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CHAPTER 16

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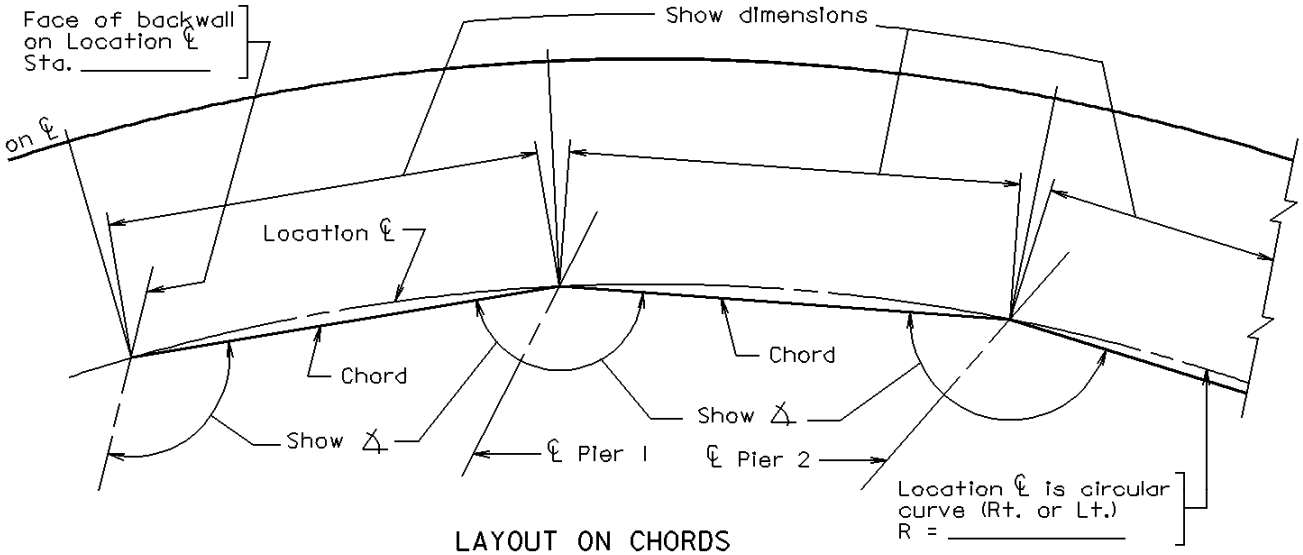
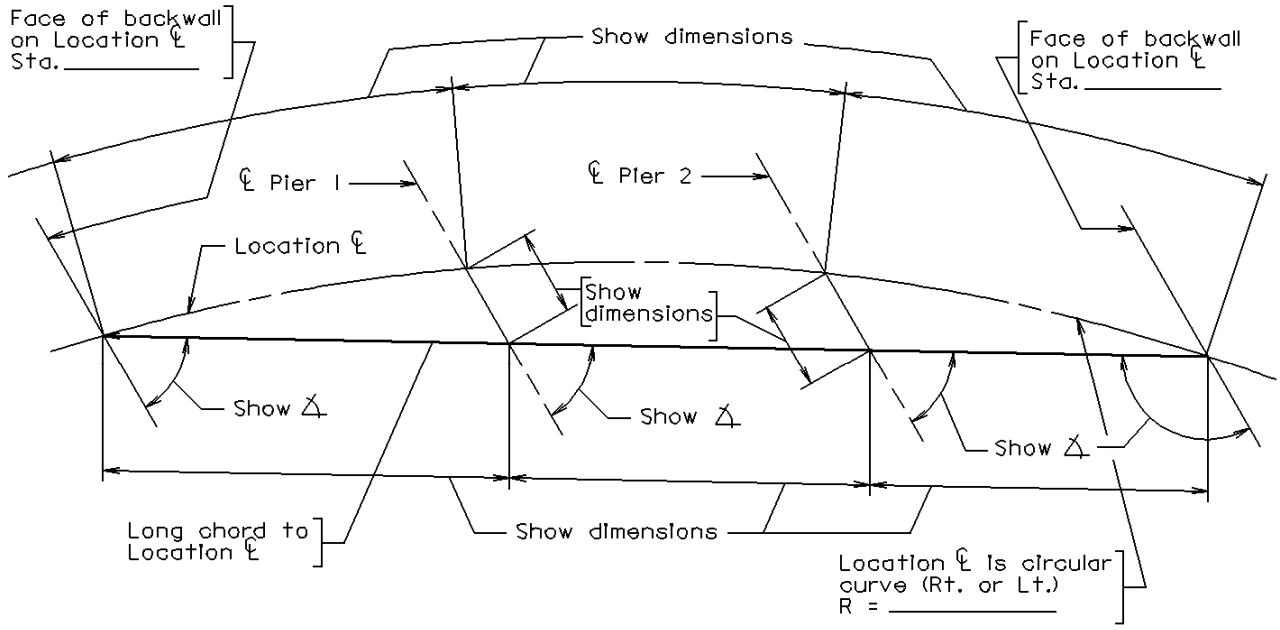
*Indicates 11 x 17 sheet; all others are 8½ x 11.



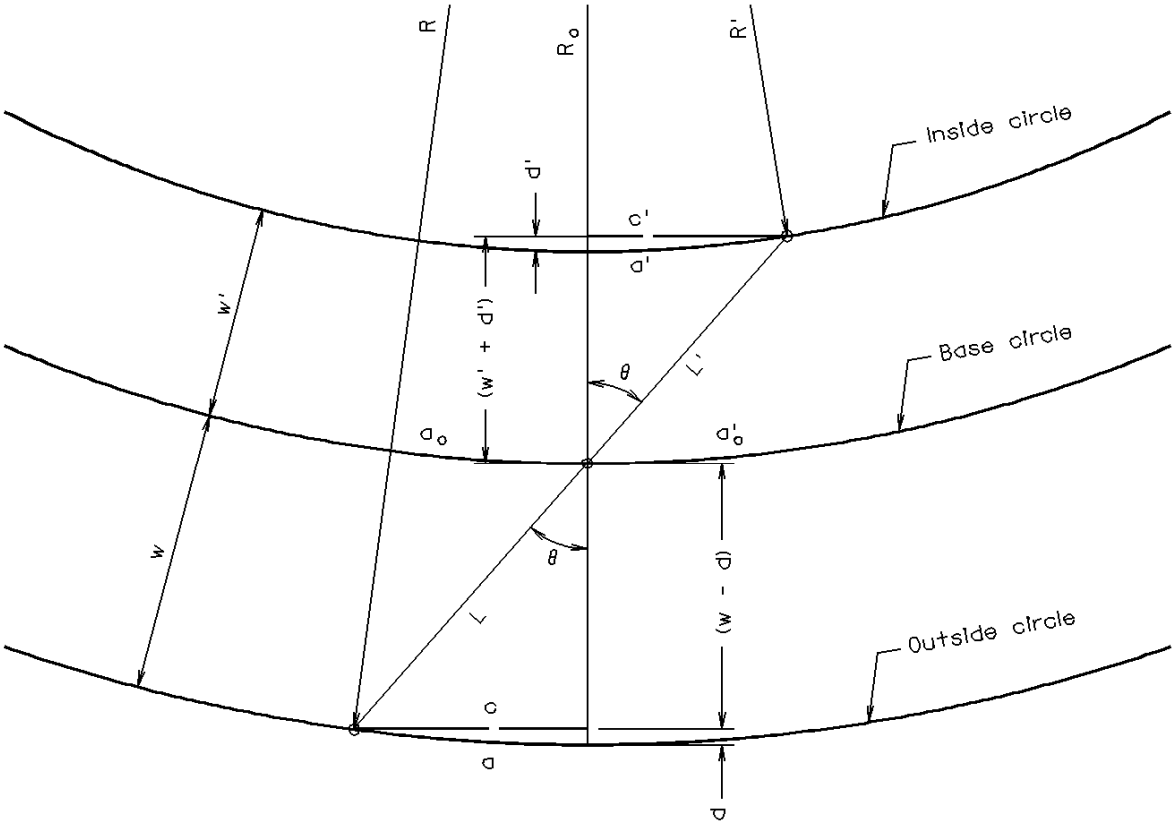
LAYOUT ON CHORDS
END-TO-END OF SPANS



LAYOUT ON COMMON CHORD

Layout on common chord to be used whenever middle ordinate of location centerline is equal to or less than one-fourth the width of the superstructure. Dimensions and elevations are to be referenced to the location centerline.

GEOMETRY **CURVED BRIDGE LAYOUT**	VOL. V - PART 2 DATE: 27Aug2010 SHEET 1 of 1 FILE NO. 16.01



Inside Circle

$$c' = (w' + d')\tan\theta$$

$$d' = \frac{(c')^2}{(2R' - d')}$$

$c' = \ldots$ (2nd time)

$d' = \ldots$ (2nd time)

$$a' = c' + \frac{c'}{6}\left(\frac{c'}{R'}\right)^2 + P\,\frac{9}{20}\left(\frac{c'}{R'}\right)^2 + ..$$

$$a'_o = a' + \frac{w'}{R'}\,a'$$

$$L' = \frac{c'}{\sin\theta} = \frac{(w' + d')}{\cos\theta}$$

Outside Circle

$$c = (w - d)\tan\theta$$

$$d = \frac{c^2}{(2R - d)}$$

$c = \ldots$ (2nd time)

$d = \ldots$ (2nd time)

$$a = c + \frac{c}{6}\left(\frac{c}{R}\right)^2 + P\,\frac{9}{20}\left(\frac{c}{R}\right)^2 + ..$$

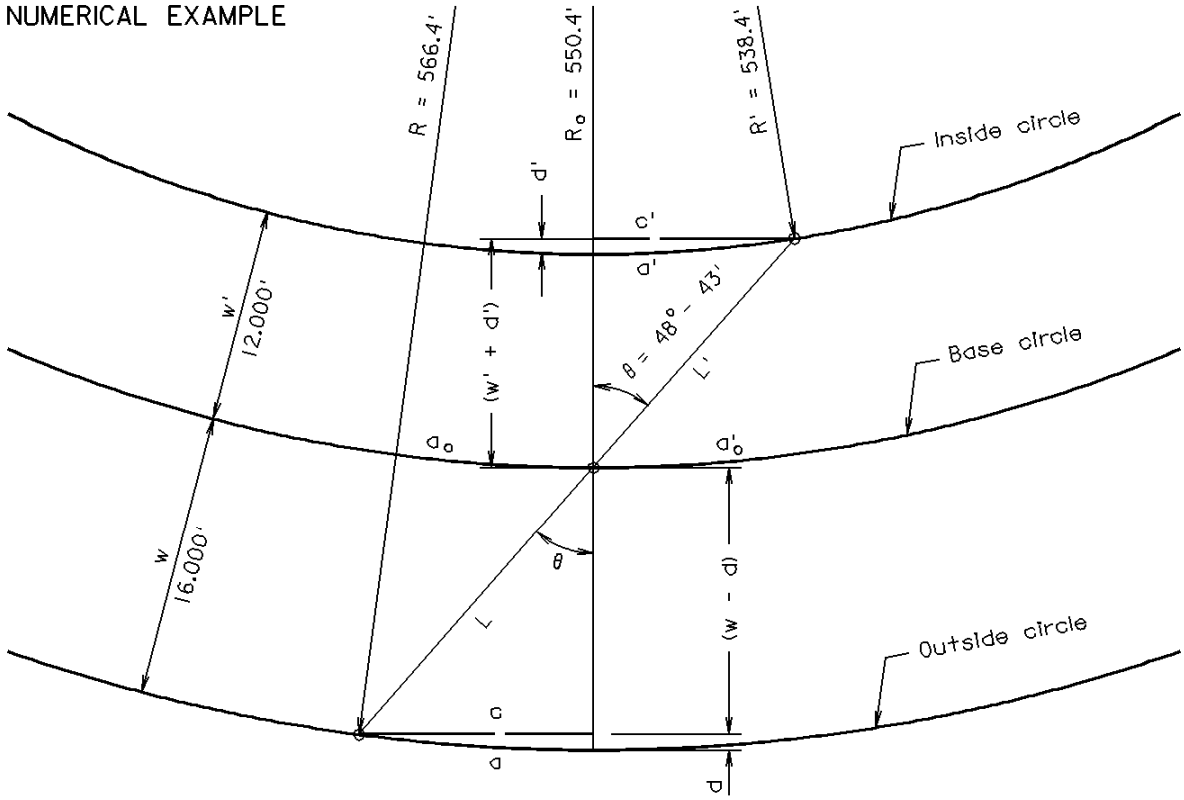
$$a_o = a - \frac{w}{R}\,a$$

$$L = \frac{c}{\sin\theta} = \frac{(w - d)}{\cos\theta}$$

P = Numerical value of preceding term in series.

GEOMETRY
SKEWED LINES INTERSECTING CONCENTRIC CIRCLES

NUMERICAL EXAMPLE



$c' = w' \tan\theta + d' \tan\theta = 12.000 \times 1.1389 + d'(1.139) = 14.8$
$13.667 + 0.23 = 13.90$ -------- First time
$13.667 + 0.204 = 13.871 = c'$ -- Second time

$d' = \dfrac{(c')}{(2R' = d')} = \overline{14.8}^2 / (1077 - d') = 0.20$ ----- First time
$\overline{13.90}^2 / (1077 - 0.20) = 0.179$ --- Second time

$$a' = c' + P\,\frac{1}{6}\left(\frac{c'}{R'}\right)^2 + P\,\frac{9}{20}\left(\frac{c'}{R'}\right)^2 + .. = 13.871 + \frac{13.9}{6}\left(\frac{13.9}{540}\right)^2 = 13.873 = a'$$

$$a'_o = a' + a'\,\frac{w'}{R'} = 13.873 + 13.87\,\frac{12.00}{538} = 14.182 = a'_o$$

$$L' = \frac{c'}{\sin\theta} = \frac{13.871}{0.7515} = 18.458$$

$c = w \tan\theta - d \tan\theta = 16.000 \times 1.1389 - d(1.139) = 17.1$
$18.222 - 0.30 = 17.92$ ------- First time
$18.222 - 0.322 = 17.900 = c$ -- Second time

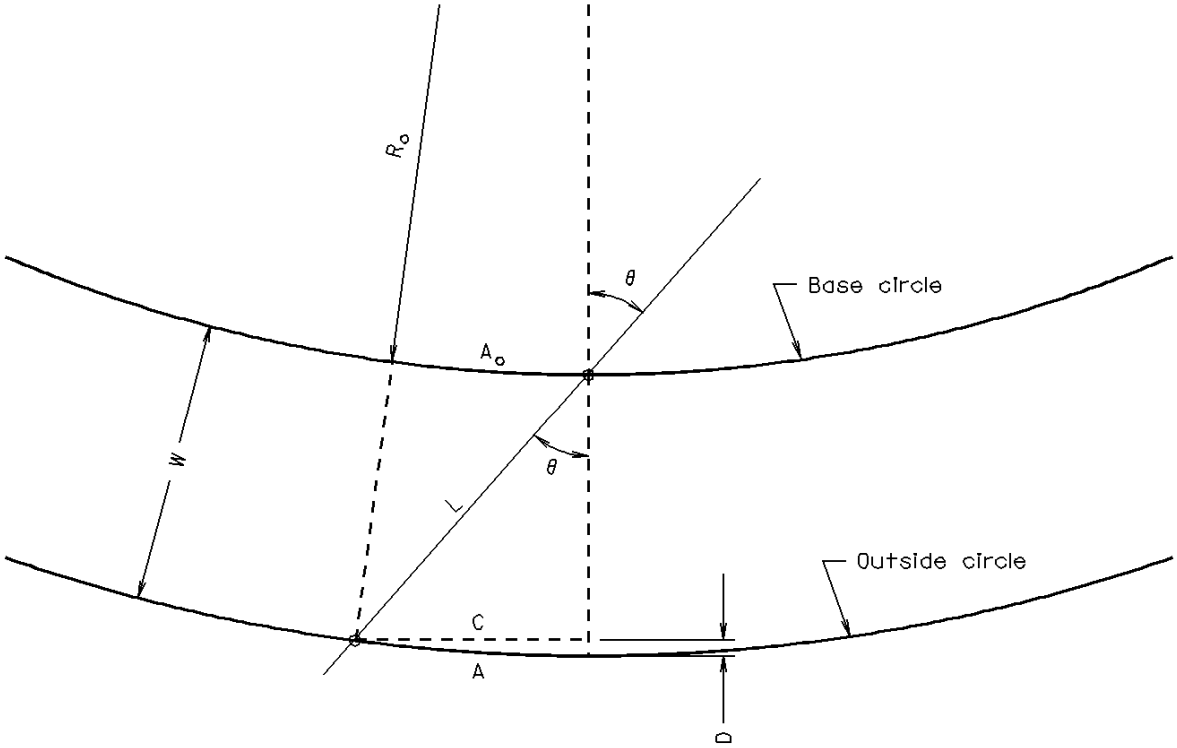
$d = \dfrac{c^2}{(2R - d)} = \overline{17.1}^2 / (1133 - d) = 0.26$ ----- First time
$\overline{17.92}^2 / (1133 - 0.26) = 0.283$ --- Second time

$$a = c + P\,\frac{1}{6}\left(\frac{c}{R}\right)^2 + P\,\frac{9}{20}\left(\frac{c}{R}\right)^2 + .. = 17.900 + \frac{17.9}{6}\left(\frac{17.9}{570}\right)^2 = 17.903 = a$$

$$a_o = a - a\,\frac{w}{R} = 17.903 - 17.90\,\frac{16.000}{566} = 17.397 = a_o$$

$$L = \frac{c}{\sin\theta} = \frac{17.900}{0.7515} = 23.835'$$

SKEWED LINE INTERSECTING CONCENTRIC CIRCLES



$$D = \frac{(W \sin\theta)^2}{2(R_o \cos^2\theta + W)} + \frac{D^2}{2(R_o \cos^2\theta + W)}$$

$$L = \frac{W-D}{\cos\theta} \qquad A = C + \frac{P}{6}\left(\frac{C}{R_o+W}\right)^2 + P\left(\frac{9}{20}\right)\left(\frac{C}{R_o+W}\right)^2 + \text{----}$$

$$C = L \sin\theta \qquad A_o = A - \left(\frac{W}{R_o+W}\right) A$$

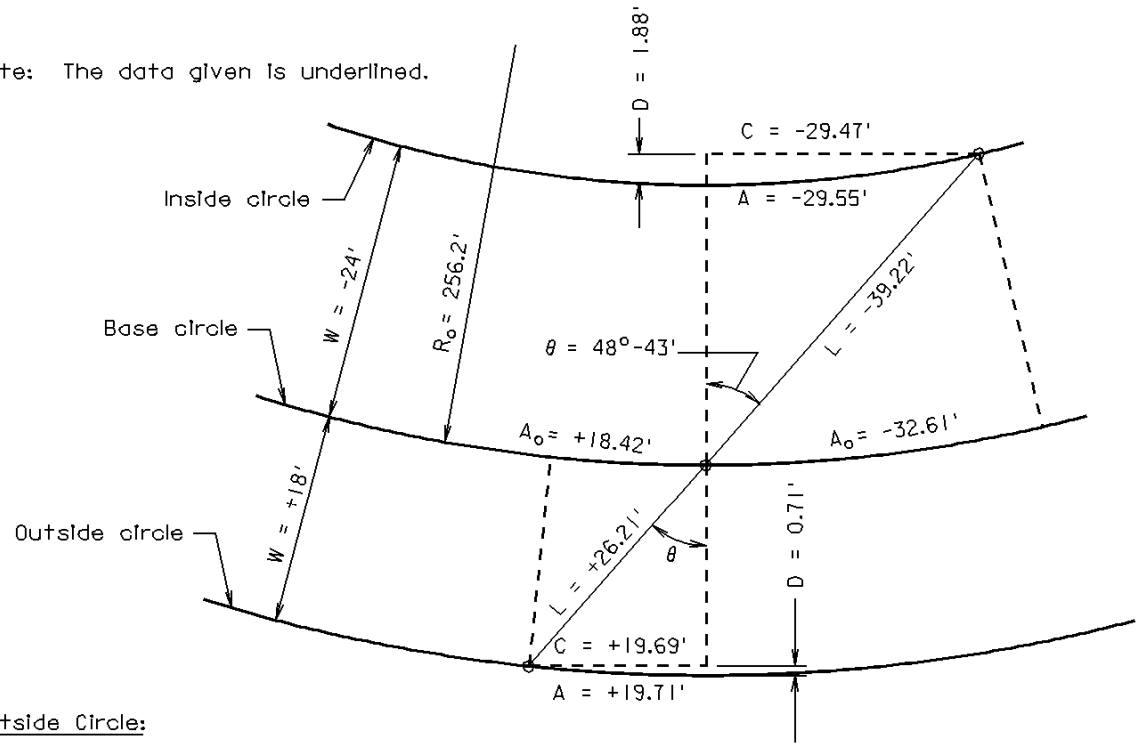
Check: $(R_o + W)(\cos\frac{A_o}{R_o} - \sin\frac{A_o}{R_o}\cot\theta) = R_o$

P = Algebraic value of preceding term in series

Note:
W, C, A, A_o, and L are positive for concentric circle outside of base circle; negative for concentric circle inside of base circle. D and R_o are always positive.

NUMERICAL EXAMPLE

Note: The data given is underlined.



Outside Circle:

$$D = \frac{(W \sin\theta)^2}{2(R_o \cos^2\theta + W)} + \frac{D^2}{2(R_o \cos^2\theta + W)}$$

First Term: $\dfrac{(18.000 \times 0.7515)^2}{2\left[256.2 \times (0.6598)^2 + 18.000\right]} = \dfrac{182.98}{259.06} = 0.706$

Second term iteration: $0.706 + \dfrac{(0.706)^2}{259.06} = 0.706 + 0.002 = 0.708 \quad D = 0.708'$

$$L = \frac{W-D}{\cos\theta} = \frac{+18.000 - 0.708}{0.6598} = +26.208'$$

$$C = L\sin\theta = +26.208 \times 0.7515 = +19.695'$$

$$A = C + \frac{P}{6}\left(\frac{C}{R_o+W}\right)^2 + P\left(\frac{9}{20}\right)\left(\frac{C}{R_o+W}\right)^2 + \text{------}$$

$$= +19.695 + \frac{19.695}{6}\left(\frac{19.695}{256.2 + 18.000}\right)^2 + \text{----} = 19.695 + 0.017 + \text{----} = +19.712'$$

$$A_o + A - A\left(\frac{W}{R_o+W}\right) = +19.712 - 19.712\left(\frac{18.000}{256.2 + 18.000}\right) = +19.712 - 1.294 = +18.418'$$

Check:

$$A_o/R_o = \frac{18.418}{256.2} = 0.07189 \text{ rad.;}$$

$$= (R_o + W)\left(\cos\frac{A_o}{R_o} - \sin\frac{A_o}{R_o}\cot\theta\right) = (256.200 + 18.000) \times (0.99742 - 0.07183 \times 0.8780)$$

$$= 256.199 = R_o \text{ (Check)}$$

NUMERICAL EXAMPLE (continued)

Inside Circle:

$$D = \frac{(W \sin\theta)^2}{2(R_o \cos^2\theta + W)} = + \frac{D^2}{2(R_o \cos^2\theta + W)}$$

First Term: $\frac{(-24.000 \times 0.7515)^2}{2\left[256.2 \times (0.6598)^2 - 24.000\right]} = \frac{325.30}{175.06} = 1.858$

Second term iteration: $1.858 + \frac{(1.858)^2}{175.06} = 1.858 + 0.020 = 1.878 \quad D = 1.878'$

$$L = \frac{W-D}{\cos\theta} = \frac{-24.000 - 1.878}{0.6598} = -39.221'$$

$$C = L\sin\theta = (-39.221) \times 0.7515 = -29.475'$$

$$A = C + \frac{P}{6}\left(\frac{C}{R_o+W}\right)^2 + P\left(\frac{9}{20}\right)\left(\frac{C}{R_o+W}\right)^2 + \text{------}$$

$$= -29.475 + \left(\frac{-29.475}{6}\right)\left(\frac{-29.475}{256.2 - 24.000}\right)^2 + \text{----} = -29.475 - 0.079 \text{ ----} = -29.554'$$

$$A_o = A - A\left(\frac{W}{R_o+W}\right) = -29.554 - (-29.554)\left(\frac{-24.000}{256.2 - 24.000}\right) = -29.554 - 3.055 = -32.609'$$

Check:

$$A_o/R_o = \frac{-32.609}{256.2} = -0.12728 \text{ rad.;}$$

$$= (R_o + W)\left(\cos\frac{A_o}{R_o} - \sin\frac{A_o}{R_o}\cot\theta\right)$$

$$= (256.200 - 24.000)(0.99191 + 0.12694 \times 0.8780) = 256.200 = R_o \text{ (Check)}$$