Master Thesis Research Goals/Ideas

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Introduction

- The turning point of the Back Squat is the point where the velocity of the barbell is zero and changes sign.
- Idea: approximate the turning point of the Back Squat with an ideal Mass-Spring system and deduce the spring constant k.
- The spring constant k is a measure for the mechanical stiffness of the body.
- Focus on vertical stiffness, not leg nor joint stiffness.

Squat Movement: Eccentric and Concentric phase

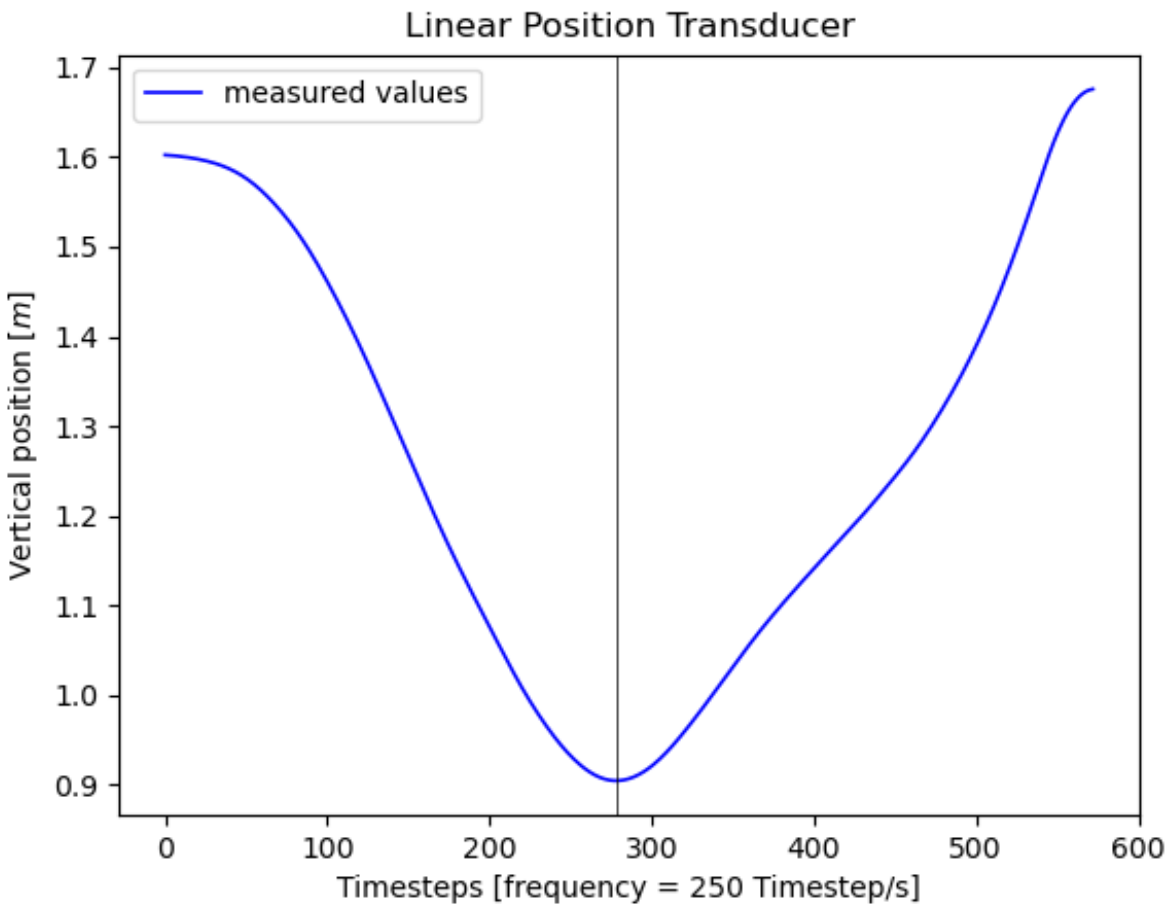

Figure: Time evolution of the vertical position of the barbell. The left part represents the Eccentric phase, while the right part represents the Concentric phase.

Forces during the Back Squat

- Ground reaction force F_{GRF}, gravity F_g and the force that the Barbell exerts on the body F_{WK}.
- We are interested in two important positions: the center of mass of the body $y_{CoM}(t)$, and the position of the barbell $y_W(t)$.

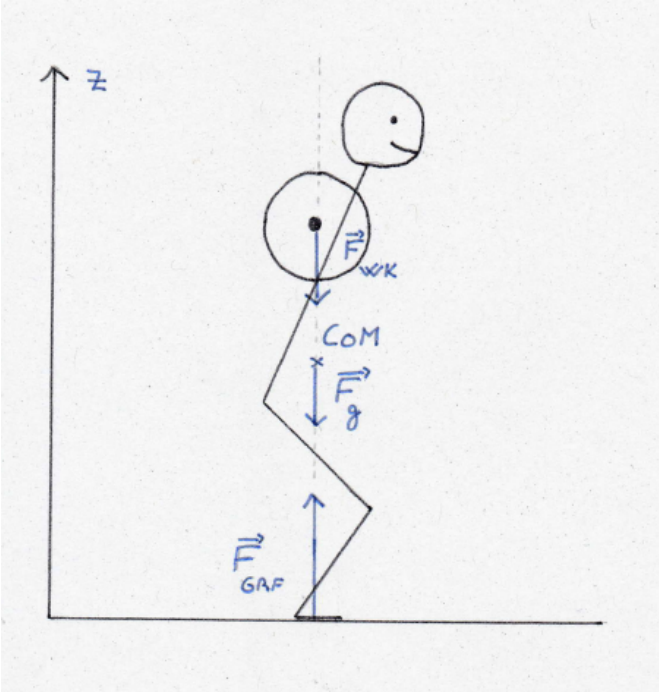

Figure: Forces acting during the Back Squat. The barbell is considered an external object.

Semester Project: first estimation of the elastic constant

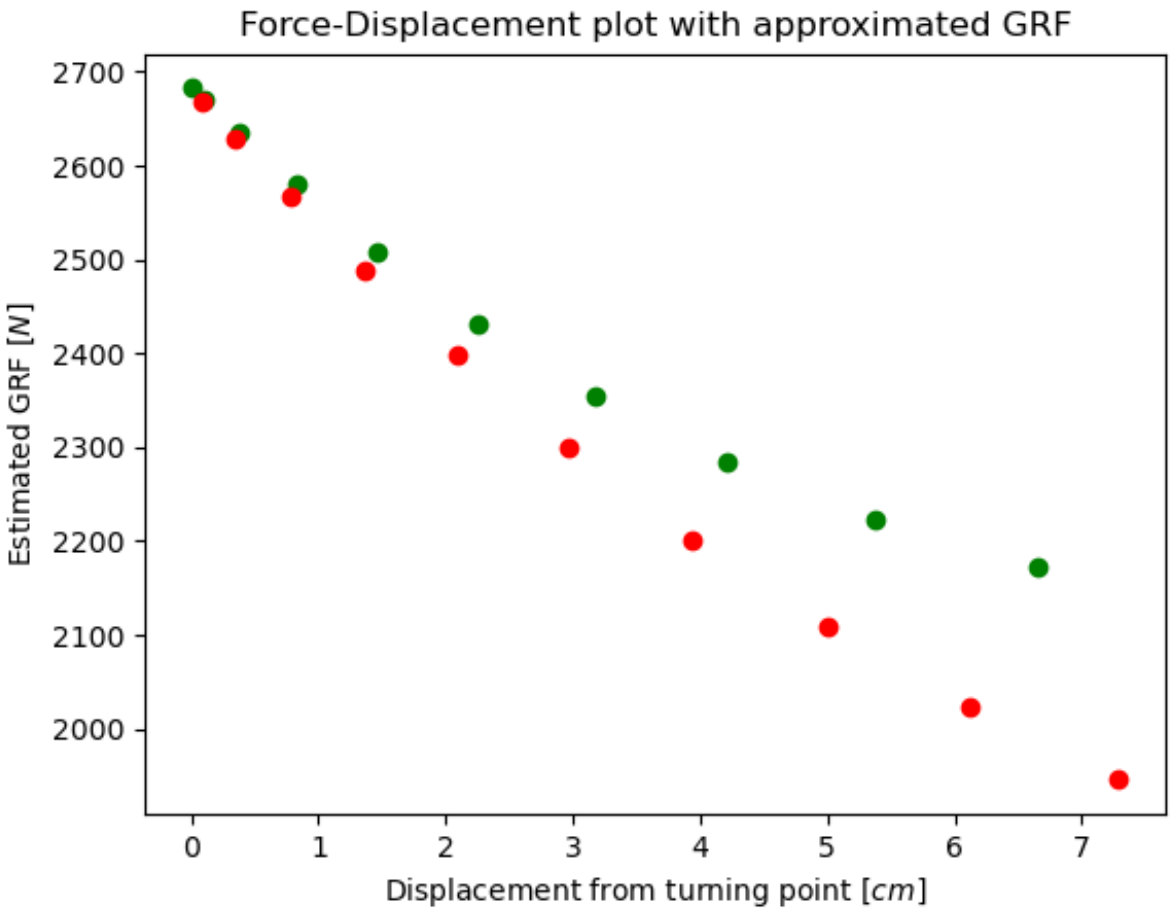

Figure: The green points represents the Eccentric phase, while the red ones the Concentric phase. With linear regression we obtain $k = (132.6 \pm 5.1)\text{Ncm}^{-1}$.

1) Kinematics between $y_{CoM}(t)$ and $y_W(t)$

- The body is not just translating, but also rotating: extension to the 2D sagittal plane.
- Goal 1: Understand the kinematics between $y_{CoM}(t)$ and $y_W(t)$.

$$m_K \cdot \ddot{y}_{CoM}(t) = F_{GRF} - (m_W + m_K) \cdot g - m_W \cdot \ddot{y}_W(t)$$

- Hypothesis: $y_{CoM}(t) = \sum_{k=0}^{n} b_k \cdot t^k + y_W(t)$.

2) Rest Position of Spring

- Rest position: $y_{CoM} = 0$.
- Goal 2: Find a general method that defines the rest position of the spring.
  In the rest position $F_{GRF}(t)$ and $y_{CoM}(t)$ start to depend linearly on each other.
- $F_{GRF}(t) = -k \cdot y_{CoM}(t) + F_0$. Role of F_0?

3) Rotational "dissipation" energy

- The turning point is not well-defined: Δt between the turning point of the "hips" and the turning point of the "barbell".
- Goal 3: calculating the dissipated rotational energy could serve as an estimator of technique quality.