The Work At Height Safety Association

Technical Guidance Note 9

"Guidance on the selection, use, maintenance and inspection of connectors"

A series of informative notes for all industries
involved with work at height or rescue.

WAHSA technical guidance note no. 9

Guidance on the selection, use, maintenance and inspection of connectors

Introduction

This guidance note gives guidance on the selection, use, maintenance and inspection of connectors for work at height. These products are commonly known as karabiners or snaphooks.

Connectors have been used for many years in a wide range of industries and are sometimes used in applications which are not covered by the European Standard (BS EN 362) test criteria. This type of use raises safety issues (see 3.0).

1.0 What are connectors?

Connectors are openable components used to link other components together in a personal fall protection system, for example, to link a lanyard to an anchor. There are two standards which connectors can be approved to, BS EN 362: 2004 (industrial – personal protective equipment against falls from height) and BS EN 12275: 2013 (mountaineering equipment).

Connectors conforming to BS EN 362: 2004 should be used when working at height. Connectors conforming to certain classes of connector in BS EN 12275: 2013 also meet the requirements of BS EN 362: 2004, and these connectors are also suitable. In the case of such connectors, conformity to BS EN 362: 2004 should be confirmed before use.

There are five classes of connector described in BS EN 362: 2004, which are suitable for use when working at height, as follows:

i. *Basic connector* - Class B. Self-closing connector intended to be used as a component
ii. *Multi-use connector* - Class M. Basic or screw-link connector intended to be used as a component, which may be loaded in the major and minor axis
iii. *Termination connector* – Class T. Self-closing connector designed to allow fixing as an element of a sub-system in such a way that the loading is in a predetermined direction
iv. *Anchor connector* – Class A. Connector which closes automatically, designed to be linked directly to a specific type of anchor as a component
v. *Screwlink connector* – Class Q. Connector which is closed by a screw-motion gate, which is a load bearing part of the connector when fully screwed up, intended to be used only for long-term or permanent connections

Only connectors which have a closure that provides protection against inadvertent opening of the gate, for example by means of a screwed sleeve or an automatic locking device, should be used.
Connectors with a self-locking gate shall lock the gate automatically when the gate shuts, and shall require at least two different deliberate manual actions to open the gate.
Connectors with a manual-locking gate, except screwlink connectors, shall require a deliberate manual action to lock the gate, and shall require at least two different deliberate manual actions to open the gate.
Screwlink connectors shall require at least four complete rotations of the screw-motion gate from the fully screwed up position to disengagement of the threads. The threads shall not be visible when the gate is locked.

All connectors must meet the minimum static strength detailed in BS EN 362: 2004 or the claims of the manufacturer if higher.

2.0 When should connectors be used?

When selecting a connector, users should take note of the type of gate locking system employed and should consider how and where the connector will be used in the fall protection system.
Connectors are available with various gates with the following types of closing and locking mechanisms.

i. *Manual closing and manual locking.* The gate is typically closed by a screwed sleeve which links the keeper to the body, which must be manually screwed to open and close it, thus protecting the keeper from inadvertently opening. This type of mechanism is used in screwlink connectors.
ii. *Automatic closing and manual locking.* The keeper is spring loaded to hold it in the closed position and has to be depressed to open it. The keeper is protected from inadvertent opening by a manually operated sleeve that links the keeper to the body. This type of mechanism is used in screwgate karabiners.
iii. *Automatic closing and automatic locking, with spring loaded sleeve.* In most designs, the keeper is spring loaded to hold it in the closed position as described above (ii). A spring loaded locking sleeve automatically links the keeper to the body. This type of mechanism is used in autolock (twistlock) karabiners.
iv. *Automatic closing and automatic locking with spring loaded sleeve and additional safety mechanism.* In addition to the features described in item (iii) the sleeve itself is automatically locked into place on the body to prevent roll-out. This type of mechanism is used in triple-lock (supersafe) karabiners.
v. *Automatic closing and automatic locking with spring loaded lever.* The keeper is spring loaded to hold it in the closed position as described in item (ii) and a spring loaded lever automatically prevents the keeper from opening. This type of mechanism is used in snaphooks.
vi. *Automatic closing and automatic locking with spring loaded lever and additional safety mechanism* .In addition to the feature described in item (v) the spring loaded lever itself is automatically locked into place to prevent roll-out, even if the safety catch on a double-action safety hook is unintentionally pressed against the user's body or a structure. This type of mechanism is used in triple-action snaphooks.
vii. *Automatic closing and automatic locking with special design.* Specifically designed for attachment to certain types of anchor. An example of this type is manucreche connectors for attachment to round bar or tubing (e.g scaffolding).

Note: Roll-out is accidental opening of the gate and release of the connecting component from the connector as a result of pressure on the gate by a connecting component (such as an anchor, harness attachment point(especially if made of metal), webbing, rope, or another connector) when the safety catch mechanism on the locking gate is tripped.
Depending on the type of locking gate there a typically two ways that the safety catch mechanism could be accidently tripped:

- The action of rope running over the top of some types of gate which incorporate a twist-action safety catch
- The unintentional pressing of a safety catch on a 'double-action' safety hook either against the user's body or a structure

The potential for roll-out can be largely avoided by considering how loads can be inadvertently applied to the connector during use, and then choosing the correct connector for the application.

Screwlink connectors are most suitable for permanent and semi-permanent connections, where the connectors do not need to be removed and reconnected several times a day. The design of the gate allows screwlink connectors generally to be more compact than other connectors.

Screwgate karabiners are available in several shapes, including pear-shaped, oval, D-shaped and triangular, and offset versions of most of these are also available.

Listed in Table 1 are some of the advantages and disadvantages of different types of closing and locking mechanisms. Care should be taken to select a connector with a gate closing and locking mechanism suitable for the intended application.

Connector gate closing and locking mechanism	Advantages	Disadvantages
Manual closing and manual locking (e.g screwlink connectors)	No possibility of roll-out. Usually provides a stronger gate area than other connectors Unlikely to become accidently undone	Usually very weak in the unlocked position Slow to open and close Gate opening dimension is small
Automatic closing and manual locking (e.g screwgate karabiners)	Very low possibility of roll-out Very low possibility of other types of inadvertent opening	The user has to remember to lock the gate
Automatic closing and automatic locking with spring loaded sleeve (e.g. autolock karabiner)	User does not have to remember to lock the gate	Does not provide complete protection against inadvertent opening (e.g.roll-out) Awkward to operate when intentionally opening the gate
Automatic closing and locking with spring loaded sleeve and additional safety mechanism	User does not have to remember to lock the gate No, or very low, possibility of inadvertent opening (e.g. roll-out)	Awkward to operate when intentionally opening the gate
Automatic closing and locking with spring loaded lever	User does not have to remember to lock the gate	Does not provide complete protection against inadvertent opening (e.g.roll-out) Awkward to operate when intentionally opening the gate
Automatic closing and locking with a spring loaded lever and additional safety mechanism.	User does not have to remember to lock the gate No, or very low, possibility of inadvertent opening (e.g. roll-out)	Awkward to operate when intentionally opening the gate
Automatic closing and locking with a special design (e.g manucreche karabiner).	User does not have to remember to lock the gate No, or very low, possibility of inadvertent opening (e.g. roll-out)	Limited use for special applications

3.0 Safety Issues

Several safety issues have been raised with respect to the use of connectors. They are:

- choke hitching of line through a connector
- using the connector in a situation where the gate cannot close due to the shape of the anchor
- connector unable to rotate freely in the anchor point
- anchor line termination bearing on the connector mechanism
- connector being used over an edge
- connector bearing against a rough edge
- incorrect width of anchor point or attachment materials (webbing etc.)
- 3-way loading of connector

Although this guidance note cannot give definitive guidance on all aspects of the issues associated with the above, it is intended to clarify some misconceptions and to highlight safety critical aspects.

3.1 Choke hitching of line through a connector

This method of attachment should not be used, as it may lead to roll-out. This may affect strength issues due to the inside-out nature of the applied load causing side loading of the connector.

3.2 Using the connector in a situation where the gate cannot close due to the shape of the anchor.

The use of a connector with the gate unable to close is not acceptable. This compromises the strength of the connector, and increases the possibility that the connector can become detached from the anchor.

3.3 Connector unable to rotate freely in the anchor point.

This type of use does not allow the connector to freely align with the direction of the dynamic load in the event of a fall.

3.4 Anchor line termination bearing on the connector mechanism.

This is often referred to as side-loading. In most connectors the gate is the weakest point, so loading against the gate should be avoided as this can cause breakage of the connector, or roll-out.

3.5 Connector being used over an edge.

Connectors should not be positioned such that they would be bent over an edge if subjected to a dynamic load. This would put stresses in all of the wrong places of a karabiner, rendering it prone to premature failure. This could include side loading of the gate mechanism as per 3.4.

3.6 Connector bearing against a rough edge.

Connectors should not be used on an anchor which has a rough edge due to the possibility of a saw-like movement cutting into the connector and weakening it significantly. Also, when selecting a connector for use, the material should be such that it will not be damaged by the surface of the anchor point, e.g. an aluminium connector should not be connected to a steel anchor point.

3.7 Incorrect width of anchor point or attachment material.

The strength of a connector when tested according to BS EN 362: 2004 is determined by pulling between 12mm pins. If the load is not applied parallel to and close to the spine (e.g. when using wide webbing slings, double ropes or oversized anchor point) the weaker, gated side of the connector will take more of the load and its breaking load might be less than specified. The strength loss in this situation can be as high as 45%.

3.8 3-way loading of connector.

Connectors loaded in 3 directions (unless specifically designed for this purpose) can cause undue stresses on the weaker, gated side of the connector. The breaking load might then be less than specified (as 3.7).

4.0 Using connectors

It is very important that users always read the manufacturer's instructions to ensure that the product is suitable for its intended purpose. The following critical safety measures must be addressed prior to use:

- a suitable pre-use check has been carried out (see 5.1)
- the connector is suitable for the type of anchorage
- a suitable anchor is being used (strength and type of connection)
- the position of the anchor is appropriate
- there are no sharp edges that interfere with the connector
- sufficient clear fall distance has been allowed
- area of fall is free from obstruction
- connector between the lifeline and the harness is fully closed and secured
- connector is secured to a suitable fall arrest attachment point on the user's harness

5.0 Inspections and checks

For general information about inspecting fall protection equipment see WAHSA TGN03. This indicates several types of inspection, such as pre-use checks (carried out by the user), detailed inspection (sometimes referred to as 'periodic examination') and, where required, interim inspection (see also INDG367 – HSE).

5.1 Pre-use checks

Before a connector is used, hang the device to a suitable anchor point. Make sure it is hanging vertically. Then carry out the following:

- Check that the connector is free to move in the anticipated direction of load

- Carry out a visual and tactile check. The connector should be free from burrs, cracks and marks. Deformity, sharp edges and traces of corrosion should not be present
- Check the function of the barrel. The barrel should be rotated, and should return to its original position when released
- Check the function of the gate. Operate the gate and check the alignment of the gate with the nose. While the gate is open apply sideways pressure to check for excessive wear of the pin. Check the rivet and sleeve are present and their condition
- Check the screw locking mechanism on screw locking connectors
- Check the markings are legible

5.2 Detailed Inspection

These are the same as the pre-use checks carried out by a competent person at a set period (WAHSA recommends every 3 months). These checks must be documented and the documents kept.

5.3 Interim Inspection

These are additional detailed inspections. The need for and frequency of interim inspections will depend on the use and the environment. Examples of situations where they may be appropriate include: marine and/or offshore environments, arduous working environments involving paints, chemicals, grit blasting operations and acidic or alkaline environments. The results of interim inspections should be recorded and kept.

5.4 Servicing

Connectors are not serviceable.

6.0 Longevity and obsolescence of connectors.

Advice on obsolescence will be contained within the manufacturer's user instructions. The frequency and conditions of use together with the quality of cleaning and storage will determine the safe and effective working life of personal protection equipment (PPE).

7.0 Cleaning and maintenance

Connectors should be cleaned regularly (or after every use in a marine environment) with a mild non-caustic solution (maximum temperature 40°C) and excess moisture should be removed with a clean cloth before being allowed to dry naturally. Moving parts may be lubricated regularly with a light oil (3-in-1 oil or similar), PTFE, silicone spray or graphite powder.

8.0 Storage

Connectors should be stored in a clean dry, ventilated area free from corrosive or chemical substances.

9.0 Rescue

A rescue plan should be formulated for the rescue of a person with the required equipment and trained personnel to carry it out. (See WAHSA TGN05).

10.0 Training

Users should be trained in the proper use and practical / physical limitations of connectors. This includes pre use checks and compatibility with other items of PPE. (See WAHSA TGN01).

11.0 Useful References

The Work at Height Regulations 2005

BS 8437: 2005 *Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace*

BS EN 360: 2002 *Personal protective equipment against falls from a height - Retractable type fall arresters*

BS EN 362: 2004 *Personal protective equipment against falls from a height - Connectors*

BS EN 364: 2000 *Personal protective equipment against falls from a height - Test methods*

BS EN 365: 2004 *Personal protective equipment against falls from a height - General requirements for instructions for use, maintenance, periodic examination, repair marking and packaging*

BS EN 12275: 2013 Mountaineering equipment – Connectors – safety requirements and test methods.

INDG 367 *Inspecting fall arrest equipment made from webbing or rope (HSE)*