IRATA International code of practice for industrial rope access

Part 3: Informative annexes

Annex Q: Fall factors, fall distances and associated risks

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Annex Q (informative)
Fall factors, fall distances and associated risks

Introduction

Annex Q gives advice and other information that could be relevant to users of rope access methods and is one of a number of informative annexes in Part 3 of this code of practice. This informative annex should be read in conjunction with other parts of this code of practice, should not be used in isolation and is not intended to be exhaustive. For further advice, readers should refer to relevant specialist publications.

Q.1 General

Q.1.1 Fall factors are used to measure the severity of a fall when using ropes or lanyards and are defined as the length of a potential fall divided by the length of rope or lanyard available to arrest it.

Q.1.2 An understanding of fall factors and their effects is important in both the planning and application of rope- or lanyard-based access work. Those who understand the effects are better able to select the correct equipment for the application or look for alternative methods if the potential effects are unacceptable.

Q.2 Explanation of fall factors and their effects

Q.2.1 **Figure Q.1** shows a person attached to a rigid horizontal anchor line (a rigid rail) in three different positions. The rigid horizontal anchor line depicted is for illustration purposes only and has been chosen for simplicity and clarity. The far-right position 3 shows a person in a fall factor two situation (FF 2). This is considered to be a high severity fall factor. The centre position 2 shows a fall factor one situation (FF 1), which is considered to be a medium severity fall factor, and the far-left position 1 shows a very low fall factor situation (almost FF 0), i.e. a very low severity fall factor. The fall factor scenario shown in **Figure Q.1** also applies when other anchor methods are employed, e.g. where the lanyard is connected to an anchor device fixed to masonry or to a vertical anchor line (when the connection would normally be via an anchor line device).

Q.2.2 Where someone is connected to an anchor by a lanyard of, say, one metre length and the harness attachment point is level with that anchor, (e.g. as shown in 2 in **Figure Q.1**), the potential fall distance is one metre. (In this example and the one in **Q.2.3**, no account is taken of any elongation of the lanyard.) The length of the fall (one metre) divided by the length of lanyard available to arrest it (one metre) gives a result of one ($1 \div 1 = 1$), i.e. fall factor one (FF 1).

Q.2.3 Using the same length of lanyard as in **Q.2.2**, i.e. one metre, if the person climbs above the anchor to the maximum height that the lanyard allows (e.g. as shown in 3 in **Figure Q.1**), the length of the potential fall is now two metres, the length of the lanyard remains the same at one metre and the fall factor is two ($2 \div 1 = 2$).

Q.2.4 Although the lanyard length is the same in both the examples given in **Q.2.2** and **Q.2.3**, the distance of the two falls is markedly different and so too can be the effect. The impact loads experienced by the user and the anchor in the example given in **Q.2.3** (FF 2) are likely to be much higher than those in the example given in **Q.2.2** (FF 1) and the potential for collision of the user with the ground or structure is also increased.

Q.2.5 If the position of the person is as shown in 1 in **Figure Q.1**, the result of a fall is likely to be much less serious than those shown in 2 and 3. The fall would be very short; the impact load on the user and the anchor is likely to be insignificant and, therefore, the chance of the user hitting the structure or ground is minimized, as is the force at which the user might collide with them.

Q.3 Other considerations

Q.3.1 The length of a potential fall and its consequences and/or the calculation of the fall factor are sometimes not quite as obvious as it seems. In some situations, the length of the potential fall and the impact loads likely to be experienced can be increased without realizing it. For example, a common practice is to pass an anchor sling, such as a wire strop or webbing sling, around the structure and link it with a connector, which is then used as the anchor point for the user, either directly or via a lanyard. If the user moves above that anchor point (which is not recommended), the anchor sling could be raised above its natural hanging (lowest) position, see **Figure Q.2**. This would affect the potential fall distance.

Q.3.2 In the scenario described in **Q.3.1**, the length of the potential fall is no longer directly related to the length of the lanyard but is now related to a combination of the length of the lanyard plus the distance from the lowest point at which the anchor sling would hang naturally to its highest point in use. The combined effect of the increase in potential fall distance and poor energy-absorbing characteristics of the strop or sling is likely to produce unacceptable impact loads on the user in a fall, thereby increasing the risk of injury. The increased length of the potential fall also increases the risk of the user colliding with the ground or structure.

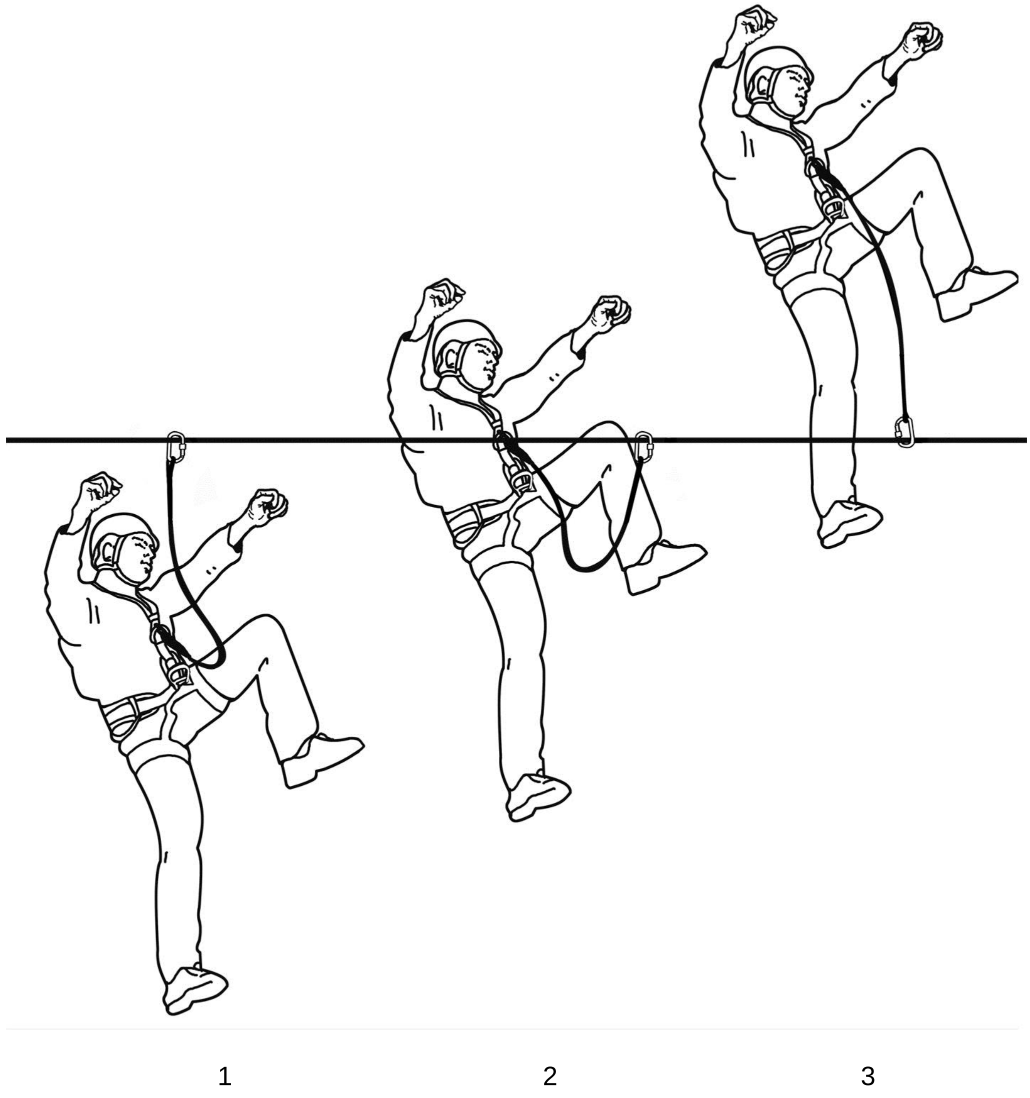
Q.3.3 An increased fall distance can also arise in situations other than those described in **Q.3.1** and **Q.3.2**. An example is if an anchor lanyard or an anchor sling is attached to the structure in such a way that it is free to slide, such as when it is attached to a vertical or diagonal section of steel lattice-work (not recommended), see **Figure Q.3**. (In this example, in addition to the increased fall distance, there is also a danger of incorrect loading and failure of the connectors.) A fall distance can also be increased by elongation of the safety line when a load is applied to it, e.g. in a fall.

Q.3.4 It is essential that fall factors are kept as low as possible at all times so that, should a fall occur, the resulting impact loads on the user are minimised. If the combined length of all the connecting elements (e.g. lanyard plus connectors plus anchor sling) is kept as short as possible and is combined with a low fall factor, e.g. by always working below the anchor point, the user is less likely to collide with the structure or the ground and the potential impact loads experienced are also likely to be low.

Q.3.5 It should be remembered that the impact loads experienced in a fall depend not only on the fall factor and length of fall but also on the characteristics of the connecting elements and especially their ability to absorb energy, e.g. the amount of energy absorbed by an anchor line can be influenced by the length of the anchor line above the anchor line device. Energy absorption capability is important, especially in high fall factor situations, and while it should be to an acceptable level (which varies between countries), the increase in fall distance that it brings with it, e.g. by elongation of the connecting elements, can also be a hazard.

Q.3.6 To minimize impact loads on the user in a fall, it may be necessary to consider the incorporation of commercially-made energy absorbers, especially where the energy-absorbing characteristics of the lanyard are poor and/or the potential fall distance is considered to be high. When energy absorbers are activated, they extend, or allow slippage, e.g. along the anchor line, and thus the effective length of the lanyard is increased, so the reduced impact load is at the expense of a longer fall, with an increased risk of collision and injury.

Q.3.7 There are examples in personal fall protection where a good understanding of fall factors allows equipment with reduced energy-absorbing capabilities to be used safely, as long as fall factors are kept very low and as close to zero as possible. This can be advantageous in a number of different ways: for example, the use of low stretch ropes for anchor lines allows more precise work positioning and more efficient ascending than dynamic rope would, and the use of short non-stretch connecting elements during aid climbing helps the user to conserve energy and to work more efficiently. Thus, it is often preferable to use equipment with low energy absorption characteristics combined with a very low fall factor, rather than accept a high fall factor with increased energy absorption and the resulting increased potential fall distance and risk of injury though collision with the ground or structure.



Key

1 Very low fall factor (almost 0)
2 Fall factor 1
3 Fall factor 2

Figure Q.1 — Illustration to show different fall factors

Figure Q.2 — Lifting an anchor sling from its normal hanging position increases the potential fall distance

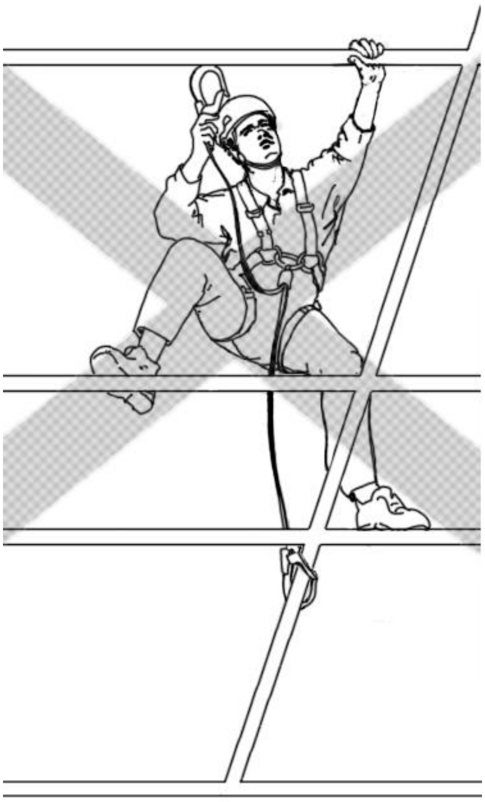


Figure Q.3 — Attaching an anchor lanyard (or anchor sling) in such a way that it can slide downwards during a fall increases the potential fall distance