Important Highway Geometric Design Formulas PDF

Formulas
Examples
with Units

List of 26
Important Highway Geometric Design Formulas

1) Gradients Formulas

1.1) Camber given Gradient Formula

Evaluate Formula

Formula

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

Example with Units

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

1.2) Grade Compensation formula 1 Formula

Evaluate Formula

Formula

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

Example with Units

$$1.2308 = \frac{30 + 130\,\text{m}}{130\,\text{m}}$$

1.3) Grade Compensation formula 2 Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5769 = \frac{75}{130\,\text{m}}$$

1.4) Gradient given Camber Formula

Evaluate Formula

Formula

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

Example with Units

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

1.5) Radius of Road given Grade Compensation formula 1 Formula

Evaluate Formula

Formula

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

Example with Units

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

1.6) Radius of Road given Grade Compensation formula 2 Formula

Evaluate Formula

Formula

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

Example with Units

$$60.9756\,\text{m} = \frac{75}{1.23}$$

2) Horizontal Curves Formulas

2.1) Extra Widening on Horizontal Curves Formulas

2.1.1) Psychological Widening on Horizontal Curves Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3039\,\text{m} = \frac{50\,\text{km/h}}{9.5 \cdot \left(300\,\text{m} \right)^{0.5}}$$

2.1.2) Total Extra Widening required on Horizontal Curves Formula

Evaluate Formula

Formula

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

Example with Units

$$0.8439\,\text{m} = \left(\frac{9 \cdot \left(6\,\text{m}^2 \right)}{2 \cdot 300\,\text{m}} \right) + \left(\frac{50\,\text{km/h}}{9.5 \cdot \left(300\,\text{m}^{0.5} \right)} \right)$$

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

Evaluate Formula

Formula

$$W_e = \left(W_{ps} + W_m \right)$$

Example with Units

$$0.89\,\text{m} = \left(0.52\,\text{m} + 0.37\,\text{m} \right)$$

3) Set Back Distance and curve Resistance Formulas

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

Evaluate Formula

Formula

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

Example with Units

$$10.6667\,\text{m} = \frac{160\,\text{m}^2}{8 \cdot 300\,\text{m}}$$

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$10.6036\,\text{m} = 300\,\text{m} - 300\,\text{m} \cdot \cos\left(\frac{160\,\text{m}}{2 \cdot 300\,\text{m}} \right)$$

4) Summit Curve Formulas

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

Evaluate Formula

Formula

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

Example with Units

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

4.2) Length of Summit Curve for Stopping Sight Distance when Curve Length is more than SSD Formula

Evaluate Formula

Formula

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

Example with Units

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

4.3) Length of Summit Curve when Length of Curve is greater than OSD or ISD Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

5) Transition Curve Formulas

5.1) Length of Transition Curve according to Rate of change of Centrifugal Acceleration Formula

Evaluate Formula

Formula

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

Example with Units

$$36.3926\,\text{m} = \frac{17\,\text{m/s}^3}{0.45\,\text{m/s}^3 \cdot 300\,\text{m}}$$

5.2) Length of Transition Curve according to Rate of Introduction of Superelevation Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$0.9633\,\text{m} = \frac{17\,\text{m/s}^2}{300\,\text{m}}$$

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

5.6) Radius of Circular Curve given Length of Transition Curve Formula

Evaluate Formula

Formula

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

Example with Units

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

6) Valley Curve Formulas

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Highway Geometric Design Formulas above

- **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 *(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)*

Constants, Functions, Measurements used in list of Highway Geometric Design Formulas above

- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- 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

- 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)*
- α Beam Angle *(Degree)*

Download other Important Highway Engineering PDFs

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

Try our Unique Visual Calculators

- Percentage decrease
- HCF of three numbers
- Multiply fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/8/2024 | 1:08:37 PM UTC