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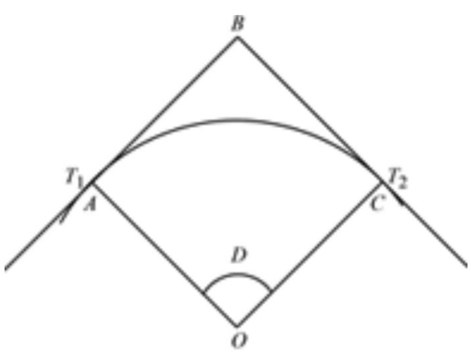
Curves

Curves are regular bends provided in the lines of communication like roads, railways and canals etc. to bring about gradual change of direction.
They enable vehicle to pass from one path to another when the two paths meet at an angle.They are also used in the vertical plane at all changes of grade to avoid abrupt change of grade at the apex.



Simple Curve

HORIZONTAL CURVES

Curves provided in the horizontal plane to have the gradual change in direction are known as horizontal curves.

VERTICAL CURVES

Curves provided in the vertical plane to obtain the gradual change in grade are called as vertical curves.

NEED OF PROVIDING CURVES

Curves are needed on Highways, railways and canals for bringing about gradual change of direction of motion. They are provided for following reasons.

i)To bring about gradual change in direction of motion.

ii) To bring about gradual change in gradeand for good visibility.

ii) To alert the driver so that he may not fall a sleep.

iv)To layout Canal alignment.

V) To control erosion of canal banks by the thrust of flowing water in a canal.

CLASSIFICATION OF CIRCULAR CURVES

Circular curves are classified as

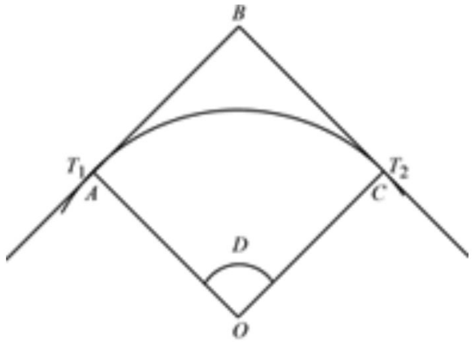
(i) Simple Curves.

(ii) Compound Curves.

(ii) Reverse Curves.

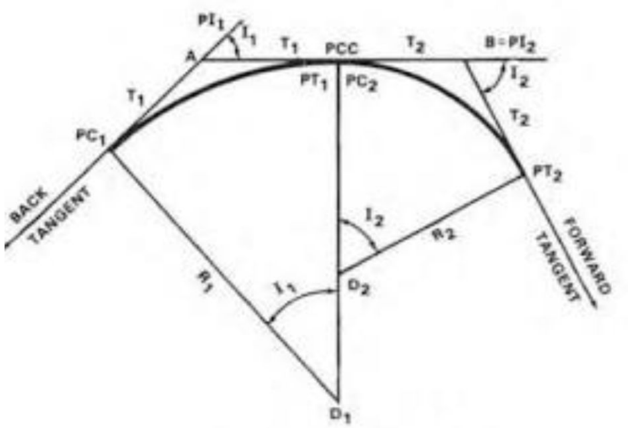
i) Simple Curve:

A simple curve Consists of a single circle connecting two straights. It has radius of the same magnitude throughout arc of circle.

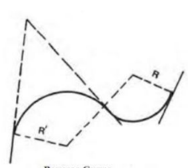


Simple Curve

Compound curve:-
A compound Curve consists of two or more simple curves having different radii bending in the same direction and lying on the same side of the common tangent. Their centres lie on the same side of the curve.

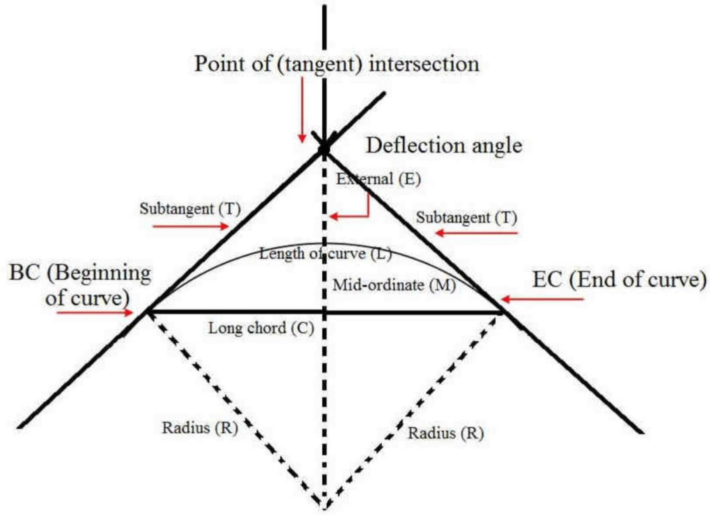


REVERSE CURVE :-
A reverse curve is made up of two arcs having equal or different radii bending in opposite direction with a common tangent at their junction
Their centres opposite sides of the curve. Reverse curves are used when the straights are parallel or intersect at a very small angle.



Reverse Curve

Elements of Simple circular curve :-



- (1) The two straight lines AB and BC which
connected by the curve are called **tangents or straights** to the curve.
- (2) The point of intersection of the two straights is called the **intersection point**
or the vertex.
- (3) When the curve deflects to the right side of the progress of survey ,it is termed as right
handed curve and when to the left , it is
termed as left handed curve.
- (4) The lines AB and BC are tangents the
curve. AB is called the first tangent or the rear tangent . BC is called the second tangent or the forward tangent.
- (5) The points (T1 and T2) at which the
curve touches the tangents are called the tangent points of the curve. (T1) is called beginning of the curve qnd (T2) is called the end of the curve .
- (6) The angle between the lines AB andBC(LABC) is called the angle of intersection.
- (7)The angle by which the forward tangent deflects from the rear tangent is called the deflection angle (¢) of the curve.
- (8) The distance from the point of intersection to the tangent point is called tangent length.
- (9)The line joining the two tangent points (T1to T2) is known as the long chord.

Formula for elements :-

1. Length of Curve (l):

$$l = R\Delta, \text{ where } \Delta \text{ is in radians}$$

$$= R\Delta \times \frac{\pi}{180} \text{ if } \Delta \text{ is in degrees}$$

If the curve is designated by degree of curvature D_a for standard length of s, then

$$l = R\Delta \frac{\pi}{180}$$

$$= \frac{s}{D_a}\frac{180}{\pi}\cdot\Delta\frac{\pi}{180}, \quad \text{since from equation 2.1, } R = \frac{s}{D_a}\frac{180}{\pi}$$

$$l = \frac{s\Delta}{D_a}$$

Thus,

If $s = 30, \quad l = \dfrac{30\Delta}{D_a}$

and if $s = 20 \text{ m}, \quad l = \dfrac{20\Delta}{D_a}$

2. Tangent Length (T):

$$T = T_1V = VT_2$$

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

3. Length of Long Cord (L):

$$L = 2\,R \sin\frac{\Delta}{2}$$

4. Mid-ordinate (M):

$$M = CD = CO - DO$$

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

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

5. External Distance (E):

$$E = VC = VO - CO$$

$$= R \sec \frac{\Delta}{2} - R$$

$$= R\left(\sec \frac{\Delta}{2} - 1\right) = R \text{ exsec } \frac{\Delta}{2}$$

Example . A circular curve has 300 m radius and 60° deflection angle. What is its degree by (a) arc definition and (b) chord definition of standard length 30 m. Also calculate (i) length of curve, (ii) tangent length, (iii) length of long chord, (iv) mid-ordinate and (v) apex distance.

Solution:

$$R = 300 \text{ m} \quad \Delta = 60°$$

(a) Arc definition:

$$s = 30 \text{ m},$$

$$R = \frac{s}{D_a} \times \frac{180}{\pi}$$

$$\therefore \quad 300 = \frac{30 \times 180}{D_a \pi} \quad \text{or} \quad D_a = 5.730 \qquad \textbf{Ans.}$$

(b) Chord definition:

$$R \sin \frac{D_c}{2} = \frac{s}{2}$$

$$300 \sin \frac{D_c}{2} = \frac{30}{2}$$

$$\therefore \quad DC = 5.732 \qquad \textbf{Ans.}$$

(i) Length of the curve:

$$l = R\Delta \frac{\pi}{180} = 300 \times 60 \times \frac{\pi}{180} = 314.16 \text{ m} \qquad \textbf{Ans.}$$

(ii) Tangent length:

$$T = R \tan \frac{\Delta}{2} = 300 \tan \frac{60}{2} = 173.21 \text{ m} \qquad \textbf{Ans.}$$

(iii) Length of long chord:

$$L = 2 R \sin \frac{\Delta}{2} = 2 \times 300 \times \sin \frac{60}{2} = 300 \text{ m} \qquad \textbf{Ans.}$$

(iv) Mid-ordinate:

$$M = R\left(1 - \cos \frac{\Delta}{2}\right) = 300\left(1 - \cos \frac{60}{2}\right) = 40.19 \text{ m} \qquad \textbf{Ans.}$$