FE Civil

Free practice problems and worked solutions

This sample contains 14 original problems, one from each knowledge area, already available free on EngineerProof. The original Form A problem numbers are retained. This is a sample, not a complete 110-question exam or a predictor of your NCEES result.

Work the questions before consulting the solutions. Each solution includes the calculation and an explanation of the other choices. The full forms, contents, and purchase conditions are at:

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Practice questions

Mathematics and Statistics

1. A rectangular open channel must provide a flow cross-sectional area of $8\ \text{m}^2$. The lining covers the channel bottom and both vertical sides; the water surface is free. The minimum lined perimeter of the cross section is most nearly:

(A) 6.0 m

(B) 8.0 m

(C) 8.5 m

(D) 12.0 m

Ethics and Professional Practice

11. An engineer employed by a municipal public works department is evaluating bids for a water main replacement contract. Before the award, one of the bidding contractors offers the engineer tickets to a professional sporting event with a face value of USD 300. According to the NCEES Model Rules, the engineer should:

(A) accept the tickets because their value is nominal relative to the contract amount

(B) accept the tickets and disclose the gift to the department after the contract is awarded

(C) decline the tickets and continue the impartial evaluation of all bids

(D) decline the tickets and disqualify the contractor from the bidding process

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Engineering Economics

15. Two booster pump stations are being considered for a water main extension. Station A has a first cost of USD 60,000 and annual operating costs of USD 11,000. Station B has a first cost of USD 95,000 and annual operating costs of USD 5,000. Both stations have 10-year lives with no salvage value. At an interest rate of 8% per year, the equivalent uniform annual cost of the more economical alternative is most nearly:

(A) USD 11,560

(B) USD 14,500

(C) USD 19,160

(D) USD 19,940

Statics

19. A 500-N traffic signal head hangs from point A. Cable AB extends from A to a pole on one side and rises at 30° above the horizontal; cable AC extends to a pole on the opposite side and rises at 45° above the horizontal. The tension in cable AB is most nearly:

(A) 366 N

(B) 414 N

(C) 448 N

(D) 500 N

Dynamics

28. A water jet discharges from a nozzle at grade with an initial velocity of 18 m/s at an angle of 35° above the horizontal. Air resistance is neglected. The horizontal distance from the nozzle to the point where the jet returns to nozzle elevation is most nearly:

(A) 15.5 m

(B) 18.9 m

(C) 31.0 m

(D) 37.9 m

Mechanics of Materials

33. A straight steel member with a cross-sectional area of 8.0 in^2 is fully restrained against axial deformation between two bridge abutments. The coefficient of thermal expansion is 6.5×10^{-6} per degree F, and the modulus of elasticity is 29×10^{6} psi. For a uniform temperature rise of 70 degrees F, the compressive force developed in the member is most nearly:

(A) 13.2 kips

(B) 58.6 kips

(C) 106 kips

(D) 190 kips

Materials

42. A sieve analysis of a concrete fine aggregate gives cumulative percentages retained on the 4.75-mm, 2.36-mm, 1.18-mm, 0.600-mm, 0.300-mm, and 0.150-mm sieves of 4, 15, 36, 58, 78, and 89, respectively. The fineness modulus of the aggregate is most nearly:

(A) 0.89

(B) 2.80

(C) 3.20

(D) 3.80

Fluid Mechanics

47. A vertical rectangular gate in a reservoir retaining wall is 4 ft wide and 6 ft tall. The top edge of the gate is 8 ft below the free water surface. The specific weight of water is 62.4 lbf/ft^3. The magnitude of the resultant hydrostatic force on the gate is most nearly:

(A) 12,000 lbf

(B) 16,500 lbf

(C) 21,000 lbf

(D) 24,500 lbf

Surveying

54. A water main is to be laid from point A (N 1,200.00 m, E 800.00 m) to point B (N 950.00 m, E 1,100.00 m). The azimuth from north of line AB is most nearly:

(A) 39.8°

(B) 50.2°

(C) 129.8°

(D) 230.2°

Water Resources and Environmental Engineering

59. A rectangular concrete-lined drainage channel has a bottom width of 8 ft and carries uniform flow at a depth of 3 ft. The Manning roughness coefficient is 0.013, and the bed slope is 0.002 ft/ft. The discharge is most nearly:

(A) 118 ft^3/s

(B) 176 ft^3/s

(C) 255 ft^3/s

(D) 275 ft^3/s

Structural Engineering

71. A determinate portal frame consists of vertical columns AB and DC, each 4 m tall, and horizontal beam BC spanning 6 m between the column tops B and C. The frame is supported by a pin at base A and by a roller at base D that resists vertical force only. A horizontal load of 30 kN is applied at joint B, directed toward C. The maximum bending moment in the frame is most nearly:

(A) 60 kN·m

(B) 80 kN·m

(C) 120 kN·m

(D) 180 kN·m

Geotechnical Engineering

82. A saturated clay specimen has a water content of 40% and a specific gravity of solids of 2.70. The saturated unit weight of the specimen is most nearly:

(A) 8.0 kN/m³

(B) 12.7 kN/m³

(C) 17.8 kN/m³

(D) 24.3 kN/m³

Transportation Engineering

94. A two-lane rural highway approaches an intersection on a 4.0% downgrade. The design speed is 50 mph, the perception-reaction time is 2.5 s, and the deceleration rate is 11.2 ft/s². The stopping sight distance is most nearly:

(A) 271 ft

(B) 399 ft

(C) 423 ft

(D) 454 ft

Construction Engineering

105. Between station 12+00 and station 30+00, a roadway grading plan shows 8{,}200 yd³ of excavation (bank measure) and 6{,}600 yd³ of embankment (compacted measure). The shrinkage factor from bank volume to compacted volume is 0.88. The change in the mass haul diagram ordinate across this interval, expressed in bank volume, is most nearly:

(A) 1{,}600 yd³

(B) 2{,}390 yd³

(C) 2{,}720 yd³

(D) 700 yd³

Worked solutions

Mathematics and Statistics

Problem 1

Answer: (B)

A rectangular open channel must provide a flow cross-sectional area of $8\ \text{m}^2$. The lining covers the channel bottom and both vertical sides; the water surface is free. The minimum lined perimeter of the cross section is most nearly:

Lining is minimized at the half-square section: $d = 2$ m, $b = 4$ m, giving $P = b + 2d = 8.0$ m.

With bottom width b and depth d, the constraint $bd = 8$ makes the lined perimeter a function of depth alone.

$$P = b + 2d = \frac{8}{d} + 2d$$

The optimum lies where the slope of $P(d)$ vanishes.

$$\frac{dP}{dd} = -\frac{8}{d^2} + 2 = 0$$

$$d^2 = 4, \quad d = 2\ \text{m}$$

Then $b = 8/2 = 4$ m, and $16/d^3 > 0$ confirms a minimum.

$$P = 4 + 2(2) = 8.0\ \text{m}$$

FE REFERENCE HANDBOOK — MATHEMATICS: DIFFERENTIAL CALCULUS, TEST FOR A MINIMUM

WHY THE OTHER CHOICES APPEAR

(A) Sums one width and one side wall only, $b + d = 4 + 2 = 6.0$ m, omitting the second side.

(C) Assumes a square section with $b = d = \sqrt{8} = 2.83$ m, giving $P = 3(2.83) = 8.5$ m.

(D) Counts the free water surface as lined, $2b + 2d = 8 + 4 = 12.0$ m.

Ethics and Professional Practice

Problem 11

Answer: (C)

An engineer employed by a municipal public works department is evaluating bids for a water main replacement contract. Before the award, one of the bidding contractors offers the engineer tickets to a professional sporting event with a face value of USD 300. According to the NCEES Model Rules, the engineer should:

A gratuity from a bidder on work the engineer is evaluating must be refused outright — no value threshold, no cure by disclosure — but refusal, not disqualification, is the limit of the engineer's own authority.

Licensees may not solicit or accept anything of value, directly or indirectly, from contractors or their agents in connection with work for their employer or client.

Tickets from a bidder whose bid the engineer is judging fall squarely within that prohibition; neither the USD 300 value nor after-the-fact disclosure changes it.

Disqualifying the bidder is a procurement decision that belongs to the department, not the individual engineer. The duty is to refuse and keep the evaluation impartial.

FE REFERENCE HANDBOOK — ETHICS AND PROFESSIONAL PRACTICE: NCEES MODEL RULES, RULES OF PROFESSIONAL CONDUCT (CONFLICTS OF INTEREST AND GRATUITIES PROVISIONS)

WHY THE OTHER CHOICES APPEAR

(A) Applies a nonexistent de minimis exception; the Model Rules prohibition on gratuities from contractors in connection with the licensee's work contains no value threshold.

(B) Treats disclosure as a cure for acceptance; disclosure applies to unavoidable conflicts of interest, not to gratuities, which must be refused outright.

(D) Overextends the engineer's authority; the ethical duty is to refuse the gratuity, and unilaterally disqualifying the bidder is a procurement action the rules neither require nor authorize the engineer to take alone.

Engineering Economics

Problem 15

Answer: (C)

Two booster pump stations are being considered for a water main extension. Station A has a first cost of USD 60,000 and annual operating costs of USD 11,000. Station B has a first cost of USD 95,000 and annual operating costs of USD 5,000. Both stations have 10-year lives with no salvage value. At an interest rate of 8% per year, the equivalent uniform annual cost of the more economical alternative is most nearly:

At 8% the capital recovery factor is 0.14903; Station B annualizes to USD 19,158 against USD 19,942 for Station A, so the economical alternative costs most nearly USD 19,160 per year.

Equal 10-year lives with no salvage make equivalent uniform annual cost the natural basis; first find the capital recovery factor.

$$(A/P, 8\%, 10) = \frac{0.08(1.08)^{10}}{(1.08)^{10} - 1} = 0.14903$$

$$EUAC_A = 60,000(0.14903) + 11,000 = 19,942$$

$$EUAC_B = 95{,}000(0.14903) + 5{,}000 = 19{,}158$$

FE REFERENCE HANDBOOK — ENGINEERING ECONOMICS: CAPITAL RECOVERY (A/P, I%, N)

WHY THE OTHER CHOICES APPEAR

(A) Using the sinking fund factor (A/F, 8%, 10) = 0.06903 in place of (A/P) for Station B gives 95,000(0.06903) + 5,000 = 11,558.

(B) Dividing the first cost of Station B by the life without interest gives 95,000/10 + 5,000 = 14,500.

(D) USD 19,942 is the equivalent uniform annual cost of Station A, the less economical alternative.

Statics

Problem 19

Answer: (A)

A 500-N traffic signal head hangs from point A. Cable AB extends from A to a pole on one side and rises at 30° above the horizontal; cable AC extends to a pole on the opposite side and rises at 45° above the horizontal. The tension in cable AB is most nearly:

Force balance at A in both directions yields $T_{AB} = 500/(\sin 30^\circ + \cos 30^\circ) = 366$ N.

Three forces meet at A: the 500-N weight and the two cable tensions.

$$\Sigma F_x : T_{AB}\cos 30^\circ = T_{AC}\cos 45^\circ$$

$$\Sigma F_y : T_{AB}\sin 30^\circ + T_{AC}\sin 45^\circ = 500 \text{ N}$$

With $\tan 45^\circ = 1$, the horizontal equation gives $T_{AC}\sin 45^\circ = T_{AB}\cos 30^\circ$; the vertical sum then contains only T_{AB}.

$$T_{AB}(\sin 30^\circ + \cos 30^\circ) = 500$$

$$T_{AB} = \frac{500}{1.366} = 366 \text{ N}$$

FE REFERENCE HANDBOOK — STATICS: EQUILIBRIUM REQUIREMENTS

WHY THE OTHER CHOICES APPEAR

(B) Assumes the two cable tensions are equal and sums vertical components, $T(\sin 30^\circ + \sin 45^\circ) = 500$, giving 414 N.

(C) Reports the tension in cable AC (448 N) instead of cable AB.

(D) Sets the cable tension equal to the full supported weight.

Dynamics

Problem 28

Answer: (C)

A water jet discharges from a nozzle at grade with an initial velocity of 18 m/s at an angle of 35° above the horizontal. Air resistance is neglected. The horizontal distance from the nozzle to the point where the jet returns to nozzle elevation is most nearly:

Symmetric flight over level ground: the jet stays aloft for $t = 2v_0 \sin\theta / g$ while drifting downrange at $v_0 \cos\theta$, landing 31.0 m from the nozzle.

Velocity components at launch:

$$v_x = 18 \cos 35^\circ = 14.74 \text{ m/s}$$

$$v_y = 18 \sin 35^\circ = 10.32 \text{ m/s}$$

Zero net vertical displacement fixes the time aloft:

$$t = \frac{2 v_0 \sin\theta}{g} = \frac{2(10.32)}{9.81} = 2.105 \text{ s}$$

Carried at constant v_x for that time, the jet travels

$$x = v_x t = 14.74 \times 2.105 = 31.0 \text{ m}$$

FE REFERENCE HANDBOOK — DYNAMICS: PROJECTILE MOTION

WHY THE OTHER CHOICES APPEAR

(A) Omits the factor of 2 in the range expression, computing $v_0^2 \sin\theta\cos\theta / g = 324(0.5736)(0.8192)/9.81 = 15.5$ m.

(B) Uses $\sin\theta$ instead of $\sin 2\theta$ in $R = v_0^2 \sin 2\theta / g$, giving $324(0.5736)/9.81 = 18.9$ m.

(D) Multiplies the full speed 18 m/s, instead of the horizontal component, by the flight time 2.105 s, giving 37.9 m.

Mechanics of Materials

Problem 33

Answer: (C)

A straight steel member with a cross-sectional area of 8.0 in^2 is fully restrained against axial deformation between two bridge abutments. The coefficient of thermal expansion is 6.5×10^{-6} per degree F, and the modulus of elasticity is 29×10^6 psi. For a uniform temperature rise of 70 degrees F, the compressive force developed in the member is most nearly:

Restrained thermal strain converts entirely to stress: $\sigma = E\alpha\Delta T = 13,195$ psi, which over 8.0 in^2 is $105,600$ lb — about 106 kips.

Left free, the member would expand by $\alpha \Delta T$; the abutments deny all of it.

$$\epsilon_t = \alpha \Delta T = (6.5 \times 10^{-6})(70) = 4.55 \times 10^{-4}$$

That denied strain returns as elastic stress.

$$\sigma = E\alpha \Delta T = (29 \times 10^6)(4.55 \times 10^{-4}) = 13,195 \text{ psi}$$

$$F = \sigma A = (13,195)(8.0) = 105,600 \text{ lb} \approx 106 \text{ kips}$$

FE REFERENCE HANDBOOK — MECHANICS OF MATERIALS: THERMAL DEFORMATIONS

WHY THE OTHER CHOICES APPEAR

(A) Stopped at the restraint stress, 13,195 psi = 13.2 ksi, and reported it as a force in kips.

(B) Converted the 70 degree F rise to 38.9 degrees C while keeping alpha per degree F, giving (188.5)(38.9)(8.0) = 58.6 kips.

(D) Used the SI coefficient 11.7e-6 per degree C with the Fahrenheit temperature rise, giving 23,751 psi times 8.0 in^2 = 190 kips.

Materials

Problem 42

Answer: (B)

A sieve analysis of a concrete fine aggregate gives cumulative percentages retained on the 4.75-mm, 2.36-mm, 1.18-mm, 0.600-mm, 0.300-mm, and 0.150-mm sieves of 4, 15, 36, 58, 78, and 89, respectively. The fineness modulus of the aggregate is most nearly:

The six cumulative retained percentages total 280, making the fineness modulus 280/100 = 2.80.

Fineness modulus works on cumulative percent retained — not incremental values, not percent passing.

$$FM = \frac{\sum(\text{cumulative percent retained})}{100}$$

$$4 + 15 + 36 + 58 + 78 + 89 = 280$$

$$FM = \frac{280}{100} = 2.80$$

FE REFERENCE HANDBOOK — CIVIL ENGINEERING: AGGREGATE GRADATION, FINENESS MODULUS

WHY THE OTHER CHOICES APPEAR

(A) Sums the incremental (individual) percentages retained, which totals 89, and divides by 100, giving 0.89.

(C) Sums the cumulative percentages passing (96 + 85 + 64 + 42 + 22 + 11 = 320) instead of retained, giving 3.20.

(D) Adds 100 percent for the pan to the cumulative retained sum, (280 + 100)/100 = 3.80.

Fluid Mechanics

Problem 47

Answer: (B)

A vertical rectangular gate in a reservoir retaining wall is 4 ft wide and 6 ft tall. The top edge of the gate is 8 ft below the free water surface. The specific weight of water is 62.4 lbf/ft^3. The magnitude of the resultant hydrostatic force on the gate is most nearly:

Pressure at the centroid governs: $\bar{h} = 11\,ft$ over $A = 24\,ft^2$ gives $F_R = \gamma \bar{h} A \approx 16,500\,lbf$.

Depth to the gate centroid, and the wetted area.

$$\bar{h} = 8 + \frac{6}{2} = 11 \text{ ft}$$

$$A = 4 \times 6 = 24 \text{ ft}^2$$

Centroid pressure times area gives the resultant on any plane surface.

$$F_R = \gamma \bar{h} A$$

$$F_R = 62.4 \times 11 \times 24 = 16,474 \text{ lbf}$$

FE REFERENCE HANDBOOK — FLUID MECHANICS: FORCES ON SUBMERGED SURFACES (RESULTANT FORCE ON A PLANE SURFACE)

WHY THE OTHER CHOICES APPEAR

(A) Using the depth to the top edge (8 ft) instead of the centroid gives 62.4 x 8 x 24 = 11,981 lbf.

(C) Using the depth to the bottom edge (14 ft) instead of the centroid gives 62.4 x 14 x 24 = 20,966 lbf.

(D) Integrating the pressure prism from the free surface to the bottom edge over the gate width, (1/2)(62.4)(14^2)(4), gives 24,461 lbf.

Surveying

Problem 54

Answer: (C)

A water main is to be laid from point A (N 1,200.00 m, E 800.00 m) to point B (N 950.00 m, E 1,100.00 m). The azimuth from north of line AB is most nearly:

AB runs southeast ($\Delta N = -250$ m, $\Delta E = +300$ m), so the $50.19°$ bearing angle becomes azimuth $180° - 50.19° = 129.8°$.

Inverse from A to B.

$$\Delta N = 950.00 - 1200.00 = -250.00 \text{ m}$$

$$\Delta E = 1100.00 - 800.00 = +300.00 \text{ m}$$

Departure over latitude gives the angle off the meridian.

$$\theta = \arctan\left(\frac{300.00}{250.00}\right) = 50.19°$$

$\Delta N < 0$ with $\Delta E > 0$ places the line S 50.19° E; the azimuth folds back from 180°.

$$Az = 180° - 50.19° = 129.8°$$

FE REFERENCE HANDBOOK — CIVIL ENGINEERING, SURVEYING: COORDINATE INVERSE (AZIMUTH FROM LATITUDES AND DEPARTURES)

WHY THE OTHER CHOICES APPEAR

(A) Inverts the tangent ratio, computing arctan(250/300) = 39.8° and stopping without quadrant adjustment.

(B) Reports the reference angle 50.2° (the bearing angle) without converting to an azimuth in the southeast quadrant.

(D) Places the line in the southwest quadrant, computing 180° + 50.2° = 230.2° (sign error on the departure).

Water Resources and Environmental Engineering

Problem 59

Answer: (B)

A rectangular concrete-lined drainage channel has a bottom width of 8 ft and carries uniform flow at a depth of 3 ft. The Manning roughness coefficient is 0.013, and the bed slope is 0.002 ft/ft. The discharge is most nearly:

With $A = 24$ ft² and $R = 1.714$ ft, the USCS Manning equation gives 176 ft³/s.

Only the bed and the two side walls are wetted.

$$A = by = (8)(3) = 24 \text{ ft}^2$$

$$R = \frac{A}{b + 2y} = \frac{24}{14} = 1.714 \text{ ft}$$

Manning's equation governs uniform flow; in USCS units the 1.486 factor is mandatory.

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.486}{0.013}(24)(1.714)^{2/3}(0.002)^{1/2} = 175.7 \text{ ft}^3/\text{s}$$

FE REFERENCE HANDBOOK — WATER RESOURCES AND ENVIRONMENTAL ENGINEERING: MANNING EQUATION

WHY THE OTHER CHOICES APPEAR

(A) Omitting the USCS conversion factor 1.486 (using the SI form with n = 0.013) gives 118 ft³/s.

(C) Using the flow depth 3 ft as the hydraulic radius instead of A/P gives 255 ft³/s.

(D) Raising R to the 3/2 power instead of the 2/3 power gives 275 ft³/s.

Structural Engineering

Problem 71

Answer: (C)

A determinate portal frame consists of vertical columns AB and DC, each 4 m tall, and horizontal beam BC spanning 6 m between the column tops B and C. The frame is supported by a pin at base A and by a roller at base D that resists vertical force only. A horizontal load of 30 kN is applied at joint B, directed toward C. The maximum bending moment in the frame is most nearly:

Only the pin at A can resist horizontal force, so column AB carries the full 30 kN and the moment peaks at its top: $30 \times 4 = 120$ *kN·m.*

With the roller at D unable to take horizontal force, the pin at A resists the full 30 kN; the vertical reactions form a couple balancing the overturning.

$$A_x = 30 \text{ kN}$$

$$\Sigma M_A = 0: \quad D_y(6) = 30(4) \Rightarrow D_y = 20 \text{ kN } (\uparrow),\ A_y = 20 \text{ kN } (\downarrow)$$

Cut column AB just below B: the 30-kN base shear acting through 4 m sets the joint moment. Along the beam it falls linearly to zero at C, since column DC carries axial force only.

$$M_B = 30 \text{ kN} \times 4 \text{ m} = 120 \text{ kN} \cdot \text{m}$$

FE REFERENCE HANDBOOK — STATICS: EQUATIONS OF EQUILIBRIUM (FRAMES AND FREE-BODY DIAGRAMS)

WHY THE OTHER CHOICES APPEAR

(A) Splits the 30-kN lateral load equally between the two columns as in the portal method, giving 15 x 4 = 60 kN·m, although the roller cannot resist horizontal force.

(B) Multiplies the 20-kN vertical reaction at D by the 4-m column height instead of tracking the lateral load path.

(D) Multiplies the 30-kN load by the 6-m beam span instead of the 4-m column height.

Geotechnical Engineering

Problem 82

Answer: (C)

A saturated clay specimen has a water content of 40% and a specific gravity of solids of 2.70. The saturated unit weight of the specimen is most nearly:

Saturation forces e = wG_s = 1.08, and the phase relation returns γ_sat = 17.8 kN/m³.

Saturation ($S = 1$) fixes the void ratio through $Se = wG_s$.

$$e = wG_s = 0.40 \times 2.70 = 1.08$$

With e known, the unit weight follows directly, taking $\gamma_w = 9.81$ kN/m³.

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1 + e} = \frac{(2.70 + 1.08)(9.81)}{1 + 1.08} = 17.8 \text{ kN/m}^3$$

FE REFERENCE HANDBOOK — GEOTECHNICAL: PHASE RELATIONSHIPS (UNIT WEIGHT EQUATIONS)

WHY THE OTHER CHOICES APPEAR

(A) Reports the buoyant (submerged) unit weight, 17.83 − 9.81 = 8.0 kN/m³, instead of the saturated unit weight.

(B) Reports the dry unit weight, G_s·γ_w/(1+e) = 12.7 kN/m³, omitting the pore water.

(D) Computes the void ratio as e = w/G_s = 0.148, giving (2.70 + 0.148)(9.81)/1.148 = 24.3 kN/m³.

Transportation Engineering

Problem 94

Answer: (D)

A two-lane rural highway approaches an intersection on a 4.0% downgrade. The design speed is 50 mph, the perception-reaction time is 2.5 s, and the deceleration rate is 11.2 ft/s². The stopping sight distance is most nearly:

A downgrade reduces the effective deceleration, stretching the braking distance to 270.7 ft; added to 183.75 ft of perception-reaction travel, the SSD is 454 ft.

On a downgrade gravity works against the brakes, so $G = 0.04$ subtracts inside the braking term.

$$SSD = 1.47\,Vt + \frac{V^2}{30\left(\frac{a}{32.2} - G\right)}$$

Reaction covers ground before the brakes do anything.

$$1.47(50)(2.5) = 183.75 \text{ ft}$$

Braking distance follows, with $a/32.2 = 11.2/32.2 = 0.3478$.

$$\frac{50^2}{30(0.3478 - 0.04)} = \frac{2500}{9.235} = 270.7 \text{ ft}$$

$$SSD = 183.75 + 270.7 = 454.5 \text{ ft}$$

FE REFERENCE HANDBOOK — TRANSPORTATION: STOPPING SIGHT DISTANCE (GRADE-ADJUSTED BRAKING DISTANCE EQUATION)

WHY THE OTHER CHOICES APPEAR

(A) Omits the perception-reaction distance and reports the braking distance alone, 270.7 ft.

(B) Adds the grade term instead of subtracting it (treats the downgrade as an upgrade): 183.75 + 2500/(30 x 0.3878) = 398.6 ft.

(C) Ignores the grade entirely: 183.75 + 2500/(30 x 0.3478) = 423.3 ft.

Construction Engineering

Problem 105

Answer: (D)

Between station 12+00 and station 30+00, a roadway grading plan shows 8{,}200 yd³ of excavation (bank measure) and 6{,}600 yd³ of embankment (compacted measure). The shrinkage factor from bank volume to compacted volume is 0.88. The change in the mass haul diagram ordinate across this interval, expressed in bank volume, is most nearly:

Compacted fill converts to 6,600/0.88 = 7,500 yd³ of bank material, leaving a 700 yd³ cut surplus across the interval.

Cut and fill must be compared in the same measure, so bring the embankment to bank volume.

$$V_{bank} = \frac{6,600}{0.88} = 7,500 \text{ yd}^3$$

Surplus cut drives the ordinate upward: the change is cut minus fill, both in bank measure.

$$\Delta = 8,200 - 7,500 = 700 \text{ yd}^3$$

FE REFERENCE HANDBOOK — CIVIL ENGINEERING: EARTHWORK FORMULAS (SHRINKAGE/SWELL) AND MASS DIAGRAM

WHY THE OTHER CHOICES APPEAR

(A) Ignores shrinkage and subtracts volumes in different measures (8,200 − 6,600 = 1,600).

(B) Multiplies the fill by 0.88 instead of dividing (8,200 − 6,600 × 0.88 = 2,392).

(C) Applies the factor to the cut instead of the fill (8,200/0.88 − 6,600 = 2,718).