HIGH STRENGTH SOFT SHACKLES
USING THE “BRION TOSS BUTTON” KNOT

Last modified July 2023
(This document is work in progress spanning several years of making and extensively using soft shackles)

"High Strength" soft shackles made of UHMWPE single braid (eg Dyneema or Acera Amundsen or Spectra or Stealth Super-12) have a breaking load of approximately 230% of line strength. This is 30% higher than the design that uses a Diamond knot as a stopper. This is achieved by burying the tails in the legs at the base of the stopper and therefore strengthening the weak point of the shackle. The eye at the end becomes the new weak point.

High strength shackles come in various forms, one of which is made using a button stopper knot. Coming up with this design and testing it was a team effort by Brion Toss (who developed the button itself), Allen Edwards and Evans Starzinger.

Brion modestly called the button stopper that he developed a “Button knot”. No name at all really, as there are over a hundred types of button knots listed in The Ashley Book of Knots. In the second edition of his book The Complete Rigger’s Apprentice, he does not even take credit for developing this knot, but from the long thread on Sailing Anarchy that he contributed to at the time, it is clear that this was his invention.

Very sadly, Brion passed away on the 6th June 2020. This is a great loss not just to his family and closest friends, but to the entire sailing community.

I admired him tremendously. Not just for his depth of skill and knowledge, but for his enthusiasm and passion for passing on his skills.

I am going to start referring to this knot as the Brion Toss Button. If it catches on, which I hope it does, it will be only the second knot in history to be named after a person. The Matthew Walker knot is the other. That is also a stopper knot and also possibly named after a rigger.

I think this is a small tribute we can pay to a great man.

Why bother with this stronger shackle when you could bump up strength just by using a thicker line and making the "easy" design using a Diamond stopper? Firstly, without a stumpy bit poking out of the top of the stopper, opening and closing soft shackles made with Brion Toss Buttons is significantly easier when fingers are cold and wet. Secondly, there are applications such as connecting anchor chain to snubber where line diameter is limited by chain size and cannot simply be bumped up. Thirdly, it is not much harder to make once you have conquered tying the Brion Toss Button. Last, but not least, I think they are mini works of art.

Dozens of these shackles are currently in use on our boat.

The early instructions I found for tying the Brion Toss Button were downright scary, and viewing was not for the faint hearted. Some of these have since improved, but I initially struggled. The button is a bit complex to weave correctly the first few attempts, but that wasn't actually the hard bit. The main difficulties I had with it were:
1. In the very final step working out exactly where to poke the ends relative to the standing ends
2. Dressing (ie tightening) the knot. It collapses easily if tightened carelessly.

I found easy ways to overcome these problems so several years ago I photographed the steps with my explanations to help anyone trying to learn how to tie this knot. The tips can be used in conjunction with other instructions if you find any of them make more sense to you. Once you know what you are aiming for, I think the Brion Toss Button becomes no harder than the Diamond knot to tie. With enough practice I can vouch that it can even be tied with your eyes closed.

“BRION TOSS BUTTON” KNOT INSTRUCTIONS

I am starting with the button, as that is the only complicated bit when making this High Strength soft shackle. The rest is child's play. I have used thin, easy to handle double braid polyester line of different colours to demonstrate this.

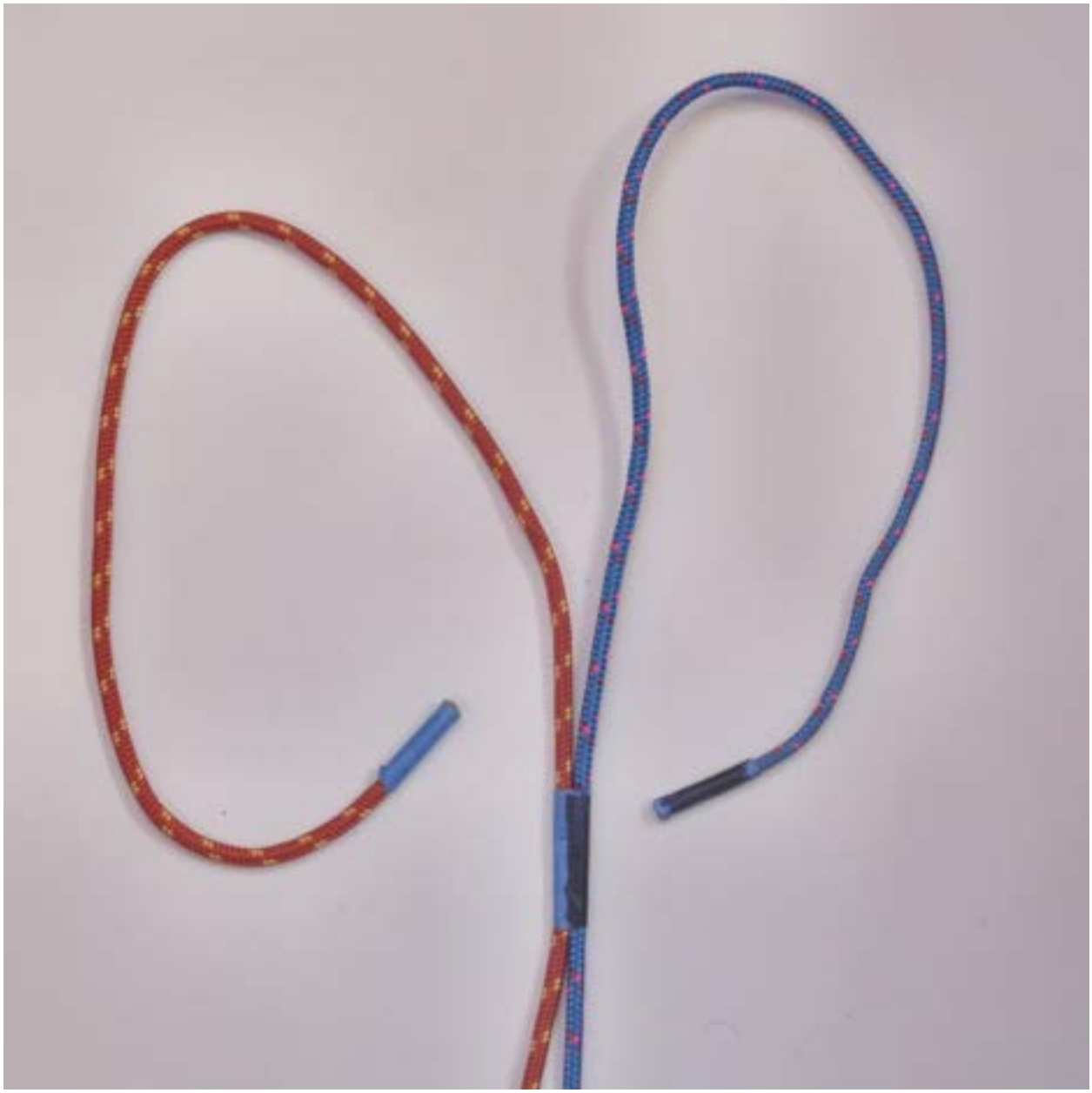
TIP: Tie a few Brion Toss Buttons first in different coloured double braid to get the hang of this knot before you attempt it in soft, slippery, unsheathed UHMWPE (such as Dyneema, Spectra, Acera or Stealth Super-12).

TIP: Remember that if you use this method, the working ends continually move anticlockwise and the knot is tightened with the lines moving anticlockwise as well. This helps if you get a bit stuck.

Step 1:

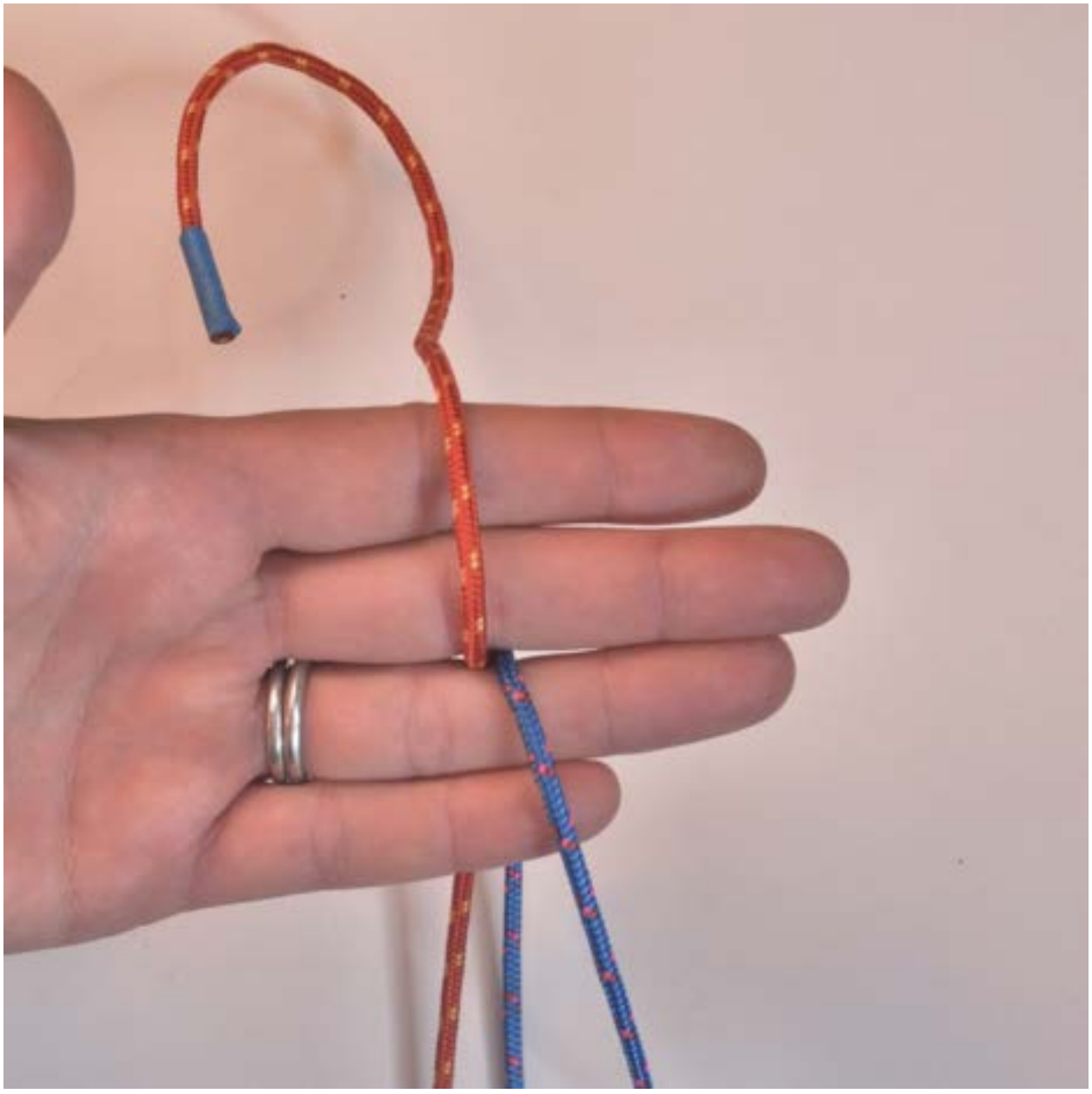
Firmly tape the two standing portions of line just below the spot where you want to form the button. This makes the button MUCH easier to tie. Taping the ends of the line to stop it fraying is optional.

Trim the ends to be of equal length, so that you can later check that you have tightened up both portions evenly (the tails should be of equal length when you have tightened up the button).

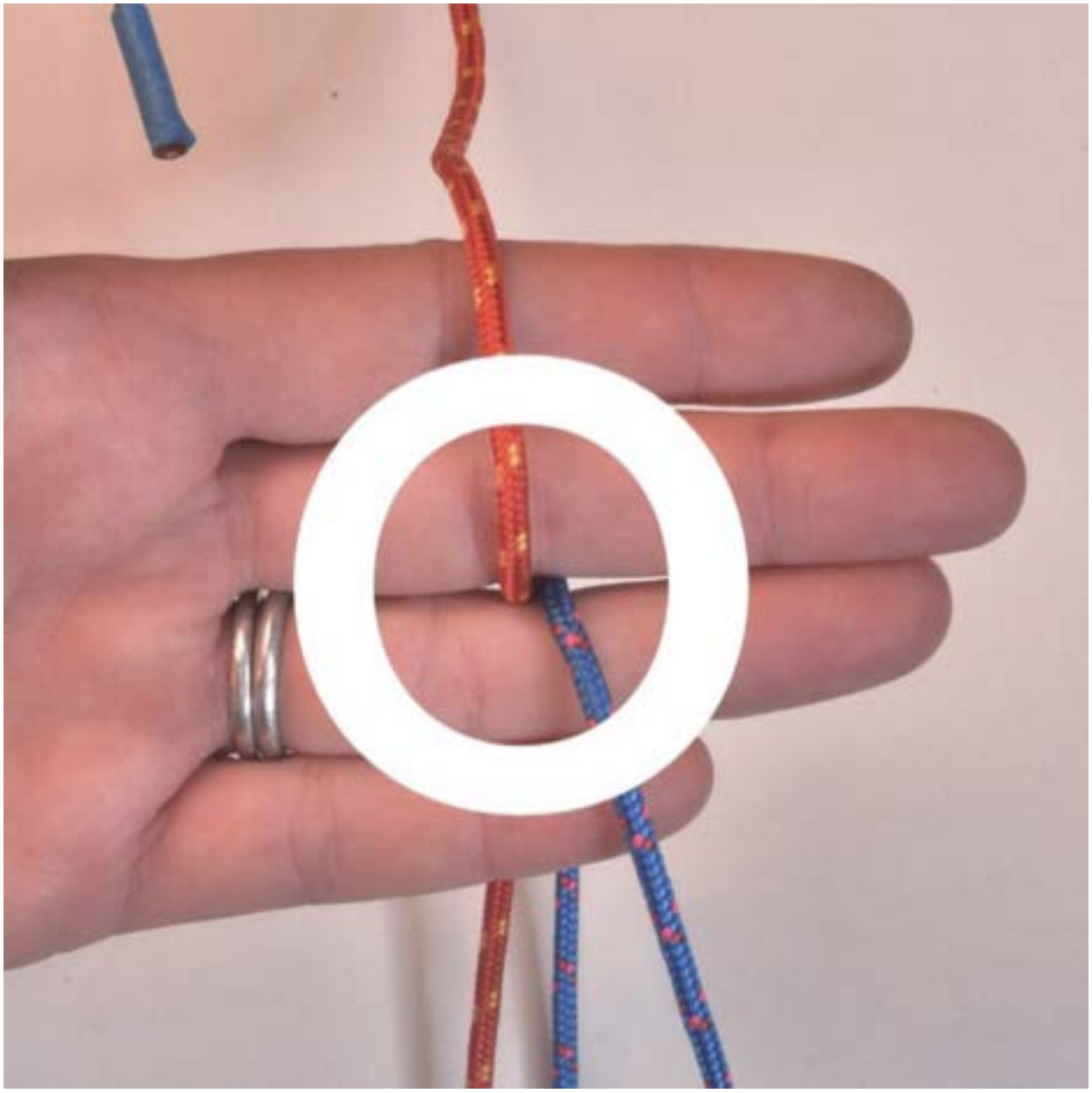


Step 2:

Grip the line between your fingers near the top of the taped bit as shown below.

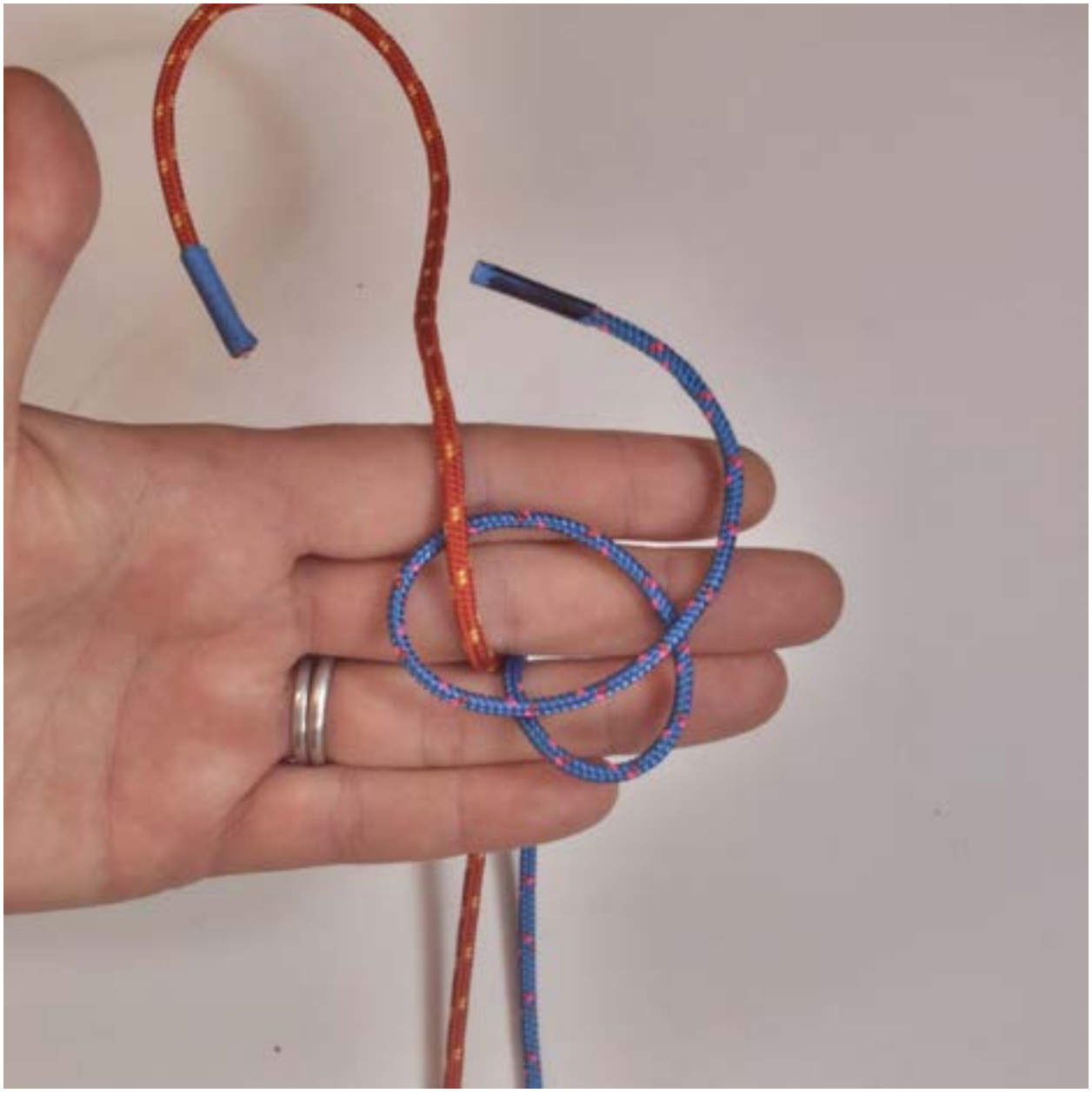


Remember this pattern of emerging lines, as you need to reproduce this at the end:



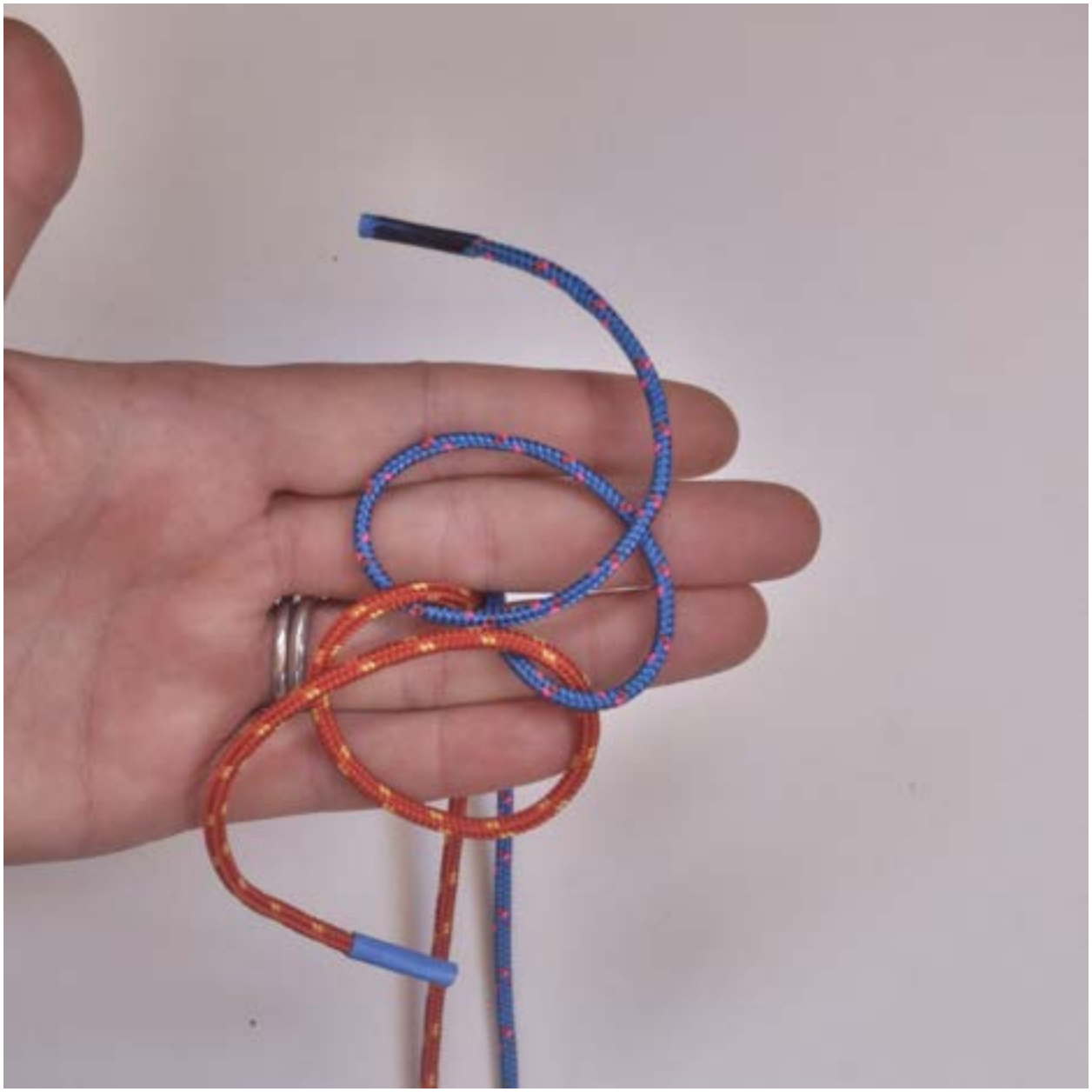
Step 3:

Pass the blue line anticlockwise under the red one and lay it over the TOP of the blue loop formed:



Step 4:

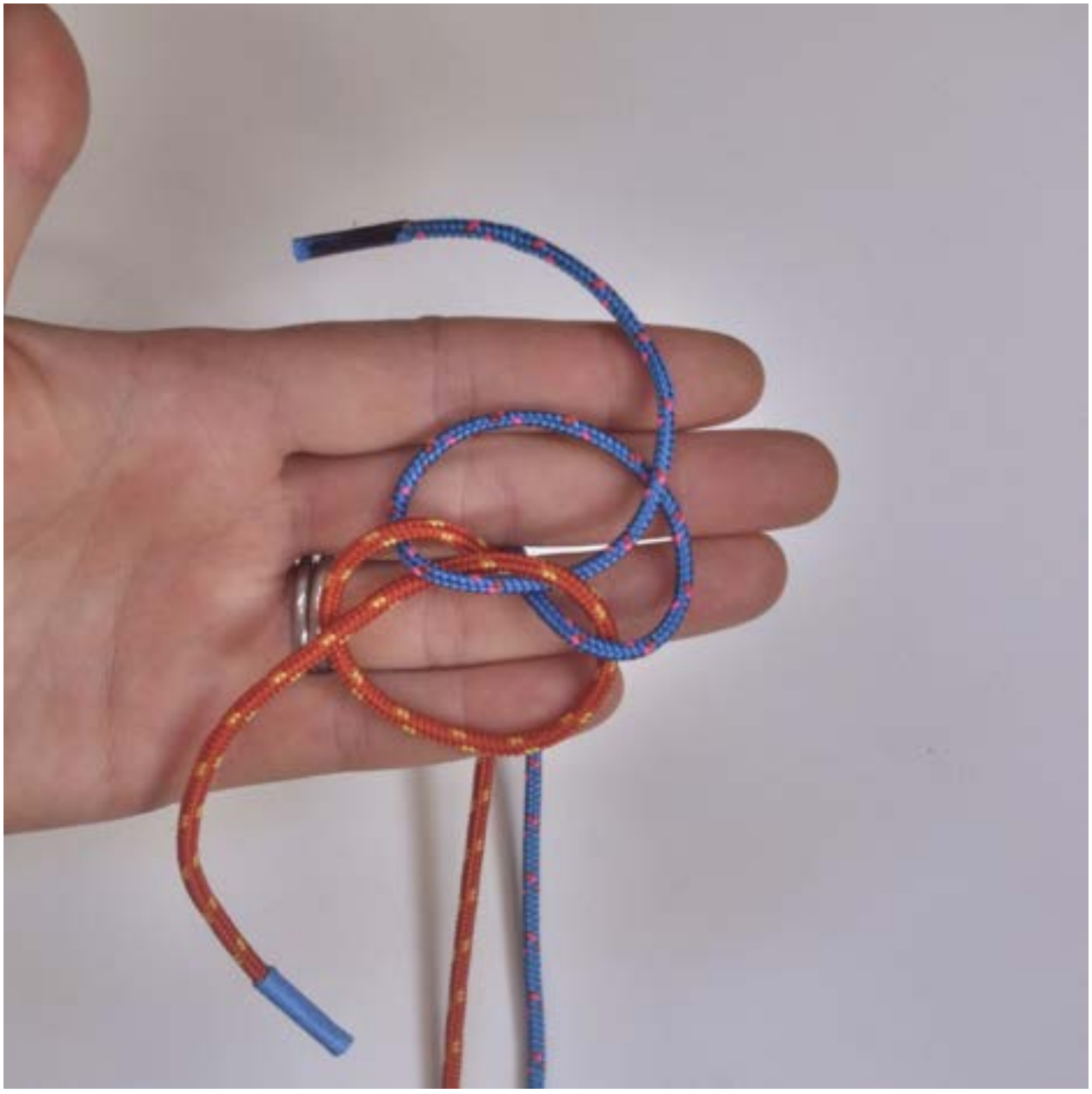
Bring the red line anticlockwise and pass it under the loop of the blue as shown:



Step 5:

Cross the red over and under the blue working line in the centre.

TIP: Keep this crossing centred over the top of the taped bit while you continue working.



Step 6:

Bring the blue line around anticlockwise and under two bits of the red as shown:

Step 7:

Bring the red line around anticlockwise and under two bits of the blue as shown (make sure it passes under the working end of the blue line initially):

Step 8:

Open up this crossing in the centre widely by moving the red and blue lines in the crossing at the centre, as shown:

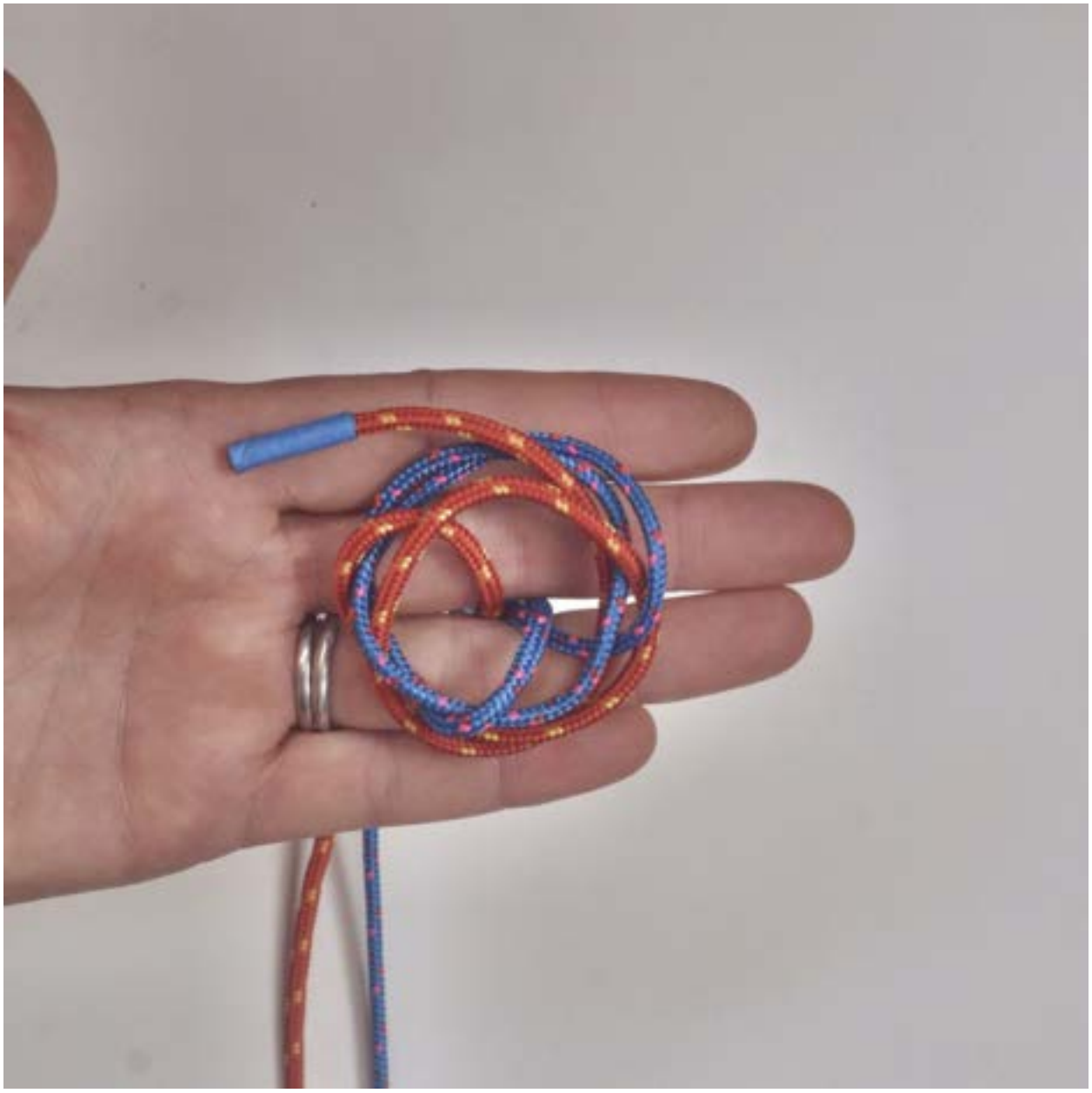
This is what you should aim to end up with:

Step 9:

Arrange the two bits of the standing end that emerge immediately from the tape so they look as they did in Step 1. You will be poking the two working ends on either side of the taped standing ends through the big gap you have created, on either side of the taped standing ends. The blue line will go into the blue circle in this photo. The red line will go into the red circle. It is important that the red and blue lines emerging from between your fingers follow the same pattern as they did in Step 1:

Step 10:

Poke the blue line down through the gap between your fingers just to the right of the taped standing line (note that this places the blue working end adjacent to the blue standing end):



Step 11:

Poke the red line down through the your fingers just to the left of the taped standing line (note, this places the red working end adjacent to the red standing end):

TIP: Lock this configuration between your fingers until the knot has been tightened up the first time. This helps to ensure the weave at the top of the button will be correct.

Step 12:

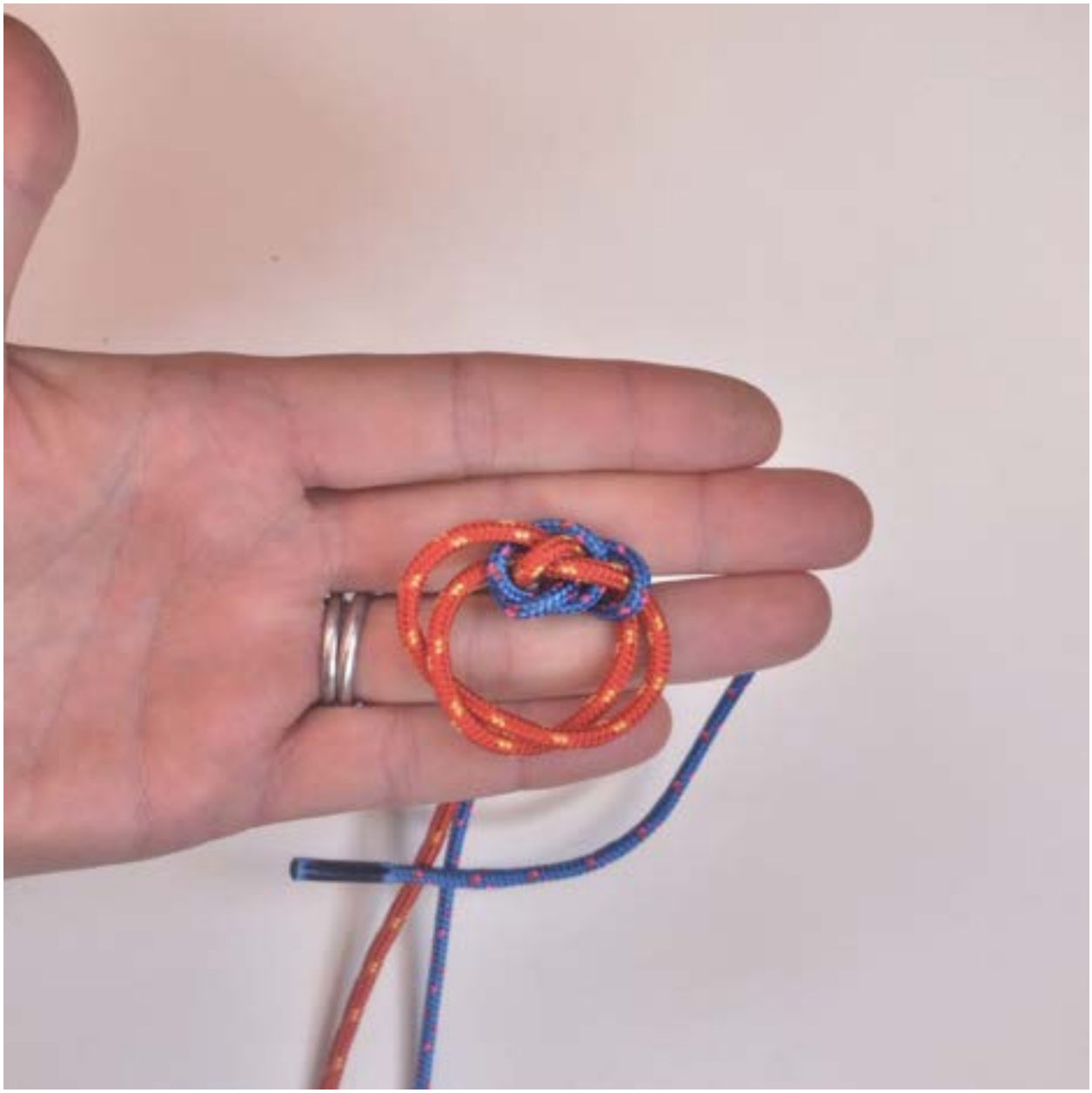
Dressing the knot:
Very lightly pull on the two working ends from below and coax into a loose, neat shape in the centre. **This will end up being the top of the Button so don't over tighten.** Do NOT attempt to enthusiastically tighten up the two big loops on either side of the centre by tugging on the working ends. This will truly stuff it all up, as it draws what should be the top of the Brion Toss Button down towards the base. The result is very ugly if you do that.

This is how it looks after the working ends are very lightly tightened:

Step 13:

Dressing continued:

Continue gripping the working ends and taped standing ends in the correct configuration. Starting from the top of the taped blue standing end, tighten up the blue line just enough to lightly snug it up. Make sure the first bit tightens BELOW the portion identified above as the 'top' of the button. You need to try and leave this "top" portion as high as you can. Tighten all the way around and take up the final slack in the line by giving it a LIGHT pull on the working end. After the first line is tightened it looks a bit of a mess, but don't worry, as long as you didn't yank on the working ends initially, it will all come good:



Step 14:

Dressing continued:
Repeat with the red line. If you give the knot a little wriggle between your fingers to even it out, you should now seemingly miraculously see a lovely symmetrical pattern.
If it looks right, it is most likely is right.

Step 15:

Dressing continued:
It is now fine to release the grip on the base of the button. Starting from the base of the knot go around once more, tightening up as firmly as you can (I find a marlin spike helps enormously). To complete the hand tightening, slip on a big washer so that it sits right under the button, pop the button under the jaws of a vice (don't tighten the jaws, they should not grip the line at all) and pull on the taped standing pair as hard as you can, then each working end in turn. Repeat. It should feel rock solid at this stage. The button will now be smaller and extremely hard.
This is the side view:

TIPS:
Before making your first soft shackle using the Brion Toss Button, practice tying the button in UHMWPE. It is a LOT harder than using thin, differently coloured double braid, as the material is so slippery.

When you are first learning, mark one of the lines both at the end and the base of the knot with a marking pen. This helps identify the line as the “blue one” and makes the instructions easier to follow using UHMWPE.

On Cruisers Forum, Harry from S/V Juno posted an additional tip. When he was first making these using dyneema, to identify the blue line in the instructions he ran a length of contrasting coloured whipping line in and out of one leg with the stitches about an inch apart leaving a long tail with no knot at each end. Before tightening up the button he pulled the thread out.

Initially allow lots of extra line, as a minimum length can only be used if you are skilled. Novices will need to allow a significantly greater amount to tie the button.

When you become proficient at tying the knot in UHMWPE, measure how much length you need to tie the knot. This will help you determine exactly how much line you need to make the soft shackle and help prevent wastage.

INSTRUCTIONS FOR THE HIGH STRENGTH SOFT SHACKLE

To make the smallest possible high strength soft shackle of this design (one with no central crossover), I have found that the absolute minimum length of single braid UHMWPE line such as Dyneema or Spectra or Acera Amundsen or Stealth Super-12 (in no particular order) needed is 240 x line diameter.

Unless you are highly experienced, allow at least 250 x line diameter. For example, 1500mm if using 6mm line. This leaves a little extra length to help tie the Brion Toss Button more easily. Increase the length if you need a longer shackle or if you don't have much experience tying the button.

For longer soft shackles, the length of line that you need =
(twice the required finished length of the soft shackle from the tip of the eye to the base of the button when it is open) +
10 x line diameter (= roughly the amount the two central portions will shrink by when the tails are buried) +
(the minimum amount you need to tie a Brion Toss Button in the chosen line diameter).

The minimum amount needed to tie the button leaves enough length for the bury of the ends, so this does not affect calculations.

During the following process, ensure that the line is not twisted at any stage. This will weaken the soft shackle.

STEP 1

<u>FORM THE EYE AT THE END:</u>
- If you are using only lightly coated UHMWPE, tape the ends of the line to stop them unraveling while you work (Stealth Super-12 and Acera Amundsen are quite stiff and don't need to be taped).

- Find the halfway mark. Roughly 7 x line diameter below this point squish the line together to loosen the weave and using a marlin spike or knitting needle or ball point pen with its point retracted (I find a fid too sharp for this), poke a hole cleanly through the centre of the line **leaving 6 strands on each side and making sure none of the strands are snagged**. The exact hole position needed is determined by the required eye size, but for now the selected point is not critical, as the ends will be trimmed precisely later.

- Poke the longer end of the line through the hole. A fid helps, but is not essential. A bit of thin stainless steel wire doubled over works best of all.

SIZE OF THE EYE:

The eye will have 4 lots of line passing through it when the soft shackle is closed. If it is made only just large enough to fit this, the super tight grip will create a sharp throat angle and weaken the eye. Also there is then no room for error. If the legs ultimately shift slightly and the eye becomes even a whisker smaller than the size able to hold 4 lots of line, then the loading is on one leg only and the strength skydives.

The critical thing is to make the eye larger than 4 lots of line, but smaller than the knot itself. The eye on many commercial soft shackles I have seen is way too small (as it is on many of the instructions presented online) and the resulting noose will limit their strength. I think constant references to the eye as a noose (there is nothing noose-like about it) and the concept that the eye must be super snug for soft shackles to work are largely to blame for these errors.

I have looked at the appearance of various sizes of eyes carefully under load (applied on a winch) and without making the eye excessively large I think the sweet spot is an eye size capable of holding somewhere between 6 and 8 lots of line. The base of the eye just looks very stressed (with strands subject to tearing force under load) if the eye is made smaller.

So what size do you go for? I was making the eye capable of holding 8 x line diameter for many years and it sat beautifully. These soft shackles were successfully used for multiple purposes on board our 49' aluminium cruising boat, including connecting sheets to headsail clews and the snubber to chain. In 2020 I read the first report I had seen of soft shackles on headsails opening inadvertently. No details of construction technique were given. It was suggested that making the eye "*tight*" (but not too small) reduces this risk while only weakening the soft shackle "*a bit*". I would personally not make the eye any smaller than capable of holding 6 lots of line tightly cinched. Taking the above report into consideration, the following directions use this value.

- Pull the ends to firmly tighten the eye around the 6 lots of line (simply bend the loose ends over a couple of times until you have 6 lots of line and feed them through the eye to determine the size), then tape the bent line tightly near the base of the eye to secure it. Gently pull out the bits of line that were used to determine the eye size. If you yank them out you may disrupt the size of the taped eye.

STEP 2

CREATE A “CROSSOVER” TO IMPROVE HANDLING:

This step can be skipped (Kohlhoff style soft shackles do not incorporate this crossover), but unless you are making a very small soft shackle where there is no room for a central crossover, include this to improve handling. It also stops the legs flapping wildly when not under load, which looks very disconcerting and may increase the rare risk of the soft shackle opening inadvertently.

Roughly 15-20 x line diameters (eg 90-120 mm if using 6 mm line) from the base of the eye create a hole cleanly through the centre of one line and poke the other one through (as you did earlier to form the eye). The position of this crossing is not important, but you do need to leave enough room to open the eye widely if you have passed one line through the other to create a lock. You also need to leave sufficient room between the crossover and the base of the button to bury the ends in the final stage.

Depending on which line you choose to form the hole in, a Brummel type lock may be created if you try to open the eye too far. I have recently NOT been using the configuration to produce a lock, finding this marginally better. The choice is yours.
- Tape the two lines again just past this crossover to secure the legs while measuring further.make sure none of the line is twisted during construction.

STEP 3

TAPE THE TWO LEGS AT THE POINT WHERE THE BASE OF THE BRION TOSS BUTTON WILL SIT:

- To allow for the bury of the ends, the **minimum** distance needed between the last crossover (either the one used to form the eye, or any additional ones you have added) and the base of the button is 35 x line diameter. Although only 30 x line diameter is being buried, extra length is needed for the legs, as this portion will shrink when the tails are buried.

- Firmly tape the lines together just below where you need the base of the button to sit. Remember the final length of the soft shackle will be approximately 10 x line diameter less than the selected length once the tails are buried.
- **Trim one end so that the two are the same length.** This will enable you to later see if you have tightened the stopper evenly.

- When you are making your first few, it helps to mark one end so that you can easily identify the "blue" line in the earlier instructions for tying the button. See the tips given at the end of that section for further details.

STEP 4

TIE AND HAND TIGHTEN THE BRION TOSS BUTTON:

- Using the earlier instructions, tie the button positioning the base just above the taped legs.

- Tighten the button as instructed earlier keeping the base positioned just above the tape. The button should feel rock hard at this stage.The two working ends should be of equal length if you have tightened the stopper evenly.

TIP: If your UHMWPE has been well coated and is very stiff, before tightening up the button with a marlin spike, soak the button in some warm water for a few minutes. It becomes very soft and significantly easier to tighten. It will stiffen up again when dry.

STEP 5

BURY THE TAILS THROUGH THE STANDING LEGS:

NOTE: If the button is not pretensioned manually until it feels rock hard, then pretensioning it on a winch before burying the tails will result in a skewed, weaker knot. If in doubt about your manual tightening skills then bury the tails before tightening the button further. After tightening on a winch, the entry point for the bury then ends up slightly further from the knot (the exact distance depends on how well you have tightened it manually), but the tails can always be pulled out and reburied closer after load has been applied on the winch if the button has moved significantly.

Load testing has shown that a minimum of 30 x line diameter is needed for the bury length (eg 180mm for 6mm line) to grip. If there is enough length in the central portion of the shackle to bury more than this, I don't trim the ends down to 30 x line diameter, but instead bury whatever tail length is left over.
- Very smoothly and gradually taper the last third of the tails, as you would with an eye splice, cutting the strands on a diagonal for an even smoother result. I find the ends are much easier to bury if they are tapered first (I do this with eye splices as well now).

Tapering example:

- It may help if you bury the tail into its corresponding standing leg rather than the other one. To identify the correct leg, hold the button and give the open shackle a little shake to see where the lines fall naturally. Looking down on the top of the button, the correct leg for each tail is the one that is immediately next to it clockwise (if you have tied the stopper anticlockwise to start with).
- **The tails need to be pulled through the standing legs as close as possible to the base of the stopper.** Rather than using a Selma style fid to push the working end through the centre of the standing leg, it helps to use a fid that pulls the line through from the opposite direction (eg a homemade wire fid or needle fid or splicing wand).
- When the tail has been pulled through, make sure the buried length is not twisted. Pull it through as much as possible then smooth the tapered end (it will be a bit scrunched up) before milking the outer portion down smoothly. The end will disappear into its centre.
- Repeat with the other tail.

STEP 6

PRETENSION THE SOFT SHACKLE:

Simply close the soft shackle, make sure it is not twisted and attach it between two winches and slowly but steadily winch it tight. Let it sit like this for at least 20 minutes. If this is not done, you may have reduced strength if a shock load is applied before the stopper has been fully tightened. It is better to be safe than sorry. UHMWPE has a low melting point and if the line in the knot starts sliding rapidly as it tightens up during a shock load, the fibres will melt and failure may occur.

Lately I have been rotating the stopper 180° and again applying load. This may be overkill, but it loads the stopper symmetrically.

This photo was taken when I was not burying the ends until after the final tensioning, but it gives you a general idea of the arrangement:

The final result:

A few additional notes follow on long shackles, captive shackles and reinforced eyes.

MAKING VERY LONG SOFT SHACKLES

When making very long soft shackles I include more than one “crossing” in the central portion to stop the legs flapping around disconcertingly when the soft shackle is not under load.

These crossings are very simple to do and are difficult to get wrong if a little care is taken to make sure 6 strands are left on each side of the opening and none of the strands are pierced, so unlike burying one strand in another I don’t think the added complexity has the potential to affect strength at all.

MAKING CAPTIVE SOFT SHACKLES

It is often useful to “capture” a soft shackle so that it cannot be lost when left open. A few of the soft shackles connecting our snubber and anchor chain escaped overboard before I adopted this practice.

Any soft shackle with twin legs can be made captive, but the eye it is attached to needs to be formed subsequently (or if the eye is already fixed the soft shackle needs to be constructed around it).

This is how a line can be woven through a soft shackle to capture it:

An example in use:

REINFORCED SUPER STRENGTH SOFT SHACKLES

The name is a little premature, as I have no idea how much stronger these are than the usual design, but the concept is intriguing.

The usual failure point in standard designs of high strength soft shackles is the eye. Burying a portion of line in the eye is an obvious solution and has been vaguely discussed in the past. I think Brion Toss and Evans Starzinger explored this option, but I had seen no photos or description of anything tried. I had not attempted this earlier thinking it was not viable, but since mid 2021 I have been playing with this.

Load testing reports are still needed, as well as a lot of experimentation regarding optimal insert diameter and length and amount of taper. If this design is significantly stronger than the usual “High strength” version, the appeal over simply bumping up line diameter to improve strength is the cost. Increasing the diameter from, for example, 6 mm to 8 mm line (the next readily available size) adds significantly to the price, as so much extra more expensive line is needed. Reinforcing the eye to increase strength just requires a small additional portion of line.

I have tried various diameters and I find it handles best in UHMWPE thinner than 8mm.

Currently my main use for this is when using 3mm line, not to increase strength, but to improve handling. It is usually hard to pick the eye open in a conventional thin soft shackle and as a result over time the eye tends to fray due to damaged fibres, but often 3mm is all that is required strength wise. Given 3mm line is so inexpensive (very cheap if purchased by the spool), significantly improving the handling of these soft shackles has been invaluable. I have found homes for dozens on board.

<u>My technique for 3mm line:</u>
- Cut a 160 mm length of 3mm UHMWPE to use as the insert.
- Gradually taper the last 40 mm from each end.
- Mark the line used for the soft shackle at the centre (the apex of where the eye will be) and 100 mm either each side of this.
- Feed the tapered insert between the extreme two marks, initially not allowing the tapered portion to bury at all.
- Firmly hold the marked centre, then let go of the tails and they should bury reasonably evenly either side of the centre.
- The hole for the eye is surprisingly easy to create despite containing the buried portion. After making sure the hole is centred and none of the outer strands are inadvertently pierced, just enlarge it with a marlin spike, pushing through the core.
- Then proceed with making the soft shackle the usual way.

To open the eye, push the stiffened leg adjacent to it rather than pulling on the eye itself. There is added friction where one thickened leg passes through the thickened portion of the other, making this easy.

Here are a cluster of 3mm easy to handle “Super Strength” soft shackles ready for action:

Photos of the “Super Strength” design made using 5 mm UHMWPE:

I hope these notes have been useful. It is largely due to the shared online contributions of many people scattered around the globe that have relatively swiftly enabled us to reach this level of excellence in making soft shackles. Many thanks to all those who have contributed.

Angela
(posting as Seaworthy Lass, on sailing forums)