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Forces on Steering System and Axles Formulas

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List of 14 Forces on Steering System and Axles Formulas

Forces on Steering System and Axles 🗗

1) Centripetal Acceleration during Cornering 🗗

fx $a_c = \dfrac{v_t \cdot v_t}{R}$

ex $400\text{m/s}^2 = \dfrac{60\text{m/s} \cdot 60\text{m/s}}{9\text{m}}$

2) Characteristic Speed for Understeer Vehicles 🗗

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

ex $913.9383\text{m/s} = \sqrt{\dfrac{57.3 \cdot 2.7\text{m} \cdot 9.8\text{m/s}^2}{0.104°}}$

3) Critical Speed for Oversteer Vehicle 🗗

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

ex $-913.9383\text{m/s} = -\sqrt{\dfrac{57.3 \cdot 2.7\text{m} \cdot 9.8\text{m/s}^2}{0.104°}}$

4) Front Slip Angle at High Cornering Speed 🗗

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

ex $0.77° = 0.34° + \left(\left(\dfrac{1.8\text{m} \cdot 25\text{degree/s}}{60\text{m/s}} \right) - 0.32° \right)$

5) Lateral Acceleration during Cornering of Car 🗗

fx $A_\alpha = \dfrac{a_c}{g}$

ex $40.81633\text{m/s}^2 = \dfrac{400\text{m/s}^2}{9.8\text{m/s}^2}$

6) Load on Front Axle at High Speed Cornering 🔗

fx $W_{fl} = \dfrac{W \cdot b}{L}$

ex $1481.481N = \dfrac{20000N \cdot 0.2m}{2.7m}$

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7) Load on Rear Axle at High Speed Cornering 🔗

fx $W_r = \dfrac{W \cdot a}{L}$

ex $13333.33N = \dfrac{20000N \cdot 1.8m}{2.7m}$

Open Calculator 🔗

8) Moment about Steeraxis due to Driveline Torque 🔗

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

ex $170.3342N*m = 450N \cdot ((0.21m \cdot \cos(4.5°) \cdot \cos(10°)) + (0.35m \cdot \sin(10° + 19.5°)))$

Open Calculator 🔗

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

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

ex $28.37197N*m = (510N + 520N) \cdot 0.35m \cdot \tan(4.5°)$

Open Calculator 🔗

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

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

ex $4N*m = (560N - 460N) \cdot 0.04m$

Open Calculator 🔗

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

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

ex $0.108424N*m = ((650N - 600N) \cdot 0.04m \cdot \sin(4.5°) \cdot \cos(0.32°)) - ((650N + 600N) \cdot 0.04m \cdot \sin(10°) \cdot \sin(0$

Open Calculator 🔗

12) Rear Slip Angle due to High Speed Cornering 🔗

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

ex $0.256667° = 0.34° - \left(\dfrac{0.2m \cdot 25degree/s}{60m/s} \right)$

Open Calculator 🔗

13) Self Aligning Moment or Torque on Wheels ↗

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

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

14) Track Width of Vehicle using Ackermann Condition ↗

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

ex $1.99783 \text{m} = (\cot(16°) - \cot(20°)) \cdot 2.7 \text{m}$

Variables Used

- **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)*
- 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)*
- **ν** Caster Angle *(Degree)*

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: **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.
- 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.
- Function: **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.
- Function: **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

Check other formula lists

- **Forces on Steering System and Axles Formulas** ↗
- **Movement Ratio Formulas** ↗
- **Steering System Formulas** ↗
- **Turning Dynamics Formulas** ↗

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