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# Highway Geometric Design Formulas

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# List of 32 Highway Geometric Design Formulas

## Highway Geometric Design

### Gradients

#### 1) Camber given Gradient

Open Calculator

fx $$H_c = \frac{h_{Elevation}}{2}$$

ex $$1.5\text{m} = \frac{3\text{m}}{2}$$

#### 2) Distance from Center of Camber given Height for Parabolic Shape Camber

Open Calculator

fx $$X = \left(\frac{H_c \cdot (h_{Elevation} \cdot B)}{2}\right)^{0.5}$$

ex $$3.940178\text{m} = \left(\frac{1.5\text{m} \cdot (3\text{m} \cdot 6.9\text{m})}{2}\right)^{0.5}$$

## 3) Grade Compensation formula 1

Open Calculator

fx $$s = \frac{30 + R_c}{R_c}$$

ex $$1.230769 = \frac{30 + 130\text{m}}{130\text{m}}$$

## 4) Grade Compensation formula 2

Open Calculator

fx $$s = \frac{75}{R_c}$$

ex $$0.576923 = \frac{75}{130\text{m}}$$

## 5) Gradient given Camber

Open Calculator

fx $$h_{Elevation} = 2 \cdot H_c$$

ex $$3\text{m} = 2 \cdot 1.5\text{m}$$

## 6) Gradient given Height for Parabolic Shape Camber

Open Calculator

fx $$h_{Elevation} = \frac{2 \cdot \left(X^2\right)}{H_c \cdot B}$$

ex $$2.93913\text{m} = \frac{2 \cdot \left((3.9\text{m})^2\right)}{1.5\text{m} \cdot 6.9\text{m}}$$

## 7) Height for Parabolic Shape Camber

Open Calculator

$$H_c = \frac{2 \cdot \left(X^2\right)}{h_{Elevation} \cdot B}$$

$$1.469565\text{m} = \frac{2 \cdot \left((3.9\text{m})^2\right)}{3\text{m} \cdot 6.9\text{m}}$$

## 8) Height for Straight Line Camber

Open Calculator

$$H_c = \frac{B}{h_{Elevation} \cdot 2}$$

$$1.15\text{m} = \frac{6.9\text{m}}{3\text{m} \cdot 2}$$

## 9) Radius of Road given Grade Compensation formula 1

Open Calculator

$$R_c = \frac{30}{s - 1}$$

$$130.4348\text{m} = \frac{30}{1.23 - 1}$$

## 10) Radius of Road given Grade Compensation formula 2

Open Calculator

$$R_c = \frac{75}{s}$$

$$60.97561\text{m} = \frac{75}{1.23}$$

### 11) Width of Road given Height for Parabolic Shape Camber

Open Calculator

fx $$B = \frac{2 \cdot \left(X^2\right)}{H_c \cdot h_{Elevation}}$$

ex $$6.76\text{m} = \frac{2 \cdot \left((3.9\text{m})^2\right)}{1.5\text{m} \cdot 3\text{m}}$$

### 12) Width of Road given Height for Straight Line Camber

Open Calculator

fx $$B = H_c \cdot (h_{Elevation} \cdot 2)$$

ex $$9\text{m} = 1.5\text{m} \cdot (3\text{m} \cdot 2)$$

## Horizontal Curves

## Extra Widening on Horizontal Curves

### 13) Psychological Widening on Horizontal Curves

Open Calculator

fx $$W_{ps} = \frac{v}{9.5 \cdot (R_t)^{0.5}}$$

ex $$0.303869\text{m} = \frac{50\text{km/h}}{9.5 \cdot (300\text{m})^{0.5}}$$

## 14) Total Extra Widening required on Horizontal Curves

Open Calculator

fx $$W_e = \left(\frac{n \cdot \left(l^2\right)}{2 \cdot R_t}\right) + \left(\frac{v}{9.5 \cdot \left(R_t^{0.5}\right)}\right)$$

ex $$0.843869\text{m} = \left(\frac{9 \cdot \left((6\text{m})^2\right)}{2 \cdot 300\text{m}}\right) + \left(\frac{50\text{km/h}}{9.5 \cdot \left((300\text{m})^{0.5}\right)}\right)$$

## 15) Total Extra Widening required on Horizontal Curves wrt Wm and Wps

Open Calculator

fx $$W_e = (W_{ps} + W_m)$$

ex $$0.89\text{m} = (0.52\text{m} + 0.37\text{m})$$

# Set Back Distance and curve Resistance

## 16) Set Back Distance by Approx Method (L is greater than S)

Open Calculator

fx $$m = \frac{SSD^2}{8 \cdot R_t}$$

ex $$10.66667\text{m} = \frac{(160\text{m})^2}{8 \cdot 300\text{m}}$$

## 17) Set Back Distance by Approx Method (L is less than S)

Open Calculator

$$m = \frac{L_c \cdot (2 \cdot SSD - L_c)}{8 \cdot R_t}$$

$$10.5\text{m} = \frac{140\text{m} \cdot (2 \cdot 160\text{m} - 140\text{m})}{8 \cdot 300\text{m}}$$

## 18) Set Back Distance by Rational Method (L is greater than S) Single Lane

Open Calculator

$$m = R_t - R_t \cdot \cos\left(\frac{SSD}{2 \cdot R_t}\right)$$

$$10.60361\text{m} = 300\text{m} - 300\text{m} \cdot \cos\left(\frac{160\text{m}}{2 \cdot 300\text{m}}\right)$$

# Summit Curve

## 19) Length of Summit Curve for Stopping Sight Distance when Curve Length is less than SSD

Open Calculator

fx
$$L_{Sc} = 2 \cdot SSD - \left( \frac{\left( (2 \cdot H)^{0.5} + (2 \cdot h)^{0.5} \right)^2}{N} \right)$$

ex
$$265.0368\text{m} = 2 \cdot 160\text{m} - \left( \frac{\left( (2 \cdot 1.2\text{m})^{0.5} + (2 \cdot 0.15\text{m})^{0.5} \right)^2}{0.08} \right)$$

## 20) Length of Summit Curve for Stopping Sight Distance when Curve Length is more than SSD

Open Calculator

fx
$$L_{Sc} = \frac{N \cdot SSD^2}{\left( (2 \cdot H)^{0.5} + (2 \cdot h)^{0.5} \right)^2}$$

ex
$$465.7662\text{m} = \frac{0.08 \cdot (160\text{m})^2}{\left( (2 \cdot 1.2\text{m})^{0.5} + (2 \cdot 0.15\text{m})^{0.5} \right)^2}$$

### 21) Length of Summit Curve when Length of Curve is greater than OSD or ISD

Open Calculator

fx $$L_{Sc} = \frac{N \cdot \left(SSD^2\right)}{8 \cdot H}$$

ex $$213.3333\text{m} = \frac{0.08 \cdot \left((160\text{m})^2\right)}{8 \cdot 1.2\text{m}}$$

### 22) Length of Summit Curve when Length of Curve is less than OSD or ISD

Open Calculator

fx $$L_{Sc} = 2 \cdot SSD - \left(\frac{8 \cdot H}{N}\right)$$

ex $$200\text{m} = 2 \cdot 160\text{m} - \left(\frac{8 \cdot 1.2\text{m}}{0.08}\right)$$

## Transition Curve

### 23) Length of Transition Curve according to Rate of change of Centrifugal Acceleration

Open Calculator

fx $$L_s = \frac{v_1^3}{C \cdot R_t}$$

ex $$36.39259\text{m} = \frac{(17\text{m/s})^3}{0.45\text{m/s}^3 \cdot 300\text{m}}$$

## 24) Length of Transition Curve according to Rate of Introduction of Superelevation

Open Calculator

fx $$L_e = \left(\frac{e \cdot N_{Rate}}{2}\right) \cdot (W + W_{ex})$$

ex $$562.1245\text{m} = \left(\frac{0.07 \cdot 150.1}{2}\right) \cdot (7\text{m} + 100\text{m})$$

## 25) Length of Transition Curve by Empirical Formula for Mountainous and Steep Terrains

Open Calculator

fx $$L_{Slope} = \frac{v_1^2}{R_t}$$

ex $$0.963333\text{m} = \frac{(17\text{m/s})^2}{300\text{m}}$$

## 26) Length of Transition Curve by Empirical Formula for Plain and Rrolling Terrain

Open Calculator

fx $$L_{Terrain} = \frac{2.7 \cdot (v_1)^2}{R_t}$$

ex $$2.601\text{m} = \frac{2.7 \cdot (17\text{m/s})^2}{300\text{m}}$$

### 27) Length of Transition Curve if Pavement is Rotated about Inner Edge

Open Calculator

$$L_t = e \cdot N_{Rate} \cdot (W + W_{ex})$$

$$1124.249\text{m} = 0.07 \cdot 150.1 \cdot (7\text{m} + 100\text{m})$$

### 28) Radius of Circular Curve given Length of Transition Curve

Open Calculator

$$R_t = \frac{v_1^3}{C \cdot L_s}$$

$$300.0214\text{m} = \frac{(17\text{m/s})^3}{0.45\text{m/s}^3 \cdot 36.39\text{m}}$$

## Valley Curve

### 29) Length of Valley Curve for Head Light Sight Distance when Length is less than SSD

Open Calculator

$$L_{Vc} = 2 \cdot SSD - \left(\frac{2 \cdot h_1 + 2 \cdot SSD \cdot \tan(\alpha)}{N}\right)$$

$$154.5767\text{m} = 2 \cdot 160\text{m} - \left(\frac{2 \cdot 0.75\text{m} + 2 \cdot 160\text{m} \cdot \tan(2.1^\circ)}{0.08}\right)$$

## 30) Length of Valley Curve for Head Light Sight Distance when Length is more than SSD

Open Calculator

fx $$L_{Vc} = \frac{N \cdot SSD^2}{2 \cdot h_1 + 2 \cdot SSD \cdot \tan(\alpha)}$$

ex $$154.7545\text{m} = \frac{0.08 \cdot (160\text{m})^2}{2 \cdot 0.75\text{m} + 2 \cdot 160\text{m} \cdot \tan(2.1^\circ)}$$

## 31) Length of Valley Curve given Beam Angle and Height of Head Light

Open Calculator

fx $$L_{Vc} = 2 \cdot SSD - \left(\frac{1.5 + 0.035 \cdot SSD}{N}\right)$$

ex $$231.25\text{m} = 2 \cdot 160\text{m} - \left(\frac{1.5 + 0.035 \cdot 160\text{m}}{0.08}\right)$$

## 32) Length of Valley Curve given Height of Head Light and Beam Angle

Open Calculator

fx $$L_{Vc} = N \cdot \frac{SSD^2}{1.5 + 0.035 \cdot SSD}$$

ex $$288.4507\text{m} = 0.08 \cdot \frac{(160\text{m})^2}{1.5 + 0.035 \cdot 160\text{m}}$$

# Variables Used

- **B** Pavement Width *(Meter)*
- **C** Rate of Change of Centrifugal Acceleration *(Meter per Cubic Second)*
- **e** Rate of Superelevation
- **h** Height of Subject above Pavement Surface *(Meter)*
- **H** Height of Eye Level of Driver above Roadway *(Meter)*
- $h_1$ Average Head Light Height *(Meter)*
- $H_c$ Height of Camber *(Meter)*
- $h_{Elevation}$ Elevation Difference *(Meter)*
- **l** Length of Wheel Base as per IRC *(Meter)*
- $L_c$ Length of Curve *(Meter)*
- $L_e$ Transition Curve Length for Superelevation *(Meter)*
- $L_s$ Length of Transition Curve *(Meter)*
- $L_{Sc}$ Length of Parabolic Summit Curve *(Meter)*
- $L_{Slope}$ Transition Curve Length for Slope *(Meter)*
- $L_t$ Transition Curve Length *(Meter)*
- $L_{Terrain}$ Transition Curve Length for Terrain *(Meter)*
- $L_{Vc}$ Length of Valley Curve *(Meter)*
- **m** Set Back Distance *(Meter)*
- **n** Number of Traffic Lanes
- **N** Deviation Angle
- $N_{Rate}$ Allowable Rate of Change of Superelevation
- $R_c$ Radius of Circular Curve *(Meter)*

- $R_t$ Radius of Curve for Road *(Meter)*
- **s** Percent Grade
- **SSD** Stopping Sight Distance *(Meter)*
- **v** Speed of Vehicle *(Kilometer per Hour)*
- $v_1$ Design Speed on Highways *(Meter per Second)*
- **W** Normal Pavement Width *(Meter)*
- $W_e$ Total Extra Widening Required on Horizontal Curves *(Meter)*
- $W_{ex}$ Extra Widening of Pavement *(Meter)*
- $W_m$ Mechanical Widening on Horizontal Curves *(Meter)*
- $W_{ps}$ Psychological Widening on Horizontal Curves *(Meter)*
- **X** Distance from Center of Camber *(Meter)*
- **α** Beam Angle *(Degree)*

# Constants, Functions, Measurements used

- Function: **cos**, cos(Angle)
  *Trigonometric cosine function*
- Function: **tan**, tan(Angle)
  *Trigonometric tangent function*
- Measurement: **Length** in Meter (m)
  *Length Unit Conversion*
- Measurement: **Speed** in Kilometer per Hour (km/h), Meter per Second (m/s)
  *Speed Unit Conversion*
- Measurement: **Angle** in Degree (°)
  *Angle Unit Conversion*
- Measurement: **Jerk** in Meter per Cubic Second ($m/s^3$)
  *Jerk Unit Conversion*

## Check other formula lists

- **Highway and Road Formulas**
- **Highway Geometric Design Formulas**
- **Sight Distances of Highway Formulas**

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