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Steering System Formulas

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List of 12 Steering System Formulas

Steering System

1) Motion Ratio or Installation Ratio in Suspension

Open Calculator

$$M.R. = \frac{ST}{WT}$$

$$0.65 = \frac{65mm}{100mm}$$

2) Pinion Pitch Circle Radius

Open Calculator

$$r = \frac{t \cdot p}{2 \cdot \pi}$$

$$9.549297mm = \frac{6 \cdot 10mm}{2 \cdot \pi}$$

3) Steering Ratio

Open Calculator

$$S_r = \frac{R}{r}$$

$$23.33333 = \frac{350mm}{15mm}$$

4) Torque Acting on Steering Arm

Open Calculator

$$T = F_f \cdot r_s$$

$$6.6N*m = 300N \cdot 22mm$$

5) Understeer Gradient

Open Calculator

$$K = \left(\frac{W_{fl}}{g \cdot C_{af}}\right) - \left(\frac{W_r}{g \cdot C_{\alpha r}}\right)$$

$$0.218659rad = \left(\frac{9000N}{9.8m/s^2 \cdot 40N}\right) - \left(\frac{7800N}{9.8m/s^2 \cdot 35N}\right)$$

6) Understeer Increment due to Steering System Compliance

Open Calculator

$$K_{strg} = \frac{W_f \cdot (R_{turn} \cdot K + p)}{K_{ss}}$$

$$0.252rad = \frac{1000N \cdot (10000mm \cdot 0.06rad + 30mm)}{2500N*m}$$

Angles Related to Steering System

7) Ackermann Steering Angle at Low Speed Cornering

Open Calculator

$$\delta_S = \frac{b}{R}$$

$$0.257143rad = \frac{2700mm}{10500mm}$$

8) Caster Angle

Open Calculator

$$K = \sin(C_1) - \sin(C_2) - (\cos(C_2) \cdot \cos(T_2) - \cos(C_1) \cdot \cos(T_1)) \cdot \frac{\tan(S)}{\cos(C_2) \cdot \sin(T_2) - \cos(C$$

$$0.067547rad = \sin(0.122rad) - \sin(0.09rad) - (\cos(0.09rad) \cdot \cos(0.165rad) - \cos(0.122rad) \cdot \cos(0.19rad))$$

9) Slip Angle at High Cornering Speed

Open Calculator

$$\alpha = \frac{F_y}{C_\alpha}$$

$$22rad = \frac{110N}{5}$$

10) Steer Angle given Understeer Gradient

Open Calculator

$$\delta = \left(57.3 \cdot \left(\frac{b}{R}\right)\right) + (K \cdot A_\alpha)$$

$$14.90069rad = \left(57.3 \cdot \left(\frac{2700mm}{10500mm}\right)\right) + (0.104rad \cdot 1.6m/s^2)$$

11) Steering Angle at High Cornering Speed

Open Calculator

$$\delta_H = 57.3 \cdot \left(\frac{b}{R}\right) + (\alpha_f - \alpha_r)$$

$$14.80429\text{rad} = 57.3 \cdot \left(\frac{2700\text{mm}}{10500\text{mm}}\right) + (0.24\text{rad} - 0.17\text{rad})$$

12) Vehicle Body Slip Angle at High Cornering Speed

Open Calculator

$$\beta = \frac{v}{v_t}$$

$$0.866667\text{rad} = \frac{52\text{m/s}}{60\text{m/s}}$$

Variables Used

- A_{α} Horizontal Lateral Acceleration *(Meter per Square Second)*
- **b** Wheelbase of Vehicle *(Millimeter)*
- C_1 Camber 1 *(Radian)*
- C_2 Camber 2 *(Radian)*
- C_{af} Cornering Stiffness of Front Wheels *(Newton)*
- C_{α} Cornering Stiffness
- $C_{\alpha r}$ Cornering Stiffness of Rear Wheels *(Newton)*
- F_f Frictional Force *(Newton)*
- F_y Cornering Force *(Newton)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **K** Understeer Gradient *(Radian)*
- **K** Caster Angle *(Radian)*
- K_{ss} Effective Stiffness of Steering System *(Newton Meter)*
- K_{strg} Under Steer Increment due to Steering Compliance *(Radian)*
- **M.R.** Motion Ratio in Suspension
- **p** Linear or Circular Pitch *(Millimeter)*
- **p** Pneumatic Trail of Tire *(Millimeter)*
- **r** Pinion Pitch Circle Radius *(Millimeter)*
- **R** Steering Wheel Radius *(Millimeter)*
- **R** Radius of Turn *(Millimeter)*
- r_s Scrub Radius *(Millimeter)*
- R_{turn} Turning Radius of Car *(Millimeter)*
- **S** Steering Axis Inclination *(Radian)*
- S_r Steering Ratio
- **ST** Spring/Shock Travel *(Millimeter)*
- **t** Number of Pinion Teeth
- **T** Torque *(Newton Meter)*
- T_1 Toe Angle 1 *(Radian)*
- T_2 Toe Angle 2 *(Radian)*
- **v** Lateral Velocity Component *(Meter per Second)*
- v_t Total Velocity *(Meter per Second)*
- W_f Weight under Front Axle *(Newton)*
- W_{fl} Load on Front Axle at High Speed Cornering *(Newton)*
- W_r Load on Rear Axle at High Speed Cornering *(Newton)*

- **WT** Wheel Travel *(Millimeter)*
- **α** Slip Angle at High Cornering Speed *(Radian)*
- α_f Slip Angle of Front Wheel *(Radian)*
- α_r Slip Angle of Rear Wheel *(Radian)*
- **β** Vehicle Body Slip Angle *(Radian)*
- **δ** Steer Angle *(Radian)*
- δ_H Ackermann Steering Angle at High Cornering Speed *(Radian)*
- δ_S Ackermann Steering Angle in Slow Speed cornering *(Radian)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- Measurement: **Length** in Millimeter (mm)
  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: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion

Check other formula lists

- **Movement Ratio Formulas**
- **Pivot Centre, Wheel Base and Track Formulas**
- **Steering System Formulas**
- **Turning Radius Formulas**

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