow the work if the employee remains within arm's reach of the edge.

97. Employees must enter a 6-ft-deep excavation in a former landfill area where a hazardous atmosphere could reasonably be expected. Before entry, what OSHA action is required regarding the atmosphere?

- A. Test only after an employee reports symptoms.
- B. Test the atmosphere before employees enter the excavation.
- C. Testing is unnecessary unless the excavation exceeds 10 ft in depth.
- D. Ventilate for 15 minutes and enter without testing.

98. A scaffold work platform is 3 ft above the nearest point of access. Under OSHA scaffold-access requirements, which approach is acceptable?

- A. Require workers to climb the cross braces because the platform is under 6 ft high.
- B. Permit workers to jump down because the vertical difference is less than 4 ft.
- C. No access provision is needed unless the platform is more than 10 ft high.
- D. Provide an approved access method such as a ladder, stair tower, ramp, walkway, or integral scaffold access.

99. During trench excavation, a worker walks beneath a loaded excavator bucket while it is being swung toward a truck. Which statement best reflects OSHA's construction excavation requirement?

- A. The worker must not be permitted underneath the load handled by the digging equipment.
- B. The worker may pass underneath if wearing a hard hat.
- C. The worker may pass underneath if the operator sounds a warning horn.
- D. The worker may remain underneath for less than one minute at a time.

100. A non-self-supporting portable ladder has a 20-ft working length from foot to top support. Using OSHA's approximate 1-horizontal-to-4-vertical setup rule, how far should the ladder foot be from the top support horizontally?

- A. 4.0 ft
- B. 10.0 ft
- C. 5.0 ft
- D. 20.0 ft

Practice Exam 7: Answer Key and Explanations

- 1. D** — Use the layer-by-layer total stress sum, $\sigma = \sum(\gamma H)$. With the stated values, $118(4) + 124(6) = 1,216 \text{ psf} = 1.216 \text{ ksf}$, giving 1.216 ksf. This matches option D. The other choices reflect common errors such as using only one layer, averaging without thickness weighting, or converting psf to ksf incorrectly.
- 2. B** — Compute effective stress with moist unit weight above the water table and submerged unit weight below it. The calculation is $115(5) + (120 - 62.4)(7) = 978.2 \text{ psf} = 0.978 \text{ ksf}$, matching option B. The distractors use saturated weight below water, apply buoyancy above the water table, or omit one soil layer.
- 3. A** — Use Rankine active pressure, $K_a = (1 - \sin \phi)/(1 + \sin \phi)$. With the stated values, substitution of $\phi = 32$ degrees gives $K_a = 0.307$, giving 0.307. This matches option A. The other choices reflect common errors such as using the passive coefficient, using $\sin(\phi)$ by itself, or reversing the numerator and denominator.
- 4. C** — Use the triangular Rankine thrust, $P = 0.5 K_a \gamma H^2$. With the stated values, $0.5(0.33)(120)(14^2) = 3,880.8 \text{ lb/ft} = 3.881 \text{ kip/ft}$, giving 3.881 kip/ft. This matches option C. The other choices reflect common errors such as omitting the one-half for a triangular distribution, doubling the pressure resultant, or substituting height linearly.
- 5. D** — Use the normally consolidated settlement equation using base-10 logarithms. With the stated values, $8/(1+0.82)(0.22) \log_{10}(2.5/1.5)(12) = 2.574 \text{ in.}$, giving 2.574 in.. This matches option D. The other choices reflect common errors such as omitting the void-ratio denominator, using the stress increase alone in the logarithm, or forgetting the feet-to-inches conversion.
- 6. A** — Use allowable pressure as ultimate capacity divided by factor of safety. With the stated values, $9.6/3.0 = 3.2 \text{ ksf}$, giving 3.2 ksf. This matches option A. The other choices reflect common errors such as multiplying by the factor of safety, subtracting the factor numerically, or dividing by an unrelated value.
- 7. B** — Use factor of safety as resisting action divided by driving action. With the stated values, $425/285 = 1.491$, giving 1.491. This matches option B. The other choices reflect common errors such as reversing the ratio, subtracting the moments, or applying an unnecessary factor of two. Keeping units consistent and checking the governing relationship before rounding is the reliable construction-exam approach.
- 8. C** — Use the sum of triangular soil thrust and rectangular surcharge thrust. With the stated values, $0.5(0.30)(115)(10^2) + (0.30)(250)(10) = 2,475 \text{ lb/ft} = 2.475 \text{ kip/ft}$, giving 2.475 kip/ft. This matches option C. The other choices reflect common errors such as including only soil, including only surcharge, or adding surcharge pressure without its wall height.
- 9. A** — Use relative compaction as field dry density divided by laboratory maximum dry density. With the stated values, $116.5/121.0(100) = 96.28 \text{ percent}$, giving 96.28%. This matches option A. The other

choices reflect common errors such as reversing the density ratio, using the density difference as a percentage, or omitting the factor of 100.

10. C — Use grade times horizontal distance to obtain the elevation change. With the stated values, $642.35 - 0.022(180) = 638.39$ ft, giving 638.39 ft. This matches option C. The other choices reflect common errors such as adding a falling grade, treating 2.2 percent as 0.22, or applying the grade to the elevation instead of distance.

11. B — Use the simple-curve tangent relation, $T = R \tan(\Delta/2)$. With the stated values, $650 \tan(19 \text{ degrees}) = 223.81$ ft, giving 223.81 ft. This matches option B. The other choices reflect common errors such as using the full central angle, substituting sine for tangent, or treating the radius as a diameter.

12. D — Use arc length, $L = \pi R \Delta/180$ when Δ is in degrees. With the stated values, $\pi(720)(46)/180 = 578.05$ ft, giving 578.05 ft. This matches option D. The other choices reflect common errors such as using the half-angle, multiplying radius directly by degrees, or using the chord formula instead of arc length.

13. B — Use the long-chord relation, $C = 2R \sin(\Delta/2)$. With the stated values, $2(500) \sin(16 \text{ degrees}) = 275.64$ ft, giving 275.64 ft. This matches option B. The other choices reflect common errors such as using the full angle, omitting the factor of two, or using tangent length in place of chord length.

14. D — Use grade as elevation change divided by horizontal distance times 100. With the stated values, $7.8/520(100) = 1.50$ percent, giving 1.50%. This matches option D. The other choices reflect common errors such as reversing rise and run, moving the decimal one place, or reporting the ratio without converting to percent.

15. A — Departure is the line length times the sine of a bearing angle measured from north. Here, $240 \sin(35 \text{ degrees}) = 137.66$ ft east, matching option A. The distractors use cosine, treat the angle itself as a decimal multiplier, or assign the full 240-ft line length to the eastward component instead of resolving it.

16. C — First compute height of instrument: $388.62 + 5.14 = 393.76$ ft. The required foresight is HI minus the design-point elevation, $393.76 - 390.08 = 3.68$ ft, matching option C. The distractors reverse a subtraction, use only the elevation difference, or add the rod readings. Level work should always preserve the HI relationship.

17. C — The ratio is water mass divided by cementitious-material mass, so rearrange as cementitious mass = water divided by the permitted ratio. Thus $312/0.48 = 650$ lb, matching option C. The distractors multiply instead of divide, double the water approximately, or combine unrelated values. Meeting a maximum ratio requires at least this cementitious-material mass for the stated water.

18. A — Yield equals total batch mass divided by measured fresh unit weight, followed by conversion from cubic feet to cubic yards. Here, $14,850/148.5 = 100 \text{ ft}^3$, and $100/27 = 3.704 \text{ yd}^3$, matching option A. The distractors stop at cubic feet, use a nominal batch size, or mishandle the 27 ft^3 per yd^3 conversion.

19. D — Use air content as air volume divided by total concrete volume times 100. With the stated values, $0.135/3.00(100) = 4.50$ percent, giving 4.50%. This matches option D. The other choices reflect

common errors such as using a decimal without converting to percent, dividing total volume by air volume, or multiplying the two volumes.

20. B — Use total reinforcement area as bar count times area per bar. With the stated values, $9(0.79) = 7.11 \text{ in}^2$, giving 7.11 in^2 . This matches option B. The other choices reflect common errors such as using eight bars, using a nominal diameter as area, or dividing area by the number of bars.

21. C — Elastic axial deformation is $\delta = PL/(AE)$, using consistent inch-based units. Converting 12 ft to 144 in. gives $42(144)/[(2.4)(29,000)] = 0.087 \text{ in.}$, matching option C. The distractors leave length in feet, omit the cross-sectional area, or double the load effect. Unit consistency is the key check for this deformation calculation.

22. B — Use wood moisture content as water mass divided by oven-dry mass times 100. With the stated values, $(57 - 50)/50(100) = 14.00 \text{ percent}$, giving 14.00% . This matches option B. The other choices reflect common errors such as dividing by wet mass, reporting water mass directly as a percent, or adding 100 to the correct percentage.

23. D — Use absorption as the SSD-minus-oven-dry mass divided by oven-dry mass times 100. With the stated values, $(102.4 - 100.0)/100.0(100) = 2.40 \text{ percent}$, giving 2.40% . This matches option D. The other choices reflect common errors such as dividing by SSD mass, omitting the factor of 100, or reporting the SSD mass itself.

24. A — Treat the trench as a rectangular prism, then convert cubic feet to cubic yards. The volume is $420(5.5)(8)/27 = 684.44 \text{ yd}^3$, matching option A. The distractors forget the $27 \text{ ft}^3 \text{ per yd}^3$ conversion, multiply by 27 instead of dividing, or add an unsupported swell factor. The question asks specifically for in-place excavation quantity.

25. D — Use pad volume times the number of pads, followed by conversion to cubic yards. With the stated values, $12(8)(8)(1.75)/27 = 49.78 \text{ yd}^3$, giving 49.78 yd^3 . This matches option D. The other choices reflect common errors such as calculating one pad only, leaving the result in cubic feet, or adding an unstated waste allowance.

26. C — Use area times compacted thickness times density, with square yards converted to square feet and pounds to tons. With the stated values, $1,800(9)(4/12)(145)/2,000 = 391.50 \text{ tons}$, giving 391.50 tons . This matches option C. The other choices reflect common errors such as omitting the square-yard conversion, forgetting the pounds-to-tons conversion, or adding an unstated waste factor.

27. A — Use unit cost as daily crew cost divided by accepted daily production. With the stated values, $1,860/155 = \$12.00 \text{ per BCY}$, giving $\$12.00/\text{BCY}$. This matches option A. The other choices reflect common errors such as reversing cost and production, dividing by an assumed workday length, or multiplying cost by production.

28. B — Use adjusted quantity times unit cost. With the stated values, $325(1.07)(\$18) = \$6,259.50$, giving $\$6,259.50$. This matches option B. The other choices reflect common errors such as omitting the waste factor, applying seven percent twice, or calculating only the waste-dollar increment. Keeping units

consistent and checking the governing relationship before rounding is the reliable construction-exam approach.

29. D — Use single-payment present value, $PV = F/(1+i)^n$. With the stated values, $125,000/(1.06^4) =$ approximately \$99,012, giving \$99,012. This matches option D. The other choices reflect common errors such as leaving the future amount undiscounted, multiplying by the discount factor, or applying only a simple-interest adjustment. Keeping units consistent and checking the governing relationship before rounding is the reliable construction-exam approach.

30. A — Use break-even by equating total-cost equations and dividing the fixed-cost difference by the hourly-cost difference. With the stated values, $(30,000 - 18,000)/(85 - 65) = 600$ hr, giving 600 hr. This matches option A. The other choices reflect common errors such as adding the fixed costs, dividing by only one hourly rate, or reversing the cost differences without preserving signs.

31. C — Cost performance index is $CPI = EV/AC$, so solve for actual cost as $AC = EV/CPI$. Substituting gives $540,000/0.90 = \$600,000$, matching option C. The distractors multiply by CPI, confuse the cost variance with actual cost, or move the decimal incorrectly. Rewriting the earned-value equation before substituting prevents the common ratio-direction error.

32. B — Use productivity as installed quantity divided by total labor-hours. With the stated values, $960/[4(10)] = 24.0$ LF per labor-hour, giving 24.0 LF/labor-hr. This matches option B. The other choices reflect common errors such as using crew-hours instead of labor-hours, multiplying instead of dividing, or dividing by workers without including shift length.

33. C — Project duration is governed by the longest start-to-finish path. The three listed path lengths are 13, 14, and 13 days, so the critical path is B-E-F and the duration is 14 days, matching option C. The distractors choose a shorter path, average the path lengths, or combine activities from different mutually exclusive network paths.

34. B — Use total float as LS minus ES, equivalently LF minus EF. With the stated values, $11 - 8 = 3$ days, which also equals $17 - 14$, giving 3 days. This matches option B. The other choices reflect common errors such as using activity duration, adding early and late dates, or assuming every scheduled activity is critical.

35. A — Use free float as the earliest successor ES minus the activity EF. With the stated values, $\min(12,15) - 9 = 3$ days, giving 3 days. This matches option A. The other choices reflect common errors such as using the later successor, subtracting ES from EF in the wrong direction, or automatically setting free float to zero.

36. D — PERT expected duration uses the weighted mean $te = (a + 4m + b)/6$. Substituting 5, 8, and 17 days gives $(5 + 32 + 17)/6 = 9.0$ days, matching option D. The distractors use the most-likely time alone, a simple average, or an incorrect weighting. The fourfold weight belongs on the most-likely estimate.

37. B — Use PERT variance as $[(b - a)/6]^2$. With the stated values, $[(15 - 3)/6]^2 = 4.0$ days², giving 4.0 days². This matches option B. The other choices reflect common errors such as stopping at the standard deviation, using the full range as variance, or squaring the range without dividing by six.

38. D — The acceleration cost slope is the increase in direct cost divided by the reduction in duration. Cost increases by \$7,200 while three days are saved, so $\$7,200/3 = \$2,400$ per day, matching option D. The distractors divide by the wrong duration, report the full cost increase, or use one of the original daily cost levels instead.

39. C — For least-cost crashing, use available reductions on the critical path in ascending cost-slope order. The first activity can supply the full required two-day reduction at \$1,000 per day, so added direct cost is \$2,000, matching option C. The distractors buy only one day, crash the more expensive activity first, or purchase unnecessary reductions from both activities.

40. A — Resource loading requires summing only activities that overlap on each day. Activities A and B overlap on days 3 and 4, producing $5 + 4 = 9$ workers, the peak demand and option A. The distractors add all three crews regardless of timing, miss an overlap interval, or average demand rather than identifying the maximum simultaneous requirement.

41. D — Linear planned progress after 8 days of a 20-day activity is $8/20 = 40\%$. Field progress is 35%, so actual progress is 5 percentage points behind plan, matching option D. The distractors report actual percent complete, confuse days with percent, or treat 35% as the planned value. Percentage-point difference is the requested schedule measure here.

42. C — Use duration as total quantity divided by production rate. With the stated values, $3,600/450 = 8.0$ working days, giving 8.0 days. This matches option C. The other choices reflect common errors such as multiplying quantity by rate, converting an already daily rate again, or rounding away a full day without basis.

43. A — Use the arithmetic mean of all four cylinder strengths. With the stated values, $(4,250 + 4,410 + 4,330 + 4,370)/4 = 4,340$ psi, giving 4,340 psi. This matches option A. The other choices reflect common errors such as choosing the lowest result, choosing the last result, or summing strengths without dividing by the number of tests.

44. B — Use coefficient of variation as standard deviation divided by mean times 100. With the stated values, $225/4,500(100) = 5.00$ percent, giving 5.00%. This matches option B. The other choices reflect common errors such as reversing mean and standard deviation, adding the values, or reporting the decimal ratio without converting to percent.

45. B — Use percent compaction as field dry density divided by laboratory maximum dry density times 100. With the stated values, $124.2/130.0(100) = 95.54$ percent, giving 95.54%. This matches option B. The other choices reflect common errors such as reversing the ratio, using only the density difference, or omitting the conversion to percent.

46. A — Use yield as batch mass divided by unit weight and then by 27 ft³ per yd³. With the stated values, $27,000/150 = 180$ ft³; $180/27 = 6.667$ yd³, giving 6.667 yd³. This matches option A. The other choices reflect common errors such as stopping at cubic feet, dividing by unit weight twice, or applying an unsupported nominal truck capacity.

- 47. C** — Use the Nurse-Saul maturity sum, $M = \sum[(T - T_0) \Delta t]$. With the stated values, $22(6) + 28(8) + 32(10) = 676$ C-hr, giving 676 C-hr. This matches option C. The other choices reflect common errors such as omitting the datum-temperature correction, multiplying temperature by total elapsed time, or using only the final temperature interval.
- 48. D** — Use density ratio as compacted bulk density divided by theoretical maximum density times 100. With the stated values, $142.5/150.0(100) = 95.00$ percent, giving 95.00%. This matches option D. The other choices reflect common errors such as reversing the ratio, using the density difference as percent, or subtracting five points from an unrelated target.
- 49. A** — Use the simplified torque-tension relation with torque converted from ft-lb to in-lb. With the stated values, $250(12)/(0.20)(0.75) = 20,000$ lb = 20.00 kip, giving 20.00 kip. This matches option A. The other choices reflect common errors such as leaving torque in ft-lb, multiplying by K_d instead of dividing, or omitting the conversion from pounds to kips.
- 50. C** — Deposition rate is deposited weld-metal mass divided by productive arc time. The calculation is $72/9 = 8.0$ lb/hr, matching option C. The distractors reverse mass and time, multiply instead of divide, or substitute an unstated shift duration. Using productive arc-hours, rather than total clock hours, keeps the rate tied to the quantity actually deposited during welding.
- 51. B** — Three-sigma control limits lie three standard deviations below and above the process mean, so the full band width spans six standard deviations. With $\sigma = 1.1$ units, the width is $6(1.1) = 6.6$ units, matching option B. The distractors use three sigma, two sigma, or seven sigma. The process mean cancels when only total band width is requested.
- 52. D** — Use percent passing as passing mass divided by original sample mass times 100. With the stated values, $186/200(100) = 93.0$ percent, giving 93.0%. This matches option D. The other choices reflect common errors such as reporting percent retained, reversing the mass ratio, or reporting the passing mass directly as a percentage.
- 53. D** — Use beam equilibrium. Taking moments gives the right reaction as $30(7)/20 = 10.5$ kip, so vertical-force balance gives the left reaction as $30 - 10.5 = 19.5$ kip, matching option D. The distractors use the opposite reaction, place the full load at one support, or apply an incorrect lever-arm ratio. Both reactions must sum to 30 kip.
- 54. C** — For a simply supported beam under full uniform load, $M_{\max} = wL^2/8$. Rearranging gives $w = 8M/L^2$. Substitution yields $8(72.9)/(18^2) = 1.80$ kip/ft, matching option C. The distractors omit the factor of eight, double the correct intensity, or use an unrelated division. Solving symbolically first helps prevent inversion mistakes. This inversion check prevents a common setup error.
- 55. B** — Flexure stress is $f = Mc/I$, so the moment corresponding to allowable stress is $M = fI/c$. Using 6.0 ksi, 1,800 in⁴, and 10 in. gives 1,080 kip-in., or 90 kip-ft, matching option B. The distractors omit the inch-to-foot moment conversion, divide by I , or apply an unnecessary factor of two.
- 56. A** — Use section modulus for a rectangle followed by $f = M/S$. With the stated values, $S = 8(14^2)/6 = 261.33$ in³ and $54(12)/261.33 = 2.480$ ksi, giving 2.480 ksi. This matches option A. The other

choices reflect common errors such as using area instead of section modulus, omitting the kip-ft conversion, or applying the depth only to the first power.

57. D — Use average shear stress as applied shear divided by resisting area. With the stated values, $42/18 = 2.333$ ksi, giving 2.333 ksi. This matches option D. The other choices reflect common errors such as reversing force and area, multiplying force by area, or dividing by twice the stated area without justification.

58. A — Average axial stress is $\sigma = P/A$. Using 210 kips and 32 in^2 gives $210/32 = 6.563$ ksi, matching option A. The distractors divide by twice the area, reverse force and area, or mix pounds and kips inconsistently. Because ksi is kips per square inch, the stated units can be used directly without another conversion.

59. B — Elastic axial deformation is $\delta = PL/(AE)$. Convert 15 ft to 180 in., then calculate $95(180)/[(4.8)(29,000)] = 0.123$ in., matching option B. The distractors leave the length in feet, omit cross-sectional area, or double the deformation. With E in ksi and area in in^2 , length must be expressed in inches for compatible units.

60. C — Use cantilever tip deflection, $\delta = PL^3/(3EI)$, with length expressed in inches. With the stated values, $4.2(120^3)/[3(29,000)(520)] = 0.160$ in., giving 0.160 in.. This matches option C. The other choices reflect common errors such as using L squared instead of L cubed, omitting the factor of three, or leaving length in feet.

61. B — Combine axial and bending normal stress by superposition at the extreme fiber where they act in the same direction. Axial stress is $160/40 = 4$ ksi and bending stress is $35(12)/140 = 3$ ksi, so the maximum is 7 ksi, matching option B. The distractors use one component alone, subtract them, or omit the moment conversion.

62. C — Use average bearing pressure as centered load divided by footing plan area. With the stated values, $640/(10)(12) = 5.333$ ksf, giving 5.333 ksf. This matches option C. The other choices reflect common errors such as dividing by only one footing dimension, using half the area, or moving the decimal one place.

63. D — Rearrange the Rational Method relation $Q = 1.008CIA$ to solve for area: $A = Q/(1.008CI)$. Substituting 52.25 cfs, $C = 0.75$, and $I = 2.8 \text{ in/hr}$ gives 24.68 acres, matching option D. The distractors omit the runoff coefficient, misapply the conversion factor, or multiply by intensity instead of dividing. Algebraic rearrangement should precede substitution.

64. A — Use runoff volume as depth in feet times watershed area in square feet. With the stated values, $(2.4/12)(6)(43,560) = 52,272 \text{ ft}^3$, giving 52,272 ft^3 . This matches option A. The other choices reflect common errors such as using inches directly as feet, omitting the acreage conversion, or multiplying by twelve instead of dividing.

65. B — For the rectangular channel, area $A = 10 \text{ ft}^2$ and wetted perimeter $P = 9 \text{ ft}$, so hydraulic radius $R = 1.111 \text{ ft}$. Manning's equation then gives $Q = 67.40 \text{ cfs}$, matching option B. The distractors use flow depth as hydraulic radius, omit the square root of slope, or include the free surface in wetted perimeter.

66. A — Use continuity, $V = Q/A$. Convert 30 in. to 2.5 ft, giving pipe area $A = \pi(2.5^2)/4 = 4.909 \text{ ft}^2$. Then $V = 8.5/4.909 = 1.732 \text{ ft/s}$, matching option A. The distractors treat diameter as area, miss the inch-to-foot conversion, or multiply discharge by area instead of dividing. Units remain consistent.

67. C — Use continuity storage change as net inflow rate times elapsed time in seconds. With the stated values, $(14 - 9)(25)(60) = 7,500 \text{ ft}^3$, giving $7,500 \text{ ft}^3$. This matches option C. The other choices reflect common errors such as using inflow without subtracting outflow, leaving minutes unconverted, or adding inflow and outflow rates.

68. D — Use the standard water-pumping horsepower relation with pump efficiency in decimal form. With the stated values, $900(65)/[3,960(0.78)] = 18.94 \text{ hp}$, giving 18.94 hp . This matches option D. The other choices reflect common errors such as multiplying by efficiency instead of dividing, omitting efficiency entirely, or treating 78 percent as the number 78.

69. B — Use effective seconds available per hour divided by seconds per cycle. With the stated values, $50(60)/32 = 93.75 \text{ cycles/hr}$, giving 93.75 cycles/hr . This matches option B. The other choices reflect common errors such as using all 60 clock minutes, dividing minutes directly by seconds, or multiplying cycle time by efficiency.

70. A — Truck production equals capacity times cycles per hour times job efficiency. The truck makes $60/24 = 2.5 \text{ cycles per hour}$, so $18(2.5)(0.85) = 38.25 \text{ LCY/hr}$, matching option A. The distractors omit efficiency, apply it twice, or multiply capacity by cycle minutes rather than converting cycle time into hourly cycle frequency.

71. C — Use fleet balance as total truck cycle time divided by excavator loading time per truck. With the stated values, $25/5 = 5 \text{ trucks}$, giving 5 trucks . This matches option C. The other choices reflect common errors such as subtracting loading time from cycle time before dividing, rounding an exact ratio incorrectly, or multiplying cycle and loading times.

72. B — Use blade load times cycles per hour times job efficiency. With the stated values, $6.5(60/4)(0.80) = 78.0 \text{ LCY/hr}$, giving 78.0 LCY/hr . This matches option B. The other choices reflect common errors such as omitting efficiency, applying efficiency to cycle time incorrectly, or using four cycles per hour instead of fifteen.

73. D — Use loose volume as bank volume multiplied by one plus the swell fraction. With the stated values, $10,800(1.22) = 13,176 \text{ LCY}$, giving $13,176 \text{ LCY}$. This matches option D. The other choices reflect common errors such as subtracting swell, adding only 22 yd^3 , or reporting the swell increment instead of total loose volume.

74. C — Use compacted volume as bank volume multiplied by one minus the shrinkage fraction. With the stated values, $14,000(0.88) = 12,320 \text{ CCY}$, giving $12,320 \text{ CCY}$. This matches option C. The other choices reflect common errors such as adding shrinkage instead of subtracting it, adding 12 yd^3 , or reporting only the lost volume.

75. D — Use unit equipment cost as hourly ownership-and-operation cost divided by hourly production. With the stated values, $240/60 = \$4.00 \text{ per BCY}$, giving $\$4.00/\text{BCY}$. This matches option D. The other

choices reflect common errors such as reversing production and cost, multiplying the quantities, or dividing by an assumed workday that is not part of the unit rate.

76. A — Use net allowable payload as gross chart capacity minus hook-block and rigging weights. With the stated values, $38,000 - 1,200 - 800 = 36,000$ lb, giving 36,000 lb. This matches option A. The other choices reflect common errors such as treating gross capacity as payload, subtracting only one accessory weight, or subtracting the accessory weights twice.

77. A — For a symmetric two-leg sling with angle measured above horizontal, vertical equilibrium is $2T \sin(\theta) = W$. Thus $T = 18,000/[2 \sin(50 \text{ degrees})] = 11,749$ lb per leg, matching option A. The distractors split the load without angle effects, use cosine for the stated angle reference, or double the correct leg tension.

78. D — Use pumping time as volume divided by effective flow rate, followed by conversion from minutes to hours. With the stated values, $48,000/[320(0.80)] = 187.5$ min = 3.125 hr, giving 3.125 hr. This matches option D. The other choices reflect common errors such as using rated flow without the stated duty factor, multiplying by flow, or leaving the time in minutes.

79. C — Use blows per foot as 12 inches divided by penetration per blow. With the stated values, $12/0.75 = 16.0$ blows/ft, giving 16.0 blows/ft. This matches option C. The other choices reflect common errors such as using inches per foot as the answer, multiplying instead of dividing, or converting the decimal penetration in the wrong direction.

80. B — Use factored total vertical load divided equally among the four supports. With the stated values, $180(1.15)/4 = 51.75$ kip per support, giving 51.75 kip. This matches option B. The other choices reflect common errors such as omitting the dynamic factor, assigning the total factored load to one support, or dividing the unfactored load by an incorrect number of supports.

81. A — Use bucket payload as heaped capacity times fill factor times loose unit weight. With the stated values, $2.8(0.90)(2,900) = 7,308$ lb, giving 7,308 lb. This matches option A. The other choices reflect common errors such as omitting the fill factor, applying fill factor to unit weight incorrectly, or multiplying only two of the three stated quantities.

82. B — For a uniform lateral pressure, resultant load on a one-foot-wide wall strip is pressure times height. Thus $950(12) = 11,400$ lb/ft = 11.40 kip/ft, matching option B. The distractors apply a triangular one-half factor, report pressure alone without integrating over height, or double the uniform resultant. The pressure distribution is explicitly stated as uniform.

83. C — Use tie load as design pressure times the tie's tributary panel area. With the stated values, $900(2.0)(2.5) = 4,500$ lb = 4.50 kip, giving 4.50 kip. This matches option C. The other choices reflect common errors such as using only one spacing dimension, multiplying by an extra factor of two, or treating pressure directly as a point load.

84. D — Use combined area load times the shore tributary area. With the stated values, $(170 + 50)(6)(6) = 7,920$ lb = 7.92 kip, giving 7.92 kip. This matches option D. The other choices reflect common errors

such as omitting the construction live load, using only the live load, or doubling the correct tributary load.

85. C — With equal load sharing, divide the total construction load by the number of shores. The calculation is $360/48 = 7.50$ kip per shore, matching option C. The distractors multiply load by the shore count, divide by an unrelated area, or convert to pounds while leaving the option units in kips. No unequal distribution factor is specified.

86. D — Use total platform live load plus scaffold self-weight divided equally among four legs. With the stated values, $20(5)(75) + 1,000 = 8,500$ lb total; $8,500/4 = 2,125$ lb per leg, giving 2,125 lb. This matches option D. The other choices reflect common errors such as omitting self-weight, assigning total load to one leg, or dividing only the self-weight by four.

87. B — Use horizontal equilibrium, $F_{\text{brace}} \cos(\theta) = H$ when the brace angle is measured from horizontal. With the stated values, $12/\cos(40 \text{ degrees}) = 15.665$ kip, giving 15.665 kip. This matches option B. The other choices reflect common errors such as multiplying by cosine, using sine for the horizontal component, or assuming axial force equals horizontal force without resolving components.

88. A — Use equal direct shear distribution among identical bolts. With the stated values, $72/6 = 12.0$ kip per bolt, giving 12.0 kip. This matches option A. The other choices reflect common errors such as dividing by twice the bolt count, adding bolt count to the force, or multiplying force by bolt count.

89. A — Use the simply supported uniform-load moment, $M_{\text{max}} = wL^2/8$. With the stated values, $3.2(8^2)/8 = 25.60$ kip-ft, giving 25.60 kip-ft. This matches option A. The other choices reflect common errors such as omitting the division by eight, using half the correct value, or substituting wL instead of wL squared over eight.

90. D — Use average pressure times tributary wall area carried by the strut. With the stated values, $600(12)(8) = 57,600$ lb = 57.6 kip, giving 57.6 kip. This matches option D. The other choices reflect common errors such as using only one tributary dimension, applying an unnecessary one-half to an average pressure, or doubling the wall area.

91. C — Use wale line load as wall pressure times vertical tributary spacing. With the stated values, $750(6) = 4,500$ plf = 4.50 kip/ft, giving 4.50 kip/ft. This matches option C. The other choices reflect common errors such as reporting pressure without multiplying by tributary height, using half the spacing, or doubling the line load.

92. B — Use average bearing pressure as outrigger reaction divided by mat contact area. With the stated values, $145/(6)(8) = 3.021$ ksf, giving 3.021 ksf. This matches option B. The other choices reflect common errors such as using only one mat dimension, dividing by half the area, or multiplying reaction by area.

93. D — Use the simply supported uniform-load relation, $M_{\text{max}} = wL^2/8$. With the stated values, $2.4(16^2)/8 = 76.8$ kip-ft, giving 76.8 kip-ft. This matches option D. The other choices reflect common errors such as using a one-half factor instead of one-eighth, doubling the result, or substituting wL for wL squared over eight.

94. C — Use Euler buckling, $P_{cr} = \pi^2 EI / (KL)^2$, with the 12-ft length converted to 144 in.. With the stated values, $\pi^2(29,000)(150) / (144^2) = 2,070.4$ kip, giving 2,070.4 kip. This matches option C. The other choices reflect common errors such as leaving length in feet, omitting the square on effective length, or applying an unnecessary factor of two.

95. A — Use average contact pressure as total equipment weight divided by the combined tire contact area. With the stated values, $11,200 / [4(7)(9)] = 44.44$ psi, giving 44.44 psi. This matches option A. The other choices reflect common errors such as using one tire area for the total weight, dividing by four twice, or using perimeter instead of contact area.

96. B — OSHA 29 CFR 1926.501(b)(1) requires protection for employees on walking or working surfaces with unprotected sides or edges 6 ft or more above a lower level. Therefore option B is correct. The listed systems are guardrails, safety nets, or personal fall arrest. A 10-ft threshold applies to many scaffold situations, not this general unprotected-edge condition.

97. B — OSHA 29 CFR 1926.651(g)(1)(i) requires atmospheric testing before employees enter excavations more than 4 ft deep when oxygen deficiency or another hazardous atmosphere exists or could reasonably be expected. Thus option B is correct. The rule is preventive; it does not wait for symptoms, and the trigger is not a blanket 10-ft excavation depth.

98. D — OSHA 29 CFR 1926.451(e)(1) applies when scaffold platforms are more than 2 ft above or below a point of access. It requires an approved means such as ladders, stair towers, ramps, walkways, integral access, or equivalent safe access. Option D states that rule. Cross braces are not a substitute, and the threshold is not 6 or 10 ft.

99. A — OSHA 29 CFR 1926.651(e) states that no employee may be permitted underneath loads handled by lifting or digging equipment. Option A therefore gives the required action: keep the worker out from under the loaded bucket. Personal protective equipment, warning signals, or short exposure duration do not create an exception to this falling-load prohibition.

100. C — OSHA's ladder setup rule places the foot of a non-self-supporting ladder approximately one-quarter of its working length from the top support horizontally. For a 20-ft working length, $20/4 = 5.0$ ft, matching option C. The distractors use one-fifth, one-half, or the full working length. This is the familiar approximate 1-horizontal-to-4-vertical setup relationship.