Static Pull Strength and Reliability of the VT (6/1) Prusik Hitch

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Abstract

The purpose of this research is to test the strength and reliability of the VT Prusik Hitch (VT), specifically the 6/1 Asymmetric Prusik in rope-rigging and rescue applications. The VT Prusik is an eye-to-eye hitch cord constructed of an Aramid fiber sheath with a nylon core and is used to tie this Asymmetric Prusik. The focus of the testing process is to observe the performance of the VT in a static slow pull environment and attempt to replicate prior testing to gain insight on reliability.

Keywords: VT Prusik, 6/1, Max/1, Friction Hitches, Prusik,

Background

The VT Prusik is a friction hitch that is becoming a more prevalent choice for riggers and technicians in SAR, mountain rescue, and rope access communities, implemented in a max over one setting (commonly 6/1 on 11mm ropes). The hitch has numerous benefits, including durability, ease of tying/untying, and consistency in materials and performance. The purpose of this research is to test the strength and reliability of the VT Prusik Hitch (VT), specifically the 6/1 Asymmetric Prusik in rope-rigging and rescue applications.

The research performed is relevant to the rope using community in multiple cases. By adding to the limited data currently available on this product, we hope to bolster the reliability of conclusions people make regarding the use of the VT.

Working Definitions

VT Prusik (VT) All references herein to the "VT Prusik" or "VT" represents the 6/1 asymmetric Prusik seen in Figure 1, tied using the BlueWater Ropes VT Prusik.

Yielding is defined as the breaking or weakening of materials and equipment such that they no longer perform their intended function or breaking strength is diminished significantly.

Holding Force is defined as the maximum force (kN) a friction hitch holds before primary slippage occurs.

Figure 1. 6/1 Asymmetric VT Prusik on 11mm Rope

Figure 2. 3/3 Symmetric Prusik on 11mm Rope

Testing Phases Defined

Phase 1 New 11mm KMIII and new tied 8mm cord (3/3)
Phase 1.5 New 11mm HTP and new tied 8mm cord (3/3)
Phase 2 New 11mm KMIII and new VT Prusik
Phase2.5 New 11mm HTP and new VT Prusik
Phase 3 New 11mm KMIII and reused VT Prusiks from phase 2. Each VT tested 3 additional times on new sections of rope
Phase 3.5 Used 11mm KMIII and reused VT Prusiks from phase 2. Each VT tested 3 additional times on new sections of rope
Phase 4 New 11mm HTP and reused VT Prusiks from phase 2.5. Each VT tested 3 additional times on new sections of rope

Objectives

1. Compare baseline holding strength between the triple-wrap nylon Prusik on KMIII rope and on HTP Static rope.
2. Compare a base line slipping strength between the VT Prusik on KIII rope and on HTP Static rope.
3. Compare results with other existing data on the VT

Testing Methods

- In tests using tied loops of 8mm accessory cord, loops where cut, tied with a Double Fisherman's Bend, and preloaded with 100kg to set the bend.
- Hitches, knots, and bends were tied by the same person to minimize human variables.
- All testing phases used a Rock Exotica Enforcer loadcell set to fast sampling mode (500hz).
- Ropes where attached to the load cell using a Figure-eight on a bight. See Figure 3 for standard testing setup.
- Once hitches and knots were tied and dressed, the pull rig was loaded to 100kg to set knots and hitches before returning to zero tension. Host rope was then marked at starting point for Prusiks.
- Tests were halted once initial slippage was observed.
- Tension was brought down to zero before measuring slip distance.
- Raw data was extracted from Enforcer and analyzed in Microsoft Excel. See Results section for analysis.

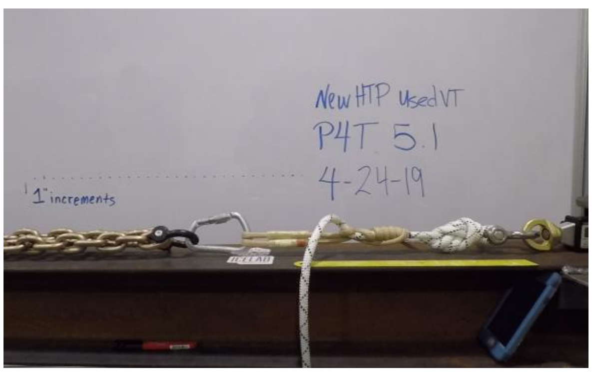


Figure 3. Standard Setup for Testing

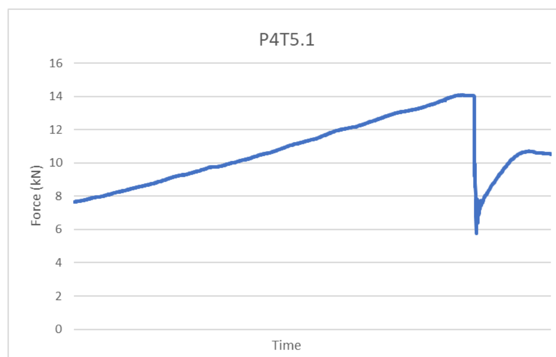


Figure 4. Example of Test Output

Variables

- Bluewater 8mm VT Prusik
- Sterling 8mm Nylon Accessory Cord
- New England KMIII Rope – 11mm new and used, polyester sheath, nylon core
- Sterling HTP Static Rope – 11mm new, polyester sheath, polyester core
- Slow pull testing (Approx. 42mm/sec) using a 9,500lb truck winch with the addition of a 4:1 mechanical advantage system. See Figures 5 and 6.

Figure 5. Static Pull Rig

Figure 6. Static Pull Rig

Results

	Sample Size	Mean Peak Force (kN)	Peak Force Range (kN)	Standard Deviation Peak Force (kN)	Slip Distance Range (cm)	Mean Slip Distance (cm)
VT Prusik	65	12.84	10.9-14.58	1.01	4.10-7.10	5.57
Nylon Prusik	29	11.34	8.71-14.09	1.51	3.60-9.80	6.93

Figure 7. Summary of Statistics

	Sample Size	Mean Peak Force (kN)	Peak Force Range (kN)	Standard Deviation Peak Force (kN)	Slip Distance Range (cm)	Mean Slip Distance (cm)
Phase 1	15	10.5	8.71-12.04	1.1	3.6-8.4	5.48
Phase 1.5	14	12.24	9.92-14.09	1.39	6.8-9.8	8.08
Phase 2	10	13.07	11.81-14.21	0.8	4.6-6.6	5.65
Phase 2.5	10	12.95	11.67-14.58	0.94	5.4-7	6.19
Phase 3	15	13.73	11.74-14.24	0.59	4.3-6.5	5.49
Phase 3.5	15	11.77	10.90-13.26	0.62	4.1-7.1	5.28
Phase 4	15	12.8	11.16-14.12	0.89	4.5-6.9	5.43

Figure 8. Statistics by Phase

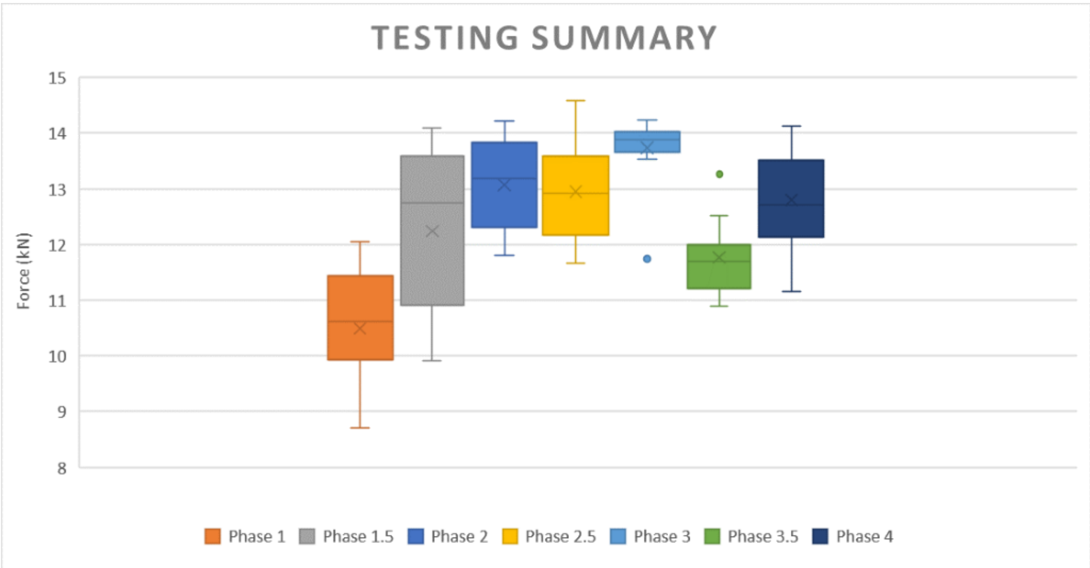
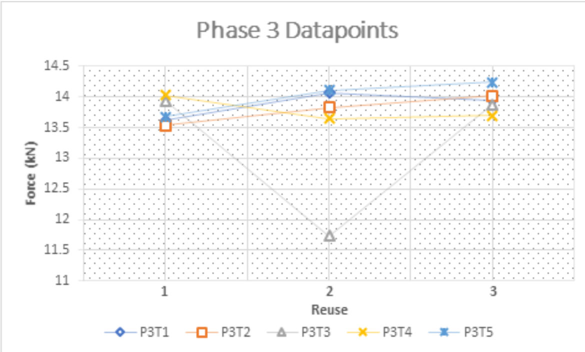
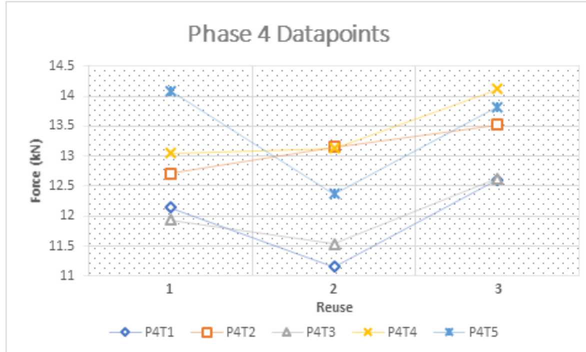


Figure 9. Box Plot Summary of Testing Data





Figures 10 and 11. Data points from re-use of VTs

Discussion

Material Variability (Nylon Prusiks)

There is a large range in performance of various nylon cords with standard 3 wrap Prusiks. This is seen with a mean of 11.34kN in this data set (figure 7 and 8), other testing on the same setup showed a slip at 9kN with Cypher cordage and testing from Gibbs showed 8.7kN using CMC sewn loops on various rope types. (Gibbs, 2014)

The diversity in materials and performance on the market today is something that needs to be accounted for and understood when selecting tools to implement in rigging.

Observations When Reusing VTs

When comparing Phase 2 and Phase 3 (Both on KMIII Rope) results using a Two-Sample T-test Assuming Unequal Variances and an Alpha of .05 we found that there was a statistically relevant difference in the means of our data sets (14.3% decrease when reusing Bluewater VTs). There was not a relevant difference when the same analysis was done with phases using HTP static. Further, this decrease did not appear to continue during successive tests which supports an observation of a break-in period for the Bluewater VT and a plateau in performance during our testing: See Figure 10 and 11.

Slip-Force

Means and ranges from testing showed similar results when comparing data done by Rigging for Rescue in 2014. RFRs summary stats showed a range of 7.2-14.5kN and a mean of 11.4kN. (Gibbs, 2014) This dataset shows fewer slips on the lower end of this range with a range of 10.9-14.58kN and a mean of 12.84kN. It is worth noting that host ropes used in this testing varied from ropes used in Gibbs testing.

Breakability

After conducting tests where 2kN was subjected to the 6/1 VT, then broken manually, the VT was very tight, and sometimes required great manual force, but the user was able to release tension from the system in most instances. This breakability is not seen after larger cyclical loading events or dynamic events such as a mainline failure. This breakability is more reliable in static loading events under 1.5kN however the breakability of the VT still greatly outperforms that of a standard 3 wrap Prusik.

Final Words

The testing supports the applicability of the VT to hold rescue loads as a progress capture, and rope grab in a static environment; however, more research should be done on varying environmental conditions and its performance when interfaced with decent control devices in a range of configurations to continue to analyze the VT's applicability.

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