BS 8411:2019

BSI Standards Publication

Safety nets on construction sites and other works – Code of practice

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Contents

Summary of pages
This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 24, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 October 2019. It was prepared by Subcommittee B/514/27, *Nets and sheets*, under the authority of Technical Committee B/514, *Access and support equipment*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 8411:2007, which is withdrawn.

Relationship with other publications

This British Standard gives recommendations on how safety nets manufactured to conform to BS EN 1263-1:2014 and installed as specified in BS EN 1263-2:2014 can be used to enhance safety for those working at height.

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- removal of additional half metre safety zone;
- removal of the technique of pinning as no longer used;
- clarification of temporary repairs;
- clarification relating to rigging nets as close as possible to working level; and
- clarification on working practices in eaves bags.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Attention is drawn to the following legislation:

- The Health and Safety at Work etc. Act 1974 [1];
- The Management of Health and Safety at Work Regulations 1999 [2];
- The Work at Height Regulations 2005 [3]; and
- The Construction (Design and Management) Regulations 2015 [4].

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Introduction

Safety nets are used on construction sites and similar works mainly to arrest a person's fall, although they can also be used to catch or contain debris. Safety nets reduce injury because they absorb a large proportion of the energy from a falling body through suffering plastic deformation when impacted, dissipating this energy with minimum rebound.

Safety nets provide a collective protection system that is constantly available for those persons working above it, i.e. one which requires no input from the workers it is being used to protect.

Safety nets are manufactured from synthetic materials. While they are lightweight and rot-resistant, they can be easily damaged by improper use, wear and tear, heat or flame, and handling and storage. They can also be adversely affected by ultraviolet (UV) degradation and environmental factors, resulting in some strength loss. Safety nets are subject to regular examinations by competent persons including periodic testing in accordance with the manufacturer's instructions.

1 Scope

This British Standard provides recommendations on the safe use, installation and effective maintenance of safety nets on construction sites and other works where there is a risk of fall. It is intended for use by designers, engineers, safety net installers, end users and authorities having jurisdiction, for example the Health and Safety Executive (HSE).

It is applicable to safety nets that conform to BS EN 1263-1:2014 and that are installed within the positioning limits given in BS EN 1263-2:2014. However, as these standards give specific minimum size limits, this British Standard also gives guidance on how to assess the reliability of safety nets outside these limits.

NOTE *Advice is given in Annex A.*

This British Standard covers safety net systems "S", "T" and "U" as given in BS EN 1263-2:2014, Clause **5**, Clause **6** and Clause **7** respectively. It does not cover system "V" (Clause **8**).

This British Standard does not cover tensioned access platform nets, which are intended for persons to stand on either for access, egress or work.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document.[1] For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5975, *Code of practice for temporary works procedures and the permissible stress design of falsework*

BS 7883, *Code of practice for the design, selection, installation, use and maintenance of anchor devices conforming to BS EN 795*

BS EN 362, *Personal protective equipment against falls from a height — Connectors*

BS EN 795, *Personal fall protection equipment — Anchor devices*

BS EN 1263-1:2014, *Temporary works equipment — Safety nets — Part 1: Safety requirements, test methods*

1 Documents that are referred to solely in an informative manner are listed in the Bibliography.

BS EN 1263-2:2014, *Temporary works equipment — Safety nets — Part 2: Safety requirements for the positioning limits*

BS EN 13374, *Temporary edge protection systems — Product specification — Test methods*

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

3.1 anchorage point

feature or position on a structure to which a safety net is attached

3.2 attachment device

device or system used to connect a safety net to an anchorage point

3.3 border rope

rope that passes through each mesh at the perimeter of a safety net and determines the overall dimensions of the net

[SOURCE: BS EN 1263-1:2014, **3.2.6**, modified]

3.4 catching width

distance beyond the working area into which a person could fall

3.5 class

classification of a net according to energy absorption capacity and mesh size

3.6 competent person

person with professional or technical training and knowledge, experience and authority to enable them to:

- carry out their assigned duties at the level of responsibility allocated to them;
- recognize potential hazards related to the work (or equipment) under consideration and be able to implement adequate control measures; and
- detect any defects or omissions in that work (or equipment), recognize any implications for health and safety caused by those defects and omissions, and be able to specify a remedial action to mitigate those implications

NOTE 1 "Authority" in this context means authority delegated to the individual by their employer.

NOTE 2 See Clause 5 for recommendations on competence and training.

NOTE 3 See also BS EN 1263-1:2014.

3.7 coupling rope

rope that joins two or more safety nets together

NOTE This is sometimes referred to as a lacing rope.

3.8 debris net

fine net or sheet laid over a safety net and used to catch or contain lightweight debris

3.9 eaves bagging

rigging technique that removes the natural waisting form, or horizontal deflection, at an unsupported net perimeter, typically at eaves, at overhangs or at core walls

3.10 initial deformation (sag)

amount of sag induced by the weight of a net when influenced by the horizontal tension within the net

3.11 karabiner

safety link formed as a complete loop with a spring-loaded entry gate safeguarded in the closed position

3.12 laced joint

method of joining two safety nets together

3.13 mesh cord

cord from which the mesh of a net is constructed

NOTE *This is often referred to as mesh rope.*

3.14 mesh size

distance between the centres of mesh cords

[SOURCE: BS EN 1263-1:2014, **3.2.4**, modified]

3.15 net system

arrangement of mesh, border ropes, coupling ropes, tie ropes and/or attachment devices, and supporting framework, which are linked together as a system to provide a means of arresting falls

3.16 plastic deformation

net meshes stretching to absorb the load but not returning to their original state

3.17 safety net

mesh plus border rope, test meshes or cords, labels and serial numbers

3.18 supporting framework

structure to which nets are attached and which can contribute to the absorption of the kinetic energy due to a fall

3.19 test cord

separate sacrificial length of net cord of the same material as the net, produced in the same batch and used for periodic testing

NOTE *Test cords are only present in knotted nets.*

3.20 test mesh

separate sacrificial area of net mesh of the same material as the net, produced in the same batch and used for periodic testing

NOTE *Test meshes are present in knotless nets and occasionally in knotted nets.*

3.21 tie rope

rope used for securing the border rope of a safety net to a suitable anchorage

3.22 under-rolling

means of reducing the size of a standard net to fit a specific space or to provide a strong edge to which the tie rope or attachment system is attached

3.23 waisting

effect of the self-weight of a net at an unsupported perimeter where the net pulls horizontally away from an adjacent structure or the required line of the net

4 Layout and applications

4.1 Layout

4.1.1 General

Safety nets may be used by themselves or in combination with other fall arrest and fall protection systems to mitigate the consequences of a fall at openings or edges, or where working over or near fragile materials. Safety nets of various sizes may be linked together (see **7.3.3**) so as to span large areas.

Nets may be used in the form of a protection fan (e.g. BS EN 1263-1:2014, Figure 2), enhanced where required by placing debris netting over the safety nets to prevent smaller debris from falling through the net. The debris netting should be able to withstand the type of material likely to fall in to it, and gaps should be avoided at edges and around service ducts so that debris is not permitted to pass through.

In order to minimize the risk of injury to those who might fall into safety nets, nets should be capable of deforming and deflecting sufficiently under impact to largely absorb the energy of the falling person; this deformation and deflection being possible through the net cords slipping and tightening (knotted nets) or net meshes (knotless nets) deforming or stretching through plastic deformation. Tie ropes and border ropes might also stretch under load, so absorbing some of the falling energy. Safety nets should have sufficient clearance below them in order to allow for this deflection while ensuring that the person falling does not strike any object.

NOTE 1 Generally, the greater the fall height and the smaller the net area, then the greater the energy absorption capacity per unit area that is required to safely contain the fall (for further information see Annex A).

A workable rescue plan with the required equipment and skills to effect it should be in place before any works are carried out above the net.

NOTE 2 Industrially recognized training is available on the subject of rescue planning.

NOTE 3 While safety nets are designed to catch people, they can also be used to retain or control debris, although debris within the net can also injure anyone subsequently falling into it. The effect of debris in the net depends on the mass, shape, nature and falling height of the debris.

The likelihood of debris falling into the net and not being regularly cleared should be assessed by a competent person, who may recommend additional safety measures if this is anticipated to be an issue. In particular, this assessment should establish the likelihood of the net being overloaded, causing excessive deflection and tension in the net, ties and anchorages, and/or the risk of material bouncing out of or being deflected from the net, to the danger of anyone in the vicinity. Safety nets used with or without containment nets as protection fans (system "T") should not be used to catch materials deliberately thrown into them or for storing debris or materials.

Following the impact of any heavy objects into the nets, the nets should be taken out of service for checking, and repair when necessary (see Clause **8**).

Damaged nets should be immediately taken out of service. However, as an immediate short-term measure, damage of up to three adjacent meshes should be repaired with a tie rope by a qualified rigger. There should be not more than two temporary repairs in a single net. Once the immediate

work is complete the damaged net should be either repaired fully before reuse (see Clause **8**) or destroyed.

No persons, materials or machinery should be permitted within the area of maximum deformation as defined within BS EN 1263-2:2014, Figure 4.

It should not be possible for anyone to enter the area below the safety nets when persons are working above them, unless there is no risk of them being struck by falling objects.

4.1.2 Classification of safety nets

NOTE 1 Safety nets conforming to BS EN 1263-1:2014 are classified according to mesh size and energy absorption characteristics, as shown in Table 1. Two energy absorption capabilities are referenced, each in two mesh sizes.

Table 1 — *Classification of nets according to mesh size and energy absorption*

Type	**Energy absorption**	**Max. mesh size**
(from BS EN 1263-1:2014)	kJ	mm
A1	2.3	60
A2	2.3	100
B1	4.4	60
B2	4.4	100

*NOTE 2 Safety nets of both mesh sizes described in BS EN 1263-1:2014 are suitable for use, although the 100 mm mesh net is usually lighter and has a lower initial deformation due to its self-weight. All classes of safety net are available as either diamond mesh (when their designation includes the letter "D") or square mesh (when their designation includes the letter "Q") (see BS EN 1263-1:2014, Figure 1). Generally, a square mesh deforms less when rigged, therefore, at its mid-point it is closer to the working level, minimizing the possible fall height (see **4.1.3**).*

4.1.3 Positioning parameters and net selection

Safety nets should always be rigged as close as possible to the working level. Nets should be installed in accordance with BS EN 1263-2:2014 and additionally with the following recommendations.

Where reasonably practicable, safety nets should be not more than 2 m below the working level. The extent of the area protected by the safety nets should be clearly identified to those working above, to warn them not to move beyond the protected area.

Where used in system "T", safety nets should only be used as a secondary form of protection to supplement the use of, for example, guard rails and toe boards. System "T" nets should be either laid horizontally or slightly inclined back towards the working surfaces.

Where safety nets conforming to class A and in system "S" are subject to falls greater than 2 m, their individual area should be not less than 35 m^2 and their shortest side should be not less than 5 m. Where either of these two criteria cannot be met, then a class B net should be used. Safety nets of smaller areas should be installed only after consultation with a competent person (for further information see Annex A).

Where nets are to protect persons falling from an edge of an area, they should extend for a suitable catching width appropriate to the likely horizontal trajectory of anyone falling from that edge.

NOTE In the UK the catching width is typically 3 m, based on a maximum fall height of 2 m (see BS EN 1263-2:2014).

The desired working life of a net in any particular location should be taken into account when selecting the appropriate net for a given application, as the energy absorption capacity can reduce with age. Therefore, where a net is to remain in place for a year or more, checks should be carried out to confirm that the ageing process, while the net is in use, is not reducing its energy absorption capacity below its classified level.

4.2 Applications

4.2.1 General

For all applications the recommendations of BS 5975 should be followed with regards to the planning of temporary works utilizing safety nets.

4.2.2 New roof construction

NOTE 1 Safety nets used to give protection against falls during roof work might be required to guard a person having a horizontal trajectory as well as a vertical one, such as might occur at the eaves of the roof.

Safety nets can be provided to protect the roofer when loading out and fixing purlins and sheets [for use when laying metal decking and concrete floor slabs (see **4.2.4**)], however, materials should not be stored on safety nets, and safety nets should not be used to provide a means of access or as a place of work.

Steel components, particularly sheets and offcuts, should be prevented from falling into nets (see **4.1.1**) by, for example, stacking and securing the sheets in positions where they cannot be blown or fall onto nets.

NOTE 2 Guidance on this is given on the FASET website [5].

Safety nets should be supported from the truss/rafter members of the building, and rigged to follow the line of the roof.

Nets should be kept within a 2 m vertical distance of the work area by securing them to the portal rafter itself.

Safety nets should be tied at the eaves and core walls in such a way as to prevent the nets from waisting across the bay with the risk of leaving a gap through which a person could fall (see Figure 1). When an eaves bag is formed, the end openings (commonly known as teardrops) should be closed to prevent uncontrolled egress in the event of a fall. The border rope should be securely attached at both ends of the eaves bag to suitable attachment points and be taut.

NOTE 3 There is no limit to the span of an eaves bag.

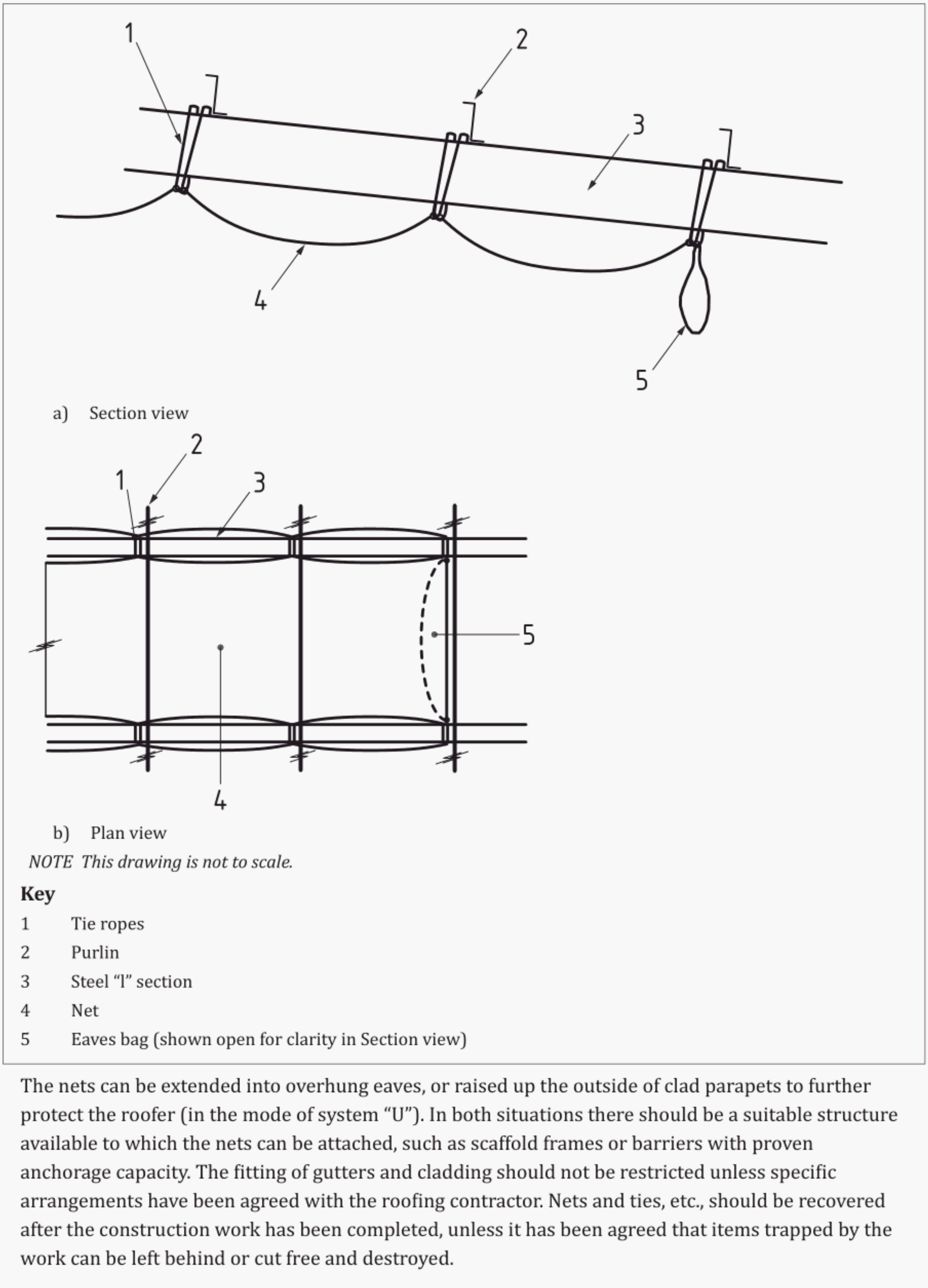
If an eaves beam is available and has structural capacity to withstand a characteristic loading of 6 kN at 45° to the horizontal, this should be used to tie the edge of the nets (i.e. no need for eaves bagging). Nets should not be secured to gutter supports or sheeting rails unless there is evidence that the supports have capacity to withstand the lateral forces from a fall. Ties holding the safety nets should not restrict the installation of other building components [see **6.2**i), **6.2**ii) and **6.2**v)].

Similarly, safety nets should not be fitted to cold-formed sections such as purlins or sheeting rails as these might not have the required structural capacity to support the energy from a falling body and could cut or damage the tie ropes. When tying nets to such items which have the required structural capacity, any sharp edges should be wrapped to protect the tie ropes.

NOTE 4 In most cases where safety nets are anchored to hot-rolled steel members and to node points in trusses, there is sufficient anchorage capacity.

With certain types of new build roofing, the structural liner spans across the truss/portal bays, and sits flush on top of the primary steelwork. In this case it might be necessary to fit the nets to clamp brackets onto the steelwork, or other suitable attachment devices (see **7.3.4**). In such cases, the anchors should be arranged so that the nets remain as close to the working surface as possible, and within 2 m of it.

Figure 1 — *Eaves bagging to avoid waisting*



NOTE This drawing is not to scale.

Key

1 Tie ropes
2 Purlin
3 Steel "I" section
4 Net
5 Eaves bag (shown open for clarity in Section view)

The nets can be extended into overhung eaves, or raised up the outside of clad parapets to further protect the roofer (in the mode of system "U"). In both situations there should be a suitable structure available to which the nets can be attached, such as scaffold frames or barriers with proven anchorage capacity. The fitting of gutters and cladding should not be restricted unless specific arrangements have been agreed with the roofing contractor. Nets and ties, etc., should be recovered after the construction work has been completed, unless it has been agreed that items trapped by the work can be left behind or cut free and destroyed.

Overhung gables can present rigging problems, as often in these situations the only structure available is the rail across the end of the cantilevered purlins. Eaves bagging should be installed such as to enable the net to span between the rafters.

4.2.3 Refurbishment

NOTE 1 The recommendations in 4.2.2 for new build roofing also apply for roof refurbishment applications.

NOTE 2 Where there are existing roof-mounted services and floor level access restrictions these could complicate the rigging process.

Where net protection is only required over a localized area, it should, where necessary, offer protection over a suitable catching width (typically 3 m) beyond the protected edge.

When using safety nets as a combined means for protecting both the worker at height and debris falling to the ground below, a containment net or sheet should be fitted to the safety net. The principle should always be followed that materials should not be allowed to fall, or only to fall in a controlled manner to a contained space; the containment net being a second line of defence.

When used for protection and when repairing or replacing random sheets in various locations, the extent of the area protected by the safety nets should be clearly identified to those working on the roof, to warn them not to move beyond the protected area.

The layout of the net should be arranged to allow the laced joints between the nets to be in positions where gaps are required for services; alternatively the services should be lifted or disconnected and held above the level of the net. The nets should be supported by primary structural members, and should generally span the truss bays following the line of the roof. Where fixings are to be provided by eyebolts, the procedure recommended in 7.3.9 should be followed.

When the purlins are built into the gable wall, the safety net may be supported by the purlins directly adjacent to their point of support (to minimize any bending load), provided that their structural capacity has been verified by a suitably competent person and any sharp edges on the steelwork are properly wrapped to prevent damage to the nets, tie ropes, etc. The fitting of the new roof sheets or walls should not be impeded.

Abrasive blasting works should be segregated from the safety nets to prevent damage (which might not be visible). Where it is suspected that contamination has occurred, a competent person should be consulted as to their continued use.

Where nets cannot be proven to be clear of any asbestos contamination, they should be treated as contaminated and should be disposed of appropriately.

4.2.4 Formwork and pre-cast concrete works

When using safety nets in this application, the nets are not normally effective in holding the heavier materials that could fall (such as pre-cast concrete units). If materials do fall into the net, the occurrence should be reported to the installer and the net removed from service.

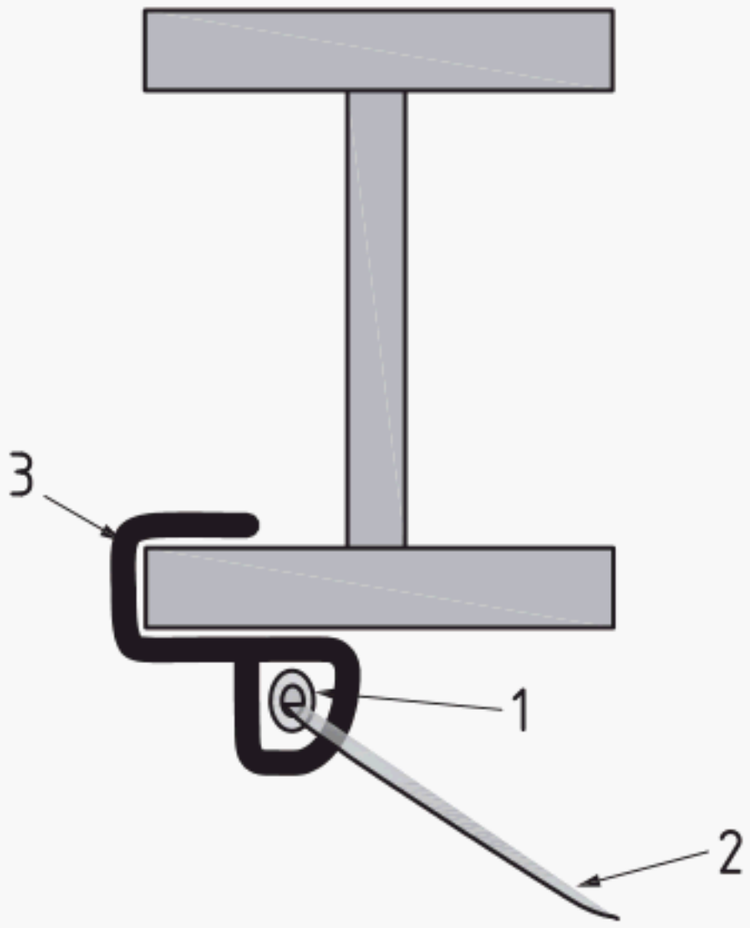
Many formwork systems and pre-cast concrete members sit flush onto their support structure, which prevents ties being made around the support member. In these instances attachment devices should be used (see Figure 2 and also 7.3.4); alternatively consideration could be given at the design stage (see 6.2) to the provision of suitable fitting points (lugs or holes) which could be designed into the supports.

4.2.5 Metal decking

Hot works should not be carried out above or adjacent to a safety net where the heat generated could melt the safety net material and therefore compromise its engineered performance parameters.

NOTE This type of damage can be to such small areas that it can be difficult to discover during routine inspection and examination procedures.

Figure 2 — *Typical attachment device*



Key

1 Border rope

2 Net

3 Typical attachment device

When it is necessary to cut a deck it should be pulled back onto a previously decked area to prevent sparks from landing on the safety net.

Safety nets should always be completely removed prior to stud welding. Safety nets should be stored well away from all hot works.

5 Competence and training

5.1 General

As safety nets are safety critical, the persons who rig, inspect or examine safety nets should be competent.

5.2 Competence

Three competences should be demonstrated to ensure the safe and effective use of safety nets:

1) competent rigging;

2) competent inspection; and

3) competent maintenance (carried out by examiners and repairers).

Competent riggers should have suitable industry recognized training, qualification and practical experience of rigging safety nets to the application areas within which they work, and understand the attributes and limits of the type of safety netting they are using.

Competent inspectors should have suitable industry recognized training and experience to be able both to recognize faults and to advise on suitable corrective procedures.

Competent examiners and repairers should have undertaken industry recognized training to carry out full examination and repair of safety nets. They should be able to assess the level at which a net is repairable, and at which level a net needs to be withdrawn from service.

5.3 Training

All those who are involved with the provision, design, installation and inspection of safety nets should have training and experience to be able to undertake their duties in relation to safety nets so that these are installed and maintained to be adequate for the situation where they are used.

The installation and dismantling of safety nets should be undertaken by a minimum of two operatives. All operatives installing or dismantling safety nets should be suitably trained. At least one of the operatives should be a qualified rigger; the rigger may be assisted by a labourer who may not participate in the installation of the safety nets. Trainees should be directly supervised by the qualified rigger.

Those involved in the inspection of a rigged safety net system should be able to confirm whether the net and the supporting system are fit for continued use. Such inspectors should have undertaken industry recognized training.

NOTE Training in the installation, maintenance and inspection of safety net assemblies is available within the industry. Information regarding training can be obtained from the FASET website [5].

6 Planning of net installations

6.1 General

NOTE 1 Attention is drawn to the Construction (Design and Management) Regulations 2015 [4].

*NOTE 2 The use of safety nets can be more effectively planned and their installation designed through the co-operation of all interested parties (see **6.2** to **6.4**).*

Matters that should be taken into account include, where relevant:

a) experience and competence of the net installers (see Clause **5** for recommendations on training and competence);

b) sequence and type of work being carried out during installation and dismantling;

c) sequence of the building work while the nets are in place;

d) provision of effective anchorages (see BS EN 1263-2:2014 for the maximum load at anchorages);

e) means of access for installing and dismantling the net;

f) access for inspection, debris removal and temporary repair of the net;

g) clearance distances below the safety net;

h) protection of those below; and

i) means of recovering persons who might fall into the net.

6.2 The role of designers of the permanent works

The principal designer should ensure:

a) where safety nets are identified as a specific precaution to protect against a significant risk of falls from height, this is clearly stated in the pre-construction information for the project. In addition, the principal designer should check that the other designers have discharged their duties [see **6.2**i) to v)]; and

b) systems are in place to facilitate co-operation between the various relevant designers associated with the work.

In addition, all designer(s) who are specifying the use of safety nets, or who are informed that safety nets are employed as a means of controlling risks during initial construction, maintenance and refurbishment, should:

i) avoid design details that can make nets difficult or dangerous to install, e.g. poor access, structures that are unable to support sufficient temporary loads, lack of positions for tying off;

ii) design suitable fixing points on the drawings to facilitate rapid installation and removal of safety nets and ensure that these can carry the characteristic loadings;

iii) calculate the likely forces on the structure due to the self-weight of the net assembly and the impact of a falling person, and assess the effect, if any, on the structure (see BS EN 1263-2:2014, Figure 4);

iv) specify additional bracing or other support if appropriate; and

v) ensure the need for access during rigging and striking when determining sequence of installation, and inspection when nets are to be used for long periods (i.e. greater than 12 months).

6.3 The role of the supplier and installer

6.3.1 Suppliers

Suppliers of safety nets should ensure that the nets are manufactured to BS EN 1263-1:2014 and supplied with the certification of conformity. Suppliers should also ensure that there is evidence that the minimum absorption capacity of the net is noted on the label.

6.3.2 Installers

Before arriving on the site, installers should inform the principal contractor of their requirements. As a minimum, they should inform the principal contractor of:

a) their training and competence (see Clause **5** for information on training and competence);

b) the plant they intend to use, e.g. mobile elevating work platforms (MEWPs);

c) the access facilities they require, e.g. surface preparation;

d) the requirements for anchorage of the nets and any actions needed to ensure that these are suitable and sufficient;

e) the requirements for the maintenance of clearance distance below the safety net at all times (even after the installers has left site);

f) the rescue plan;

g) the means of protecting anyone below;

h) confirmation that the safety nets and other equipment have undergone a suitable maintenance regime (including having been subject to periodic testing) and have a sufficient energy absorption capacity for the period while they are in use; and

i) confirmation that the temporary works design check certificate conforms to BS 5975 and is relevant to the category of the installation being undertaken.

NOTE This might involve consultation with other designers of the project.

While on the site, installers of safety nets should:

1) check that the anchorages provided are adequate;

2) ensure that the nets, when erected, are fit for purpose; and

3) ensure there is adequate clearance distance under the net.

Before leaving the site or section of site, installers should:

i) ensure that the principal contractor has all other necessary information to ensure that the nets are used in accordance with the manufacturer's instructions;

ii) ensure that the installer's handover certification is in order;

iii) explain what access is necessary for future inspections;

iv) issue written confirmation of the net's capability to the principal contractor;

v) issue guidance to the principal contractor on the rescue plan for anyone who falls into the net; and

vi) give guidance to the principal contractor about the need for retrieval of debris from the net.

6.4 The role of the principal contractor

Before the net installers arrive on the site, the principal contractor should ensure that the following issues are covered in the construction phase health and safety plan, and that they are taken into account in determining the sequencing of work:

a) access requirements for the rigging of safety nets;

b) suitable ground conditions where mobile access equipment is required;

c) programming of the works, such as mezzanine floor installation, that could reduce access or clearance distances;

d) ensure that the installers are competent to erect the nets. If there is no proof of competence, they should not be allowed to start work (see Clause **5** for information on training and competence);

e) advise what the net is to be used for; and

f) indicate what provision has been made for anchorages and explain what tests, if any, have been carried out to verify that the anchorages are adequate.

When the net installers arrive on the site, the principal contractor should:

1) ensure that the nets supplied for a project perform as required for the duration of the project by checking that the most recent test certificate for the nets predicts an acceptable working life; and

2) check that the supporting certification accompanying the nets is current and appropriate for the net application.

Before works commence above the safety nets, the principal contractor should ensure that:

i) a workable rescue plan is in place and has been communicated to all those working above the safety net; and

ii) the installer's handover certification is in place.

In addition, the principal contractor should ensure that:

- all other subcontractors have received adequate information on the purpose and function of safety nets, and that this is included in the site induction programme as appropriate, such as the importance of reporting all falls into the net by persons or heavy debris;
- nets used on site are maintained in accordance with the supplier's instructions (in particular see Clause **8**); and
- the health and safety plan specifies who carries out inspections of safety nets once rigged and when such inspections are carried out.

7 Installation, use and dismantling

7.1 General

Those supplying and installing safety nets should be familiar with the limitations of this type of equipment and how to maximize the benefits of its use.

Safety nets should not be used to store materials or to provide means of access or egress.

Safety nets are primarily a means of arresting the fall of persons and should not be used to arrest the fall of building products and other components without the advice of a person competent to do so.

Any object that falls into the safety net should be safely removed as soon as reasonably practicable.

NOTE 1 It is good practice to agree who is responsible for removing any objects from the net and how this is undertaken prior to works commencing.

Following handover, configurations and rigging methods should never be altered without the installer's consent and then only by persons competent to do so.

Nets that have been loaded should not be used again until a competent person advises it is safe to do so.

A net that has arrested a fall of persons or significant debris should be taken out of service.

NOTE 2 Significant debris is that which is likely to cause damage to the net due to weight or form.

Debris nets, when used, should deform in the event of a fall.

NOTE 3 This can be achieved by ensuring that the debris net is oversized and loosely attached to accommodate the safety net's sag.

7.2 Wind load

Wind loading should be taken into account where nets are used.

NOTE Wind-induced movement of the safety net system can result in damage to the system.

The potential for debris to fall from the net through the action of the wind should be minimized by appropriate disposal and containment of debris.

For the purpose of wind load design, a net covered with debris netting should be assumed to have an impermeable surface.

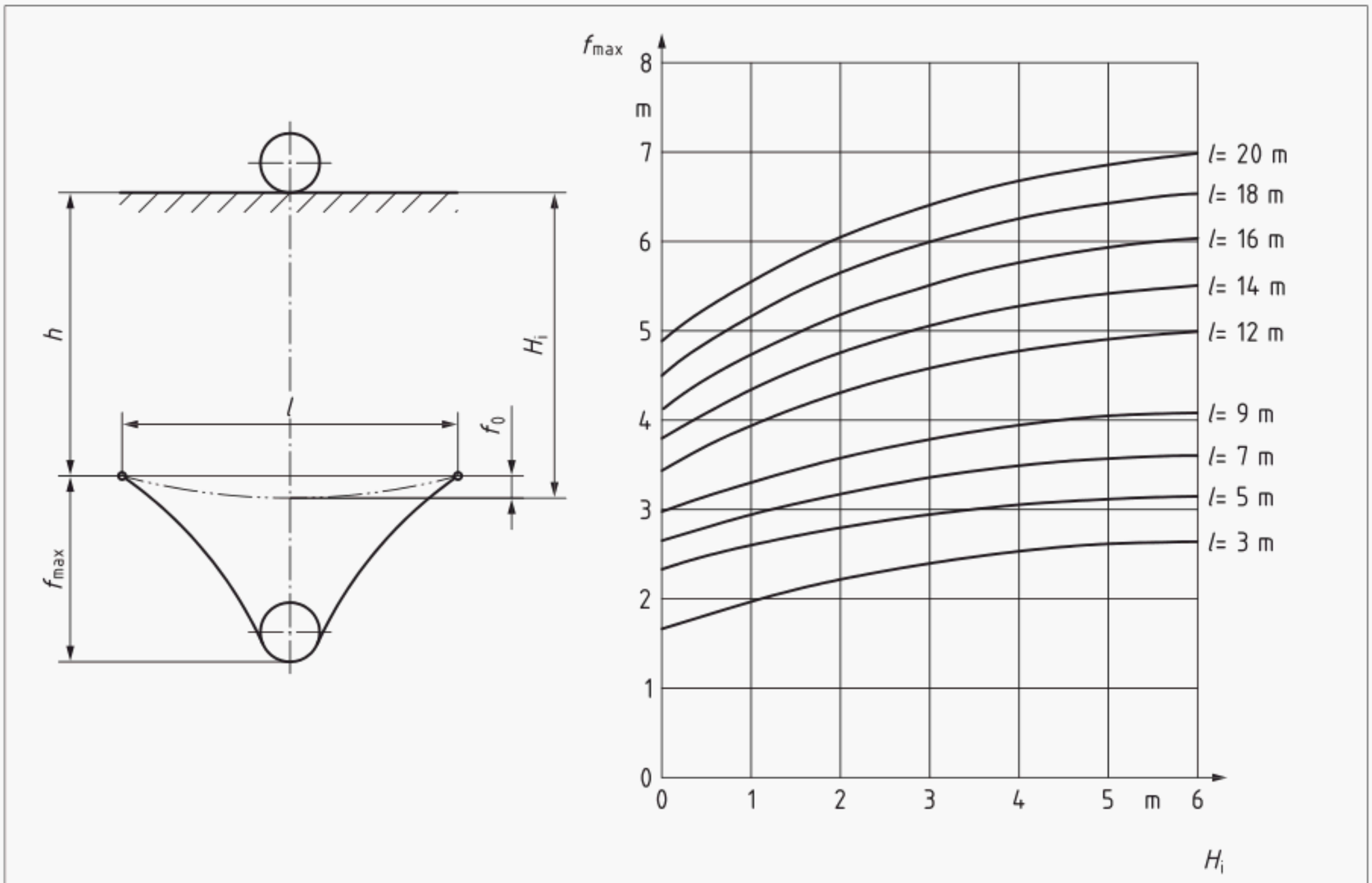
7.3 Installation

7.3.1 General

There should be adequate clearance distance below the anchorage point. The deflection criteria for the net as shown in Figure 3 should be applied.

NOTE 1 In UK construction situations the total deformation is often assumed to be 3 m. This is based on typical maximum fall heights and net spans.

Figure 3 — *Maximum deflection for nets greater than 35 m² in area*



Key

l Span of the safety net (smallest side)

h Vertical distance between anchorage point of the safety net and the working level above

H_i Vertical distance between the safety net and the working level above

f_0 Deformation caused by the self-weight of the safety net

f_{max} Maximum deformation caused by the self-weight of the safety net plus dynamic load

The curves only apply if:

— $f_0 \leq 0.1 \cdot l$

— $H_i = h + f_0 \leq 6.0\,\text{m}$

Nets should be installed as close as possible to the working level.

Nets should not be over-stretched when installed, and should have an initial deformation (or "sag") of between 5% and 10% of the net's smallest side.

Safety nets should not be sited in close proximity to high voltage cables, moving gantries and other dynamic structures. When nets are used over water, suitable rescue and recovery facilities should be provided.

When nets are to be installed to protect persons working on structures that span over motorways, roadways or other routes used by the public, the loading, design and installation methods should be agreed with the appropriate authorities.

NOTE 2 Attention is drawn to the hierarchy of safety in the Work at Height Regulations 2005 [3], which gives preference to those means of protection that prevent a fall rather than arresting one after the fall has occurred. When arresting a fall, preference is given to minimizing the distance and consequences of the fall. The closer the safety net can be rigged to the working platform or working level, the closer it is to meeting this requirement.

If the nets are temporarily dismantled to facilitate the clearing of rubbish, personnel should be restricted from entering those areas that were protected by the nets unless they are provided with other suitable means of protection installed by a competent person.

The method of rigging nets should be determined from a suitable and sufficient risk assessment of the site conditions.

NOTE 3 Methods of rigging nets include the following:

a) remote attachment;

b) rigging from MEWPs;

c) rigging from ladders;

d) specialist rigging techniques; and

e) rope access.

There are exceptional circumstances where mobile access towers may be used subject to stability of the tower and manual handling considerations.

NOTE 4 Attention is drawn to the Work at Height Regulations 2005 [3].

When installing nets in the vicinity of live lines or overhead power cables, the appropriate authority should be consulted before work is commenced to check whether the lines are dead or to verify the appropriate clearance distances.

Safety nets should not be tied or fixed through individual mesh cords. All ties should be made using methods that absorb the impact loads through a multiple number of mesh cords and border ropes, e.g. by attaching to the border rope or under-rolling.

7.3.2 Provision of access to the net

Safety nets should be sited so that access to them is possible and convenient, particularly so as to facilitate the rescue of any person who falls into them.

NOTE Safe and convenient access to safety nets can be achieved by installing the net adjacent to a working platform, floor or other access point, or by providing such platforms or access points adjacent to the net.

7.3.3 Coupling ropes

NOTE Adjacent nets can be laced together using tie ropes (type "M") or coupling ropes (type "O"), as outlined in BS EN 1263-1, woven between each mesh of each net in such a manner that any gaps between the nets do not exceed 100 mm.

Where the edges of the net have been under-rolled to reduce their size, the coupling rope should be woven around the excess net.

7.3.4 Attachment devices

NOTE 1 Safety nets may be attached to the structure using proprietary attachment devices. They may be installed using a remote attachment pole thereby avoiding work at height. They also offer an alternative to tie ropes which might become trapped when the sheet, deck or plank is installed.

Proprietary clips or cable ties should be used, particularly at building edges and openings, to prevent attachment devices becoming detached from the net.

NOTE 2 This is particularly important at building edges and openings. Typically, this can be achieved with proprietary clips or cable ties.

At all times, the specifiers and installers of these devices should be aware of the manufacturer's instructions (see Figure 2 as an example of an attachment device).

NOTE 3 Instructions are available from the manufacturer of the attachment device, typically on request or via their website.

7.3.5 Border ropes

Most net systems have a border rope that allows connection to be made to the edge of the net. If the net does not have a border rope (e.g. as in systems "T" and "U" in BS EN 1263-2:2014, Clause **6** and Clause **7** respectively), each individual mesh should be connected to the net system's supporting framework (see 7.3.7).

7.3.6 Attachment spacings

The spacing of all the tie ropes should be regular, at not more than 2.5 m. Where attachment devices are used, the spacing should be in accordance with the manufacturer's recommendations.

7.3.7 Supporting frameworks

NOTE 1 Safety nets can be supported directly by either a border rope or a supporting framework.

The individual net system should be designed in accordance with the manufacturer's recommendations and instructions. Systems incorporating a particular supporting framework should only use that specific supporting framework, as it could form an integral part of the energy absorption system as a whole, and any variations in the supporting framework could affect the ability and performance of the net system.

NOTE 2 The framework anchor or tie positions that carry or support the safety net may be either integral with the net or designed as independent structural members.

The nets should be arranged so that they protect a falling person from impact onto the frameworks as far as possible.

NOTE 3 It is likely that nets rigged on supporting frameworks are small and therefore the net might be unsuitable for withstanding heavy impact forces.

In support frameworks that are integral with the net, the anchors or ties should be tested with the net, in accordance with BS EN 1263-1, to show that their inter-dependency is safe.

Where nets are used in temporary edge protection, nets should be installed in accordance with BS EN 13374.

7.3.8 Deflection of the net

NOTE 1 Figure 3 shows the typical deflection of the net in relationship to the fall height and net span when the load impacts the net. The figure can be used to calculate the clearance distance below the net for nets of greater than 35 m^2.

The net class should be appropriate to the circumstance in order to enhance the deflection characteristics.

The net should be placed beneath the working surface, as close as possible in order to reduce the fall height.

Checks should be carried out to ensure that there is sufficient clearance below the net so that as it deflects during/after a fall, the person does not strike anything (see Figure 3).

NOTE 2 In some situations, there might not be sufficient clearance below the net and therefore it might be appropriate to use catenary lines (to support the net mid span to help reduce deflection).

7.3.9 Fixing and anchorage points

Anchorage points, such as special frames, scaffold tubes, structural steelwork and eyebolt anchors or similar, should be selected by a competent person as being capable of supporting the characteristic loads on the nets. The anchorage points should be selected taking account of the method of attachment, e.g. to avoid the risk of chafing when using tie ropes, and to the ease of access for rigging and striking. If it is necessary to fit safety nets to eyebolts, these should conform to BS EN 795 and

should be installed in accordance with BS 7883, irrespective of whether their use is intended as a temporary measure or if they are permanent fixings.

NOTE 1 For system "S" nets, see BS EN 1263-2:2014, Figure 3, for characteristic loads at the anchor positions.

Safety nets should be rigged as close as is practicable to the underside of the working surface to minimize any potential fall.

NOTE 2 The positioning requirements of BS EN 1263-2:2014 are the "maximum permissible".

Safety nets should be fixed such that they do not impede any construction work that is to be carried out around them.

Under normal circumstances the net should be fitted to ensure that no gaps greater than 100 mm develop around the edge of the net (through waisting between fixings), but in exceptional circumstances, gaps of up to 225 mm might be deemed acceptable where this gap cannot open up any further. Nets can be joined by lacing with tie ropes or coupling ropes linking the border ropes of the nets together, or by overlapping the nets, tiling down the slope to prevent the possibility of anyone falling under the upper net. Overlaps should be not less than 2 m in the middle of the net, conforming to BS EN 1263-2:2014.

7.3.10 Ties and karabiners

Tie ropes and karabiners may be used to attach the net, or net system, via the border rope or supporting framework, to the anchorage point. Where these are of rope they should be knotted or looped around the border rope and adjacent mesh cord, passed through or around the anchorage points, and secured in such a way as to prevent chafing. Where karabiners are used these should be attached in accordance with BS EN 362.

7.4 Dismantling

During dismantling, nets and their associated equipment should be recovered intact and should not be dropped to the floor below.

NOTE It is good practice to consider issues around dismantling at the planning stage of the work.

The default method for dismantling nets should be from a safe working platform. The sequence for dismantling should be the reverse of that used for installation.

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8 Care and maintenance of safety nets

8.1 Examination

8.1.1 Prior to rigging

Before being put into service, safety nets should be thoroughly examined on each side by a competent person. Checks should be made that the identification marking as required by BS EN 1263-1 remains visible on the nets, allowing them to be traced back, via an identity number, to the manufacturer's original test certificates.

A check should also be made that verification by testing has been carried out (see **8.1.2**) in the last 12 months. If the identification marking is not available, testing cannot be carried out and it cannot therefore be determined whether the net is safe – it should therefore be withdrawn immediately from use and not returned to service.

NOTE It is good practice for the installers to undertake an additional check of the nets in-situ before dismantling and once back in the yard.

The examination should be recorded and kept available for inspection. If the examination reveals any deterioration or defect which gives rise to doubt about the performance of the net, it should either be repaired before being taken back into service or destroyed.

8.1.2 Periodic testing

The manufacturer should supply safety nets with test meshes or cords, which can be removed one at a time and tested in accordance with BS EN 1263-1:2014.

NOTE 1 This testing can be carried out by a trained operator of a calibrated test machine.

Only nets that have passed testing within the previous 12 months should be used.

NOTE 2 This testing is to determine whether the safety net has a predicted breaking strength (measured in kN) or energy absorption (measured in J) in excess of the manufacturer's minimum criteria for the next 12 months as given on the net's identification marking.

The test meshes/cords should not be used for any other purpose and should remain fixed to the net until required for testing.

Nets that have undergone this periodic testing should be supplied with a test tag verifying that the net still meets the manufacturer's criteria and indicating the date that the next test is due. There should be a corresponding test certificate that gives greater detail, e.g. date of previous test, date when next test is due.

With the exception of installed anchors, a safety net system or any of its component parts used for the safety of personnel should not be subject to load testing.

8.2 Repair

Only a competent person should carry out repairs and assess the repaired net for its suitability for continued use.

NOTE It is good practice to effect repairs away from site to ensure that the quality of repair is in line with the manufacturer's instructions.

A tag should be fixed to each repair which proves the identification of the repairer and date of repair.

Any repairs undertaken should not be detrimental to the strength or impede the performance of the net.

Repairs should be carried out using new materials that are compatible with the net.

Any damaged border ropes should be repaired using new materials by a competent person.

Damaged coupling ropes or ties should be scrapped, not repaired.

8.3 Inspection

8.3.1 Site inspection

Site inspections should be carried out to ensure that the nets remain serviceable. Advice from a competent person should be sought when there is any doubt about the suitability of nets for use after any known contamination.

The entire safety net installation should be formally inspected immediately following installation, when a handover certificate should be issued. Further formal weekly inspections should be carried out thereafter. A record of these inspections should be kept. The system should also be visually inspected each morning before work starts.

The following are the main points that a site inspection should cover.

a) All maintenance and repair work on safety nets and their anchorages shown to be required by the site inspection should be carried out by a suitably competent person (see **7.3.9** and **8.2**).

b) The nets and the net assembly should have appropriate certification as described in **8.1.2**. Checks should be made to ensure that the net has been tested (if older than 12 months from manufacture) and labels have been affixed as described in **8.1.2**.

c) Checks should be made to see if there are any distortions in the line or appearance of the net and any supporting frameworks.

d) Checks should be made of whether the net has been used to arrest a fall or loaded in any way (usually this shows as a local deformation in the net).

e) Checks should be made on whether all the anchorages remain intact and in good order.

f) Checks should be made on whether the net is clear of debris or, if it contains debris, whether this has damaged the net. Immediate action should then be taken to remove the debris and carry out any necessary repairs.

g) Checks should be made on whether any meshes or mesh cords have been cut. Where this is the case, the net should immediately be withdrawn from service until repaired by a competent person.

NOTE 1 Up to two temporary repairs/net (using tie ropes) can be effected by a competent person before withdrawing the net from service.

Safety nets should be kept free of all debris that could cause injury to persons falling into them. If this requires the safety net to be disconnected and reinstalled for the removal of debris, a competent rigger should carry this out.

NOTE 2 Discoloration, or lack of coloration, can be a misleading indication of the safety net's condition.

Those inspecting, installing and controlling works around the nets should be aware that the following conditions affect the integrity of the safety net installation while in use:

1) sparks, etc., from welding, grinding and burning operations, hot gases from blow lamps, hot ash from chimneys or furnaces;

2) chemical contamination by caustic and other harmful substances;

3) radiation, e.g. due to radio frequency;

4) adverse weather conditions, e.g. strong winds, snow and ice;

5) any significant load or impact; and

6) other forms of abuse.

Where safety nets are subject to adverse conditions, the frequency of inspection should be increased. If any deformations, fraying or discoloration in the net materials are identified, advice should be obtained from a competent person.

Where safety nets are to remain in use for 12 months or more, test meshes/cords should be in the area exposed to maximum UV concentrations. Such test meshes or test cords should be positioned to allow safe access for retrieval.

8.3.2 Mechanical damage

The following situations should be avoided as far as possible, during installation and use, in order to prevent unnecessary wear and mechanical damage that are likely to weaken the net:

a) dragging over rough surfaces;

b) contact with sharp edges;

c) stacking material on the net;

d) accumulation of debris in the net;

e) persons jumping or throwing objects into the net;

f) supporting framework being struck by a moving load; and

g) unauthorized interference with any part of the net assembly.

Special care should be exercised and suitable precautions taken to protect the net and supporting framework when unavoidably exposed to any of the hazards in a) to g).

8.4 Storage

When not in use, nets should be stored under cover and be protected from weather and sunlight. When removed from storage after more than 12 months, an examination should be carried out (see **8.1.1**). The nets should not be stored in conditions that might affect the manufacturer's minimum criteria. In all cases the advice of the manufacturer provided with the net should be followed.

Nets and accessories should:

a) be stored in dry conditions;

b) be protected against UV and other radiation sources;

c) not be stored close to sources of heat;

d) not be stored in places where they could come into contact with aggressive materials/substances (acids, dyes, solvents and oil, etc.); and

e) be protected against vermin.

8.5 Identification and recording

Safety nets should have individual identity numbers, added by the manufacturer, so that they can be readily identified. The installer should keep comprehensive records linking to this identity number, including the following:

a) certificate of conformity provided by the manufacturer and/or annual test for UV degradation (whichever is the most recent). Test records should be retained for the life of the net as a minimum;

b) records of where the net has been put into service, including site details;

c) the results of the formal examinations for each net;

d) any repairs carried out to the net; and

e) the destruction of a net at the end of its working life.

Annex A (informative)
Assessing the reliability of safety nets

A.1 Background information

The development and use of modern safety net assemblies owes much to the research carried out by the Bauberufsgenossenschaft in Germany [6].

This research initially considered the best way of preventing or reducing injury where a person suffers a fall. The research considered various options including a boarded deck, safety harnesses and safety nets. It then drew the conclusion that safety net assemblies are far more likely to prevent or reduce injury than the other options considered.

The research then continued looking for the most appropriate layout of a safety net assembly to best perform these safety functions.

Accordingly, tests were carried out dropping a manikin 7 m into the centre of a 35 m^2 net measuring 7 m × 5 m, with fixed, rigid support frameworks. The deceleration of this manikin, the loads on the anchors and ties, and the performance of the net cords were all assessed in these tests.

While certain conclusions can be drawn from the tests, the application of this research to areas outside the research parameters, such as impact close to the sides of the net, the effects of plastic deformation of the anchors and the effects of pre-tensioning the net, is somewhat vague. Other research into these areas has been undertaken by the HSE and can be found in its report *Evaluation of safety nets by experiment* [7].

The main principle of safety net design and installation is to reduce the forces on the body suffering a fall to such limits that the likelihood of injury is reduced to a minimum. The mechanics of such an approach require that:

- the net assembly (i.e. the net, the ties, the anchors and the supporting framework) progressively deflects under load, absorbing most of the energy of a fall, so that the remaining forces on the body would be unlikely to cause injury;
- the net assembly is able to progressively deform or deflect so that the falling energy can be safely absorbed;
- this absorption can be the sum total of the energy absorbed by the nets, ties, border ropes, anchors and supporting frameworks;
- the net and net assembly are free to deflect and realign to be best able to absorb the impact energy of a falling body; and
- sufficient mesh cords are available within the net, of which the combined tensile strength and ability to deform are sufficient to withstand the design impact. This combined strength is not so high as to make the net too stiff or rigid so as to cause injury to a falling person.

Effective design and installation of a safety net system would therefore not only recognize the parameters described above, but also how these might be affected by the age and wear and tear on the net, and the rigidity of the ties and anchors (those that are over-rigid could reduce the flexibility of the system and its ability to deform under load to the extent that the resulting load on a falling body would be high enough to cause injury and/or rupture of the net).

Energy absorption does not necessarily equate to static strength, for which good elastic properties are required. Therefore, while some net manufacturers might use a form of static testing as described

in BS EN 1263-1:2014, this is used only to confirm that a product run conforms with a prototype that has been subject to dynamic testing.

Impact at those areas where the safety net assembly is less able to deflect under load, such as along the edges of the net and particularly at the corners, therefore needs to be reduced by ensuring that the falling height is minimized.

A.2 Calculations

The safe use of nets requires that the falling energy of a person can be effectively absorbed by the complete safety net assembly, and that the class of net chosen has greater energy absorption characteristics than the impacting energy of a falling body. The energy in kilojoules (kJ), E, with which a person impacts with the net can be calculated as follows, assuming that the person weighs 100 kg:

$$E = \frac{100 \times g \times H}{1000}$$

g is the acceleration due to gravity, in metres per second squared (m/s^2), taken as 10 m/s^2;

where:

H is the height of the fall in metres (m).

NOTE 1 In order for the net assembly to be subject to forces no greater than those investigated in the Bauberufsgenossenschaft in Germany, H does not exceed 6.0 m measured between the level of the working platform from which a fall could occur to the level of the net where impact would occur.

For the net to be suitable for purpose, E does not exceed the stated absorption capability of the net.

The net assembly gains the necessary absorption characteristics through the actions of the various components in the assembly. However, the chief of these are the absorption characteristics of the net itself.

The basic absorption of a net in kilojoules (kJ), F_{NB}, is calculated as follows:

$$F_{NB} = F_N \times L_K \times L_a \times A_n$$

where:

A_n is the number of cords sharing the load (or effect of effective net area);

F_N is the strength of the net cord when new, in kilojoules (kJ);

L_a is the loss due to ageing and mechanical damage, as a percentage (%);

L_K is the loss due to knots, as a percentage (%).

The basic absorption of the net assembly in kilojoules (kJ), F_{NA}, is calculated as follows:

$$F_{NA} = F_{NB} \times A_n \times D_n \times C_n$$

where:

A_n is the number of cords sharing the load (or effect of effective net area);

C_n is the percentage of the falling energy absorbed at the net anchorages;

D_n is the energy absorbed by the border ropes and supporting frameworks, etc.

NOTE 2 For normal forms of construction, C_n and D_n are taken as zero.

A suitable factor of safety is also used in this equation, but it is determined by the manufacturer in designing the product to conform to the characteristic classification.

It has been found that the soft body tissue in a person can itself absorb up to 20% of the falling energy, although this is not considered in designing net assemblies.

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Useful websites

Health and Safety Executive [Available at: https://www.hse.gov.uk/].

Temporary Works Forum [Available at: https://www.twforum.org.uk/home].

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