

## Basket Hitch Anchors



#### Joe Ray/Keith Conover, Allegheny Mountain Rescue Group

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## What's the best anchor?

• In 2017, helped by a Mountain Rescue **Association grant he** obtained, Joe Ray, with help from others in AMRG, did some tests on basket hitches





#### **Basket Hitch**

Empirically Derived Breaking Strengths for Basket Hitches and Wrap Three Pull Two Webbing Anchors Thomas Evans<sup>a</sup> and Aaron Stavens<sup>b</sup> "Montana State University, Department of Earth Sciences, PO Box 173480, Bozeman, MT 59717-3480, cavertevans@gmail.com baaron.stavens@caves.org

#### Introduction and Background:

All rope rescue systems have an anchor, and if the system is designed conservatively, the anchor should be stronger than the rest of the system (ideally the rope is the weakest point in the system). Consequently it is important to know the strengths of our anchors, as well as the relative strength of the anchors in different configurations. Copious pull tests and dynamic tests of anchors have been performed in the past however few of these testing programs have been published for a wider audience, and rarely are the conditions of the tests reported in sufficient detail for others to independently determine the validity and rigor of the testing programs. In addition, statistically significant numbers of tests are usually absent, meaning that the variability in anchor performance is nearly entirely unknown. The research program presented here is designed to measure the absolute breaking strength of two anchor types (basket hitches and wrap three pull two anchors (W3P2)), observe their relative strengths, the variability in breaking strengths and breakage patterns, and ultimately to ascertain if both are acceptable rescue anchors as expected.

4. Basket hitches break, on average, at a higher strength and with less variability (smaller standard deviation) than W3P2 anchors.
5. Basket hitches appear to be between 705 to 775 lbs stronger than W3P2 anchors in the configuration tested.









## The Hypothesis

 A basket hitch anchor tied with a high internal angle and using a single carabiner will cause off-axial loading to such an extent that the carabiner could be damaged or fail: **–Before the webbing fails** -At loads within our standard 10:1 static safety factor



## Methods

- Testing was done using standard rope rescue equipment
- All equipment was purchased new for the purposes of this testing
- MRA provided a grant for the test equipment and Rock Exotica Enforcer load cells for the testing
- Anchors used were those typically used in rope rescue systems (trees, telephone poles)
- Cribbing was used in some tests to maximize the angle of the webbing



## Methods

- Force was slow-pull using several different methods in various tests:
- mechanical advantage rope systems
- A 3 ton come-a-long
- 6 ton winch on Harmony Fire Districts Rescue 22 truck
- Measurements of the internal angle of the anchor were taken at the following intervals:
- 50 lbs, 1000 lbs, 2000 lbs, 3000 lbs, 4000 lbs, 5000 lbs













## 2,200 lbs



#### 5,808 lbs



## 4,144 lbs



# Results

- Initial internal anchor angle: 86-124°
- Under load, webbing stretched, and angles decreased 10%-29%
- 3,000 lbs,: 74-94°
- Larger initial angle = larger stretch (3-4")

# Results

- Steel carabiners: no damage or failures
- Aluminum locking carabiners: failures within our 10:1 safety margin, as low as 4,144lbs/18.42 kN
- Aluminum non-locking climbing carabiners, as low as 2,200 lbs/9.78 kN
- The more exotic the shape of the carabiner, the more likely to sustain damage or fail
- On asymmetrical carabiners, the wide side experienced more issues than the narrow side

## **Other issues and failures**

- 9 Prusiks melted/destroyed
- One tree pulled out of ground at <4000lbs</li>
- 1 load releasing hitch melted at ~3000lbs
- Anchor strap damaged by abrasion on the anchor
- 1 screw link was damaged under normal usage

## Conclusion and Recommendations

- The basket hitch is as strong or stronger than the W3P2 when tied with an internal angle less than 45 degrees: avoid extreme angles!
- Use a rigging plate and/or multiple carabiners to avoid triaxial loading on a single carabiner
- If using an asymmetrical carabiner, position the smaller end of the carabiner on the anchor side and the wider end on the load side







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