

# Stadium Resonance project

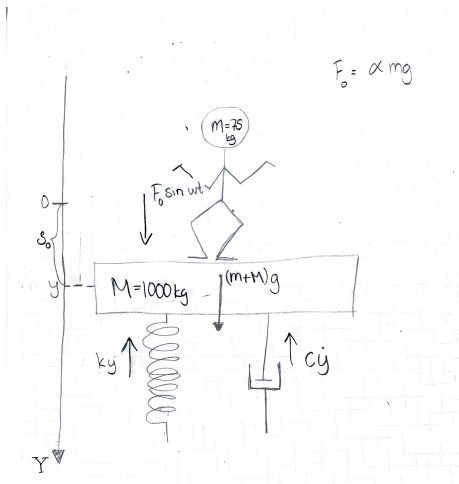
May 24, 2023

# Intro

[https://www.youtube.com/watch?v=Q5TArPeNB6o&ab\\_channel=WeShowFootball](https://www.youtube.com/watch?v=Q5TArPeNB6o&ab_channel=WeShowFootball)

- ▶ Derive from power equation
- ▶ Plot of the dynamic response
- ▶ Plot of the dynamic response,  $k$  is adjusted
- ▶ Plot of the dynamic response,  $\zeta$  is adjusted
- ▶ Countour plot

## Force Body diagram



Power equation:

$$(m + M)\ddot{y} = (m + M)g - k(y + \delta_0) - c\dot{y} + \alpha \cdot m \cdot g \sin(\omega t)$$

We get  $k$  from equilibrium  $0 = -k\delta_0 + (M + m) \cdot g$

$$\ddot{y} + \frac{c}{(m + M)}\dot{y} + \frac{k}{(m + M)}(y + \delta_0) = g + \alpha \left( \frac{m}{M + m} \right) \cdot g \sin(\omega t)$$

$$2\zeta\omega_n = \frac{c}{m + M}$$

$$\omega_n^2 = \frac{k}{m + M}$$

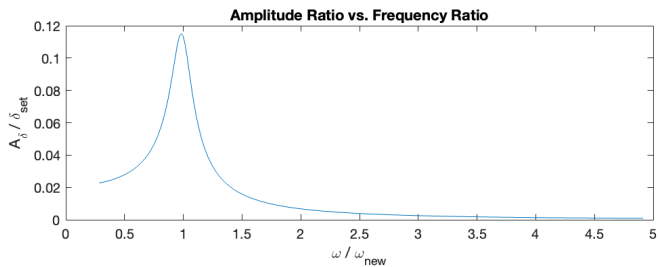
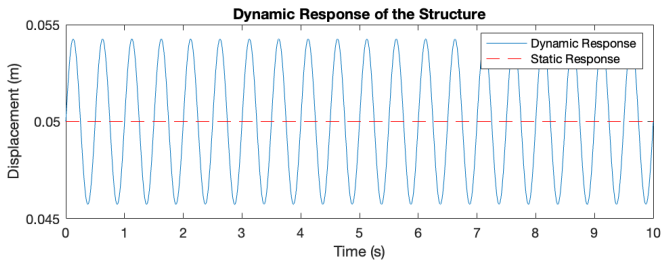
$$\ddot{y} + 2\zeta\omega_n\dot{y} + \omega_n^2 \cdot y = \frac{\alpha mg}{(m + M)} \sin(\omega t)$$

Detta ger

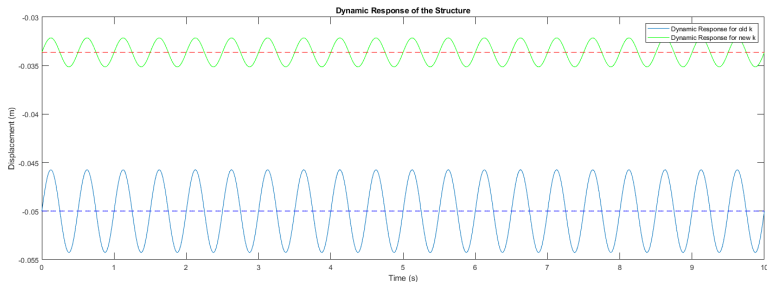
$$Y = \frac{\frac{\alpha mg}{m+M}}{\sqrt{\left(\frac{g}{\delta_0} - \omega^2\right)^2 + \left(\frac{c\omega}{m+M}\right)^2}}$$

Förstoringsfaktor  $M = Y/Y_{\omega=0}$

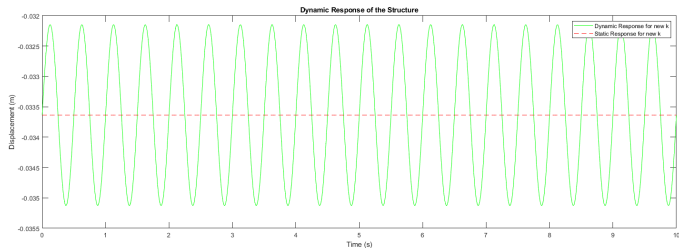
$$M = \frac{\delta_0}{\sqrt{\left(\frac{g}{\delta_0} - \omega^2\right)^2 + \left(\frac{c\omega}{m+M}\right)^2}}$$



The calculated spring constant  $k$ : 313515 N/m



The calculated spring constant  $k$ : 313515 N/m





The calculated attenuation factor  $\zeta$ : 0.373313

