Break testing of the Alpine Butterfly Knot

done by: Andy Schmitz, April of 2015

Thesis:

Due to the asymmetry of the Alpine Butterfly Knot, one leg, or "side", of the knot will have a higher breaking strength than the other leg.

Conclusion:

The thesis is disproved. There is no difference in strength between sides of an Alpine Butterfly Knot. The knot is symmetrical in terms of strength, but slightly asymmetrical in terms of geometry.

Method:

28 pieces of 3/16" Barry Cordage "luff line" black (product #LLP0604) were cut from a used piece of line. Randomly selected pieces were tied with either a left hand loaded, or right hand loaded Alpine Butterfly Knot. The other end of each sample line was tied with a Figure of 8 Loop, generally known to be stronger than the Alpine Butterfly. All knots were tied, dressed, and set by the same person. Each sample was attached to a break testing rig. Each Butterfly knot was anchored to ¼" diameter quick link. Each Figure of 8 Knot was tied to a 7/16" diameter carabiner. One end of each sample was anchored, and the other end was pulled using a 3Ton lever type chain puller, anchored to a Dillon 10,000 lbs mechanical (dial type) dynamometer. Each sample was pulled to breaking, and the peak load on the dynamometer recorded. It was additionally noted as to where in the sample the breaking occurred.

Summary of Findings:

Average Breaking Strength of "Left-hand" loaded knot:	926.7 lbs
Average Breaking Strength of "Right-hand" loaded knot:	926.4 lbs
Difference between Left and Right hand averages:	**.238 lbs**
Breaking strength of un-knotted line (provided by Barry Cordage):	1080 lbs
"Left-handed" Alpine Butterfly breaking efficiency:	85.80%
"Right-handed" Alpine Butterfly breaking efficiency:	85.78%
Difference between Left and Right hand breaking efficiencies:	**0.02%**
Lowest breaking load:	815 lbs
Lowest breaking efficiency:	75.46%
Highest breaking load:	1080 lbs
Highest breaking efficiency (see note below)	100%
Range of breaking loads:	265 lbs
Range of breaking loads as % efficiency	24.54%

Sources of error:

1. The breaking strength of 1080 lbs for this line, a figure supplied by Barrry Cordage, yields surprising breaking efficiencies for the Alpine Butterfly Knot. (ie, one sample broke at 100% breaking efficiency, a surprising, and suspect result!) I find the 1080lbs breaking strength suspicious, perhaps there is some error in the figures provided by Barry. I intend to confirm the breaking strength of this line with another series of break testing. In the mean time, I have decided to provide these preliminary results. Regardless of the accuracy of the braking efficiency figures, the difference in average breaking strength between the left and right hand loading in this test is **less than one pound**. Whatever the true breaking strength of the line is, the difference in breaking strength between sides of the knot will remain very small.

2. The testing line was not new, it was previously used, exposed to various and dynamic loading. Sorry, but I can't afford to break test new rope! By randomly selecting which of the cut samples would be tied in each "handedness" I tried to mitigate any uneven wear and loading that may have occurred in the sample rope.

3. The Dynamometer measuring the load has an accuracy of plus or minus 0.5% of full scale capacity. For this 10,000lbs capacity dyno used in the testing, that margin is plus or minus 50lbs. Additionally, for this 10,000lb capacity model, the lowest graduation on the dial is 100 lbs. I estimate that reading the needle on the dial is only accurate to about 20lbs.

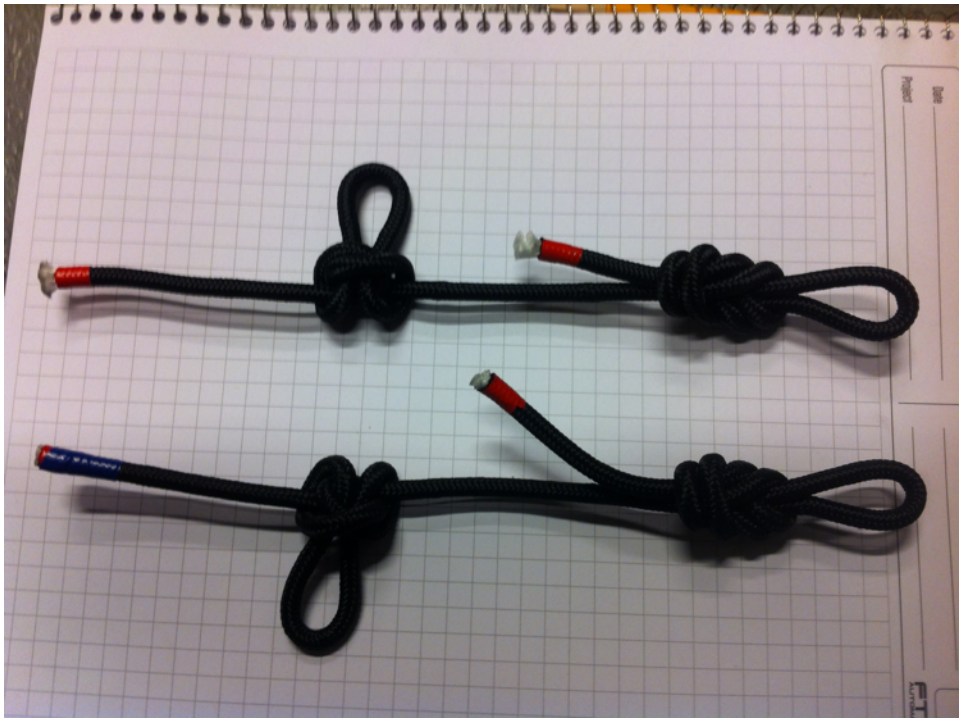
4. The method of breaking does not comply with the recommended standard for determining the tensile strength in rope. Ideally the anchoring of the line should be done with multiple wraps around a large diameter capstan, which approaches 100% breaking efficiency. Also, the rate of increase in tension is generally precisely controlled, as with a computer controlled hydraulic device.

Despite the admitted sources of error in this testing method, I'm confident that the conclusion of this experiment is accurate: The strength of the Alpine Butterfly Knot is symmetrical.

Data:

date	sample	left or right	breaking load	where it broke
5/24/2015	1	Right	900	entrance to butterfly knot
5/24/2015	2	Left	900	entrance to butterfly knot
5/24/2015	3	Right	1005	entrance to butterfly knot
5/24/2015	4	Left	1070	entrance to butterfly knot
5/24/2015	5	Right	1000	entrance to butterfly knot
5/24/2015	6	Left	880	under collar of butterfly knot
5/24/2015	7	Left	815	under collar of butterfly knot
5/24/2015	8	Right	990	entrance to butterfly knot
5/24/2015	9	Right	890	entrance to butterfly knot
5/24/2015	10	Left	875	under collar of butterfly knot
5/24/2015	11	Right	860	under collar of butterfly knot
5/24/2015	12	Right	985	entrance to butterfly knot
5/24/2015	13	Left	990	inside figure 8 knot
5/24/2015	14	Left	985	under collar of butterfly knot
5/24/2015	15	Left	1000	inside figure 8 knot
5/24/2015	16	Left	995	entrance to butterfly knot
5/25/2015	17	Right	950	entrance to butterfly knot
5/25/2015	18	Left	880	under collar of butterfly knot
5/25/2015	19	Left	1050	under collar of butterfly knot
5/25/2015	20	Right	1080	under collar of butterfly knot
5/25/2015	21	Right	890	entrance to butterfly knot
5/25/2015	22	Left	850	entrance to butterfly knot
5/25/2015	23	Left	820	under collar of butterfly knot
5/25/2015	24	Left	1000	under collar of butterfly knot
5/25/2015	25	Right	840	entrance to butterfly knot
5/25/2015	26	Right	840	entrance to butterfly knot
5/25/2015	27	Right	860	entrance to butterfly knot
5/25/2015	28	Right	880	entrance to butterfly knot

Photos:

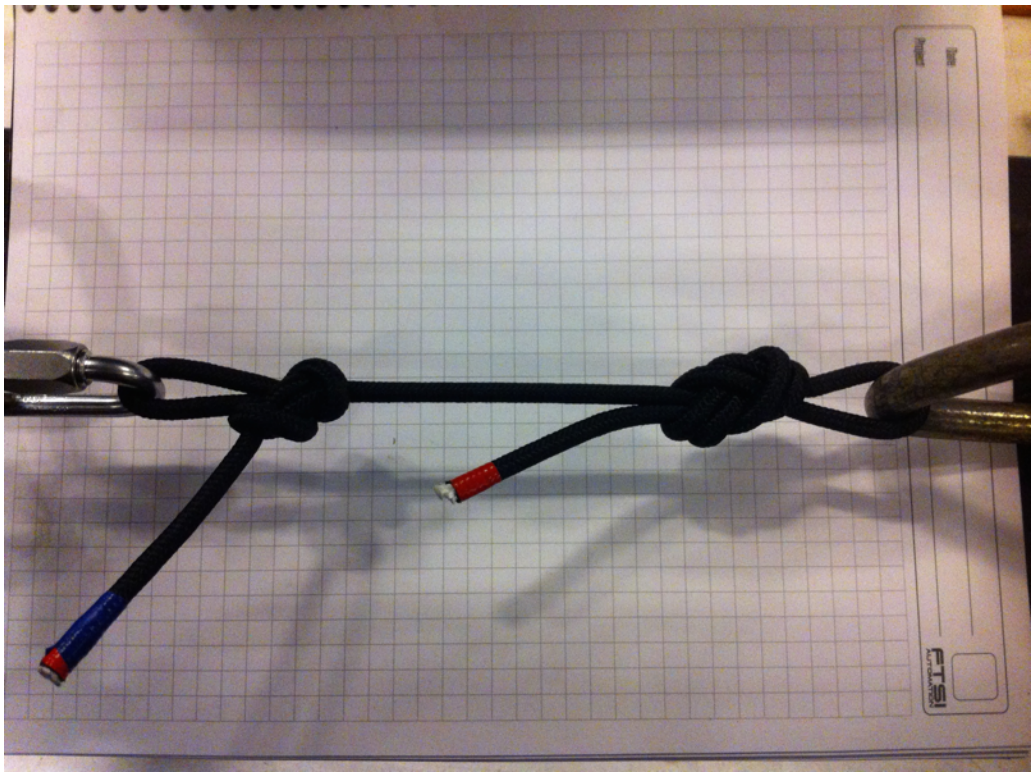


Typical breaking samples, top is right handed, bottom is left handed.

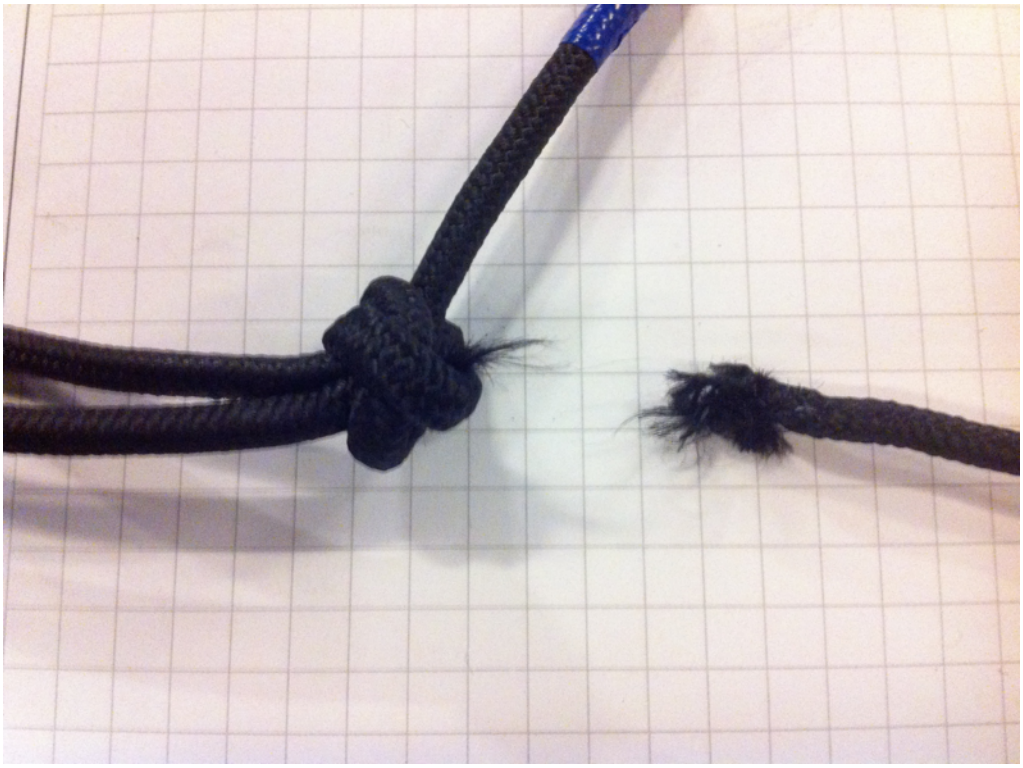
Left handed butterfly on Left, Right handed Butterfly on Right (top of picture is standing end)

front and back views of Right handed Butterfly (top of picture is standing end)

front and back views of Left handed Butterfly (top of picture is standing end)



typical sample attached to breaking rig



typical example of line breaking where the line enters the body of the knot

method of applying and measuring load

the dynamometer, the red needle shows peak load