Instructor's Manual

for

Applied Statics and Strength of Materials

Seventh Edition

George F. Limbrunner (Inactive)

Craig T. D'Allaird

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Contents

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FOR

APPLIED STATICS AND STRENGTH OF MATERIALS

Seventh Edition

George F. Limbrunner, P.E., (INACTIVE)

Craig T. D'Allaird, P.E.

NOTES:

1. The solutions presented herein are, in general, somewhat abbreviated to conserve space. Very little explanation is furnished. Sketches are kept to a minimum. Few checks are shown.

2. The solutions follow the procedures developed in the examples in the text.

3. The solutions are based on the limited tables furnished in the text and/or the appendices. The tables furnished are for the purposes of this text only and should not be used for design.

4. The solutions for the design problems are generally not the only solution nor are they necessarily the most economical solutions.

5. Please note that problem numbers in the solution manual are depicted with both dashes (-) and periods (.) between the chapter and problem numbers. These are interchangeable.

6. It should be noted that the previous editions of the text used lowercase s to denote stresses. This has changed in the 7^{th} edition, but due to time constraints this solution manual has not been completely updated to reflect such.

7. If you find errors in this manual or in the text, please forward them to me at c.dallaird@hvcc.edu.

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January 2021

Prob. 1.1

(a) $c = \sqrt{10^2 + 7^2} = 12.21$ ft
(b) $b = \sqrt{20^2 - 16^2} = 12.00$ m

Prob. 1.2

(a) $a = 25 \sin 48° = 18.58$ ft

(b) $b = \sqrt{25^2 - 18.58^2} = 16.73$ ft

(c) $h = \text{b} \sin 48° = 16.73 \ \sin 48° = 12.43$ ft

Prob. 1.3

$a = \sqrt{72^2 - 67.3^2} = 25.59$ ft

$A = \cos^{-1}(67.3/72) = 20.8°$

$B = \sin^{-1}(67.3/72) = 69.2°$

Prob. 1.4

$AB = 28 \sin 70° = 26.3$ ft

Prob. 1.5

$c = \sqrt{10^2 + 6^2} = 11.6$ ft

$\theta = \tan^{-1}(6/10) = 31.0°$

Prob. 1.6

$AB = \sqrt{12^2 + 16^2} = 20$ ft

$BC = \sqrt{12^2 + 32^2} = 34.2$ ft
$A = \tan^{-1}(12/16) = 36.9°$

$C = \tan^{-1}(12/32) = 20.6°$

Prob. 1.7

$\theta = \sin^{-1}(5/6) = 56.4°$

$x = \sqrt{12^2 + 10^2} = 6.63$ ft

Prob. 1.8

Assume all angles to be 45°

$R_x = +2 + 3\cos 45° + 0 - 6\sin 45° = 0.1213$ mi

$R_y = 0 - 3\sin 45° + 6 - 6\sin 45° = -0.364$ mi.

$R = \sqrt{(-0.1213)^2 + (-0.364)^2} = 0.384$ mi.

Prob. 1.9

(a) $c^2 = 11^2 + 13^2 - 2(11)(13)\cos 80°$

$= 15.50$ ft

$$\frac{\sin 80°}{15.50} = \frac{\sin A}{11} = \frac{\sin B}{13}$$

$\rightarrow A = 44.3°$, $B = 55.7°$

(b) $a^2 = 78^2 + 85^2 - 2(78)(85)\cos 72°$

$= 96.0$ ft

$$\frac{\sin 72°}{a} = \frac{\sin C}{85} = \frac{\sin B}{78}$$

$\rightarrow A = 57.4°$, $B = 50.6°$

(c) Right Triangle Check

Check $a^2 + b^2 = c^2$

$A = \tan^{-1}(7/24) = 16.26°$

$B = \tan^{-1}(24/7) = 73.7°$

Prob. 1.10

$C = 180° - 55° - 63° = 62°$

$$\frac{a}{\sin 63°} = \frac{100}{\sin 55°} = \frac{c}{\sin 62°}$$

$$\therefore a = \frac{\sin 63°}{\sin 55°}(100) = 108.8 \text{ ft}$$

$$\& \; c = \frac{\sin 62°}{\sin 55°}(100) = 107.8 \text{ ft}$$

Perimeter = $a + b + c = 317$ ft

Prob. 1.11

S = weight of one shock

P = weight of one set of brake pads

Eq1: $8S + 10P = 101.6$ lb

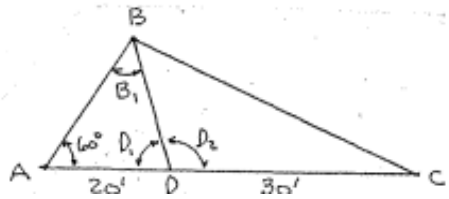
Eq2: $10S + 6P = 106.2$ lb

Multiply Eq2 by 8/10:

Eq3: $8S + 4.8P = 84.96$ lb

$$8S + 10P = 101.6 \text{ lb}$$
$$-8S - 4.8P = -84.96 \text{ lb}$$
$$5.2P = 16.64 \text{ lb}$$
$$P = 3.20 \text{ lb}$$
$$\therefore \quad S = 8.70 \text{ lb}$$

Prob. 1.12



$$\frac{20}{\sin B_1} = \frac{26}{\sin 60°} \rightarrow \therefore \ B_1 = 41.77°$$

D_1= 78.23° and D_2= 101.77°

$$\frac{AB}{\sin 78.23°} = \frac{20}{\sin 41.77°} \rightarrow \therefore AB = 29.39 \text{ ft}$$

$$BC = \sqrt{(AB)^2 + 50^2 - 2(AB)(50)\cos 60°}$$

$$BC = 43.52 \text{ ft}$$

$$\frac{50}{\sin B} = \frac{43.5}{\sin 60°} \rightarrow \therefore B = 84.25°$$

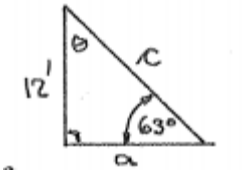
C = 180° – 60° – 84.25° = 35.75°

Prob. 1.13

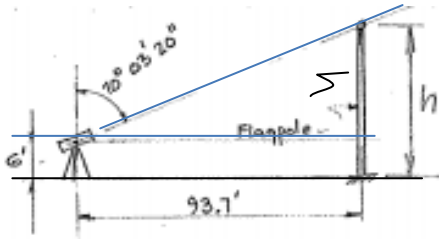
(a) $c = \dfrac{12}{\sin 63°} = 13.47 \text{ ft}$

(b) $a = \dfrac{12}{\tan 63°} = 6.11 \text{ ft}$

(c) $\theta = 90 - 63 = 27°$



Prob. 1.14



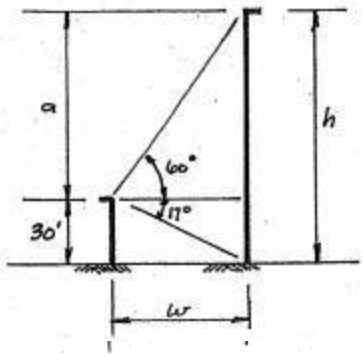
$$h = 6 + \frac{93.7}{\tan 70°03'20''} = 40.0 \text{ ft}$$

Prob. 1.15

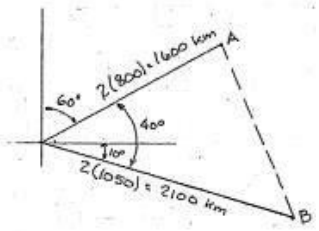
$AB = 32(\tan 55°) = 45.7$ m

Prob. 1.16

$W = 30/(\tan 17°)$
$= 98.13$ ft
$a = 98.13(\tan 60°)$
$= 169.97$ ft
$h = 30 + 169.97$
$= 200$ ft

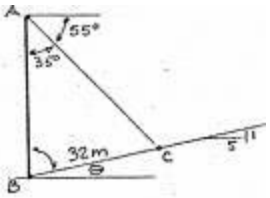


Prob. 1.17



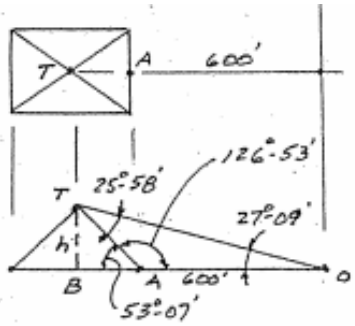
$$(AB)^2 = 1600^2 + 2100^2 - 2(1600)(2100)\cos 40°$$
$$= 1350 \text{ km}$$

Prob. 1.18



$$\theta = \tan^{-1}(1/5) = 11.31°$$
$$\angle CBA = 90 - 11.31 = 78.69°$$
$$\angle C = 180 - 78.69 - 35 = 66.31°$$
$$\frac{AB}{\sin 66.31°} = \frac{32}{\sin 35°} \rightarrow AB = 51.1 \text{ m}$$

Prob. 1.19

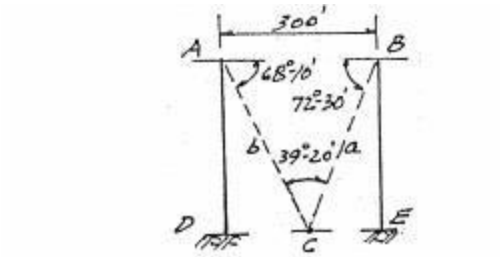


$$\frac{TO}{\sin 126°53'} = \frac{600}{\sin 25°58'} \rightarrow TO = 1096 \text{ ft}$$

$$h = (TO)\sin 27°09' = 500 \text{ ft}$$

$$OB = \sqrt{1096^2 - 500^2} = 975 \text{ ft}$$
$$BA = 975 - 600 = 375 \text{ ft}$$
$$\therefore \text{Base width} = 2 \times BA = 750 \text{ ft}$$
$$TA = \sqrt{500^2 + 375^2} = 625 \text{ ft}$$

Prob. 1.20



$\angle C = 180° - 68°10' - 72°30' = 39°20'$

$$\frac{300}{\sin 39°20'} = \frac{a}{\sin 68°10'} = \frac{b}{\sin 72°30'}$$

$a = 439.36$ ft

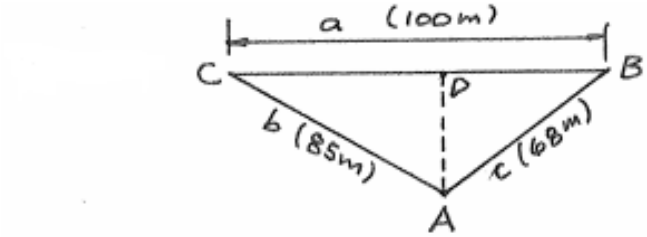
$b = 451.41$ ft

DC = 451.41 sin(90° – 68°10′) =167.88 ft

EC = 439.36 sin(90° – 72°30′) = 132.12 ft

Tower ht $= \sqrt{439.36^2 - 132.12^2} = 419$ ft

Prob. 1.21



$$A = \cos^{-1}\left[\frac{100^2 - 85^2 - 68^2}{-2(85)(68)}\right] = 80.8°$$

$$\frac{\sin B}{85} = \frac{\sin 80.0°}{100} \rightarrow B = 57.0°$$

$AD = 68 \sin B = 57.0$ m

Prob. 1.22

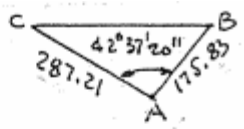
x = Building area
y = Parking lot area

I. $x + y = 90{,}000$
II $y = 43{,}560/2 + 3x$

Solve I for y: $y = 90{,}000 - x$
Substitute into II:
$90{,}000 - x = 21{,}780 + 3x$
$x = 17{,}060$ ft^2 (Building)
$Y = 72{,}900$ ft^2 (Parking lot)

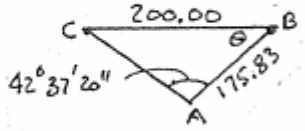
Prob. 1.23

(a)



$(CB)^2 = 175.83^2 + 287.21^2$
$- 2(175.83)(287.21)\cos 42°37'20"$
$CB = 197.7$ m

(b)



$$\frac{\sin C}{175.83} = \frac{\sin 42°37'20"}{200} \rightarrow C = 36.5359°$$
$\theta = 180° - 42°37'20" - C = 100.8419°$

$$\frac{AC}{\sin\theta} = \frac{200}{\sin 42°37'20"} \rightarrow AC = 290.08 \text{ m}$$

Prob. 1.24

(a) $0.015 \text{ ton} \times 2000 \text{ lb/ton} = 30.0 \text{ lb}$

(b) $30.0 \text{ lb} \times 16 \text{ oz./lb} = 480 \text{ oz.}$

Prob. 1.25

(a) $5 \text{ mi} \times 5280 \text{ ft/mi} \times 1 \text{ yd}/3 \text{ ft} = 8800 \text{ yd}$

(b) $5 \text{ mi} \times 5280 \text{ ft/mi} = 26{,}400 \text{ ft}$

Prob. 1.26

$$60\frac{\text{mi}}{\text{hr}} \times 5280\frac{\text{ft}}{\text{mi}} \times \frac{1\text{hr}}{60\text{ min}} \times \frac{1\text{ min}}{60\text{ sec}} = 88\frac{\text{ft}}{\text{sec}}$$

Prob. 1.27

$$43{,}560\frac{\text{ft}^2}{\text{acre}} \times \left(\frac{1\text{ yd}}{3\text{ ft}}\right)^2 \times \left(\frac{1\text{ rod}}{5.5\text{ yd}}\right)^2 = 160\frac{\text{rod}^2}{\text{acre}}$$

Prob. 1.28

(a)

$$\frac{125{,}000{,}000{,}000\text{ gal}}{7.481\frac{\text{gal}}{\text{ft}^3} \times 43{,}560\frac{\text{ft}^2}{\text{acre}}} = 384 \times 10^3\text{acre} - \text{ft}$$

(b)

$$\frac{125{,}000{,}000{,}000\text{ gal} \times 62.4\frac{\text{lb}}{\text{ft}^3}}{7.481\frac{\text{gal}}{\text{ft}^3} \times 2000\frac{\text{lb}}{\text{ton}}} = 521 \times 10^6\text{ tons}$$

Prob. 1.29

$$(a) 27' - 7\frac{3}{4}'' \rightarrow \frac{7.75\text{ in.}}{12\frac{\text{in}}{\text{ft}}} = 0.646\text{ ft} \rightarrow 27.65\text{ ft}$$

$(b) 1.815\text{ ft} \rightarrow \text{in.}$

$$0.815\text{ ft} \times 12\frac{\text{in}}{\text{ft}} = 9.78\text{ in.}$$

$$0.78\text{ in.} \times 32 = 24.96$$

$$\therefore 1.815\text{ ft} = 1' - 9\frac{25}{32}''$$

Prob. 1.30

Volume=Area × length

$$= \frac{\frac{\pi(2\text{ in.})^2}{4}(0.25\text{ mi})\left(5280\frac{\text{ft}}{\text{mi}}\right)\left(12\frac{\text{in.}}{\text{ft}}\right)}{1728\frac{\text{in.}^3}{\text{ft}^3}}$$

$=28.80\ ft^3$

Flushing Water=$2(28.8\ ft^3)(7.481\ gal/ft^3) = 431\ gal$

Prob. 1.31

$$2\frac{tons}{ft^2}\times 2000\frac{lb}{ton} = 4000\frac{lb}{ft^2}$$

$$2\frac{tons}{ft^2}\times 2000\frac{lb}{ton}\times\frac{1\,ft^2}{144\,in.^2} = 27.8\frac{lb}{in.^2}$$

Prob. 1.32

$$\frac{1\,mi}{4\,min}\times\frac{60\,min}{hr} = 15\ mph$$

$$\frac{26\,mi}{2\,hr - 47\,min} = \frac{26\,mi}{2.78\,hr} = 9.35\ mph$$

Prob. 1.33

(a)

$$5000\frac{ft^3}{sec}\times 7.481\frac{gal}{ft^3}\times 60\frac{sec}{min} = 2{,}240{,}000\frac{gal}{min}$$

(b)

$$5000\frac{ft^3}{sec}\times\frac{1\,mi^3}{(5280\,ft)^3}\times 60\frac{sec}{min}\times 60\frac{min}{hr}$$

$$\times 24\frac{hr}{day}\times 365\frac{days}{yr} = 1.071\frac{mi^3}{yr}$$

Prob. 1.34

Wt of sand: $816 - 38 = 778$ lb

$$\frac{778\,lb}{55\,gal}\times 7.481\frac{gal}{ft^3} = 105.8\ pcf$$

Prob. 1.36

60.5 ft × 0.3048 m/ft = 18.44 m
90.0 ft × 0.3048 m/ft = 27.4 m
413.0 ft × 0.3048 m/ft = 125.9 m

Prob. 1.37

(a) 2212 lb × 0.4536 kg/lb = 1003 kg
(b) 87 ft^2 × 0.0929 m^2/ft^2 = 8.08 m^2
8.08 m^2 × 10^6 mm^2/m^2 = 8.08 × 10^6 mm^2
(c)

$$18{,}460\frac{\text{lb}}{\text{in.}^2}\times 0.006895\frac{\text{MPa}}{\text{lb/in.}^2}=127.3\,\text{MPa}$$

= 127 300 kPa

Prob. 1.38

(a) 18.6 ft × 0.3048 m/ft = 5.67 m
5.67 m × 1000 mm/m = 5670 mm
(b) 8 ft - 10 in. = 106 in.
106 in. × 25.4 mm/in. = 2690 mm
2690 mm × 1 m/1000 mm = 2.69 m
(c) 27.5 in. × 25.4 mm/in. = 699 mm
699 mm × 1 m/1000 mm = 0.699 m

Prob. 1.39

(a) 248 lb × 4.448 N/lb = 1103 N
= 1.103 kN
(b) 3.65 k × 1000 lb/k × 4.448 N/lb
=16 240 N = 16.24 kN
(c) 8.7 tons × 2000 lb/ton × 4.448 N/lb
= 77 400 N = 77.4 kN

Prob. 1.40

(a) $627\ \text{in.}^2 \times 645.2\ \text{mm}^2/\text{in.}^2$
$= 404\,500\ \text{mm}^2 = 0.4045\ \text{m}^2$

(b) $14\ \text{yd}^2 \times 0.8361\ \text{m}^2/\text{yd}^2$
$= 11.71\ \text{m}^2 = 11.71 \times\times\ 10^6\ \text{mm}^2$

(c) $3.5\dfrac{\text{k}}{\text{ft}} \times 14\,594\dfrac{\text{N/m}}{\text{k/ft}} \times \dfrac{1\,\text{kN}}{1000\ \text{N}} = 51.1\dfrac{\text{kN}}{\text{m}}$

(d) $8470\dfrac{\text{lb}}{\text{in.}^2} \times 0.006895\dfrac{\text{MPa}}{\text{lb/in.}^2} = 58.4\,\text{MPa}$
$= 58\,400\ \text{kPa}$

(e) $1740\dfrac{\text{lb}}{\text{ft}^2} \times 47.88\dfrac{\text{Pa}}{\text{lb/ft}^2} = 83\,300\ \text{Pa}$
$= 83.3\ \text{kPa}$

(f) $2.8\,\text{k/ft}^2 \times 47.88\dfrac{\text{kPa}}{\text{k/ft}^2} = 134\,\text{kPa}$

(g)
$$247\frac{\text{lb}}{\text{ft}^3} \times 4.448\frac{\text{N}}{\text{lb}} \times \frac{1\,\text{ft}^3}{0.02832\,\text{m}^3} \times \frac{1\,\text{kN}}{1000\ \text{N}}$$
$$= 38.8\ \text{kN/m}^3$$

Prob. 1.41

$$V = \frac{\pi(50\,\text{mm})^2}{4}\left(\frac{1\,\text{m}^2}{10^3\ \text{mm}^2}\right)(400\text{m})$$
$$= 0.7854\ \text{m}^3$$

Flushing water
$= 2(0.7854\ \text{m}^3)(1000\ \text{liters/m}^3)$
$= 1571$ liters

Prob. 1.42

(a) $V = \dfrac{4}{3}\pi(27\,\text{in.})^3 = 82{,}400\,\text{in.}^3$

(b) $82{,}400\ \text{in.}^3 \times 16{,}387\ \text{mm}^3/\text{in.}^3$
$= 1.350 \times 10^9\ \text{mm}^3$

(c) $1.350 \times 10^9\ \text{mm}^3 = 1.350\ \text{m}^3$

(d) $1.350\ \text{m}^3 \times 1000\ \text{liters/m}^3 = 1351$ liters

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