

The influence of low-friction quickdraws on impact forces in climbing falls

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Introduction

Background and reasons for the project

Introduction

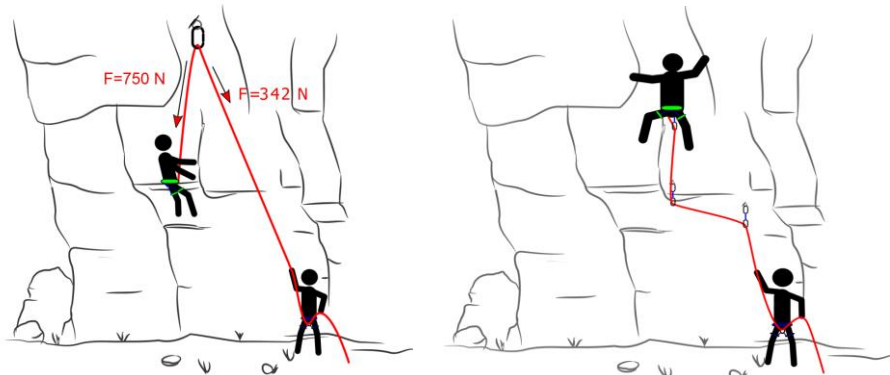
- Helmut Mägdefrau proved influence of rope friction on impact forces 1989.
- Complex mathematical models expect much higher impact forces in case of rope friction within the belay chain
- Models validated in laboratory
- No scientific field studies published

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Introduction

- Rope friction at anchor points



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Introduction

- Effect of low-friction quickdraws was not evaluated till now



source: <http://dmmclimbing.com/products/revolver>

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Research Questions

- Will the usage of low-friction quickdraws influence the impact forces in climbing falls?
 - Lower maximum impact force at the falling mass and last anchor expected
 - Higher maximum impact force at the belay point expected

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6

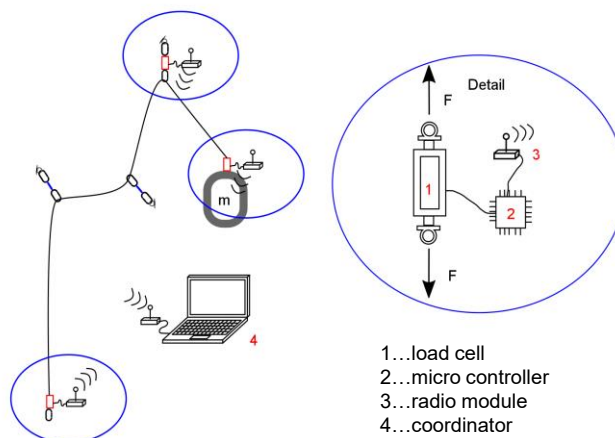
Methods

measurement setup, study design and data analysis

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7

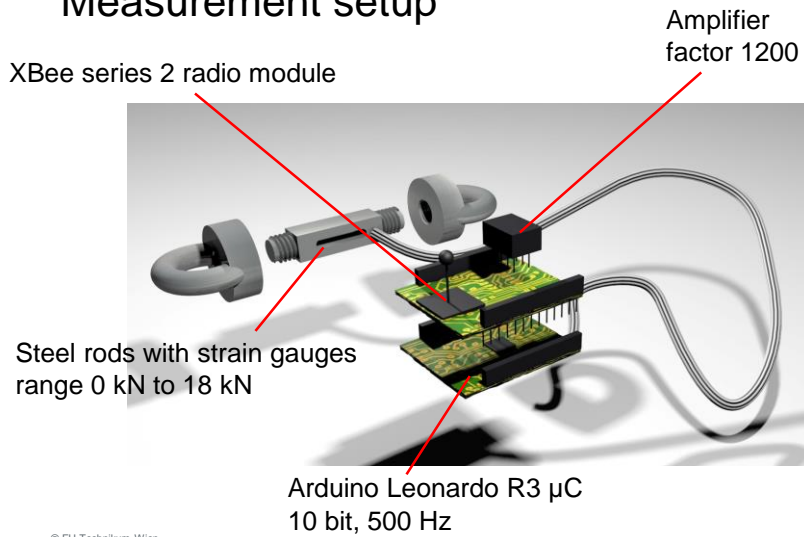
Measurement setup



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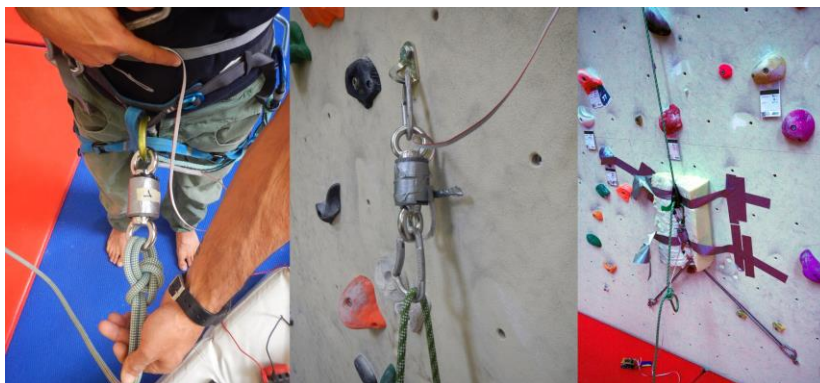
8

Measurement setup



Design field study

- Setup application in case of static belay technique



Design field study

- Setup application in case of dynamic belay technique



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11

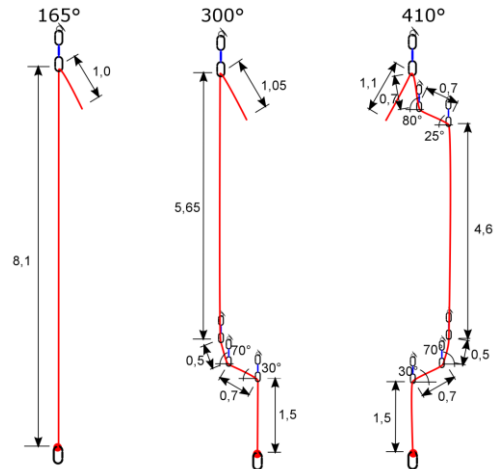
Design field study

- Artificial climbing wall with 17° overhang
- Human subject as falling mass (76 kg, 180 cm, age 32)
- Human subject as belayer (66 kg, 174 cm, age 25)
- Semi-automatic belay device (Edelrid Eddy)
- Three different rope setups
- Same fall factor, different amount and degree of rope redirection

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Design field study



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13

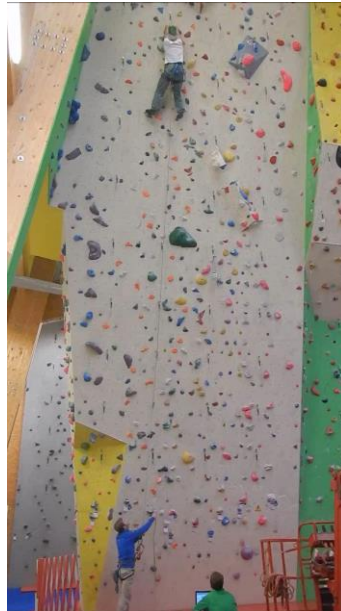
Design field study

- Standard carabiner (AustriAlpin Inox) and low friction carabiner (DMM Revolver)
- Static and dynamic belay technique
- Ten falls for each test series
- New rope for each test series (Edelrid Boa 9,8)
- Detailed planned procedure and precise instructions for test subjects

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14

Design field study

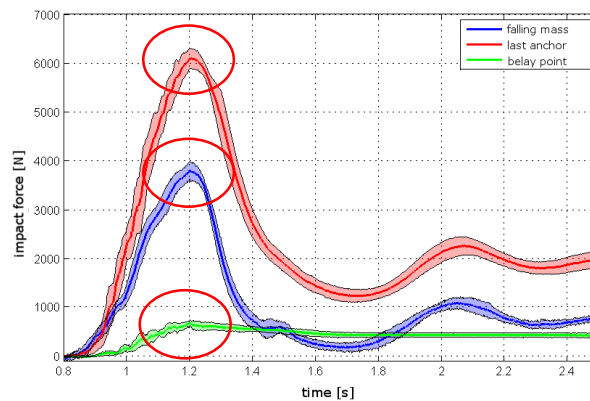


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Data analysis

- Mean value and standard deviation of $\max F$
- Lilliefors test for normal distribution
- Welch test for significance of differences (5 % level)



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17

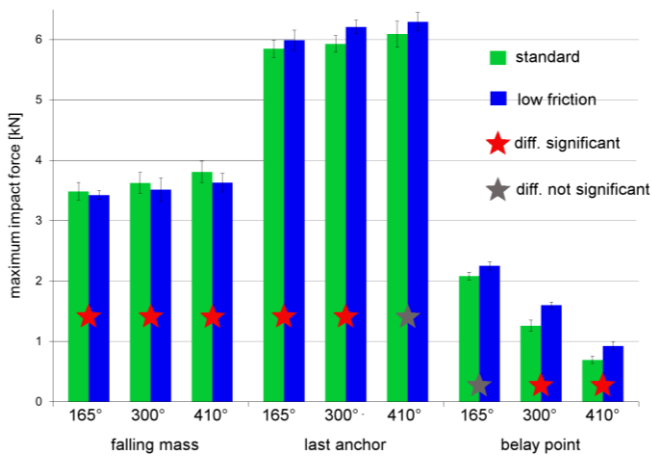
Results

Comparison of maximum impact forces

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18

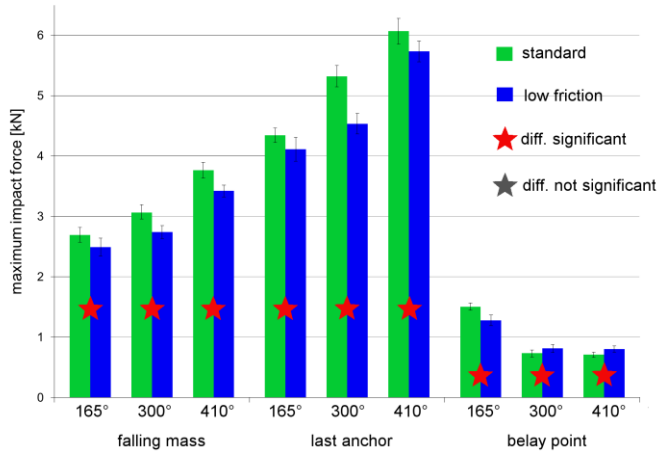
Results static belay



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19

Results dynamic belay



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20

Discussion

What does it mean?

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21

Discussion

- Usage of low-friction quickdraws led to significantly lower maximum impact forces at the falling mass
- Usage of low-friction quickdraws led to higher maximum impact forces at the belay point
- Behaviour at the last anchor depends on situation
- major differences when using dynamic belay technique

Discussion

- More dynamic elongation and higher energy dissipation capacity at the belay point
- Effect of rope elongation was smaller than expected
- Not possible to recommend a particular type of quickdraws
- Study helps to understand the complex mechanisms within belay chain in case of rope friction
- Increase awareness and safety of climbers

Questions?

