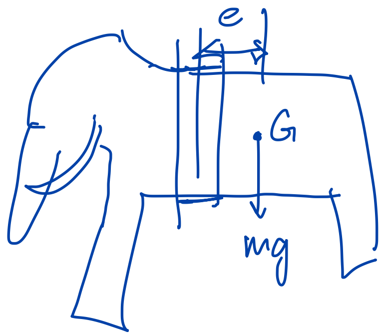
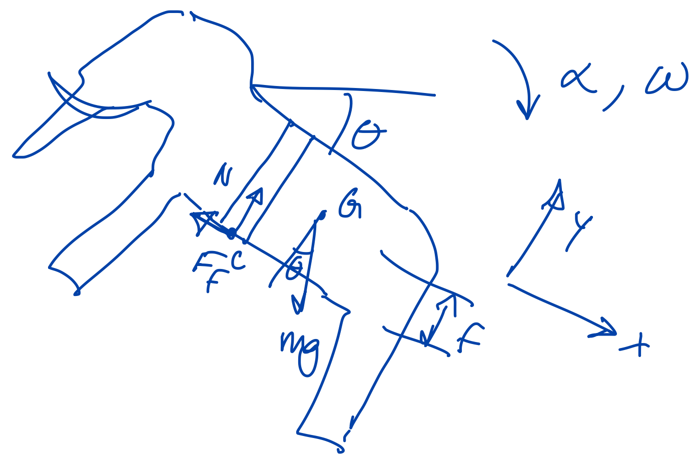
Mammoth slipping   Angle for slip.





At slip:

① $F_{fs} = \mu N$ (just before slip, exceeds F_{fs}, goes to F_{fk})

(μ given)

Assume mammoth rotating about C (bottom of sling)

② $\Sigma F_x: -F_f + mg\sin\theta = ma_{Gx}$

③ $\Sigma F_y: N - mg\cos\theta = ma_{Gy}$

④ $\Sigma M_C: \vec{r}_{G/C} \times \vec{W} = I_G\vec{\alpha} + \vec{r}_{G/C} \times m\vec{a}_G$

$\vec{r}_{G/C} = e\hat{i} + f\hat{j}$ (values given)

⑤ + ⑥

$\vec{a}_G = \cancel{\vec{a}_C}^{\,0} + \vec{\alpha} \times \vec{r}_{G/C} - \omega^2 \vec{r}_{G/C} = a_{Gx}\hat{i} + a_{Gy}\hat{j}$ ($a_{Gy} \neq 0$, $a_{Gx} \neq 0$)

$\vec{W} = mg(+\sin\theta\,\hat{i} - \cos\theta\,\hat{j})$

$\vec{\alpha} = -\alpha\hat{k}$

$\vec{\omega} = -\omega\hat{k}$

unknowns: F_f, N, a_{Gy}, a_{Gx}, α, ω, θ

7 unknowns

– need W-E equation

①+②: $-\mu N + mg\sin\theta = ma_{Gx}$

+③ $-\mu(mg\cos\theta + ma_{Gy}) + mg\sin\theta = ma_{Gx}$

④ $(e\hat{i} + f\hat{j}) \times (mg(\sin\theta\,\hat{i} - \cos\theta\,\hat{j}))$

$= -emg\cos\theta\,\hat{k} - fmg\sin\theta\,\hat{k}$

$-I_G\alpha + (e\hat{i} + f\hat{j})\,m \times (a_{Gx}\hat{i} + a_{Gy}\hat{j})$

$(= -I_G\alpha + ema_{Gy} - fma_{Gx})\hat{k}$

$\Rightarrow -emg\cos\theta - fmg\sin\theta = -I_G\alpha + ema_{Gy} - fma_{Gx}$

⑤ + ⑥ $a_{Gx}\hat{i} + a_{Gy}\hat{j} = -\alpha\hat{k} \times (e\hat{i} + f\hat{j}) - \omega^2(e\hat{i} + f\hat{j})$

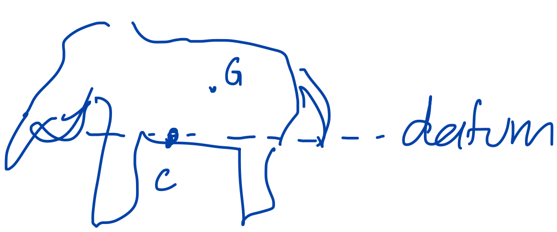
$a_{Gx}\hat{i} + a_{Gy}\hat{j} = -\alpha e\hat{j} + \alpha f\hat{i} - \omega^2 e\hat{i} - \omega^2 f\hat{j}$

$\hat{i}: \quad a_{Gx} = \alpha f - \omega^2 e$

$\hat{j}: \quad a_{Gy} = -\alpha e - \omega^2 f$

<u>W-E</u>

<u>state 1</u>

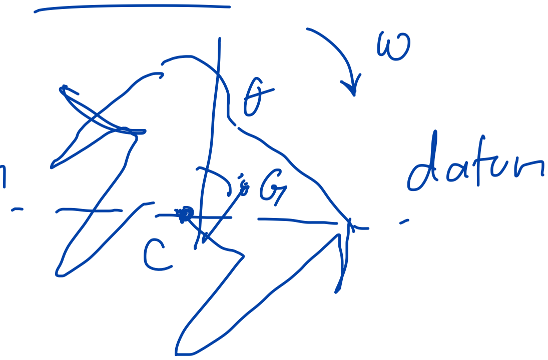


$T = 0$

$V = mgf$

$\sum U_{1\to 2} = 0$

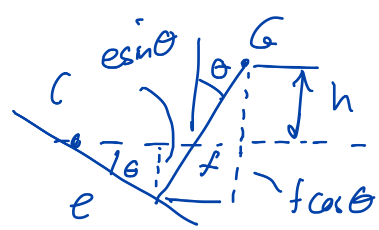
<u>state 2</u>



$T = \frac{1}{2} I_C \omega^2$

$V = mgh$

$= mg(f\cos\theta - e\sin\theta)$



$h = f\cos\theta$
$- e\sin\theta$

$$\Rightarrow mgf = \frac{1}{2} I_C \omega^2 + mg(f\cos\theta - e\sin\theta) \qquad (7)$$

$$I_C = I_G + m\left(\sqrt{f^2 + e^2}\right)$$

need k_G for $I_G = m k_G^2$

Solve 7 eqns, 7 unknowns.