CE 211 – Surveying Engineering
Class 20: Route Surveying

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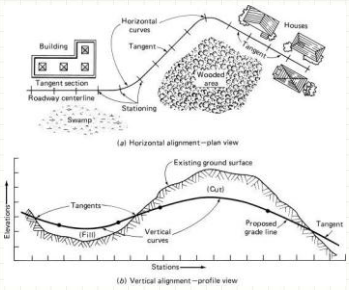
Class Objectives

- Identify route surveying objectives and procedures
- Define horizontal curves parameters and equations
- Define degrees of curvatures for horizontal curves using arc and chord definitions
- Relate R, D, Δ, L, LC, T, E, and M for a horizontal curve
- Restation horizontal curves

ROUTE SURVEYS

- Route surveying includes the field and office work required to plan, design, and lay out any "long and narrow" transportation facility.
- Most of the basic surveying concepts and methods described in the previous chapters apply to route surveying.
- Horizontal distances, elevations, and angles must be measured, maps must be drawn, and profile and cross section views of the route must be prepared.

ROUTE SURVEYS



The route alignment for a road or railway line comprises a connected series of tangents and curves.

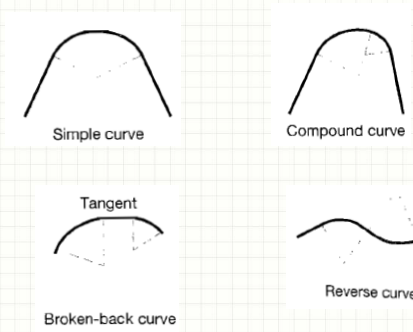
HORIZONTAL CURVES

- **Computing the Curve**
  - **Degree of Curve**
- **Stationing Along a Route**
  - **Restationing**

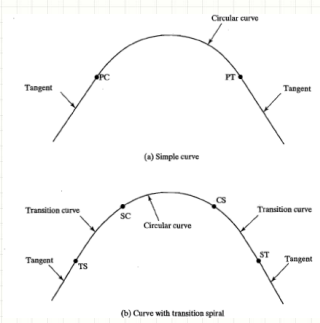
Horizontal Curves

- Why do we need them?
  - topographical constrains
  - minimize cost
  - driver attention
- How sharp (or smooth) they should be?
  - Speed limit
  - Terrain(flat, rolling, and mountainous)

Horizontal Curves- Types

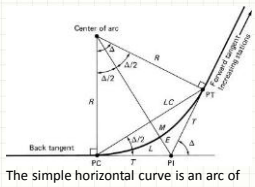


Horizontal Curves - Types



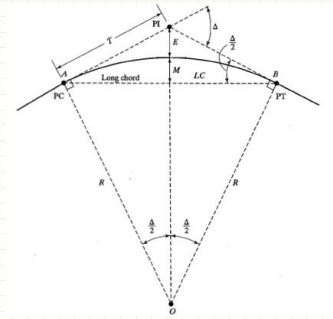
HORIZONTAL CURVES

- The most common type of horizontal curve is a single arc of a circle, called a *simple curve.*
- *Stationing??*



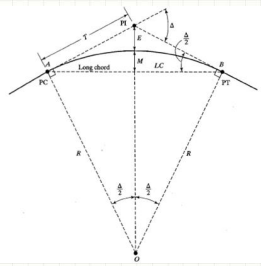
The simple horizontal curve is an arc of a circle.

Horizontal Curves – Basic Definitions

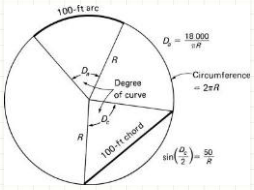


Circular Curve- Definitions

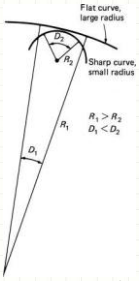
- PC "Point of Curvature"
- PT "Point of Tangent"
- PI "Point of Intersection"
- R "Radius"
- D "Degree of Curvature"
- Δ "Intersection angle"
- T "Tangent Length"
- L "Curve Length"
- LC "Long chord Length"
- E "External distance"
- M "Middle ordinate"



HORIZONTAL CURVES



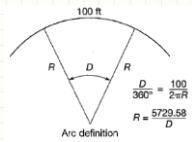
The degree of curve may be determined by the arc definition (*Da*) or by the chord definition (*Dc*).



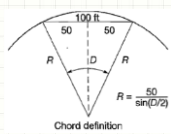
A sharp curve and a flat curve.

Horizontal Alignment

- Degree of Circular Curves (Degree of Curvature)
  - Arc definition

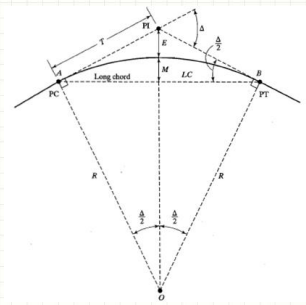


  - Chard definition



Circular Curve Formulas

- PC, PI, & PT
- R, D & I
- T, E, & M
- L



Circular Curve Formulas

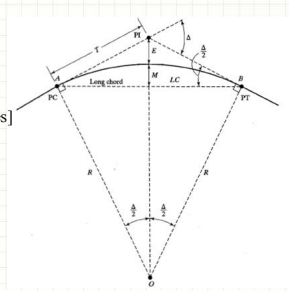
$$L = 100\frac{\Delta^o}{D^o}(feet)$$

$$L = \frac{\Delta^o}{D^o}(stations)$$

$$L = \frac{\Delta}{360}(2\pi R) \quad [\Delta \text{ in degrees}]$$

$$L = R\Delta(\Delta \text{ in radians})$$

$$LC = 2R\sin\frac{\Delta^o}{2}$$



Circular Curve Formulas

$$R = \frac{5729.58}{D}(ft) \quad [\text{arc definition}]$$

$$R = \frac{50}{\sin(D/2)}(ft) \quad [\text{chord definition}]$$

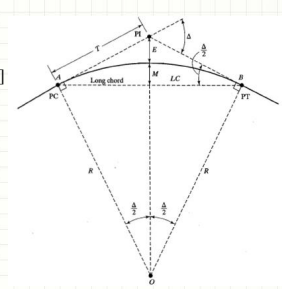
$$T = R\tan\frac{\Delta^o}{2}$$

$$E = T\tan\frac{\Delta^o}{4}$$

$$E = R\left(\frac{1}{\cos(\Delta/2)} - 1\right)$$

$$M = E\cos\frac{\Delta^o}{2}$$

$$M = R\left(1 - \cos\frac{\Delta^o}{2}\right)$$

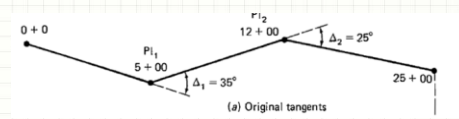


Example

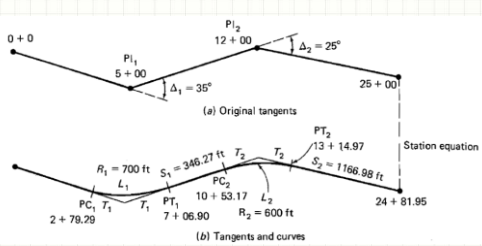
- R = 300 ft
- Two tangents that form an intersection angle of 74°46'36"
- The station of PI is 7+47.64
- Find: Station of PC and PT
  - Station PC = Station PI – T
  - Station PT = Station PC + L

The Restationing process - example

- A 2500-ft roadway route centerline is established during a preliminary survey. The three tangent sections are to be connected by two simple curves with R1=700 ft and R2 = 600 ft
- Find: The stations of the PCs and PTs, the total length of the route, and the last station in the final route.



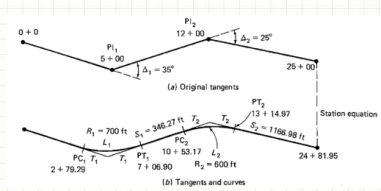
The Restationing process - example



The Restationing process - example

T1=220.71
L1=427.61

T2=133.02
L2=261.80



PC1=500-220.71= 279.29
=2 + 79.29

PT1=279.29+427.61=706.90
=7 + 06.90

$$S_1 = (1200.00 - 500.00) - 220.71 - 133.02 = 346.27 \text{ ft}$$

PC2=706.90+346.27=1053.17
=10+53.17

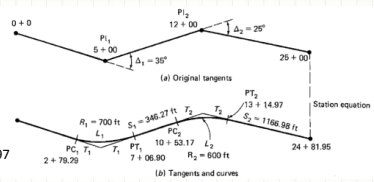
PT2=1053.17+261.80=1314.97
=13+14.97

The Restationing process - example

T1=220.71
L1=427.61

T2=133.02
L2=261.80

PT2=1053.17+261.80=1314.97
=13+14.97



$$S_1 = (1200.00 - 500.00) - 220.71 - 133.02 = 346.27 \text{ ft}$$
$$S_2 = (2500.00 - 1200.00) - 133.02 = 1166.98 \text{ ft}$$
$$\text{Total length} = \text{PT}_2 + S_2 = 1314.97 + 1166.98 = 2481.95 \text{ ft}$$

The Restationing process - example

T1=220.71
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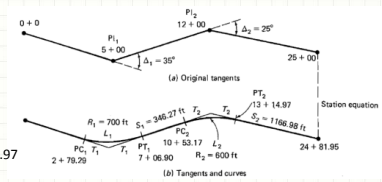
L2=261.80

PT2=1053.17+261.80=1314.97
=13+14.97



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