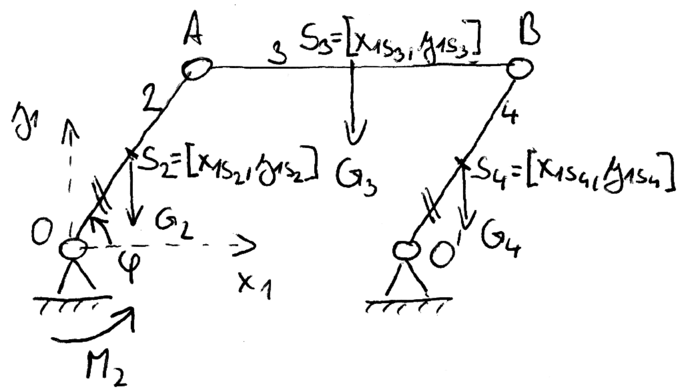
Metoda redukce

Dáno: $m_2, m_3, m_4, I_{2S_2}, I_{3S_3}, I_{4S_4}, M_2,$
$|AB| = l, |OA| = |O'B| = r$
(paralelogram)

Určit: VPR (metodou redukce)



$$m^*\ddot{q} + \frac{1}{2}\frac{dm^*}{dq}\dot{q}^2 = Q$$

$$\frac{1}{2}m^*\dot{q}^2 = \frac{1}{2}m_2\left(\dot{x}_{1S_2}^2 + \dot{y}_{1S_2}^2\right) + \frac{1}{2}I_{2S_2}\dot{\varphi}_2^2 + \frac{1}{2}m_3\left(\dot{x}_{1S_3}^2 + \dot{y}_{1S_3}^2\right) + \frac{1}{2}m_4\left(\dot{x}_{1S_4}^2 + \dot{y}_{1S_4}^2\right) + \frac{1}{2}I_{4S_4}\dot{\varphi}_4^2$$

Za nezávislou souřadnici zvolíme φ_2 a zjednodušíme zápis vynecháním indexu:

$$q = \varphi_2 = \varphi$$

Kinematika:

$$x_{1S_2} = \frac{r}{2}\cos\varphi \quad \rightarrow \quad \dot{x}_{1S_2} = -\frac{r}{2}\sin\varphi\dot{\varphi}$$

$$y_{1S_2} = \frac{r}{2}\sin\varphi \quad \rightarrow \quad \dot{y}_{1S_2} = \frac{r}{2}\cos\varphi\dot{\varphi}$$

$$x_{1S_3} = r\cos\varphi + \frac{l}{2} \quad \rightarrow \quad \dot{x}_{1S_3} = -r\sin\varphi\dot{\varphi}$$

$$y_{1S_3} = r\sin\varphi \quad \rightarrow \quad \dot{y}_{1S_3} = r\cos\varphi\dot{\varphi}$$

$$x_{1S_4} = \frac{r}{2}\cos\varphi + l \quad \rightarrow \quad \dot{x}_{1S_4} = -\frac{r}{2}\sin\varphi\dot{\varphi}$$

$$y_{1S_4} = \frac{r}{2}\sin\varphi \quad \rightarrow \quad \dot{y}_{1S_4} = \frac{r}{2}\cos\varphi\dot{\varphi}$$

Dosazení vztahů pro kinematiku:

$$\frac{1}{2}m^*\dot{\varphi}^2 = \frac{1}{2}m_2\left(\frac{r}{2}\right)^2(\sin^2\varphi + \cos^2\varphi)\dot{\varphi}^2 + \frac{1}{2}I_{2S_2}\dot{\varphi}^2 + \frac{1}{2}m_3r^2(\sin^2\varphi + \cos^2\varphi)\dot{\varphi}^2$$
$$+\frac{1}{2}m_4\left(\frac{r}{2}\right)^2(\sin^2\varphi + \cos^2\varphi)\dot{\varphi}^2 + \frac{1}{2}I_{4S_4}\dot{\varphi}^2$$

$$\frac{1}{2}m^*\dot{\varphi}^2 = \frac{1}{2}I_{2O}\dot{\varphi}^2 + \frac{1}{2}m_3r^2\dot{\varphi}^2 + \frac{1}{2}I_{4O'}\dot{\varphi}^2 \quad \rightarrow \quad m^* = I_{2O} + I_{4O'} + m_3r^2$$

Redukovaná hmotnost m^* je konstantní, nezávisí na poloze, a proto

$$\frac{dm^*}{dq} = 0$$

Zobecněný silový účinek Q určíme metodou virtuálních prací:

$$Q\delta q = M_2\delta\varphi - G_2\delta y_{1S_2} - G_3\delta y_{1S_3} - G_4\delta y_{1S_4}$$

$$Q\delta\varphi = M_2\delta\varphi - G_2\frac{r}{2}\cos\varphi\,\delta\varphi - G_3 r\cos\varphi\,\delta\varphi - G_4\frac{r}{2}\cos\varphi\,\delta\varphi$$

$$Q = M_2 - (G_2 + 2G_3 + G_4)\frac{r}{2}\cos\varphi$$

Vlastní pohybová rovnice:

$$(I_{2O} + I_{4O'} + m_3 r^2)\ddot{\varphi} = M_2 - (G_2 + 2G_3 + G_4)\frac{r}{2}\cos\varphi$$