Fighting Falls: Ladder safety, slip resistance, and how to keep your team safe on site

May 5, 2021
Ladder Use Fatal Statistics

- Fatal Ladder Falls increase every year
- Source of Info is BLS in USA; access through SIRI
- Deaths 300-400 every year (Industry and Residential)
- Low height falls (10-20 ft) typical
- Extension and Step Ladders and Fixed Ladders mix
FATAL work falls in USA:
Sales of fall equipment up 10%/yr yet Fall deaths up 11%/year 2019 BLS

- **UK** Total work fall deaths are “100”/year* 2016 HSE
- **US** Total work fall deaths are 880/year 2019 ref BLS

**8X fall fatality rate in USA**

- *Relative Work Population per Siri
- Standards rigorously enforced through inspection in UK.
- Ladders represent 300 deaths/yr or more incl. Residential
What EFSS Does!

• Assessments of Fall Hazards, Proposals for Solutions
• Installations, Inspection, Advanced Training
• We are Certified Safety Professionals (CSP’s)
• We are Registered Structural Engineers (PE’s)
• Our business is Fall Protection Hazard Control
• We sit on major standards committees in USA incl. A14
• Forensic Engineering and Expert Witness Services
• FallSafety.com for more info
• Contact efss@FallSafety.com with questions

Fall Hazard Recognition!
efss@FallSafety.com
At Publisher
Noted Speaker Today

- Kurt Beschorner leading ladder researcher in USA
- Met several years ago in London at a slip/fall conference
- His team is well-respected in the World for continuing ladder research
Kurt Beschorner

- Associate Professor in Bioengineering
- University of Pittsburgh PA
- Kurt’s work is to apply engineering principles to prevent falling accidents
- Today’s focus is on Ladders and their hazards research
- Supported by NIOSH and NIH grants
- His Team Provides Safety Solutions for Private Companies
Biomechanics of ladder falls: Informing fall prevention efforts

Kurt Beschorner, Ph.D.
Human Movement and Balance Lab
University of Pittsburgh
May 5, 2021
National Safety Council Meeting
Ladders are frequently involved in fatal and disabling falls in the workplace.

**Fatal Falls**
- Ladder: 16%
- Roof: 37%
- Scaffold: 25%
- Structural steel: 9%
- Other: 13%

**Disabling Falls**
- Ladder: 22%
- Roof: 8%
- Scaffold: 9%
- Vehicle: 6%
- Same level: 40%
- Other: 15%

Ladder fall type

Falls with Ladder

Falls from Ladder

Initiating events for ladder falls

- Unspecified
- Stepping on/off ladder
- Ladder instability
- Slipped/lossed balance

Beschorner research focus

Engineering mechanics analyses

Human motion

Fall prevention

Ergonomic interventions
Organization of presentation

• Biomechanical tools

• Risk factors

• Research findings

• Future work
Biomechanical tools for studying falls from ladders
Biomechanical factors: Force
Biomechanical factors: Motion
Measuring strength
Simulating falls in safe environment
Risk factors of ladder falls
Ladder design/installation/setup

Toe gap distance

Ladder angle
Ladder use practices

Hand grasping
Biomechanical risk factors
Individual physical risk factors

**Upper body strength**

- Loadcell
- Handle
- Winch

**Height**
Research findings connecting risk factors to ladder falls
Ladder design: Toe gap distance

Leave at least 7” of toe gap distance to reduce slip risk

Ladder design: angle

Non-vertical ladders have reduced slip risk

Grasping force on recovery
Grasping surface

Different designs

Maximum achievable force

Grasping surface on response to slip

Muscle responses to the slip

Controlled grasping
Grasping rails slow the slip response

Biomechanical risk factor: Body positioning

Biomechanical positioning

Frictional Requirements
Biomechanical factors: Foot and body positioning influence slip risk

Individual risk factors: Strength

Strength

Recovery from induced misstep
Individual factors: Sex and grip strength can predict recovery from a ladder fall.

Higher Fall Risk

Ladder fall protection should be prioritized for individual’s with lower upper body strength.

Factors associated with greater safety

Environmental
• Unrestricted foot placement
• Non-vertical ladders (~75°)

Human factors
• Grasping rungs instead of rails
• Keeping body weight over feet
• Maintaining level feet
• Accommodating lower upper body strength individuals
Current research: Results coming soon!

- Washing the windows
- Changing a light bulb
- Cleaning a gutter

Behavioral Risk
Task Performance
Judgment Error
Upcoming research: Influence of individual and ladder design factors on slipping events
NIOSH: R01OH011799: Predicting slips during ladder climbing: novel methods for assessing shoe-rung friction
Additional factors identified since funding that are being considered

• Ladder-to-roof transition (and vice versa)
• Base-to-fly transition during descent
• Role of footwear
Partner with us!

• We are always recruiting industry partners to help with our research
• Share stories of ladder slip and fall events (beschorn@pitt.edu)
• We will be recruiting participants in Pittsburgh for Fall, 2021.
• Benefits of being a partner:
  • Ensuring research results are relevant to your workers
  • Early access to research results
  • Flexible testing times → no interruption to work
  • Worker’s get reimbursed for their time
Acknowledgements:

• NIOSH R01 OH 011799: Predicting slips during ladder climbing: novel methods for assessing shoe-rung friction

• NIOSH R21 OH 010038: Quantifying the Recovery Response and Role of Hand Strength During Ladder Falls

• NIOSH T42 OH 008672: Effects of Hand and Foot Positions on Ladder Slip and Fall Outcomes

Thank You!

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Thank you!

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