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## Advanced Anchor Building

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## Equalization Considerations

In *Trad Climbing Basics*, we introduced various methods of creating belay master points by tying an overhand knot in a sling or cordelette.

These methods are safe, simple and perfect for most situations that a beginner trad climber would find themselves in. However, they have drawbacks in more complicated belay

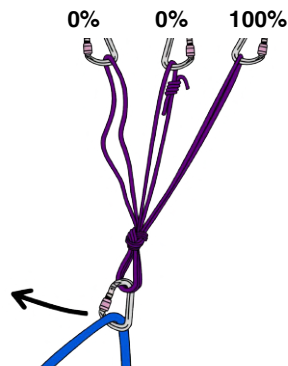
setups. The main problem with the overhand knot is that it does not spread the load equally between the pieces, especially if one strand is short, or if the loading direction changes.

This uneven distribution of force could mean that all of the force is applied to the poorest piece of the anchor.

### Loading Direction

When loaded directly downwards, each piece of this anchor will take 33.3% of the load. If the loading direction changes (e.g; the climber

moves to one side and then falls), 100% of the force will go onto one piece. This could cause that piece to fail.

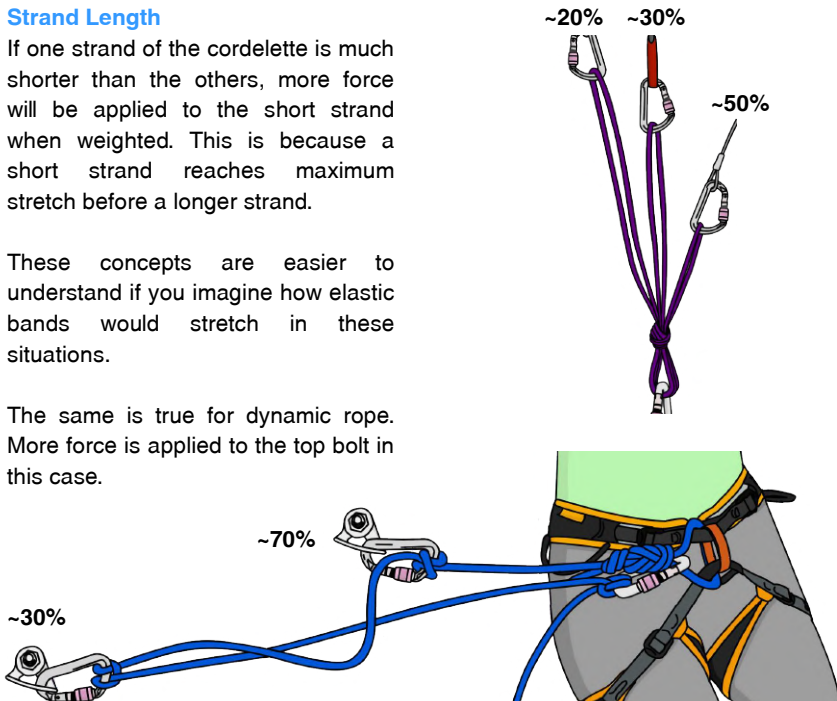


### Strand Length

If one strand of the cordelette is much shorter than the others, more force will be applied to the short strand when weighted. This is because a short strand reaches maximum stretch before a longer strand.

These concepts are easier to understand if you imagine how elastic bands would stretch in these situations.

The same is true for dynamic rope. More force is applied to the top bolt in this case.

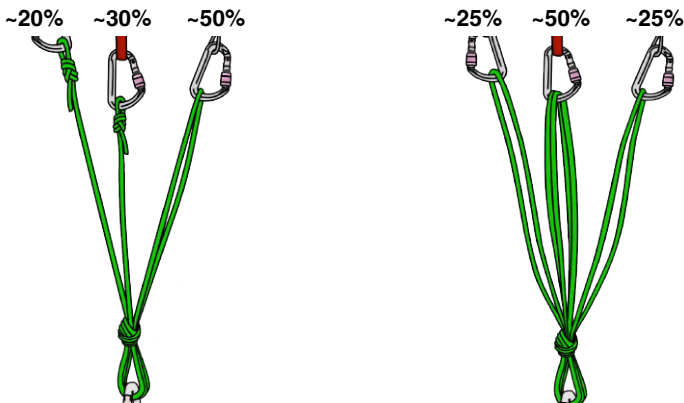


### Number of Strands

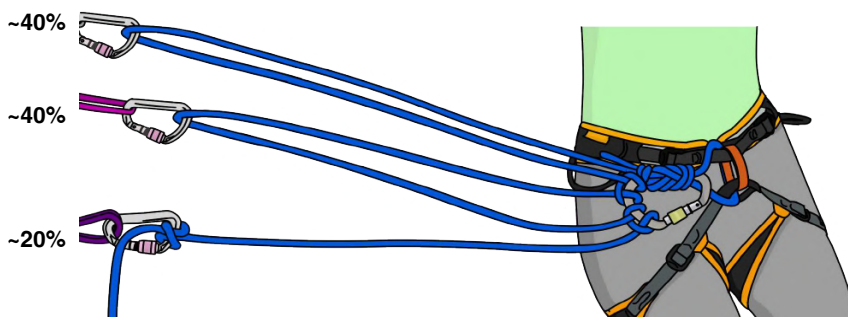
A double strand of cord (or rope) stretches less than a single strand when weighted.

More force is applied to the right piece in the example below.

In this anchor, the strand of cord on the center piece has been doubled up to keep the master point higher. Because of this, more force will be applied to the center piece when weighted.



Similarly, more force is applied to the upper two pieces in this anchor.



Getting perfect equalization is not so important for situations when each piece of the belay is bomber. In most cases, the variations described on the previous pages are fine.

However, in more complicated belay setups, or for equalizing marginal lead protection, a self-equalizing method could be much safer.

## Self-Equalizing Anchors

### Advantages

The main advantage of using a self-equalizing anchor is that it continues to distribute the load equally between the anchor pieces as the loading direction changes.

This maintains a lower force on each piece, therefore decreasing the likelihood of anchor point failure.

This is especially useful when equalizing marginal pieces of lead protection.

### Disadvantages

The main disadvantage of using self-equalizing knots at the anchor is that if one piece fails, the whole belay shifts. This shift is barely noticeable on a well set up anchor. However, with some setups the sudden jolt could cause you to lose control of your belay device.

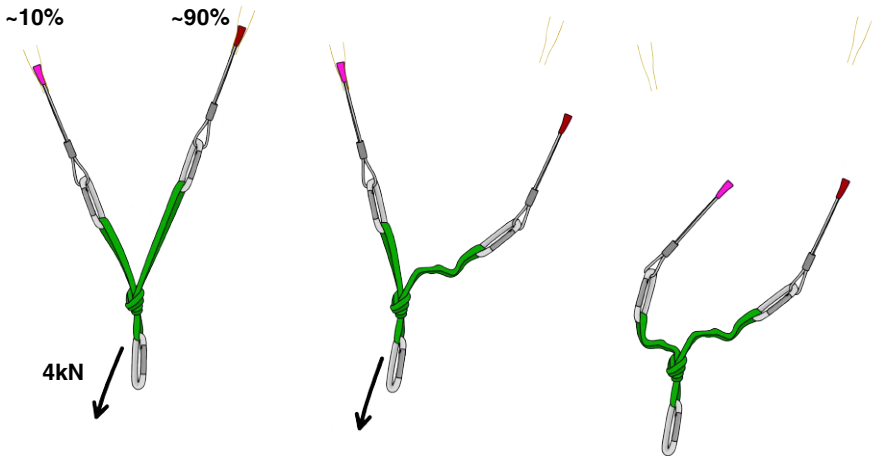
Be careful where you use self-equalizing anchors and make sure to tie appropriate extension-limiting knots to reduce the possible sudden shift in belay position.

### Example

If two micro nuts are equalized with an overhand knot as shown, it is likely that one of them would take most of the force of a leader fall.

This could be due to a slightly off-centre adjustment of the knot, or a

slightly different loading direction (you may not fall directly downwards). If the fall generates 4kN of force, it will cause the 3kN piece on the right to fail. This will put 100% of the force on the remaining piece, which will most likely cause that to fail too.



If the same two micro nuts were equalized with a sliding-X, the knot would self-equalize during the fall and distribute 50% of the force (2kN) onto each nut. The nuts would then be much more likely to hold the fall.



## The Sliding-X

The sliding-X is useful for:

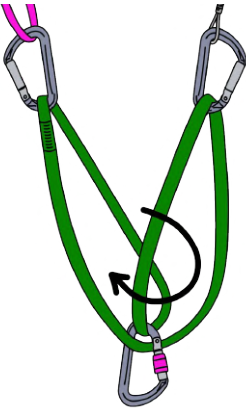
- Equalizing two pieces of trad gear as part of an anchor
- Equalizing a two-bolt anchor for top roping
- Equalizing two pieces of lead protection

### Step 1

Clip a sling through two pieces of gear. Make sure the sewn section of the sling is near the top of one of the pieces so it doesn't interfere with the sliding-X knot.

### Step 2

Twist the sling 180 degrees and then attach a carabiner to it. The central point will now be equalized even when the pull comes from different directions.

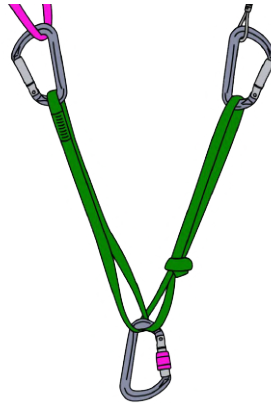


### Step 3

Position the central point where you want it. Unclip the sling from one piece and tie an overhand knot near to the central point. This is known as an extension-limiting knot. The closer to the central point you tie them, the less the anchor will extend if one piece fails.

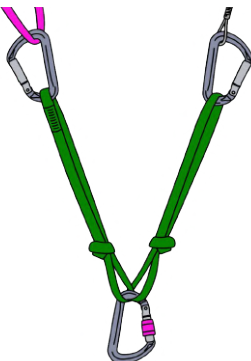
### Step 4

Clip the sling back into the piece.

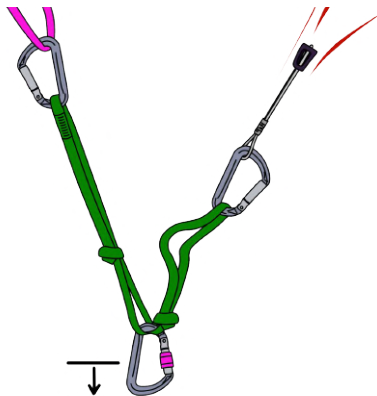


### Step 5

Repeat steps 3 and 4 with the other side. You can now adjust the overhand knots so they are as far down as possible while still allowing the central point to move freely where it needs to.



If one piece fails, the central point will shift as shown below.

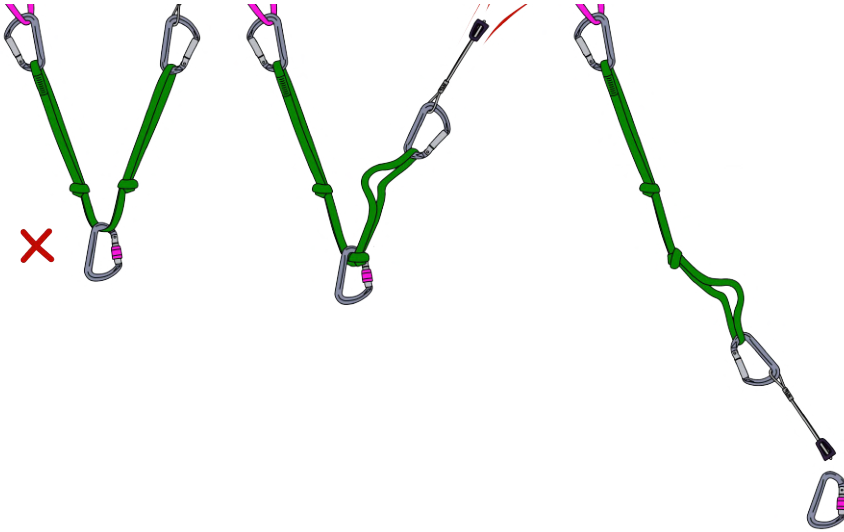


## Warnings

1) It's essential that you twist the sling in step 2. If you don't, the central point can become completely detached from the anchor if one piece fails.

2) It can be difficult to clip another carabiner into the main point of a

sliding-X when it is weighted. If you must do so, make sure you have clipped the carabiner through the sling in exactly the same way as the original carabiner. A much better alternative is to use the quad anchor (see page 22).



## Sliding-X Variations

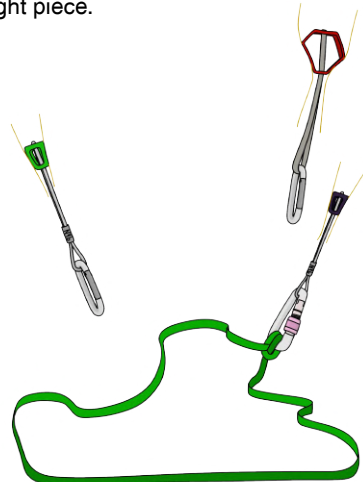
There are many ways of incorporating the sliding-X into an anchor. However you do it, make sure that if any piece failed, the resulting anchor shift:

- Is minimal
- Causes the remaining pieces to re-equalize
- Will not cause you to lose control of the belay

The following arrangement uses one 120cm sling to equalize three pieces.

### Step 1

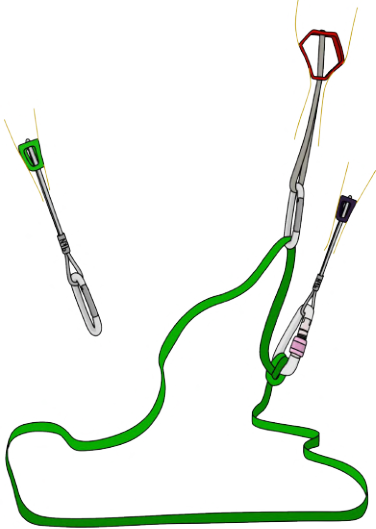
Clovehitch a 120cm sling to the lower right piece.





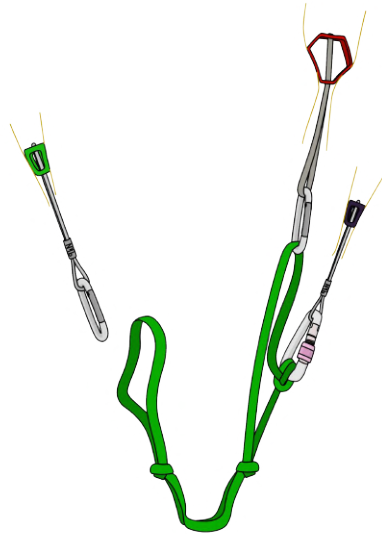
### Step 2

Clip the sling through the upper right piece.



### Step 3

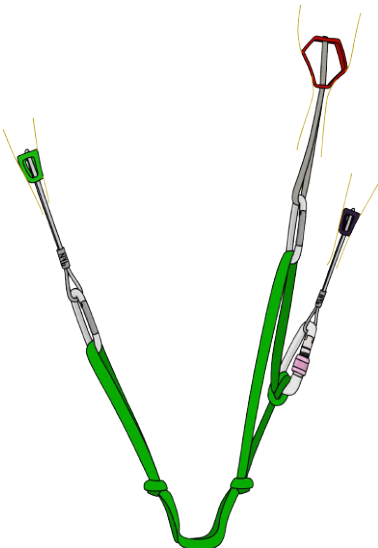
Add two extension-limiting knots.



### Step 4

Clip the sling into the left piece.

Adjust the knots so they limit extension while allowing for some directional movement.



### Step 5

Put a 180 degree twist in one of the master point strands and clip a carabiner through both loops as shown.



You could also equalize four pieces by clovehitching another piece on the left.

You may need to adjust the extension-limiting knots after adding the fourth piece.

If your belay consists of one bomber piece (the bolt) and four mediocre pieces (the micro nuts), you could use an arrangement like the one below.

This method equalizes the pieces so the bolt takes 50% of the load and the four micro nuts take approximately 12.5% each.



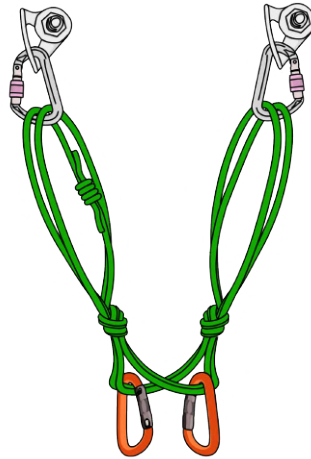
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## The Quad Anchor

The quad anchor self-adjusts to keep an equal force on each anchor point in a similar way to the sliding-X.

### Advantages

- \* Distributes the load equally between the anchor pieces. This puts less force on each piece, therefore decreasing the likelihood of anchor point failure.
- \* Provides two independent attachment points for the belayer and climber. This helps to prevent carabiners from jamming up at the same master point.



### Disadvantages

- \* The two attachment points adjust laterally, meaning that the anchor remains equalized even when different directions of pull are applied at the same time. This is useful during multi-pitch belay changeovers, or if the route traverses in or out from the belay.
- \* On multi-pitch routes where each bolted anchor is approximately the same, you can speed up your anchor building by keeping the quad tied.
- \* The quad will extend slightly should either anchor point fail. This can shock-load the remaining piece(s).
- \* Since the quad needs to be doubled up, it is difficult to equalize anchors where the placements are far apart.

### Best Situation To Use The Quad Anchor

To equalize two bomber anchor points, such as two bolts.

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## How To Tie the Quad Anchor

### You Will Need:

- \* 2, 3 or 4 solid anchor points
- \* A cordelette
- \* 3-4 screwgate carabiners

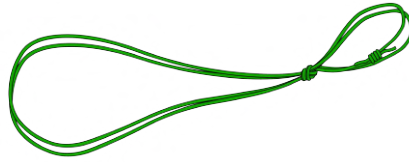
### Step 1

Double over a cordelette so there are four strands of cord. Make sure the double fisherman's bend of the cordelette is near one end.



## Step 2

Tie an extension-limiting knot on one side of the cordelette. This can be either an overhand knot or a figure-8 (The figure-8 is easier to untie after loading. The overhand uses slightly less cord).

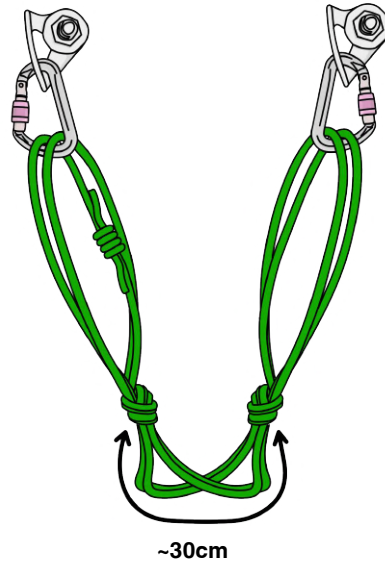


## Step 3

Tie another extension-limiting knot on the other side and clip both ends of the cordelette to the anchor points with screwgate carabiners.

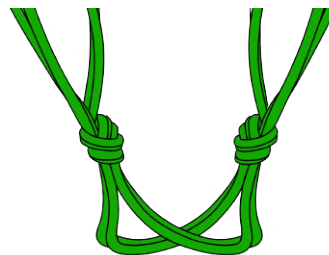
Make sure the knots are fairly even when the anchor is weighted in the direction of loading. The four-strand 'master point' should normally be around 30cm long.

If the strength of your anchor points are difficult to assess (e.g. older bolts), you should move the overhand knots closer together. However, this also reduces the lateral range over which the quad self-equalizes.



## Step 4

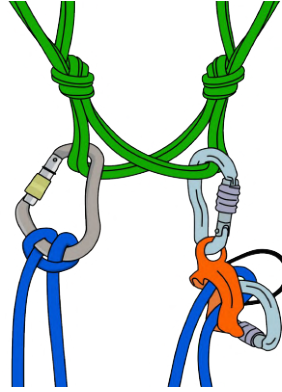
Separate the four strands of the master point into two doubled strands. It doesn't matter which two you separate.



### Step 5

Attach yourself to two of the master point strands (using a clovehitch or figure-8 on a screwgate carabiner).

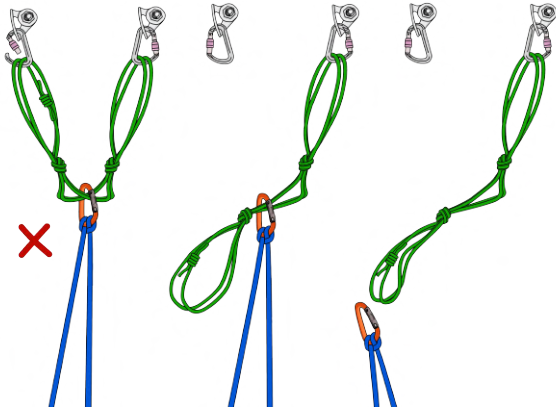
If belaying in guide mode, attach your belay device to the other two master point strands.



### Warning!

It is important to only clip into two of the master point strands.

If you clip into all four, you could become completely detached from the anchor if one point fails.

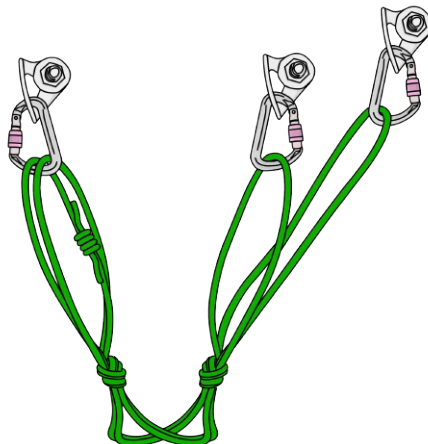


## The Quad Anchor – Equalizing 3 or 4 Anchor Points

To equalize three anchor points, simply split one of the double-loops and attach one loop into each piece.

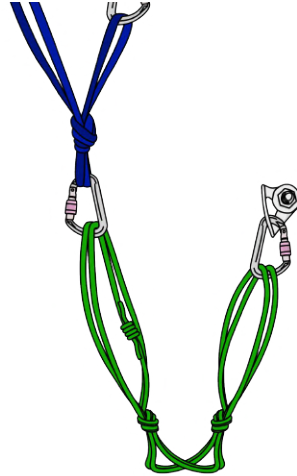
You will need to re-tie the extension-limiting knots to equalize these pieces since they will probably be at varying heights.

Do the same with the other side to equalize four points.



Sometimes it can be difficult to equalize three or four points correctly, as this uses up a lot of cordelette.

In this case, consider equalizing the furthest away pieces with a sling to create two anchor points. Then attach your quad to those.



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## The Quad Anchor – Setting Up a Top Rope

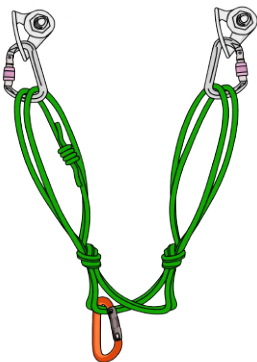
You can use the quad anchor to set up a top rope. This is useful if you want to top rope two different routes which are immediately next to each

other, but share the same anchor. The quad will self-equalize for both routes without needing any adjustment.

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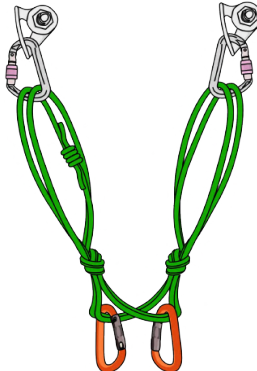
### Step 1

Clip a screwgate carabiner into two of the master point strands.



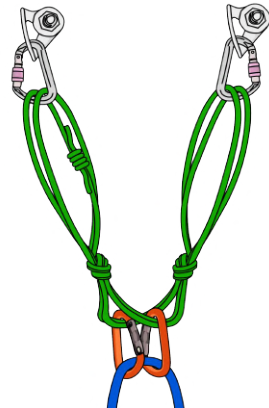
### Step 2

Clip another screwgate into the other two master point strands.



### Step 3

Clip the rope through the screwgates and fasten them. It is important not to clip a carabiner through all four strands (as described earlier).



## Building Anchors with the Rope

You can build an equalized anchor without using slings or a cordelette — great if you've used them all during the pitch. Many variations are possible. Two simple methods are

shown below, along with the more advanced equalizing figure-8. These methods use up quite a lot of rope, so you might not have enough on those long pitches.

### Rope Anchors – Simple Methods

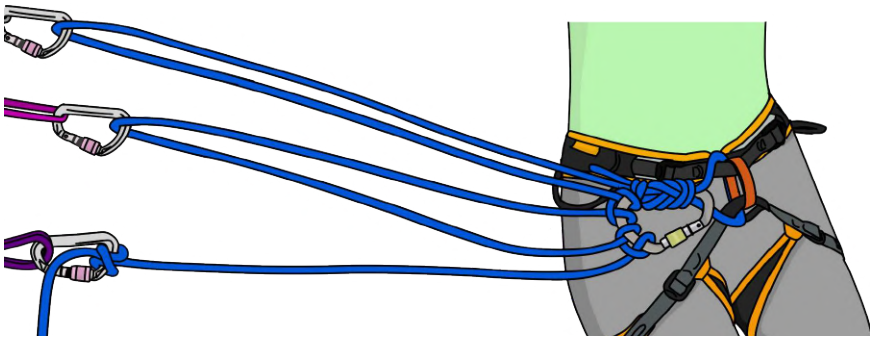
#### Advantages

- Can equalize pieces which are very far apart.

#### Disadvantages

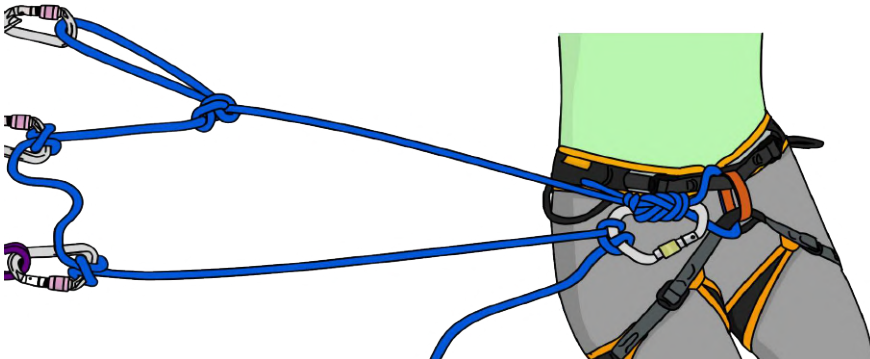
- Often uses a lot of rope.
- Must belay directly from harness.
- Difficult to get perfect equalization.

- Very difficult or impossible to escape the belay in an emergency situation.
- Not great for multi-pitch belays if the same person is leading every pitch. To attach to the anchor, the belayer will have to clip each piece in the same way as the leader. This is time consuming and can be a bit awkward.



Tying an alpine butterfly knot as shown below will use less rope, but

still has the same disadvantages as the example above.



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## Rope Anchors – The Equalizing Figure-8

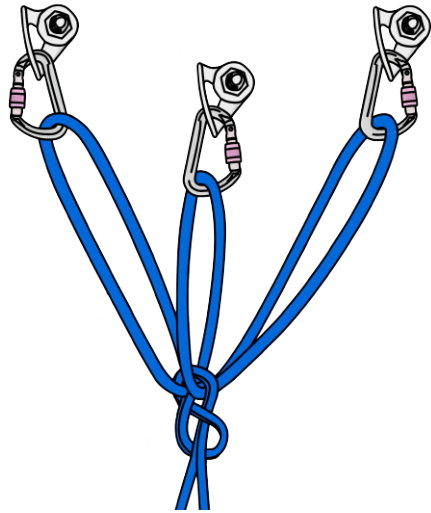
The 'equalizing figure-8' is a rarely used knot which could be useful in some belay setups.

### Advantages

- Creates a master point in the rope so you can belay directly from the anchor in guide mode.
- Much easier to escape the belay than the previous two methods.

### Disadvantages

- Difficult to equalize anchor points which are very far apart.
- Difficult to adjust belay position once set up.
- The equalizing figure-8 is not redundant. If one piece fails, the whole anchor shifts down. Only use this method with bomber gear, such as bolts.



- In the unlikely event that one rope loop is cut, the whole anchor could fail.

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### Step 1

Tie a figure-8 with a large loop.



### Step 2

Pass the loop back through the figure-8 as shown.

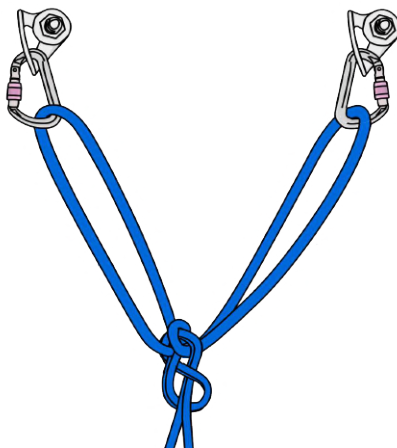
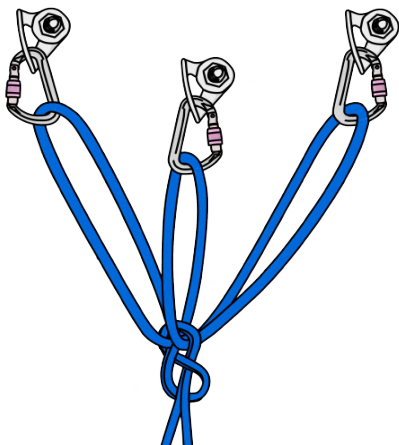




### Step 3

This creates three new loops. Clip each loop into an anchor piece and adjust them as necessary.

Alternatively, collapse one loop for clipping into two pieces.



### Step 4

To create a master point, tie a figure-8 loop in the rope just below the equalizing figure-8.

You can belay in guide mode directly from this.



## Building Anchors with Minimal Gear

The following methods are great to know in case you reach the top of a pitch without a cordelette, only a meter of rope to spare and not quite enough slings to create a self-equalizing anchor.

Endless variations and combinations are possible depending on the

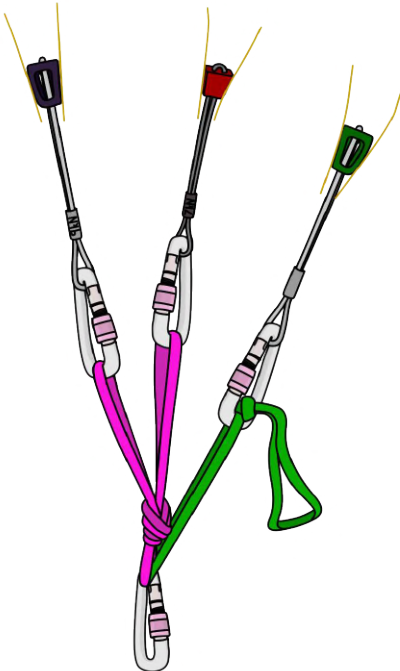
equipment you have and where the gear placements are. A few examples are given below.

It's hard to get any of these anchors equalized perfectly, but if you're short on slings and rope, these are probably your best options.

### Example 1

A 120cm sling equalizes the two pieces on the left.

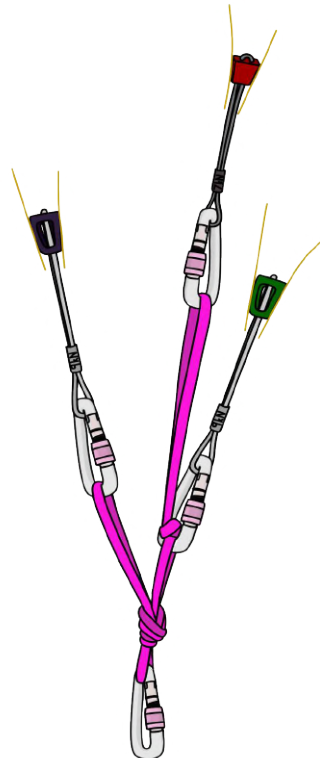
An overhand knot is tied in the 60cm sling on the right to equalize it with the others.



### Example 2

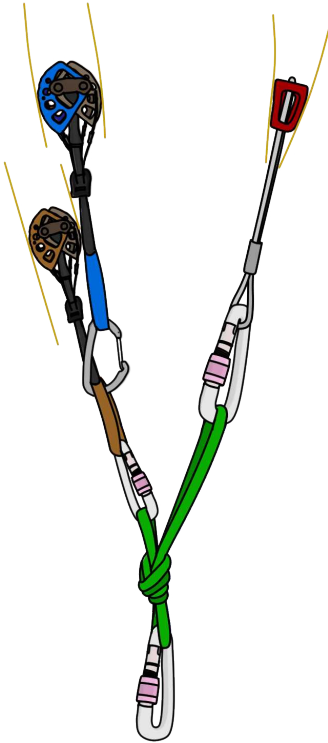
A 120cm sling can join three pieces, if two of them are in line with each other.

Simply tie an overhand knot in the sling above the lower piece.



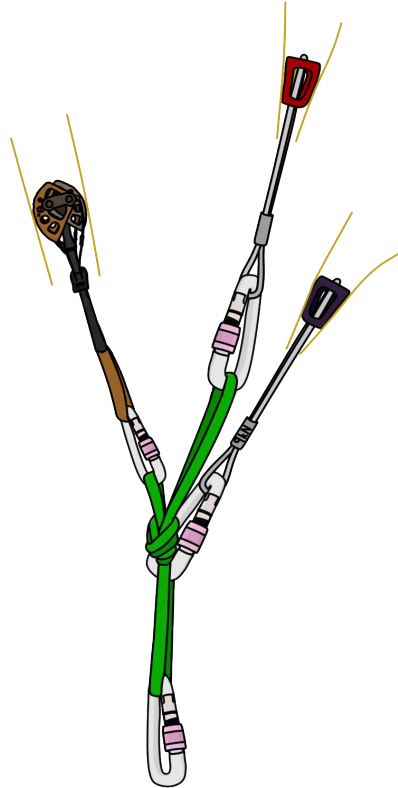
### Example 3

The upper cam is clipped through the sling of the lower cam. This isn't ideal, but it's better than just having one cam. Often you can slide cams up or down a placement to fine tune their position.



### Example 4

The upper two pieces are equalized with a 120cm sling. The overhand knot is adjusted so the lower piece can contribute to the anchor.

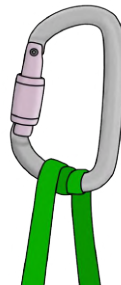


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### Top Tip — Minor Adjustments

You can wrap a sling two or more times through a carabiner to shorten it slightly. Keep the wraps close together and away from the gate if possible.

If you need to shorten a sling more, it's better to tie an overhand knot as shown in Example 1.



## Advanced Anchor Building – Summary

There isn't a 'best' method of equalizing anchors, since every trad anchor situation is different. Understanding the advantages and

limitations of a wide range of anchor systems gives you more options. Use your knowledge to select the best method for each unique situation.

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