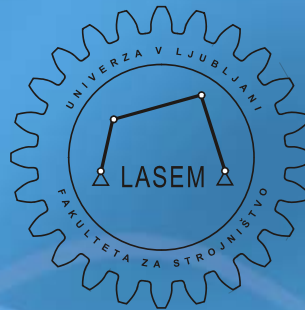


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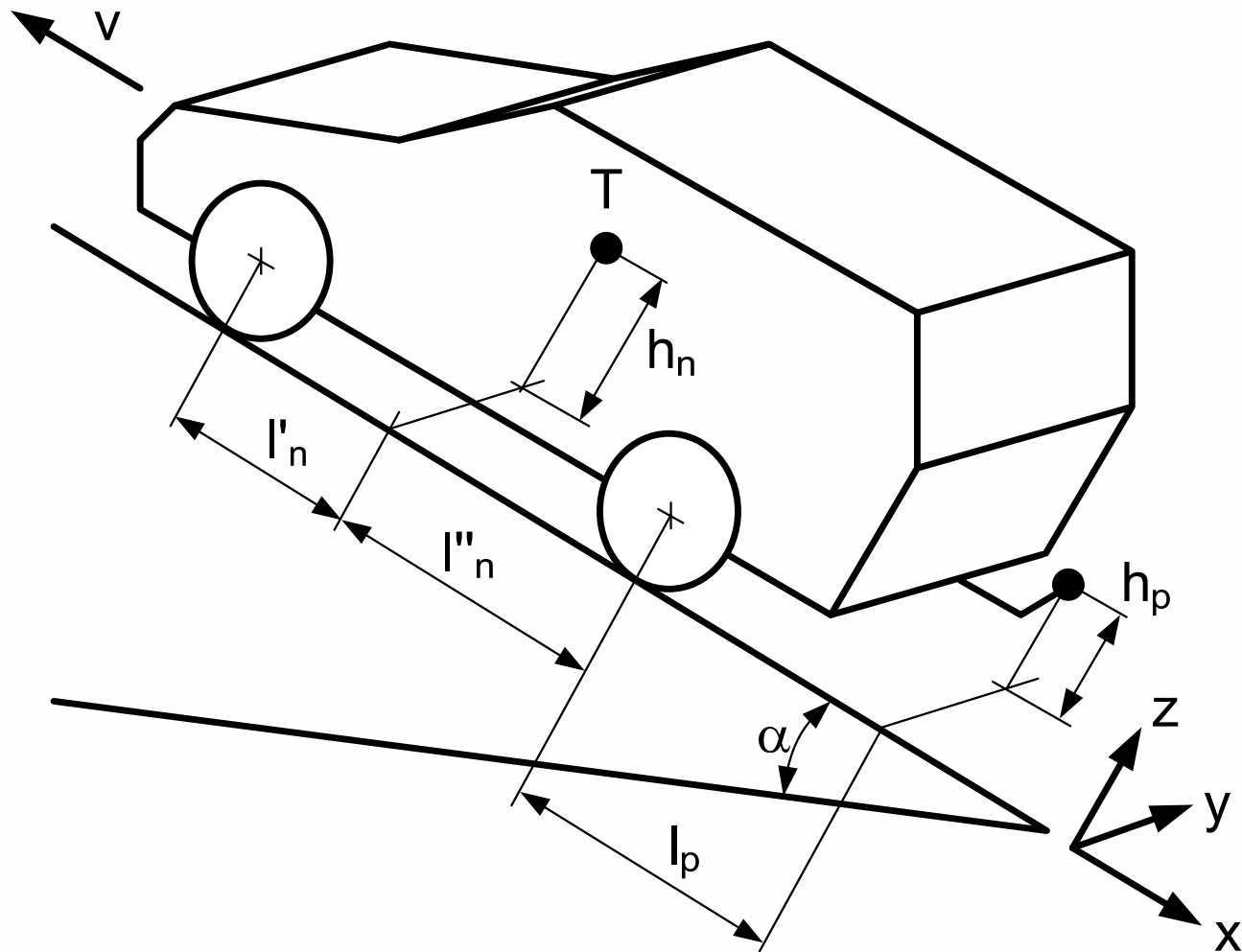
Katedra za strojne elemente in razvojna vrednotenja



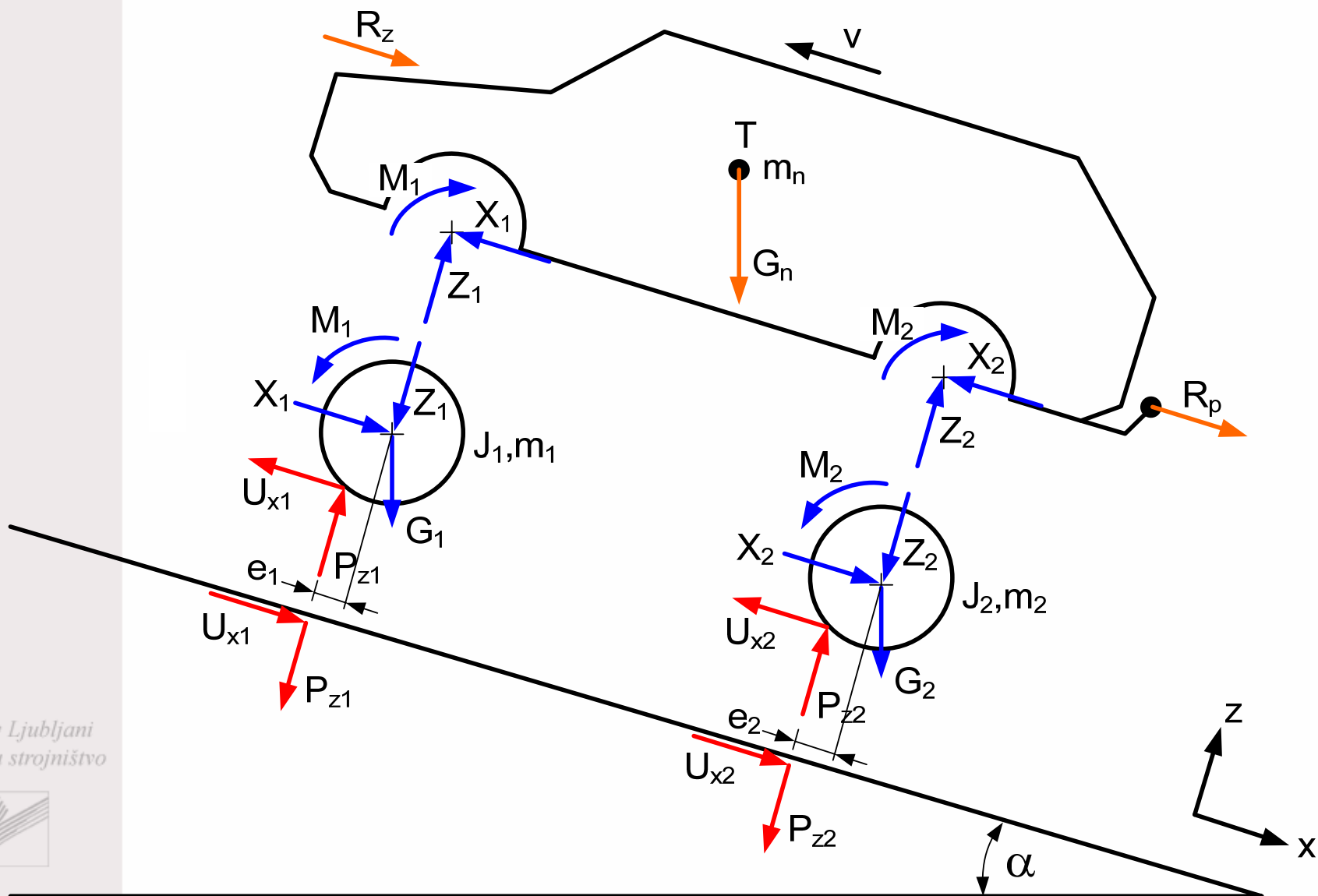
DINAMIKA VOZIL – Gibalna enačba vozila

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Koordinatni sistem vozila



Sile na vozilo v X-Z ravnini



Sistem ravnotežnih enačb za vozilo

Gibalne enačbe za nadgradnjo:

$$(1) \quad \sum F_{x,i} = m_n \cdot \ddot{x}_n = -G_n \cdot \sin \alpha + X_1 + X_2 - R_z - (R_p)$$

$$(2) \quad \sum F_{z,i} = 0 = Z_1 + Z_2 - G_n \cdot \cos \alpha$$

$$(3) \quad \sum M_i = 0 = -(M_1 + M_2) - Z_1 \cdot l'_n + Z_2 \cdot l''_n - \\ - X_1 \cdot (h_n - r_{st1}) - X_2 \cdot (h_n - r_{st2}) + [R_p \cdot (h_n - h_p)]$$

Gibalne enačbe za prvo podvozje:

$$(4) \quad \sum F_{x,i} = m_n \cdot \ddot{x}_1 = U_{x1} - X_1 - G_1 \cdot \sin \alpha$$

$$(5) \quad \sum F_{z,i} = 0 = P_{z1} - Z_1 - G_1 \cdot \cos \alpha$$

$$(6) \quad \sum M_i = J_1 \cdot \ddot{\varphi}_1 = M_1 - U_{x1} \cdot r_{st1} - P_{z1} \cdot e_1$$



Gibalne enačbe za drugo podvozje:

$$(7) \quad \sum F_{x,i} = m_n \cdot \ddot{x}_2 = U_{x2} - X_2 - G_2 \cdot \sin \alpha$$

$$(8) \quad \sum F_{z,i} = 0 = P_{z2} - Z_2 - G_2 \cdot \cos \alpha$$

$$(9) \quad \sum M_i = J_2 \cdot \ddot{\varphi}_2 = M_2 - U_{x2} \cdot r_{st2} - P_{z2} \cdot e_2$$



Sistem ravnotežnih enačb za vozilo

$$\underline{(2) + (5) + (8):} \quad P_{z1} + P_{z2} = (G_n + G_1 + G_2) \cdot \cos \alpha$$
$$G_n + G_1 + G_2 = G$$

$$\underline{(6):} \quad \frac{J_1 \cdot \ddot{\varphi}_1}{r_{st1}} = \frac{M_1}{r_{st1}} - U_{x1} - \underbrace{P_{z1} \cdot \frac{e_1}{r_{st1}}}_{R_{f1}}$$

$$\frac{J_1 \cdot \ddot{\varphi}_1}{r_{st1}} = \frac{M_1}{r_{st1}} - U_{x1} - R_{f1}$$

$$\underline{(9):} \quad \frac{J_2 \cdot \ddot{\varphi}_2}{r_{st2}} = \frac{M_2}{r_{st2}} - U_{x2} - \underbrace{P_{z2} \cdot \frac{e_2}{r_{st2}}}_{R_{f2}}$$

$$\frac{J_2 \cdot \ddot{\varphi}_2}{r_{st2}} = \frac{M_2}{r_{st2}} - U_{x2} - R_{f2}$$



Gibalna enačba vozila

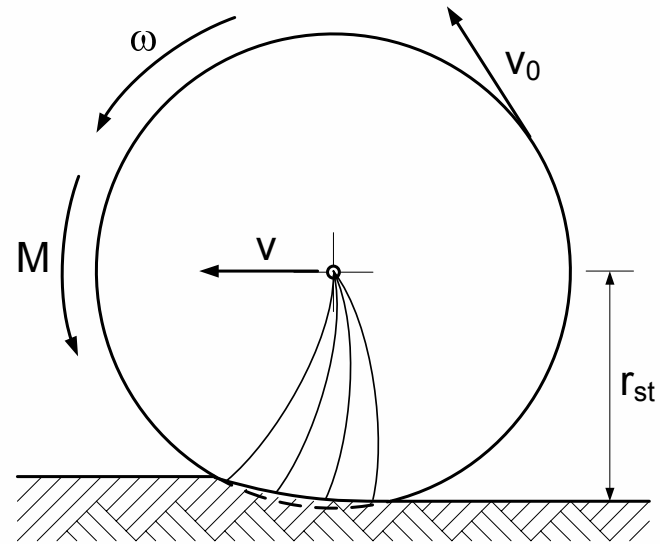
(1) + (4) + (6) + (7) + (9):

$$r_{st} \cdot \omega = v_0 < v$$

$$\sigma_t = \frac{v - v_0}{v_0} \Rightarrow v = \omega \cdot r_d$$

$$\ddot{\varphi}_i = \frac{\ddot{x}_i}{r_{d,i}}; x_n = x_1 = x_2$$

$$m_n + m_1 + m_2 = m = G / g$$

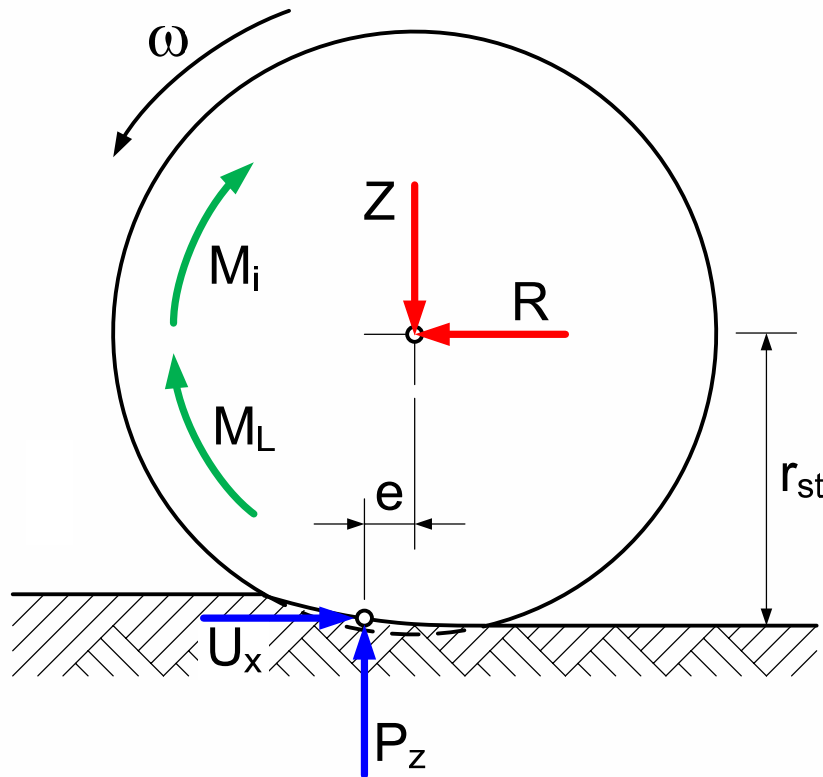


$$\frac{M_1}{r_{st1}} + \frac{M_2}{r_{st2}} = F_{K1} + F_{K2} =$$

$$= \left[\frac{G}{g} + \frac{J_1}{r_{st1} \cdot r_{d1}} + \frac{J_2}{r_{st2} \cdot r_{d2}} \right] \cdot \ddot{x} + G \cdot \sin \alpha + R_z + \underbrace{R_{f1} + R_{f2}}_{R_f} + (R_p)$$



Sile in navori na potiskanem kolesu



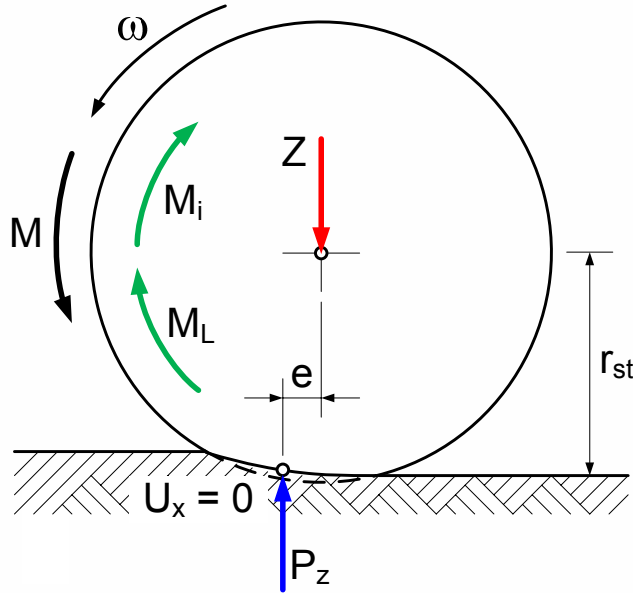
M_i ... Navor za premagovanje vztrajnostni kolesa

M_L ... Navor za premagovanje uporov v ležajih, ventilacijskih izgub itn.

$$R = U_x = Z \cdot \underbrace{\frac{e}{r_{st}}}_{R_f} + \frac{M_L}{r_{st}} + \frac{M_i}{r_{st}}$$



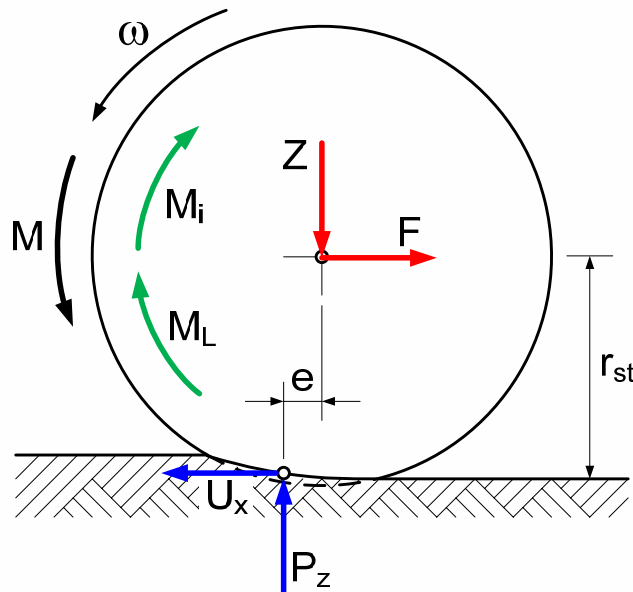
Sile in navori na gnanem kolesu



Pogonski navor

kompenzira upore:

$$\frac{M}{r_{st}} = Z \cdot \underbrace{\frac{e}{r_{st}}}_{R_f} + \frac{M_L}{r_{st}} + \frac{M_i}{r_{st}}; U_x = 0$$



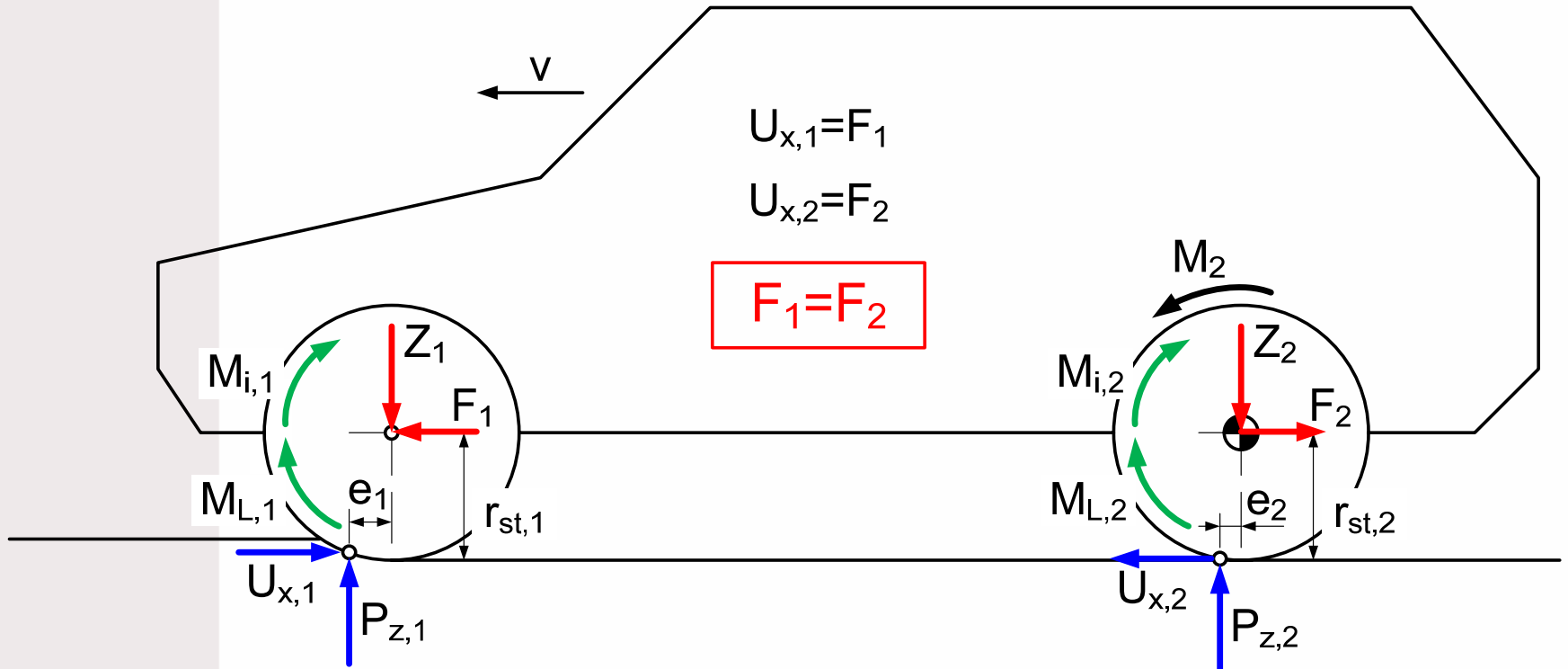
Pogonski navor

omogoča pogonsko silo:

$$\frac{M}{r_{st}} = Z \cdot \underbrace{\frac{e}{r_{st}}}_{R_f} + \frac{M_L}{r_{st}} + \frac{M_i}{r_{st}} + F; F = U_x$$



Sile pri pogonu 4x2, pogon na zadnjih kolesih

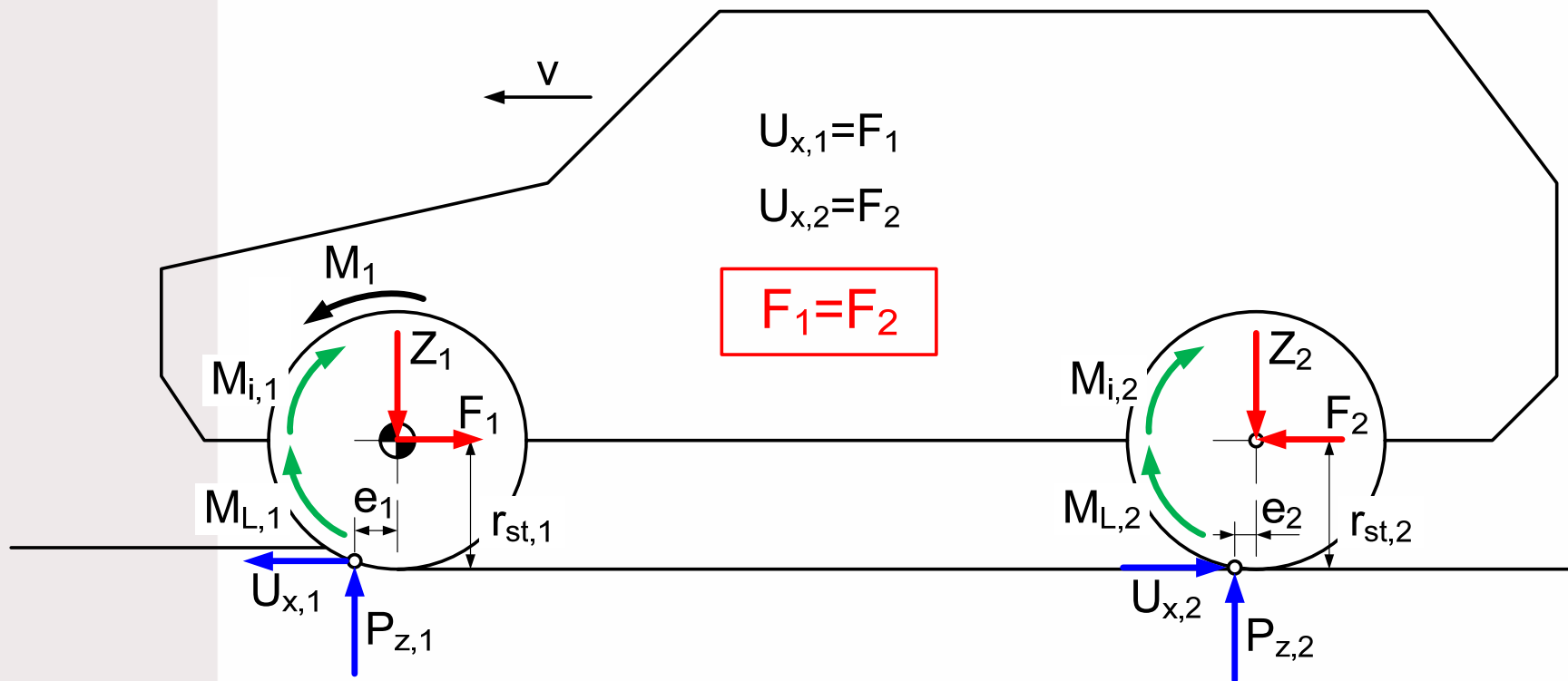


$$R_{f1} > R_{f2}$$

$$F_1 > F_{tr,1} = \frac{Z_1}{\mu_{tr}} \Rightarrow \text{zdrs}$$



Sile pri pogonu 4x2, pogon na sprednjih kolesih



Sile pri pogonu 4x4

