



Wānaka Mountain Guides

Mountaineering Manual

Section 1: Mountaineering

Mountaineering objectives in New Zealand's Southern Alps require competency in moving through a variety of terrain. From steep bush, over glaciers, classic ridges and steep alpine faces. Developing an awareness of how conditions and terrain affect travel effort and hazards combined with good fitness and movement skills will minimise the risks that mountaineers are exposed to.

Due to New Zealand's maritime climate, high levels of precipitation result in large amounts of glaciation. Up to 30m of snow can fall on the West Coast glaciers every year. The Southern Alps are endowed with an array of classic easy to moderate snow routes. This requires being able to move quickly and efficiently on various snow slopes.

Terrain analysis

Safe mountain travel is primarily achieved through a combination of good terrain analysis, translated into good route finding, taking into current and changing conditions. Intuitive movement skills will allow confident, less rushed and consequently more efficient travel with a bigger safety margin.

Terrain analysis both requires preparation and planning as well as maintaining situational awareness whilst moving through the mountains. Sources of information include maps, guidebooks and cloud-based geospatial analysis platforms such as Google Earth or Fatmap, that enables users to visualise images of the terrain.

It is useful to consider the three terrain scales; macro, micro and meso:

- The **macro** scale is likely to have been covered during the planning stage and consists of choosing the large scale feature of a valley, flank of a mountain;
- The **micro** scale is about finding the optimum route along a feature and this again is aided by good research;



- The **meso** scale relates to the ground beneath your feet and your footing. The trick is to be considerate of all the scales at all times. Even when the ground is difficult and requires concentration, you need to be looking ahead at the bigger picture and avoiding traps.

Snowcraft

Walking on snow

Before resorting to using crampons or for short sections of snow without consequence, it may be quicker to stay in boots. On low angled slopes, stiff boots with a good edge can swipe into the snow to create a secure platform even if it is firm. The most efficient way of ascending moderate slopes is to zig-zig. On steeper slopes, the toe of the boot may be able to be kicked straight in and the slope ascended directly.

When snow becomes softer, crampons do not add more security and it may be better to remove them. Particularly in soft wet snow when it can build up between the points of crampons rendering them useless, known as balling. Plastic anti-balling plates, supplied with all modern crampons, help to avoid this becoming a problem but it still needs to be monitored and dealt with if need be.

In soft snow conditions, whether in crampons or not, it is most efficient to descend slopes facing out and directly down the fall line. Plunging heels into the snow will provide a positive platform. Alternatively facing in will be slower, less comfortable but feel more secure.

Crampon techniques

When climbing snow or ice, every step counts. When using crampons, good technique must be well practised and intuitive to avoid dangerous mistakes, especially at the end of a long day in the mountains. Attention must be maintained especially on easier slopes where complacency can lead to catastrophic results.

When using crampons feet should be parallel to each other about shoulder width apart. This will help reduce the likelihood of a crampon catching the other leg and causing a trip. Ensure loose straps are secure and tidy. Having a crampon come off whilst climbing can be disastrous. Crampons must be put on securely at the beginning of the day and checked periodically throughout the day.

When descending firm snow, all the crampon points must be engaged. Leading too much with the heel points (which is the usual technique for soft snow) may cause the heel points to skid.





Flat-foot technique (also known as French technique) maximises the number of crampon spikes that are in contact with a snow slope and can be used on low and moderate angled snow (up to 45°). When flat-footing it is important to roll ankles so that all vertical points are penetrating the snow, which can feel awkward at first.



Mixed technique (also known as American technique) uses one foot flat-footing and the other foot front-pointing (see below). Mixed technique is an efficient way to move directly up moderately steep snow (30° to 45°) that is too steep to comfortably flat-foot with both feet, and for which front pointing would be tiring. It is commonly used in combination with the daggering ice axe technique (see below). The front-pointing foot can be alternated to minimise strain.



Front pointing is a secure method for ascending or descending steep snow, (steeper than 45°) and ice but requires stiff soled boots otherwise it quickly becomes tiring. The two front points of the crampons are kicked into the snow. Feet should be parallel, shoulder width apart, perpendicular to the snow, and the soles of the boots should be horizontal. On snow, this technique is often used with the daggering ice axe technique.



Ice axe techniques

Walking with the ice axe



When walking on low angled snow where a slip or stumble could lead to a slide, the axe is held in the uphill hand with the adze facing forwards and the pick backwards. This is the best position from which the self-arrest position can be easily adopted (see below). How much the axe is used for support and balance will depend on the angle of the slope and the hardness of the snow. On moderate slopes a slightly longer axe is useful as it encourages a balanced, upright stance.

Ascending low and moderated angled snow with an ice axe requires a stable rhythm that keeps two points in contact with the snow at all times. This

means the ice axes are placed then both feet are moved up in turn before moving the ice axe again.

When ascending low and moderated angled snow it is most efficient to zig-zig. To change direction, stand in a secure and stable position before swapping the ice axe into the other hand and manoeuvring your feet round to point in the other direction. The leash must be used or stowed around the shaft of the axe to avoid getting it snagged on crampon points.

Self-arresting

Self-arresting is the process of using an ice axe for stopping an uncontrolled slide on snow. Good movement skills and situational awareness should avoid ever having to do it for real but it is still a fundamental skill for moving safely on snow. There is no substitute for practising a range of scenarios in a safe location until it becomes instinctive.

In the event of a slip:

1. The initial reaction should be to dig everything in to stop the slide accelerating;
2. If this does not arrest the slip and it accelerates into a slide, manoeuvre into the self arrest position with chest facing the snow and head pointing uphill. If you have a tool in each hand or a walking pole, these need to be discarded so that both hands can be used on the axe. Especially on firmer snow, crampons can catch and cause a falling climber to catapult



uncontrollably down the slope. It is therefore important, after committing to a self-arrest, to lift your feet and point your toes in;

3. Place the head of the ice tool under your shoulder and hold the shaft near the spike with your other hand;
4. Arch your body with knees apart and use your weight to drive the pick in and slow you down. The spike must be lifted clear of the snow, and to protect your face, look away from the head of the ice axe.

A slide can initiate from a variety of positions, on the back or front, head facing uphill or downhill. It is therefore important to practise getting into the self arrest position from all these variations. A key step is to use a widely placed ice axe to pivot legs around so they are pointing downhill and to roll towards the hand holding the head of the ice axe to get into the front on self arrest position.

Step cutting

Cutting steps with the adze of the ice axe can also increase security in firm snow with or without crampons. Especially to change direction when zig-zagging up a slope. With each swing, cut the step away so that the ice is free to fall out of the step. The same techniques can also be used to create rest ledges when climbing steep snow or more comfortable stances when doing pitched climbing. If donning crampons is inevitable, it is much easier to stop early to put crampons on rather than persevere without.

Dagging

Dagging (also known as north wall technique) is commonly used in combination with mixed crampon technique or front-pointing on steep snow (40° to 60°). The ice axe or axes are held near the top of the shaft, just under the pick, and the pick is 'punched' into the snow at waist level, about shoulder width apart. Once the snow becomes too steep to keep your balance or too hard to push the pick into the snow then it is time to resort to swinging the axe above the head as for ice climbing.

Snow protection and anchors

Snow protection is most commonly used in NZ to abseil or belay over crevasses and bergschrunds and in the event of a crevasse fall, building rescue anchors. They are occasionally used for pitching moderate angled snow slopes but climbers need to be aware of the anchors limitations in this application. In the event of a fall, forces generated could exceed the maximum strength of any snow anchor. It is therefore important to understand likely loads, be able to



recognise the factors that affect snow strength and be able to choose the best solution from a variety of snow protection options.

Unlike rock protection, the strength of snow can vary to a large degree and can change on an hourly and daily basis. Snow can be hard and almost ice through soft powder or wet snow. The only way to develop an awareness of snow anchor strength is to practise building and testing them in different snow conditions over and over again. Any snow anchor relies on experience and judgement. As they are often used singularly, when they fail, they do so catastrophically.

Snow stakes

There are two main types of stakes used for snow anchors. The T cross-section shaped stakes (MSR Coyote®) are more resilient and resist deforming when pounded into very hard snow. They are always placed with the upright of the T pointing in the direction of load. The V shaped stakes (Aspiring Safety) are wider and therefore offer a greater surface area so they are more useful in softer snow. Whenever using snow stake anchors it is important to keep the direction of pull low.

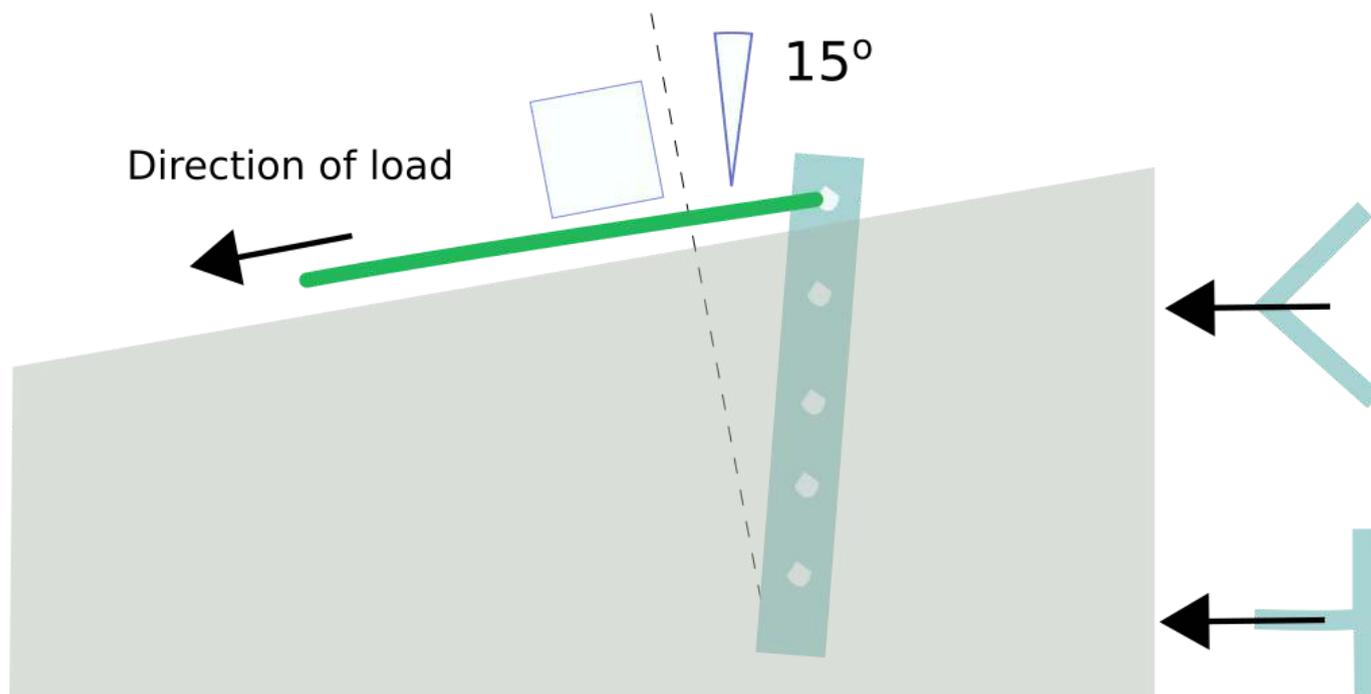
Snow conditions can broadly be divided into four ranges. Each snow condition demands a specific configuration of snow stake to get the most reliable piece of protection.

These snow types are:

- **Very hard snow** - Snow that is so hard that it cannot be compacted and cannot have a slot cut into it.
- **Hard snow** – Snow that is so hard that it cannot be compacted but can have a slot cut into it with the pick of an ice axe.
- **Compressible snow** – Snow that can be compressed to make denser snow.
- **Soft snow** – Snow that cannot be packed to make it harder. This is usually very wet or very dry snow.

Very hard snow – Vertical top-clip





Vertical top-clip

The Vertical top-clip is the simplest snow stake configuration to place but has limitations as it is very dependent on consistent and very hard and strong snow for its strength. A sling is often put through the top holes of snow stakes so that they are ready to be used in this way.

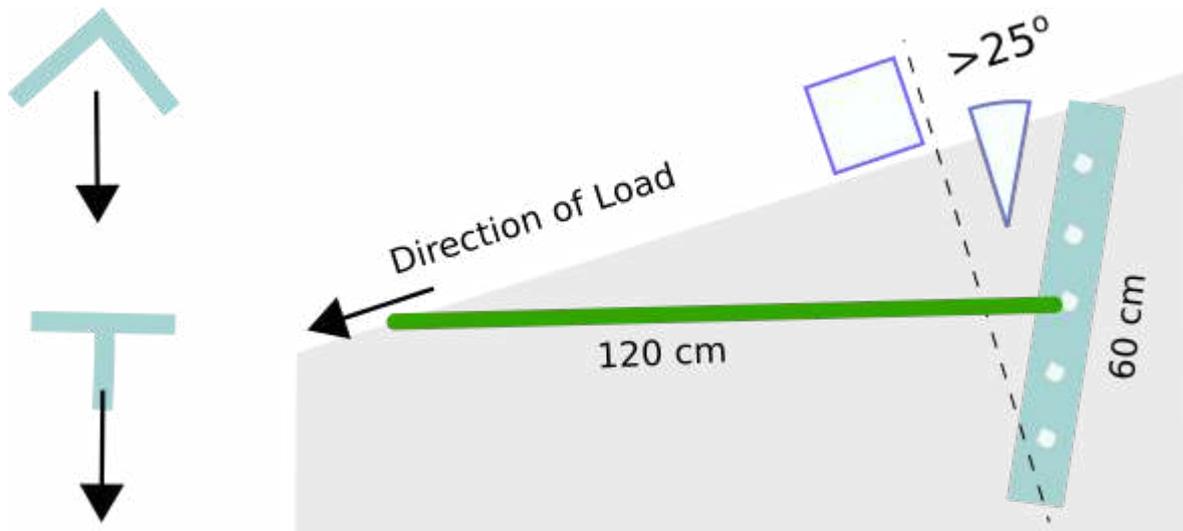
The snow stake is angled 15° back from perpendicular to the snow surface and driven in. For a V shaped stake, the apex of the V points towards the load.

If it takes less than 15 blows with the hammer to drive in the snow stake then it is quite likely that the snow is too soft and weak for this configuration of snow stake and an alternative (or combining multiple snow stakes) is more appropriate.

Make sure the direction of pull is parallel to the surface to avoid any upward pull. A longer tie-in may be needed to accomplish this.

Hard snow - Vertical mid-clip





Vertical mid-clip

The Vertical mid-clip orientation can be used in hard snow and has the potential to be the strongest configuration of snow stake.

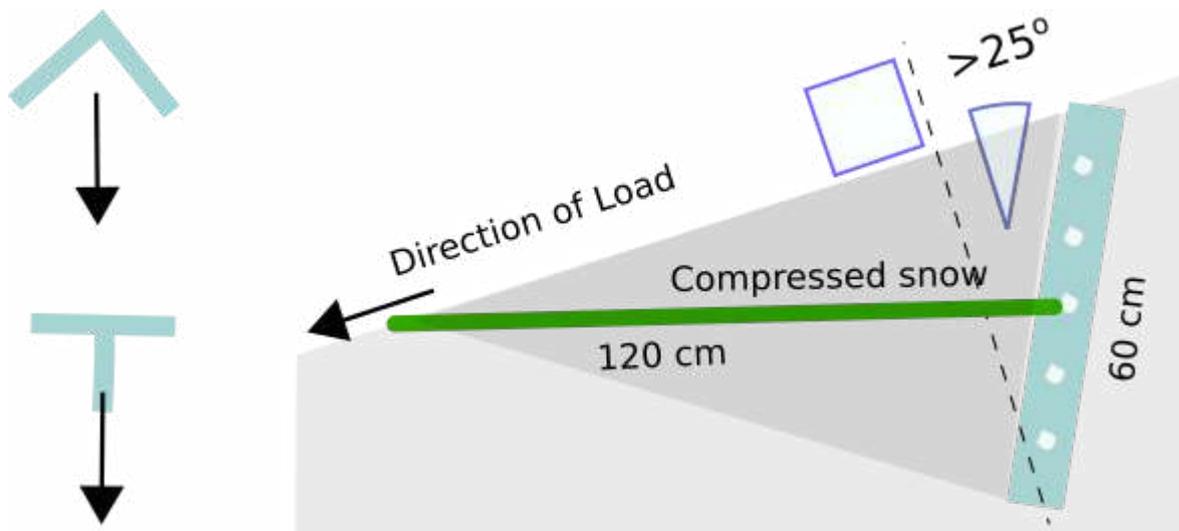
This anchor requires a wire cable attachment to the centre of the V stake or a T shaped stake that a thin double length sling (120cm) can be clipped through the centre hole. Cut a slot with an ice axe pick for the cable trying not to disrupt the snow in front of the stake. A snow saw is also useful for this. The slot must be deep enough for the attachment to run straight and if the slot is too wide it will seriously compromise the placement's strength.

Hammer the stake in at least 25° back from perpendicular to the surface. For a V shaped snow stake, the open part of the V points in the direction of load in contrast to when using the same snow stake in the Vertical top-clip configuration. Even though the stake may not be fully in the snow, pulling from the centre spreads the load more evenly and the anchor strength will be far higher than the strength of the full stake pulled from its top in the Vertical top-clip configuration.

The wire cables and double length slings are both 120cm long, twice the length of a typical snow stake. This is handy because if the top of the snow stake and the end of the wire/sling is flush with the surface of the snow and the wire/sling is not kinked, the stake will be positioned at the correct angle back from perpendicular.

Compressible snow – Vertical mid-clip





Vertical mid-clip in compressible snow

The Vertical mid-clip can also be used in compressible snow. This is snow that when compressed is made stronger and denser. A good test of snow's compressibility is if a snowball can be made out of it that is hard to drive the pick of the ice axe into. As it can take a lot of judgement to determine the strength of compressed snow, this is more of use as an emergency anchor.

Dig a V shape hole with the open end of the V facing the direction of pull. As with the vertical mid-clip above, place the stake at 25 degrees back from perpendicular to the surface so that the top of the stake is below the snow surface. Have it well below the surface in order to increase its strength.

Backfill the hole and compress the snow in it taking care to make sure it is compressed evenly from its base to the snow surface. Using hands rather than feet is the best way to achieve this.

Snow stake attachments

If a snow stake does not have a permanent mid-point attachment, the strongest possible improvised attachment is achieved by using a carabiner through the holes which is easier with a T stake. Improvising a mid-clip by larks footing a sling around a V stake should be avoided due to potential for twisting and crushing the stake or sliding towards one end causing rotation of the stake. A clove hitch performs better.

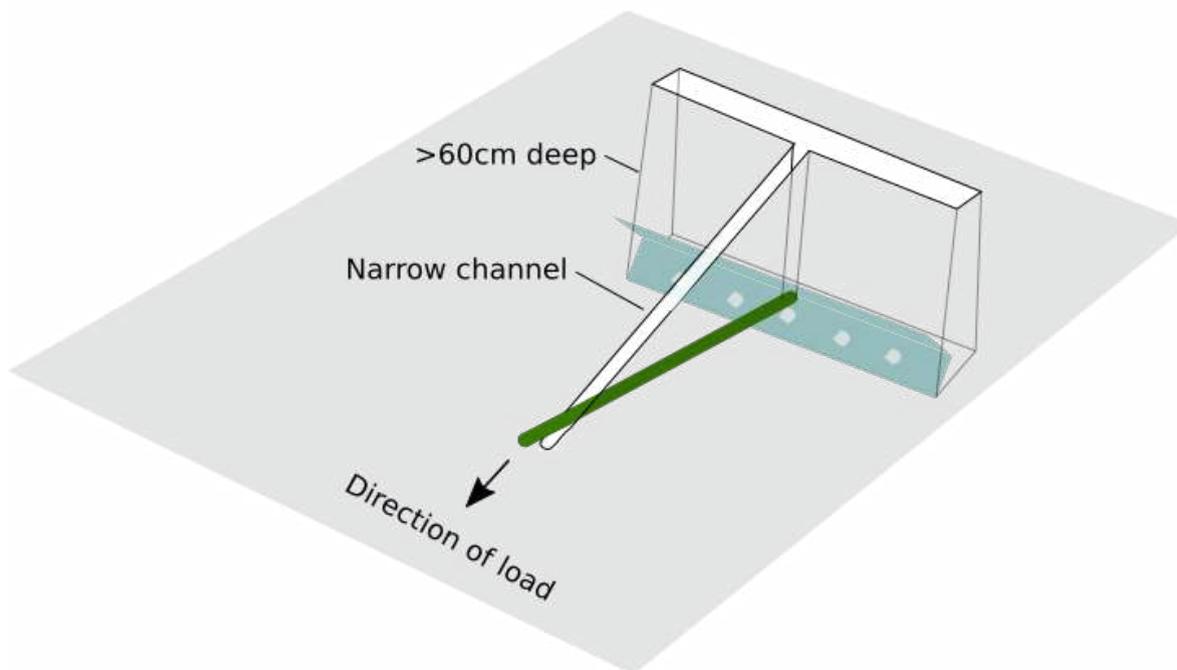




Crushing of snow stakes by improvising a mid clip (Aspiring Safety)



Soft snow - Buried objects



T-slot (buried snow stake)

Soft snow that is either very dry or very wet cannot be made stronger through compacting and is the most difficult snow to build an effective anchor in. Climbing in very soft powder or very wet snow should be avoided if possible for both security and avalanche considerations.

In soft snow, the strongest possible anchors are created by placing an object with the biggest surface area as possible, as deep as possible.

A snow stake is often used in this way as a T-slot. If using a snow stake it must be buried deeper than 60cm to be more effective than a standard vertical mid-clip. The channel for the attachment must be as narrow as possible and the front face of the slot can also be undercut. Unless the snow is compatible, the snow in front of the T-slot should not be disturbed. Backfilling the slot does not increase the strength of the placement.

Skis, backpacks, stuff sacks filled with snow or large rocks can also be used in this way. Whilst digging the slot, observe the snow hardness and any weak layers that will affect the strength of the placement.

Bollards



Other snow protection commonly used include snow bollards, body stances such as bucket seats dug in the snow and quickly and efficiently counter balancing terrain features such as bergschrunds, wind scoops and ridge crests.

Alpine rock

Rock protection and anchors

Rock protection is usually preferred where available the first choice for protection and anchors as it is easily placed and removed and can be more reliable.

Wires (also known as chocks, nuts Rocks[®] or Walnuts[®]) are a passive type of protection placed behind constrictions in cracks. Wires rely upon the strength of the rock around them and a sufficient amount of surface area in contact with the rock for their strength. Wires are usually only good for loading in a certain direction. A Nut key or ice axe pick is quite often necessary to remove wires.



Spring Loaded Camming Devices, most commonly known as cams or by the product names of Friends[®] or Camalots[®] are an active form of protection using spring-loaded, cam-shaped lobes that expand outward until held in place by the rock around them. They have the outstanding property of actively camming in place in parallel-sided cracks. Ice in cracks can affect the holding power of rock protection such as cams and in some situations passive protection such as nuts, hexentrics and pegs provide more secure placements.



Pitons (also known as pegs or pins) – are steel wedges that are hammered into narrow cracks. There are a number of different designs each coming in a range of different sizes, known by names such as angles, knife blades and lost arrows. They can be especially useful in winter for mixed climbing when cracks can be filled with ice and can provide reliable protection in narrow cracks when no other options exist. If carrying pitons, a piton or ice hammer must be carried to insert and retrieve them.



Spikes can be used for quick pieces of protection. Slings can be hooked over the spike providing the spike is solid and that the sling sits well when loaded in the anticipated direction of pull. Spikes are commonly used to construct abseil anchors only necessitating leaving behind an inexpensive length of cord.

Bolts are the most common form of fixed protection and often found in popular ice climbing areas where there is good but compact rock adjacent to the ice and especially useful for abseil anchors. Bolts in ice climbing areas should be checked for the tightness as the cold can cause the metal to contract slightly, eventually loosening the bolts. It is therefore useful to carry a spanner to tighten loose bolts.

Icecraft

Front pointing

When front pointing the soles of boots should be horizontal and shoulder width apart. If the heels of the boots are raised too high, the rubber toe of the boot will strike the ice first making it difficult to get a secure placement or front points will tend to shear downwards out of the ice. No amount of kicking will get a rubber boot to grip in the ice. If heels are too low, calves will become tired quickly and the points will not positively engage in the ice. With dual front points, the boots should be perpendicular to the ice to ensure both points are equally engaged.

It is common for beginners to kick too hard or repeatedly resulting in wasted energy. Usually a confident and well directed single kick is enough to get enough front point into the ice for a secure placement. Features of the ice can be used as when rock climbing, looking for edges and pockets to place the front points in to save effort.



Front pointing



On anything less than vertical most of the weight should be just on the feet and the stronger leg muscles with tools only being used for balance. Pulling excessively on tools may cause them to rip out. Keeping in balance and taking small steps will save valuable energy in the arms for when the going gets steeper.

Ice tool techniques

On hard or steep ice, tools will have to be swung to penetrate the pick. Swing tools from the elbow with a final rotation of the wrist to drive the pick in. If the picks get stuck, avoid pulling outwards on the handle and instead pull the pick out the way it went in, pulling upwards on the head. Tapping upwards on the head of the ice axe can help loosen it.

More reach can be achieved by choking the tool. This is moving the grip up the shaft and modern tools have grips for this purpose. Maintaining a low pull is vital when choking as it puts more outwards force on the placement that can pull it out of the ice.



Swinging ice tools



Removing a stuck pick

Ice protection and anchors

Ice screws

Ice screws are used almost exclusively on pure ice routes. They come in a number of different designs but most modern options have a fold out handle that helps screwing them in and out. They come in a variety of sizes up to 22cm long. The strength of the ice screw placement comes



from the thread so longer ice screws do not necessarily make for a strong placement, but just engages the thread deeper and through the softer surface ice.

In good quality ice, the placement can potentially be stronger placed 10° down in the direction of potential pull. In less reliable ice, a placement 10° upwards in the opposite direction will be stronger. Perpendicular placement can provide high strength protection in both circumstances so if unsure stick with this.



To place an ice screw clean off the softer surface ice to reach the good quality ice underneath. It may be useful to use an ice tool to make a small indentation to help get the ice screw to bite initially. Push and rotate the screw into the ice, aiming to place the screw perpendicular (90°) to the surface of the ice. Once the screw has bitten, start cranking on the handle. The quality of the ice and the reliability of the placement can be monitored by feeling the resistance as it screws into the ice and the consistency of the core being bored out of the centre of the screw.

Placing ice screws is worth practising including placing them one handed, with either hand from the security of a top rope before having to place them on lead.

Before placing an ice screw, place ice tools securely and high in order to hang from a straight arm on the upper tool. Bent arms will accelerate fatigue. Ice screws should be placed at waist level or below. Too high above waist level is difficult, tiring and dangerous as it ends up pulling outwards on tools.

Place ice screws from restful positions in good quality ice, extending them with longer runners if required to keep the rope running direct. The best ice to climb may be different for the best ice for placing screws.

When removing ice screws, always clear the ice out of the inside of ice screws by gently tapping the top of the screw (not the thread or teeth!) against the head of an ice tool or blowing to prevent the ice core freezing in place which can make it very difficult to place the ice screw again.

V-Threads

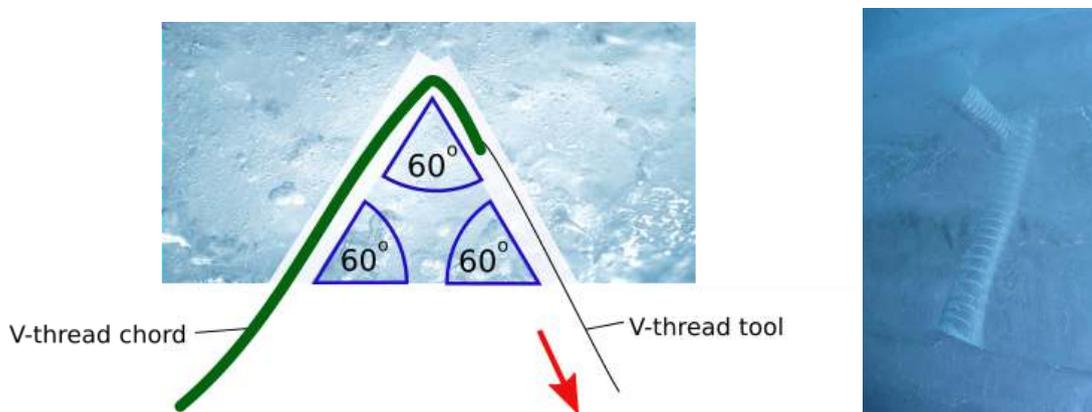
V-threads (also known as an Abalakov thread) are a strong type of ice protection that are often used as abseil anchors as it avoids leaving expensive ice screws behind. They can have a similar strength to a single ice screw placed in the same ice but their strength is usually limited by the breaking strain of the cord being used. V-Threads do take longer to build than placing an ice



screw, but practice does improve the process. A piece of wire or purpose designed V-Thread tool is needed to pull the cord or tape through the V in the ice.

A V-Thread anchor can be built using a single ice screw. Begin with placing the screw 60° to the surface of the ice on the horizontal plane. Remove it and measure out the position for the second hole using the length of the ice screw. The second hole will also need to be 60° and will need to be eyed up to intersect with the first hole. If all goes well and the holes meet up with the end of the cord can be poked into the first hole and using the V-Thread tool, hook and pull it out of the second hole. The cord can then be tied off with an overhand knot.

Although traditional practice was to build V-Threads in the horizontal plane, recent research has indicated that V-Threads built in the vertical plane (also known as A-Threads) have the potential to be slightly stronger.



V Thread

