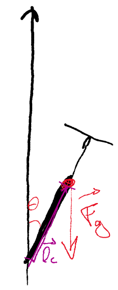
(1) https://mit-unicycle.github.io/mit-unicycle/pdfs/ResearchGate.pdf (2) https://www.researchgate.net/publication/379878928_Using_a_Flywheel_to_Stabilize_a_Self-Balancing_Bicycle

front view



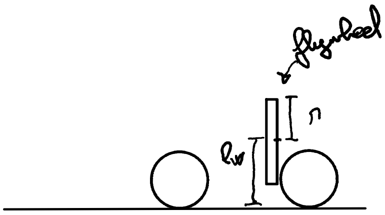
$$T_{tot} = I_B \ddot{\theta} = T_g - T_w$$

$$T_g = \vec{l}_c \times \vec{F}_g = l_c m_e g \sin\theta$$

suppose

$m = 2$ kg
$l_c = 0{,}15$ m
$\theta = 30°$

then $T_g = 1{,}4715$ Nm



to maximise recovery angle:

- minimize l_w
- maximise r (because it optimises wheel weight to moment of inertia ratio)

⇓

ideally $r \approx l_w$ (bottom of the wheel almost touching the ground)

But we want to have the structural connection between the front and back of the bike under the flywheel

$\Rightarrow l_w - r \approx 2$ cm ?

in study 1 they used a 10,5 cm flywheel radius, the previous MIT project had $r = 10$ cm

estimating moment of inertia of the flywheel we weighted:

total weight : 159.1 g
weight of screws : $16 \cdot 7g = 112\ g = m_e$
weight of 3d print : $159.1 - 112 = 47.1\ g = m_d$
I assume the 3d print is a disk, of radius $r = 10$ cm, and the screws form a circular loop of radius $r_e = 9{,}5$ cm

$$I_w = I_{disk} + I_{loop} = \frac{1}{2} m_d r^2 + m_e r_e^2 = 0{,}0012463\ \text{kg}\cdot\text{m}^2$$

(In reality the 3d print is not a disk and so has a slightly higher moment of inertia)

equilibrium at a 30° angle of tilt:

$T_g = 1{,}4715$ $\quad T_w = I_w \cdot \dot{\omega}$ ← angular acceleration

$$T_g = T_w = I_w \cdot \dot{\omega} \Leftrightarrow \dot{\omega} = \frac{T_g}{I_w} \approx 1180{,}69 \quad \frac{1}{s^2}$$