The Mountaineers
Leadership Conference 2017

Knots 101

Lunchtime mini-session

What Will You Learn?

1. Knot Terminology
2. General Knot Information
3. Does Dressing Knots Matter?
4. Tail Lengths
5. Climbing Knots and Their Effect on Breaking Strength
6. Rappel Knots

1. Knot Terminology

Knot vs. Hitch vs. Bend
We've all heard terms like hitch or bend thrown around, but how are those different from a knot?

- **Knot** – a knot is tied in a rope or piece of webbing.
- **Hitch** – a hitch connects a rope to another object like a carabiner or even another rope.
- **Bend** – a bend is a knot that joins two ropes together.

What other terms should you know for this session?

- **Bight** – a bight is a section of rope between the ends.
- **Standing end** – the standing end or part of the rope is the side that's not being used during knot tying.
- **Working end** – the working end or part of the rope is the side that is being used during knot tying.
- **Dressing** - Knot dressing is the process of arranging a knot in such a way as to improve its performance. Crossing or uncrossing the rope in a specific way, depending on the knot, can increase the knot's strength as well as reduce its jamming potential.
- **Setting** - The process of tightening it. Improper setting can cause certain knots to underperform. Setting the knot is part of dressing the knot.

2. General Knot Information

Relative knot strength, also called knot efficiency, is the breaking strength of a knotted rope in proportion to the breaking strength of the rope without the knot.

- Any knot tied in a rope creates a weak point. In most drop and pull tests, a rope will break at a knot.
- Repeated, dynamic loads can cause virtually every knot to fail.

- The efficiency of common knots ranges between 40—80% of the rope's original strength.
- For climbing specific knots, the efficiency range is typically between 60-80%.

Modern climbing ropes have a tensile strength of upwards of 6,000 pounds. The strength and elasticity of climbing ropes makes it virtually impossible to generate enough force to cause knot failure in real life scenarios.

Even if a rope does not break, a knot may still fail to hold. Repeated, dynamic loads can cause virtually every knot to fail.

The main ways knots fail to hold are:

Slipping

Example: A short tail on a double fisherman slowly shortens due to repeated strain and slack, causing the knot to fail.

Capsizing/Rolling

Example: A flat figure 8 bend used to join two ropes can roll, causing the ropes to come apart. This knot should never be used to rappel.

Sliding

Example: A 7mm Prusik being used on an 8mm rope may slide due to a lack of friction.

3. Does Dressing a Knot Matter?

There are many advantages to a properly dressed knot.

- Proper knot identification - A well dressed knot allows you to confidently identify that the correct knot is being used.
- Easier to untie - Properly dressed knots are easier to untie, especially after being loaded heavily.
- Strength - Any knot weakens a system. A system failure is typically going to be at the knot. A properly dressed knot more evenly distributes forces, keeping it stronger. Reduction in strength is about 10%, so not significant to cause failure, but still important.

4. Tail Lengths

The length of tail on knots can be a matter of life and death. Knowing the proper tail length of a knot is very important.

As a general rule, a longer knot tail is preferred to a short one. When in doubt, make your tail a bit longer than you think you might need. There are exceptions to this, but this rule of thumb will keep you safe.

- Figure 8 (all types except Flemish Bend) - 6 inches

- Figure 8 Bend (Flemish Bend) - 18 inches
- Double Fisherman - 18 inches (rappelling) or 3 inches (accessory cord for anchors)
- Bowline - 12-18 inches
- Barrel - 18 inches
- Stopper - 18 inches
- Overhand Bend - 12-18 inches
- Water Knot - 3 inches
- Clove - 18 inches

5. Climbing Knots and Their Effect on Breaking Strength

Rope strength after tying a knot in the system:

- No Knot 100%
- Double Fisherman's 65-70%
- Bowline 70-75%
- Water Knot 60-70%
- Figure 8 (on harness) 75-80%
- Clove Hitch 60-65%
- Fisherman's 60-65%
- Overhand 60-65%
- Butterfly 70-75%

6. Rappel Knots

There are many opinions out there regarding what type of knots should be used during a rappel. We will focus primarily on how to join two ropes together safely, using a bend.

What bends are safe to use for a double rope rappel?
For the purposes of this seminar, there are 3 bends that can safely be used to rappel on two joined ropes.

- **Flat Overhand Bend**
- **Double-Fisherman's Bend**
- **Flemish Bend**

Knot/Bend	Pros	Cons
Flat Overhand Bend	Low profile, efficient, easy to untie	Weakest rappel knot
Double-Fisherman's Bend	Strong	Bulky, inefficient to tie, hard to untie
Flemish Bend	Strong, easy to untie	Bulky, inefficient to tie

Avoid the Flat Figure 8 Bend. This knot is known to cause a catastrophic knot failure.

So which bend is best for joining two ropes?
There are pros and cons to each of the three bends, and you may find it advantageous to use one over another, depending on circumstances. The best all-around bend to join two ropes for a rappel is the ***Overhand Bend***.

Why the overhand bend?

- Unlike many other bends, the flat overhand bend is low-profile, meaning it won't get stuck as easily.
- The flat overhand bend is easy to tie, easy to untie, saving significant time.
- Tests have shown the flat overhand bend to be more than strong enough for rappelling
- With proper tail length, and an optional backup knot, the flat overhand bend is not prone to rolling to the point of failure, unlike the double figure 8.

What should you consider when using this bend?

- This bend must be well-dressed and pre-tensioned to work properly
- Must have sufficient tail (at least 1 to 1.5 feet, but be wary or more as it can be another thing to get stuck). This tail allows the knot to roll without failing.
- Don't use for tying webbing, cordelette, sling anchors. Use water knot or double-fisherman.

Can I use this bend on ropes of different diameters?
Yes. A recent Black Diamond test showed a flat overhand bend to be sufficiently strong with ropes of varying sizes.

Rope failure under load: **Average Knot Strength (lbf)**

Rope Combination	Double Fisherman's	Flat Overhand Bend
10.2mm / 10.2mm	6630	4950
10.2mm / 8.1mm	3730	3100
8.1mm / 8.1mm	4064	2850

Source: https://www.blackdiamondequipment.com/en_US/qc-lab-what-is-the-best-rappel-knot.html