Mech 305/306 Capstone Experiment Abstract

Failure Angle and Distance of Climbing Camming Devices

Mech 306 Lab Section L2B Team # 35
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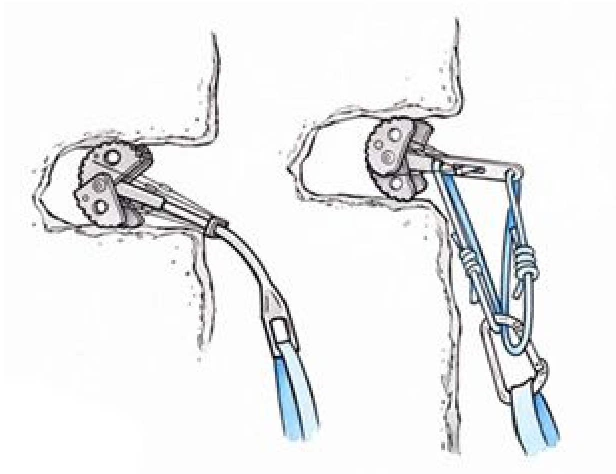
Motivation

In outdoor rock climbing, climbers use protection equipment (just referred to as “protection”) to secure their rope to the rock faces. A climber places piece of protection in natural formations on the rock, clips their rope to the protection, and then they continue to climb above it. If the climber were to fall, their fall is arrested by the protection they have placed.

One of the most common forms of protection is a spring-loaded camming device, or “cam” for short. Cams come in a variety of different sizes and shapes, and they are typically placed in cracks or other parallel features.

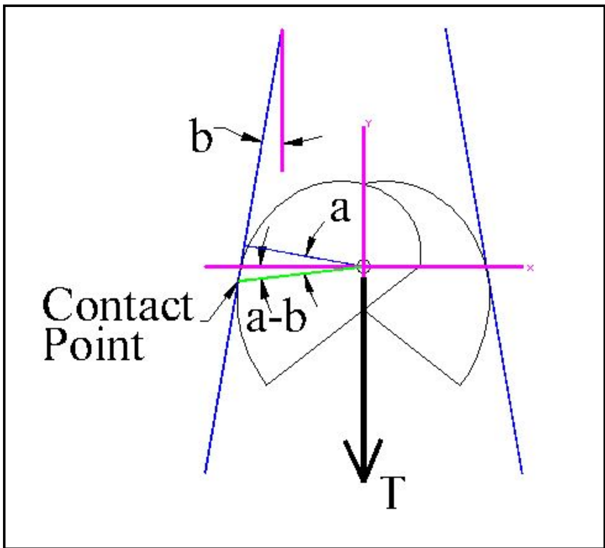


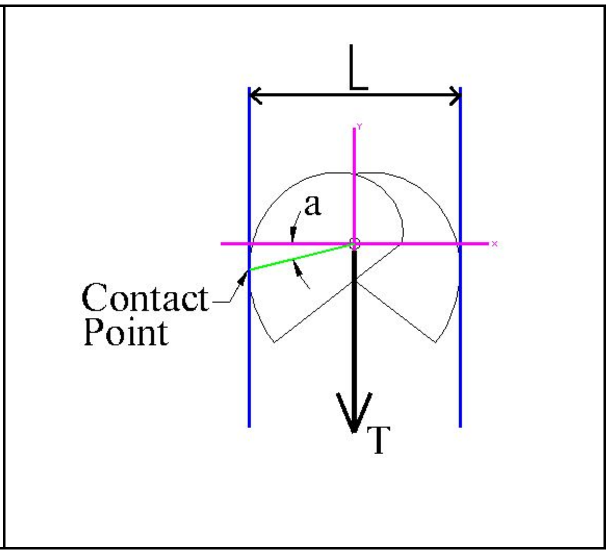
A climber puts his life in the hands of these devices. It is extremely rare for a crack to have ideal geometry for cam strength, therefore the purpose of this experiment is to determine the reliability of a cam in features of varying geometry, in an effort to improve knowledge of effective cam placements for climbers.

Experimental Objectives

The experimental objective of this capstone experiment is to find the effect of crack angle and crack width on the reliability of the cam. The angle *b (see images below)* of the crack would be incremented between 0 and 60 degrees. The width *L* would be in similar increments, between 1n-3n, where n is the unopened width of the cam. Combinations of different angles and widths may be tested depending on how the mounting jig is designed. The static load *T* would be based on common load while climbing (e.g average man's body weight, body weight with a rope, etc.). The size of each increment would depend on the time and resources later available to the team.

The reliability of the cam would be measured in a pass-fail fashion, where failure means that the cam has released from the crack. We can categorize the results and derive a reliability function with angle, width, and load as parameters.





Proposed Methods

To test the different loading forces, we would create a jig that can vary opening width and opening angle. Varying the width and angle, we attach the cam to the jig and load it with static loads at different increments. This can be done with the tension testing machine, or manually with weights. If the cam does not give within a certain amount of time (around 30s to ensure a secured load), we categorize it as pass; otherwise, it fails.

We have anticipated some issues with the method, such as the jig's manufacturing process, or multiple test measurements wearing out the jig's surface. While we can make some choices per anticipated issues, such as slotting a part of the jig so we can replace the surface that touches the cam, there may be issues we can not anticipate, so those experiment design flaws may be in our method. After talking to Dr. Schajer, we found that the best way to proceed is by making preliminary measurements. While setting up for those, more issues are going to appear and our experimental method can be adjusted to correct those issues.

Image Sources in Chronological Order

http://thetravelingnaturalist.com/resources/cam%20placement.jpg
http://www.vainokodas.com/climbing/spir2.gif
http://www.vainokodas.com/climbing/spir1.gif