FE Civil Exam Review Guide

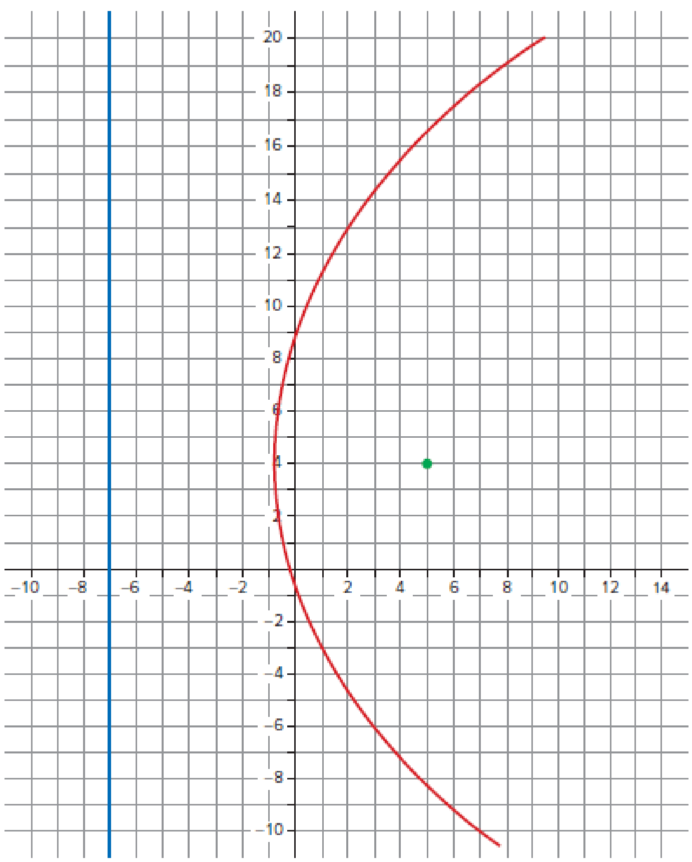
Errata

(updated 10/29/2021)

This document will be updated regularly.

CHAPTER 1: Mathematics & Statistics

(1) p. 8: In Example 1.4, the figure in the problem statement is incorrect. It should appear as follows:



(2) p. 10: In Example 1.5, the last number set in the solution should be (-2, 3) rather than (-1, 3). Therefore, the dots on the image should appear as follows.

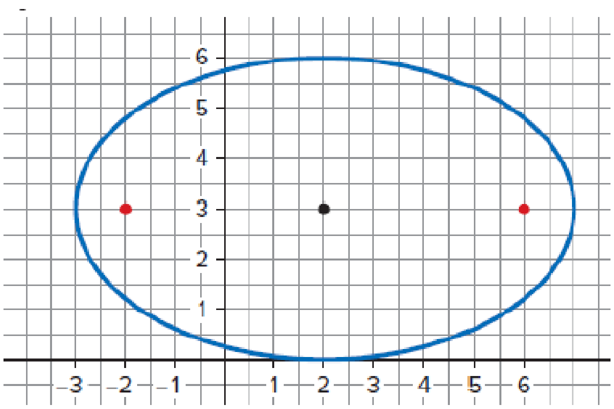
Example 1.5: From Equation to Geometry of an Ellipse

Find the center and two focus points for the ellipse:

$(x - 2)^2/25 + (y - 3)^2/9 = 1$

Solution

The center is $(h, k) = (2, 3)$. The values for a and b are given by $a^2 = 25$ and $b^2 = 9$, so $a = 5$ and $b = 3$. The value of e is $e = \sqrt{1 - b^2/a^2} = \sqrt{1 - 9/25} = 4/5$, so the focus points are at $(h + ae,\ k) = (2 + 5 \times (4/5),\ 3) = (6,\ 3)$ and $(h - ae,\ k) = (2 - 5 \times (4/5),\ 3) = (-2,\ 3)$.



Remember the relative coordinates: add (h, k) to the coordinates for your focus points.

(3) p. 10: In Equation 1-8, the standard equation for a hyperbola, the plus sign should be changed to a minus sign as shown below.

$$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$$

(4) p. 14: The table embedded in the solution to Example 1.8 contains two typographical errors, shown below in red boxes.

	$2x + 3$	$x^2 + 6x + 5$	$5e^{0.2x}$	$2 \sin x + 3$
$y_1 = f(x_1) = f(0)$	3	5	5	3
$y_2 = f(x_2) = f(3)$	9	32	9.11	3.28
$y_2 - y_1$	6	27	4.11	0.28
$(y_2 - y_1)/(x_2 - x_1)$	2	9	1.37	0.09

(5) p. 17: In Section 1.2.2.1, the second instance of the word "increasing" should read "decreasing." The correction is shown below:

1.2.2 Applications of the Derivative

1.2.2.1 Optimization

The derivative is an essential tool for determining maximum and minimum values of a given function $y = f(x)$. To do this, the derivative dy/dx indicates the instantaneous rate of change of the y quantity per unit of increase in the x quantity. Thus,

dy/dx is positive at x if y is increasing at x.

dy/dx is negative at x if y is decreasing at x.

(7) p. 20: There are some errors in the solution for Example 1.15. The corrections are shown below:

Example 1.15: Curvature

Find the curvature of the function $y = x^3 - 75x$ at the value $x = 4.9$.

Solution

See the above formula. We will need to compute both the first and second derivatives. The first derivative is $y' = 3x^2 - 75$; the second derivative is $y'' = 6x$. Next, evaluate the derivatives at the given value, $x = 4.9$:

$y'(4.9) = 3(4.9)^2 - 75 = -2.97 \quad y''(4.9) = 6(4.9) = 29.4$

We can now compute the curvature as:

$$K = y''/[1 + (y')^2]^{3/2}$$
$$= 29.4/[1 + (-2.97)^2]^{3/2}$$
$$= 29.4/(9.82)^{3/2}$$
$$= 29.4/30.77$$

Answer: 0.955 (approximately)

The corresponding radius of curvature is $R = 1/K = 1/0.955 = 1.047$ (approximately). This can be visualized as a circle, tangent to the graph at $x = 4.9$, and also curving at the same rate as the graph:

$$\lim_{x \to 3} \frac{2}{(2x - 13)} = \frac{2}{(2(3) - 13)} = \frac{2}{-7} = \frac{-2}{7}$$

$$\boldsymbol{u} = \left(\frac{1}{T}\right) < a, b > = \frac{1}{|\mathbf{v}|} < a, b > = \frac{1}{\sqrt{(a^2 + b^2)}} < a, b > \qquad \textbf{Equation 1-33}$$

(10) pp. 36-37: In the third line of the solution to Example 1.36, 37 should be 39 and 3.7 should be 3.9. Two other instances of 3.7 should be changed to 3.9. The corrections appear in red boxes below.

Solution

X_i = value of the ith observation

w_i = weight applied to X_i

Here, this would be $\overline{X}_w = (2 \times 1 + 3 \times 3 + 4 \times 2 + 5 \times 4) / (1 + 3 + 2 + 4) =$ 3.9/10 = 3.9.

This is simply the sample mean $\overline{X}$ of the original data set of $n = 10$ values. Again, the weight here is simply the frequency of the values (for example, the value 4 occurs twice in the original data set).

In this situation, the sample mean is sometimes also known as the expected value. You may think of an experiment of randomly selecting one value X from the data set; then the sample mean 3.9 is the probability-weighted average result, considering that the

Example 1.36 *(continued)*

sample contains more values of 5 (weight of 4) and 3 (weight of 3), and fewer values of 2 and 4 (weights of 1 and 2, respectively). In other words, in a single random draw, some values have higher probability than others.

Answer: The average outcome is 3.9.

CHAPTER 3: Engineering Economics

(1) p. 90. In the solution of Example 3.4, the "$" sign in front of the 31.6235 and 31.6245, in both locations, otherwise the content is correct.

CHAPTER 4: STATICS

(1) p. 121: In the solution of Example 4.11, 34.5 kN should appear as 37.5 kN.

Example 4.11 *(continued)*

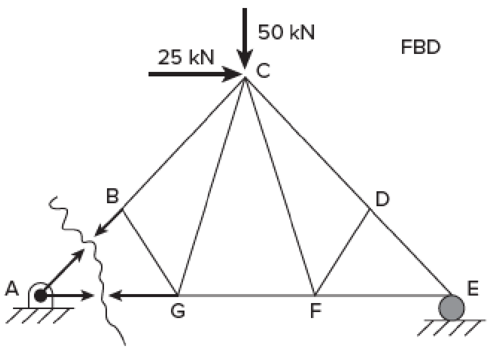
Solution

Find the reaction force at E.

$\sum M_A = 0$

$\therefore R_E \; 60 \text{ m} = 25 \text{ kN } (30 \text{ m}) + 50 \text{ kN } (30 \text{ m})$

$R_E = 37.5 \text{ kN}\uparrow$



Cut sections AB and AG and take moment at point C.

$M_C = 0$

$\therefore R_E \; (30 \text{ m}) = \text{AG}(30 \text{ m}) \qquad\qquad R_E = 37.5 \text{ kN}\uparrow$

$$\text{AG} = \frac{(37.5 \text{ kN})(30 \text{ m})}{30 \text{ m}}$$

$\text{AG} = 37.5 \text{ kN}$

CHAPTER 8: Fluid Mechanics

(1) p. 217: There is a typographical error in the solution to Example 8.14. Replace 363.58 with 640 as shown below. The solution is correct.

Example 8.14: Buoyancy

A hollow sphere is anchored at the bottom of a lake. The sphere radius is 20 in, and the anchoring line has a tension of 600 lb. It is known that lake water has a specific weight of 64.0 lb/ft^3. What is most nearly the mass of the sphere?

Solution

$$F_{net} = 0 = F_{buoyant} - W - T$$

$$F_{buoyant} = \frac{4}{3}\pi r^3 \gamma_{lakewater} = \frac{4}{3}\pi (20\,\text{in})^3 64.0 \frac{\text{lbf}}{\text{ft}^3} \frac{\text{ft}^3}{12^3\ \text{in}^3} = 1{,}241\ \text{lbf}$$

$$T = 600\ \text{lbf}$$

$$W = (1{,}241 - 600)\,\text{lbf} = 640\ \text{lbf}$$

$$m = \frac{F}{g} = \frac{\boxed{640}\ \text{lbf}}{32.2\frac{\text{ft}}{\text{s}^2}} \times \frac{32.2\ \text{lbm ft}}{1\ \text{lbf s}^2} = 640\ \text{lbm}$$

Answer: 640 lbm

Example 8.15: Fluid Flow

A pipe carrying oil with a specific gravity of 0.877 changes in size from 8 in at section A to 20 in at section B. Section A is 14 ft lower than B, and the pressures are 13.2 psi and 8.75 psi, respectively. If the discharge is 5.27 ft^3/s, determine the head loss and the direction of flow.

Solution

$$\text{Head} = z + \frac{v^2}{2g} + p/\gamma \quad \text{(from energy equation)}$$

Assume A as the data point plane:

$$V_A = Q/A_A = \frac{5.27\frac{ft^3}{s}}{\frac{1}{4}\pi\left(\frac{8}{12}\right)^2 ft^2}$$

$$V_A = 15.1\,\frac{ft}{s}$$

$$V_B = Q/A_B = \frac{5.27\frac{ft^3}{s}}{\frac{1}{4}\pi\left(\frac{20}{12}\right)^2 ft^2}$$

$$V_B = 2.4\,\frac{ft}{s}$$

$$H_A = 0 + \frac{\left(15.1\frac{ft}{s}\right)^2}{2\times 32.2\frac{ft}{s^2}} + \frac{13.2\frac{lbf}{in^2}\times\frac{144\,in^2}{ft^2}}{(0.877)\left(62.4\frac{lbm}{ft^3}\right)\left(\frac{lbf}{lbm}\right)}$$

$$H_A = 0 + 3.54\text{ ft} + 34.734\text{ ft}$$

$$H_A = 38.27\text{ ft}$$

$$H_B = 14 + \frac{\left(2.4\frac{ft}{s}\right)^2}{2\times 32.2\frac{ft}{s^2}} + \frac{8.75\frac{lbf}{in^2}\times\frac{144\,in^2}{ft^2}}{(0.877)\left(62.4\frac{lbf}{ft^3}\right)} = 14 + 0.09 + 23.02$$

$$H_B = 37.11\text{ ft}$$

Since $H_A > H_B$ flow goes from A to B, the head loss is (38.27 - 37.11) ft

Answer: 1.16 ft; from A to B

CHAPTER 9: Surveying

(1) p. 254: In example 9.15, remove the line of “Azimuth bearing:” from the solution information. See the corrections below in red.

Example 9.15 *(continued)*

Land bearing = 360°0′0″ − 273°20′24″

Land bearing = N 86°39′36″ W

~~Azimuth bearing: N 86°39′36″ W~~

CHAPTER 10: Water Resources & Environmental Engineering

(1) p. 319: There is a typographical error in the solution to Example 10.29 that changes the answer. The corrected version is below.

Example 10.29 *(continued)*

Solution

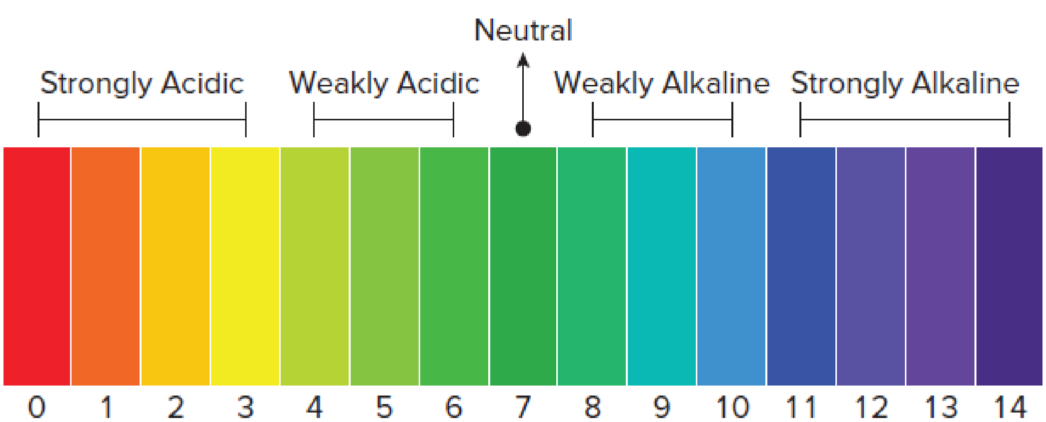
The measured velocity is the actual velocity.

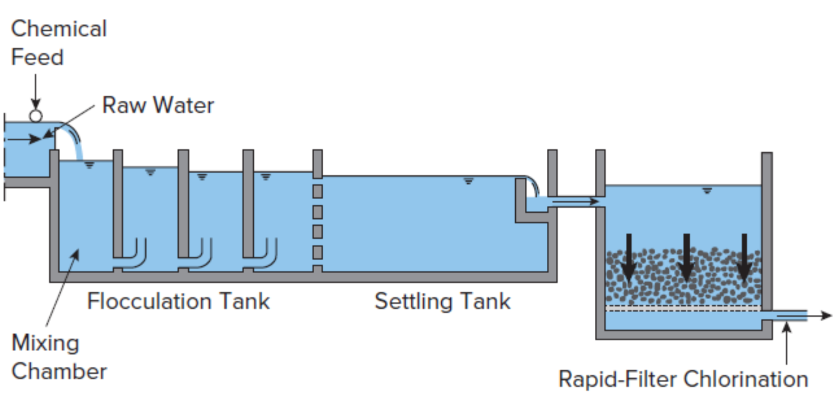
$v = -(K/n)(dh/dx)$ **Equation 10-64**

$$\frac{0.005\ \text{m/day}}{86{,}400\ \text{s/day}} = -\left(\frac{4.0\times 10^{-5}\ \text{m/s}}{0.28}\right)\left(\frac{dh}{-50\ \text{m}}\right)$$

$$dh = 0.02\ \text{m}$$

Answer: 0.02 m





(4) p. 344: In Figure 10.60, there is a typographical error. Setting should be Settling. The corrected figure follows:

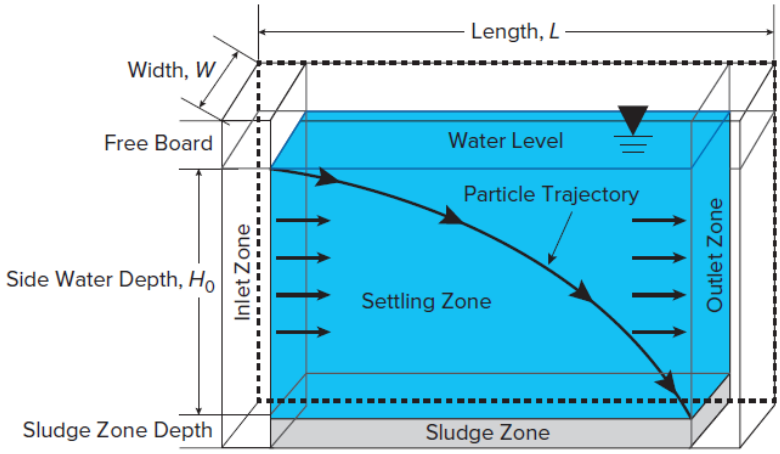


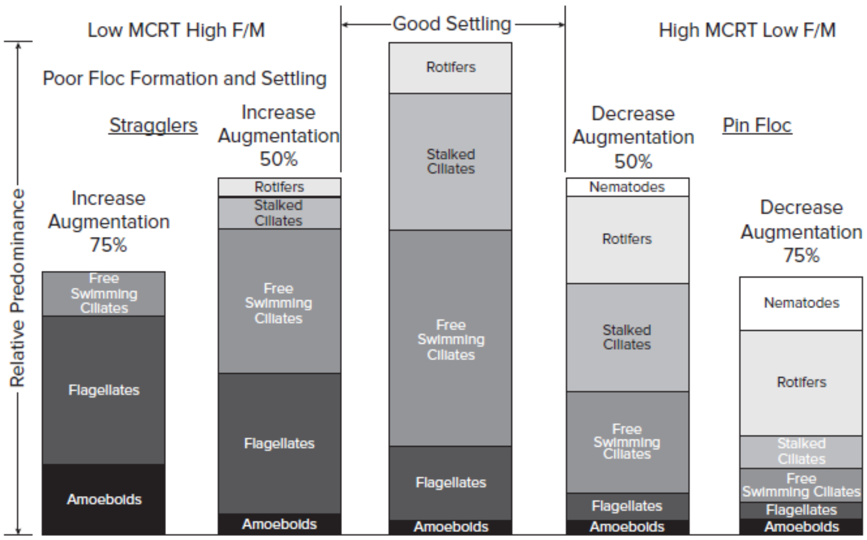
TABLE 10.15 Design Criteria for Sedimentation Basins

Design Criteria for Sedimentation Basins

Type of Basin	Overflow Rate Average (gpd/ft²)	Overflow Rate Average ($m^3/m^2\cdot d$)	Overflow Rate Peak (gpd/ft²)	Overflow Rate Peak ($m^3/m^2\cdot d$)	Solids Loading Rate Average (lb/ft^2–d)	Solids Loading Rate Average ($kg/m^2\cdot h$)	Solids Loading Rate Peak (lb/ft^2–h)	Solids Loading Rate Peak ($kg/m^2\cdot h$)	Hydraulic Residence Time (hr)	Depth (ft)
Water Treatment										
Clarification following coagulation and flocculation:										
Alum coagulation	350–550	14–22							4–8	12–16
Ferric coagulation	550–700	22–28							4–8	12–16
Upflow clarifiers										
Groundwater	1,500–2,200	61–90							1	
Surface water	1,000–1,500	41–61							4	
Clarification following lime-soda softening										
Conventional	550–1,000	22–41							2–4	
Upflow clarifiers										
Groundwater	1,000–2,500	41–102							1	
Surface water	1,000–1,800	41–73							4	
Wastewater Treatment										
Primary clarifiers	800–1,200	32–49	1,200–2,000	50–80					2	10–12
Settling basins following fixed film reactors	400–800	16–33							2	
Settling basins following air-activated sludge reactors										
All configurations EXCEPT extended aeration	400–700	16–28							2	12–15
Extended aeration	200–400	8–16	1,000–1,200	40–64	19–29	4–6	38	8	2	12–15
Settling basins following chemical flocculation reactors	800–1,200		600–800	24–32	5–24	1–5	34	7	2	

Source: Metcalf & Eddy, Inc.; Tchobanoglous, George; Stensel, H. David; Tsuchihashi, Ryujiro; Burton, Franklin L.; Abu-Orf, Mohammad; Bowden, Gregory; Pfrang, William. *Wastewater Engineering: Treatment and Resource Recovery*, McGraw-Hill, 2013. Used by permission.

(6) p. 356: Above the center bar in Figure 10.69, there is a typographical error. Setting should be Settling. The corrected figure follows:



Example 10.44 *(continued)*

Solution

The solids residence time (θ_C) is computed from:

$\theta_C = \frac{Vol\, X_A}{Q_w X_w + Q_e X_e}$, where *Vol* is the aeration basin volume, X_A is the mixed liquor volatile suspended solids (biomass) concentration in the basin, Q_W and Q_e are the waste and effluent flow rates, and X_W and X_e are the waste and effluent suspended solids concentration.

Here $V =$ 15,000 gal, $X_A = 1{,}700$ mg/L, $Q_W = 600$ gal/day and $Q_e = 30{,}000$ gal/day, $X_W = 3{,}000$ mg/L, and $X_e = 30$ mg/L.

Solving for $\theta_C =$ (15,000 gal)(1,700 mg/L)/[(600 gal/day)(3,000 mg/L) + (30,000 gal/day)(30 mg/L)] = 9.4 days.

Answer: 9.4 days

CHAPTER 12: Geotechnical Engineering

(1) p. 433: In Figure 12.2, there is a typographical error that appears twice. In the top line, Course should be Coarse. The corrected figure follows:

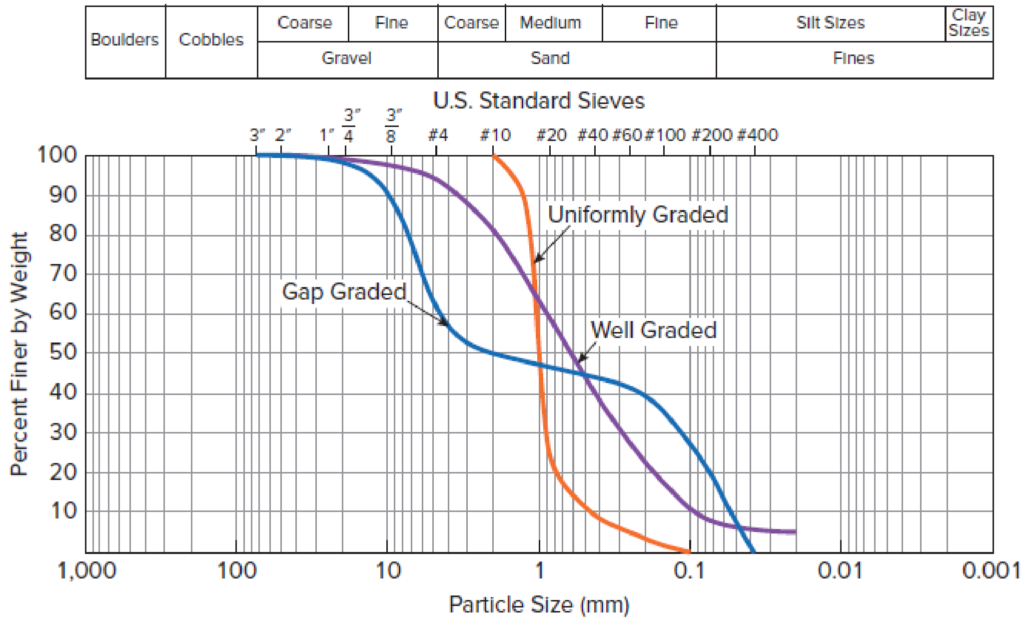


TABLE 12.6 Variation of Time Factor with Degree of Consolidation

U (%)	T_v	*U* (%)	T_v	*U* (%)	T_v
0	0	34	0.0907	68	0.377
1	0.00008	35	0.0962	69	0.390
2	0.0003	36	0.102	70	0.403
3	0.00071	37	0.107	71	0.417
4	0.00126	38	0.113	72	0.431
5	0.00196	39	0.119	73	0.446
6	0.00283	40	0.126	74	0.461
7	0.00385	41	0.132	75	0.477
8	0.00502	42	0.138	76	0.493
9	0.00636	43	0.145	77	0.511
10	0.00785	44	0.152	78	0.529
11	0.0095	45	0.159	79	0.547
12	0.0113	46	0.166	80	0.567
13	0.0133	47	0.173	81	0.588
14	0.0154	48	0.181	82	0.610
15	0.0177	49	0.188	83	0.633
16	0.0201	50	0.197	84	0.658
17	0.0227	51	0.204	85	0.684
18	0.0254	52	0.212	86	0.712

CHAPTER 13: Transportation Engineering

(1) p. 501: In the problem statement for Example 13.10, "30 ft" should be deleted from the "Centerline degree of curvature" measurement.

Example 13.10: Sight Distance on Horizontal Curve

A six-lane divided highway with a design speed of 55 mph has the following dimensions:

- Grassy median: 20 ft wide
- Median shoulders: 4 ft wide
- Lanes: 12 ft wide, 3 lanes directional
- Right-side shoulders: 10 ft wide
- Centerline degree of curve 4° ~~30 ft~~ (at center of highway median)

Example 13.15: Pavement Thickness

Every day, 30 trucks deliver merchandise to a distribution center. Each truck consists of a single axle of 18,000 lb (front axle), two tandem axles of 36,000 lb each (middle axles), and one single axle of 24,000 lb (rear axle). The road is asphalt-paved with design SN = 5.8.

The entrance road pavement structure consists of the following materials:

- A 12-in-thick sand subbase with a layer coefficient of 0.11
- An 8-in-gravel base with a layer coefficient of 0.36
- A Superpave wearing course with a layer coefficient of 0.40

What is the required asphalt-concrete thickness (in inches) of the incoming traffic (loaded trucks)?

A. 2.5 in
B. 3.0 in
C. 3.5 in
D. 4.0 in

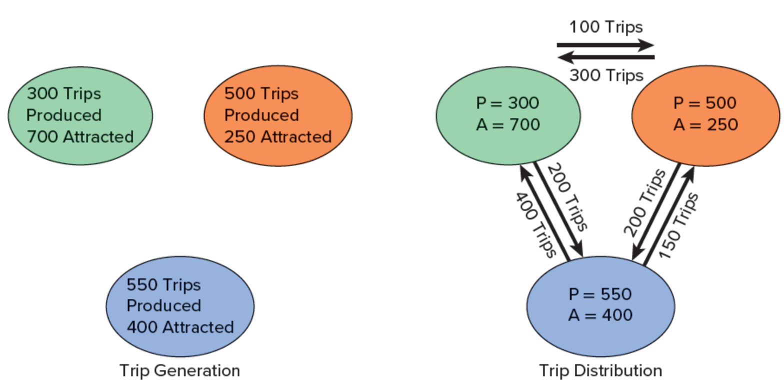


FIGURE 13.42 Zones Producing and Attracting Trips Distributed Among the Zones in a Study Area