

# MECHANICAL PROPERTIES OF A SPRING-HINGED FLOOR REACTION ORTHOSIS

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## Background

- A Floor Reaction Orthosis (FRO) aims to counteract excessive knee flexion in the stance-phase of gait in Cerebral Palsy (CP)
- Since a conventional FRO is stiff, it obstructs ankle push-off
- A more spring-like FRO could potentially enhance ankle-push off power, as it can store and release energy

**Purpose: to evaluate the mechanical properties of a newly developed hinge with adjustable springs within a test FRO**

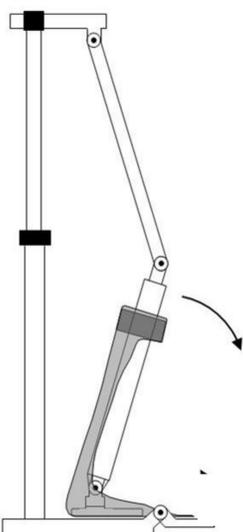
## Materials & Methods

- A special test FRO with integrated hinge was constructed
- **Five springs of different stiffness\* (i.e. 0.02; 0.18; 0.50; 0.48; 1.28 Nm/deg) and Range of Motion\* (ROM) (i.e 15; 15; 10; 10; 5 deg) were tested (Fig. 1)**



Figure 1. The 14mm Neuro Swing® hinge with five springs, labeled by color. ©Fior & Gentz, Lüneberg, Germany

The spring's mechanical properties were measured with BRUCE (Fig. 2):



- Range of Motion [deg]  
*mean excursion of compression and release phase*
- Stiffness [Nm/deg]  
*slope of the linear fit*
- Threshold [Nm]  
*exerted moment at the start of the ROM*
- Hysteresis [%E<sub>STOR</sub>]  
*storage (E<sub>STOR</sub>) minus release of energy*

Figure 2. BRUCE measures AFO angle and exerted net moment continuously

\* Technical specifications as reported by the manufacturer

## Results

Table 1. Mechanical properties of the five springs fitting the 14mm hinge, integrated into a test FRO

Spring	ROM [deg]	Stiffness [Nm/deg]	Threshold [Nm]	Hysteresis [% E <sub>stor</sub> ]
Blue	13.7	0.02	0.9	33.6
Green	14.0	0.24	2.5	30.8
White	8.7	0.52	5.5	35.6
Yellow	10.6	0.64	7.6	31.9
Red	4.2	1.71	17.8	30.6

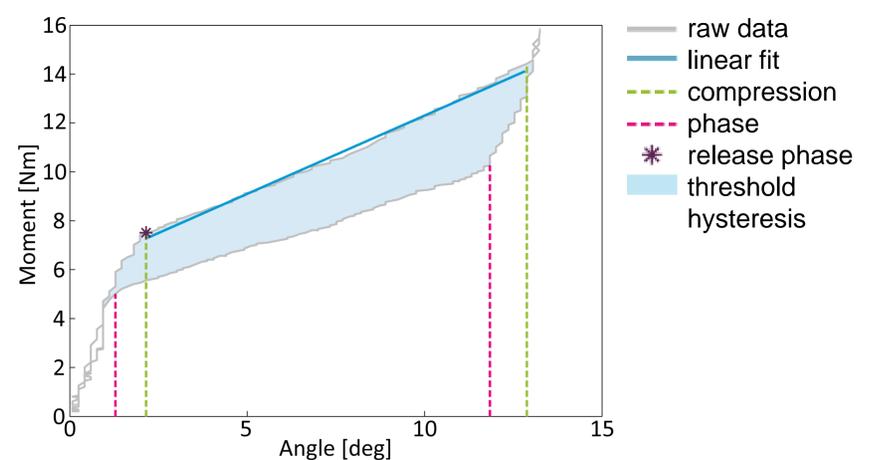


Figure 3. Example of a typical result (yellow spring)

## Discussion & Conclusion

- **Results of this study generally correspond to the manufacturer's technical specifications**
- Hysteresis results in a loss of energy that potentially could have enhanced ankle push-off power
- Nevertheless, the energy return of the spring-hinged FRO might be more beneficial than a stiff FRO, in which no energy can be stored
- Reduced stiffness of the spring-hinged FRO might compromise its function to promote knee extension in stance

**In future research, we will study the effects of the mechanical properties of a spring-like FRO on gait in children with CP**

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