



# Highway Geometric Design Formulas

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# List of 32 Highway Geometric Design Formulas

### Highway Geometric Design 🗗

### Gradients 🚰

1) Camber given Gradient

$${
m H_c} = rac{{
m h_{Elevation}}}{2}$$

Open Calculator 🗗

$$\boxed{1.5\mathrm{m} = \frac{3\mathrm{m}}{2}}$$

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

$$X = \left(rac{H_{c}\cdot(h_{
m Elevation}\cdot B)}{2}
ight)^{0.5}$$

Open Calculator 🗗

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



#### 3) Grade Compensation formula 1

 $|\mathbf{f}| = rac{30 + R_c}{R_c}$ 

Open Calculator

 $= 1.230769 = \frac{30 + 130 \mathrm{m}}{130 \mathrm{m}}$ 

### 4) Grade Compensation formula 2

fx  $s=rac{75}{R_c}$ 

Open Calculator

5) Gradient given Camber

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

Open Calculator 🚰

 $|\mathbf{a}| = 2 \cdot 1.5 \mathbf{m}$ 

# 6) Gradient given Height for Parabolic Shape Camber

 $\mathbf{h}_{\mathrm{Elevation}} = rac{2 \cdot \left( \mathrm{X}^2 
ight)}{\mathrm{H_c} \cdot \mathrm{B}}$ 

Open Calculator

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





#### 7) Height for Parabolic Shape Camber

 $\mathbf{H}_{\mathrm{c}} = rac{2 \cdot \left(\mathrm{X}^2
ight)}{\mathrm{h}_{\mathrm{Elevation}} \cdot \mathrm{B}}$ 

Open Calculator

 $oxed{ex} 1.469565 \mathrm{m} = rac{2 \cdot \left( \left( 3.9 \mathrm{m} 
ight)^2 
ight)}{3 \mathrm{m} \cdot 6.9 \mathrm{m}}$ 

### 8) Height for Straight Line Camber

 $ext{fx} ext{H}_{ ext{c}} = rac{ ext{B}}{ ext{h}_{ ext{Elevation}} \cdot 2}$ 

Open Calculator

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

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

 $\left| \mathbf{R}_{\mathrm{c}} = rac{30}{\mathrm{s}-1} 
ight|$ 

Open Calculator 🖸

 $= \frac{30}{1.23 - 1}$ 

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

 $R_{\rm c}=rac{75}{
m s}$ 

Open Calculator







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

 $\mathbf{E} = rac{2 \cdot \left( \mathrm{X}^2 
ight)}{\mathrm{H_c} \cdot \mathrm{h_{Elevation}}}$ 

Open Calculator

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

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

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

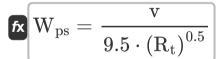
Open Calculator

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

### Horizontal Curves

### Extra Widening on Horizontal Curves

### 13) Psychological Widening on Horizontal Curves



$$oxed{ex} 0.303869 \mathrm{m} = rac{50 \mathrm{km/h}}{9.5 \cdot \left(300 \mathrm{m}
ight)^{0.5}}$$



#### 14) Total Extra Widening required on Horizontal Curves 🗗

Open Calculator 2

$$\mathbf{K} \mathbf{W}_{\mathrm{e}} = \left(rac{\mathrm{n}\cdot\left(\mathrm{l}^{2}
ight)}{2\cdot\mathrm{R}_{\mathrm{t}}}
ight) + \left(rac{\mathrm{v}}{9.5\cdot\left(\mathrm{R}_{\mathrm{t}}^{0.5}
ight)}
ight)$$

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

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

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

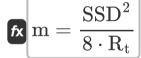
Open Calculator

Open Calculator 2

$$\boxed{0.89 \mathrm{m} = (0.52 \mathrm{m} + 0.37 \mathrm{m}) }$$

### Set Back Distance and curve Resistance G

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



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





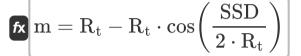
#### 17) Set Back Distance by Approx Method (L is less than S)

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

Open Calculator

 $extbf{ex} 10.5 ext{m} = rac{140 ext{m} \cdot (2 \cdot 160 ext{m} - 140 ext{m})}{8 \cdot 300 ext{m}}$ 

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



Open Calculator

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



#### **Summit Curve**

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

Open Calculator 🛂

$$ext{L}_{ ext{Sc}} = 2 \cdot ext{SSD} - \left( rac{\left( \left( 2 \cdot ext{H} 
ight)^{0.5} + \left( 2 \cdot ext{h} 
ight)^{0.5} 
ight)^2}{ ext{N}} 
ight)$$

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

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

$$extbf{L}_{ ext{Sc}} = rac{ ext{N} \cdot ext{SSD}^2}{\left( \left( 2 \cdot ext{H} 
ight)^{0.5} + \left( 2 \cdot ext{h} 
ight)^{0.5} 
ight)^2}$$

Open Calculator

$$egin{aligned} egin{aligned} egin{aligned} egin{aligned} egin{aligned} & 465.7662 ext{m} = rac{0.08 \cdot (160 ext{m})^2}{\left( \left( 2 \cdot 1.2 ext{m} 
ight)^{0.5} + \left( 2 \cdot 0.15 ext{m} 
ight)^{0.5} 
ight)^2} \end{aligned}$$





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

 $\mathbf{L}_{\mathrm{Sc}} = rac{\mathrm{N} \cdot \left(\mathrm{SSD}^2
ight)}{8 \cdot \mathrm{H}}$ 

Open Calculator 🚰

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

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

 $ag{L_{
m Sc}} = 2 \cdot {
m SSD} - \left(rac{8 \cdot {
m H}}{
m N}
ight)$ 

Open Calculator

 $oxed{ex} 200 \mathrm{m} = 2 \cdot 160 \mathrm{m} - \left( rac{8 \cdot 1.2 \mathrm{m}}{0.08} 
ight)$ 

#### **Transition Curve**

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

 $v_{1}^{3}$ 

Open Calculator

$$\mathbf{L}_{\mathrm{s}} = rac{\mathrm{v}_{1}^{3}}{\mathrm{C}\cdot\mathrm{R}_{\mathrm{t}}}$$

$$oxed{ex} 36.39259 \mathrm{m} = rac{\left(17 \mathrm{m/s}
ight)^3}{0.45 \mathrm{m/s^3 \cdot 300 m}}$$





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

 $\mathbf{L}_{\mathrm{e}} = \left(rac{\mathrm{e}\cdot\mathrm{N}_{\mathrm{Rate}}}{2}
ight)\cdot\left(\mathrm{W}+\mathrm{W}_{\mathrm{ex}}
ight)$ 

Open Calculator 🗗

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

 $\left| \mathrm{L_{Slope}} = rac{\mathrm{v}_1^2}{\mathrm{R_t}} 
ight|$ 

Open Calculator

 $ext{ex} \left[ 0.963333 ext{m} = rac{\left( 17 ext{m/s} 
ight)^2}{300 ext{m}} 
ight]$ 

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

 $\mathbf{L}_{\mathrm{Terrain}} = rac{2.7 \cdot (\mathrm{v}_1)^2}{\mathrm{R}_{\mathrm{t}}}$ 

Open Calculator 🗗

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





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

 $\mathbf{L}_{\mathrm{t}} = \mathrm{e} \cdot \mathrm{N}_{\mathrm{Rate}} \cdot (\mathrm{W} + \mathrm{W}_{\mathrm{ex}})$ 

Open Calculator 🗗

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

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

 $\left| \mathbf{R}_{\mathrm{t}} = rac{v_{1}^{3}}{\mathrm{C} \cdot \mathrm{L}_{\mathrm{s}}} 
ight|$ 

Open Calculator

### Valley Curve

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

fx

Open Calculator 🗗

$$\mathrm{L_{Vc}} = 2 \cdot \mathrm{SSD} - \left(rac{2 \cdot \mathrm{h_1} + 2 \cdot \mathrm{SSD} \cdot \mathrm{tan}(lpha)}{\mathrm{N}}
ight)$$

$$\boxed{ 154.5767 \mathrm{m} = 2 \cdot 160 \mathrm{m} - \left( \frac{2 \cdot 0.75 \mathrm{m} + 2 \cdot 160 \mathrm{m} \cdot \tan(2.1°)}{0.08} \right) }$$



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

 $\mathbf{L}_{\mathrm{Vc}} = rac{\mathrm{N}\cdot\mathrm{SSD}^2}{2\cdot\mathrm{h}_1 + 2\cdot\mathrm{SSD}\cdot\mathrm{tan}(lpha)}$ 

Open Calculator

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

 $extbf{L}_{ ext{Vc}} = 2 \cdot ext{SSD} - \left(rac{1.5 + 0.035 \cdot ext{SSD}}{ ext{N}}
ight)$ 

Open Calculator

 $oxed{ex} \left| 231.25 \mathrm{m} = 2 \cdot 160 \mathrm{m} - \left( rac{1.5 + 0.035 \cdot 160 \mathrm{m}}{0.08} 
ight) 
ight|$ 

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

 $extbf{L}_{ ext{Vc}} = ext{N} \cdot rac{ ext{SSD}^2}{1.5 + 0.035 \cdot ext{SSD}}$ 

Open Calculator 🚰



#### 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**<sub>1</sub> Average Head Light Height (*Meter*)
- **H**<sub>C</sub> Height of Camber (*Meter*)
- h<sub>Elevation</sub> Elevation Difference (Meter)
- Length of Wheel Base as per IRC (Meter)
- L<sub>c</sub> Length of Curve (Meter)
- Le Transition Curve Length for Superelevation (Meter)
- L<sub>s</sub> Length of Transition Curve (Meter)
- L<sub>Sc</sub> Length of Parabolic Summit Curve (Meter)
- L<sub>Slope</sub> Transition Curve Length for Slope (Meter)
- L<sub>t</sub> Transition Curve Length (Meter)
- L<sub>Terrain</sub> Transition Curve Length for Terrain (Meter)
- Lvc Length of Valley Curve (Meter)
- m Set Back Distance (Meter)
- n Number of Traffic Lanes
- N Deviation Angle
- N<sub>Rate</sub> Allowable Rate of Change of Superelevation
- R<sub>c</sub> Radius of Circular Curve (Meter)





- R<sub>t</sub> Radius of Curve for Road (Meter)
- S Percent Grade
- SSD Stopping Sight Distance (Meter)
- V Speed of Vehicle (Kilometer per Hour)
- V<sub>1</sub> Design Speed on Highways (Meter per Second)
- W Normal Pavement Width (Meter)
- **W**<sub>e</sub> Total Extra Widening Required on Horizontal Curves (Meter)
- Wex Extra Widening of Pavement (Meter)
- W<sub>m</sub> Mechanical Widening on Horizontal Curves (Meter)
- W<sub>ps</sub> 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/s³)

  Jerk Unit Conversion





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- Highway and Road Formulas Sight Distances of Highway
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   Formulas
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