Test Yourself

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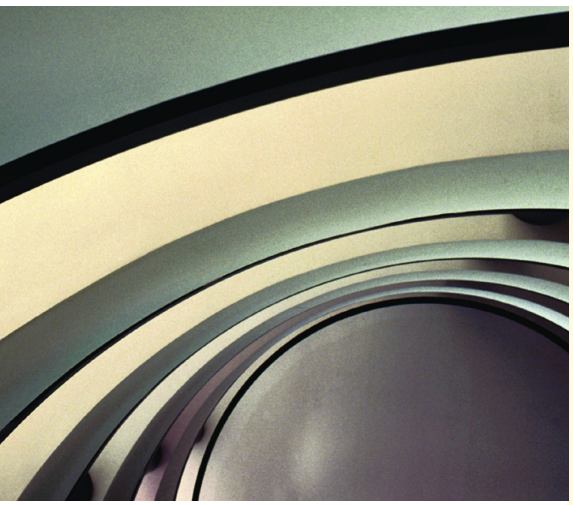
Computing Horizontal and Vertical Curves



Here is a word problem taken from a recent sophomore-level "Fundamentals of Surveying" final exam for Civil Engineering students at the University of Missouri-Rolla. (UMR has been designated as one of the nation's top 25 undergraduate civil engineering programs by U.S. News.) This problem would be too long for either of the NCEES exams, but split into two parts (its horizontal and vertical components), it would be appropriate for the "Fundamentals" exam. You must create your own diagram.

For the solution to this problem (and much more), please visit our website at: *www.TheAmericanSurveyor.com.* Good luck!

For more information about the PLS exam and its contents, visit the NCEES website at www.ncees.com.

For this curve system (a combination horizontal and vertical curve) compute the horizontal coordinates and elevation for Station 142+69.09. For the horizontal circular curve, the PI coordinates are 246,198.62 North and 111,694.87 East. The bearing from the PC to the PI is North 84°01'42" West. The curve's "Delta" (or "I") is 38°38'16" Left and its D is exactly 3°. The PT Station is 149+26.42. For this route centerline the vertical curve beginning point (BVC) is at Station 132+61.97. The vertical curve's length is 1400.00 feet. Its grades are positive 2.5% entering the curve (g1) and negative 3.0% leaving (g2). The vertical curve's BVC elevation is 1126.94. The coordinates and elevation are in feet.

First for the horizontal coordinates:

$$R = \frac{5729.57795}{3} = 1909.859'$$

$$T = R \tan \frac{\Delta}{2} = 669.530'$$

PC Coordinates are: 246,128.96 North; 112,360.77 East

$$L = \frac{2\pi R\Delta}{360} = 1287.93'$$

PC Station = PT Station – L = 136+38.49

Deflection Angle at PC to Station 142 + 69.09 = $\frac{\ell D}{360}$

$$= \frac{(142 + 69.09 - 136 + 38.49)(3)}{200} = 9°27'32'$$

Subchord distance, PC to Station 142+69.09 = 2Rsin(defl. angle)

(2)(1909.859)sin9°27'32' = 627.73'

Azimuth, PC to station 142+69.09 = 266°30'46"

Therefore, coordinates of station 142+69.09 are: 246,090.78 North 111,734.20 East

Now for the elevation:

From the general equation for the elevation of a point at some station on a vertical curve:

$$\text{Elevation at X} = \left(\frac{g_2 - g_1}{2L}\right) X2 + g_1X + \text{Elev. BVC}$$

Where: X is distance (in stations, BVC to point).

g_1 and g_2 are grades "in" and "out" of the curve in percent, respectively.

X = 142+69.09 – 132+61.97 = 10.0712

g_1 = + 2.5

g_2 = -3.0

L = 14

$$\text{Elevation at X} = \left(\frac{-3-2.5}{(2)(14)}\right)10.0712^2 + (2.5)(10.0712) + 1126.94$$

Elevation at 142+69.09 = 1132.19 feet

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