PA3DJS

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Hedden Autoblock Hybrid friction hitch (HAH-hitch)

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Additional disclaimer

Climbing, lifting, working at height and related activities are dangerous. Friction hitches don't have anti-panic features that are present on several mechanical devices. The use of friction hitches may be prohibited or discouraged in your industry sector, or community.

Good operation of friction hitches depends on many factors, not limited to; hitch type, weather conditions, rope/cord thickness, rope/cord construction and tightness of the hitch. You should be well trained/instructed before using friction hitches in situations where expected and unexpected behavior can lead to loss or damage. You need to be your own devil's advocate. The information shown in this document is not a substitute for good training.

Wim Telkamp, PA3DJS

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1. Introduction

This document discusses a combination of a Hedden and Autoblock Friction Hitch to create a friction hitch where each turn consists of two cord sections. It has to work well with standard Nylon (PA) or Polyester (PES) accessory cord (to Std. EN 564).,

The load is distributed across 4 cord sections, throughout the friction hitch. Therefore thin more flexible accessory cord can be used.

It uses the same retrace technique as used for the single cord Distel-Offset hitch to create the eyes for the carabiner.

The reason for this friction hitch is that the double cord Distel-Offset hitches do not perform as expected.

The goal of the document is to encourage experimenting with friction hitches. Testing must be part of experimenting, as lot of things can go wrong. The focus is on climbing use of friction hitches.

1.1. Friction hitches in general

Friction hitches can be used for many purposes:

- temporary or permanent connection to rope and solid objects
- means of adjustment in work positioning lines
- binding things together, similar to using cable ties.
- anchor points during climbing on solid objects (choking anchors)
- ascending/descending aid (with a foot loop, or foot/hand ascender)
- rigging for lifting loads

A friction hitch enables to connect a cord to the main rope without tying a knot in the main rope. The cord can be the main rope itself to form an adjustable loop (for example Blake's Hitch). These hitches are not discussed here.

When the cord is not loaded, the friction hitch can be moved along the main rope. Once loaded, the hitch can't be moved in most cases (it is "locked" onto the main rope, or "grabbed" the main rope). When the load is removed, or sufficiently reduced, the hitch can be released and moved to another position on the main rope.

> In this document "**Rope**" is used for the main rope, "**Cord**" is used for the rope that you use to tie the friction hitch. In most cases the "cord" is called accessory cord, prusik/prussik cord, cordelette, reepschnur, or hitch cord. All are designed for climbing applications.

Lock and release behavior is less important for static applications. As long as it holds when locked onto the rope, and it is not too difficult to release. Nearly every friction hitch works in that case, as long as it has sufficient turns and doesn't slide down when the load is (temporary) removed.

There are applications that require frequent locking, releasing and moving. There is a tradeoff between locking, releasing and no-load friction. You can't have all three at the same time. A hitch that moves very easy after release may not lock when it should, and that can be really dangerous.

For some applications backlash is also of importance. During the transition from unlocked state to locked state, part of the hitch moves in the direction of the load. This effect is called backlash, or sit back.

1.2. Locking and holding power

A friction hitch must grab the line when it should. Whether or not a hitch grabs depends on many factors. Important factors are:

- Hitch cord over (climbing) rope diameter ratio (large ratio increases risk of not locking)
- Surface finish of rope and hitch cord (affects friction, especially glazing can be dangerous)
- flexibility (knotability) of the hitch cord (the more flexible, the better it locks)
- tightness of the hitch (improves locking, but also increases no-load friction and may increase holding power)
- Wet or dry rope (as this affects friction)
- Rope diameter variation of (climbing) rope (for example due to sheath slippage or heavy load onto the rope below the hitch)
- of course the type of friction hitch,
- number of top turns (more turns improve locking due to higher friction)

Locking is not the same as holding power. A hitch may lock (that is grab the rope). However, when increasing the load, it may (temporary) slip at some load. Slippage limits the holding power of the hitch. Slipping may occur at relative small load, and when it doesn't stop, Nylon or Polyester accessory cord will melt. Factors affecting holding power:

- Insufficient top turns,
- using relative large hitch cord over rope diameter ratio (increases slippage),
- using double cord for the hitch (larger advance per turn gives higher slippage risk),
- rope or hitch cord is contaminated with a greasy substance.
- The hitch is loose, resulting in deformation of the turns pattern
- Excessive cord stretch, resulting in deformation of the turns pattern (Polyester stretches less compared to Nylon (Polyamide))
- Glazing of the surface of the hitch/prusik cord (reduces friction).

Slipping is not always problematic. It should happen well beyond the intended load, and it should not result in fusion between rope and cord fibers (due to melting. It will only slip shortly in case of an unforeseen shock load. When it slips, it reduces the peak load.

Several institutions dynamically tested friction hitches according to EN 353-2 (Guided Type Fall Arresters). Peak arresting force shows significant variation. The peak force can be well below but can also be well above 6 kN. It all depends on; the type / diameter of climbing rope, type of hitch, number of turns and type / diameter of hitch cord (here accessory cord).

What will happen with the friction when some dust from drilling accumulates on your climbing rope?

> Your operation should never rely on friction hitch slippage to reduce shock load, as the weight where slippage occurs shows large variation.

1.3. Long term effects, locking and holding power

There are some things that may affect both locking and holding power. These effects occur when a friction hitch is used several times, without retying the hitch.

- Change of cross section of the cord.
- Glazing of the surface of the cord that is in contact with the rope.

Change of cross section
The first effect occurs relatively fast. Initially a cord or rope has circular cross section. However when you wrap it around an object, its cross section becomes more or less oval. This is shown in figure 1.1A.

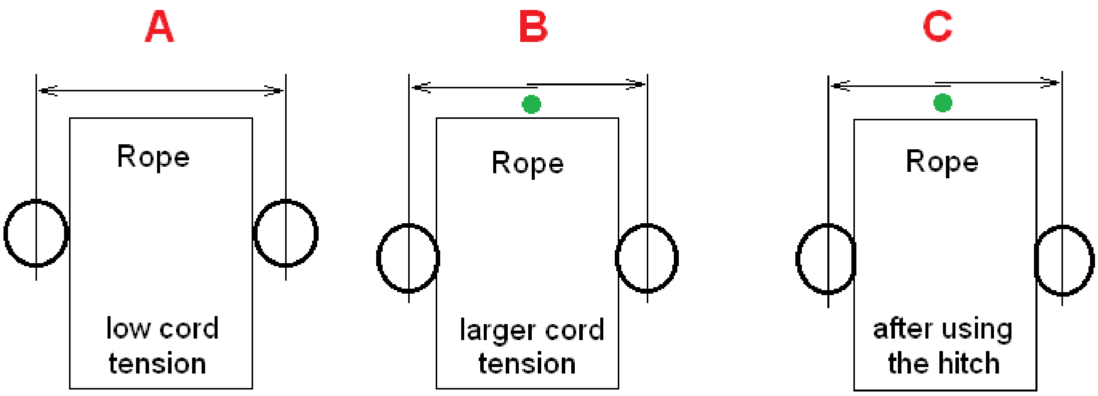

Figure 1.1; Change of cross section of prusik cord

When you wrap it more tightly (or load a friction hitch) the cord's cross section becomes more oval, and it bites somewhat into the rope. This is shown in figure 1.1B. The average cord diameter reduces as can be seen at the overlapping ends of the arrows at the green dot. Thin rope protrudes into the rope relatively better, as its contact pressure is higher. This increases the friction due to the deformation of the rope at the contact area. It is one of the reasons that friction hitches out of thin rope grab and hold better. It is also said they "bite" better.

After some use of a friction hitch, the cross section becomes even more oval, so the average diameter reduces further. This can be seen above the green dot in figure 1.1C. Smaller diameter creates excess cord (slack) inside the hitch.

The cord area that is in contact with the rope flattens, see figure 1.1C. You can see this when untying a friction hitch out of regular accessory cord. A flat surface bites less into the rope so has less friction.

> Both effects (flattening of the contact surface and average diameter reduction) reduce locking behavior, and reduce holding power of a friction hitch.

Glazing of the cord surface
After some use, especially when the hitch slips (can be on purpose), there will be plastic (permanent) deformation in the cord fibers, due to heat. The cord fibers that make contact with the rope will stick to each other and deform forming a compact surface that may be even somewhat glossy. This effect is called glazing.

A glazed cord surface has lower friction coefficient towards the rope. This will negatively affect locking, and reduces the holding power. When the holding power reduces below the rated load, the hitch will slide and keeps sliding.

Polymer cord (such as PA (Nylon) or PES (Polyester)) will melt completely. This can be fatal in case of human load. Cord with an Aramid sheath (Kevlar, Technora, etc) will not glaze as aramids don't melt, but just disintegrate (blacken, carbonize) like many natural fibers. Disintegration of Aramids happens at a temperature where all polymer rope is molten completely. That is why Aramid hitch cords are used by arborists.

Friction of Aramid sheathed cord may reduce when rope fibers from the Nylon (PA) climbing rope transfer to the cord and creep into the space between the Aramid fibers.

Conclusion regarding long term effects
Hitches that use a double rope (loop) such as the Autoblock hitch (Marchad hitch) are more friendly to the climbing rope, but have less holding power given the same number of turns.

In the beginning, a friction hitch may lock very well and has good holding power. Holding power can be checked by jumping onto a foot loop that is connected to the hitch. Breaking the hitch under load and see how it slides may give you an idea of its holding power due to further flattening of the cord and deformation/reorientation of turns.

After using the hitch for certain time, locking may be less reliable and holding power may reduce over time. This is potentially dangerous as you may not notice this. Deformation of cord cross section goes relatively fast, however glazing may occur slower, depending on the use of the hitch. Making many short descents may give you a good idea about the influence of glazing when using PA or PES cord.

It is therefore recommended to experiment with the rope-cord combination you want to use. Holding power can more then halve referenced to the initial holding power just after tying. Test your hitches close to the ground so that you can handle unexpected hitch behavior. See chapter 6 for testing your hitches.

1.4. *Improving locking using lateral force*

Easiest way to improve locking is to force the cord turns onto the rope by having a tight hitch. The downside of a very tight hitch is that it moves difficult when not loaded. This is acceptable for several applications (think of rigging). For applications where the hitch has to be repositioned frequently, this is at least annoying.

There is another way to improve the locking behavior (not holding power) of a friction hitch without increasing its no-load friction: having the load bearing strands offset from the rope so that a diagonal cord section appears. This introduces lateral forces in the top turns. When a small force (F_{load}) is applied, additional friction appears proportionally. This helps locking of the hitch.

The effect of offset is shown in figure 1.3.

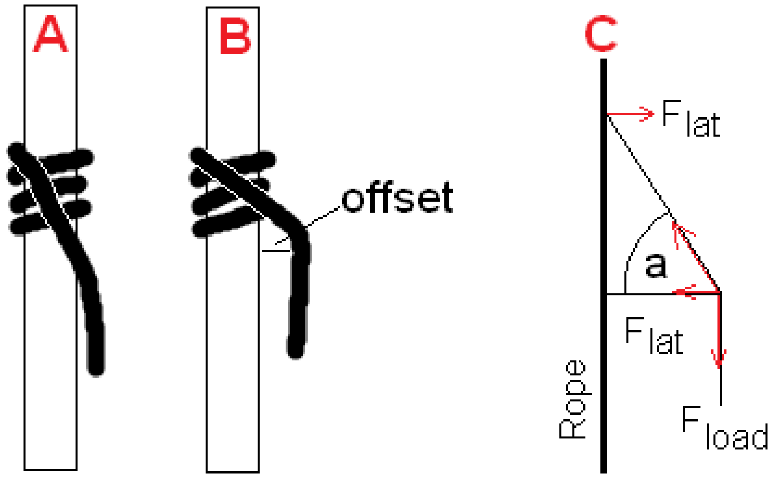

Figure 1.3; Relation between Lateral force and offset

There is always some friction between the hitch cord and the rope. That must be there to avoid that a friction hitch slides down due to its own weight (yes, this can happen with a loose hitch, or stiff accessory cord in combination with climbing rope with greasy contamination on it, or climbing rope that is loaded below the hitch).

Due to hitch cord and rope thickness, F_{load} does not work pure vertically on the turns. This is shown in figure 1.3A. When F_{load} starts to increase, two opposing lateral forces are generated. This is shown in figure 1.3C. The load bearing strand is pulled to the left, and the cord section that comes from the top turn is pulled to the right. These sideways acting forces add friction to the already present rope to hitch cord friction. This additional friction should avoid that the turns slide down along the rope during constricting of the turns that happens when F_{load} is applied.

With certain pretention in the turns, rope and hitch cord combination, increase of friction force due to F_{lat}, may not be sufficient to counteract F_{load}. If so, the hitch doesn't lock and slides down. This risk increases when using relative stiff / bouncy accessory cord.

When F_{load} gets additional offset, angle "a" reduces, see figure 1.3B. This increases the lateral force (F_{lat}) due to F_{load}. Larger F_{lat}, gives more friction between the rope and the hitch cord. This reduces the risk of not locking.

1.5. Taking in or giving out cord

During its use, a friction hitch may take in some cord. This means that there will be more cord in the hitch, resulting in loosening of the turns. This reduces the static friction, thereby increasing the risk of not locking and/or slipping at certain load.

When there is slack inside the hitch, the hitch may still lock when having very flexible cord. It may however slip under load as the advance of the turns increases with more slack and/or turns may slide over each other. So just checking a hitch by checking whether it grabs/locks is <u>not</u> sufficient.

Whether a hitch takes in cord, or gives out cord depends on many factors and on how you use the hitch. Giving out cord causes the hitch to release or move more difficult, but that is better then a hitch that slides/slips, or doesn't lock at all.

The single cord Distel-Offset friction hitch tends to take in cord. The Hedden-Autoblock Hybrid friction hitch tends to give out cord, but not to a level that the hitch binds to the rope. The HAH-hitch is therefore more forgiving.

1.6. Rope diameter change and locking

The diameter of (climbing) rope, as mentioned on the label, is measured with certain tension in the rope. Ropes for climbing are measured with a 10 kg load on a new, unused rope. Other specification uses a preload of a certain percentage of the breaking strength.

Without any load it is thicker. With your body weight the diameter reduces below the size on the label.

When using a part of your rope frequently, especially with friction hitches, the sheath may move a bit (milking) and that reduces the diameter further, and increases the no-load diameter where the sheath accumulates. Fiber compaction at frequently used sections also reduces the diameter. A 1..1.5 mm diameter change is not uncommon. That means you can have a slack of 3..4.5 mm per turn of hitch cord that is around the rope.

When a rope bears heavy load, its surface changes, as fibers in the braid become more compact (air is squeezed out). This changes the friction (especially on new rope), thereby increasing the risk of sliding down under its own weight.

Figure 1.4 shows what can happen.

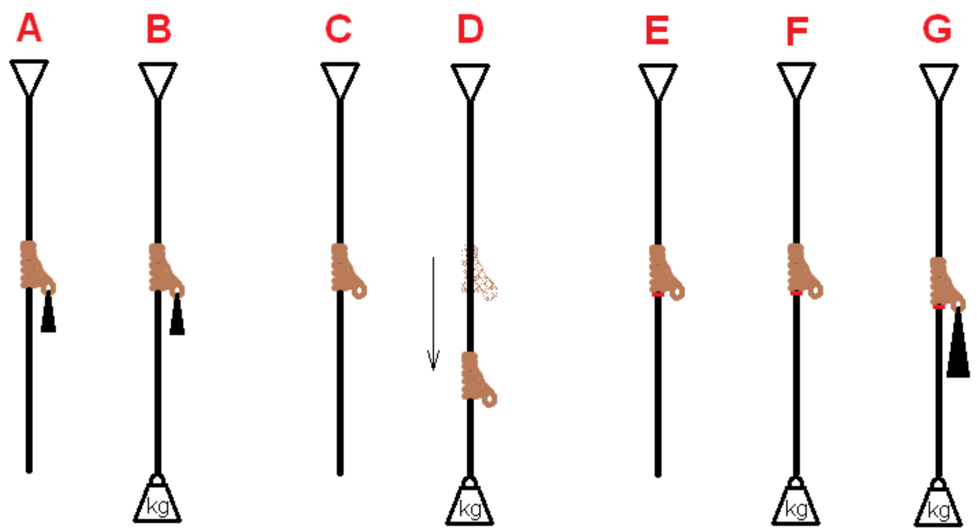

Figure 1.4; sliding of a hitch due to rope diameter change

The A-figure shows a hitch with a small weight, so that it is locked. That weight can be one or two steel carabiners. The weight (force) to move the hitch up or down is well below the weight of the small weight, so you know it is locked. The rope is moved a lot, so that there is no stress in the rope from previous loading.

In the B-figure the rope is loaded (for example with your weight). It becomes 1 mm thinner and nothing happens (the hitch may slide a few cm). The hitch remains locked due to the small weight. The more flexible the cord, the less weight is required to keep it locked during a reduction of diameter.

The C-figure shows a hitch without any load that moves relatively easy along the rope. It doesn't slide down due to its own weight. The eyes are not loaded, so that it is in its unlocked state.

Now in the D-figure weight is added to the rope, the diameter reduces, and the hitch slides down due to its own weight! The D-situation is easy to replicate with both dynamic rope and semi-static (low stretch) rope with hitches using regular accessory cord. When you remove the weight, the sliding stops.

When there would be some load, but not sufficient to lock the hitch in the beginning, the hitch will slide down, but may likely lock at some irregularity in the rope.

The hitch will also lock when you pull it down with a speed higher then the own weight slide speed. In all cases, a sliding hitch is not what you want. You cannot use such a hitch as a backup or other serious application where near zero shock load is required.

Avoiding unintentional sliding of the hitch

You need certain friction; otherwise you can't get force in the diagonal rope section that goes to the top turn (figure 1.3C). Some force in that section is required to start the constriction process of the cord turns that provides the friction to carry the load. The more flexible the cord, the less force is required to start the constriction process.

There is a way to solve the unintentional sliding problem. Make sure to have some cord to rope friction that is independent of the rope diameter.

From experimentation, the added friction force is most effective when it acts about halfway the number of top turns. The position is not very critical, one turn above or below is fully acceptable.

The provision providing the friction may slip between the rope and the top turns and that is not desired. Second best is to have the friction below the hitch, so that the bottom turn doesn't slide down. It does work, but isn't optimal compared to adding friction in the top turns. That means you need more friction.

The E-figure shows the situation. The friction can be made using elastic cord (shock cord), shown in red.

In the F-figure the rope is loaded, the diameter reduces, but nothing happens. The non-diameter dependent friction avoids that the hitch slides down.

The G-figure shows the situation when a weight is added slowly. The hitch may slide a few cm, but then it locks. Moving slowly takes out acceleration forces that help locking.

When you move the hitch up and down with the eyes, it won't slide down, only up (in case of a self-tending hitch).

Experimentation showed that the friction can be added about halfway the top turns using the "shock cord friction loop". The advantage is that it doesn't interfere with tending devices below the hitch, and the hinge function of the lower part of the hitch is not negatively affected. See chapter 4 for practical implementation.

Hoisting with a friction hitch in the top

Non-locking of a hitch may also happen in a hoisting situation, or when pulling your own weight in a climbing situation. The hoisting example is shown in figure 1.5.

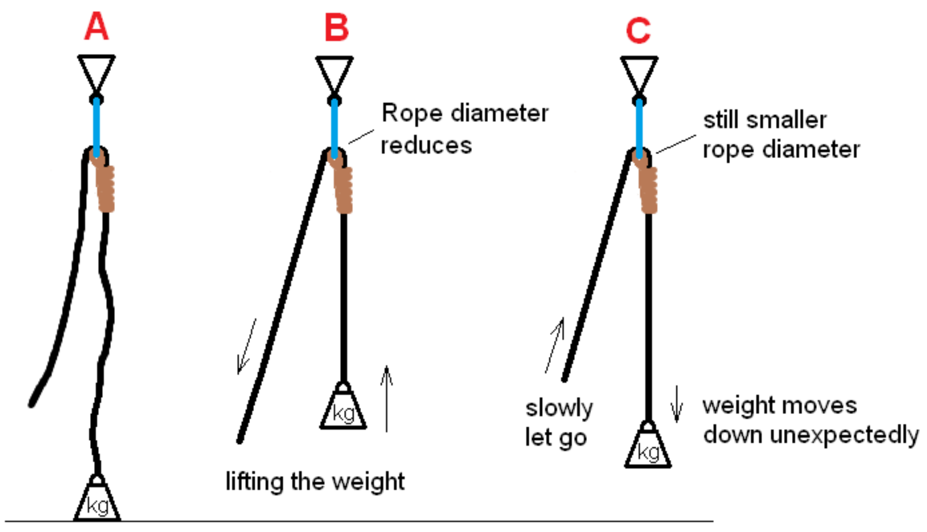

Figure 1.5; non-locking of hitch during hoisting

The situation in the A-figure may not be a favorite one, but it may be useful, especially in climbing. Instead of a self-locking pulley a (blue) carabiner is used with a friction hitch upside down. Several friction hitches tend well without the need of additional tending. This comes with a risk.

In the A-figure both rope sections are unloaded. In the B-figure the weight is raised. Both rope section are now loaded, hence the diameter of both rope sections reduce.

When you slowly let go (C-figure), the tension remains in the rope section, hence their diameter remains small, compared to the A-figure situation. The hitch may not lock resulting in unintended lowering of the weight. The small bend radius of the rope inside the carabiner flattens the rope’s cross section, resulting in higher change of locking. Experimentation shows that rope flattening is not always sufficient. The hitch may not lock, and that is an undesired situation.

Adding friction or additional tending (elastic/shock cord) may be required to assure good locking. In a climbing situation dynamic rope may be used for lanyard applications. Due to the intended large elongation of dynamic ropes, their diameter will also reduce significantly, resulting in larger risk of non-locking.

2. The Hedden-Autoblock Hybrid Friction Hitch

2.1. Introduction

The Hedden-Autoblock Hybrid Friction Hitch is a “mix” between the Hedden friction hitch and the Autoblock friction hitch. Eyes (for the carabiner) are made by retracing the cord ends back into the Hedden hitch.

2.1.1. The Autoblock Friction Hitch (French Prusik)

The Autoblock Friction Hitch is a well-known hitch. It is frequently used as backup hitch during rappelling (descending, abseil). It is also used in rigging applications to connect a pulley to a rope (use 6 or more turns). It is shown in figure 2.1.

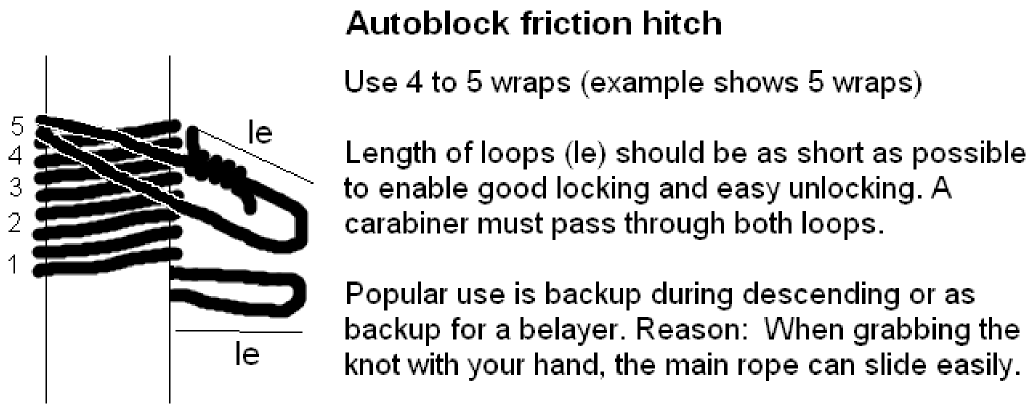

Figure 2.1; Autoblock Friction Hitch (French Prusik)

The force is reasonably distributed along 4 rope strands giving it a construction strength of about 200% of cord MBS when using a double fisherman’s bend to make the loop. There are virtually no high stress points along the cord and rope, reducing cord and rope wear. As the force is transferred over relative large surface area, it is a strong friction hitch.

The force distribution is also a disadvantage; the contact pressure between the cord and the rope is less, reducing friction. This together with the larger turns advance increases the risk of slipping. When it needs to carry full body weight, you need more double turns, 5 is not sufficient.

The hitch releases well as all 4 strands fully unload when removing the load.

2.1.2. The Hedden Friction Hitch (Hedden knot)

This is not a well-known hitch. It is more or less a wrong, or upside-down tied Klemheist hitch. It is shown in figure 2.2. The C-figure version is the standard version, but it can be tied as in the B-figure.

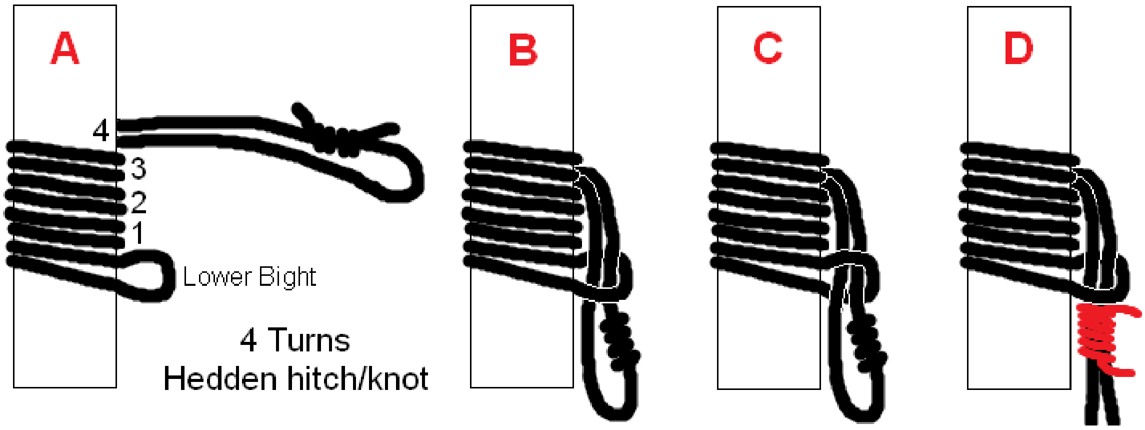

Figure 2.2; Hedden Friction Hitch

It locks surprisingly well with very good holding power, despite being a double turn hitch. Constriction is strongest in the top turns. The bottom double turn exerts the lowest constriction force onto the rope.

It is mostly used as a rigging hitch for creating anchor points on a rope, but it can be used as a progress capture device (rope grab function) as shown in figure 2.3. Tending goes via the thin white cord that connects to shock cord. It is not the best solution, but it does work.

Figure 2.3; Hedden Friction Hitch as progress capture device

The load force is on two cord sections, so its construction strength is in the range of 100% of cord MBS (assuming 50% knot efficiency). Once loaded, you can't "break" it. This is opposite to the Autoblock hitch.

2.2. The Hedden-Autoblock Hybrid Friction Hitch

The Hedden-Autoblock Hybrid Friction Hitch combines these two hitches. The geometry of the hitch is shown in figure 2.4.

Paragraph 2.5 shows a slightly different version that can be tied using a loop with an offset overhand bend or square knot. It performs the same, with the difference that you don't need to tie a knot.

Hedden Autoblock Hybrid Friction Hitch (HAH-Hitch)

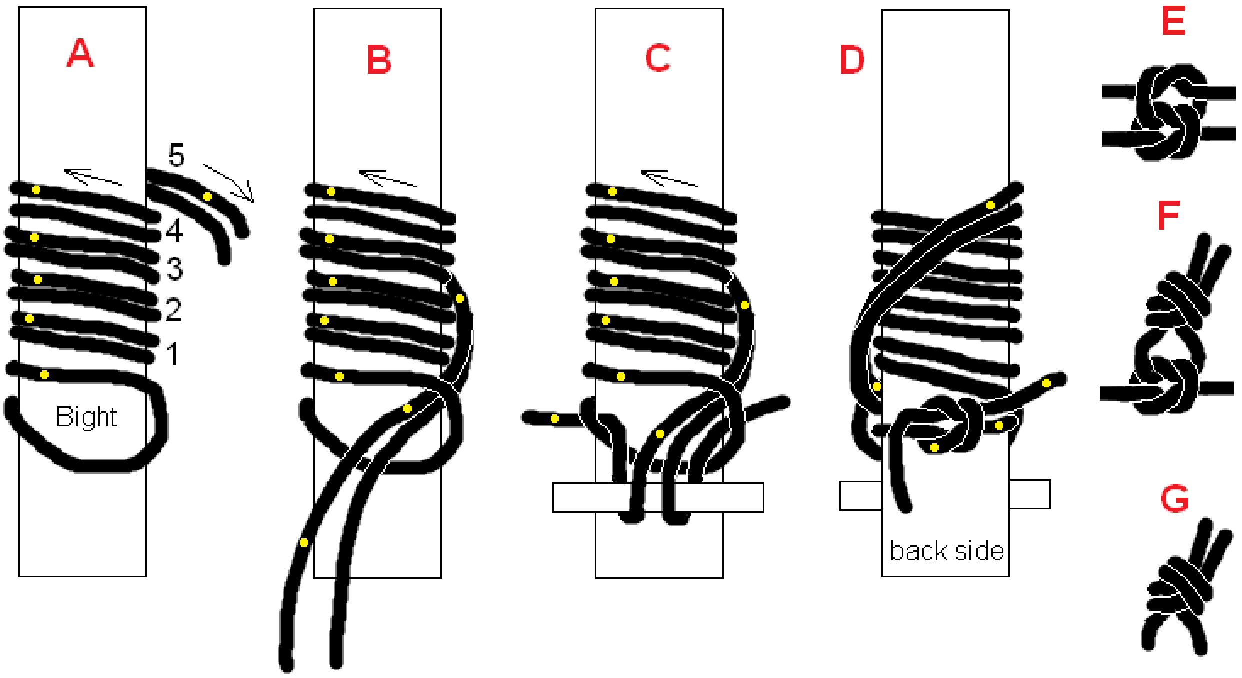

Figure 2.4; HAH-Friction Hitch tying procedure

Tying instructions (figure 2.4)

A-figure

Start with 1.5 m of accessory cord when using 10.5 mm rope and 5 top turns. Fold the cord in half and wrap 5 double turns around the rope. There are ten turns in total. They should not cross each other.

Rock the two rope ends up and down during winding, as this rearranges the fibers in the cord. This improves locking.

Relative long cord is required to have sufficient length to secure the square knot with an offset overhand bend (or just an offset overhand bend).

B-figure

Feed the cord ends through the bight to form a Hedden Hitch/knot. Pull the hitch tight (with force) and wiggle the turns so that they sit nicely onto the rope. This takes out some stretch due to rearrangement of the cord fibers.

C-figure

Loosen the Hedden hitch somewhat to get a larger bight. It makes this step easier. Feed the cord ends over the carabiner and then through it. Push the cord ends back through the bight. One end goes left, one end goes right. Feeding the cord ends first over the carabiner, and then through it, adds offset. This improves locking and releasing.

You may combine step B and C.
You make two bights with the cord ends of the A figure. These will be the eyes for the carabiner. Push them through the bight of the A-figure as you normally do for

the Hedden Hitch. Insert a carabiner through the two eyes and move the yellow marked cord end to the other side of the rope.

D-figure (the hitch is shown on the backside)

Tie a square knot on the back of the rope.

Load the hitch and check correct operation. You may readjust the square knot when the eyes are large. When you know the position of the knot, you may use a flat overhand bend / knot (G-figure). It is compact, works fine, and is strong in this application.

E and F-figure

When the hitch is working well, you can leave the offset overhand bend. You may add a backup offset overhand knot. When using the square knot, tie another overhand knot on top of the square knot (E-figure) to secure the square knot. This creates two interlaced square knots. This method works fine for temporary use of the hitch, as tying goes fast, but there is a risk.

You have to make sure that there will be no significant load on one of the cord ends, as this may cause the two interlaced square knots to capsize.

For long term use, secure the square knot with an offset overhand bend (F-figure). It is advised to completely untie the square knot and tie the offset overhand knot / bend (G-figure). Pull the cord ends hard to set the overhand knot.

When in doubt about locking, or very reliable locking is of prime importance, use the “shock cord friction loop”.

Figure 2.5 shows two photos of the HAH Hitch.

It is recommended to add the “shock cord friction loop” about halfway the number of turns, or somewhat below. It increases locking significantly, especially on old rope with varying diameter due to use (compaction of fibers and sheath slippage). Make sure to apply the loop around turns that belong to each other, as otherwise free movement of the turns slightly reduces. See also chapter 4.

The friction loop in figure 2.5 is at 2.5 turns as seen from the bottom. The friction loop works the same when it is on 1.5 turns from the bottom. It also shows a tending ring below the hitch.

It is highly recommended to use the most flexible accessory cord you can get, as locking goes really better. When you need the “shock cord friction loop”, only small friction is required compared to using stiff cord (see also paragraph 5.3.

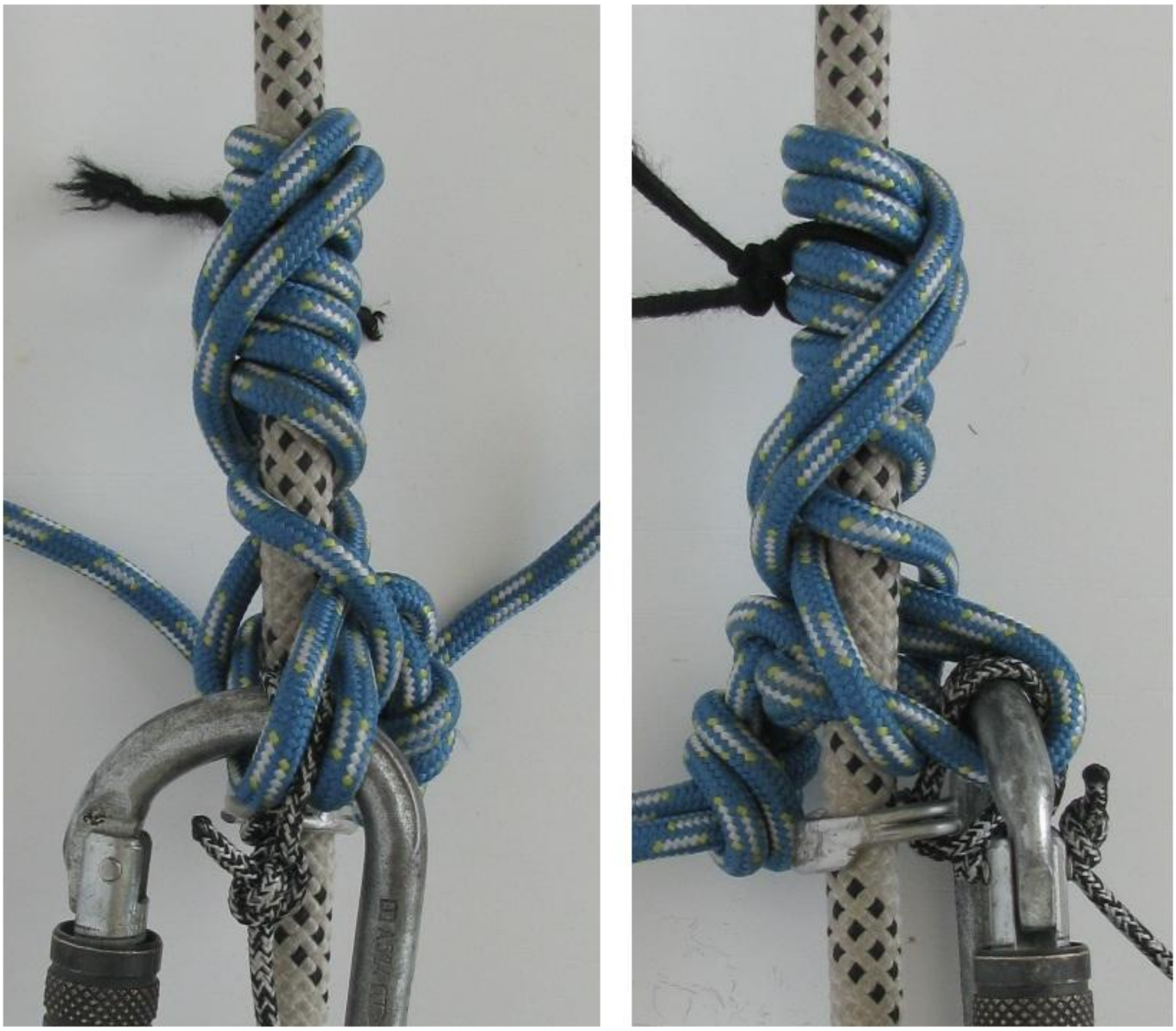

Figure 2.5; Photo of a 5 turns Hedden-Autoblock Hybrid Friction Hitch

2.3. Geometry of the turns and cord twist

The two cord sections that go down from the top and run through the bight, don't run parallel with the rope. The two sections more or less spiral around "old" turns after loading the hitch. This also happens to a lesser extend with single cord hitches, such as the Distel and Michoacan.

Figure 2.5 shows the spiraling. The two sections that run down towards the carabiner make a full 360^0 turn around the "old" turns. So 4 double turns are around the rope, and one double turn is around both the rope and the "old" turns, making a total of 5 double turns.

You can manipulate the hitch so that the last turn spirals down over say 540^0 (1.5 turn) instead of a full 360^0 turn. This changes the hitch properties. You need to take this into account when testing your hitch.

More turns over the existing “older” turns, without changing the total number of turns, gives better locking, but reduce the holding power, due to slipping and it increases the no-load friction.

When having high (6 or greater) number of double turns, make sure to test your hitches with the geometry that is most natural.

By applying some torsion in the cord during winding, you can affect the natural geometry. This may be on purpose, but also accidently. Figure 2.5.1 shows torsion (twist) in the cord. For a double cord hitch, the effect is the same.

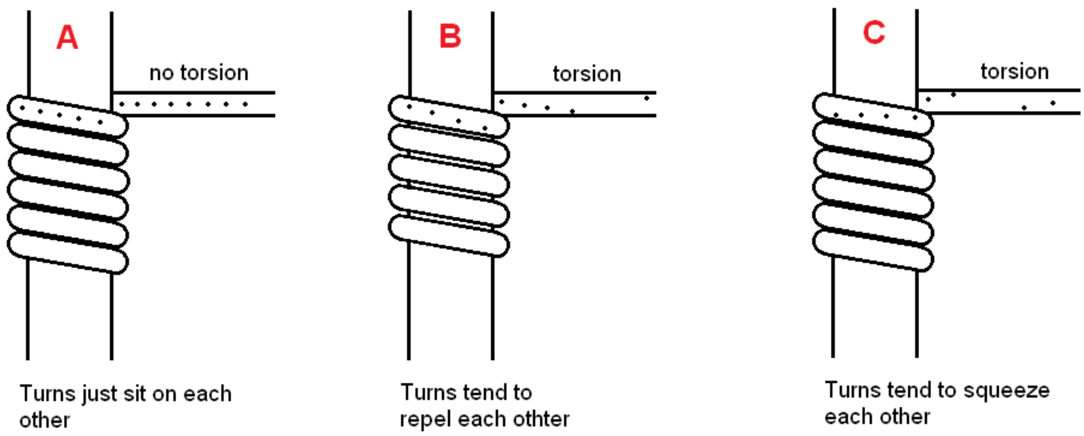

Figure 2.5.1; cord twist or torsion

You should avoid intentional or unintentional torsion that squeezes the turns on to each other, as shown in figure 2.5.1C. It impedes constriction of the turns due to increased turn-to-turn friction, resulting in bad locking of the hitch. Applying slight twist as in the B-figure improves locking somewhat.

2.4. Hitch Properties

The HAH-hitch is a rather strong hitch, as force is reasonably distributed across 4 cord sections. The load is distributed over larger sheath area compared to a Distel or Michoacan hitch. This is similar to the Autoblock hitch.

Where the Autoblock hitch has virtually no pressure points, the HAH hitch has a pressure point at the lowest point in the bight. At that point cord wear is highest.

The hitch is self-tightening after some load / release cycles.

It is reasonable self-tending on LSK (semi-static) rope, but with more friction.

You generally need more double turns. Many people operate a Distel Hitch with 4 top turns (5 in total), but the HAH-hitch needs 5 double turns minimum. On LSK (semi-static) rope, you may likely need 6 double turns when using thick cord.

Due to the double turns (larger advance), it locks slightly less reliable compared to a Distel Hitch. This is partly compensated by the fact that you may use thinner cord compared to a Distel or Michoacan. The “shock cord friction loop” can do a great job to improve locking, especially when the rope diameter varies (due to heavy use on a part of the rope, or dynamic preload below the hitch).

For fully suspended use (full body weight onto the hitch), I prefer this double cord hitch over short single cord hitches (for example the Distel hitch). It is better for the cord and the rope, and you can break the hitch.

Tending

The hitch is self-tending on semi static rope (LSK climbing rope, to Std. EN 1891), but with increased friction compared to using a tending device. It only self-tends when the eyes are small (smaller then on the photo). For reasonable self-tending, the part of the carabiner that pass through the eyes should almost touch the rope.

When the carabiner is pulled away from the rope (force component perpendicular to the rope), friction increases significantly, disabling its self-tending property.

The hitch will not self-tend with large eyes. The hitch also doesn't self-tend on most dynamic climbing rope. It is therefore highly recommended to use a tending device.

When tending the hitch using a tending device, the eyes may be larger (compared to the hitch on the photo in figure 2.5), especially in case of a lanyard. When using the hitch in an adjustable lanyard (work positioning line) a significant part of the tending force is sideways. This virtually always locks a hitch, as long as the tending device is well adjusted so that the hitch receives some sideways force.

You may need the "shock cord friction loop" when using rope with irregular diameter in combination with stiff cord. The HAH friction hitch gives out rope when cycling between locking and releasing. It therefore doesn't loosen itself. It is however not recommended to use larger eyes then strictly necessary for good operation.

Giving out cord example

Figure 2.6 shows two photos of the same hitch.

The left photo shows a 5 turns HAH Friction Hitch where manually all cord from the eyes is moved into the hitch. The turns are very loose around the rope, so this is a real "unhealthy" hitch. The "shock cord friction loop" provides about 0.1 kg of force to avoid that the hitch slides down. The total friction (friction loop + cord to rope) is just sufficient to avoid sliding. The right photo shows the hitch after about 10 release and lock cycles. This shows reliable locking without sliding.

The eyes are now 25 mm larger. This means that the hitch gave out 100 mm (4") of rope. The hitch on the right photo meets the short descent test (short descents, followed by jumping onto the foot loop that is connected to the carabiner). After the short descent test, the eyes became 35 mm larger compared to the left photo. The hitch gave out 140 mm (5.5") of rope. No binding during release occurred.

This example is just to show that the HAH hitch tends to give out rope and that makes it safer to use. It is however <u>not recommended</u> to use a hitch with 35 mm of slack in the eyes.

Figure 2.6; Photo of unhealthy HAH friction hitch (too much slack)

Retracing to make eyes for the carabiner does also work when using a Klemheist, but you lose the tightening property as shown in figure 2.6. This makes a retraced klemheist less forgiving compared to a retraced Hedden hitch.

When using a micro pulley (as in figure 2.6), you can have some slack in the eyes to enable smooth release of the hitch when tending, but not as much as in figure 2.6!

Note that longer eyes increase sit back and you need to enlarge the grey/white loop that connects the tending ring to the carabiner (See figure 2.5, and chapter 3).

The short descent tests were carried out as described in chapter 6, using 6 and 7 mm PA (Nylon) accessory cord on 10.5 mm and 12 mm LSK rope, both on “fresh” and heavily used sections. Tests were also carried out with cord where one core strand is taken out. This greatly improves locking and reduces no load friction.

It is recommended to use minimum 5 top double cord turns with <u>minimum</u> 5 mm EN 564 accessory cord (PA or PES). I use 6 mm (5 turns) or 7 mm cord (6 turns) on 10.5 mm rope and 7 mm (5 or 6 turns) on 12 to 13 mm rope. When you take out a core strand, use at least 6 mm cord.

Construction strength

The load is on 4 cord strands throughout the hitch. The square knot with backup (or preferred offset overhand bend) receives 25% of the load, so it is expected that the strength of the hitch is about 200% of MBS (PA or PES accessory cord). It should be noted that before reaching a load of 200% of cord MBS, the hitch will very likely slip and/or the sheath of the rope is damaged.

The cord section that goes around the rope via the square knot receives 25% of the load. That is half compared to the load in the bottom turn of (for example) a Distel hitch. This reduces wear compared to a Distel hitch (or many other friction hitches). Untying the knot on the back of the hitch goes easy, even after some shock load.

Descending

Though the stress in the cord is 25% of the load, descending with your full body weight causes lots of wear on especially the accessory cord. Most wear is at the lowest part of the bight (figure 2.4A). Descending is possible but doesn't go smooth when working in a suspension harness. It goes better when standing in a foot loop that is connected to the hitch.

You need a significant part of your body weight on top of the hitch to break the hitch. You definitely need to practice close to the ground, as you need to reduce the force on top of the top turns as soon as the hitch starts to slip. You need to get that into your muscle memory. A wrong (panic) reflex will send you to the ground.

When you plan to descent a short distance with your full body weight, it is advised to use the thickest cord that gives still satisfying performance, as thick cord works better when descending.

> When using thicker cord, you may need 6 instead of 5 double turns, as slippage risk increases when using thick cord,

Note that the "shock cord friction loop" wears always, even when you don't descent with the hitch, so check it regularly. When using thicker cord, you need more friction for reliable locking, as thick cord is less flexible.

Disadvantages

Its main disadvantage is higher risk of human error compared to hitches using (sewn) eyes, cord loops, or mechanical solutions. You need to tie a square knot (or the preferred overhand knot/bend). It is **not advised** to use the hitch with only the square knot. When you tied it wrong, the hitch will fail.

Tying two interlaced square knots reduce the risk of human error, as when tying one of the overhand knots the wrong way, it still has sufficient holding power. It is however recommended to use an overhand bend to secure the square knot. Reason for that is that even several square knots on top of each other may capsize when one cord end is heavily loaded (due to getting stuck).

When the hitch is working well, you may untie the square knot and use a flat overhand bend as shown in figure 2.4G. Make sure to have tails of at least 10 cm, or add a backup.

The “shock cord friction loop” improves locking significantly, even with an unhealthy loose hitch, but you need a well tied hitch to start with.

The hitch hasn’t a distinctive appearance compared to a Distel Hitch or a standard Prusik Hitch. This makes inspection more demanding, especially at a distance.

It is good to remember the length of the tails when the hitch is finished. When you accidently applied 4 instead of 5 turns, you may notice this because of the longer tails.

It is strongly advised to count the number of turns during final inspection (valid for any Friction Hitch). A hitch with insufficient turns may work well in the beginning, but may slip after some use due to deformation of the cord cross section and/or glazing.

The hitch is relatively long compared to single turn hitches (Distel, Michoacan, etc). That may be a disadvantage, for example in case of a work position line (between the waist D-rings of your harness).

2.5. The Hedden-Autoblock Hybrid Friction Hitch, loop version

When tying the HAH hitch, two cord strands (that come down from the top) pass through the bight on the same side of the rope. This creates the Hedden hitch. They pass on the right side in figure 2.4B. You may feed one of the strands through the bight via the other side of the rope. It is less intuitive, but enables to tie the hitch using a cord loop.

Using a loop “solves” two disadvantages of the regular version:

1. You don’t need to tie a knot, as a loop is used
2. Less change of wrapping insufficient turns, as that will give larger eyes.

It adds a disadvantage:

1. Counting turns is slightly more elaborate, as one strand passes on the other side of the rope.
2. Wear is always on the same spots.

The loop version of the HAH hitch, uses a loop with an offset overhand bend (aka flat overhand bend or [wrongly] EDK). It does not work with an inline single or double fisherman’s bend. It does work with an offset (flat) double fisherman’s bend or half Gibbs bend. Do not use an offset figure 8 knot.

The rope strands that go towards the knot carry 25% of the load. A flat overhand bend is therefore fine for all situations. You need to test the cord loop – rope combination beforehand very well. When done you may tie a backup knot. This is recommended when the system containing the hitch is used by persons that do not self-check their equipment.

Hedden Autoblock Hybrid Friction Hitch (HAH-Hitch) Using a loop

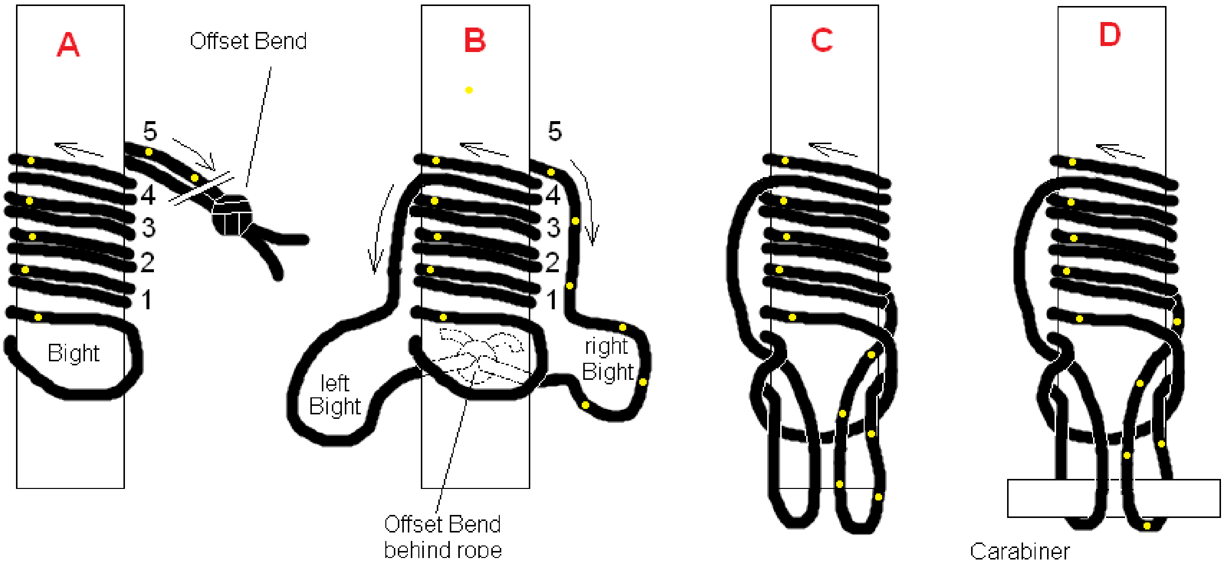

Figure 2.7; HAH friction hitch, loop version, non-dressed

How to tie it?
Tying instructions are shown in figure 2.7 and the text below.

A-figure

Hold the Bight with your finger onto the rope and wrap 5 turns around the rope. When the twist in the cord loop increases, wind in opposite direction. Do not tie the offset bend knot when using new cord.

B-figure

Position the Offset Bend behind the rope and make the left and right bights. The upper strand of the double turn (yellow marked) makes total 5 turns, but the lower strand makes about 4.5 turns.

C-figure

Push the left and right bight through the bight from the A-figure. This makes the eyes for the carabiner. Pull onto the eyes, especially the cord strands that originate from the turns. This sets the hitch.

D-figure

Push a carabiner through the eyes. Tie the offset bend when you used new cord.

When you tie the hitch using new cord, do not tie the bend knot as shown in figure 2.7A. You tie it when testing the hitch. This is to allow for some twist that occurs during the winding process. When using just cord, you mostly don't notice that.

Load and test the hitch (to take stretch out of the cord) adjust the knot, etc. A 5-turn hitch using 6 mm cord onto 10.5 mm rope requires cord length of 1.5 m. This is long enough to tie the backup knot.

When the hitch works fine, you may add the backup knot (not shown in the A-figure, but shown in figure 2.8).

When starting from a fresh cord without the bend knot
Before removing the hitch after testing, mark the center of the bight and the inner side of the bight at two positions. This allows you to tie the hitch in the same way as the first time the cord was new. When you remove the cord from the rope, you will notice a small twist in the cord. This is as expected.

When you wind it in the other direction, there will be more twist in the loop. When you notice this, do not force the twist out of the cord, but wind in the other direction. When using the marking, you always start right.

Figure 2.8; Photo of HAH friction hitch, loop version, with tending ring

When you use ropes with varying diameter, you may need several cord loops with different length. This creates the risk of using a cord with non-optimal length.

Figure 2.8 shows a side and front view photo of a 5 turns HAH Hitch using a loop. Rope diameter is 10.5 mm, cord is 6 mm. A tending ring can also be seen.

Does it behave differently compared to the other version?
In my opinion it behaves the same as the regular version, except for upside down operation (figure 3.2).

Operation in “poor men’s pulley mode” goes slightly better. This is because the eyes are more symmetrical around the rope.

Tying with cord vs cord loop?
When you put markings on your cord (in the top of the bight and the side of the bight) you can always wind the cord in the same way. This saves time as the first try is right. When you tie in the other direction, you will notice strong twist and you need to start all over again.

Tying the knot always the same way with the loop, also means that wear is always on the same spots.

You can’t apply some twist (figure 2.5.1B) when using relative stiff accessory cord when using the loop. You may add that during the creation of the loop when using new cord for the first time.

Tying this version using just a piece of cord requires tying the overhand bend, but when done with your work, the hitch can be removed with a single pull. The flat overhand bend you can undo when you are at ground level.

You may put markings on the rope so that you can tie the offset overhand bend at the same spot without testing the hitch every time.

It is up to you which version you use. I tie the knot mostly without the flat / offset overhand bend (so I just use a piece of cord).

3. Friction hitch tending methods

3.1. Introduction

Tending a friction hitch, is to move the hitch in the desired direction. In virtually all cases the hitch is not loaded, and the tending direction is mostly upwards (as gravity acts downwards).

You can tend with your hand, mostly by wrapping your hand around the rope below the hitch, and push the hitch upwards. People may also grab the whole hitch and push it upwards. Some hitch designs can be tended by just pulling the carabiner upwards (so-called “self-tending”).

Tending can also be done by using a device, a so-called “tender” or “tending device”. The reason is simple; you don’t want to “spend” your hand to move a hitch upwards. When it goes automatically, you have your both hands free to do your work.

Some examples where tending makes working easier:

- Adjusting a work positioning lanyard around your back, or between the waist D-rings (on your harness). When you pull the loose end sideways, the hitch should release and move in the desired direction (to get a shorter lanyard).
- Adjusting a vertical work positioning lanyard to raise your vertical work position
- Climbing a rope using two friction hitches and a foot loop. The hitch should automatically move upwards as your body moves upwards along the rope.
- “let go” prevention when lifting objects.

Tending devices can be: pulley, ring, piece of rope, very small carabiner, or the carabiner itself (rope goes through carabiner), etc.

A tending device has two functions:

1. Removing sufficient load from the hitch so that it can move up or down
2. Pushing the hitch in the desired direction.

The load must be taken off the eyes to enable the hitch to release (unlock) or to avoid high no-load friction.

3.2. Manual tending

Pushing up the hitch manually goes easiest by grabbing the rope under the hitch with one hand and moving your hand upwards. Of course there must be tension in the rope below your hand; otherwise you lift the rope also.

When there is tension in the rope above the hitch, there is a sweet spot. When having very flexible/thin cord, the sweet spot may not give lowest friction. You only need to push at the space between the rope and the carabiner. When there is slack in the rope above you, you also need to push upwards the bottom turn to avoid tipping over of the hitch.

When there is still some load onto the eyes, there will be higher no-load friction. You may need to lift the carabiner together with the hitch.

3.3. Basic tending device operation

Figure 2.1 shows the basic tending operation when using the carabiner and a piece of thin cord.

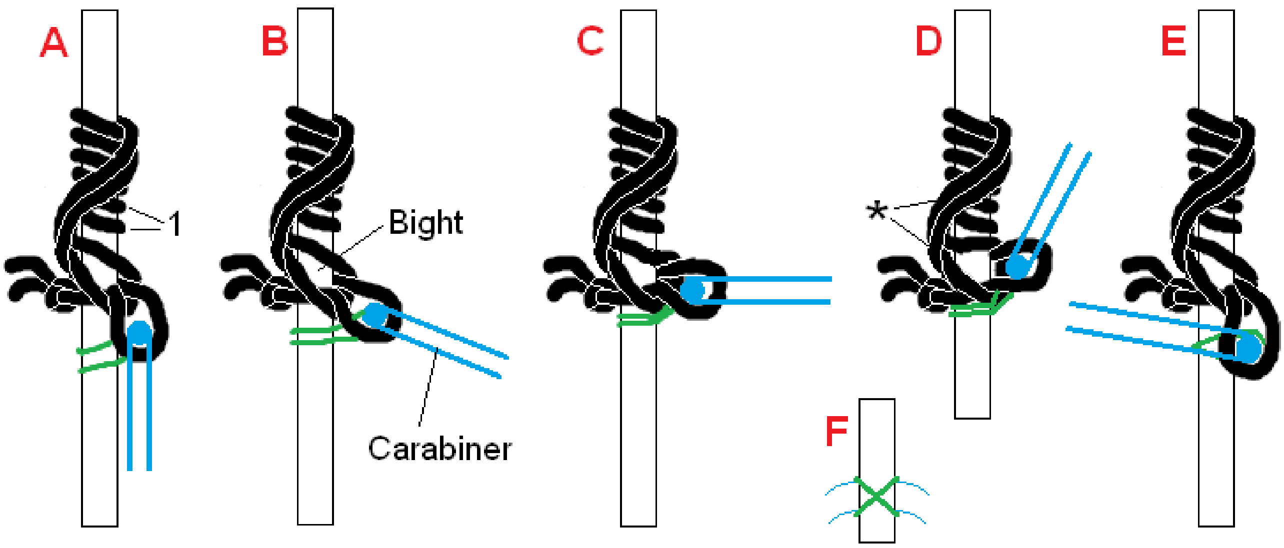

Figure 3.1; 5 turns HAH-hitch with tending device

A HAH-hitch is shown in figure 3.1A with a blue carabiner and a green cord loop (as tending device) that goes around the carabiner and the rope. The green cord loop should be adjustable. 3 mm Nylon (PA) or Polyester (PET) cord works well. See Annex 1 for a simple loop friction hitch. You may have a ring around the rope that connects to the green loop.

Though not shown in the A, B C and D figure, a cross in the cord that you use to tend the hitch reduces friction, see figure 3.1F.

The rope below and above the hitch has tension. The green cord doesn't interfere with the hitch when the carabiner is pulled down (A-figure). When you pull a bit sideways, you arrive in the B-figure. The green cord still has slack so doesn't interfere with the hitch or rope.

In the C-figure the carabiner is pulled fully sideways. The force goes to the rope via the green tending cord. The eyes are loose around the carabiner and move a bit into the hitch. The bight also moves a bit upwards so that there is no tension in the top turns anymore and the hitch starts to release. .

In the D figure the green cord lifts the lower part of the hitch (the bight) and that pushes the top turns upwards. The eyes are loose around the carabiner. The eyes may further go into the hitch releasing the hitch further.

A well-adjusted green cord length assures that the eyes are tensioned as long as possible. This increases the locking reliability of hitches that may take in cord.

Adjustment tips

- When the green cord loop is too long, not all force is transferred to the rope and that increases the friction while raising the hitch
- When the green cord loop is too short, there will be more risk of non-locking and/or the eyes cannot move upwards a bit, increasing friction.

Rope inside carabiner
Several hitches tend well when the rope is inside the carabiner, as shown in figure 3.1E. The green loop should be tight, so that there is just a few mm between the carabiner and the rope. Small clearance is required to avoid that the carabiner may position itself onto the hitch instead of below it. Some hitches with very tight eyes don't need the green cord.

The HAH-hitch tends well when the rope is inside the carabiner. Though the hitch is self-tightening, it is not recommended to use excessive large eyes. Large eyes also increase sitback / backlash.

You lose a sideways force, and the eyes need to be larger as they can't bend upwards. Both increase the risk of non-locking, so you need to check good operation very well.

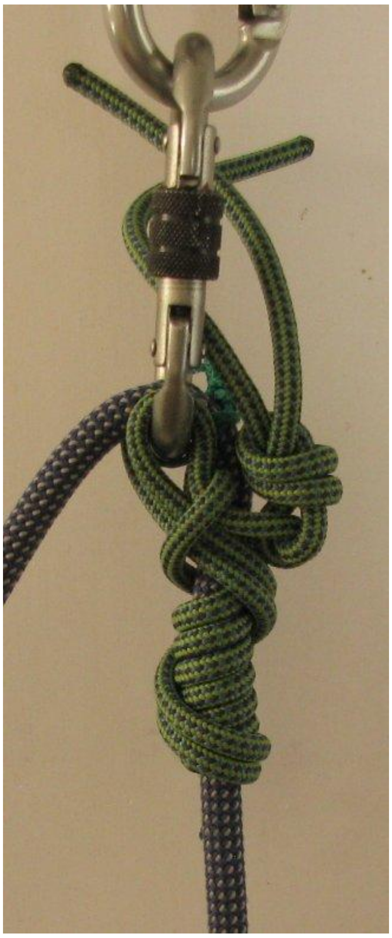

Figure 3.2; upside down hitch

Rope inside carabiner, used as poor man's pulley
The carabiner in figure 3.1E can be used as a poor man's self-locking pulley, when used upside down. This is shown in figure 3.2. When you unload the left rope section, the friction hitch will take over the load. The green loop that goes around the carabiner and the rope is hardly visible.

The poor man's self-locking pulley is also useful as an adjustable work positioning lanyard. The rope goes from your harness upwards, then through the friction hitch and the carabiner, and down to your hand. The difference with the regular flipline or lineman's belt is that when you pull, you help yourself to ascend.

Hitch locking
The rope makes a sharp bend around the carabiner, This seems to help locking of the friction hitch, but may also impede releasing. Rope diameter reduction increases risk of non-locking. You need to test very well and may consider the "shock cord friction loop".

When using the “poor men’s pulley”, the loop version as discussed in paragraph 2.5 works slightly better.

3.4. Tending a hitch without pulling the carabiner

One can tend the hitch by looping a cord around the carabiner as shown in figure 3.3A. That cord is in between the eyes of the hitch. The carabiner goes (for example) to the ventral (belly button) D-ring on your suspension harness. The red cord (shock/elastic cord) goes to your neck, via your shoulder behind your back, or goes to the sternal (chest) D-ring. This keeps the hitch as high as possible reducing slack and/or sitback when ascending.

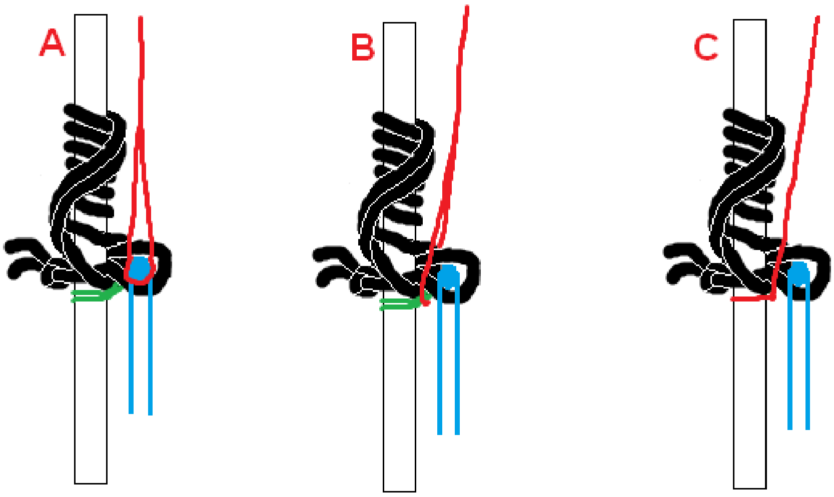

Figure 3.3; 5 turns HAH-hitch with other ways of tending

You can also loop a cord around the hitch with green cord, as shown in figure 3.2B. this goes faster. You may need to change the green loop cord length a bit.

You need to experiment with this option as good operation depends on the length of the green cord loop and the size of the eyes of the hitch. Most of these methods works better on Low Stretch semi-static rope compared to dynamic climbing rope.

3.5. Tending a hitch without a tending device

Figure 3.4A and B use the green cord as tending device. When tending the hitch with near zero load onto the eyes, lifting can be done with a piece of cord directly, without any other cord. This is shown in figure 3.3.C. this method introduces the least risk of taking in cord by the hitch (cord eating), as some load at the eyes is maintained by the weight of the carabiner and the tension of the shock cord. It should be noted that the HAH-hitch does (virtually) not take in cord.

A non-tightened overhand knot is tied around the rope (semi-static, LSK). A PA or PET cord with 3…4 mm thickness is recommended. Thin cord increases the friction between the cord and the rope.

The two ends go upwards and connect to shock cord that goes around your neck (in case of ascending a rope), or via your shoulder back to your harness. The shock cord provides always some force onto the sweet spot in between the rope and the carabiner.

As soon as the force is removed from the carabiner, the eyes move a bit upwards. This releases / unlocks the hitch and the hitch is lifted by the cord / shock cord combination. The loose overhand knot avoids that the tending cord moves away from the sweet spot to the right.

When load is applied, the eyes are pulled down, and that locks the hitch. The shock cord keeps some tension onto the eyes, so it will always lock, even with large eyes. This method works very well when used in a hoisting operation (let go protection) or ascender setup.

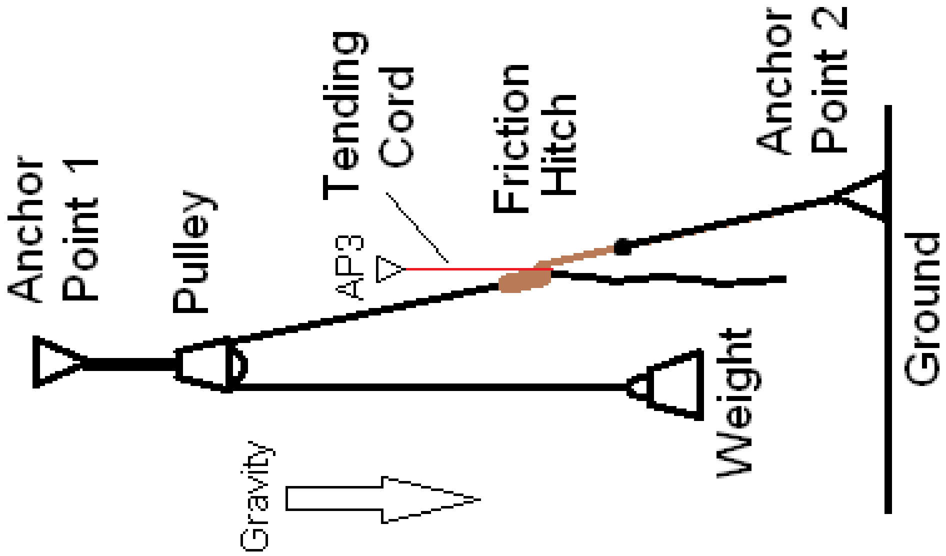

Figure 3.4; Let go prevention in a hoisting application

Example “let go” prevention (figure 3.4)

In this example a friction hitch catches the lifting rope when one would let go the rope. Note that gravity works to the right.

Anchor Point 1 (AP2) and 2 are strong points, where AP2 bears greater then twice the load (depending on pulley energetic efficiency). AP3 is a very weak one. As shown in figure 3.4, the load is fully supported by the friction hitch. AP2 carries the weight now. The red tending cord has slight slack (just a cm).

When you pull the loose rope, the weight is gradually transferred from the hitch to you, as you pull the rope. When all weight is onto the rope the hitch moves a bit down, but is caught by the tending cord at the sweet spot. Now there is no slack in the red tending cord and very small slack in the rope section between AP2 and the hitch. That small slack releases the hitch.

When further lifting the weight, the lifting rope moves through the hitch. When you led go the rope, the hitch catches the rope and moves a bit upwards until the slack is out of the black rope section between AP2 and the hitch.

When using strong enough shock cord as tending cord, the system works without any slack. The only slack that is in the system is because of the backlash in the friction hitch. As this system avoids taking in cord (see figure 3.3C), the backlash of the hitch is just a few cm.

Disadvantage of this system is that you need a third hand to release the hitch when you want to lower the weight.

An ascender setup is virtually the same as the hoisting setup of figure 3.4.

- The hitch goes to your belly button D-ring instead of AP2.
- The red tending cord goes to you neck or sternal D-ring instead of AP3.

When using shock cord, the setup provides a progress capture with very low sitback, as the cord / shock cord combination always provides a lifting force onto the hitch. This prevents taking in cord.

The disadvantage is that when the cord / shock cord combination isn't present, you can't lift the hitch by pulling the carabiner (or soft shackle) upwards, as you don't have a tending device. You need to do it manually.

Of course you can have the green cord loop present, but you should enlarge it, so that when tending according to figure 3.3C, the green cord doesn't interfere with the hitch. When you want to switch to another tending method, you just need to adjust the green cord loop.

3.6. Tending using a ring

Friction reduces significantly when replacing the cord with a ring that is connected directly to the carabiner, or via a piece of cord.

Figure 2.5, 2.8, and 3.5 shows some examples. The ring can be a real ring. Its disadvantage is that you need access to the end of the rope to put it onto the rope. The ring can also be U-shaped (figure 3.5) so that you can "clip" it onto the rope, than push a carabiner or cord through it.

Figure 3.5; Tending ring shape

The shape of the ring (when looking to a side of the hitch) has influence on the friction when tending. Tending goes more or less sideways in a work positioning line. This is shown in figure 3.5-left. When you use the same ring in an ascender (progress capture) application, the ring hangs down a bit (figure 3.5-middle). Only one side of the hitch is tended. This increases friction when using very flexible or thin cord.

Figure 3.5-right shows a ring with a V-shape. This ring tends both the front and back of the hitch. The back is where the flat overhand band is.

When you use the hitch for both ascending (with elastic cord to reduce sitback), and work positioning, use the flat ring (figure 3.5-left). The V-shape ring (figure 3.5-right) doesn't perform well when tending using the loose end.

Further improvement can be made by using a micro pulley (such as in figure 2.6). You lose the adjustment possibility with the green cord loop. So adjustment for good operation has to be done by varying the length of the eyes.

When you need 10 mm longer eyes, you need 40 mm longer cord.

4. Solving unintended sliding of a friction hitch

4.1. The problem

You have a hitch that works well. It has acceptable no-load friction and it works perfectly in an ascending setup with a piece of shock cord around your neck. It also works fine as a hitch for a foot loop below the ascender hitch, or in a work positioning line.

However when using the hitch in situations where the rope is loaded below the hitch, without tending the hitch, the hitch slides down and locks not well. When it slides down under its own weight, it can't lock (unless pulling down fast). The reason is the instantaneous reduction of the rope diameter because of the load. It can reduce over >1 mm. This effect is discussed in chapter 1.7.

If you don't want this, you should tie the hitch so tight, that it moves very difficult along non-loaded rope sections, or sections that are a bit thicker (for example due to sheath slippage over time). Other option is to use very flexible (more expensive) special hitch cord. See chapter 5.

Backup use
When you use a friction hitch above you as a backup on a single rope, sliding down is not desired. When you get an instantaneous failure of your primary hitch, your body is completely off the rope, the rope jumps upwards and that will lock every friction hitch.

But when you get a partial failure that results in (slowly) sliding down, there will be still tension in the rope. This may result in sliding down of the backup hitch. In virtually all cases it will lock in the end, and take over your weight, but you want to be 100% sure that it locks immediately, no discussion. Initial sliding will introduce shock load.

The backup hitch is normally above your ascending hitch, or better on a second rope. You need to reposition it every time so that it is above you to limit your fall distance. This is most important when you are close to an anchor point above you, as then there isn't sufficient rope above you to spread out the shock load in time (so that the peak force is limited).

> Do evaluate the peak load that will occur when your main hitch fails abruptly. You may arrive in a situation where you need a shock absorber. When that is an industrial 6 kN screamer, it is not advised to use a friction hitch.

4.2. Adding static friction

4.2.1. Introduction

The trick to avoid sliding down due to rope diameter reduction is adding some friction at the right spot that is near independent of rope diameter.

Before using the added friction trick

- use a hitch that is tighten such, that the no-load friction is acceptable. You should not use this trick to “correct” a loose hitch, as a very loose hitch has less holding power.
- Use it on a hitch that passed the short descent and long descent (glazing) test (see chapter 6).
- The trick works on all hitches, with double or single cord.

The reason for the above points is that using the trick on an unreliable hitch is not the way to go. The trick only improves locking, but doesn’t increase holding power.

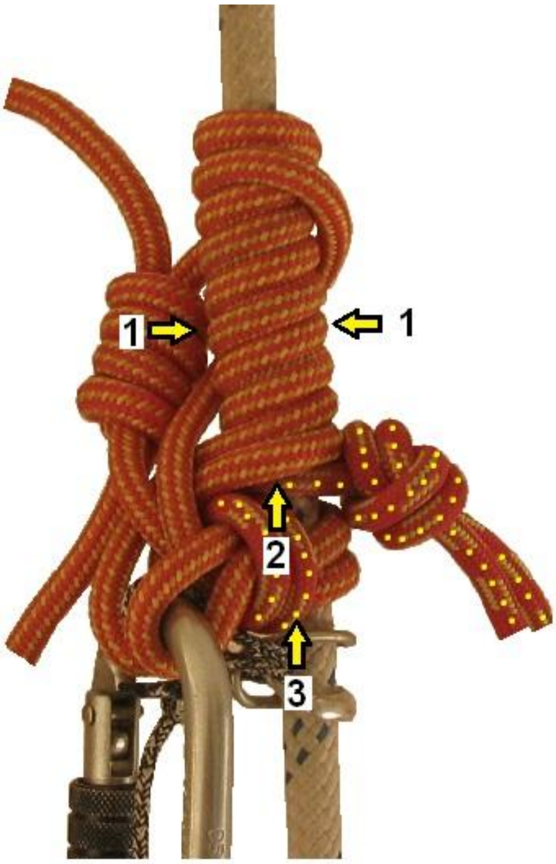

Figure 4.1; Friction hitch with markings for friction positions

Adding static friction nearly independent of rope diameter can be done in several ways.

Figure 4.1 shows a 5 turns double cord DO-Hitch with 2 auxiliary turns.

The best position to add friction is directly onto the top turns, as that directly translates to force in the rope sections that go to the top turns.

It can be done via a constant compression force on a top turn, indicated with “1”, or via friction around the rope that tries to push up the top turns, indicated with “2”.

Other option is by adding friction around the rope just below the bottom turns, indicated with “3”.

Figure 4.1; Friction hitch with markings for friction positions

By far, option 1 works best using a thin piece of shock cord. It doesn’t interfere with normal hitch operation and/or tending devices. Option 1 requires the least additional friction force.

4.2.2. The “shock cord friction loop”

After experimenting, there is a very simple way to add friction in one of the top turns: a shock cord loop that goes both around the rope (to introduce friction) and around a top turn (so that it cannot get between the rope and the cord). It is shown in figure 4.2. Note that the cord in the photo is 3 mm for clarity. Thinner shock cord is recommended.

The shock cord is not eaten by the top turns, even under shock load and descending (intended sliding of the hitch when loaded). That piece of shock cord is called “shock cord friction loop” throughout this document.

Recommended thickness is 1.5 to 3 mm. When using 1.5 mm shock cord, you mostly use the double loop (upper loop in figure 4.2. When very low friction force is required, use the single loop (figure 4.2). When using 2 mm shock cord, the single loop is recommended. The stopper knot is just an overhand knot. The HAH-hitch mostly requires only small additional friction force for good locking. Using 3 mm cord is mostly not recommended.

Tighten the cord just enough so that the hitch doesn’t slide down under its own weight, and check whether the hitch locks (slowly pulling). Excessive tension makes tending more difficult (higher no-load friction and more wear on the shock cord’s braid/sheath).

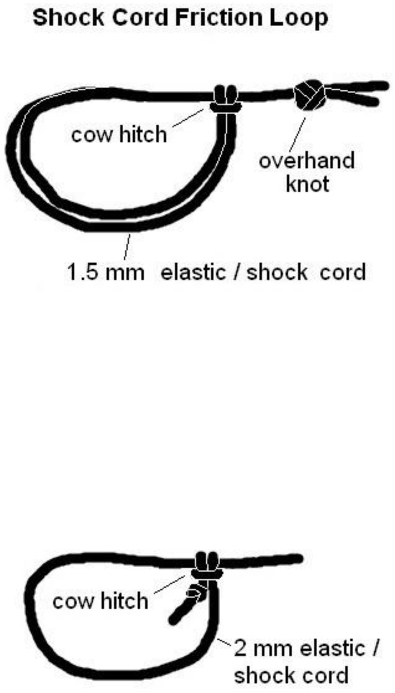

Figure 4.2; HAH-Friction Hitch with shock cord friction loop

The “shock cord friction loop” is about halfway the number of top turns, or just below. The friction loop is at 2.5 turns in figure 4.2. When it is at 1.5 turns, it behaves the same, so the position is not critical. Make sure it does not interfere with the top turns pair that comes down. The eyes in this hitch are very short. They need to be larger for smooth operation on dynamic climbing rope (to Std, EN 892).

Shock cord friction loop inspection
The part of the friction loop that moves along the rope is in between the turns of the friction hitch. Even when the friction hitch itself is not loaded when moving, the shock cord friction loop provides some friction and therefore wears fast. You can't see the wear, as it is on the inside of the loop.

> Check the status of the braid regularly, especially in the beginning. This will allow you to set the inspection interval. You need to pull the cord out of the top turns to see the braid.

Use elastic cord with a Nylon (PA) braid, as that has better abrasion resistance compared to Polypropylene (PP).

5. Recommended cord

The Hedden-Autoblock Hybrid Friction Hitch uses double cord. The cord load everywhere inside the hitch is 25% of the load, So you can use cord with >71% of the diameter of the cord that you would use for a Distel Hitch.

Even a Distel Hitch with sewn eyes doesn't have 200% construction strength. The small bend radius of the lowest half hitch around the rope is the weak point in that case.

Aside from strength, flexibility of the cord is important for good hitch operation. The more flexible the cord, the better the hitch locks (and the lowest amount of additional friction with the "shock cord friction loop" can be used). A simple test is to form a bight between your fingers, and observe how it bends, see figure 5.1. When you need force to form the cord into a narrow bend, it is not a good cord for a smooth working hitch.

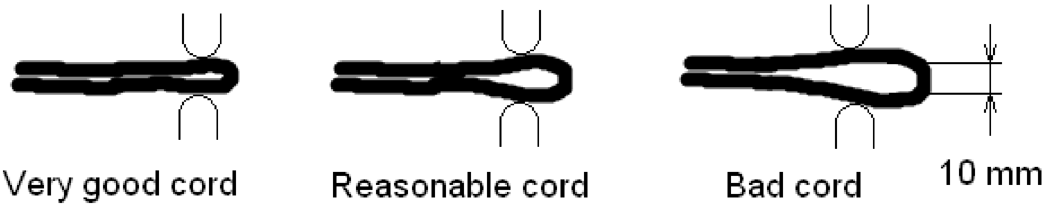

Figure 5.1; testing accessory cord

The width of the bend (inside measure) must be well below the diameter of the rope. 10 mm as shown in the right figure will give a bad locking friction hitch when using say 9.8 mm climbing rope. It may work on a 11 mm (or thicker) semi-static rope.

Stiff cord can be made flexible by removing one core strand, but then the cord is no longer certified.

5.1. Life support application

Use accessory cord that meets std. EN 564. These static (low stretch) cords are designed for use as PPE (Personal Protection Equipment).

When considering performance/price ratio, polyester (PES/PET) accessory cord is a good choice: low elongation, stable performance wet or dry, good abrasion resistance, MBS specification, and good UV resistance. Nylon (PA) accessory cord comes twice, due to larger elongation and moisture absorption.

Strength of PES or PA accessory cord is similar (PA mostly somewhat stronger). You should think of MBS of 7 to 9 kN for 6 mm cord, and 10 to 12 kN for 7 mm cord. Read the manual, besides MBS of the cord, strength of loops made with common climbing knots is also specified.

When price is not an issue or in case of frequent use, you may use a specialist “hitch cord” with aramid sheath (see further down the text).

> Do not use nylon or polyester cord for full body weight descending using a HAH-hitch as a replacement for a figure 8 or other mechanical descender. Only use it in a real emergency.
>
> When there is a need to descent, use a second hitch with a foot loop, when possible. This enables you to transfer your weight to the non-moving hitch.

5.1.1. Occasional work

For occasional work, you can stay with the regular PES or PA accessory cords. Use minimum 5 mm cord. When you are heavy, or take lots of gear with you, or expect some shock load, use thicker cord. I use 6 mm cord, as that provide MBS > 30 kN (without knots). On thick ropes (12.5 mm), I use 7 mm cord.

Edelrid 6 mm PES (Polyester) cord has strength of 6.5 kN when using an overhand bend (follow through overhand knot). The 7 mm PES cord has strength of 7 kN when using an overhand bend. Source: user manual.

5.1.2. Professional use

There are so-called “hitch cords” containing blends of aramids (Kevlar, Technora, etc) with other fibers. They may meet Std. EN 564. These cords are specially designed for frequent, heavy professional activity, including descending on moving rope and single/stationary rope systems. These cords can be very flexible so that even hitches using thick cord lock well.

When the sheath is out of an Aramid (Kevlar, , Twaron, Technora, etc) the cord does not glaze. Aramids don’t have a melting point. Use them because of their abrasion resistance, not because of their strength.

Read the instruction manual very well, as they behave differently compared to PES or PA cord. All recently manufactured cords that meet Std. EN 564 must be provided with strength loss for common climbing knots. The strength is given for a loop (so not for a single cord).

5.1.3. Not recommended cord / rope types for life support

Do not use

- Polypropylene (PP) utility rope/cord. It has bad abrasion resistance, low melting point, and has significantly less strength. The low melting point in combinations with the low abrasion resistance makes it dangerous. A single slide of a loaded hitch out of PP can result in complete destruction of the cord.
- Paracord, the word "Paracord" is used for everything, so you don't know what you get. Though the original Paracord is made out of Nylon (PA), cord out of PP is also sold as Paracord. Don't be fooled by "Mil Spec". The strength of real Paracord is well below what you need for friction hitches that carry your body weight.
- 100% Dyneema, though a very strong fiber, it is very slippery, and most knots in Dyneema cord slip at a load well below the breaking strength of PA or PES cord. In addition, its melting point is even below that of PP. It is useless for friction hitches.

5.2. Non-critical applications

You can use Polyester, Nylon or Polypropylene braided cord from DIY stores. Note that Polyester has best UV-resistance, followed by Polyamide (PA). Polypropylene (PP) has bad UV resistance and wears out fast. If possible avoid PP for friction hitches that may (shortly) slide under (partial) load. This is because of the heat that is generated during sliding.

Use cord that has <u>at least</u> half the diameter of the main rope. When the rope material is the same, you can expect a construction strength that equals half the breaking strength of the main rope. Note that when using PA main rope and PP cord for the hitch, it is recommended to use thicker cord, as PP has less strength then PA (Nylon).

5.3. Removing a core strand

Regular PA (Nylon) or PES (Polyester) accessory cord is relatively stiff. The braid is tight around the core. This causes the stiffness.

The core of accessory cord consists of several individually twisted sub cords (or strands). This is shown in figure 5.2.

Figure 5.2; Accessory cord strands

The cord in figure 5.2 has MBS = 1200 kg, and has 9 strands. When removing 1 strand, 8 of the 9 strands remain in the sheath. The MBS will then be 1200·8/9 = 1066 kg.

> From a regulatory point of view, it is not allowed to remove a strand, as you now modified a certified product and then the certification no longer applies.

Some accessory cord may have just three core strands. In that case it is not recommended to remove a core strand as you lose 33% of the strength.

Removing a strand increases the flexibility, and reduces the static friction of the cord significantly. You can remove one strand by pulling onto one strand and milking the sheath. Gradually the strand will come out of the core. When done you need to milk in the other direction so that all strands are back in the sheath. Melt the ends to fuse the core with the sheath (braid). Do not shorten the braid. Mark cords with a missing core strand, as they no longer meet the specs.

Higher flexibility and lower static friction does not change the holding power of a friction hitch, but does increase locking significantly and reduces the no-load friction somewhat. Better locking requires less tension on the “shock cord friction loop”, or it is not required at all.

On relatively fresh rope that is used along its full length, the “shock cord friction loop” is mostly not required (from experience) when removing a core strand.

5.4. Retying of friction hitches

A friction hitch can be on a rope for a long time (adjustable lanyards). The friction is then always at the same parts of the sheath reducing its useful life.

To get the maximum lifetime out of your cords, it is better to retie them regularly so that the friction is at other positions of the sheath. Wiggle, push, pull and inspect your cords before retying the hitch.

5.5. Storing your prusik cords

Store your cords, especially cords that you use for climbing, out of sunlight in a cool, dry, ventilated place, away from chemicals (think of paint thinner alcohol, oils, fuels, etc.). Note that some specialist hitch cords have moderate to bad UV resistance. In general UV damage is not visible, unless the damage is such that the MBS has reduced so much that the rope or cord is well beyond safe to use.

Keep track of the manufacturing date and use history. Rope/Cord shelf life is 10 years. Check your cords before use. In case of any doubt, don’t use them for climbing or rigging anymore. You can use them for other applications (think of learning knots), as long as they can’t be mixed with cords you use for climbing or rigging.

When you remove a core strand to increase flexibility, mark the cord as it doesn’t meet the specs anymore.

6. Test your hitches!

6.1. Testing in general

Testing your hitches should give answers to:

1. Is its construction strong enough?
2. Can it be released?
3. Is its holding power sufficient?
4. Does it lock/grab when it needs to lock?

The first “rule” is to test your hitches under the circumstances that may occur and using the materials that you are going to use in your application. When using new rope, also test on used rope, as new rope becomes used when using it.

The first question is easiest to test, as it is just an administrative one. Use the right cord (type and thickness) in combination with the right knot and safety factor. Read the instruction manual on knot strength.

The second question is also relatively easy to test by applying some shock load and/or let it slide a few cm under load. When it can be released (easily) it is fine. You need to check this under real circumstances. That may be wet, dry, polluted, etc.

Question 3 and 4 are more elaborate, especially question 4. The last two questions are discussed below.

6.2. Holding power

This is the load force where the hitch starts to slip (or fails). A friction hitch may lock very well, but may have low holding power, and vice versa. Holding power and locking are two different things.

> Jerking onto a hitch to check that it grabs, does not automatically mean that it holds well.

The force it should withstand (without sliding), depends on the actual load (including peak load due to dynamics). In a DRT / MRS climbing system, the hitch only carries half your weight. This is similar to a work positioning line that goes around your back or connects to the left and right waist ring on your harness.

In an SRT system, or positioning line that goes directly from your harness to an anchor point, the friction hitch must carry your full body weight, and that is more demanding for the hitch.

The holding power (load were above slipping occurs) is mostly determined by the number of top turns and Dcord/Drope ratio. A double cord hitch (such as discussed here) needs generally more turns to hold well.

So check the holding power using the short descent and jump/bounce tests (paragraph 6.6 and 6.7) with a well tied hitch. Do it again with a somewhat loose hitch. Then you know whether you have sufficient margin.

6.3. Locking behavior

Locking is also very important, as when it doesn't, the outcome can be fatal.

When you tend a hitch with an elastic cord (no other tending device, see figure 3.3C), it does lock, even when the hitch is very loose. This way of tending is typically used during ascend or as let go protection when hoisting things. It can also be used as rope grab function when climbing into a construction where the rope is already in the top of the mast (so you don't need a Y-lanyard) Tending with elastic cord creates (near) zero slack, so you can't make a hard fall.

A very loose hitch you may recognize via the large distance between the top turns and the bottom turn(s) when loaded. Note that when using more top turns, the distance between the top and bottom of the hitch under load increases (due to cord stretch and rope compression).

In the event that the hitch doesn't lock during ascend, you can lock it manually and correct the issue.

Grabbing/locking

- Goes well when the no-load friction is relatively high
- Goes better when the cord is very flexible
- Instantly reduces when you load a rope below the hitch, as the diameter reduces.
- Instantly reduces when the hitch enters a region where the rope diameter is less (because of frequent use).

When having a hitch with 5 top turns, and the rope diameter reduces 1 mm (from zero load to full body weight), you have 19 mm slack inside the hitch. A hitch that wasn't already tight, may slide down when it is not loaded. When the load is removed from the rope, the rope becomes somewhat thicker and the hitch no longer slides down.

When you use a second friction hitch as a backup device (for example above your main hitch) it must lock. First sliding and then locking will introduce shock load, and it shows you that the safety margin is insufficient.

Tips to improve locking

- Keep the hitch lightweight, so do not leave longer cord tails then necessary.
- Do not use thicker cord then required for sufficient safety (thin cord is more flexible and weighs less and "bites" better)
- Use flexible cord (removing a core strand increases flexibility)
- Use a tight hitch, yes this may increase no-load friction at thicker parts of the rope, for example rope sections that were not loaded for long time.

6.4. Preparation for testing

Testing friction hitches involves putting a load onto it. The test procedures that are described here use your own body weight to test the hitches. Your body weight is used to load the hitch itself, to break the hitch, and to load the rope to reduce its diameter.

These tests involve risk of falling. You need to be prepared for that

You need

- A strong anchor point about 2.5 m above ground,
- a piece of rope that is the same as the rope you will use during the actual work,
- a foot loop (that can be just an adjustable rope loop)
- another reliable friction hitch to tension the rope.
- (climbing) harness as an option for loading the rope, and backup.
- Mats or other soft material to make a soft “landing” in case of falling.
- A backup line to catch you in case of falling (alternative for the mat).

You connect the rope to the anchor using a carabiner, or directly via a loop knot or eye termination (in case of a bar).

How to use a foot loop?
The foot loop (or just a rope loop) is an adjustable loop that connects to the carabiner that is in the eyes of the friction hitch. When you are not familiar with how to stand in a foot loop, you need to learn that first.

Stepping into the loop

Tie a reliable friction hitch at about waist level and adjust the foot loop so that it is about 20 cm above ground. Grab the rope tight with both hands at about neck level and pull it close to you.

Put your foot in the loop, bring your hips above your foot, and transfer you weight onto it. Pull the rope to your chest, push your foot backwards so that your hips remain above your foot, and straighten your back so that you don’t hang on your arms. This all goes virtually at the same time.

You may kick your other leg forwards. Other option is to place your foot on top of the one that is in the loop. Make sure to keep your hips horizontally to reduce stress on your back.

When you stay straight up and the rope touches your torso, the force to keep the rope to your chest is not that high. Pushing the other foot forward, reduces the load on your arms. You don’t hang on to the rope with your arms.

Stepping out of the loop

There are various ways to step out of the loop. The most energy saving way is to use your leg muscles. You may transfer some body weight onto your arms.

Grip the rope tight with both hands. While keeping your hips above your foot, bend your knee to lower your body so that your other foot can reach the ground. Take your foot out of the loop.

Only when you are sure your foot is out of the loop, you can release the rope.

Practice this with both feet. You may also practice standing with one arm, but that is more demanding. You may press the rope onto your body with your upper arm. The rope is than close to one of your armpits.

When a friction hitch is in a position close to your hands, make sure not to grab the hitch, or let your hands slide on top of the hitch, as both actions will send you to the ground.

Jumping into the foot loop
To test the margin of a hitch, you jump into the foot loop that is connected to the Hitch under Test (via the carabiner). It is easy to “double” your body weight during the jump.

As there is a higher risk of falling (due to human error or equipment failure) it is recommended to be prepared for that. Have mats or other shock absorbing material below you (such as in a gym). Other option is to wear a harness and connect yourself near slack free to the anchor point using dynamic rope.

Loading the rope
Loading the rope goes just via a friction hitch with foot loop that is at around waist level. The Hitch to Test is at a convenient working height. Instead of the friction hitch / foot loop method, you may use a harness. It works better as you have your hands free.

6.5. Testing for good locking

When using all measures from paragraph 6.3 optimally, it is likely that on a rope that is loaded and unloaded below the Hitch under Test, an unloaded hitch will slide down. This is just because of the dynamic variation of rope diameter. So be prepared for negative results and that the “shock cord friction loop” is required.

The tests below are for friction hitches that you use as backup above you at the same rope as you use for working. These are the most demanding conditions for a friction hitch. When there will be no dynamic load onto the rope below the hitch, some tests can be skipped.

Testing for unintended sliding
It is assumed that you already did the descent tests before these tests, as they affect sliding and locking also.

Do not load the rope yet. Move the hitch up and down and let the hitch lock to feel that it is tied correctly.

Wiggle with rope just above the foot loop hitch or eye termination to remove the stress in the core and sheath of the rope. Move the Hitch under Test down (without letting it lock) so that it is at the wiggled rope section. Wiggle with the hitch and the rope, to get the stress from previous loading out of the Hitch under Test. Let it lock with low load.

Now move the hitch above you, without loading it. During moving upwards, avoid that the carabiner hangs onto the eyes of the Hitch under Test. When you remove your hand, the hitch should not slide down. Load the rope with your body weight. The Hitch under Test should not slide down. You may repeat this test with a hitch that is somewhat loose. When the accessory cord is relatively stiff, the hitch will slide down when loading the rope. If so, this is a failure. Yes, when you pull the hitch it may lock, but it may slide down before locking, and that shows insufficient margin.

When you have a failure, repeat the test with the shock cord friction loop. The hitch should not slide down. Load the rope and push slowly on top of the top turns to feel how much margin you have. When only minor force is required to push down the Hitch under Test, you need to tighten the shock cord friction loop.

When the hitch does not slide down with repetitive loading and unloading of the rope in combination with wiggling, and you have some margin, you can go to the lock test.

Testing for good locking
Move the hitch to a position where the rope is free of stress (wiggling). Wiggle the hitch to remove stress and let it lock with virtually no load. Move the hitch above you without loading it.

Load the rope. The Hitch under Test should not slide. While standing on the foot loop (or hanging in your harness), slowly pull the load bearing eyes (mostly just pull the carabiner). The hitch must lock. Maximum 10 cm of sliding of the top turns is acceptable. Move it a bit upwards, and pull slowly again. After the first locking test, a friction hitch locks better next time in most cases.

Locking of a previously loaded hitch that has been released
Load the hitch heavily (with a foot loop, jump on it, etc). Remove the foot loop from the Hitch under Test. Release the Hitch under Test with only minor load onto the rope, move it a bit up and down. Load the rope (to reduce its diameter0 and slowly pull the hitch, it must lock without sliding. Sliding of the top turns of maximum 10 cm is acceptable. Move it a bit upwards and pull slowly again. It must lock.

You may repeat this test a few times, and with a hitch that is somewhat loose, so you know your margin.

When it doesn't lock reliably, you may tighten the shock cord friction loop somewhat to increase the no load friction. This will mostly result in a reliable locking hitch.

6.6. Testing the holding power

Testing for holding power should include the effects of

1. Deformation of the turns due to flattening of the cord cross section and stretch, increasing slack inside the hitch (figure 1.1).
2. Reducing of friction due to flattening of the cord surface that is in contact with the rope (figure 1.1C).
3. Glazing of the accessory/prusik cord area that is in contact with the rope, reducing the friction coefficient.

Though most friction hitches are not intended for frequent descending with full body weight, the HAH-Friction Hitch can be used for short descents. This may be useful to get your weight onto another device or in case of emergency. Due to the double cord, the friction force is divided over two sets of turns halving the contact pressure. This eases breaking of the hitch, and puts less (but still high) stress onto the rope and the cord.

Breaking the hitch under load is a good test to test its holding power due to reasons 1 and 2.

Short descent test
Position the Hitch under Test so that the foot loop is about 0.6m (2 feet) above solid ground. Grab the climbing rope (not the hitch) and step into the foot loop. Jump into the loop to see whether the hitch slips/slides. When it slides, you don't have to continue. You need an additional top turn (or more).

Be prepared that something slips during jumping

When standing in the foot loop, push onto the top of the hitch with your hands, so that part of your weight transfers from the foot loop to the top of the hitch. Slowly increase the force on top of the hitch, until it breaks and slides slowly down. You may wear safety gloves.

When it slides down you need to suppress your normal grab reflex, as that will send you to the ground. When it starts sliding, you reduce the force onto the hitch to control the descent rate. Descent about 10..20 cm. When you stop pressing/hanging onto the top of the hitch, it should stop sliding immediately.

Press onto the top of the hitch for the second time so that it slides about 10..20 cm. It should stop again when reducing the force onto the top of the hitch.

Carry out another (third) short descent. It is preferred to stay in the foot loop during these three short descents. Make sure that your feet don't touch the ground. jump into the foot loop (creating shock load) to check that it doesn't slip.

Three short descents of about 10 to 20 cm per descent, while remaining on the rope, are important. The descents are required as hitch behavior may change after the first descent due to rearrangement of the turns, cord stretch and flattening of the cross section. When it descent too easy after the third descent, add another turn and/or check for a loose hitch.

6.7. Testing for glazing effects

Three short descent tests are good for checking turns deformation. When doing more short descents, you can check for glazing and further flattening of cross section of the cord. You need to descent over larger distance, think of 3 m in total. Of course you can do this in many sessions so that you stay close to the ground. Just descent say 50 cm, step out of the foot loop, move the hitch up and descent again. Leave the friction hitch on the rope during all the tests. This assures that cord orientation doesn't change.

When you experience

- breaking of the hitch becomes very easy compared to the beginning of the test.
- sliding doesn't stop immediately,
- short slipping during jumping into the foot loop (shock load),
- unraveling of the braid/sheath

something is wrong. You don't have sufficient margin.

First check whether the hitch is less tight compared to the situation before the descent tests. This can be due to cord stretch, further flattening of the cross section, or due to setting of a bend. It is therefore advised to start with a hitch that is tight, as it becomes less tight during use. You may mark the cord sections that leave the bend or knot to check for giving out rope.

It should be noted that the HAH-hitch tightens itself, so rope stretch will result in larger eyes after several load/unload cycles.

Important note

> When the hitch is still tight enough after the test, but breaking goes easy, or it slips when jumping in the foot loop, there is likely glazing. You must use an additional top turn to increase the friction, and avoid slipping/descending during use.

An additional top turn adds no-load friction, but you can better be safe than sorry.

There is another reason for short descent testing, even when you will never on purpose descent using a friction hitch. You may arrive in a situation that shock load occurs. When holding power is relatively low, peak forces are limited because of slippage. That is a nice feature. However when the slippage causes glazing and flattening of the cord, and the hitch hasn't sufficient margin, it keeps slipping/sliding. This may end fatally. Therefore you need to be sure that a hitch has sufficient margin for its application.

When you plan to descent using the hitch, use cord with an aramid sheath (Kevlar, Technora, etc), and use a VT or XT hitch as that puts less stress onto the rope. Better is to use a device that takes over a significant part of your weight, or use a mechanical descender. Other option is to use a Moving Rope System configuration (MRS instead of SRS). Descending using a friction hitch with your full weight causes wear of your climbing rope. Nylon accessory cord is not suited for descending over large distance. You should only do it when you are run out of other options (for example you dropped something).

6.8. *Let's resume*

When the hitch passes all tests, you have a hitch that

- is strong enough, based on the cord, knots, expected load and type of hitch (just administration)
- releases well, also after receiving some shock load or a short descent (intended or unintended)
- locks well, also on rope that is loaded and unloaded below the hitch (diameter change issue).
- can hold the load with sufficient margin, including negative effects because of short descent, minor glazing of the cord and slight loosening of the hitch

When you change something in your setup, the above statements are generally no longer valid.

- When you use thicker cord, you need to test again. The holding power may reduce due to slipping, and locking performance worsens, as thick cord is less flexible.
- When you use thinner climbing rope, the holding power reduces and the locking performance worsens.
- When going from PES to PA accessory cord. When the flexibility is the same, the locking power reduces (slipping) due to the higher stretch of PA (Nylon).
- Increasing the number of turns is fine, the holding power increases and the no-load friction increases.
- When your new accessory / hitch cord is less flexible, its locking performance worsens.

You may think, everything is fine now, so I don't need a backup hitch. When putting your life onto a hitch, a backup is highly recommend (yes, I know many people don't). A backup hitch is on another rope, or above your primary hitch.

When using a hand ascender, add a short lanyard between the hand ascender and your harness. This adds safety when the hand ascender or your friction hitch fails. It gives you time to correct problems.

Check your gear continuously during and outside your activities, and be your own devil's advocate.

Make sure you have sufficient spare material with you, so that you can resolve problems.

Don't forget, climbing is dangerous. This document is not a substitute for good training on how to tie friction hitches and how to test and use them.

7. Annexes

7.1. Annex 1, adjustable loop hitch

This hitch is intended for creating adjustable loops where the load is inside the loop (ring load, parallel load). It is not suited for eye terminations (such as a figure 8 loop termination).

When tightened, it doesn't come loose when wiggling.
Little effort is required to release the hitch when you need to adjust is.

Tying the hitch
Figure A.1.1 shows how to tie it.

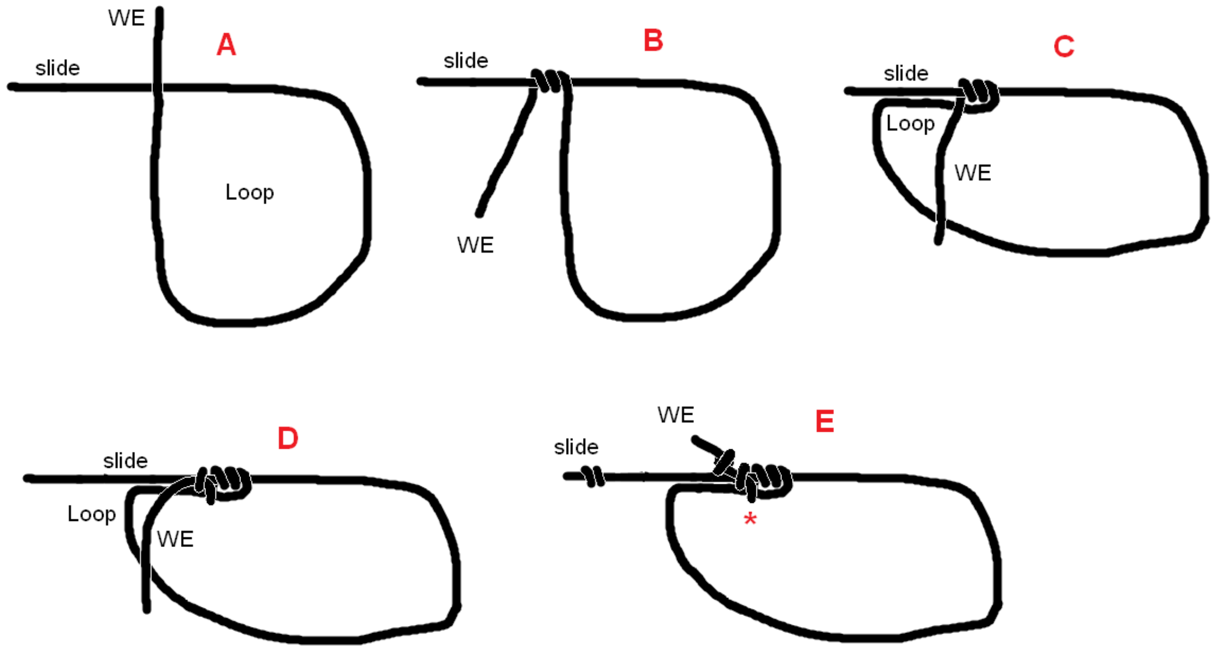

Figure A.1.1; adjustable loop hitch

Figure A, B
Start with a loop and apply 3 turns. 3 turns are mostly sufficient to create a friction hitch that has holding power >35% of MBS when using polyester or nylon cord.

Figure C
Fold a short section of the loop parallel to the slide rope section.

Figure D
Tie an overhand knot around the slide and loop rope section. The winding direction is the same as for the 3 turns.

Figure E

Put an overhand stopper knot in the working end and dress the hitch so that the overhand stopper knot touches the hitch. The E-figure shows some distance between the stopper and the hitch, this is for clarity only. There should be no clearance.

Tie a double overhand stopper knot in the slide rope section so that you can't pull through the sliding end by accident.

Making the loop larger

When the hitch wasn't heavy loaded (see figure A.1.1E)

Grab the hitch with your left hand at the most right turn and pull through the cord with your right hand.

When the hitch was heavy loaded

You first need to release the hitch. Grab the three turns with you right hand, and push the overhand knot with the thumb of your left hand to the left side. You put your thumb at the position of the red star in the E-figure.

This action creates sufficient cord inside the hitch to pull rope through the hitch when you grab the hitch at the most right turn.

Making the loop smaller

When the hitch wasn't heavy loaded

Grab the most left part of hitch with your right hand, and pull through the rope with your left hand.

When the hitch was heavy loaded

You first need to release the hitch. Grab the three turns with you right hand, and push the overhand knot with the thumb of your left hand to the left side. You put your thumb at the position of the red star in the E-figure.

This action creates sufficient cord inside the hitch to pull rope through the hitch when you grab the left side of the hitch with you right hand.

For making loops for tending a hitch without a ring, use 3 to 4 mm of Polyester or Nylon cord. When having very flexible single braid cord, you may use 5 mm as this reduces friction. PP (Polypropylene) is not recommended because of higher friction and low abrasion resistance.

You may also use the good old Blake's hitch.

7.2. Annex 2, VT style hitches

Introduction

The VT hitch combines a two strand large advance braid with wrapped turns on top of it. The braid carries a major part of the load so that the wrapped turns receive less force. The advance of the turns of the braided section is so large, that it can't carry a load on its own.

Because of only a part of the load force reaches the wrapped turns, the VT-hitch can be easily broken to descent.

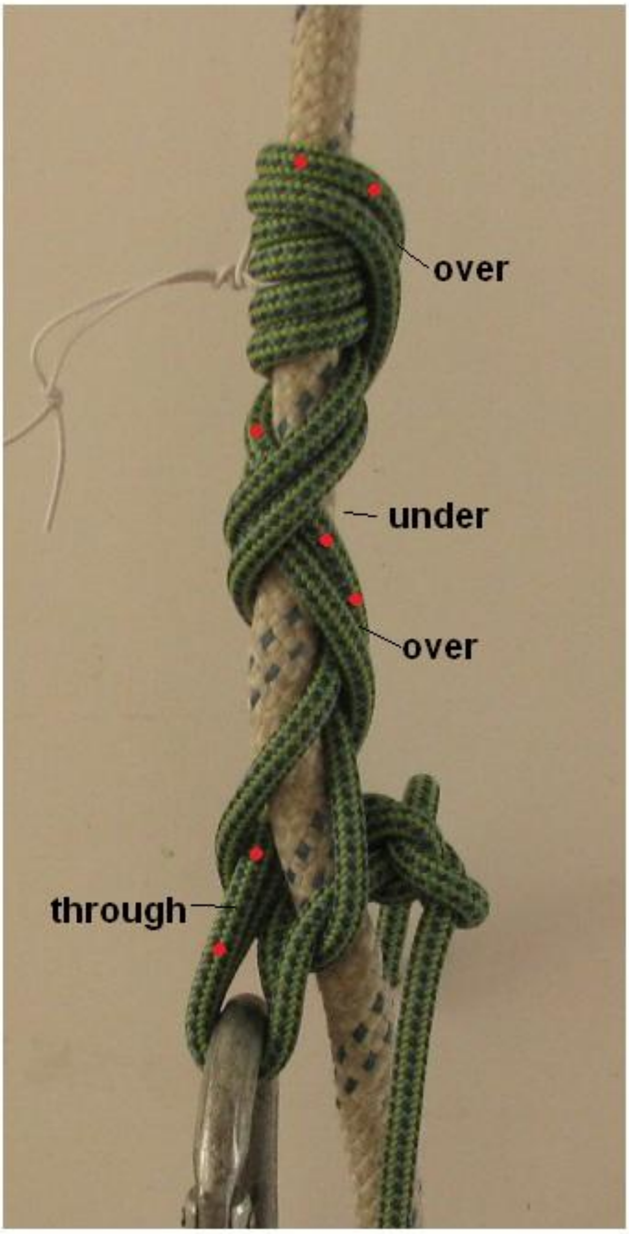

Figure A.2.1, VT hitch with HAH-hitch termination

VT-hitch with HAH termination

Figure A.2.1 shows a photo of a double cord VT hitch using the termination of the HAH-hitch.

There are 3 double turns above the first crossing of the double turns. The crossing is virtually behind the rope.

The very open braid is the part that takes over large percentage of the load.

It is a braid, not just turns on top of each other. The red marked cord section that goes down from the top first goes over existing turns (on the back), than under it, then over it, and then through the bight.

The over/under/over/etc. pattern is typical for a braid. It assures that the geometry of the braided part is stable (doesn't change much).

It was a surprise that it holds with 3 double turns. The rope, just a gift, no longer in use, very old, is about 12.5 mm thick and rough compared to my 10.5 mm LSK ropes. As it is just a piece of rope that I use to test things, its diameter varies along its length.

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The Prusik cord is 6 mm Mammut cord (7 mm would really be better for descending).

Though it does hold when it locks (jumping on a foot loop, descending, etc), it doesn't lock reliably. The "shock cord friction loop" is used for the tests.

On my regular 10.5 mm rope 3 top turns do not hold when jumping, so 4 top turns were used when testing on relative fresh 10.5 mm rope. That goes fine. Descending goes very smooth compared to a 5 or 6 double turns HAH-friction hitch.

The cord wasn't long enough to get an offset overhand bend in the tails to secure the square knot.

The "shock cord friction hitch" is tied out of 1 mm thick elastic cord using a buffalo hitch, instead of a Girth hitch (figure 4.2). The buffalo hitch ties and unties easier then the girth hitch, but is difficult to inspect.

As with the regular HAH-hitch, there is a pressure point at the lowest part of the bight (that is closest to the carabiner).

Autoblock hitch with braided eyes

The friction point at the bight can be avoided by just tying a braid below an Autoblock hitch. In fact a double cord Valdotain Tresse Hitch. Note that "tresse" is the French word for braid.

The braided eyes carry most part of the load and maybe 20% of the load is transferred to the top turns. Figure A.2.2 shows an Autoblock hitch with a braided lower section.

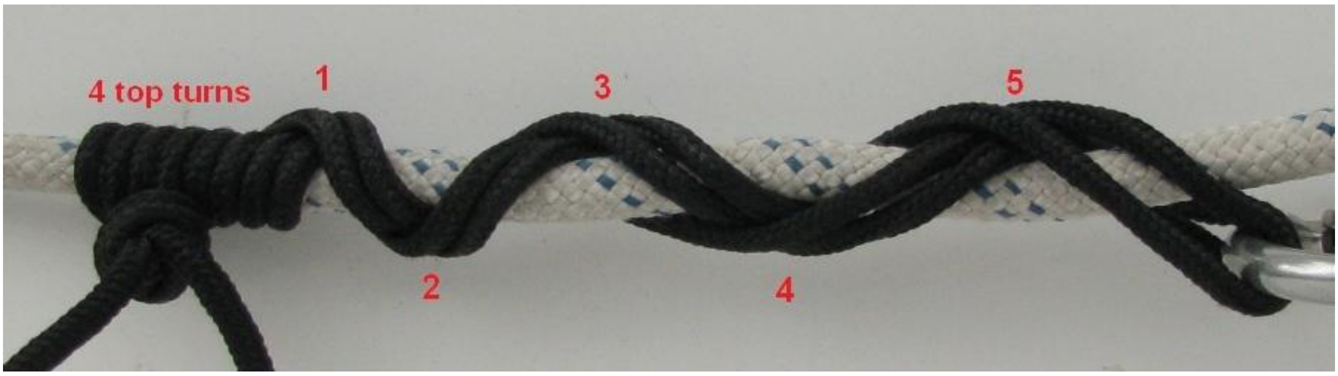

Figure A.2.2, VT hitch using a double cord (autoblock with braided eyes)

The offset bend must be in the top section to make sure it just receives a fraction of the load force. The example hitch is made out of 6 mm Polyamide from a local DIY store (not recommended). Yes, the material is tested for melting point and density to avoid getting Polypropylene instead of Polyamide cord.

The hitch in the picture (using a Half Gibbs offset bend) was tested under controlled conditions over a 20 m descent distance.

Disadvantage of tying a VT hitch with a double cord is the twist that occurs in the cord. You need to counteract that during tying the hitch; otherwise you get unacceptable twist in de cord. When using very stiff cord tying the hitch may be hard to impossible.

Do I use such braided hitches?

I haven't used them in a working situation. They were tied out of curiosity, but with an escape scenario in mind. I do not regularly descent with full body weight on friction hitches, so there is no real need for it.

Unless you "rope walk" (foot and knee ascender) its ascending efficiency is bad because of the large sitback compared to the standard HAH-hitch (or other "turns only" hitches). Due to the large number of turns/braids, the no load friction is relatively high.

The escape scenario is to get away from wasps when working in a mast with a (temporary) Semi-Static rope (to Std. EN 1891) in the top.

Braided hitches are long and that may be a disadvantage in some situations. You, or something else, may accidently push onto the hitch, resulting in an unintentional descent.

Don't forget there are more variables in this hitch. This increases the risk of human error.