Objectives for Today

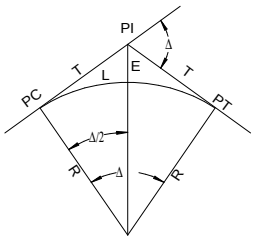
- Review Horizontal Curves

1

Introduction

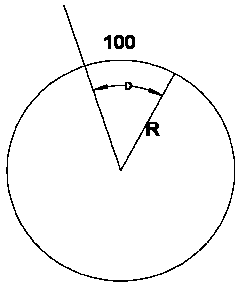
- Horizontal curves provide the means of connecting straight road segments in a smooth and safe manner.
- Types of horizontal curves:
  - Simple horizontal curves – constant radius
  - Compound horizontal curves – two or more radii
  - Spiral horizontal curve – variable radius

Horizontal Curve Elements



- PC – point of curvature
- PI – point of intersection
- PT – point of tangency
- T – tangent distance
- E – external distance
- L – curve length
- R – curve radius
  - Δ – central angle
- D – degree of curvature

Highway Definition

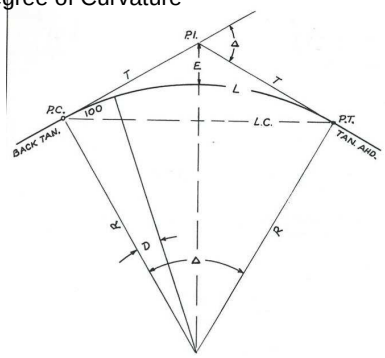


$$\frac{2\pi R}{360} = \frac{100}{D}$$

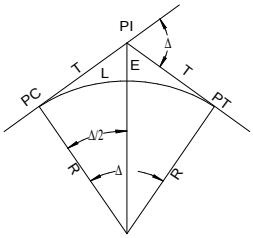
$$R = \frac{36000}{2\pi D}$$

$$R = \frac{5729.578}{D}$$

D = Degree of Curvature



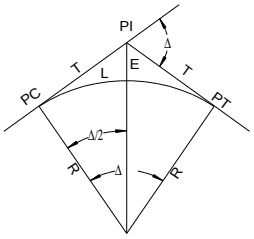
Calculating Tangent Distance



$$\tan\frac{\Delta}{2} = \frac{T}{R}$$

$$T = R\tan\frac{\Delta}{2}$$

Calculating External Distance

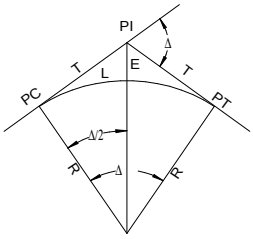


$$\cos\frac{\Delta}{2}=\frac{R}{R+E}$$

$$R+E=\frac{R}{\cos\frac{\Delta}{2}}$$

$$E=\frac{R}{\cos\frac{\Delta}{2}}-R$$

Calculating Curve Length

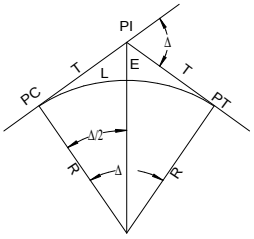


$$\frac{L}{\Delta}=\frac{100}{D}=\frac{100}{\frac{5729.578}{R}}$$

$$L=\frac{100\Delta R}{5729.578}$$

$$L=0.0174533R\Delta$$

Calculating PC and PT Stationing



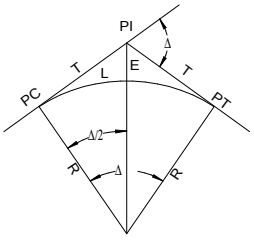
$$PC=PI-T$$

$$PT=PC+L$$

Selection of Degree of Curvature

- If curve radius is known, then there is no need to calculate D!
- However, if R is unknown, then D may be calculated in one of three ways:
  - Using a known external distance
  - Using a known tangent distance
  - Using a known curve length

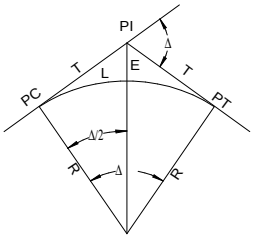
Known External Distance



$$E_1=\frac{5729.578}{\cos\frac{\Delta}{2}}-5729.578$$

$$D=\frac{E_1}{\text{desired }E}$$

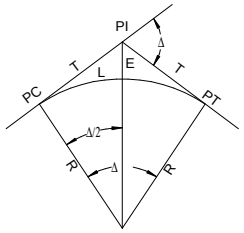
Known Tangent Distance



$$T_1=5729.578\tan\frac{\Delta}{2}$$

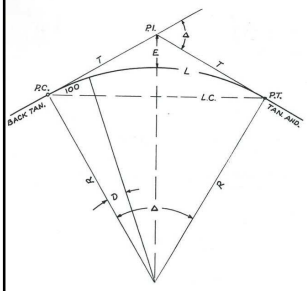
$$D=\frac{T_1}{\text{desired }T}$$

Known Curve Length



$$D = \frac{100\Delta}{\text{desired } L}$$

Calculation Summary



$$R = \frac{5729.578}{D}$$

$$L = 0.0174533R\Delta$$

$$E = \frac{R}{\cos\frac{\Delta}{2}} - R$$

$$T = R\tan\frac{\Delta}{2}$$

$$PC = PI - T$$

$$PT = PC + L$$

Curve Layout

- Requires that curve parameters have been calculated
- Methods of layout:
  - Deflection angles – requires surveying instruments
  - Tangent offset method – more office calculations
  - Chord offset method – good for reconnaissance

Tangent Offset Method

- Determine stationing to be used on curve
- Calculate tangent distance (TD) and tangent offset (TO) for each station

$$\beta = \frac{100}{stationing}$$

For each station on curve :

$$\gamma = \frac{D}{\beta} station\ number$$

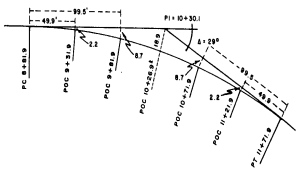
$$TD = R\sin\gamma$$

$$TO = R(1-\cos\gamma)$$

Tangent Offset Example

D	10
R	573
T	148.2
Stationing	50
Beta	2

Station #	gamma	sin gamma	cos gamma	TD	TO
1	5	0.08716	0.99619	49.94	2.18
2	10	0.17365	0.98481	99.50	8.71
3	15	0.25882	0.96593	148.30	19.52

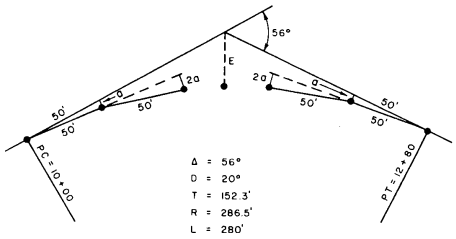


Chord Offset Method

- Choose a chord length (c), usually 25 or 50 feet.
- Calculate the chord offset (a).

$$a = \frac{c^2}{2R}$$

Chord Offset Example



Hints for Exercise #1

- Curves 1, 2, & 3 ➔ Each curve is handled independently—just choose the appropriate method for determining D and then calculate the remaining curve parameters.
- Curve 4 ➔ Calculate the tangent distances and offsets working forward from the PC to the external and working backward from the PT to the external.
- Curve 5 ➔ Calculate the value of “a”.