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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

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

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

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



3) Grade Compensation formula 1

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

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

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

4) Grade Compensation formula 2

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

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

5) Gradient given Camber

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

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

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

6) Gradient given Height for Parabolic Shape Camber

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

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

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



7) Height for Parabolic Shape Camber

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

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

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

8) Height for Straight Line Camber

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

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

9) Radius of Road given Grade Compensation formula 1

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

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

10) Radius of Road given Grade Compensation formula 2

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

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

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



11) Width of Road given Height for Parabolic Shape Camber

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

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

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

12) Width of Road given Height for Straight Line Camber

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

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

Horizontal Curves

Extra Widening on Horizontal Curves

13) Psychological Widening on Horizontal Curves

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

[Open Calculator !\[\]\(799877f5c2f906134441300079881630_img.jpg\)](#)

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



14) Total Extra Widening required on Horizontal Curves

[Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(10f8862fc183b400327470ea85afe9ae_img.jpg\)](#)

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

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

Set Back Distance and curve Resistance

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

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

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

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



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

[Open Calculator !\[\]\(feabb98897b440bc8695a03336a6e2df_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(642aa997563f9a325b310230bb5078b7_img.jpg\)](#)

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

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



Summit Curve

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

fx

Open Calculator 

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

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

fx

Open Calculator 

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

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

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

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

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

Transition Curve

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

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

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822_img.jpg\)](#)

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



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

[Open Calculator !\[\]\(99f58673407353e96a019fbca558fd72_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

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

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



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

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

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

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

28) Radius of Circular Curve given Length of Transition Curve

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

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

Valley Curve

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

fx

[Open Calculator !\[\]\(b792654f2cef9719eabeb6c5be00811e_img.jpg\)](#)

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

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



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

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

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

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

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

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

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



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)
- **h₁** 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**, $\cos(\text{Angle})$
Trigonometric cosine function
- **Function:** **tan**, $\tan(\text{Angle})$
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 ($^{\circ}$)
Angle Unit Conversion 
- **Measurement:** **Jerk** in Meter per Cubic Second (m/s^3)
Jerk Unit Conversion 



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- [Sight Distances of Highway Formulas](#) 
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