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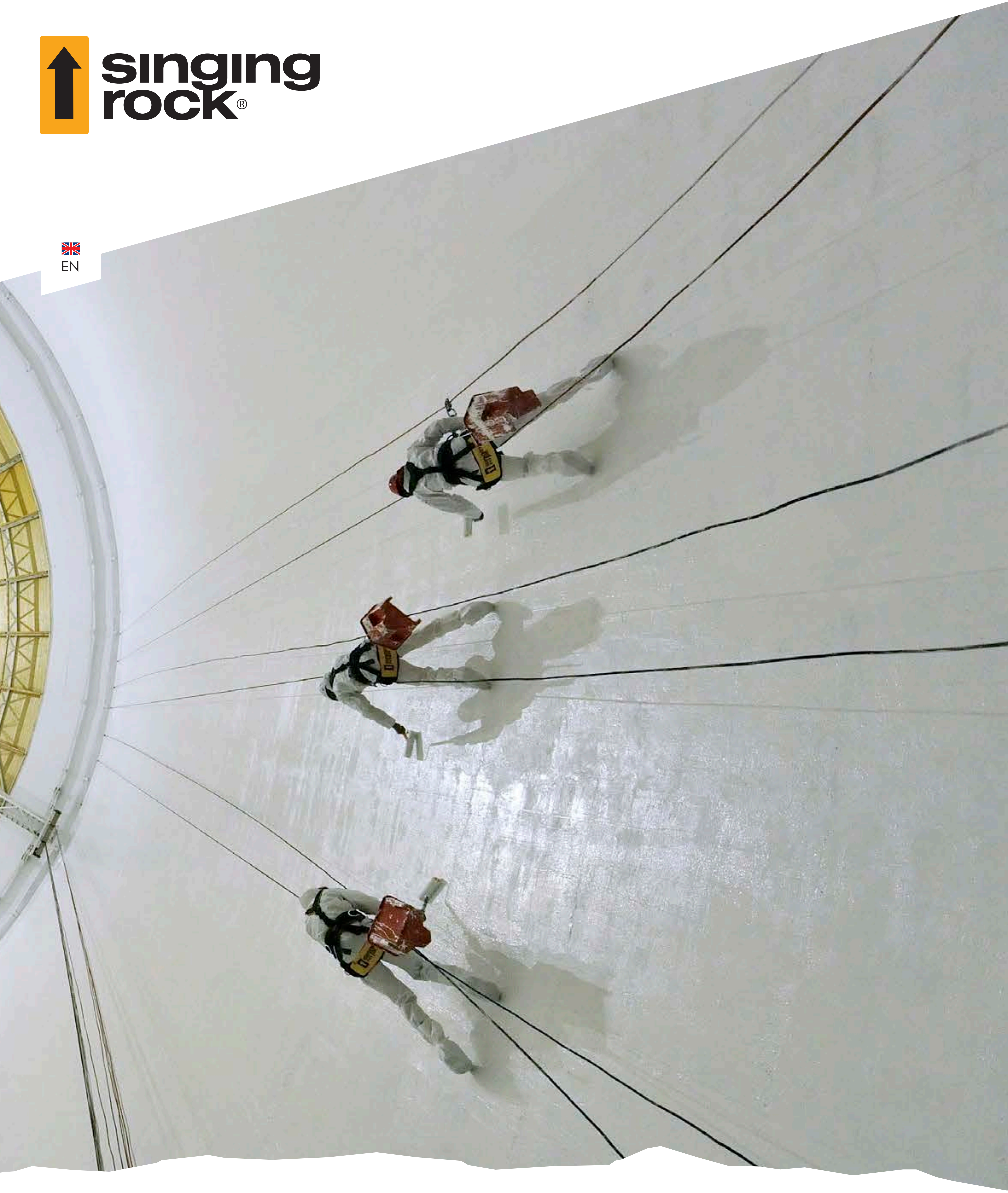

WORK AT HEIGHT TRAINING

LEVEL 2 ROPE ACCESS


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Contents

Syllabus of the OHS Training Level 2

1 Training Output

Worker is instructed in use and maintenance of PPE. He can safely use fall arrest systems and work positioning systems; work in hanging position using the double rope technique. He can anchor ropes in accordance with the rules of double rope technique and knows the rules for selecting anchor points. In case of accident he can set up a rescue system in a way that allows easy lifting or lowering of the casualty from a poorly accessible place. He can carry out a simple rescue by freeing the casualty from the rope and lowering him to the ground.

2 Theoretical Part

2.1 Introduction to the Basic Principles of Double Rope Technique

It is crucial that throughout the work at heights the worker is protected against fall by two independent systems. This means that if the worker loses support and becomes suspended he must use two independent systems as a protection against fall.
The basic principle of the double rope technique is the use of two independent lines/ropes: the working line used for work positioning (ascending or descending) and the safety line used for arresting the potential fall. In a standard situation the worker is connected to the working line by a descender (for example SIR), or chest (for example Cam Clean) and hand ascender (for example Lift) simultaneously. The worker is connected to the safety line by a guided type fall arrester (for example Locker). In cases where falling is prevented (the worker is in a tensioned system, if possible), each of these devices can be replaced by connection with a positioning sling from dynamic rope (such as Lara or Cow's tail) on one of the above mentioned ropes.

2.2 Securing the Workplace

If the worker's activity puts other person/s in danger, (s)he bears the responsibility for that. Therefore, the workplace must be secured as a part of the preparation for work. For the short-term activities it is possible to secure the workplace by barriers, in other cases we use safety guardrails or more effective measures (See Government Decree No. 362/2005 Coll.)
Note: For activities associated with risk of falling from a height it is not possible to use a barrier and more effective measures must be taken. (For example: guardrails, cover/lid, fall arrest safety net)

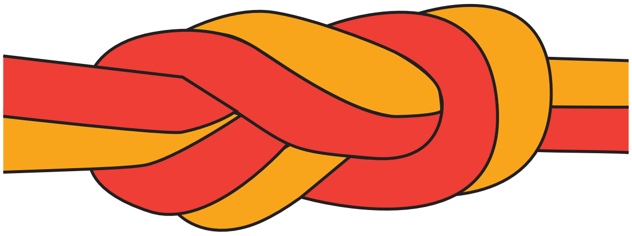
3 Practical part: Knots and Setting up the Belay System

3.1 Knots Used for Rope Access

We have to keep in mind that any knot tied on rope decreases its strength.
Strength of the rope can be reduced by:
- Concurrent straining of the rope by pressure and pull.
- Mechanical and thermal stressing of the rope caused by bending it into small bends which results in a high strain on the rope fibers.
- Slippage of the individual layers of the rope (core and sheath).

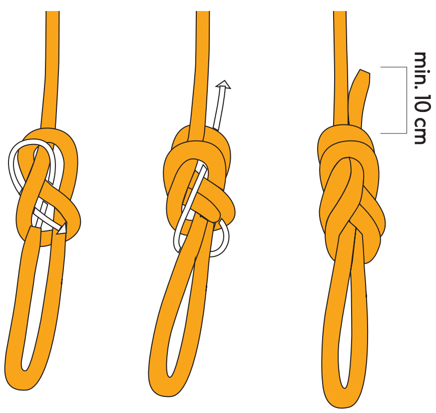
A safety knot must be easy to read and properly tightened. After finishing the works all the knots must be untied so that permanent damage to the rope does not occur.

Figure-Eight Knot



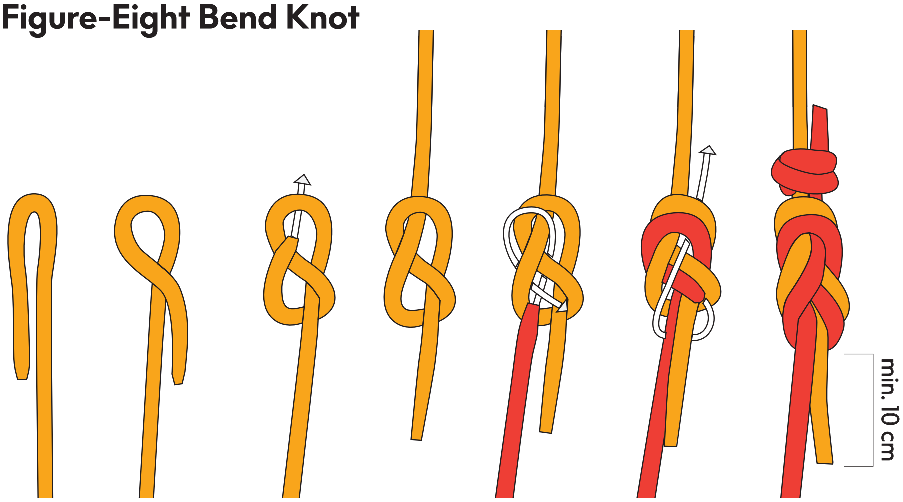
Used for anchoring and attaching the rope.
A correctly tied Figure-eight knot is arranged so that the individual strands of the knot do not cross each other but pass through the entire knot in parallel.
We tie the knot so that the length of the loose end of the rope corresponds to ten times the diameter of the rope.
Figure-eight knot reduces the strength of the rope by 23 – 34 % (all the values are only informative – the actual value depends on many factors – diameter of the rope, type of the rope, rope material etc.)

Rethreaded Figure-(of)-Eight Knot



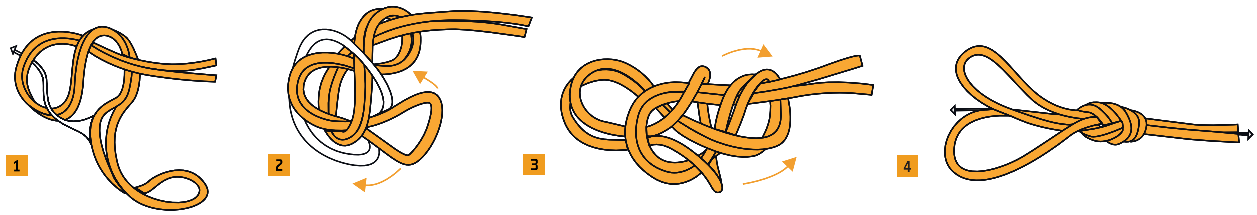
Used for anchoring and attaching the rope directly to an object without using a rope connector.
A correctly tied Figure-eight follow through knot is arranged so that the individual strands of the knot do not cross each other but pass through the entire knot in parallel.
We tie the knot so that the length of the loose end of the rope corresponds to ten times the diameter of the rope.
Figure-eight follow through knot reduces the strength of the rope by 23 – 34 %

Figure-Eight Bend Knot

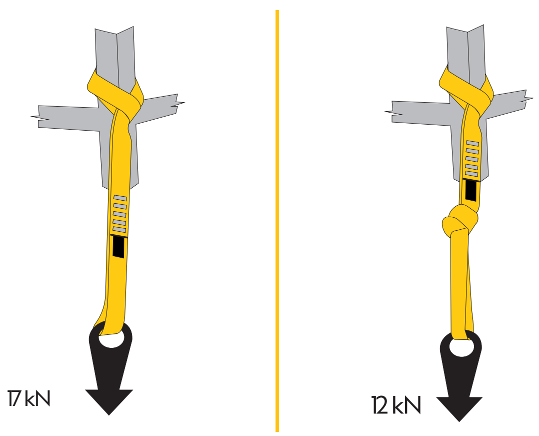


Used for joining two ropes together (for example to extend the rope)
A correctly tied Figure-eight bend knot is arranged so that the individual strands of the knot do not cross each other but pass through the entire knot in parallel.
We tie the knot so that the length of the loose ends of the ropes corresponds to ten times the diameter of the ropes. The figure-eight bend knot reduces the strength of the rope by 23 – 34 %.
This knot is not suitable for joining ropes of significantly different diameters.

Bunny Knot / Double Figure-Eight Knot

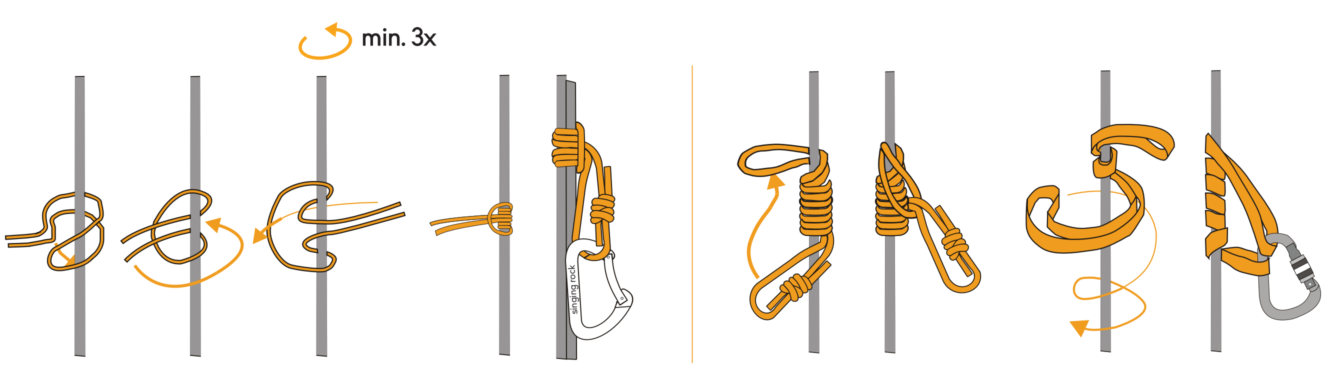


Used for attaching the rope to two anchor points.
A correctly tied Bunny knot is arranged so that the individual strands of the knot do not cross each other but pass through the entire knot in parallel.
We tie the knot so that the length of loose end of the rope corresponds to ten times the diameter of the rope.
The Bunny knot reduces the strength of the rope by 23 – 39 %
This knot is not suitable for joining ropes of significantly different diameters.

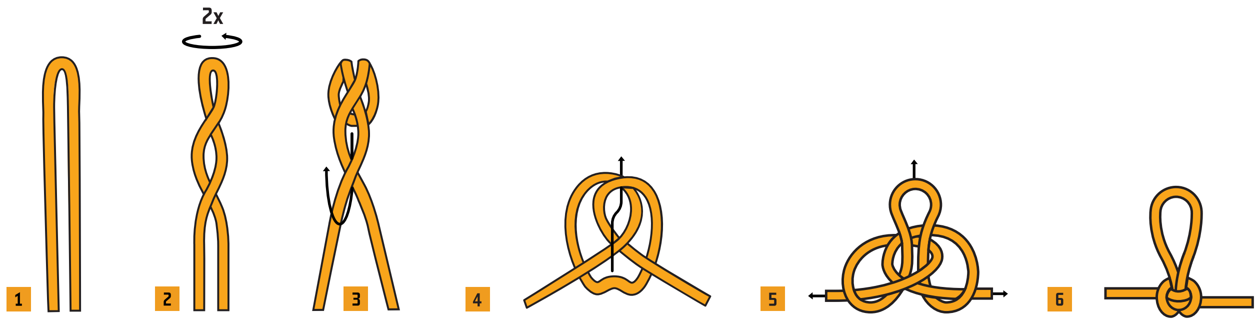


Prusik Knot, Cow Hitch – Lark's Foot

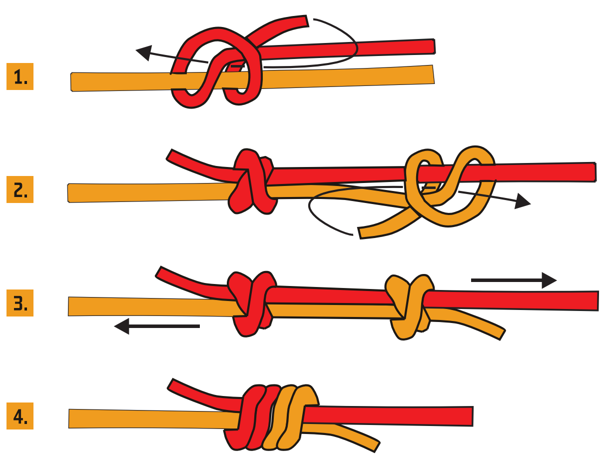
Thanks to the self-locking of these knots there is a peripheral friction that prevents their movement on the rope or the anchor point when they are loaded.
Used for anchoring on the vertical structures, ropes, columns etc. It prevents undesired shifting of the anchor device. The Prusik knot can be used with self-blocking devices, such as pulley systems.
An incorrectly used Cow hitch can reduce the strength of the rope by up to 50 %.
Increased probability of damage to the sling at the anchor point must be taken into consideration.



Alpine Butterfly

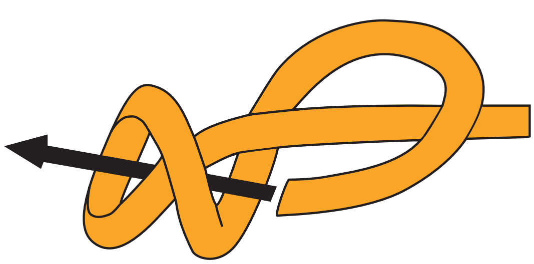


Used for anchoring in the middle of the rope, two-point anchoring (Y-hang), protecting the rope (bypass) by a steel sling, isolating a damaged part of the rope (it is a knot tied on the bight).
Alpine butterfly reduces the strength of the rope by up to 39%



Double Fisherman's Knot

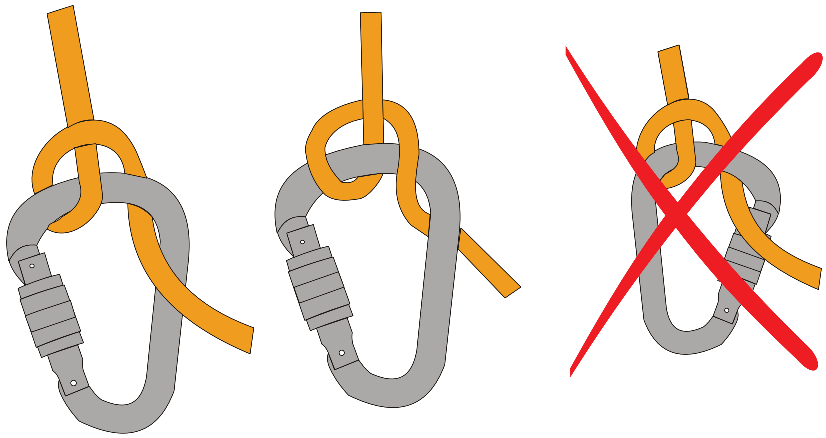
Used for joining two ropes together (suitable for ropes of small diameters too)
If the double fisherman's knot is tied correctly, the knots on both ropes fit tight together and thus tighten each other.
We tie the knot so that the length of the loose end of the rope corresponds to ten times the diameter of the rope.
Double fisherman's knot reduces the strength of the rope by up to 35 %



Barrel/Stopper knot

Used to secure the loose end of the rope against spontaneous slipping out of the descending or belay device.
We tie the knot so that the length of the loose end of the rope is at least 30 cm and that it is possible to easily connect a double fisherman's knot into this knot if there is a need to extend the rope.

Munter Hitch

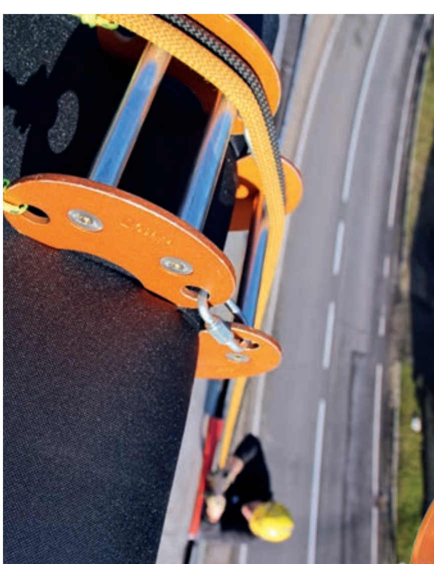


Used for lowering (of material, for self-rescue), can be used to belay the lead climber when using the climbing technique.

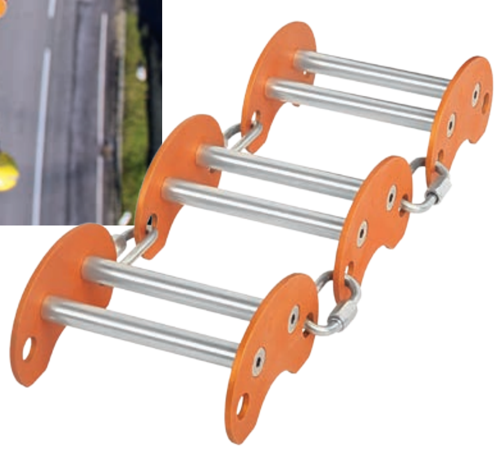
- Reduction of the force during lowering of the load is caused by friction of rope by rope, and thus the rope is considerably strained, which leads to twisting and wear.
- Munter hitch is used in combination with the HMS (HalbMastwurfSicherung) carabiner, whose shape facilitates the proper functioning of the Munter hitch.

Training: The worker ties all the above listed knots correctly.

3.2 Sharp Edges and Placing the Anchor Devices



If the anchoring equipment comes into contact with a sharp edge, there is a risk of damage and the equipment needs to be protected. A simplified definition of sharp edge is: an edge with a sharper radius than rope passing through a carabiner. If the rope or a flat sling passes over an edge with a radius of less than 3-5mm, it is recommended to use a protection made of hard material (like edge roller), if the edge is less sharp, a protection made of soft material (such as the rope protector) may be used.



3.3 Setting the Ropes for the Double Rope Technique

In order to set up a double rope technique at least two anchor points with resistance to static force of 15 kN are needed. Also, in case of failure of any anchor point or other equipment, any fall bigger than the manufacturer of the guided type fall arrester permits must be prevented. Also keep in mind the danger of an uncontrolled swing caused by a failure of the anchor point. In such a case the equipment or the rope could be damaged or a dangerous impact of the worker's body to an obstacle might occur. All the systems must be set in a way which prevents exposing the falling worker's body to the impact force of more than 6 kN.

Usual bearing capacities of anchor points according to the activity

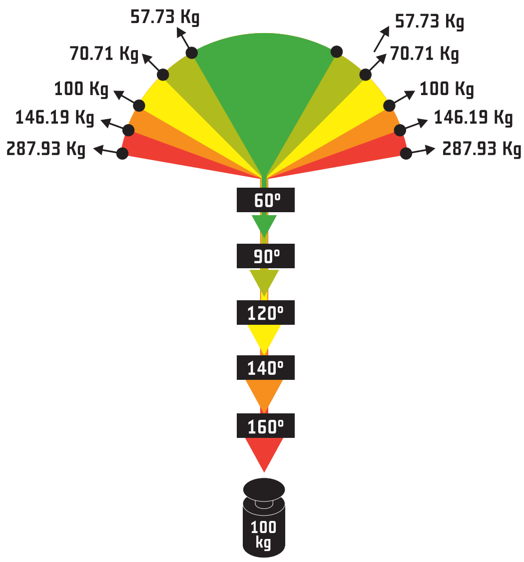
	Maximum load (kg)	Anchor point MBS kN
Work restraint	100	2
Rope access (for anchoring of one rope)	750	15
Fall arrest (anchoring the fall absorber)	600	12
Rescue, 250 kg load	1200	24

Basic Setting

If a structural anchor (such as column, H-beam, tree) is available to the worker, the ropes can be anchored to it by two anchoring devices (slings) and two connectors into which two ropes are connected. We increase the safety of the system by connecting both ropes to both the connectors. An anchoring place with bearing capacity of more than 30 kN does not require using a backup anchoring place.

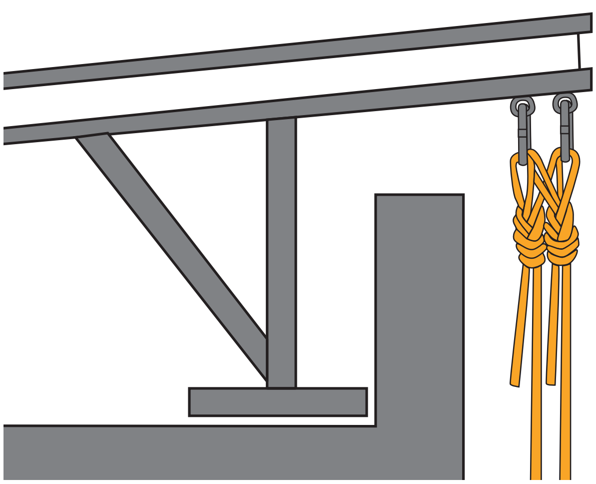
For attaching to the trees:

- The condition of the tree must be checked. Dry branches, exposed and damaged roots or missing bark are warning signals.
- The tree must not be tilted in the direction of the load.
- We calculate with 15 cm diameter of the tree trunk/branch for each 100 kg of load.



Anchoring to Two Independent Points

If there is a need to distribute the force acting on the individual anchor points, back up the anchor points in the event of failure (anchoring places with a bearing capacity of less than 30 kN and anchor points according to the EN795 standard), or to position the rope in the desired direction, we use the principle of the Y-hang.
The force diagram shows that setting up a Y-hang makes sense if the angle between the two branches of the rope is less than 120°, preferably less than 60°. We can easily achieve this with a combination of the figure-eight knot and Alpine butterfly.



The bunny knot is suitable for anchoring to the points which are close to each other (< 1m). In this case the advantage is tying only one knot which is easily adjusted to fit the required direction. The disadvantage is the need for longer rope if the anchor points are further apart.

A combination of the Alpine butterfly and the figure-eight knot should be used for anchoring between distant anchor points (>1m). This option is more time consuming but also more economical as for the required length of the rope.
If the prefabricated anchor points are further apart then 1,5 m (15kN EN 795) they should be doubled. This applies especially if there is a risk of a serious fall or swaying. This occurs in case of a vertical fall bigger than what the fall arrester allows after the failure of one of the anchor points, or the cases of swing where swaying may occur, resulting in an impact of the worker's body or cutting the ropes.

Training:

1. The worker sets up the ropes for the double rope technique.
2. The worker sets up two ropes using the figure-eight knot and the Alpine butterfly.
3. The worker adjusts the above-mentioned combination to a different direction of the load.

4 Practical Part: Worker's Preparation

4.1 Physical Training for Work in Hanging Position and the Health Risks Associated with Work in Hanging Position

Work in hanging position is one of the most strenuous types of work and there is an increased risk of injury. Before starting to work in hanging position it is recommended to warm up and stretch the most vulnerable muscle groups.

As the work in hanging position on rope falls within a group of work with increased physical stress, regular rest breaks must be included. Here we comply with the Government decree No. 361/2007 Determining Conditions for the Health Protection, with regard to the given activity.
Frequent and long-term suspension in a harness may cause neurological damage to legs, it is strongly recommended to use a work seat to relieve the vulnerable body parts.

Suspension Trauma

Being suspended for a long time can induce a so-called suspension trauma. This condition occurs due to the limited blood circulation in the body. If a person is suspended in an upright position the heart rate is reduced and this results in fainting, unconsciousness, or cardiac arrest. This can be averted by active movement so that the blood circulation in limbs is renewed, or by loading the legs in order to activate the muscles. (For example, by stepping into the sling or on the surrounding structures) We plan all the activities carried out in hanging position in a way allowing to release the worker immediately. We free the injured person as quickly as possible and place them in the recovery position.

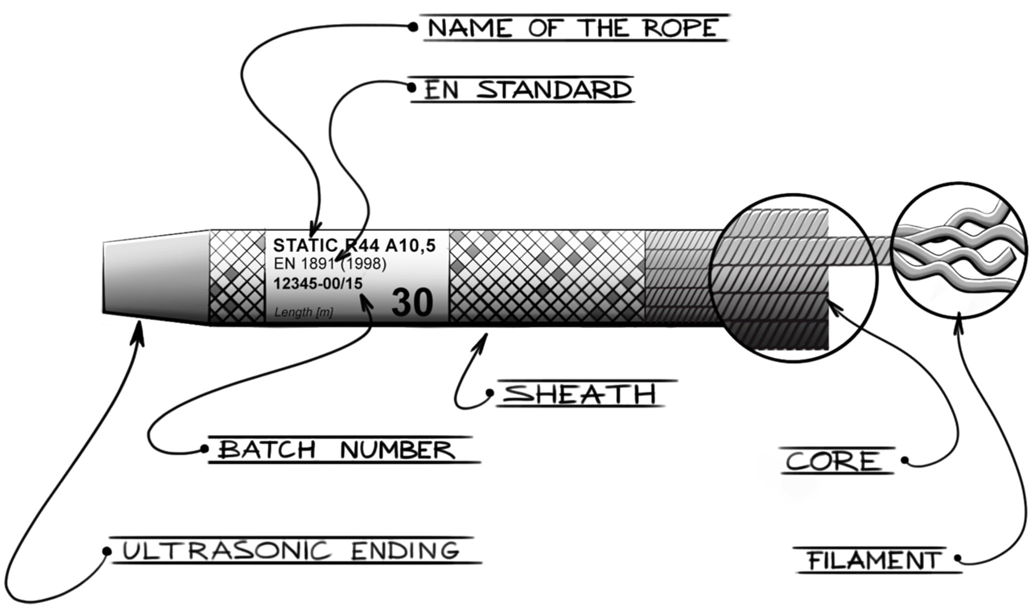
4.2 Introduction to the Equipment and Its Practical Function

Ropes

For work at height low-stretch polyamide ropes EN 1891 type A are used almost exclusively. Minimal required strength of these ropes is 15 kN. The ropes consist of a core and a protective sheath. Both these parts have a load-bearing function and must be kept in perfect condition.

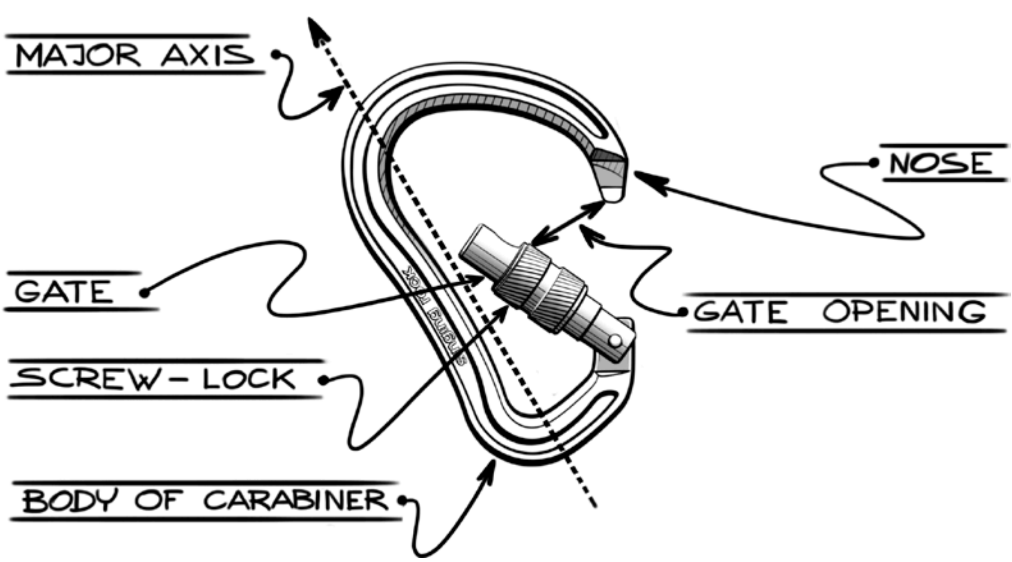
Even the low stretch ropes can stretch to a certain extent and this must be taken into consideration, especially in case of being suspended on long ropes close to an obstacle.
The important information should be provided on the rope.

DATE OF MANUFACTURE, ROPE LENGTH, DIAMETER, TYPE OF ROPE, MANUFACTURER



Rope Connectors (Carabiners)

For work at heights we prefer using the connectors according to the EN 362 standard, which sets a minimum requirement of major axis strength 20 kN and at least two independent movements for opening (we recommend to use the connectors with screw lock or triple lock).
The main part of the connector is called body. The part closing the connector is called gate. The lock blocks the connector against opening. The gate is connected to the body of the connector by a rivet and its opposite end fits into a nose.
The usage of connectors is determined by their shape and material. In rope access, we most commonly encounter the type B (connector as a part of a system) and type X (oval, general connector) connectors.
Other frequently used connectors are A type - end connector at the end of the protection system (for example hooks for climbing in structures) and Q type - connector closed by a locking sleeve which is a load carrying part of the connector and must be tightened to a required torque. (so-called maillon, named after French manufacturer Maillon Rapide France)



Fall Arresters for Rope Access

Fall arresters according to the EN 353 standard are used to arrest fall of a climber on the security rope without damaging the rope and rise of the impact force over the critical value of 6 kN (this applies to the 100 kg testing load). The correct orientation of the fall arrester on the rope must always be marked on the body of the fall arrester.
Fall arresters are tested for arresting the fall of one person.
They are attached to the fall arrest point on the harness marked with capital A.
Reaction distance must be taken into consideration so that the worker is not in danger of hitting an obstacle before the fall arrest system arrests the fall.

Descender (Rope Length Adjustment Device)

According to the EN 12841 standard the descenders are tested for at least 100 kg load if loaded by one person, and for at least 200 kg if loaded by two persons.
After releasing the handle, the descender must block automatically.
In case of fall on the descender the rope must not be torn (damage of the sheath is acceptable).
The modern descenders are equipped with the Anti Panic system. In case the worker loses control over the speed of lowering (for example due to grasp reflex) the descender blocks automatically.
During the lowering with a descender it is essential that one hand is in contact with the loose (unloaded) end of the rope all the time.

Ascenders (Rope Clamps)

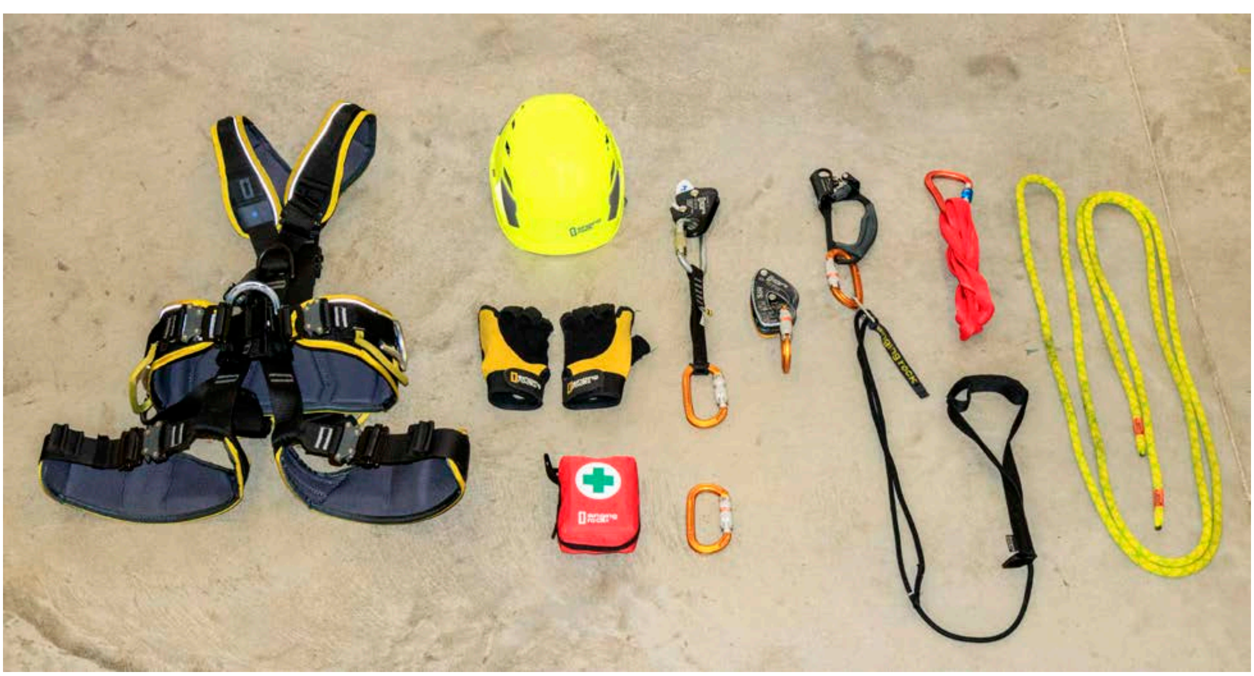
According to the EN 567 standard an ascender is a mechanical device that is clipped to a rope or a thick auxiliary cord, and if the rope or cord becomes loaded the device will grip the rope in one direction, while at the same time it can move freely in the opposite direction
Dynamic load can easily damage the rope, therefore it is essential to prevent any falls on the ascender.
The chest ascender is firmly attached to the harness and fully loaded it can be regarded as an attachment point.
The hand ascender is supplemented by a handle that facilitates the ascent and a foot loop (footer) which can carry the full weight of the person.

Pulleys

Pulley consists of one or more sheaves and side plates with holes for placing connectors so that it can be connected to another system.
The use of the pulley depends on the material of the sheave (for example the pulleys with plastic and light alloy sheaves cannot be used with wire ropes)
According to the EN 12278 standard the sheave of the pulley must rotate freely in both directions under the load of 2 kN and the static load of 15 kN.

4.3 Assembling the Basic Rope Access Kit and Mutual Check

The basic kit consists of a helmet, a combined harness for fall arrest and work positioning used for rope access along with so-called dynamic cow's tail used for work positioning. Also, there is a fall arrester, two ascenders for ascent and a descender with a corresponding number of connectors.
The extended kit is supplemented by another fall arrester and a 120 cm sling with pulley for a potential rescue, and a working seat.
A chest ascender is firmly attached to the harness. A guided type fall arrester is attached to the point A of the harness. The descender is attached to the central attachment point of the harness so that the loaded gate of the connectors is directed towards the climber. Also, two cow's tails are connected to the central attachment point of the harness (preferably these are made from dynamic rope). A hand ascender is connected to one of the cow's tails so that it can be installed on rope without being detached from the harness.



Mutual Check (Buddy Check)

When performing a buddy check the correct adjustment of the harness, fastening of the buckles and potential twisting of straps (especially in places which the worker cannot see by himself) must be checked. Do not settle for a visual inspection only. Also, we check whether the other equipment, in particular the ascent and descent kit and the fall arrester, is complete and properly attached to the harness.

Common Mistakes:

- Twisted straps of the harness
- Speed-buckles of the harness are not closed correctly (if the harness is equipped with these).
- Fall arrester incorrectly attached to the harness.
- Incorrectly tied knots on the cow's tails (short and loose ends, twisted strands of the rope in the knot).

4.4 Before Commencing the Work

Measures should be taken before starting the work to prevent unauthorized persons from entering the workplace in order to protect them from the risk of fall. (See Government Decree No. 362/2005 Coll. for more details.)

Checking the Anchoring of the Ropes and Their Direction

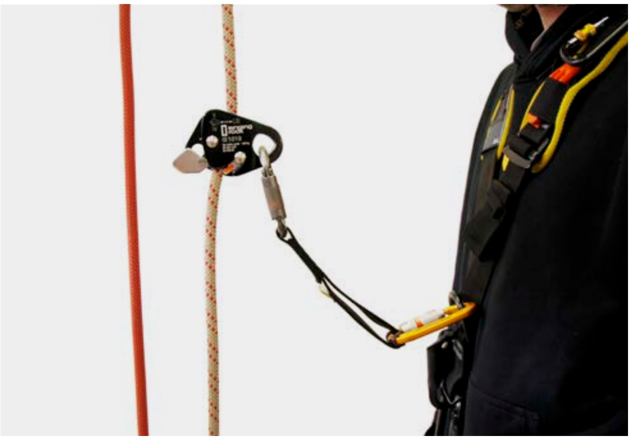
- Checking the connectors against unintended opening or applying the breaking load.
- Checking the knots.
- Checking if the rope has sufficient length.
- Checking if the rope has a stopper knot at its end.
- Checking the direction of the ropes (rope protection being applied at the vulnerable places)
- Checking the compatibility of the individual parts of the system – especially the descender, ascenders and the fall arrester – with the ropes.

5 Practical part – Double Rope Technique

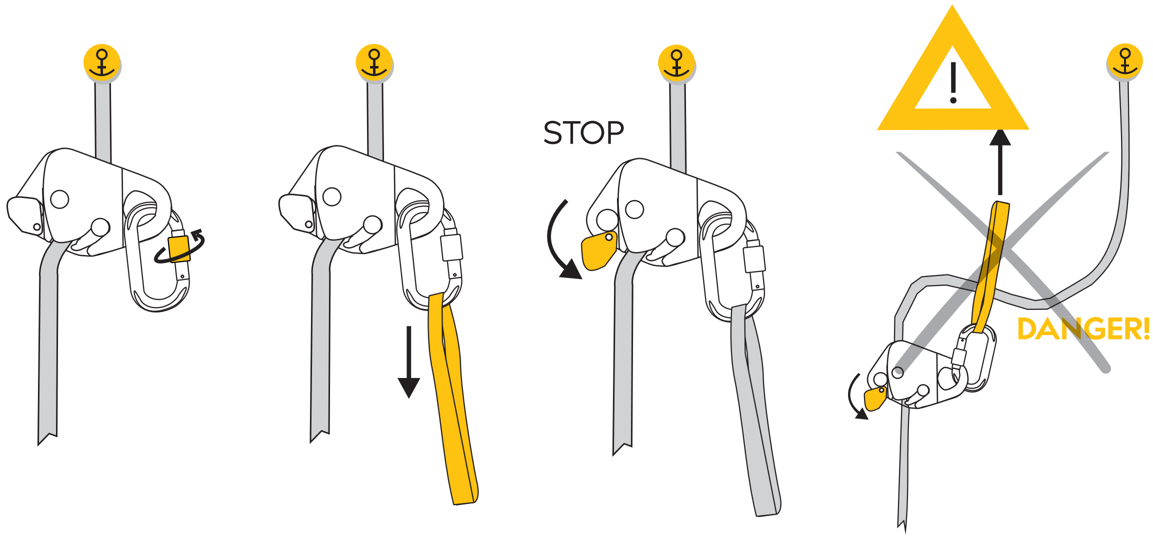
5.1 Basic Principles of the Double Rope Technique

The basic principle of the double rope technique is continuous connection of the worker to two systems. The fall arrest system – the safety line, and the work positioning system – the working line.
The worker is connected to the working line by work positioning devices – a descender, two ascenders or a so-called cow's tail.
The worker si connected to the safety line by a fall arrester, except for the cases when the option of fall is prevented. In such cases it is possible to use one of the above listed work positioning devices for connecting to the safety line.

5.2 Use of Fall Arrester



The function of the fall arrester is to arrest an unexpected fall caused by a failure of the work positioning system or an error of the user.
The fall arrester should be installed on rope first, so that the worker is protected against fall as soon as possible. Subsequently, before entering the dangerous area, the worker must carry out a function check of the fall arrester. By following this procedure, the most common mistakes will be avoided.
(Tip: By attaching the fall arrester over the hand operating the hand ascender we decrease the fall factor and thus the reaction time in case of fall.)

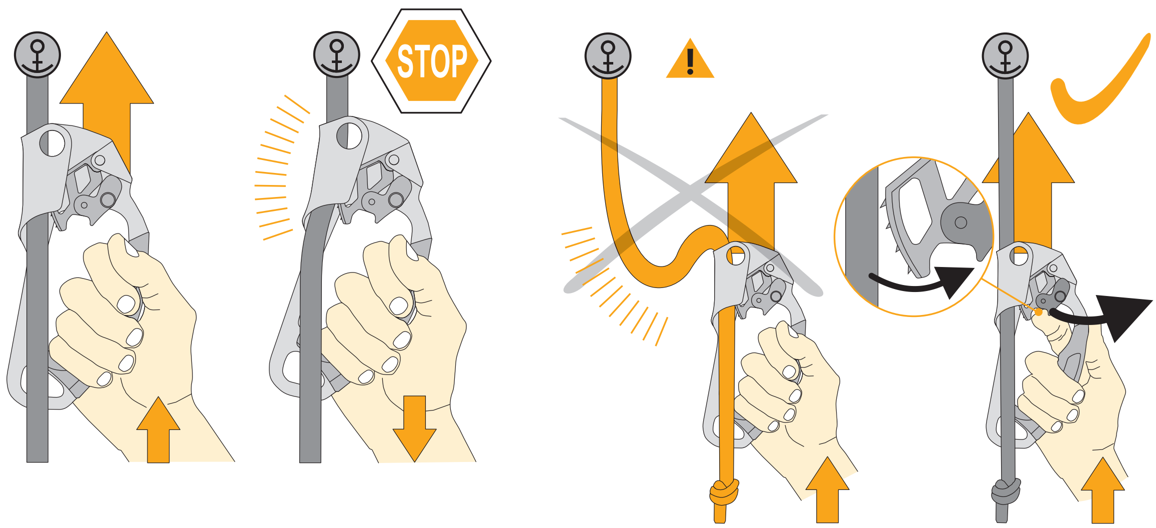


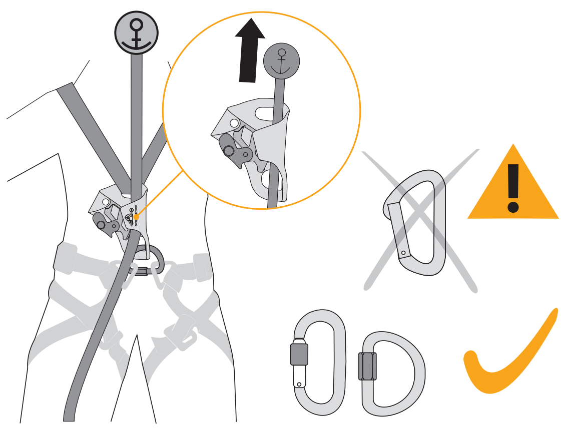
Common Mistakes:

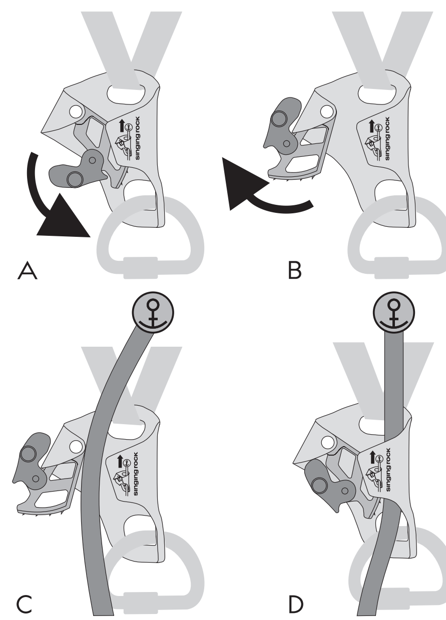
- Forgetting to attach the fall arrester.
- Attaching the fall arrester to the rope in the opposite direction.
- When using the fall arrester, the rope must pass through the device smoothly and there must not be a slack on the safety line, which could later prevent timely fall arrest.
- In order to function properly the fall arrester must be attached to the harness at the fall arrest attachment point. (point A)
- Correct configuration of attachment to the harness according to the Instructions for use must be observed.

Training: The worker places the fall arrester and checks its function.

5.3 Use of Ascenders



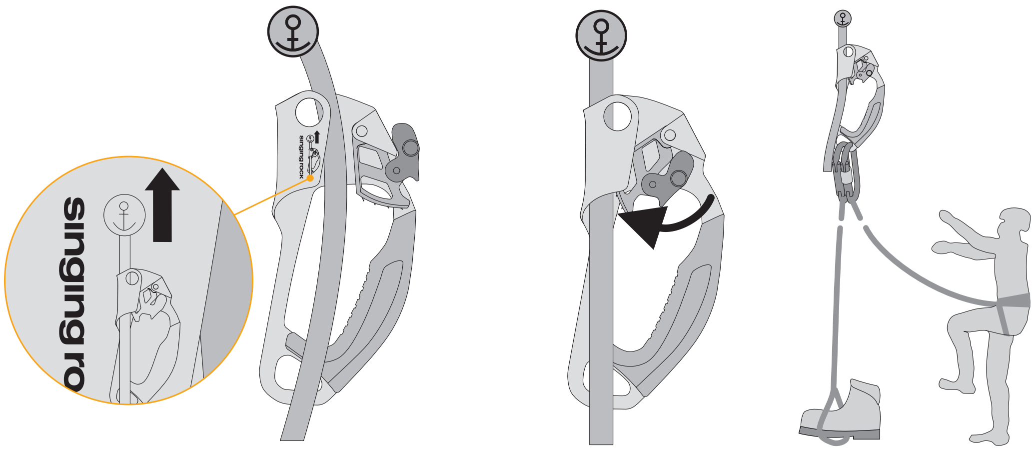




Used to reach the working position (ascent on rope). The main prerequisite for safe use is to prevent a fall on the ascender as there is a risk of damaging the rope and subsequent fall of the worker.
When the ascender is not loaded it may disconnect from the rope or a fall on an ascender may occur. Therefore, an unloaded ascender does not count as an attachment point. During the ascent the load is being transferred from the hand ascender to the chest ascender (and vice versa), therefore these two ascenders can count as one attachment point.
The main part of an ascender is a cam, which is secured against accidental opening by a safety catch. If the ascender is loaded on rope, the cam grips the rope and the teeth of the cam penetrate the sheath, therefore a loaded ascender cannot be removed without damaging the rope.

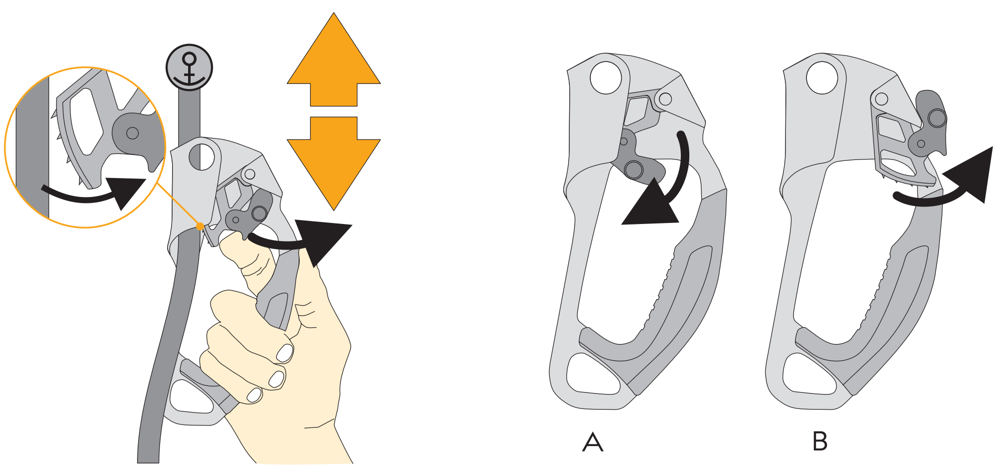
Ascent with Ascenders:

The starting position for the ascent with ascenders is hanging on the chest ascender. We then place the hand ascender above the chest ascender, place the foot to the foot loop connected to the hand ascender and lift up from this foot. (Hands are only used to maintain stability, most of the force needed for the ascent should come from the leg.) The rope should either slip through the chest ascender by itself or we can move it by hand. We then sit back on the chest ascender.
(*Tip: If the loose end of the rope from the chest ascender is directed to the side away from the cam, the rope runs through the ascender easier and does not get caught in the cam during the descent.*



Common Mistakes:
- The force of the leg is not directed in the axis of the ascent.
- Trying to make too long moves.
- At the beginning of a new move the thigh should be parallel to the ground.
- Incorrect length of the foot loop.

Descent with Ascenders:



When descending on ascenders it is recommended to shorten the foot loop attached to the hand ascender (footer) a bit, and to make short moves only. We start the descent by shifting the hand ascender down to the chest ascender and simultaneous reducing the load on the chest ascender by standing up in the footer. This little upward movement makes the teeth of the cam slide out of the sheath of the rope and the rope can then be made slide freely by pressing the cam from above with your finger or using a special opening pin.
After hanging back on the chest ascender, we move the hand ascender down.

Common Mistakes:
- Little or no lifting from the chest ascender.
- Complete opening of the cam.
- Too long moves during the descent.

Training:
- The worker ascends using the ascenders.
- The worker descends using the ascenders.

5.4 Use of a Descender

Descent with a Descender:

We attach the descender to the harness so that the locking system of the carabineer as well as the opening gate of the descender are facing towards the climber.
Before starting the descent, we firmly grasp the loose end of the rope under the descender and then we unblock the descender using the handle. During the descent the hand under the descender is in contact with the rope and controls fluency of the descent. The hand on the handle is only used to unblock the descender. Both hands can only be released if the descender is blocked.

Common Mistakes:

- Jerky movement.
- Operating the descender only by the hand on the handle.
- Not securing the descender (if required)
- Incorrect placement of the rope.

Ascent with a Descender (Only Applicable for Certain Models):

We place a hand ascender on rope above the descender, grasp the loose end of the rope under the descender and unblock the descender (if required). We hold the hand ascender with the second hand. Then we lift up from the sling connected to the hand ascender and simultaneously tighten the rope in the descender. We move the hand ascender up and repeat the procedure.

Common Mistakes:
- Uncoordinated movement: not removing the slack of the rope in the descender and lifting at the same time
- The hand tightening the descender is not in constant contact with the rope while the descender is not secured.

Training:
1. The worker ascends using the descender.
2. The worker descends using the descender.

5.5 Changeover from an Ascent to a Descent and Vice Versa

The initial position for all the activities on rope is on the descender, therefore it is always necessary to sit on the descender as soon as possible. The descender must always be placed on a loose rope, while ascenders may be placed on a tight rope, as well.

Changeover from an Ascent to a Descent:
While transferring from the ascenders to the descender we secure the fall arrester at the level of our shoulder to prevent a potential fall. Subsequently we place the descender under the chest ascender, draw it as close to the ascender as possible and secure (if required for the model used). Then we hold the hand ascender by one hand and lift up from the footer (we place the hand ascender lower in advance so that we can reach to it later). As soon as the weight transfers away from the chest ascender we use the free hand to disconnect it from the rope. After that we load the descender. We disconnect the hand ascender that we will not use any more and carry out a short descent to make sure that the descender functions properly. Then we release the fall arrester and we are ready to descend.

Common Mistakes:
- The hand ascender is too high and after the changeover we stay suspended in it.
- The fall arrester is too high and after the changeover we stay suspended in it.
- The load on the chest ascender is not reduced enough.
- Incorrect placement of the descender.

Changeover from a Descent to an Ascent:

While switching from the descender to the ascenders we secure the fall arrester as high as possible. Subsequently we move the hand ascender to the higher position, hold it with one hand and use one foot to lift up from the footer. Then we install a chest ascender on rope between the hand ascender and the descender. Last, we remove the descender from the rope and release the fall arrester.

Training:

1. The worker ascends using the ascenders and switches to the descender.
2. The worker descends using the descender and switches to the ascenders.

5.6 Passing a Knot

The usual reason for tying a knot on the rope is the damage of the rope or joining two ropes, therefore we assume that the knot cannot be used as an anchor point.

Ascent over a Knot:
When reaching a knot, we place the descender under the chest ascender and secure it. Then we move the hand ascender at least 15 cm above the knot and the chest ascender as close to the knot as possible. Then we shift the descender under the chest ascender. We shift the fall arrester as high as possible and secure it. In the last phase we lift up from the foot loop attached to the hand ascender and hold it with one hand. The second hand removes the chest ascender from the part of the rope under the knot and attaches it to the rope above the knot. Last, we remove the descender from the rope and release the fall arrester. If the knot passing is not successful, we hang on the descender and repeat the procedure.

Common Mistakes:
- Absence of a descender.
- Incorrectly set length of moves in the footer connected to the hand ascender.

Descent over a Knot:
If we lower to a knot while descending, we carry out a changeover to the ascenders. Subsequently we carry out a descent with ascenders to the knot and we place the descender under the knot. We secure the descender. We secure the fall arrester as high as the point A. After that we do a changeover to the descender.

Common Mistakes:
- The hand ascender is too high above the knot before the changeover.
- The descender is not secured (if the model used requires it)

Training:
1. The worker hanging on a rope ties a knot (Alpine butterfly) on the work rope under himself and performs a downward knot passing.
2. The worker carries out an upward knot passing on the working line and unties the knot under himself.
3. The worker hanging on a rope ties a knot on the safety line under himself and performs a downward knot passing.
4. The worker carries out an upward knot passing on the security rope and unties the knot under himself.

Knot Passing on the Safety Line with a Fall Arrester
Attention! The knot can only be untied if the fall arrester is placed above the knot.
If we have two fall arresters at hand, we attach the second fall arrester to the rope in the direction in which we plan to continue.
If a second fall arrester is not available, we connect to the **safety line** with a cow's tail attached to an alpine butterfly that we tie on the **safety line**. The fall factor for securing with the cow's tail must not be more than 1. After that the fall arrester can be placed in the direction in which we plan to continue.
Another option is to load both the ropes evenly using the ascenders and a descender. If both ropes are tensioned in a way that does not allow any fall, the fall arrester can be detached from the rope and placed behind the knot in the required direction.

Common Mistakes:
- Detaching the fall arrester and switching to the single rope technique.
- Incorrect orientation of the fall arrester on rope.
- Untying the knot above the fall arrester (a big fall factor occurs as a result).

5.7 Using and Passing the Rope Protection

Rope protection is installed on rope in places which may be damaged.
- By a sharp edge / object.
- By abrasion, wear.
- By heat.
- By aggressive substances.
- By tools (grinders, drills etc.)

The way of passing the rope protection depends on the way it is attached to the rope:
- If the rope protection is installed on rope using the Prusik knot it can be removed and installed again after being passed.
- If the rope protection is attached to the rope using an Alpine butterfly knot we proceed as with knot passing.

Common Mistakes:

- Not using a rope protector in a vulnerable place.
- Careless installation of the rope protector and its subsequent shifting away from the vulnerable place.
- Using an unsuitable rope protector.
- Passing the rope protection as a knot.

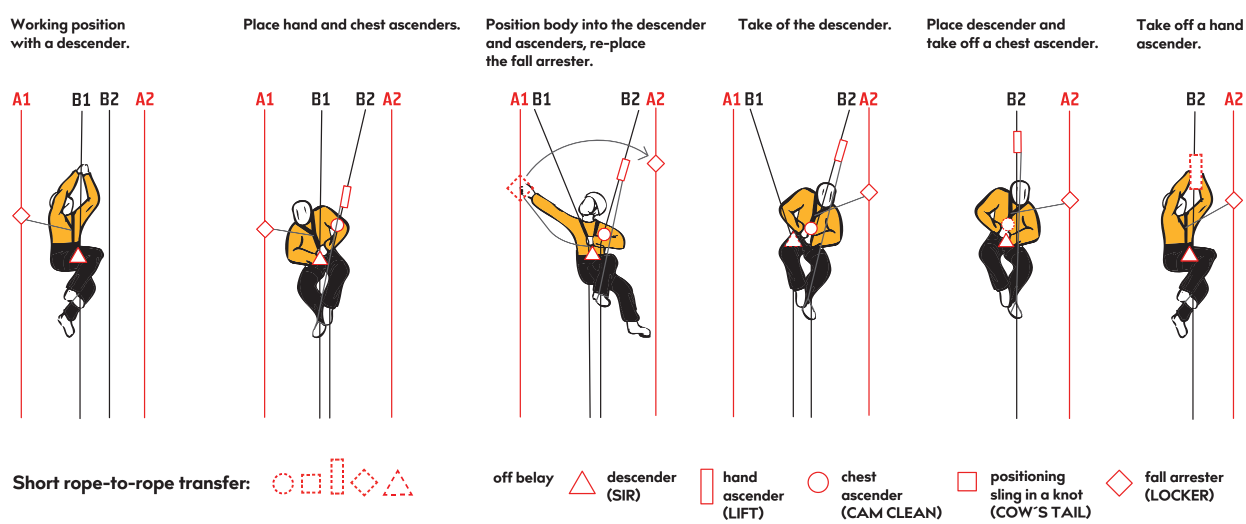
Training:

1. *The worker passes the rope protection on both the working line and the* ***safety line****.*

5.8 Rope to Rope Transfer

Short Rope to Rope Transfer

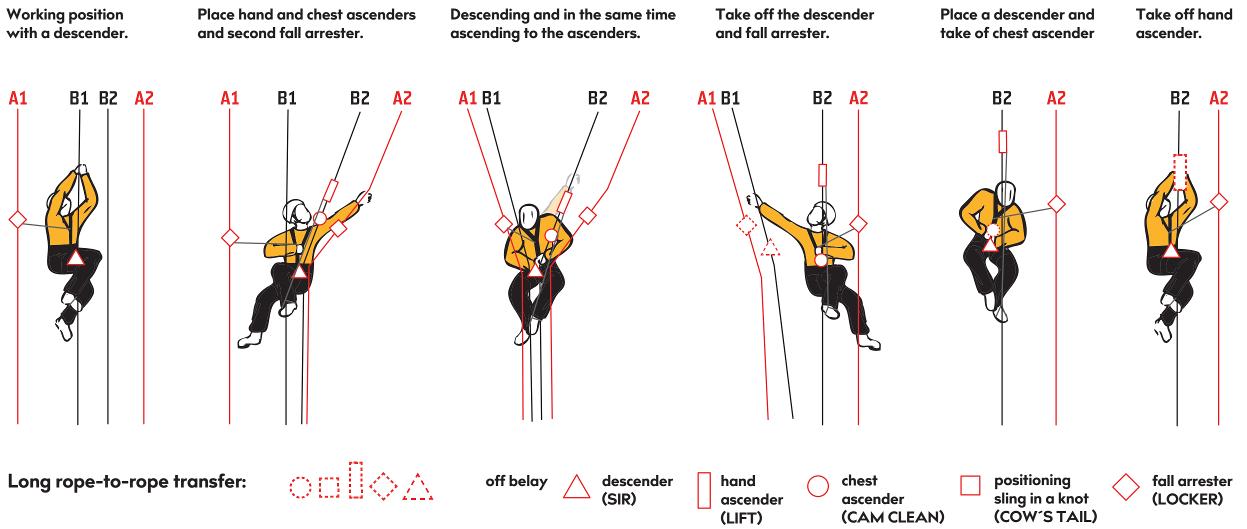
The rope to rope transfer is considered short if we can reach to the second pair of ropes by hand (their distance is less than 1,5 m). In such a case we start on the descender and attach the ascenders to the second work rope. Subsequently we balance our weight so that it is distributed evenly on both the work ropes. (This is done via a short descent on a descender or a short ascent on ascenders.) Once this is done the fall arrester can be attached to the second safety line. Subsequently we slack the descender until the weight is fully transferred from it.
(For the short transfer it is also possible to use the opposite method, i.e. proceed from the ascenders to the descender.)



Common Mistakes:

- Transferring the fall arrester when the system is not tensioned and thus there is a risk of fall on the ascenders.
- Switching to a single rope technique.

Long Rope to Rope Transfer



Long rope to rope transfer is longer than 1,5 m (we cannot reach to the second pair of ropes). In such a case a serious uncontrolled swing may occur (an uncontrolled swing may be as dangerous as a fall) and four anchor points must be used instead of two anchor points like in the previous example.
We start the long rope to rope descent on a descender and a fall arrester. We attach another fall arrester or a cow's tail attached into an Alpine butterfly tied on the safety line (so that the FF is <1). We place both ascenders on the second working line. Therefore, we have four anchor points. Subsequently we start the descent with a descender and check the free movement of the fall arrester. If we lose too much height, it is possible to start a short ascent on the ascenders. Keep in mind that the fall factor on the target safety line should not increase. Once the target ropes are loaded with full weight the transfer is finished, the descender is removed from the rope and the original fall arrester can be detached. In the end we are hanging on the ascenders and the second fall arrester (or the cow's tail anchored in the Alpine butterfly) on the target ropes. After that we only need to transfer to the descender and possibly to place the original fall arrester on the target ropes. Attention! If we untie the knot on the safety line the fall arrester must be placed above the knot.

Common Mistakes:
- Using only three anchor points and insufficient protection against swinging.
- Tangling up in the ropes.
- Starting the rope to rope transfer from the ascenders and taking up the target ropes on the descenders.

Training:
1. The worker carries out a transfer from the work rope to the security rope.
2. The worker carries out a short rope to rope transfer.
3. The worker carries out a long rope to rope transfer.

5.9 Passing an Edge (90°)

Passing an edge is done exclusively on a descender.

Passing an Edge in an Upward Direction

Once we approach the edge we transfer to the descender. We ascend the last centimeters on the descender in order to get as close to the edge as possible, then we detach the hand ascender and attach it to the work rope behind the edge. We keep adjusting the length of the foot loop so that climbing is comfortable for us. Once the descender gets almost to the edge we move the fall arrester as far over the edge as we can, and secure it. After that we shorten the foot loop connected to the hand ascender so that it provides us with sufficient support for passing the edge. Once we pass the edge we can detach the ascenders and the descender but we must stay connected to the fall arrester until we get far enough from the fall edge.

Common Mistakes:
- Passing an edge on a chest ascender.
- Applying the stress on the hand ascender to the point of breaking.
- The fall arrester in a fall factor of more than 1.

Passing an Edge in a Downward Direction

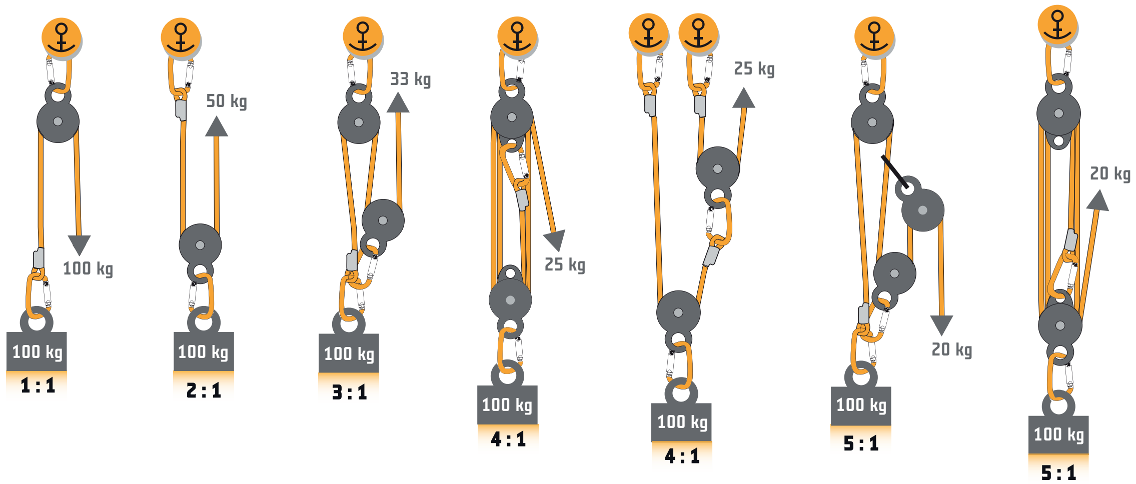
We attach the fall arrester on the safety line before we get to the dangerous distance from the fall edge. Then we attach the descender and adjust it so that it is placed on the rope over the edge and we secure it. Then we place a hand ascender on the work rope under the edge and adjust the foot loop so that it provides us a sufficient support while passing the edge. After that we carefully sit in the descender. We hold on the hand ascender and assure that the ropes lead over the edge protection. Once we are safely hanging on the descender we draw the fall arrester over the edge and detach the hand ascender. After we test the descender by a short descent we unblock the fall arrester and we are ready for lowering.

Common Mistakes:
- Tangling up in the ropes.
- Placing the descender or fall arrester in reverse.
- Applying the stress on the hand ascender to the point of breaking.
- Incorrect setting of lengths and hanging in the foot loop of the hand ascender.
- After the suspension the ropes are away from the rope protection.

Training:
1. The worker passes a 90° edge in the downward direction.
2. The worker passes a 90° edge in the upward direction.

5.10 Simple Pulley System

By a pulley system we mean a simple mechanism consisting of at least one fixed pulley and one movable (free) pulley which are interconnected by a rope or a chain. By combining a fixed pulley and a movable pulley we gain work benefits. The force needed to lift the burden is calculated based on a formula F= G/2n (F-force, G-weight of the burden, n-number of movable pulleys). When using pulley systems attention must be paid not to overload the used equipment. For most operations a 3:1 pulley system operated by one person is sufficient. Especially when lifting persons, it is necessary for lifting system to be self-blocking and ideally to allow easy lowering as well.



Common Mistakes:
- Twisting of the pulley system
- Inappropriate loading of the connectors.
- Overloading the individual parts of the system.

Training:
1. The worker assembles a 3:1 and a 2:1 pulley system.
2. The worker explains the impact of forces in the individual parts of the pulley system.

6 Practical part – Rescue Techniques

6.1 Setting up the Ropes for Easy Lowering and Lifting

When planning a work at height or above depth it is necessary to keep in mind a possibility of a potential evacuation of a worker from the dangerous area. In such a case prevention is the best solution. We always consider the possibility of having the working ropes set for easy lowering or lifting of the worker. Thus we prevent exposing the rescuer to risk or a need to climb to the rescued person.
The first option is to anchor the working line and the safety line in the descenders and to keep sufficient reserve of ropes for easy lowering of the worker. When lowering a person over sharp edges the rope protection can be burnt through and the ropes may be damaged, therefore a suitable rope protection must be selected. In case the lowering cannot be done at the anchor point it is possible to redirect the ropes by pulleys. An unattended descender must always be secured by a security knot on the loose end of the rope under the descender.
A second option for the cases where evacuation of a casualty must be carried out by lifting is to include ascenders with pulleys on the working and safety line (between the rescued person and the descenders, which in this case function as the anchor points of both the ropes) and to lead the loose ends of the ropes from the descenders through the pulleys. Thus we create 3:1 pulley systems on both ropes. In such a case the overall efficiency of the pulley system is 6:1 and freeing the worker by two rescuers is very easy.

Training:
1. The worker sets up the work ropes for a rescue by lowering.
2. The worker carries out a rescue by lowering.
3. The worker sets up the ropes for a rescue by lifting.
4. The worker carries out a rescue by lifting in a pair.

6.2 Rescue by Lowering

If it is not possible to set up the ropes for easy lowering (lifting) it is also possible to free the injured person with a rescuer being directly involved. In such a case we prefer access from above on ropes set up by the rescuer.

Rescue procedure:
1. The rescuer sets up a safe environment for himself. He eliminates the risks that might put him in danger (falling material, power sources, dangerous or noisy machines, falling from a height or into depth).
2. He finds a supervision in case he finds himself in danger
3. He ensures the safety for all the persons present in the high risk area.
4. He communicates with the casualty and approaches the casualty safely (he stays above the casualty to avoid being put in danger)
5. After approaching the casualty, he checks his equipment so that he is positioned on the descender and the descender is secured. A fall arrester with FF<1 is placed on the security rope.
6. He connects to the casualty with a loose cow's tail (a so-called soft connection) between the central attachment point of his harness and the harness of the casualty.
7. He checks consciousness, stops major bleeding and clears any obstructions in the airways (by tilting the head backwards)

8. He informs the supervisor about the condition of the casualty and calls an ambulance, if needed.
9. He connects the casualty by a short sling between the connector of his descender and point A of the casualty's harness (hard connection).
10. He detaches the fall arrester of the casualty and lowers the casualty slowly on the descender so that the casualty is suspended on the hard connection.
11. He moves the descender from the harness and rope of the casualty to his own safety line and the central attachment point of his own harness so that the connector of the descender passes through the connection of the short sling on which the injured person is suspended.
12. He carries out a short descent on his own descender so that the working line and the safety line are loaded evenly. If needed, we apply additional friction because at the moment the descender is loaded by weight of two persons.
13. The rescuer detaches his fall arrester and carries out the lowering on both the descenders.
14. After lowering the casualty to the ground the rescuer pulls them away from the dangerous area or lays them on a stretcher.
15. After detaching the casualty from the ropes the rescuer starts with first aid.

Common Mistakes:
- Suspending the rescuer with the casualty on ascenders.
- Attaching the casualty to one point only.
- Attaching the casualty elsewhere than to the connector of the descender.
- The casualty is suspended elsewhere than on the connector of the descender.
- Tangling up in the ropes.

Training: The worker carries out a rescue by lowering.

7 Testing the Acquired Skills

Test: The worker completes a theoretical written test – 30 questions in 30 min. Minimal score required to pass: 93%
Practical exam: In the practical part, the instructor gives the worker an independent assignment in order to verify the acquired skills, which shall combine several practical topics with regard to the future occupation of the worker.

For example:
a. The worker carries out an ascent using the double rope technique, rope to rope transfer and a rescue of an extra.
b. The worker sets up the ropes for double rope technique with an option of rescuing an extra by lifting.

8 Glossary of Terms:

Cow's tail – a sling used for work positioning, which is attached to the central attachment point of the harness. Preferably, we use slings made of dynamic rope to reduce impact force in the event of falling.
Foot loop (Footer) – a textile strap with adjustable length connecting the hand ascender to the foot of the climber and thus enabling the climber to ascend on rope (it is not a PPE and can be made from cord).
Giving slack – is the final part of the rappelling where the rope in the descender is loosened and the descender can be disconnected easily.
Taking – is the opposite of giving slack. During this activity we remove the slack of the rope in the descender. Thus, we reduce the distance on the rope between the anchor point and the descender.
Carabiner – a connector. According to the EN 12275 standard we use the term "carabiner" and according to the EN 362 standard we use the term "connector".
Back up – fall arrester according to the EN 353 standard
Working line – the rope carrying the load of the climber.
Safety line – the free rope used for arresting a potential fall.

9 Literature

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