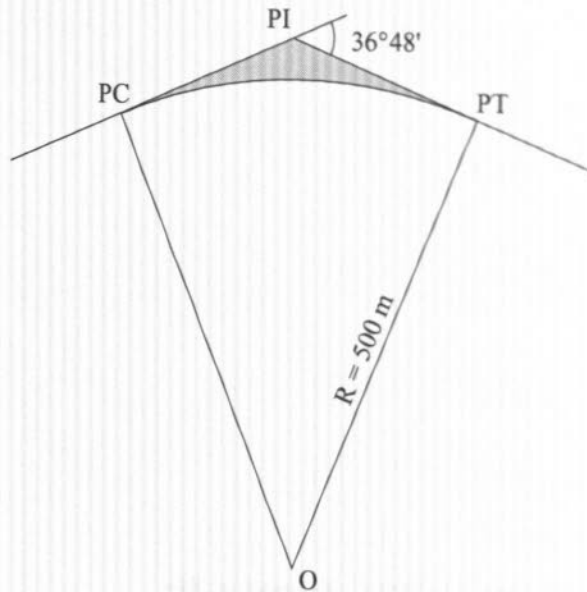# CIVIL
AFTERNOON SAMPLE QUESTIONS

NOTE: THESE QUESTIONS REPRESENT HALF THE NUMBER OF QUESTIONS THAT APPEAR ON THE ACTUAL EXAMINATION.

CIVIL SAMPLE QUESTIONS

1. A slope distance and zenith angle of 123.456 m and 102°54'00", respectively, are measured using a total station. The horizontal distance (m) is most nearly:

   (A) 123.335

   (B) 123.298

   (C) 120.511

   (D) 120.340

2. The arc definition of the Degree of Curve (D) is defined as the:

   (A) central angle subtended by 100 ft of arc

   (B) central angle subtended by 50 ft of chord

   (C) central angle subtended by 50 ft of arc

   (D) total arc length of the curve in stations divided by the total central angle in degrees

3. The area inside of the quadrilateral PC, PI, PT, and O below equals 83,164 m^2. The shaded area (m^2) between the circular curve and the tangents is most nearly:

(A) 2,879
(B) 3,577
(C) 5,407
(D) 8,286

GO ON TO THE NEXT PAGE

4. The cross-sectional areas to be excavated (cut) at certain sections of a road project are as follows:

Station	Area (ft²)
3+00	247
4+00	269
4+35	322
5+00	395
5+65	418
6+00	293
7+00	168

Using the prismoidal method, the earth to be excavated (yd^3) between Sections 4+35 and 5+65 is most nearly:

(A) 1,460
(B) 1,840
(C) 1,860
(D) 1,900

5. A 12-in.-diameter concrete sanitary sewer ($n = 0.013$, constant with depth) flows half full and is constructed on a grade of 0.5%. The flow velocity (ft/sec) in this sewer is most nearly:

(A) 1.6
(B) 2.0
(C) 3.2
(D) 32.4

6.   Two tanks are connected by a 500-ft length of 1-in.-I.D. PVC pipe. The appropriate value for the Hazen-Williams coefficient C is 150. Water at 60°F is flowing through the pipe at a velocity of 10 ft/sec. The tanks are open to the atmosphere. Entrance, exit, and minor losses are negligible. The difference in water surface elevation (ft) between the two tanks is most nearly:
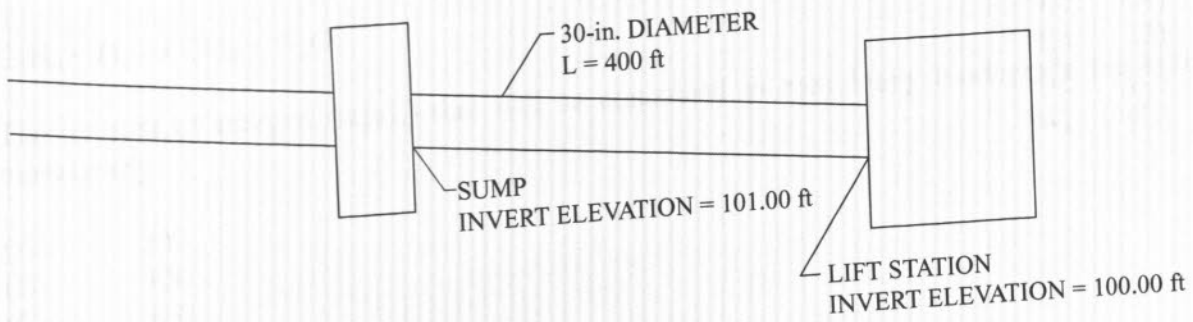
   (A)   81
   (B)   167
   (C)   182
   (D)   447

7.   Waste activated sludge can be described as a Newtonian fluid with a kinematic viscosity of 20×10^{-5} ft²/sec. At the same temperature, the kinematic viscosity v of water is 10^{-5} ft²/sec. The relative roughness of the piping system is 0.001.

   The pressure drop for flow of water at a Reynolds number of 10^7 in this piping system was determined to be 1.0 psi. If waste activated sludge flows at the same velocity through the piping system, the pressure drop (psi) is most nearly:

   (A)   1.0
   (B)   2.0
   (C)   3.0
   (D)   4.0

HE

CIVIL SAMPLE QUESTIONS

8. A sanitary sewer delivers flow from a sump to a lift station as shown in the figure below. The sewer length is 400 ft, and the diameter is 30 in. The sewer is made of concrete (Manning's roughness coefficient, $n = 0.013$, and is constant with depth).

30-in. DIAMETER
L = 400 ft

SUMP
INVERT ELEVATION = 101.00 ft

LIFT STATION
INVERT ELEVATION = 100.00 ft

For full pipe flow with water surface elevations in the upstream sewer sump and lift station wet well of 105.00 and 103.50 ft, respectively, the discharge (cfs) is most nearly:

(A) 46.1
(B) 25.1
(C) 13.8
(D) 5.1

9. An embankment having a volume of 320,000 yd³ is to be constructed from local borrow. The dry unit weight and moisture content of the borrow material were determined to be 106 pcf and 18.2%, respectively. The embankment material has a total unit weight of 122 pcf and a moisture content of 16.7%. The volume of borrow (yd³) needed to construct the embankment is most nearly:

(A) 274,100
(B) 315,500
(C) 324,500
(D) 373,600

CIVIL SAMPLE QUESTIONS

10. A sample of field sand was tested in a triaxial device. At a confining pressure of 80 psi, the field sand failed at an applied external pressure of 400 psi. The angle of internal friction of the sand is most nearly:

   (A) 53°
   (B) 42°
   (C) 34°
   (D) 24°

11. A 12-ft-high retaining wall has backfill of granular soil with an internal angle of friction of 30° and a unit weight of 125 pcf. The Rankine passive earth pressure (lb/ft^2) possible on the wall is most nearly:

   (A) 2,250
   (B) 3,000
   (C) 9,000
   (D) 27,000

12. A normally consolidated 10-ft clay layer is surcharged, which causes a decrease in thickness. The coefficient of consolidation is 0.16 ft^2 per day and the time factor is 1.2 for U = 50%. The clay layer is confined between two layers of dense sand. The time (days) required for 50% consolidation is most nearly:

   (A) 5
   (B) 38
   (C) 188
   (D) 750

13. You are designing an aerobic system to biodegrade benzene (C_6H_6). The biodegradation follows the chemical reaction below (note that you must balance this equation). The benzene concentration is 500 mg/L. (C = 12, H = 1, O = 16)

$$C_6H_6 + O_2 \rightarrow CO_2 + H_2O$$

The amount of oxygen (mg/L) that will be consumed to completely biodegrade the benzene is most nearly:

(A)   200
(B)   500
(C)   800
(D)   1,600

14. Three wastewater flows combine in a sewer, each having flows and BOD concentrations as follows.

Source	Flow (L/day)	BOD (mg/L)
1	4.0×10^6	200
2	0.8×10^6	300
3	0.2×10^6	500

If infiltration (having zero BOD) is 10% of total flow, the resulting BOD (mg/L) is most nearly:

(A)   76
(B)   207
(C)   228
(D)   333

GO

CIVIL SAMPLE QUESTIONS

Questions 15–16: A municipal activated sludge wastewater treatment plant with primary clarification and anaerobic digestion has the following influent characteristics:

Flow	5 MGD
BOD_5	200 mg/L @ 20°C
Suspended solids	220 mg/L

The facility is normally operated, and the following data apply:

Waste sludge flow rate	0.1 MGD
Mixed liquor suspended solids	2,500 mg/L
Return sludge concentration	6,000 mg/L
Waste activated sludge concentration	6,000 mg/L
Aeration basin hydraulic residence time	10 hr
Primary clarifier overflow rate	900 gal/day/ft^2
Effluent BOD_5	10 mg/L

15. If the plant BOD_5 removal efficiency is 95% and the primary clarifier removes 35% of the influent BOD, the amount of BOD_5 removed (lb/day) in the biological reaction is most nearly:

    (A)   2,919
    (B)   5,004
    (C)   6,592
    (D)   7,923

16. The aeration basin volume (gal) is most nearly:

    (A)   1,260,000
    (B)   1,870,000
    (C)   2,080,000
    (D)   50,000,000

17. Which of the following is a prominent operating characteristic of cloverleaf interchanges?

    (A)   There are no unusual signing challenges.

    (B)   Traffic exits before additional traffic enters.

    (C)   There are low speeds on the loop ramps.

    (D)   There is no weaving traffic between exiting and entering traffic.

18. A person is driving a car on a road that has a gravel surface. A deer suddenly leaps into the road. The road is on a 10% downgrade, and the car is traveling at 50 mph when the deer appears. The driver's reaction time is 1.5 sec, and the coefficient of friction on the gravel surface is 0.65.

The coefficient of friction, $f = \dfrac{\text{deceleration rate, } a}{32.2 \text{ ft/sec}^2}$

The total distance (ft) required to stop is most nearly:

    (A)   153
    (B)   222
    (C)   242
    (D)   262

19.   A freeway lane has a volume of 1,400 vehicles/hr and an average vehicle speed of 45 mph. The time spacing (sec) between vehicles (center to center) is most nearly:

(A)   2.6
(B)   5.2
(C)   15
(D)   31

20.   A street underpass has a sag vertical curve. The following data apply:

Length of vertical curve	6.00 stations
Entering profile grade, g_1	−1.5%
Exiting profile grade, g_2	+2.5%
PVI station	32+00
PVI elevation	250.00

A drainage inlet must be designed to carry away the stormwater flow at the low point of the vertical curve. The station of the center of the inlet is most nearly:

(A)   29+75

(B)   31+25

(C)   32+75

(D)   34+25

GO ON TO THE NEXT PAGE

CIVIL SAMPLE QUESTIONS

21. The 40-kip vertical load at Joint C in the steel truss shown below produces the forces given in the accompanying table. The cross-sectional area of each member is 4.0 in^2, and the length of each member is given in the table. The elastic modulus of steel is 29,000 ksi. The downward vertical displacement (in.) of Joint C is most nearly:

   (A)   1.046
   (B)   0.294
   (C)   0.132
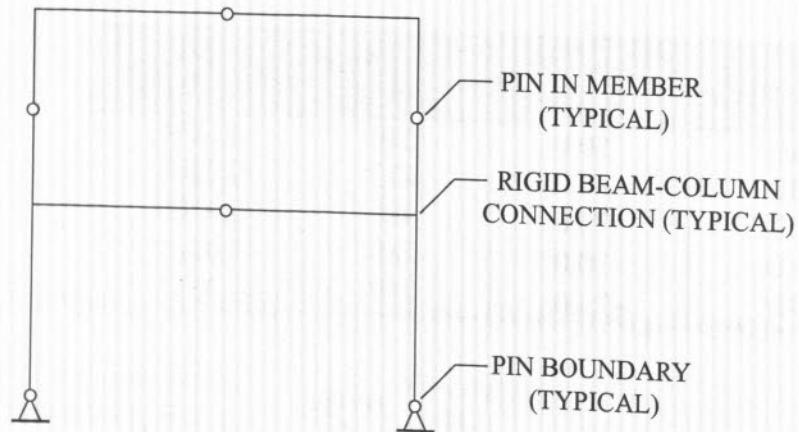   (D)   0.102

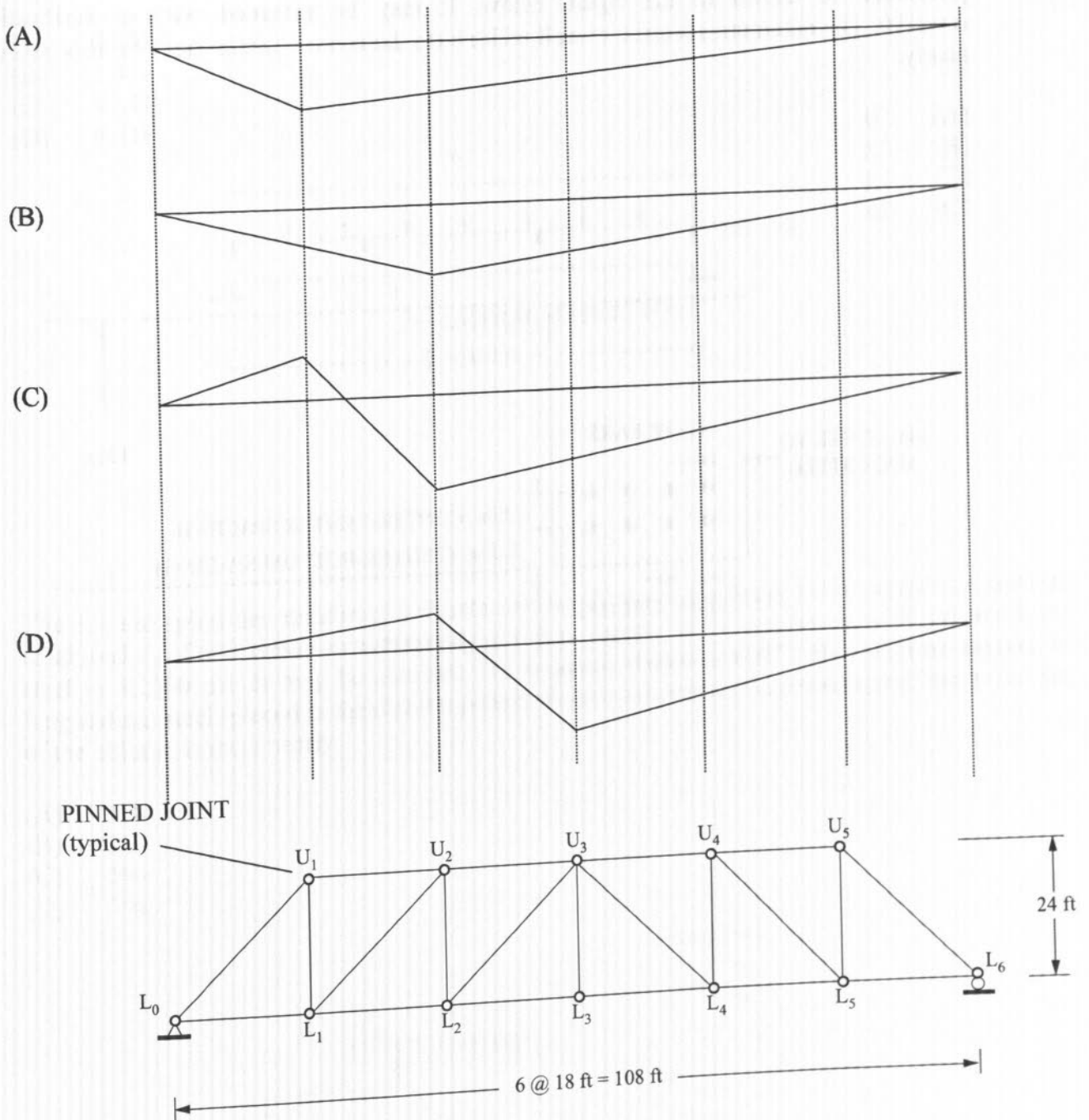| Member	Force, F (kips)	Length, L (in.)	$\dfrac{FL}{AE}$
AB	50.0	240	0.1034
BC	49.2	473	0.2008
CD	−75.0	480	−0.3103
AD	−30.0	288	−0.0745
BD	−25.0	240	−0.0517
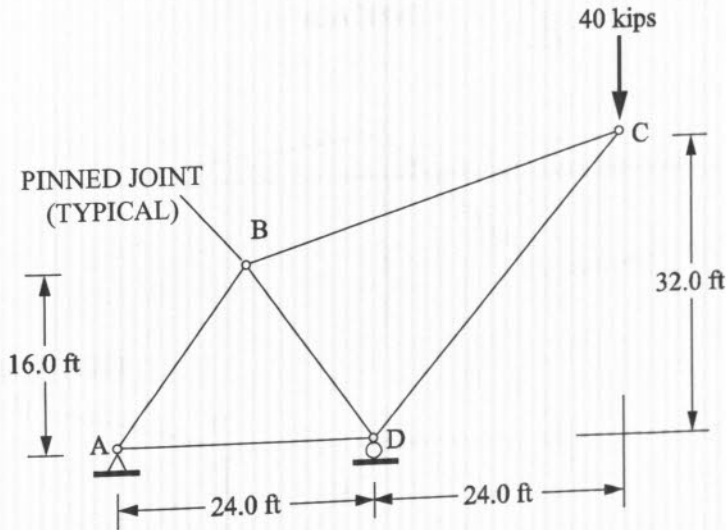
22. The frame in the figure below is:

(A) unstable

(B) stable and determinate

(C) indeterminate one degree

(D) indeterminate two degrees

PIN IN MEMBER
(TYPICAL)
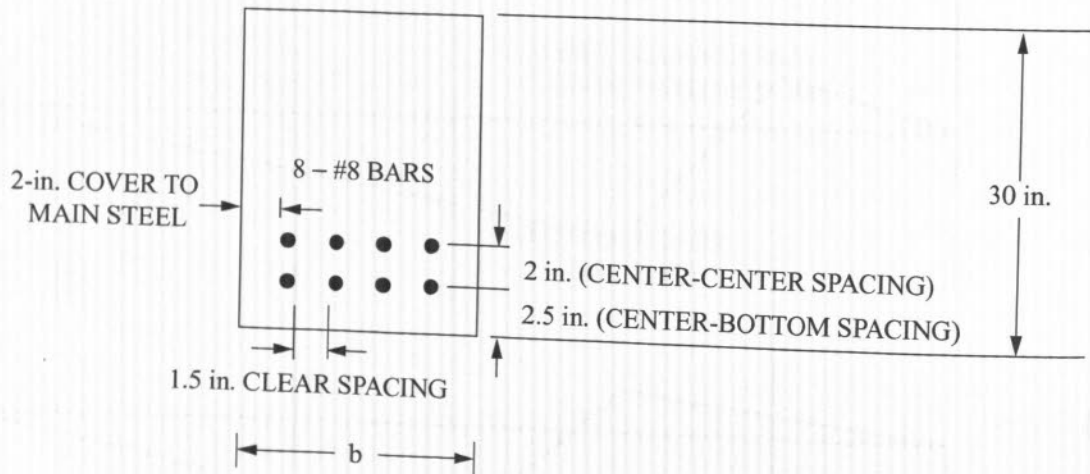
RIGID BEAM-COLUMN
CONNECTION (TYPICAL)

PIN BOUNDARY
(TYPICAL)

CIVIL SAMPLE QUESTIONS

23. Which of the vertical-load influence lines shown below is correct for Member U_2U_3 of the truss shown below?

(A)

(B)

(C)

(D)

PINNED JOINT (typical)

U_1 U_2 U_3 U_4 U_5

24 ft

L_0 L_1 L_2 L_3 L_4 L_5 L_6

6 @ 18 ft = 108 ft

GO THE GE

24. A reinforced concrete beam is subjected to a factored moment Mu = 648 ft-kips. For concrete $f_c' = 4,000$ psi, and for steel $f_y = 60,000$ psi. The beam is reinforced with eight #8 bars in two rows, positioned as shown in the figure below. It may be assumed without verification that $\phi = 0.90$. The minimum adequate overall width b (to the nearest whole inch) for this beam is most nearly:

(A)   10
(B)   12
(C)   13
(D)   15

2-in. COVER TO MAIN STEEL

8 – #8 BARS

30 in.

2 in. (CENTER-CENTER SPACING)

2.5 in. (CENTER-BOTTOM SPACING)
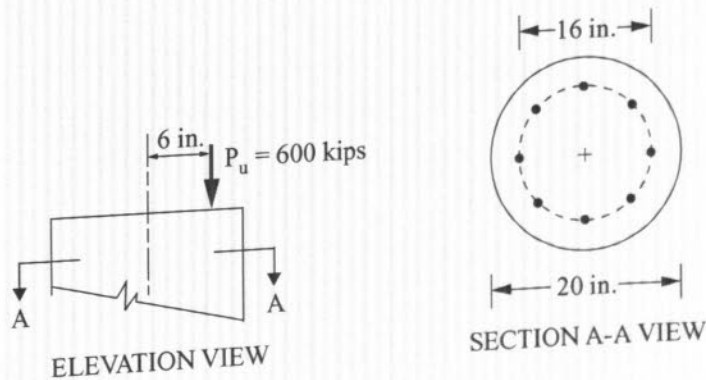
1.5 in. CLEAR SPACING

b

25. The W21 × 44 steel beam shown in the figure below has its compression flange laterally braced at the one-third points over its full length. Assume F_y = 50 ksi and C_b = 1.0 for the critical segment. The maximum factored load w_u (kips/ft) that the beam can carry for this length is most nearly:

(A)   2.187
(B)   2.444
(C)   3.191
(D)   3.548

w_u

W21 × 44

LATERAL SUPPORT POINT

|←———————— L = 30.0 ft ————————→|
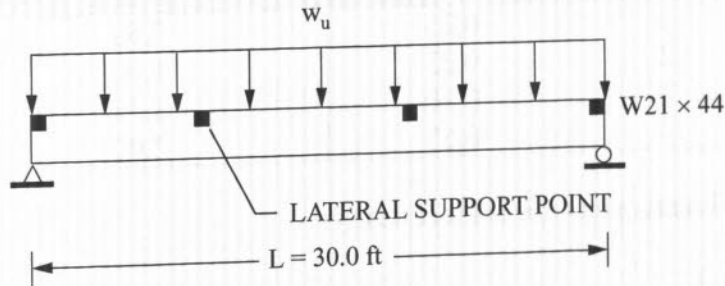
26. The circular spiral-tied reinforced concrete column shown in the figure below supports a factored axial load P_u of 600 kips at an eccentricity of 6.0 in. Assume f_c' for concrete is 4,000 psi, and f_y for steel is 60,000 psi. It may be assumed the resistance factor ϕ = 0.7. The required amount of longitudinal steel (placed in the circular pattern shown) expressed as a percentage of the gross area of the column is most nearly:

(A)   1%
(B)   2%
(C)   5%
(D)   7%

|←— 16 in. —→|

6 in.
P_u = 600 kips

|←——— 20 in. ———→|

A

A

ELEVATION VIEW

SECTION A-A VIEW

85

27. The average production of the excavator is the controlling factor in a highway ditch cleaning contract. Excavators with four different size buckets are available as rental units. The hourly rental rate is directly proportional to the bucket capacity of the excavator. Assume that production (loose yd^3/hr) is equal to (excavator cycles per hour) × (average bucket payload in LCY per cycle). The excavator characteristics are as follows:

Excavator	Minimum Cycle Time (min)	Average Bucket Payload (LCY)
1	0.25	0.50
2	0.33	1.00
3	0.50	1.75
4	0.58	2.00

The optimally efficient excavator is most nearly:

(A)   Excavator 1

(B)   Excavator 2

(C)   Excavator 3

(D)   Excavator 4

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28. Which type of contract is best suited for emergency conditions where the scope of service and materials cannot be accurately determined in advance?

   (A) Lump sum

   (B) Bonding

   (C) Unit pricing

   (D) Cost plus percentage fee

29. A steel bar is tested in tension at a stress less than the yield strength. The modulus of elasticity is most nearly:

   (A) axial stress divided by change in length

   (B) axial load divided by change in length

   (C) axial stress divided by axial strain

   (D) axial load divided by axial deformation

87

30. The following preliminary concrete mix has been designed assuming that the aggregates are in oven-dry condition.

Water	305 lb/yd^3
Cement	693 lb/yd^3
Coarse aggregate (SSD)	1,674 lb/yd^3
Fine aggregate (SSD)	1,100 lb/yd^3

The properties of the aggregates are:

Absorption (moisture content at SSD)	0.5%	0.7%
Moisture content as used in mix	2.0%	6.0%

The amount of water (lb/yd^3) that would be used in the final mix is most nearly:

(A) 206
(B) 222
(C) 305
(D) 388

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY WISH TO CHECK YOUR WORK ON THIS TEST.