Important Forces on Steering System and Axles Formulas PDF

Formulas
Examples
with Units

List of 14
Important Forces on Steering System and Axles Formulas

1) Centripetal Acceleration during Cornering Formula

Evaluate Formula

Formula

$$a_c = \frac{v_t \cdot v_t}{R}$$

Example with Units

$$400\,\text{m/s}^2 = \frac{60\,\text{m/s} \cdot 60\,\text{m/s}}{9\,\text{m}}$$

2) Characteristic Speed for Understeer Vehicles Formula

Evaluate Formula

Formula

$$v_u = \sqrt{\frac{57.3 \cdot L \cdot g}{K}}$$

Example with Units

$$913.9383\,\text{m/s} = \sqrt{\frac{57.3 \cdot 2.7\,\text{m} \cdot 9.8\,\text{m/s}^2}{0.104^\circ}}$$

3) Critical Speed for Oversteer Vehicle Formula

Evaluate Formula

Formula

$$v_o = -\sqrt{\frac{57.3 \cdot L \cdot g}{K}}$$

Example with Units

$$-913.9383\,\text{m/s} = -\sqrt{\frac{57.3 \cdot 2.7\,\text{m} \cdot 9.8\,\text{m/s}^2}{0.104^\circ}}$$

4) Front Slip Angle at High Cornering Speed Formula

Evaluate Formula

Formula

$$\alpha_f = \beta + \left(\left(\frac{a \cdot r}{v_t}\right) - \delta\right)$$

Example with Units

$$0.77^\circ = 0.34^\circ + \left(\left(\frac{1.8\,\text{m} \cdot 25\,\text{degree/s}}{60\,\text{m/s}}\right) - 0.32^\circ\right)$$

5) Lateral Acceleration during Cornering of Car Formula

Evaluate Formula

Formula

$$A_\alpha = \frac{a_c}{g}$$

Example with Units

$$40.8163\,\text{m/s}^2 = \frac{400\,\text{m/s}^2}{9.8\,\text{m/s}^2}$$

6) Load on Front Axle at High Speed Cornering Formula

Evaluate Formula

Formula

$$W_{fl} = \frac{W \cdot b}{L}$$

Example with Units

$$1481.4815\,\text{N} = \frac{20000\,\text{N} \cdot 0.2\,\text{m}}{2.7\,\text{m}}$$

7) Load on Rear Axle at High Speed Cornering Formula

Evaluate Formula

Formula

$$W_r = \frac{W \cdot a}{L}$$

Example with Units

$$13333.3333\,\text{N} = \frac{20000\,\text{N} \cdot 1.8\,\text{m}}{2.7\,\text{m}}$$

8) Moment about Steeraxis due to Driveline Torque Formula

Evaluate Formula

Formula

$$M_{sa} = F_x \cdot \left(\left(d \cdot \cos\left(\nu \right) \cdot \cos\left(\lambda_l \right) \right) + \left(R_e \cdot \sin\left(\lambda_l + \zeta \right) \right) \right)$$

Example with Units

$$170.3342\,\text{N*m} = 450\,\text{N} \cdot \left(\left(0.21\,\text{m} \cdot \cos\left(4.5° \right) \cdot \cos\left(10° \right) \right) + \left(0.35\,\text{m} \cdot \sin\left(10° + 19.5° \right) \right) \right)$$

9) Moment Arising due to Lateral Forces on Wheels during Steering Formula

Evaluate Formula

Formula

$$M_l = \left(F_{yl} + F_{yr} \right) \cdot R_e \cdot \tan\left(\nu \right)$$

Example with Units

$$28.372\,\text{N*m} = \left(510\,\text{N} + 520\,\text{N} \right) \cdot 0.35\,\text{m} \cdot \tan\left(4.5° \right)$$

10) Moment Arising from Traction Force on Wheels during Steering Formula

Evaluate Formula

Formula

$$M_t = \left(F_{xl} - F_{xr} \right) \cdot d_L$$

Example with Units

$$4\,\text{N*m} = \left(560\,\text{N} - 460\,\text{N} \right) \cdot 0.04\,\text{m}$$

11) Moment due to Vertical Force on Wheels during Steering Formula

Evaluate Formula

Formula

$$M_v = \left(\left(F_{zl} - F_{zr} \right) \cdot d_L \cdot \sin\left(\nu \right) \cdot \cos\left(\delta \right) \right) - \left(\left(F_{zl} + F_{zr} \right) \cdot d_L \cdot \sin\left(\lambda_l \right) \cdot \sin\left(\delta \right) \right)$$

Example with Units

$$0.1084\,\text{N*m} = \left(\left(650\,\text{N} - 600\,\text{N} \right) \cdot 0.04\,\text{m} \cdot \sin\left(4.5° \right) \cdot \cos\left(0.32° \right) \right) - \left(\left(650\,\text{N} + 600\,\text{N} \right) \cdot 0.04\,\text{m} \cdot \sin\left(10° \right) \cdot \sin\left(0.32° \right) \right)$$

12) Rear Slip Angle due to High Speed Cornering Formula

Evaluate Formula

Formula

$$\alpha_r = \beta - \left(\frac{b \cdot r}{v_t} \right)$$

Example with Units

$$0.2567° = 0.34° - \left(\frac{0.2\,\text{m} \cdot 25\,\text{degree/s}}{60\,\text{m/s}} \right)$$

13) Self Aligning Moment or Torque on Wheels Formula

Evaluate Formula

Formula

$$M_{at} = \left(M_{zl} + M_{zr} \right) \cdot \cos\left(\lambda_l \right) \cdot \cos\left(\nu \right)$$

Example with Units

$$100.1407\,\text{N*m} = \left(27\,\text{N*m} + 75\,\text{N*m} \right) \cdot \cos\left(10° \right) \cdot \cos\left(4.5° \right)$$

14) Track Width of Vehicle using Ackermann Condition Formula

Evaluate Formula

Formula

$$a_{tw} = \left(\cot\left(\delta_o \right) - \cot\left(\delta_i \right) \right) \cdot L$$

Example with Units

$$1.9978\,\text{m} = \left(\cot\left(16° \right) - \cot\left(20° \right) \right) \cdot 2.7\,\text{m}$$

Variables used in list of Forces on Steering System and Axles Formulas above

- **a** Distance of c.g from Front Axle *(Meter)*
- a_c Centripetal Acceleration during Cornering *(Meter per Square Second)*
- a_{tw} Track Width of Vehicle *(Meter)*
- A_α Horizontal Lateral Acceleration *(Meter per Square Second)*
- **b** Distance of c.g from Rear Axle *(Meter)*
- **d** Distance between Steeraxis and Tire center *(Meter)*
- d_L Lateral Offset at Ground *(Meter)*
- F_x Tractive Force *(Newton)*
- F_{xl} Tractive Force on Left Wheels *(Newton)*
- F_{xr} Tractive Force on Right Wheels *(Newton)*
- F_{yl} Lateral Force on Left Wheels *(Newton)*
- F_{yr} Lateral Force on Right Wheels *(Newton)*
- F_{zl} Vertical Load on Left Wheels *(Newton)*
- F_{zr} Vertical Load on Right Wheels *(Newton)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **K** Understeer Gradient *(Degree)*
- **L** Wheelbase of Vehicle *(Meter)*
- M_{at} Self Aligning Moment *(Newton Meter)*
- M_l Moment on Wheels Arising from Lateral Force *(Newton Meter)*
- M_{sa} Moment about Steeraxis due to Driveline Torque *(Newton Meter)*
- M_t Moment Arising from Traction Force *(Newton Meter)*
- M_v Moment arising from Vertical Forces on Wheels *(Newton Meter)*
- M_{zl} Aligning Moment Acting on Left Tires *(Newton Meter)*
- M_{zr} Aligning Moment on Right Tires *(Newton Meter)*
- **r** Yaw Velocity *(Degree per Second)*
- **R** Radius of Turn *(Meter)*
- R_e Radius of Tire *(Meter)*
- v_o Critical Speed for Oversteer Vehicles *(Meter per Second)*
- v_t Total Velocity *(Meter per Second)*
- v_u Characteristic Speed for Understeer Vehicles *(Meter per Second)*
- **W** Total Load of Vehicle *(Newton)*

Constants, Functions, Measurements used in list of Forces on Steering System and Axles 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: **cot**, cot(Angle)
  Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.
- Functions: **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.
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- 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 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 Degree (°)
  Angle Unit Conversion
- Measurement: **Angular Velocity** in Degree per Second (degree/s)
  Angular Velocity Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion

- W_{fl} Load on Front Axle at High Speed Cornering *(Newton)*
- W_r Load on Rear Axle at High Speed Cornering *(Newton)*
- α_f Slip Angle of Front Wheel *(Degree)*
- α_r Slip Angle of Rear Wheel *(Degree)*
- β Vehicle Body Slip Angle *(Degree)*
- δ Steer Angle *(Degree)*
- δ_i Steering Angle Inner Wheel *(Degree)*
- δ_o Steering Angle Outer Wheel *(Degree)*
- ζ Angle made by Front Axle with Horizontal *(Degree)*
- λ_l Lateral Inclination Angle *(Degree)*
- v Caster Angle *(Degree)*

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