6. Equipment

The equipment used for urban abseiling is drawn from a number of sources but predominately from the industrial rope access arena or the world of climbing. Everything is tested and rated and generally there is a piece of equipment for most scenarios. Due to the professionalisation of both industries manufacturers and end users work together to devise and create devices which are fit-for-purpose and very user friendly.
Setting up temporary abseil rigs off buildings adds an extra element of necessary improvisation and there is still a need for providers of abseiling to be able to adapt and overcome problems for which no piece of equipment has yet been created.
Being familiar with breaking strains, forces, and suitability are all an important part of the knowledge base of any climber but is a professional responsibility for a charity abseil provider.
There are obviously a number of manufacturers out there which produce climbing equipment and a smaller number which produce rope access equipment. There is not yet full *harmonisation* between manufacturer's standards to the extent that even breaking strains are recorded differently (see table 2)

Table 2 - breaking strains		
Weight	This is listed as the actual maximum working weight that an item can be subject to as opposed to its failure weight.	Recorded in kilogrammes
Force	This is the amount of force that a piece of equipment can withstand as applied by a moving object such as a 100kg descending earthwards.	Recorded in kiloNetwons
Statistics	This is an analysis of the average breaking strains of equipment and a measure applied to the likely hood of something failing at a given force.	Measured in sigma.

Care and Maintenance
Full instructions are given with each piece of equipment on purchase as well as there being extra information and support on manufacturer's websites. Specific information has been included under the relevant section but a few basics should be mentioned.
As discussed in the chapter on PPE there are guidelines on best practice which must be adhered to in order to maintain compliance with IRATA standards. The best log book system in the world however does not guard against poor care or immediate damage. Most climbing equipment is made from either metal or nylon and need to be treated accordingly.

Photo 30 A steel and an alloy HMS carabiner

Metal

Steel rusts and is heavy but is very hard wearing and is the go-to material for many industrial applications. However in an environment where weight matters such as climbing it is generally avoided. Activity centres often use steel carabiners to take into account their staff are not quite as

careful with centre kit as they might be their own and also they are less likely to be pilfered for someone's rack. Steel carabiners are also less susceptible to damage from chemicals but this is not to say that they shouldn't be looked after with care. From a charity abseiler's point of view it is useful to have a few steel carabiners available for anchoring to eye-bolts and using as direct clips to non-standard anchors but there should be no need to use them on the basis as listed above if care is taken to look after all equipment.
There are very few other items of steel in a climber's rack but be aware of random items such as springs for moving parts including the steel spring on a carabiner and rivets and swages.

Aluminium is more prone to damage from friction and chemicals nonetheless anodised aluminium is still the metal of choice for climbers. Careful checking and care should see most solid items with few moving parts such as carabiners lasting for a minimum of ten years.
Be aware of a few precautionary measures;

- A weighted rope running over an alloy carabiner will soon wear it down. This is generally not an issue when belaying
- Avoid using alloy carabiners to clip to bolts and non-standard anchors as they may develop burrs on the inside which can slice through a rope.
- Be careful when marking them – don't use stamps and avoid engraving tools.

Photo 32 A burr on the underside of a perimeter fence

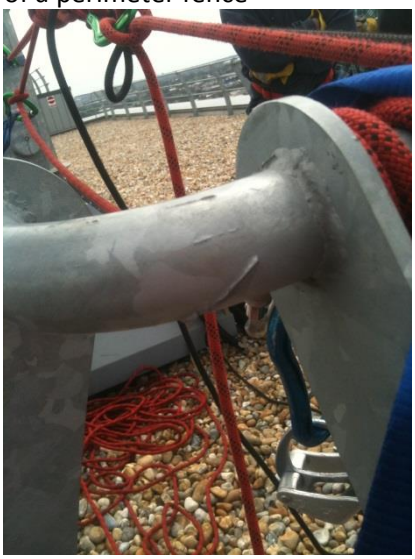


Photo 33 Different types of slings. From left; nylon, nylon/dyneema, aramid, dyneema

Nylon

Ropes and slings are made from nylon; they are susceptible to heat and chemicals and abrasion (effectively heat) and UV degradation. This is especially significant when using slings to attach to a scaffolding tower or a roof part that may have on it a variety of substances. Also be aware of burrs on the structure of the building which can slice through a sling (photo 32).

A significant factor is that ropes are protected from the worst ravages of use by a protective sheath but slings are not and any visible wear to a sling is a sign that it should be retired.
Many slings are now made from dyneema which is stronger so they are generally produced much thinner and lighter. This obviously makes them more prone to damage from abrasion. Also dyneema has a lower melting point so is not as safe for using as a prussic and has virtually no stretch at all. Even a nylon sling flexes a little which means it can absorb more force. Combination slings – made from dyneema and nylon are now available as in Photo 34 second from left which provide maximum load bearing and good abrasion resistance. Also in Photo 33, second from the right is an aramid sling which is round (like a rope) and very stiff. It has many advantages over nylon and dyneema not least a very high melting point but also as a 6mm cord it has full strength but is also pliable enough to be used as a prussic cord.

Remember harnesses are also made from nylon slings and due to the effect of UV degradation alone should be considered past their safe use by date after five years.

Forces

In a climbing environment the absorption of shock is one of the primary functions of the rope reducing the impact not only to the climber but to the equipment as well. It is not unheard of for climbers to fall several metres before the rope takes the strain of the fall and were a static rope used for this then the climber would be caused a great deal of injury indeed.
It has been shown that a fall of only 3m onto a non-shock absorbing system will kill a person. Table 3 explains fall factors.

However this is not the whole story, many other factors come into play; the stretchiness of the rope, the *dynamicism* of your belayer, the amount of rope slack in the system, the position of your belayer and the drag on the rope due to gear placement all affect the forces involved. Some negatively i.e. a dog-leg in the rope due to poor placements in effect reduces the length of the rope and increases the fall factor. Conversely a lot of slack in the system means you will fall further but on more rope so you will have a smaller fall factor (assuming you don't hit the ground).

So how does this apply to abseiling?
In short; it doesn't really.

The rope is always coming from above and the scenario where the rope is kept taught and then suddenly released is unlikely to a) happen and b) not cause a significant fall factor.
It is important to define what is a dangerous fall factor; on a dynamic climbing rope then a fall factor of 2 is still considered 'safe'. On a non or low-stretch system this reduces dramatically and the UIAA test these ropes with a fall factor 0.3.

Table 3 Fall factors -

In order to understand why we need to understand fall factors we need to be aware of the following equation.

$$\frac{\textbf{Length of fall}}{\textbf{Length of Rope}}$$

This is the maths but how does it apply to climbing?
If you are top-roping in a climbing wall then you might have 40m of rope out. Even with an inattentive belayer you may fall about 4m (for arguments sake).

- Length of fall/length of rope; 4m/40m = 0.1. A very low fall factor.

If you are leading in a climbing wall and clipping all the draws then you may have 10m of rope out and fall 5m.

- 5m/10m = 0.5. A low fall factor.

If you are leading outside and you fall the length of the crag but just missing the floor from the top then you may have 10m of rope out and have fallen 10m.

- 10m/10m = 1. A high fall factor.

If you are multi-pitching and you climb past the belay and fall before placing any runners then you might have 5m of rope out but fall 10m.

- 10m/5m = 2. A very high fall factor.

Even with an extreme drop abseil such as 200m with a low-stretch rope a fall near the bottom of the abseil of 10m would confer a maximum fall factor of 0.05.

If this scenario were to occur at the beginning of the abseil then there is a risk that the fall factor would be near to 1 – but it will not exceed 1 and the more important factors such as belaying etc would become more significant. It is extremely unlikely that a significant uncontrolled fall followed by a sudden arrest will occur in the abseil environment.

> Insert 9
> "The slack in the system would have to be just less than 43% of the distance abseiled. Thus when the belayer introduces more than 43% of this distance abseiled as slack, the fall factor will rise above 0.3." Jacques Raubenheimer (2007). *A guide to long and extreme abseils*

Any belayer having insufficient control of the rope so that large fall factors are generated would benefit from further training.

Do we need to worry about it then?
Well, yes. The place where it will be most significant is when using a sling as a cowstail. If this sling was clipped to something at ankle height and you were to slip then you would fall past it and apply a fall factor 2 fall to a non-dynamic system. It has been shown that in this situation either the sling will snap or a body part will.

The standard way for climbers to protect themselves at the top of a building is to use slings so ensuring the sling is taught at the stance is important. IRATA and cavers recommend the use of rope cowstails which adds a small amount of elasticity to the system and is also less affected by abrasion and edges. It is difficult not to strongly advise this line and indeed it is to be recommended but not at the exclusion of slings.

And the most important need is knowledge. By many standards a 'good' belayer is one who does not interfere with the act of abseiling. Jerky safety ropes are irritating and too much slack can get caught as well as creating a disconnect between the abseiler and belayer which can cause further problems. It is this disconnect that may result in a sudden fall and a 'shock' to the system. It has been shown that the forces are slight and the worst case is probably a 'hard fall' which is not a problem – unless the abseiler has a pre-disposing back problem. Or panics. Or gets a hand caught in the wrong place during free fall.

There are some instructive analyses of the forces that might theoretically be generated easily accessible on the web.

Ropes

Ropes were traditionally many strands of hemp twisted and plaited together to make up ropes of different thicknesses. Ropes made in this manner are called hawser-laid (when consisting of three strands) and are commonly used in other industries and particularly marine usage but are now made from nylon and other synthetic derivatives such as polypropylene. This twisting design of traditional

ropes gives them stretch and a high degree of strength to weight however they are rough to handle and have no protective sheath.

The development of 'kern-mantle' ropes which are made on a 'loom' and consist of an inner rope (or kern or core) providing much of the strength and an outer rope (mantle or sheath) providing further strength as well as protection. The sheath also confers onto the rope its handling properties.
The manufacture of the core determines its relative flex and stretch with more twists and shorter lengths of fibres contributing greater stretch (Fig 12).

There are two kinds of kern-mantle rope used in climbing; dynamic and semi-static or low stretch. A climber needs to be protected from the shock of a fall by having a stretchy rope but as previously discussed there is very little force generated from abseiling and low-stretch ropes are superior to use not only for the abseil rope but for the safety rope as well.
The thicknesses vary from 7mm to 11mm with the thineer ropes being designated 'twin' or double' and not to be used on their own and anything past 10mm (sometimes 9.5mm) being a 'single' rope. Abseiling rope is a single rope and is produced in 10.5mm or 11mm. The thicker ropes are better to handle for the abseiler and harder wearing and should be chosen over the thinner ropes. The thinner ropes do have a place for short abseils in centres where the majority of the clients are children.

Table 4 shows the relative stretch of the same thickness dynamic rope compared with a low-stretch rope and it can be seen that for long abseils a dynamic rope would have a significant amount of stretch on the longer abseils. The two figures show static stretch and dynamic stretch i.e. a rope will stretch further if bounced on rather than just carefully weighted. This amount of slack in the system significantly increases the risk to the abseiler due to the belayer having poor control of such a bouncy rope and then being unable to actually prevent a long fall.

A low stretch rope with a typically 3% stretch will mean that at the end of a 100m abseil there is a chance of an uncontrolled fall of 5m – certainly enough to cause an injury as they bounce into the ground. However a dynamic rope with a static stretch of 10% and even greater for a dynamic stretch then there is a strong possibility of a minimum of a 10m uncontrolled fall at the end of a 100m abseil.

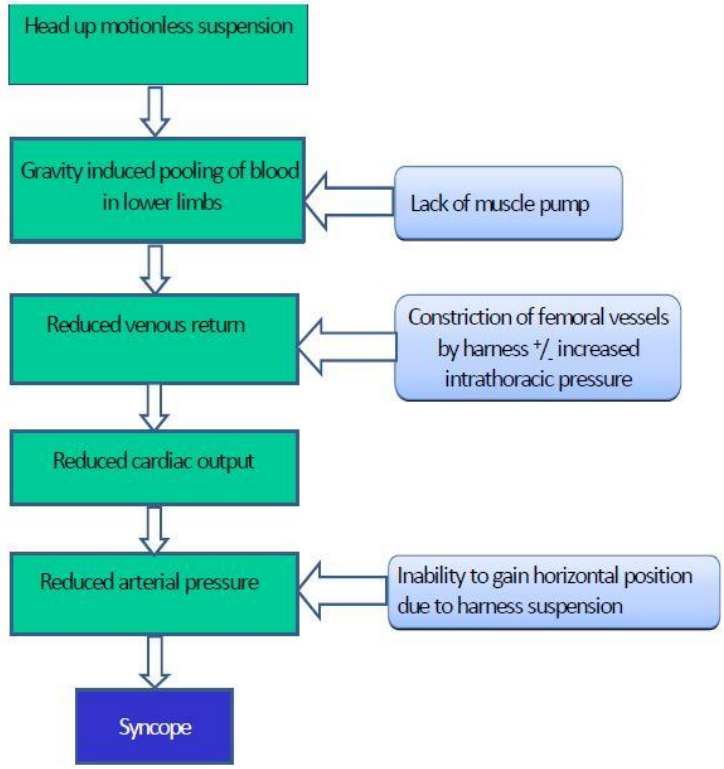
Looking after ropes is crucial. On-site hazardous materials must be avoided and sharp edges should be identified and protected against. Be mindful of burrs on railings and scaffold such as in Photo 33. When pulling the safety rope back up then feel for nadges and furring and if a team of enthusiastic abseilers are engaged to do the pulling then have a hand on the rope to check for damage.
Dirt and use can cause the ropes to shrink so be aware that your long drop ropes need checking periodically. And use can cause twisting and kinking which becomes particularly vexing over time. Be careful which belay device you choose and only use professionals to help you on events.
Wash ropes in luke-warm soapy water and allow drying to occur naturally away from direct sunlight. Log every use and change of designation i.e. belay rope being downgraded to an abseil rope or a long rope being cut.

Your ropes are your life lines (literally) and there is an increasing call for charity abseil providers to abide by industrial standards and it is in our best interest to do so as well as the interests of our clients and the industry as a whole.

Harnesses

The harnesses used in climbing and abseiling are perfectly suited to the job but within the context of long drop abseiling then we also need to consider chest harnesses and full body harnesses. The specific reason for this is suspension trauma.

Fig 13 Suspension trauma sequence.
HSE (2009) *Evidence-based review of the current guidance on first aid measures for suspension trauma*



Suspension trauma is, in short fainting in the harness which is known medically as *syncope.* The real risk is that with a sit harness there is a risk of an unconscious person then inverting which can cause either a) a sudden rush of toxic, de-oxygenated blood to the heart and then a cardiac arrest or b) a sudden overload of the right ventricle of the heart and subsequent failure as would happen when the blood pooling in the legs returned to the heart upon rescue and repositioning horizontally – so called 'rescue death'.
Fig 13 below shows the sequence of events that lead to suspension trauma and the contributing factors including 'crush injury' – the body's response to the harness crushing the legs which results in the release of proteins that can damage the kidneys.

Much research has been published about this and the HSE have thoughtfully reviewed the literature and this can be easily accessed directly from them.
It should be noted that suspension trauma is as a result of a vertical position being maintained for an excessive period of time causing venous pooling in the legs. The general advice is to use full body harness but these only secure an abseiler in a vertical position. A well-fitting sit harness will also secure an unconscious person in a vertical position and is therefore equally as likely to cause suspension trauma to an unconscious casualty but the nature of the sit harness means that the abseiler can adjust their position to the horizontal and even invert prior to unconsciousness and is therefore more able to delay the onset of fainting.
There are greater risks with a badly fitting sit harness and these will be looked at below.

The key number to remember is 10. In 10 minutes a suspended and unconscious abseiler could die and there must be systems in place to quickly pick up someone who has got stuck.

Suspension trauma is an irrefutable condition and is exacerbated by anxiety, dehydration, pre-disposing medical issues, weight and fitness and environmental conditions so is not to be taken lightly and the watchword here is prevention.
Recommended preventative measures should include:

- Correct fitting of appropriate harnesses.
- Regular 'pumping' of the legs i.e. walking down a building – this strengthens the case for set ups to always make the abseiler remain in contact with the building and ensuring the abseil point is not too overhanging.
- Medical screening – people at risk are those with cardiovascular or respiratory disease. This is not to say that they shouldn't take part merely that with the increased risk there should be more control measures in place.

As long as the stuck abseiler is lowered or rescued in good time there is nothing to worry about and remember to treat someone affected with basic 1st aid. It was originally thought that an important factor with suspension trauma was to *not* lay them horizontally on reaching the ground as it is the sudden return of blood that causes cardiac arrest. This is also known as Reflow syndrome. However the HSE has more recently amended its advice to state that there is a greater danger to the casualty in a reduced blood flow to the heart and brain so it would be more effective to lay any casualty flat.

Interestingly, according to IRATA prior to 2001 there were no incidences of suspension syncope reported and a recent review of the evidence by the HSE does not include any significant changes to current practice.

Sit harnesses

There are two types of sit harness commonly used; a standard climbing harness and a 'centre' or 'alpine' style.
Both consist of loops for the legs and one for the waist with supporting bum straps but they differ in how they are configured at the front. A standard climbing harness keeps the waist belt and leg straps separate but joins them with a vertical belay loop. This loop is very strong and is used as an attachment point for belay devices and abseil devices amongst other things. It is not recommended to tie directly to this, however and normally a rope is passed behind the belt and leg loops as shown in Photo 36.

Photo 36 Standard method of tying into a harness with a figure of eight knot and a double fisherman's

The centre harness brings all the loops together in one single attachment point for devices and for tying in (Photo 37). This has the advantage of sitting higher on the body which considerably lowers the likelihood of inversion but is, arguably not as comfortable as it tends to pull predominately from the waist. A badly fitted harness of this type can cause abseilers to feel nauseous quite quickly.

Photo 37 Tying into a centre harness

It is the fitting of the harness that is crucial and there are many ways to get it wrong:

- Waist belt too loose – if you can pull it down off your waist then it is too loose.
- Leg loops too loose – if the majority of the hanging force pulls from the waist and causes the waist belt to press against the ribs then the legs are too loose.
- Harness too low – this is more common with lads who don't want to wear the harness too high out of embarrassment or because of an abseiler with a large belly. This increases the risk of accidental inversion.
- Waist too tight – as with leg loops too loose.

There are circumstances where an ideal may not be achieved or may be necessary such as mentioned above with top heavy men whether as a result of a large belly or some body builders. A similar situation can be encountered with very top heavy women – whilst it is possible to find their waist the force through the harness might be significant and increase the risk of inversion. Also pregnant women might prefer to have a looser waist belt – it is worth remembering that the waist belt is there to stop the abseiler falling out of the harness when upside-down. Women have wider hips so can manage with slightly looser waist belts. Also some children are shapeless or have no corners such as ribs and hips so it can be very difficult to correctly position a sit harness.
In these circumstances a chest or body harness should be considered.

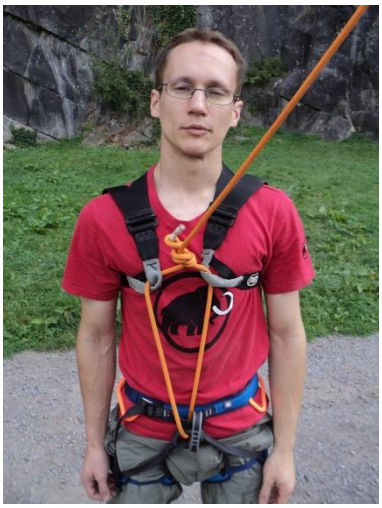


Photo 38 Chest harness with a typical tie in method although not necessarily the best.

Chest harnesses
These should be made for purpose but improvised ones can be used if required. All manufacturers of harnesses will make a corresponding chest harness and even if not used on every drop there should be some available.

The advantage of a chest harness is that the abseiler has as much freedom to move as in a sit harness therefore delaying the onset of suspension trauma and that a well tied safety rope will considerately balance the load taken between the chest and waist and keep the abseiler in a comfortable, semi recumbent position.
It is possible to improvise a chest harness and the most effective way is with a Parisienne Baudrier as in (see other books).

Full body harnesses

It should be stated that there is no evidence to show that a full body harness is safer, reduces the onset of suspension trauma or is even more comfortable. The evidence is quite the opposite but full body harnesses are *very* reassuring.

Other disadvantages are an increased likelihood for them being badly fitting and also they generally have a slightly higher attachment point which puts the abseil device closer to the face. As previously mentioned they also maintain the abseiler in a vertical position which may increase the onset and the effects of suspension trauma.

They are to be considered in certain circumstances such as with small children particularly as they tend to hang vertically on walls anyway. Also for pregnant women and with people who have medical issues such as a colostomy bag…

Harnesses should be checked regularly and monitored for signs of wear. Many modern harnesses have a layer of material around the tie in points (Photo 45) which is designed to wear out over the life of the harness. If this has worn through then the harness is due for disposal.
Store harnesses out of direct sunlight at all times as they have no protective sheath so can quickly degrade from UV exposure.
Wash harnesses in luke-warm soapy water and dry naturally.

Photo 45 The wear strip on a harness

Helmets

Helmets serve two purposes; avoid injury in the result of a trip or fall and to protect against falling objects. In the abseiling environment both are very real possibilities so helmets are to be considered mandatory. There are many helmets on the market and all UIAA certified helmets are adequate to the task but 2 different types are worth discussing. A plastic shell and cradle type and a foam helmet with composite shell. The first are a bit heavier but more widely adjustable as in the first 3 in Photo 46 and the other type are lighter and have a small adjuster at the back but are not as universally adaptable. The first type is generally

Photo 46 Modern helmets



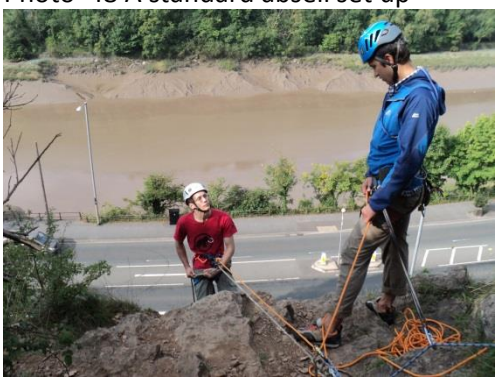
more suitable for using with large numbers of abseilers, all with different size heads.
A few exceptions should be discussed as in certain circumstances, with appropriate risk assessment it is possible to either; not wear a helmet or to use a non UIAA tested helmet. Working with people with special needs it is quite common to come across people with their own protective headwear or apparatus attached to their head for health reasons. If a helmet were to interfere with this then it

might be best to work out a way where a helmet is not required. Also some people might find a helmet too distressing and cannot be convinced to wear one. This might mean adopting different practices such as sending a 'spotter' down with the abseiler but this is perfectly acceptable.
Also Sikhs tend to prefer to not remove their turbans. It should be remembered that Sikhs are still legally able to ride a small motorbike without a helmet so if appropriate then they should not be denied the right to abseil.
Do discuss these issues with your abseilers (and their carers if appropriate) and make sure they clearly understand the risks that they take by not wearing one. If the building is such that there are too many sharp edges and a greater a risk of the abseiler hitting their head then hopefully this will have been identified in the initial risk assessment and no-one is faced with being turned away at the edge.

Helmets should be correctly fitting ensuring that they protect the forehead. Adult helmets on children are to be avoided as are child helmets on adults. Both result in reduced forehead protection.
Use the helmet to manage unruly hair or ensure the hair is tied back. Consider asking for top-knots and pigtails to be removed. Fancy dress can cause a problem but is usually manageable.

Abseil devices
The devices discussed here are ones advised for use with clients – the term abseiler will be applied but it is important to make the distinction between a competent professional and a potentially incompetent novice.
Any abseil device should be chosen for its simplicity of operation first and foremost so a simple friction device works best. Further considerations are then the effectiveness of the device over the specified distance, the effect of the device on the rope and the ease of application and removal.

Photo 48 A standard abseil set up



As previously discussed climbers generally use their belay device and modern devices are designed with this in mind. A climber might have to abseil several pitches on their belay device and they are designed to be able to sustain such distances with a degree of care. There are numerous multi-purpose devices on the market and it might be that due to an oversight these devices have to be used and it is worth considering some pros and cons of abseiling with them.

Photo 49 Different Fig 8s

The standard 'ATC' type is a very common device with a high level of friction when using 11mm low-stretch ropes and can be used effectively over long abseils. The difficulty is at the beginning of the abseil where the rope is very heavy and needs to be lifted into the device. This can cause problems and it is generally not advisable to use this device with abseils over 50m especially as the heat generated can cause damage to the rope. Also the majority of the load is taken by the carabiner and this can wear

through very quickly. Not catastrophically during one abseil but with a wet gritty rope a carabiner can be rendered unusable over the course of one event.

Most 'standard' abseils use a 'fig 8' descender (Photo 49) but they generate a large amount of heat and kink the rope. This combination tends to cause a very badly kinked and flattened rope particularly if abseilers go quickly. For long drop abseils they are also very difficult to operate near the top with smaller people particularly having to push the rope upwards into the device to descend. Apart from the obvious annoyance and difficulty people face it also increases the likelihood of an incident occurring. Fig 8s also have a unique ability in that they can 'larks-foot' around the top bar (Photo 50). This generally
happens if an abseiler presses against the wall as they go over the edge and is easily rectifiable but it can happen lower down if the safety rope is too tight and the abseiler becomes frustrated. A DMM Anka (on right of Photo 49) has phlanges which limit this possibility and were it not for the fact that they are unwieldy they should be used more often.
Fig 8 descenders also have one unique feature which resulted in a tragic death. Should the carabiner settle into such a position as to become cross loaded the Fig 8 can also act as a lever and
apply such a force as to shear the locking gate. With an attentive belayer and a safety rope this is not a disaster but it is surprising how often this situation arises and can be avoided by using suitable carabiners (see below).

Most providers of long drop abseils advise that ab-racks are used as they have a number of benefits over all the other devices:

- They don't kink the rope
- They don't need to be unclipped from the harness at the top to load into the rope so reduce the chance of them being dropped.
- Because of this they can be attached to harnesses using maillons so there is no risk of cross loading
- They don't generate as much heat
- The rope has a more consistent 'feel' throughout the drop
- There is no need to 'lift' the rope into the device as the rope is smoothly aligned through the rack.
- The racks can be loaded in a number of ways to take into account different weights of abseiler.

Photo 52 Ab-rack

The different types and how they should be loaded are shown
below. There are slight advantages with the positioning and friction generated with each type but they generally all perform excellently in this environment.

Belay devices

The system for belaying at the top of a long drop abseil is subject to many things, not least a person's preference. Even though during the initial inspection a decision can be made on the device that would be most effective this may change on the day due to a scaffolder's mistake or a rescue situation. Being familiar with a multitude of devices and their effective application is fundamental to the knowledge of a charity abseil provider.

Consider first the set up; is the belay point behind the belayer, at head height, in-front, above or below (such as flat on the roof)? Then consider the length of the abseil; climbers are used to short abseils and even a long standard abseil is less than 50m.

An Italian Hitch is just not suitable to protect long abseils. They can be used and in an improvised rescue situation or where it is necessary to lower a rope then it might be necessary but they kink the rope, generate too much heat and can trash a rope in a single abseil.

Photo 53 Lots of belay devices

The use of a standard belay device is still the most common and there are many on the market with everyone having a preference

Each manufacturer has slightly different USPs;

- Some can be used in 2 different positions thus altering the friction
- Others have teeth on one edge which can be used to increase friction on the dead rope such as when belaying with double ropes but for abseiling is generally not required.
- Alpine plate style combination devices have less friction than most and are very good for long drops but can be difficult to control in the lower sections for tired hands.

Photo 54 Belaying at the top of a crag

If the rope is laid along the ground such as at the top of a gritstone crag or as in Photo 54 then it might be necessary to have it near the belayer and to use a 'normal' climbing belay device as an Italian Hitch or an ab-rack may well get caught between device and roof when loaded.

Is it practicable to have the belay device attached close to the belayer? It is easy to see lots of reasons why not; too close to the edge, pulls the belayer off balance and can get caught in clothes but with a low take off and close anchors it might be preferable.

Using a lockable device has many advocates, not least from the world of IRATA as it adds in a failsafe mechanism. There is no significant reason to discount using a device such as an ID or Rig but if there is an increased chance of putting friction through the system then there is an increased risk of an incident occurring. This added friction will also reduce the life span of the ropes. Another disadvantage is having to have the device within easy reach for both hands which means it could impeded into the take-off zone and make the beginning of the abseil potentially more hazardous and certainly more awkward. However a well-positioned device at head height, in-front of the belayer may well be manageable but needing two hands to operate it will limit the belayer's ability to assist the abseiler.

The use of an ab-rack, set up slightly differently is a real option as the braking position is not necessarily defined and a good level of friction can be applied wherever the device is situated. The particular advantage of the ab-rack is when set up for a long abseil it might only be necessary to pass the rope around 3 bars but as the abseiler's rope gets lighter and the belayer's gets heavier extra bars can be added with minimal fuss to increase the friction. It also has all the advantages of the ab-rack as listed in the previous section and is gaining popularity amongst professional organisations.

Photo 56 Head height belay set up

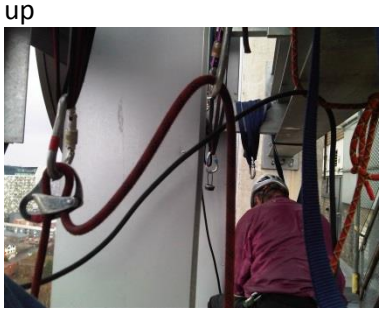
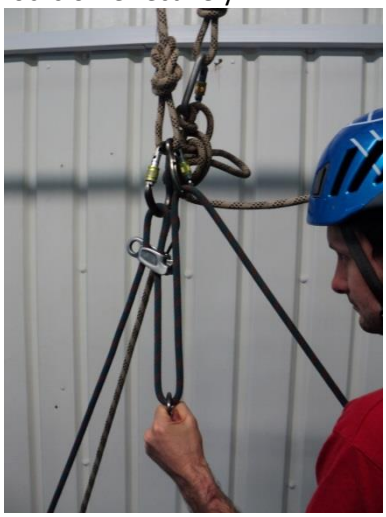


Photo 57 Use of a third crab allows for extra control but locks off effectively



A common set up more familiar to climbers is shown in Photo 56 as it uses a standard belay device and if used correctly causes minimal friction in use but locks off effectively. By passing the dead rope back to a carabiner behind the device means control can be easily maintained but when locked off then a high level of friction is applied through the device. This set up does limit the positions where it is useful (mainly in-front at head height) and it is difficult to 'take-in' any slack but with the right set up this is an extremely effective technique. It can also be enhanced by using a 'Revolver' carabiner at the rear and by the inclusion of another hand held karabiner between the device and this carabiner (Photo 57). This allows for a really nice, smooth belay action with very little friction in the system but with a sensitive feel and when a gripping force is applied from the belayer it quickly and firmly locks off with it being impossible to maintain the position of the hand held carabiner.

Photo 58 A selection of different carabiners

Carabiners and maillons

The differences between steel and aluminium have already been discussed but it is important to mention some carabiner types. These are based on personal preferences and some are only available from one manufacturer but no one manufacturer is recommended over another.

Snap links with solid gates and wire gates. Snap links are used by climbers and are, inherently safe however there is a risk that the gate can be pressed against and in effect come undone. The reduced strength of a carabiner with an open gate is not to be understated and where there is a risk of this they should not be used. So, they should not be used in abseiling in urban environments. Even to hold carpet in place.

Screw-gate carabiners are the most appropriate and come in different sizes and shapes. An important consideration is the ease of unlocking; it could be argued that all abseilers should be tied in but some may prefer, for ease to only clip in the safety rope. In these circumstances then a screwgate with another locking bar as with the one on the bottom right of Photo 61 should be considered. If tying in then there is a lot to be said for the use of a twist lock on the abseil device.

Other useful additions are specific types mad for specific purposes.

- The Revolver screw-gate has been mentioned already and it is a useful carabiner for setting up hoists and it is worth having one on the rescuer's harness.
- A screwgate with the extra locking bar is good for using with Fig 8s as it stops cross-loading of the carabiner.

Photo 59 Maillons

Maillons (Photo 59) are fixed steel rings with a solid, screw thread which must be completely undone to access and completely done up to be considered safe. They are d-shaped, oval and triangular and are sued commonly in caving and industry. For the high turnovers required in charity abseiling they are not really appropriate but can be useful for attaching to non-standard anchors, attaching between chest and sit harnesses and because there is no risk of them undoing like the magician's rings they can be clipped directly into by carabiners.

Slings

Slings (Photo 33) are nylon webbing sewn into a loop and generally come in different lengths. From a climber's perspective a 'short' sling is a 120cm length of webbing (or tape) sewn into a 60cm loop and a 'long' sling is a 240cm length sewn into a 120cm loop. Often climbers also carry very long loops for joining up multiple belays sometimes called a cordlette but not all the time and it is not unusual for a climber to have a non-specific length of tape in their rucksack should they need to tie something to the rock which will be left behind for an emergency abseil.

Photo 60 Slings around a wind turbine

The webbing is made from nylon or dyneema – the advantages of which were discussed earlier but noticeably a nylon sling is thicker; often dyneema slings are incredibly thin. In the urban abseil environment nylon slings are recommended and it is practical to carry many longer ones for joining up many different anchors or wrapping around a wind turbine mast, for example (photo 60).

Cowstails

There is a real need for guidance on cowstails and they are used infrequently by climbing instructors – the reasons were discussed in the section on forces but for most climbers this will not seem reason enough. It should also be made clear that a well-managed stance and a correctly positioned clip should not require more than a sling to clip on with but nonetheless cowstails are used as standard in caving and rope access and it is not without good reason.

Cowstails are short lengths of rope attached directly to the harness, normally with taped up knots that cannot be undone accidently. Two is normal so that one remains clipped at all times. Often the carabiners at each end have captive eyes and are of a twist-lock variety.

There is no need to try and shave weight on an abseil but there are many reasons to consider them:

- They are stronger than slings. Ropes are generally rated at 28kn and slings at 22kn. Although it could be argued that an overhand knot reduces the strength of the rope by up to 40% and a figure of eight knot by 20% which would make them weaker.
- The have up to 40% stretch with a dynamic load so will soften any fall and thus the load (fall factor) applied through the system.
- The core of the rope is protected by the sheath from sharp edges, abrasion and hazardous chemicals.
- They are thicker and more reassuring – they are. They really are.
- They are permanent fixtures of a harness, in effect and cannot be accidently unclipped or undone.
- They can also be quickly converted into a y-hang for rescues.

Although not standard practice for climbers to wear them they are recommended.

Insert 10

One event which I have experienced earlier in my career is the abseiler losing control and their weight being taken by the safety rope to the chest harness. The set-up was not thought to be unsafe but was poorly fitted with a clove hitch in the safety rope to the chest harness and too long a length from there to the sit harness. The abseiler was weak which resulted in the abseiler not resisting the chest harness as it rode up and became stuck fast around their head with their arms pinned vertically above them. The pressure then pulled on the helmet and the abseiler started to choke. They were only a short distance from the ground and I was able to reach up and unclip the helmet but this risk is a rare example of *things that should not happen*.