Rigging for Alpine SRT (Beta version 1.2)

DISCLAIMER:

BETA-TESTING RIGGING GUIDES CAN BE FATAL IF YOU FIND ANY BUGS! - Don't bother suing me if you hurt yourself - I don't have any money!

This is the prototype version of a rigging guide that I've written for NUCC people wanting to learn rigging. It hasn't yet been checked over for errors and doesn't cover all the areas that I eventually hope to include.

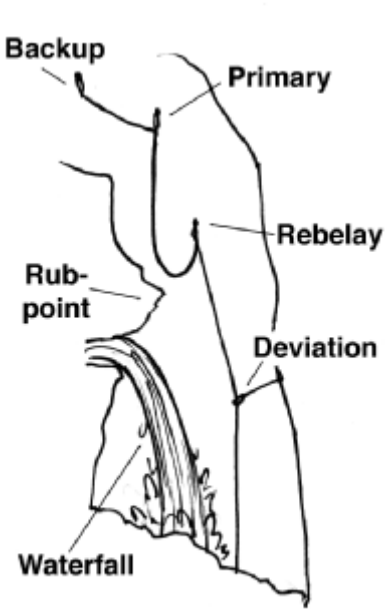
I welcome any constructive criticism. I have put this together rather quickly and there will inevitably be mistakes and things I have omitted.

Introduction

The "philosophy" of Alpine style SRT is to use light-weight smaller diameter ropes combined with rigging that avoids rub-points and other hazards. This is in contrast to "Indestructable Rope Technique" (IRT) which uses simpler rigging, and stiff abrasion resistant rope. The aims of alpine-style rigging therefore, are to achieve a free-hang (vertical drop, clear of the rock) for the rope, and to make the pitch as easy to negotiate as possible. It's no good having the perfect free-hang if you need to be Arnold Schwarzeneggar to get across the traverse. Consequently rigging a pitch is usually a compromise between the best hang for the rope, and the easiest hang for the caver.

Rigging to avoid rub-points and other hazards

As outlined above, the aim of the rigging is to arrange the rope so that it hangs down the pitch free of rub points, that is, places where the rope touches the rock. As a caver prusiks up a pitch, the rope stretches and contracts with the prusiking motion. If the rope above the caver touches the rock at any point, this stretching motion results in a sawing action which, combined with the tautness of the rope can result in very rapid rope-abrasion with potentially fatal consequences. Rigging to avoid rub points is therefore very important, particularly when using thinner and less abrasion resistant ropes.



Appropriate rigging can also be used to avoid other hazards such as waterfalls, climbs, and areas of loose rocks. For instance, in caves where water levels vary, the cave should be rigging so that waterfall pitches can still be negotiated in high water.

Rigging to give the rope a free-hang clear of projections, can often be done in a single hang by selecting the right position for the primary belay (the main attachment point at the pitch head from which the rope hangs down). The primary belay should always be backed up by at least one other belay (the back-up or secondary belay) in case the primary fails. The rope between the primary and

the backup belay, which is usually a little way back from the pitch-head, also serves as a traverse-line that cavers can clip into as they approach the pitch-head.

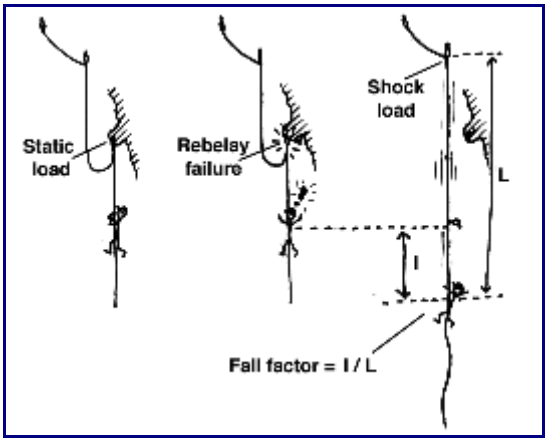
Either natural or artificial anchor points can be used for belays (see the next section on anchors). Using naturals saves time but they may not be in the right place for a free hang. Typically the primary is more likely to need a bolt, but the back-ups - where location isn't so crucial - will often be naturals.

If a free hang isn't possible from the pitch-head, the rope is rigged so it will give a free hang for as far as possible and then either a rebelay or a deviation is used further down the pitch. The rebelay or deviation is placed so that the rope below it hangs freely down the lower part of the pitch. Often more than one rebelay or deviation will be required to give free hangs all the way down. (see diagram).

Mark on exploration of vertical caves

- *Rush to the head of the pitch wooping and howling*
- *Grasp as large a piece of rock as you can physically carry*
- *Stand in absolute silence whilst heaving the monstrous rock over the pitch*
- *Stand and count quickly (mentally, the number you finally get to before hearing the huge crash as your missile careers into timeless speleolothems below is treated as seconds-see below)*
- *Multiply the number you arrived at above by itself and then by five, and Voila! you have your bullshit pitch length potential.*
- *Bullshit wildly and enthusiastically to each other about the prospect of descending the 400m pitch you have just discovered*
- *If you have no rope to descend the pitch multiply the length by two and return to the surface to tell your friends about it (they will automatically divide any length you give them by at least three- normally 5-6 would be more accurate)*

Rigging for safety under shock - loading

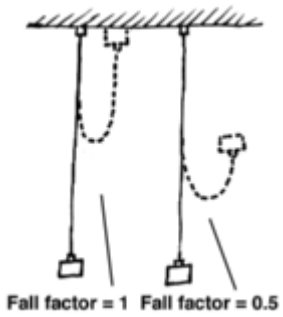


Shock loading of a belay occurs when a sudden load is applied to it. This is distinct from static loading experienced by the belay during normal prusiking or abseiling. For example, if a rebelay fails while a caver is prusiking up below it, the belay *above* the failed rebelay will experience a shock load when the rope between it and the falling caver becomes taut. Because the caver is falling, the effective load experienced by the belay is much greater than that due to someone just prusiking up the rope.

Fall Factors

The degree of shock loading depends on the ratio of the distance of the fall and the length of rope between the belay and the falling caver (and also on the weight of the caver!). The ratio of the fall distance to the rope length is called the fall factor: small fall factors result in small shock-loads and large

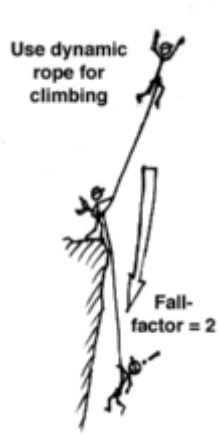
fall factors give large shock-loads. It is only this *ratio* of fall distance to rope length that counts, a 10m fall on a 10m rope (fall-factor = 1) causes just the same shock loading to the belay as a 20m fall on a 20m rope.

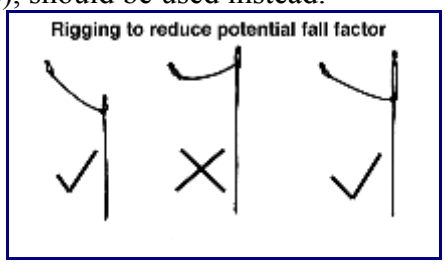


Shock-loads can be reduced by eliminating unecessary slack between belays thus reducing the potential fall. Some slack on rebelays is necessary, but there should be very little slack between the primary belay and the back-ups.

Rigging for Static Ropes

Caving ropes are *static* ropes, unlike *dynamic* climbing ropes. This means they they are not very stretchy and they are not designed to take high fall-factor falls. The lack of stretch means that much more of the force of a fall is transmitted directly to the belay rather than being absorbed by stretching of the rope. Caving rope should be rigged so that belay failure will not result in high fall factors. If you are climbing in a cave, dynamic climbing rope, which is designed to take falls from above the belay (fall factor 2), should be used instead.





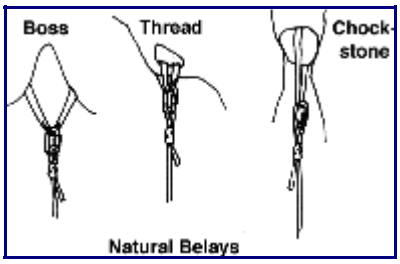
The potential fall factor is highest for back-up belays with failure of the primary. If the weight (i.e. caver) is near the top when the belay fails the fall factor could be close to 1. This can be reduced by eliminating slack in the traverse line and making sure the rope knot for the primary belay is below the secondary belay (it should never be above it). Possible shock loading on rebelays and the primary is usually much less as there will generally be quite a bit of vertical rope between the primary (or a rebelay) and the next rebelay resulting in a small fall factor.

Selecting your anchor points

Obviously for safe rigging it's essential to choose good anchor points for your belays. Anchor points can either be naturals, in which case its important to be able to identify sound ones, or artificial, in which case it is important to place them with care.

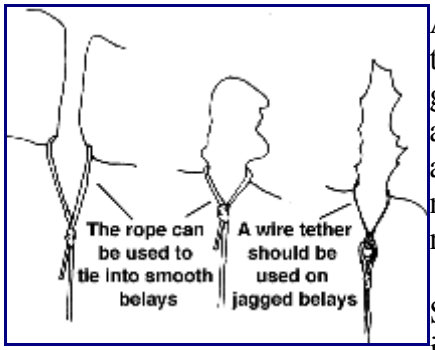
Naturals:

Typical naturals are stal bosses and columns, eyeholes in the rock, large boulders and chock stones in rifts. A tape or wire trace is looped around the natural and attached to the rope via a maillon or screw-gate krab. A loop knot such as a double figure-of-eight is used for attaching the rope to the maillon or krab (see pic). A wire can be used instead of a tape on routinely loaded belays (primary or rebelays) where the natural is sharp and could abrade a tape over a long period of use.

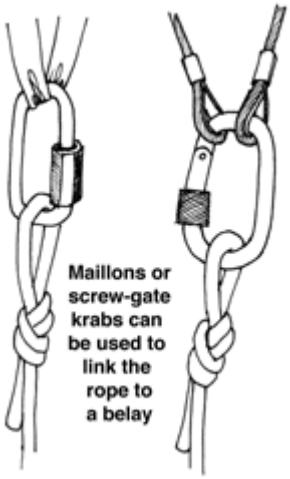


Wires shouldn't be used alone as back-up belays as they have poor performance under shock-loading. For this reason I would also suggest that when using a wire on a primary with rebelays below it, that it is backed up with a slightly longer tape or rope-loop around the same belay. The tape/rope won't be abraded as it isn't loaded in routine use, and if the rebelay fails and the wire on the primary is shock-loaded and breaks, the tape/rope will take up the load (the same set-up could be used on back-up belays where heavy

use of the traverse line abrades the tape/rope). This approach might seem a bit "belt and braces" for ordinary tourist caving trips but it is certainly a good idea on expeditions where a cave is left rigged for some time.



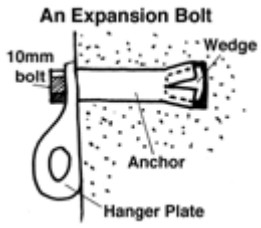
An alternative to using tapes and wires is to tie the rope directly around the natural. This is generally fine, although it will increase wear-and-tear on the rope. However it should be avoided for routinely loaded belays if the natural has sharp edges that could abrade the rope.



Selecting a sound natural is obviously very important. In well-travelled caves this isn't often a problem as any unsafe belays have in most cases already broken or fallen off! Favourite belays in popular caves often show wear marks that indicate that they're well used and therefore likely to be sound. In less travelled caves you must use your judgment. It's not a bad idea to give a prospective belay a good kick to make sure it's secure. Make sure eyeholes (threads) or flakes are in sound rock, free of fractures. If using a boulder make sure it's large and firmly based, likewise, make sure chockstones are firmly wedged. If using stal (calcite formations) bear in mind that calcite is softer and weaker than limestone, so stal belays need to be sturdy. Also, watch out for stal formations on top of mud - these might look solid but they have no strength at the base.

> ***Mark on "Other Natural belays:"***
>
> *...At a push one may rig directly into ones friends harness, at first glance this may seem to be dangerous and foolhardy, but just think about it for a moment, a pitch onto which you can only just get is hardly likely to be large enough to allow your friend to be pulled through, especially when they are flailing about wildly to avoid themselves being pulled down the pitch after you. This technique has proven especially useful in really shitty rock and when you've just run out of bolts, or even worse just dropped all the bloody things out of the bolting kit down the pitch...*

Bolts:



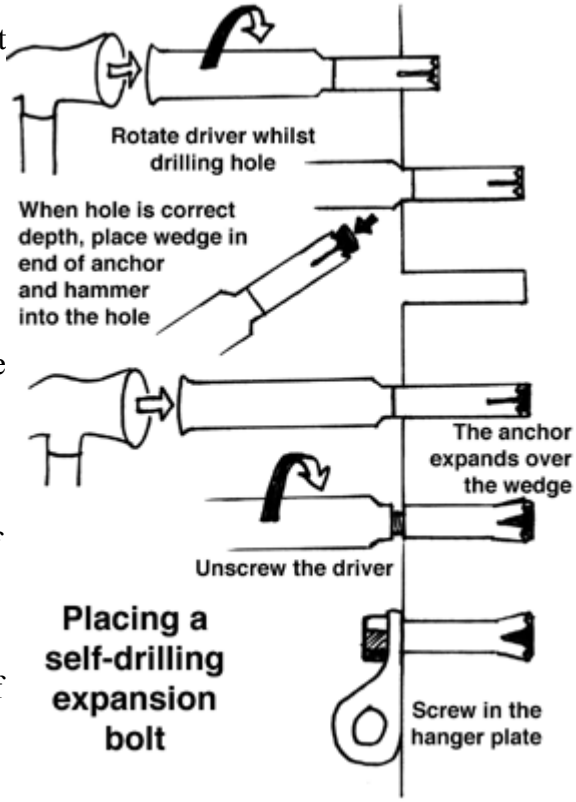
In well travelled caves it is very unlikely you would need to place a bolt because anywhere that a bolt is needed will have been bolted already. If you don't see any bolts on a well travelled pitch there will almost certainly be suitable naturals. On the other hand, when exploring a cave for the first time it is highly likely you will need to place some bolts.

When placing bolts you have the advantage(?) that the position and soundness of the belay is largely up to you. The initial considerations are positioning the bolt for a good hang and ease of use: dangling a rope down from potential locations will help you find the best spot. It is also essential that the bolt is placed in sound rock. This means avoiding cracks, calcite and detached blocks, ideally finding a clean piece of rock that is part of a solid wall.

There are a number of different types of bolts used in caving, the most common are 8mm (internal diameter) self-drilling expansion bolts, although resined-in ring or P-bolts are increasingly being placed for long-term heavy use in popular caves. Placing resined-in bolts and many of the other types of caving bolts requires a rock drill. Self-drilling anchors, on the other hand, can be placed by hand which is the main reason for their widespread popularity.

Bolts should be placed so that they are perpendicular to the surface. Prior to placing an expansion bolt

dress the rock immediately around the chosen spot with the bolting hammer. This is to remove any little knobbles so that a hanger attached to the bolt will lie flat on the rock surface. If large bits of rock flake off during dressing, try another spot.

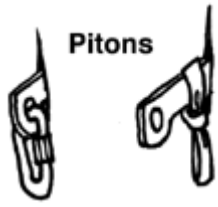


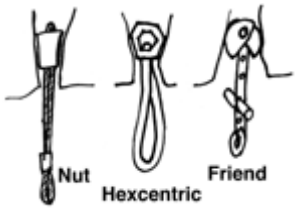
The "bolt" itself consists of an anchor and a wedge. The anchor is a hollow steel sleeve with a screw thread in it for attaching the hanger plate. The anchor is first screwed onto a bolt-driver. The other end of the anchor has a cutting surface which is used to cut a hole on the rock. Start the hole gently so the edges of it are clean cut and not chipped. Hold the end of the anchor against the rock and tap the end of the bolt driver with the hammer. Turn the driver clockwise while hammering, and regularly pull the cutting end out of the hole, blow out accumulated rockdust, and tap dust out of the anchor with the hammer. Drill the hole 1- 2mm deeper than the anchor is long - there is usually a mark or ridge on the driver that lines up with the edge of the hole when it has been drilled to the correct depth. Pull out the anchor , tap off any dust, and blow the dust out of the hole. Put the narrow end of the wedge (a conical shaped piece of metal) in the end of the anchor and put the anchor back in the hole. Holding the driver firmly, hammer the anchor in hard, this will force it to expand over the wedge and fix it in the hole. When it won't go in any further unscrew the driver from the anchor which will now form a solid bolt sleeve in the rock.

The outside end of the anchor should be flush with the rock. A hanger plate can be screwed into to the anchor, and the rope attached to it with a maillon or screw-gate krab. Don't place two anchors any closer than a handspan apart. This will stress the rock and weaken the anchors.

Other artificial belays:

Pitons, hexentrics, nuts and other climbing aids can be used as belays. Pitons should be placed so that the load is perpendicular to the shaft of the piton. Ideally the piton should be gripped in the crack for its full length and only the head should protrude. The rope is attached via a maillon or screw-gate krab.

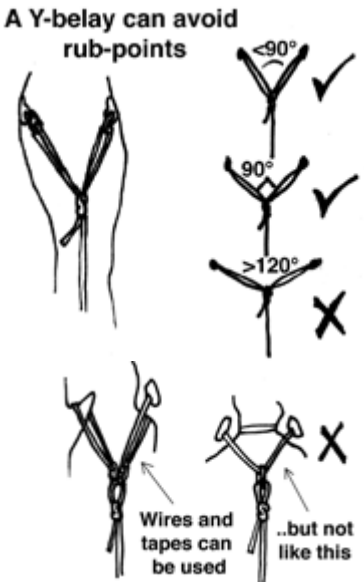




Hexentrics and nuts are basically do-it-yourself chockstones for small cracks. The strength of a hex or nut as a belay depends on the rope or wire loop fitted to it, hence the smaller size nuts and hexs will generally be weaker than other belays. Even so, a small nut could come in handy for a deviation, where it would only be partially loaded, or as some other non-essential belay. As with wire traces, nuts fitted with wires (as most are) will not be good for shock-loading.

Friends are sprung-loaded camming devices that have the useful property of camming in flaring cracks. These could be used as belays at a pinch, but can't be recommended as they tend to "walk" about in the crack when subjected to movement (such as prusiking). They are also very expensive and much better saved for climbing (or aid-climbing) for which they are excellent.

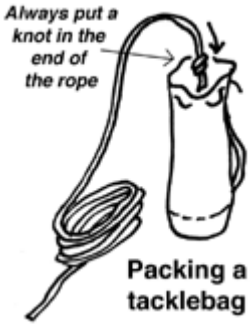
Y-belays:



The load can be shared between two anchor points forming a Y-belay. This is particularly useful for primary belays and rebelays to ge a better hang. For instance, using belays on either side of a rift (narrow passage) for a Y-hang can give a good free-hang down the middle of the rift, whereas a single belay on one side would be more likely to give a rub point.

The angle between the two "arms" of a Y-belay should ideally be no more than 90 degrees. Any more than 120 degrees and the anchor points each experience a load greater than the load on the vertical rope. Knots such as a bowline-on-the-bight which gives two attachment loops are ideal for attaching the rope for a Y-belay, though two fig-8's can also be used. Alternatively, tapes or wires can be used to form the "arms" of a Y-belay, so that the rope only needs to be attached at a single point. If tapes or wires are used, they should be rigged so that the failure of one one side of the belay doesn't automatically lead to the failure of the other.

The Rigging Procedure



Rigging really starts when packing the rope into the tacklebag. Ideally ropes of appropriate length to rig the pitches should be packed, but that's not always possible - you might be exploring a new cave for the first time. **Most importantly tie a knot in the end of each rope before it goes in the bag** . Put the rope in the bag, knotted end first, packed loose rather than plaited or coiled.

On approaching the pitch head, set up the back-up belay(s) and attach the rope using a suitable knot (figure 8 or 9 or a bowline). Put your descender on the rope, move out to the pitch-head and lock it off (an autolock descender is preferable for this). You may also want to clip in an ascender for extra security. Now look for a suitable primary belay (or belays), placing a bolt or aid if necessary, and possibly using a Y-belay to give a clear hang. Attach the rope below your descender to the primary belay using a suitable knot. Clip into the rope between the back-up and primary with your long cowstail, unclip your descender and adjust the knot for the primary belay to take out any excess slack from the traverse. Attach your descender to the rope below the belay, unclip your cowtail, and start descending.

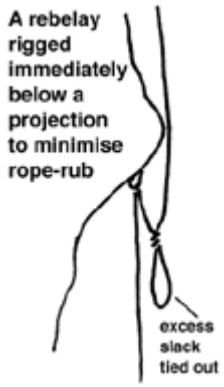
There is no need to take the whole rope out of the bag. Just pull out enough for the rigging at the pitch-head. Once abseiling, the rope should automatically feed out from the bag. This technique is called "spidermanning" and is definately a good idea on long or loose pitches where you can't see what is happening to the rope lower down if you hang it down the pitch.

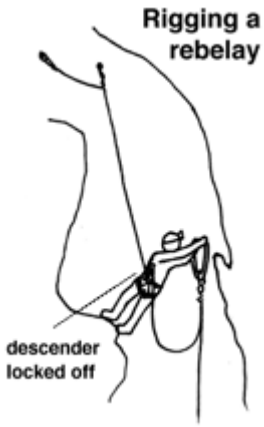
What is described above will often get you safely to the bottom of a pitch, but sometimes there are hazards, such as rub points, waterfalls or loose rock that you must rig rebelays or deviations to avoid on your way down the pitch. These are described below.

Rigging a rebelay:

On reaching the rub-point (or generic hazard) lock off your descender and select (or place) an anchor that gives a free-hang down the lower part of the pitch avoiding the rub-point. You may need to traverse out or pendule (swing) around on the end of the rope to reach a suitable belay or wall. If you are placing a

bolt, a tape around a marginal belay can be useful as a temporary way to hold yourself in a convenient position for hammering.



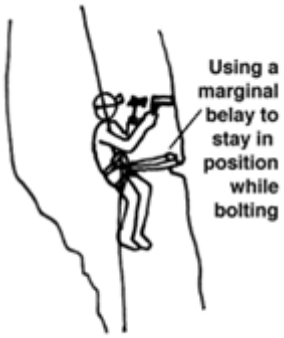


Set up the belay and attach the rope from below your descender using a suitable knot (figure 8 or 9, or alpine butterfly). Leave enough of a loop for everyone to pass the rebelay - don't forget some descenders take up more rope than others. Pass the rebelay as usual and carry on down the pitch.

For a free-hanging rebelay you may need to leave a long enough rebelay-loop for people to stand in to unweight their short cowstail, though this introduces undesirable slack into the rigging. An alternative is to hang a tape from the rebelay or to tie out the excess slack with a loop knot.

Rigging a Deviation:

On reaching the rub-point lock off your descender and select or place a suitable belay for a deviation to pull the rope clear of the projection and give a free-hang for the lower part on the pitch. Also make sure that the rope won't rub on the upper part of the pitch when you are below the deviation.



Placing a bolt

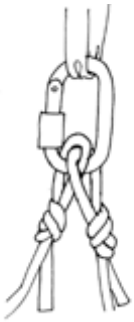
Unlike other kinds of belays, the main pull on a deviation is sideways rather than downwards, so take care that your belay won't come off with a sideways pull. Stalagmites are often unsuitable belays for deviations because of this, but using a larksfoot knot for the tape around the stalagmite will sometimes work.

Set up the belay and attach the deviation tape. Clip the deviation krab around the rope above you so that the rope runs freely through it. Unlock your descender and continue abseiling.

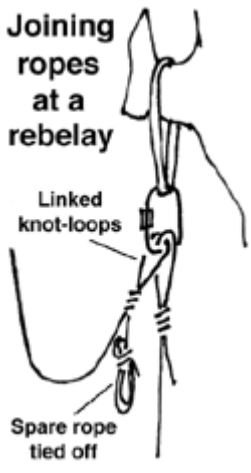
If a deviation is the last bit of rigging above the floor of the pitch tie the tail of the rope off (leave enough slack so that someone abseiling above the deviation isn't pulled over). This will prevent someone from abseiling right past the deviation and pulling the rope back through it.

If the rope isn't long enough:

When rigging you may find you reach the end of the rope before you reach the bottom of the pitch. You should find you abseil straight onto the knot (which you have tied in the end of the rope - otherwise you'd have abseiled off the end to an untimely demise).



Change to ascending and prusik up a couple of steps. Tie another rope to the and of the rope with a double fishermans knot, making sure you also tie a loop knot like a figure-of-eight in one of the "tails" of rope. Now the knot can be passed and the decent of the pitch continues.



Alternatively, it is often convenient to join two ropes at a rebelay. Make sure you tie a knot in the end of the spare tail of the upper rope, and coil it up at the rebelay so that no-one abseils down it by mistake. It is also a good idea to link the two ropes together directly via the knot loops rather than just linking them with the krab or maillon (see diagram).

You may of course prefer to simply prusik back up the pitch and get a longer rope, but this may not always be possible if there is limited gear available.

Rigging Pendules

A pendule is basically a rebelay that moves the rope much further over horizontally than usual. Pendules can be used in a variety of situations to avoid hazards, to access difficult-to-reach places or as a short-cut perhaps by-passing a climb.

Rigging pendules can be exciting!

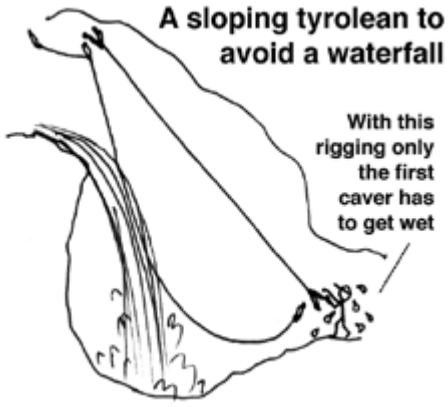
How you rig a pendule often depends on why you are rigging it. For example, pendules are often used to access a passage leading off from part way up a pitch. Rather than trying to climb up to the passage from the bottom of the pitch, you can hang from the rope level with the passage and either pull yourself over to it using the rock, or start swinging, increasing the motion as on a child's swing until you can grab the lip of the passage. You then pull yourself into it, and fix the rope to a belay. Enough of a loop should be left so that others can abseil down the pitch comfortably to the level of the passage, and then use the loop to pull themselves into the passage.

If you are rigging a pendule to avoid a hazard like a big waterfall the procedure is basically the same as rigging a rebelay except that you may need to swing or pull yourself over (as described above) to reach the chosen spot for the rebelay.

In some cases a pendule can't be rigged by swinging over to the desired spot. For instance, if a pitch is followed by a short climb, the first person may have to abseil to the bottom and then climb up the climb, but they can then rig a pendule so that those that follow can pull themselves stright over to the top of the climb without desending to the bottom of the pitch. The same approach can be used to avoid abeiling into a pool.

Sloping Tyroleans

This resembles a pendule and is most commonly used to avoid a pool or waterfall lower down a pitch, or to make wide pendules easier to negotiate. In this case a taut rope is rigged in addition to the pendule rope, between the upper and lower belays. Unless it is possible to swing over, the caver who rigs the tyrolean may have to descend into the pool or waterfall before they can rig the taut line for the cavers that follow.



The taut rope puts considerable stress on the belays when in use, so belays must be sound, and preferably independant of those for the other rope (the amount of stress on the taut rope increases with increasing angle from the vertical and also with the tautness of the rope).

Traverse lines

Sometimes a rope is required on exposed horizontal traverses, for instance where there is a traverse around the top of a pitch. In many cases a simple traverse line, belayed at regular intervals which cavers can clip into is sufficient. This is rigged in the same way as the top of a pitch; the caver moves out from the back-up belay with a descender (or ascender) on the rope for protection while traversing across and placing further belays as required. Short traverse lines will only require belays at each end, while longer ones will need intermediate belays to prevent the line becoming too slack and hanging down below the traverse level.

Tyrolean Traverse

A tyrolean traverse is used on difficult traverses where the rope is the main means of support rather than just a safety line. A very taut traverse line is rigged so cavers can hang from it without the rope stretching downwards under their weight. A second slack traverse line is also rigged for safety since the taut line has to withstand much greater forces on it than a conventional traverse line.

De-rigging

Usually, when de-rigging, the last person coming up the pitch removes the deviations and rebelays etc as they pass them and then hauls the rope up the pitch when they reach the top. The caver should clip into the traverse line while hauling up the rope and derigging the primary belay. The gear can then be packed back into tacklebags and carried out the cave.

For deep and largely vertical caves it is often more efficient to derig by tying ropes together and hauling them up as a long line. The end of the already-derigged rope is tied to the end of the rope at the bottom of the pitch. After everyone has ascended the pitch (and the last person has derigged the rebelays etc) the whole line of rope is hauled up to the base of the next pitch. On longer pitches where the rope is likely to get snagged during hauling, the already-derigged rope is hauled up seperately, with the cavers on the pitch ensuring it doesn't get jammed. The pitch is then derigged and the rope added to the top of the derigged-rope pile at the bottom of the next pitch.
