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Transition Curves Surveying Formulas

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List of 21 Transition Curves Surveying Formulas

Transition Curves Surveying

Length of Transition Curve

1) Hands-Off Velocity

$$fx \quad v = \sqrt{g \cdot R \cdot \tan(\theta)}$$

Open Calculator 

$$ex \quad 13.3546\text{m/s} = \sqrt{9.8\text{m/s}^2 \cdot 50\text{m} \cdot \tan(20^\circ)}$$

2) Length given Angle of Super Elevation

$$fx \quad L_a = (g \cdot \tan(\theta_e))^{1.5} \cdot \frac{\sqrt{R_{\text{Curve}}}}{\alpha}$$

Open Calculator 

$$ex \quad 146.2214\text{m} = (9.8\text{m/s}^2 \cdot \tan(95.4))^{1.5} \cdot \frac{\sqrt{200\text{m}}}{10\text{m/s}^2}$$

3) Length of Transition Curve given Shift

$$fx \quad L_a = \sqrt{S \cdot 24 \cdot R_{\text{Curve}}}$$

Open Calculator 

$$ex \quad 120\text{m} = \sqrt{3\text{m} \cdot 24 \cdot 200\text{m}}$$



4) Length of Transition Curve given Time Rate

$$fx \quad L_a = G \cdot \frac{V^3}{x \cdot g \cdot R_{Curve}}$$

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

$$ex \quad 108.8435m = 0.90m \cdot \frac{(80km/h)^3}{60cm/s \cdot 9.8m/s^2 \cdot 200m}$$

5) Length when Comfort Condition Holds Good for Highways

$$fx \quad L_a = 12.80 \cdot \sqrt{R_{Curve}}$$

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

$$ex \quad 181.0193m = 12.80 \cdot \sqrt{200m}$$

6) Length when Comfort Condition Holds Good for Railways

$$fx \quad L_a = 4.52 \cdot \sqrt{R_{Curve}}$$

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

$$ex \quad 63.92245m = 4.52 \cdot \sqrt{200m}$$

7) Rate of Change of Radial Acceleration

$$fx \quad \alpha = \left(\frac{V^2}{R_{Curve} \cdot t} \right)$$

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

$$ex \quad 10m/s^2 = \left(\frac{(80km/h)^2}{200m \cdot 3.2s} \right)$$



8) Shift of Curve 

$$fx \quad S = \frac{L_a^2}{24 \cdot R_{Curve}}$$

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

$$ex \quad 4.380208m = \frac{(145m)^2}{24 \cdot 200m}$$

9) Time Rate given Length of Transition Curve 

$$fx \quad x = G \cdot \frac{V^3}{L_a \cdot g \cdot R_{Curve}}$$

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

$$ex \quad 45.03871cm/s = 0.90m \cdot \frac{(80km/h)^3}{145m \cdot 9.8m/s^2 \cdot 200m}$$

10) Time Taken given Radial Acceleration 

$$fx \quad t = \left(\frac{V^2}{R_{Curve} \cdot a} \right)$$

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

$$ex \quad 3.2s = \left(\frac{(80km/h)^2}{200m \cdot 10m/s^2} \right)$$



Centrifugal Ratio

11) Centrifugal Force Acting on Vehicle

$$fx \quad F_c = \frac{W \cdot V^2}{g \cdot R_{Curve}}$$

[Open Calculator !\[\]\(74d4806277d7e73349d8e8c0897931e9_img.jpg\)](#)

$$ex \quad 166.5306N = \frac{51kg \cdot (80km/h)^2}{9.8m/s^2 \cdot 200m}$$

12) Centrifugal Ratio

$$fx \quad PW_{ratio} = \frac{V^2}{R_{Curve} \cdot g}$$

[Open Calculator !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)

$$ex \quad 3.265306 = \frac{(80km/h)^2}{200m \cdot 9.8m/s^2}$$


13) Design Speed of Highway

$$fx \quad V_1 = \sqrt{\frac{R_{Curve} \cdot g}{4}}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$ex \quad 22.13594km/h = \sqrt{\frac{200m \cdot 9.8m/s^2}{4}}$$



14) Design Speed of Railway [Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)

$$fx \quad v_2 = \sqrt{R_{\text{Curve}} \cdot \frac{g}{8}}$$

$$ex \quad 4.34791\text{m/s} = \sqrt{200\text{m} \cdot \frac{9.8\text{m/s}^2}{8}}$$

15) Radius of Curve given Centrifugal Force [Open Calculator !\[\]\(10f8862fc183b400327470ea85afe9ae_img.jpg\)](#)

$$fx \quad R_{\text{Curve}} = \frac{W \cdot V^2}{g \cdot F_c}$$

$$ex \quad 204.332\text{m} = \frac{51\text{kg} \cdot (80\text{km/h})^2}{9.8\text{m/s}^2 \cdot 163\text{N}}$$

16) Speed of Vehicle given Centrifugal Force [Open Calculator !\[\]\(35dc653d59570f8f891c312eeece91a2_img.jpg\)](#)

$$fx \quad V = \sqrt{F_c \cdot g \cdot \frac{R_{\text{Curve}}}{W}}$$

$$ex \quad 79.14742\text{km/h} = \sqrt{163\text{N} \cdot 9.8\text{m/s}^2 \cdot \frac{200\text{m}}{51\text{kg}}}$$



Superelevation

17) Cant given Width of Pavement

$$\text{fx } h = B \cdot \frac{V^2}{R \cdot g}$$

[Open Calculator !\[\]\(83f22ed94ec5517769dd76d702c6bfd8_img.jpg\)](#)

$$\text{ex } 90.12245\text{cm} = 6.9\text{m} \cdot \frac{(80\text{km/h})^2}{50\text{m} \cdot 9.8\text{m/s}^2}$$

18) Gauge Width of Track given Cant

$$\text{fx } G = \frac{h \cdot 1.27 \cdot R}{V^2}$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd_img.jpg\)](#)

$$\text{ex } 0.907058\text{m} = \frac{91.42\text{cm} \cdot 1.27 \cdot 50\text{m}}{(80\text{km/h})^2}$$


19) Pavement Width given Cant

$$\text{fx } B = h \cdot \frac{R \cdot g}{V^2}$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e_img.jpg\)](#)

$$\text{ex } 6.999344\text{m} = 91.42\text{cm} \cdot \frac{50\text{m} \cdot 9.8\text{m/s}^2}{(80\text{km/h})^2}$$



20) Radius of Curve given Cant for Road 

$$\text{fx } R = B \cdot \frac{V^2}{h \cdot g}$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$\text{ex } 49.29034\text{m} = 6.9\text{m} \cdot \frac{(80\text{km/h})^2}{91.42\text{cm} \cdot 9.8\text{m/s}^2}$$

21) Railway Cant 

$$\text{fx } h = G \cdot \frac{V^2}{1.27 \cdot R}$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$\text{ex } 90.70866\text{cm} = 0.90\text{m} \cdot \frac{(80\text{km/h})^2}{1.27 \cdot 50\text{m}}$$










Variables Used

- **B** Pavement Width (Meter)
- **F_c** Centrifugal Force (Newton)
- **g** Acceleration due to Gravity (Meter per Square Second)
- **G** Railway Gauge (Meter)
- **h** Cant (Centimeter)
- **L_a** Transition Curve Length (Meter)
- **PW_{ratio}** Centrifugal Ratio
- **R** Radius of Curve (Meter)
- **R_{Curve}** Curve Radius (Meter)
- **S** Shift (Meter)
- **t** Time taken to Travel (Second)
- **v** Hands off Velocity (Meter per Second)
- **V** Vehicle Velocity (Kilometer per Hour)
- **V₁** Design Speed on Highways (Kilometer per Hour)
- **v₂** Design Speed on Railways (Meter per Second)
- **W** Weight of Vehicle (Kilogram)
- **x** Super Elevation Time Rate (Centimeter per Second)
- **α** Rate of Radial Acceleration (Meter per Square Second)
- **θ** Angle of Super Elevation (Degree)
- **θ_e** Super Elevation Angle



Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Function:** **tan**, tan(Angle)
Trigonometric tangent function
- **Measurement:** **Length** in Meter (m), Centimeter (cm)
Length Unit Conversion 
- **Measurement:** **Weight** in Kilogram (kg)
Weight Unit Conversion 
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Speed** in Meter per Second (m/s), Kilometer per Hour (km/h), Centimeter per Second (cm/s)
Speed Unit Conversion 
- **Measurement:** **Acceleration** in Meter per Square Second (m/s²)
Acceleration Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Angle** in Degree (°)
Angle Unit Conversion 



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