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Tire Rolling and Slipping Formulas

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List of 17 Tire Rolling and Slipping Formulas

Tire Rolling and Slipping

1) Gradient Resistance of Vehicle

Open Calculator

fx $$F_g = M_v \cdot g \cdot \sin(\alpha)$$

ex $$44130.64\text{N} = 9000\text{N} \cdot 9.8\text{m/s}^2 \cdot \sin(0.524\text{rad})$$

2) Lateral Slip Velocity

Open Calculator

fx $$v_{lateral} = V_{Roadway} \cdot \sin(\alpha_{slip})$$

ex $$2.606709\text{m/s} = 30\text{m/s} \cdot \sin(0.0870\text{rad})$$

3) Longitudinal Slip Velocity

Open Calculator

fx $$v_{longitudinal} = V_{Roadway} \cdot \cos(\alpha_{slip}) - V_B$$

ex $$4.886537\text{m/s} = 30\text{m/s} \cdot \cos(0.0870\text{rad}) - 25\text{m/s}$$

4) Longitudinal Slip Velocity for Zero Slip Angle

Open Calculator

fx $$s_{ltd} = \Omega - \Omega_0$$

ex $$9\text{rad/s} = 58.5\text{rad/s} - 49.5\text{rad/s}$$

5) Roll rate or Roll stiffness

Open Calculator

$$K_\Phi = \frac{(a^2) \cdot K_t}{2}$$

$$72\text{Nm/rad} = \frac{\left((1.2\text{m})^2\right) \cdot 100\text{N/m}}{2}$$

6) Rolling Radius of Tire

Open Calculator

$$R_w = \frac{2}{3} \cdot R_g + \frac{1}{3} \cdot R_h$$

$$0.416667\text{m} = \frac{2}{3} \cdot 0.45\text{m} + \frac{1}{3} \cdot 0.35\text{m}$$

7) Rolling Resistance at Wheels

Open Calculator

$$F_r = P \cdot f_r$$

$$14.5\text{N} = 1000\text{N} \cdot 0.0145$$

8) Rolling Resistance Coefficient

Open Calculator

$$f_r = \frac{a_v}{r}$$

$$0.014 = \frac{0.007\text{m}}{0.5\text{m}}$$

9) Slip of Tire

Open Calculator

$$\lambda = \left(\frac{v - \omega \cdot r_d}{v} \right) \cdot 100$$

$$86.8 = \left(\frac{50\text{m/s} - 12\text{rad/s} \cdot 0.55\text{m}}{50\text{m/s}} \right) \cdot 100$$

10) Slip Ratio Defined According to Calspan TIRF

Open Calculator

$$SR = \Omega_w \cdot \frac{R_l}{V_{Roadway} \cdot \cos\left(\alpha_{slip}\right)} - 1$$

$$0.177788 = 44\text{rad/s} \cdot \frac{0.8\text{m}}{30\text{m/s} \cdot \cos(0.0870\text{rad})} - 1$$

11) Slip Ratio Defined According to Goodyear

Open Calculator

$$SR = 1 - \frac{V_{Roadway} \cdot \cos\left(\alpha_{slip}\right)}{\Omega_w \cdot R_e}$$

$$0.171659 = 1 - \frac{30\text{m/s} \cdot \cos(0.0870\text{rad})}{44\text{rad/s} \cdot 0.82\text{m}}$$

12) Slip Ratio Defined According to SAE J670

Open Calculator

$$SR = \Omega_w \cdot \frac{R_e}{V_{Roadway} \cdot \cos(\alpha_{slip})} - 1$$

$$0.207233 = 44\text{rad/s} \cdot \frac{0.82\text{m}}{30\text{m/s} \cdot \cos(0.0870\text{rad})} - 1$$

13) Slip Ratio given Longitudinal Slip Velocity and Velocity of Free Rolling Wheel

Open Calculator

$$SR = \frac{s_{ltd}}{\Omega_0}$$

$$0.181818 = \frac{9\text{rad/s}}{49.5\text{rad/s}}$$

14) Slip Ratio given Velocity of Driven Wheel and Free Rolling Wheel

Open Calculator

$$SR = \frac{\Omega}{\Omega_0} - 1$$

$$0.181818 = \frac{58.5\text{rad/s}}{49.5\text{rad/s}} - 1$$

15) Traction Force Required to Climb Curb

Open Calculator

$$R = G \cdot \cos(\theta)$$

$$3859.411\text{N} = 5000\text{N} \cdot \cos(0.689\text{rad})$$

16) Tractive Effort in Multi-Geared Vehicle at any given Gear

Open Calculator

fx $$F_t = \frac{T_p \cdot i_g \cdot i_o \cdot \eta_t}{r_d}$$

ex $$2078.018\text{N} = \frac{270\text{N*m} \cdot 2.55 \cdot 2 \cdot 0.83}{0.55\text{m}}$$

17) Wheel rate given Roll rate

Open Calculator

fx $$K_t = \frac{2 \cdot K_\Phi}{a^2}$$

ex $$100\text{N/m} = \frac{2 \cdot 72\text{Nm/rad}}{(1.2\text{m})^2}$$

Variables Used

- **a** Track Width of Vehicle *(Meter)*
- a_v Distance of Opposing Torque from Vertical *(Meter)*
- F_g Gradient Resistance *(Newton)*
- f_r Rolling Resistance Coefficient
- F_r Rolling Resistance at Wheel *(Newton)*
- F_t Tractive Effort in Multi-geared Vehicle *(Newton)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **G** Weight on Single Wheel *(Newton)*
- i_g Gear Ratio of Transmission
- i_o Gear Ratio of Final Drive
- K_t Wheel Rate of Vehicle *(Newton per Meter)*
- K_Φ Roll Rate/ Roll Stiffness *(Newton Meter per Radian)*
- M_v Vehicle Weight in Newtons *(Newton)*
- **P** Normal Load on Wheels *(Newton)*
- **r** Effective Wheel Radius *(Meter)*
- **R** Traction Force required to Climb Curb *(Newton)*
- r_d Effective Radius of Wheel *(Meter)*
- R_e Effective Rolling Radius for Free Rolling *(Meter)*
- R_g Geometrical Radius of Tire *(Meter)*
- R_h Loaded Height of Tire *(Meter)*
- R_l Height of Axle above Road Surface (Loaded Radius) *(Meter)*

- R_w Rolling Radius of Tire *(Meter)*
- s_{ltd} Longitudinal Slip Angular Velocity *(Radian per Second)*
- **SR** Slip Ratio
- T_p Torque Output of Vehicle *(Newton Meter)*
- **v** Forward Velocity of Vehicle *(Meter per Second)*
- V_B Circumferential Velocity of Tire under Traction *(Meter per Second)*
- $v_{lateral}$ Lateral Slip Velocity *(Meter per Second)*
- $v_{longitudinal}$ Longitudinal Slip Velocity *(Meter per Second)*
- $V_{Roadway}$ Axle Speed over Roadway *(Meter per Second)*
- α Angle of Inclination of Ground from Horizontal *(Radian)*
- α_{slip} Slip Angle *(Radian)*
- η_t Transmission Efficiency of Vehicle
- θ Angle between Traction Force and Horizontal Axis *(Radian)*
- λ Slip of Tire
- ω Vehicle Wheel Angular Velocity *(Radian per Second)*
- Ω Angular Velocity of Driven or Braked Wheel *(Radian per Second)*
- Ω_0 Angular Velocity of Free Rolling Wheel *(Radian per Second)*
- Ω_w Wheel Angular Velocity *(Radian per Second)*

Constants, Functions, Measurements used

- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Speed** in Meter per Second (m/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 Radian (rad)
  Angle Unit Conversion
- Measurement: **Surface Tension** in Newton per Meter (N/m)
  Surface Tension Unit Conversion
- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Torsion Constant** in Newton Meter per Radian (Nm/rad)
  Torsion Constant Unit Conversion

Check other formula lists

- **Angular Velocity Formulas**
- **Tire Rolling and Slipping Formulas**
- **Wheel Parameters Formulas**

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