Managing Forces in Rope Rescue Systems

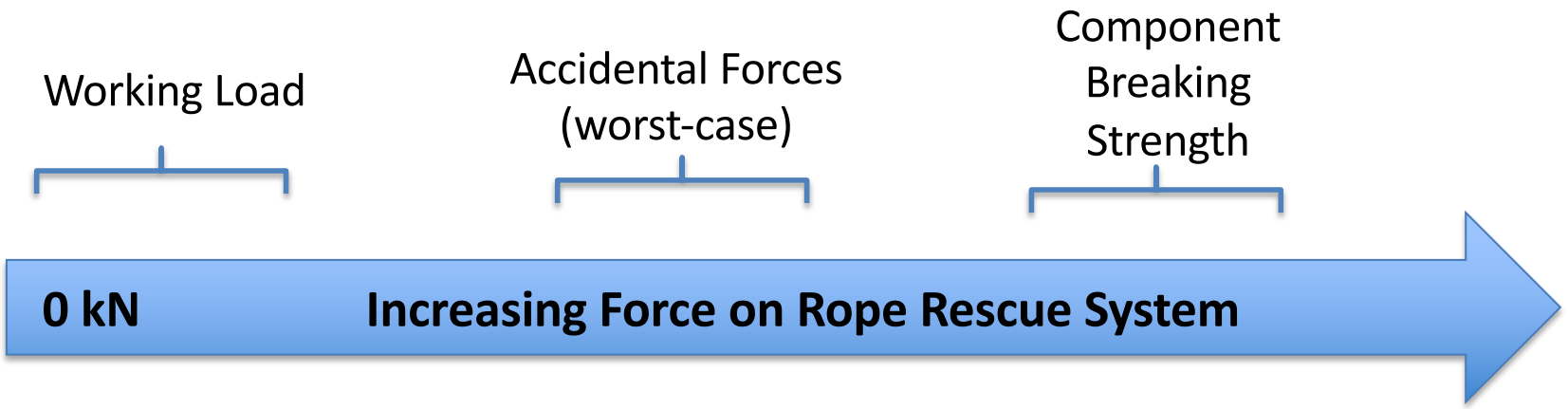
The Principles of Force Limiting

The Principles of Force Limiting:

Understanding the relationship between:

- Working Load Forces
- Maximum Forces
- Breaking Strength

Fundamentals of Rope Rescue System Design:



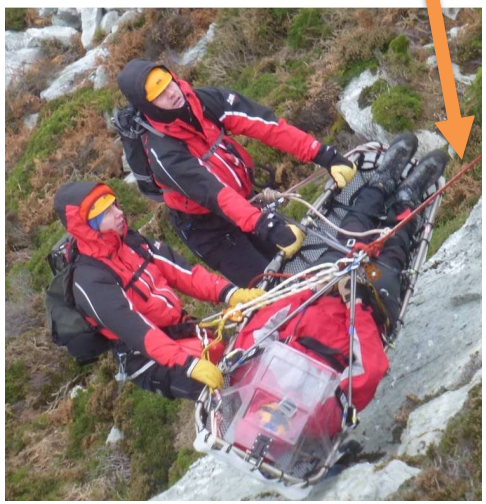
Working Load – common forces applied to the rope systems from raising, lowering, or suspending rescue loads.

Maximum Force – the worst case event
(accidental forces)

Breaking Strength – the force at which components fail

Working Load:

- Rope tension is commonly 2-3 kN
- Load bouncing can double the force; therefore 4-6 kN



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From a design perspective, the Descent Control Device (DCD) should be able to hold the force of a bounce (i.e., 6 kN), without slipping.

Purpose-Built Descent Control Devices

They are designed to ***not slip*** under normal working loads

(results are dependent on rope diameter, type & condition)

Force Limited Component-Based Systems

Tested to specific performance Criteria
(results are dependent on rope diameter, type & condition)

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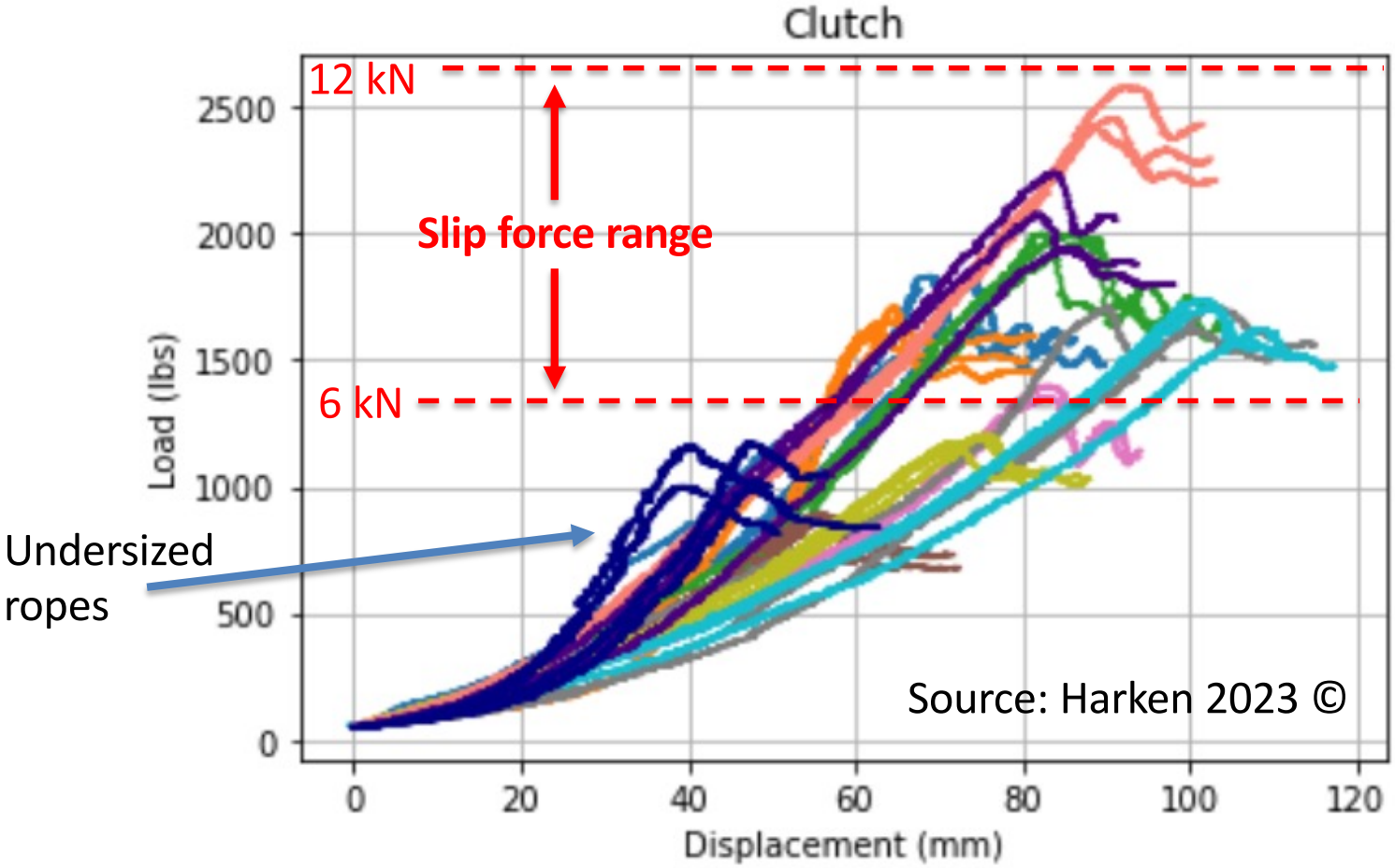


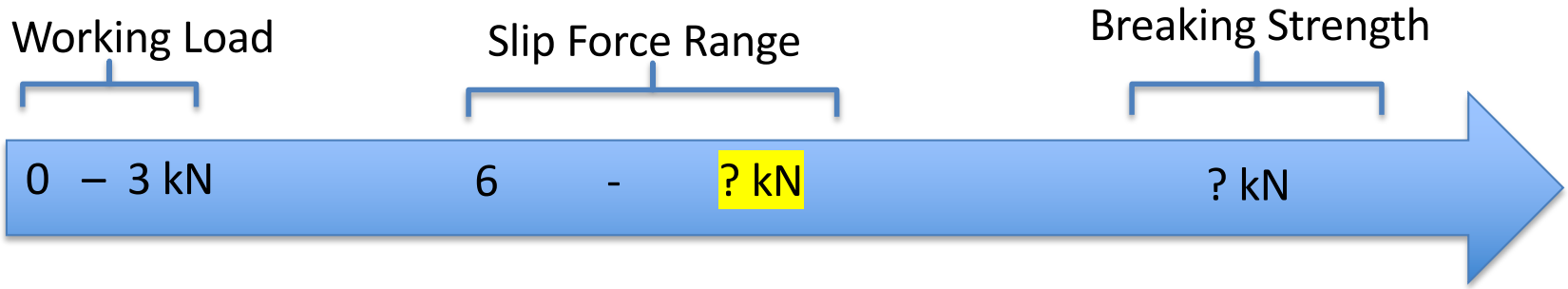
Undersized ropes

It's very important that the combination of rope and DCD have a minimum 'gripping ability' (slip force):

Otherwise, falling loads might not be able to be stopped

Target Descent Control Device Slip Force Range:

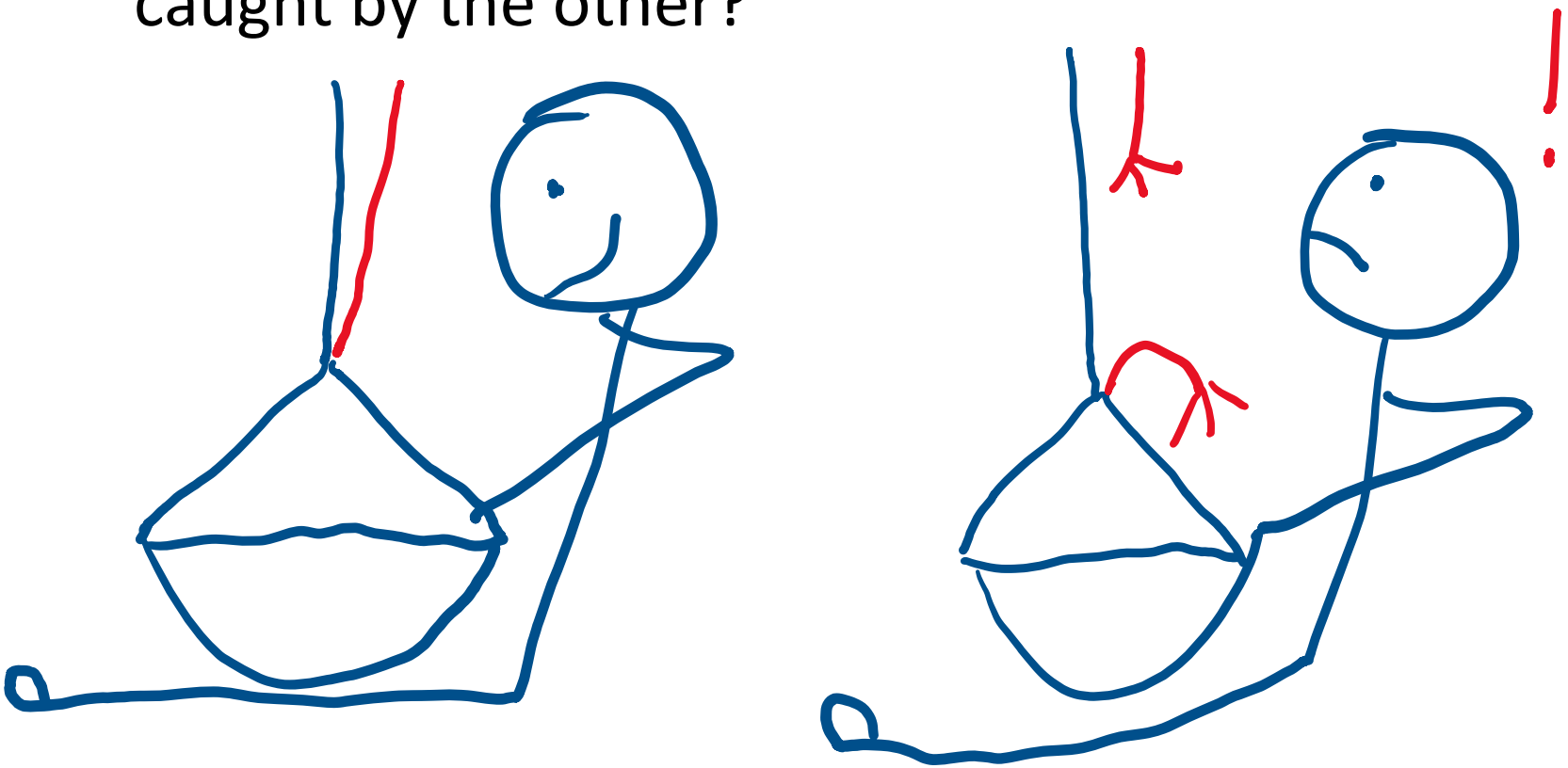
- Minimum 6 kN slip force (to prevent run-away loads)
- Maximum _____kN?



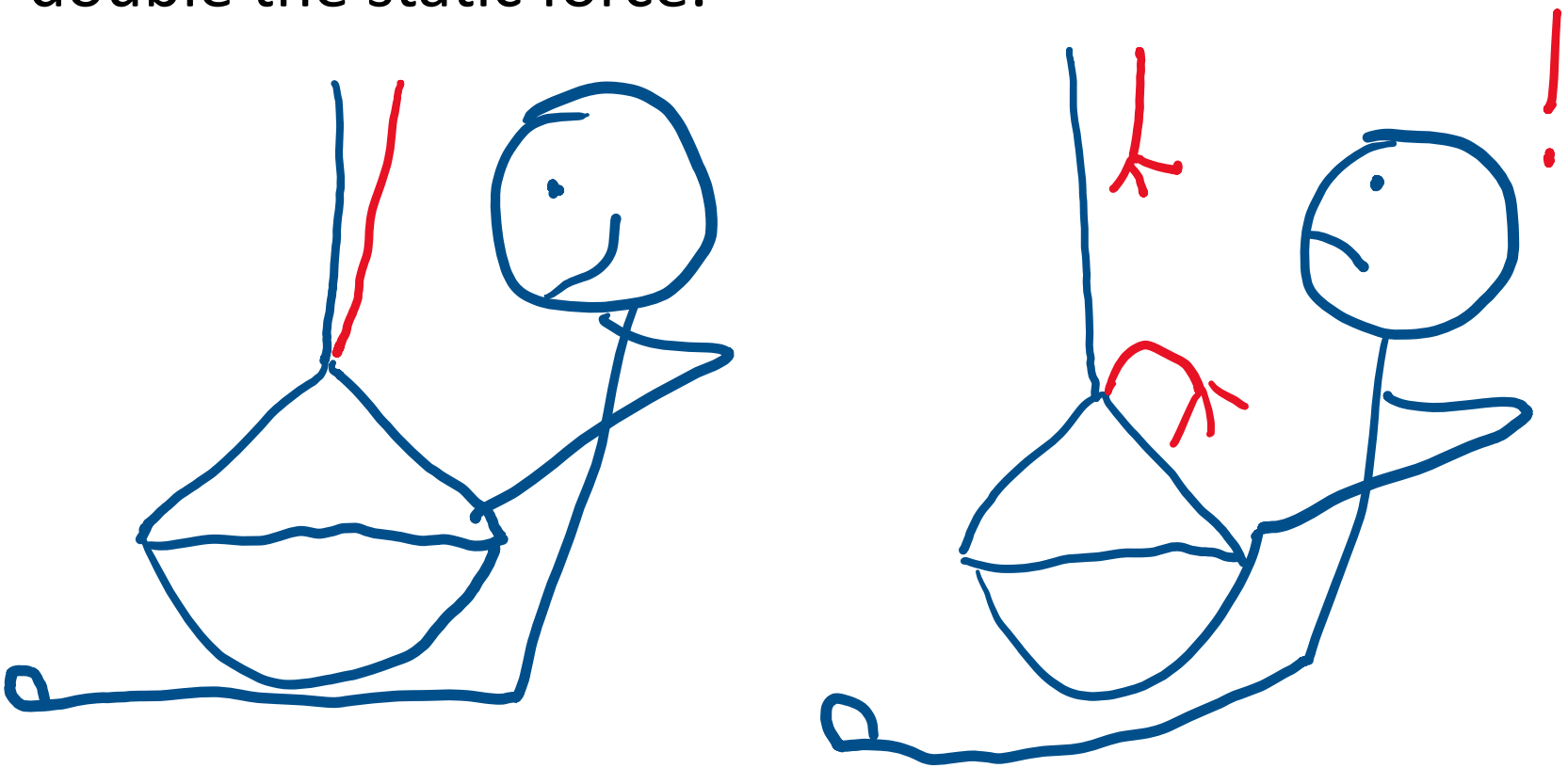
What is the maximum allowable force? What should it be limited to?

What is the worst-case event in rope rescue?

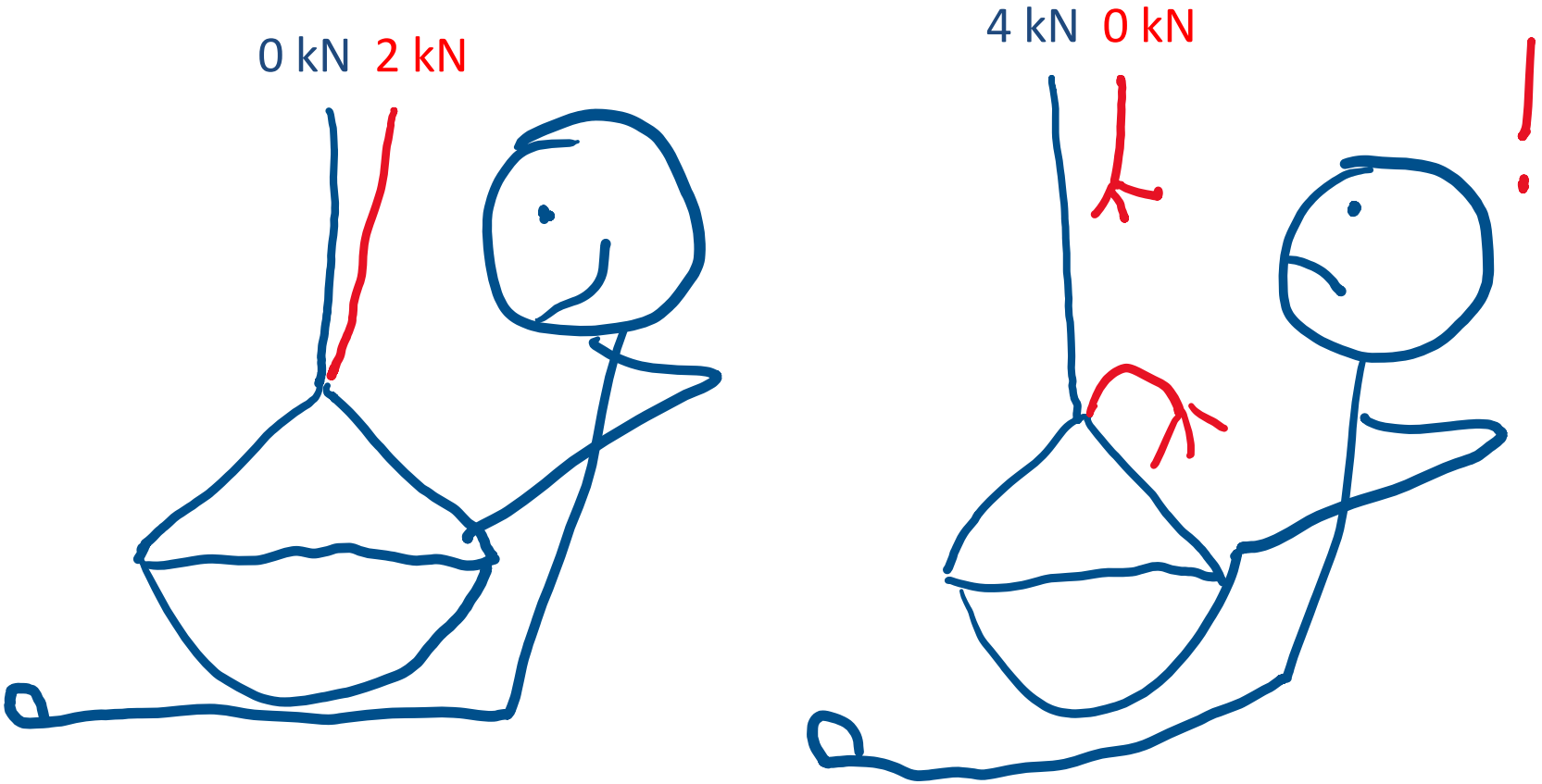
- Is it the failure of one rope, and the load being caught by the other?



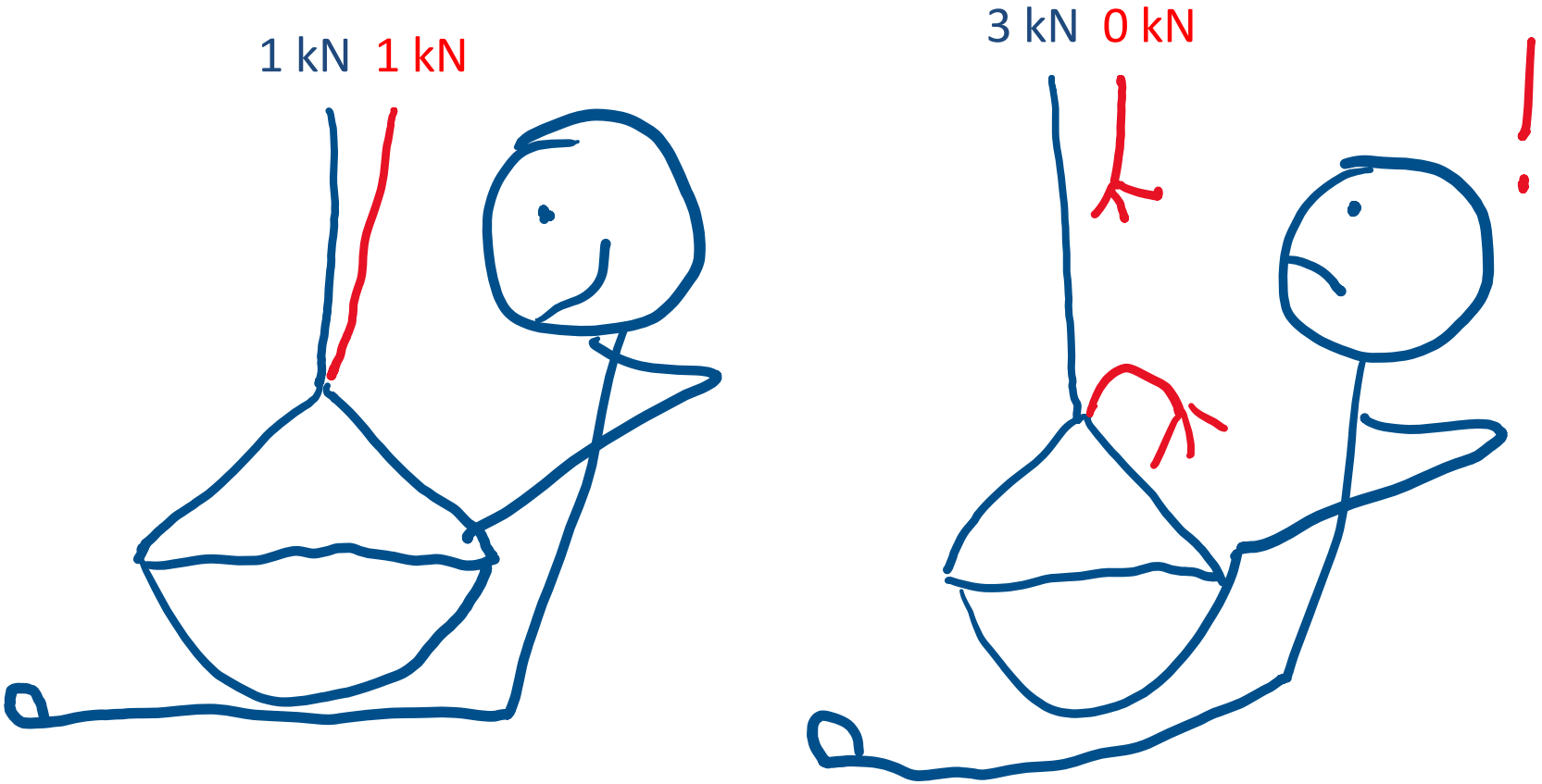
No, this is not the worst-case force. Failure of one rope and shocking the remaining rope might only double the static force.



Scenario #1: All load on one rope



Scenario #2: Equal load on each rope



A fall during an edge transition can produce the worst-case force

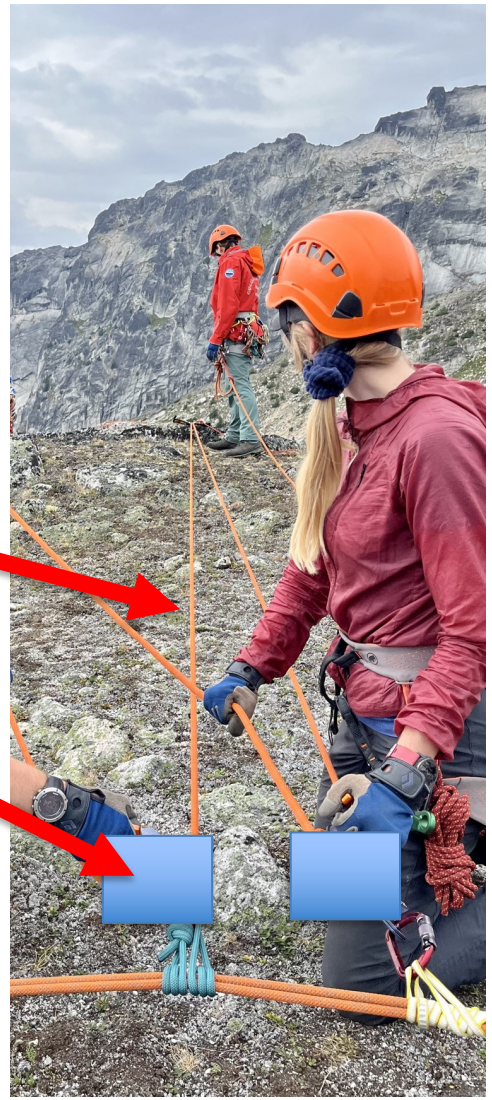
Due to the added energy from a free-fall, more force can be generated during fall arrest.

Maximum Arrest Force (MAF) is highly influenced by:

Rope Type (static, low stretch, hyperstatic)

Choice of Descent Control Device:

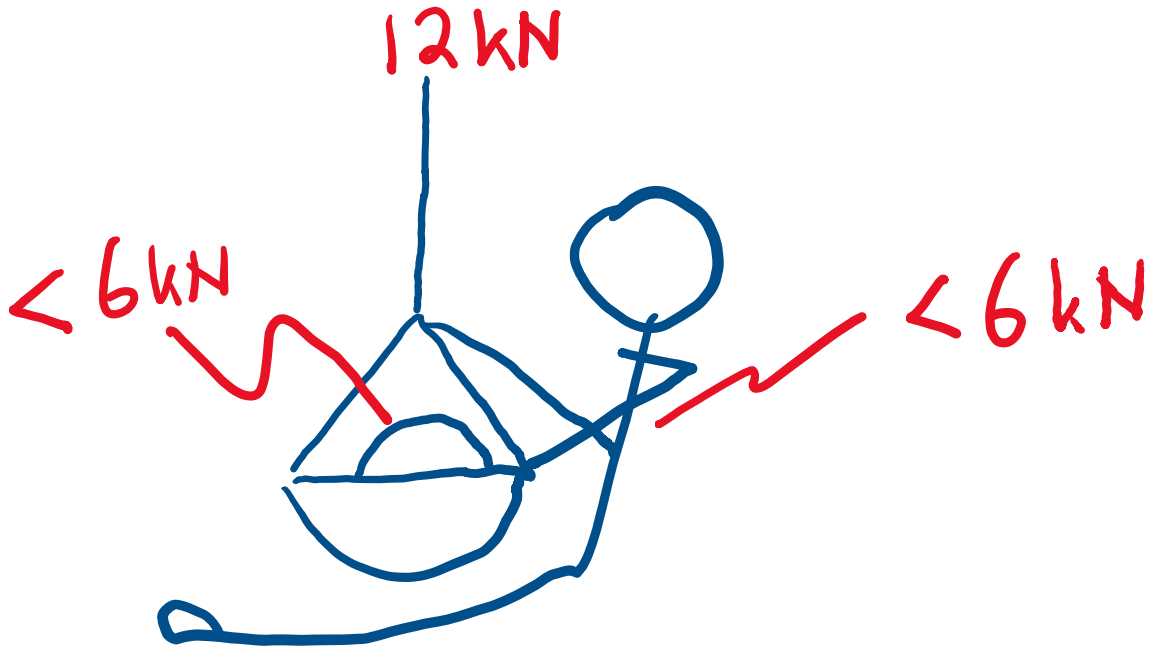
What is the preferred combination?



Internationally, there are strict regulations on the maximum allowable fall arrest force on a human

Max 6 kN

For a rescue-sized load (e.g., 2 people), to limit the force to 6 kN per person, the Maximum Fall Arrest Force cannot exceed 12 kN.



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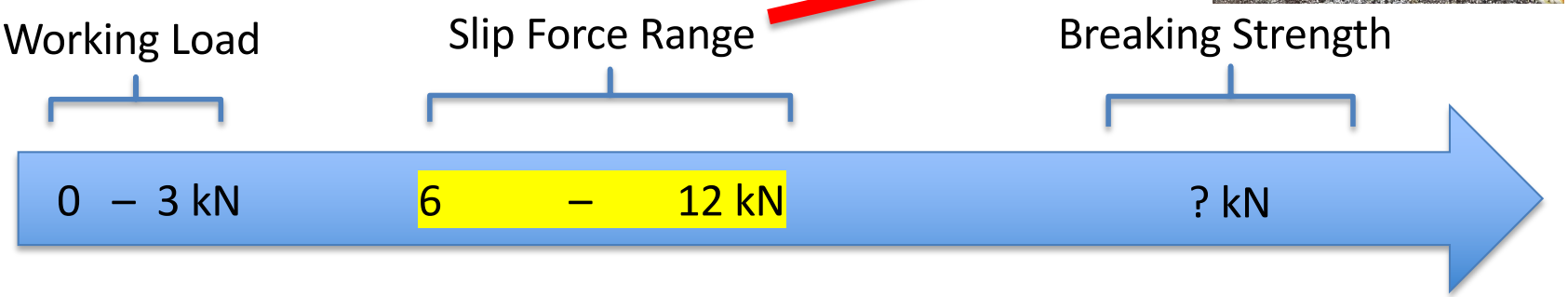
The combination of rope and DCD must keep peak forces to no more than 12 kN, but also the DCD must not slip prior to 6 kN.



Breaking Strength:

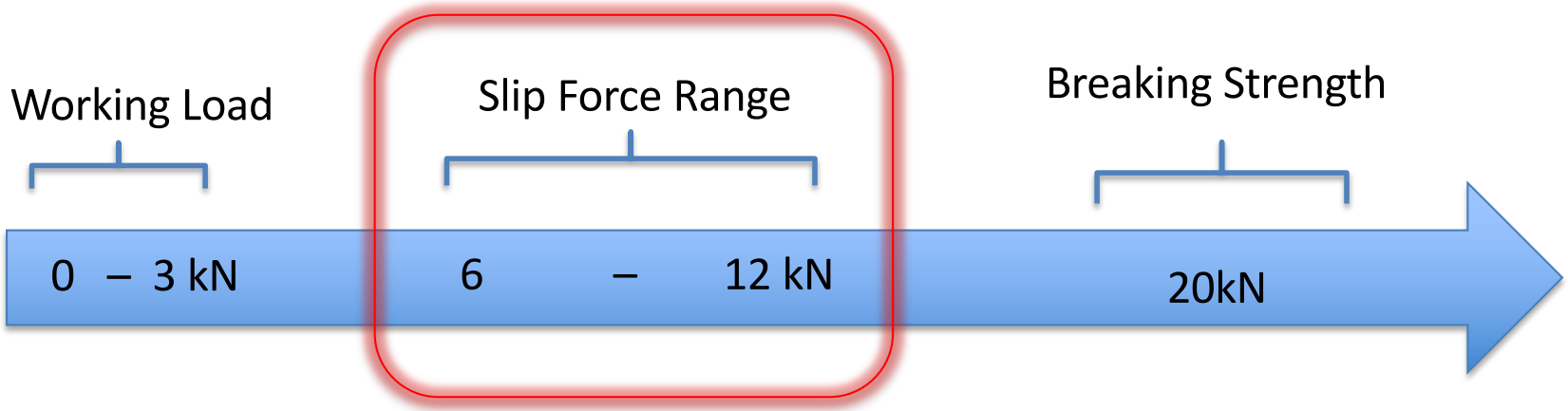
From a ‘designers’ perspective, the required breaking strength of a rope rescue *system* is, among other factors, dependent on the maximum force it might be subjected to, and how reliably that maximum force can be controlled.

Breaking Strength*:

Max force (12 kN) x 1.7 Design Factor ~ 20 kN

* Based on the Canadian model, used by British Columbia SAR; Parks Mountain Rescue; DND

Preferred ***Force Limiting*** Range for Descent Control Devices of Rope Rescue Systems



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