Resonant Frequencies
A suspension is two spring/mass/damper systems in series

- Body, chassis spring and damper
- Suspension and tire
Resonant Frequencies

Sprung Mass

\[ \text{Sprung Mass: } fn(s) = \frac{1}{2\pi} \sqrt{\frac{(K_s \cdot K_t)/(K_s + K_t)}{M_s}} \]

Unsprung Mass

\[ \text{Unsprung Mass: } fn(us) = \frac{1}{2\pi} \sqrt{\frac{K_s + K_t}{M_{us}}} \]
How Much Damping?
How Much Damping?

Critical Damping

\[ C_{cr} = \text{Critical Damping Coefficient} \]

\[ C_{cr} = 2\sqrt{K_s \times M} \]

\[ K_s = \text{Spring Rate} \]

\[ M = \text{Mass} \]
How Much Damping?

Critical Damping

\[ C_s = \text{Suspension Damping Coefficient} \]

\[ \text{Damping Ratio} = \frac{\text{Suspension Damp Coef}}{\text{Critical Damp Coef}} \]

\[ \text{Damping Ratio} = \frac{C_s}{C_{cr}} \]
Damping Calculations
Damping Force Calculations

Monotube

\[ \text{Force} = \text{Pressure} \times \text{Area} \]

\[ \text{Area} = \frac{\pi \times \text{Diameter}^2}{4} \]

\[ A_{\text{Rebound}} = A_{\text{Tube}} - A_{\text{Rod}} \]

\[ F_{\text{Rebound}} = (P_1 - P_2) \times A_{\text{Rebound}} \]

\[ A_{\text{Compression}} = A_{\text{Tube}} - A_{\text{Rod}} \]

\[ F_{\text{Compression}} = (P_2 - P_1) \times A_{\text{Compression}} \]
Damping Force Calculations

Monotube with Basevalve

\[ A_{\text{Rebound}} = A_{\text{Tube}} - A_{\text{Rod}} \]
\[ F_{\text{Rebound}} = (P_1 - P_2) \times A_{\text{Rebound}} \]
\[ A_{\text{Compression Piston}} = A_{\text{Tube}} - A_{\text{Rod}} \]
\[ F_{\text{Compression Piston}} = (P_2 - P_1) \times A_{\text{Compression Piston}} \]
\[ A_{\text{Compression Rod}} = A_{\text{Rod}} \]
\[ F_{\text{Compression Rod}} = (P_2 - P_3) \times A_{\text{Compression Rod}} \]
\[ F_{\text{Compression}} = F_{\text{comp - piston}} + F_{\text{comp - rod}} \]
Gas Pressure Calculation
Gas Pressure Calculations

Gas Force

\[ F_{\text{Gas}} = A_{\text{Rod}} \times P_{\text{Gas}} \]

Ideal Gas Law

\[ P_1 V_1 = P_2 V_2 \]

Gas Spring Rate

\[ K_{\text{gas}} = \frac{F_{\text{Gas}_1} - F_{\text{Gas}_2}}{\text{Travel}} \]