

■ Snow Anchors

Many factors contribute to the strength of snow anchors. The four main ones are:

- The strength of the snow
- The type of anchor built
- The direction of pull
- The strength and surface area of the equipment used to build the anchor

Tests done in recent years have focused on how snow strength affects anchor strength and the differences between traditional horizontal t-slot and vertical picket type anchors.

■ Terminology

Upright: Any anchor placed perpendicular or at an angle from perpendicular to the surface

Horizontal: Any anchor placed horizontally and at a right angle to the direction of load (T-Slot)

Top-Clip: Any upright anchor attached at the snow surface (see illustration below)

Mid-Clip: Any upright anchor attached at or near its mid-point below the snow surface (see illustration below)

■ Potential loads in snow applications

Climbing ropes are designed to keep the forces transferred to the anchor or climber to less than 12kN. Most manufacturers exceed this standard with many limiting the maximum force to 8-9kN. It is unlikely that one would use a snow anchor in situations where a climber can freefall onto the anchor without introducing other forms of friction. The friction generated while sliding on a 45° snow-slope will reduce the forces produced by a fall by as much as 30%.

Examples of potential anticipated loads

Load	Force
Leading on 45° snow slope or belaying over crevasse	4kN-8kN
Runner (top piece of protection with ~1.6 X multiplication of force)	8kN-12kN
Top roping 1 person or rappelling	2kN-3kN
Top roping 2 People	3kN-4kN

■ Anticipated strengths of snow anchors

Snow compression and shear

Snow fails either in shear or compression with snow anchors. Compression failure happens when the anchor pulls through the snow (usually slowly) under load. Shear failure occurs when a stress cone of snow in front of the buried object fails suddenly.

Anchor strength vs. snow hardness

Tests show that if the snow is moist (able to make a snowball), it is advisable to compact it before building the anchor. If the snow is dry and cold, it is best to leave it undisturbed. It was also noted that in tests where the anchor failed at greater than 10kN, the failure involved a component of the anchor (picket, cable, sling) and not a failure of the snow structure. Most standard picket and ice axe anchors fail at ~7kN in hard snow (>1F) however, often fail at much lower loads in softer snow conditions. Snow anchor strength is directly related to four factors;

- Surface area and strength of buried anchor
- Direction of pull
- Snow hardness
- Craftsmanship

Horizontal vs. Upright anchors

Although buried ice axe t-slot anchors have been a mainstay of Canadian guiding for many years, recent studies have shown that upright pickets clipped at their mid point can achieve strengths equal to or greater than many t-slot anchors. All other factors being equal, a t-slot needs to be buried the same depth as the bottom of a vertical picket to achieve the same strength. In shallow snow conditions or when using an ice axe as the buried anchor, T-slot anchors are often a preferable option to vertical mid-clipped pickets.

Considerations -Building upright anchors

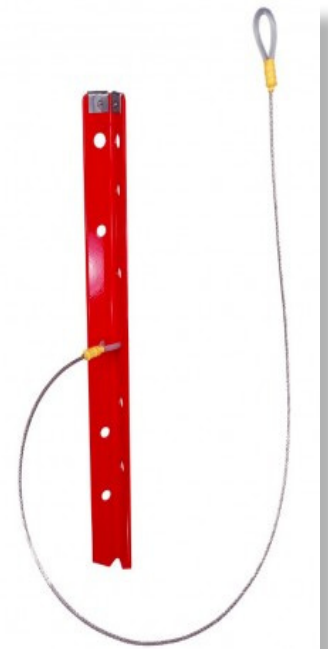
Mid clipped upright anchors

- Difficult to build without a purposely designed 'picket'
- Sling or cable should be at least twice the length of picket
- 25 degrees from perpendicular to snow surface is optimal angle of placement
- Runner or cable attached to picket at approximate mid point is generally much stronger than clipping top of picket at surface of snow
- A 4mm swaged cable or thin sling (Dyneema) have the least affect on the integrity of the snow in front of the picket
- In less than 1m of snow over a hard surface (rock slab or ice) picket may deflect when pulled deeper into snow under load. Consider using t-slot in these conditions.

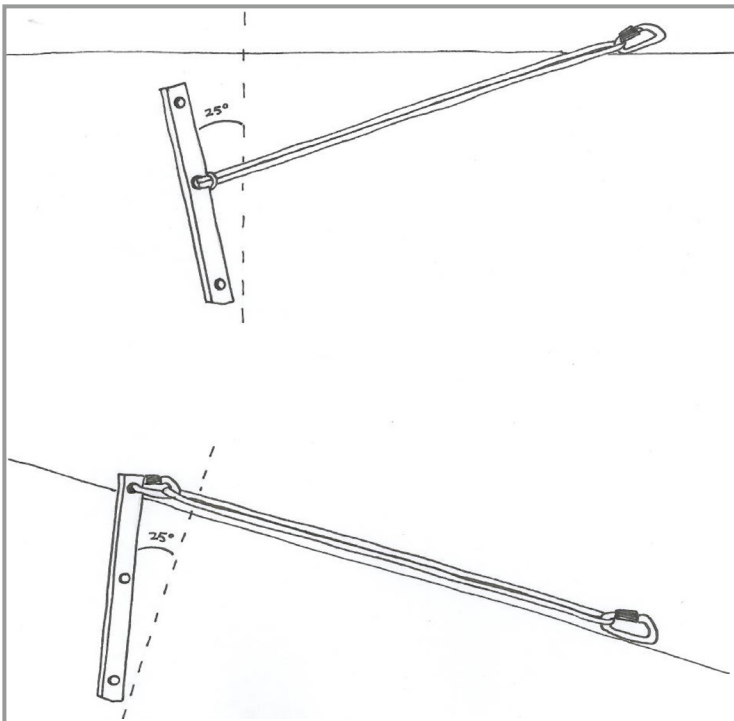
Top clipped upright anchors

- Can be built with ice axe or picket
- Very limited anchor strength in all but hardest snow conditions
- Typically only considered reliable for moderate loads when snow is sufficiently hard that the anchor must be placed using hammer

Yates Climbing Equipment is currently making a mid clip picket with swaged cable



Picket placement

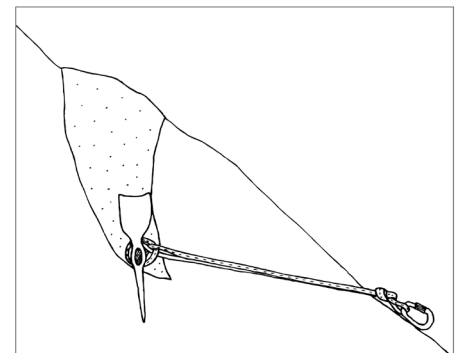


Upright picket with mid-clip
(25° back from perpendicular to surface)

Upright picket with top-clip
(25° back from perpendicular to surface)

Building horizontal anchors (T-Slots)

- Should be placed at least 15cm below start of 1F snow and a minimum of 30cm deep
- Sling must be attached as close to centre of balance as possible
- Should be buried if used for rescue or if an upward pull is possible. This should be considered to add security, not strength.



T-slot with ice axe

Belaying from snow anchors

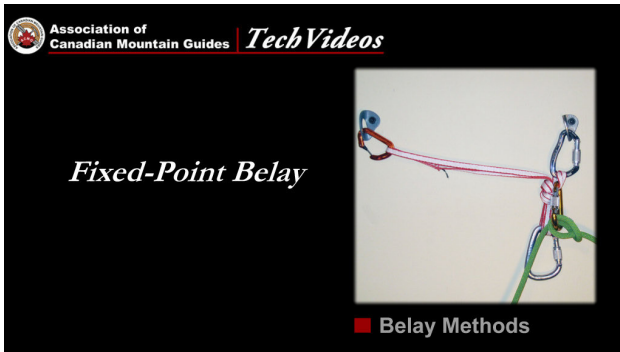
Great care must be taken when choosing the belay method to be used with snow anchors. Direction of pull must be considered in construction and care to avoid upward pull must be taken. Avoid shock loading the anchor. If using the anchor to back-up a body belay, ensure the belayer is positioned far enough below the anchor an upward pull on the anchor so they will not be created when holding a load.

Strategies for building strong anchors in weak snow

In weak snow conditions, consider using the following tactics to achieve an anchor that will be strong enough to hold the anticipated load.

- Compact the snow if it is "moist"- as illustrated by temp or the "snowball test"
- Bury larger items (packs, skis)
- Build and equalize multiple snow anchors (at least 1.5m apart)
- Add other items to the anchor to provide greater surface area (Saxon Cross)

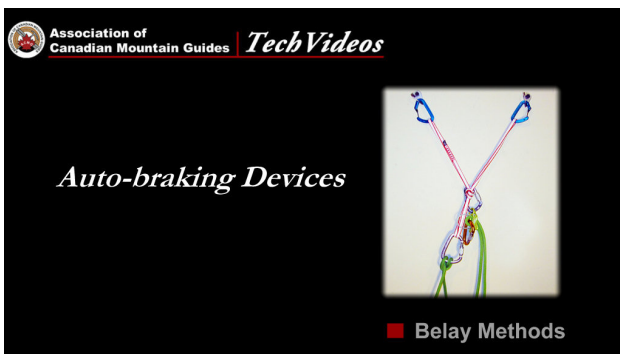
Resources



Fixed-point Belay

For a more in-depth look at fixed-point belays visit, the ACMG TechVideo on Vimeo.

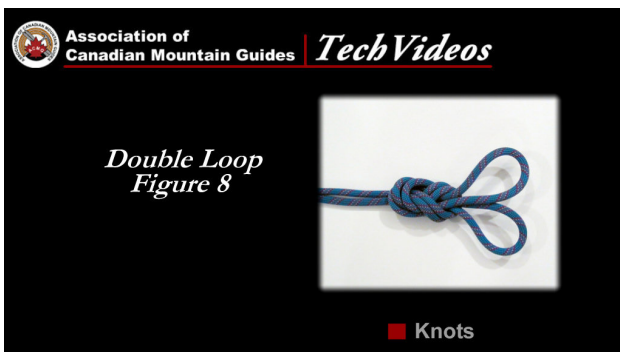
<https://vimeo.com/44869774>



Auto-braking Device Belays

For a more in-depth look at auto-braking device belays, visit the ACMG TechVideo on Vimeo.

<https://vimeo.com/44847539>



Double Loop Fig 8

For a more in-depth look at the double loop fig 8, visit the ACMG TechVideo on Vimeo.

<https://vimeo.com/44683844>



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