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Artificial climbing structures - Part 1: Safety requirements and test methods for ACS with protection points

Structures artificielles d'escalade - Partie 1: Exigences de sécurité et méthodes d'essai pour SAE avec points de protection

Künstliche Kletteranlagen - Teil 1: Sicherheitstechnische Anforderungen und Prüfverfahren für KKA mit Sicherungspunkten

This European Standard was approved by CEN on 24 February 2007.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 12572-1:2007) has been prepared by Technical Committee CEN/TC 136 “Sports, playground and recreational equipment”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2007, and conflicting national standards shall be withdrawn at the latest by October 2007.

This standard consists of a number of parts as follows:

EN 12572-1, *Artificial climbing structures — Part 1: Safety requirements and test methods for ACS with protection points*

prEN 12572-2, *Artificial climbing structures — Part 2: Safety requirements and test methods for bouldering walls*

prEN 12572-3, *Artificial climbing structures — Part 3: Safety requirements and test methods for climbing holds*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the safety requirements and test methods for artificial climbing structures with protection points (hereafter referred to as ACS).

This European Standard is applicable for ACS in normal use for sport climbing.

This European Standard is not applicable to ice climbing, dry tooling and playground equipment.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1991-1-3, *Eurocode 1 — Actions on structures — Part 1-3: General actions — Snow loads*

EN 1991-1-4, *Eurocode 1 : Actions on structures — Part 1-4: General actions — Wind actions*

EN 1991-1-5, *Eurocode 1 : Actions on structures — Part 1-5: General actions — Thermal actions*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
artificial climbing structure
(ACS)
sports equipment consisting of a purpose-built climbing structure, which shows various construction characteristics, and is designed for various uses in sport climbing objectives and is not reserved for a particular age group

3.2
protection point
attachment point on the ACS designed to protect the climber

NOTE It can be permanent (cannot be removed with tools, e.g. a glue in anchor) or non-permanent (removable with tools, e.g. a hanger).

3.3
individual protection point
intermediate protection point used to safeguard a climber in his/her progress on the ACS

3.4
individual top protection point
protection point which is fixed at the top of a climbing line and which is designed to take the rope of one climber

NOTE It can be used for top rope or lead climbing.

3.5
collective top protection system
protection system which is fixed at the top of a climbing line and which is designed to take the ropes of several climbers at once

NOTE It can be used for top rope or lead climbing.

3.6
individual base protection point
anchor point which is fixed to the base area of the ACS and which is designed either to secure a belayer controlling the rope of a lead-climber or as an anchor for a self belay system or as an anchor for a protection system

3.7
stance
position on an ACS consisting of two or more individual protection points linked together, where the climber can stop, protect him/herself and his/her fellow climber can join him/her before continuing the climb from the stance

3.8
span (see Figure F.2)
part of a collective top rope system measured between two consecutive supports or attachments

3.9
characteristic load
maximum load that can be generated in normal use

3.10
falling space
space on or around the ACS that can be occupied by the user during a fall

3.11
free space
space around the ground projection of the ACS that can be occupied by a climbing, a lowering, spotting or belaying user

4 Safety requirements and test methods

4.1 Layout and placement of individual protection points

If there are individual protection points, the height of the first point shall not exceed 3,10 m.

The maximum distance x for the placement of the individual protection point which follows the point situated at the height of h (see Figure 1) shall be determined by using Equation (1)

$$x = \frac{(h + 2{,}0)}{5} \qquad (1)$$

however, x shall not exceed: 1 m if $h \leq 5$ m;

2 m if $h \geq 5$ m

where

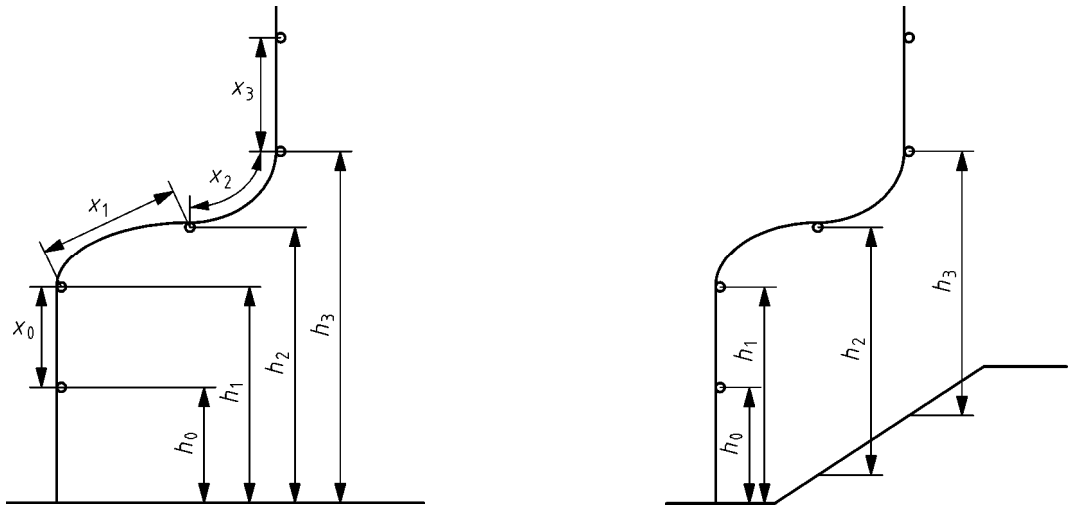
h is the distance between the point and the ground measured vertically, in metres, beneath the point in all cases.

For slabs with an inclination of more than 5° the maximum distance x shall be always 1 m (see Figure 3).

For protection points, the maximum distance shall be measured from the lowest internal point of the attachment point.

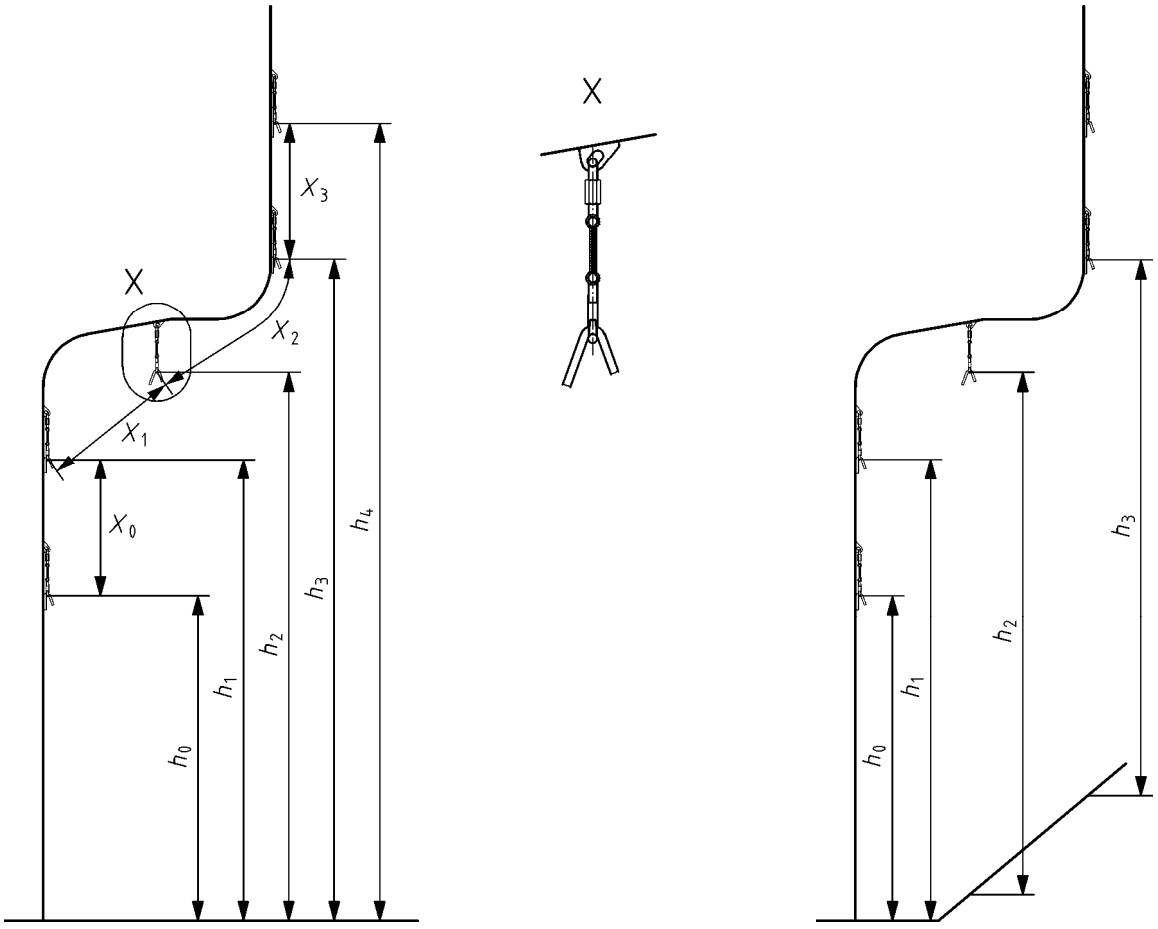
If permanent quick draws are installed, the maximum distance shall be measured from lower quick draw end to lower quick draw end. A permanent quick draw (e.g. chain secure element, Maillon Rapide) has to be disassembled from the climbing wall by means of tools (see Figure 2).

Protection points attached with bolts shall be secured, so they cannot come undone, e.g. with lock nuts.



a) b)

Figure 1 — Layout of protection points



a) b)

Figure 2 — Design and placement of permanent quick draws

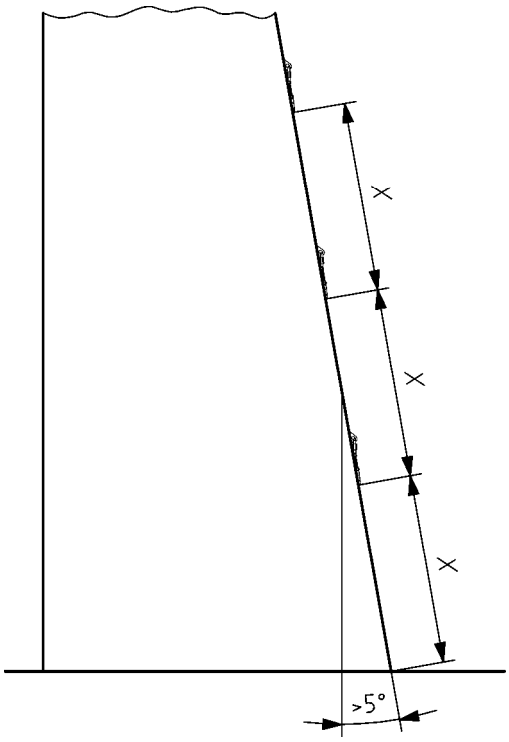


Figure 3 — Design and layout of protection points on slabs

4.2 Design of individual top protection points

The rope shall not be able to escape from the top protection points at an untimely moment, e.g. single-snap-gate karabiner is not sufficient.

Individual top protection points shall be attached to the structure by two or more points of fixation. Each fixation point shall be calculated as a protection point.

Each link between the fixing points shall have a resistance greater than or equal to each of the points which it joins together; this resistance shall be verified by either calculation (see Annex A), or a document of compliance, or tests as defined in Annex C.

4.3 Dimensions

The dimensions of all protection points and stance points with the exception of individual and collective top protection systems shall be in accordance with Figure 4.

The bar or device over or through which the rope passes in either a collective top protection system or an individual top protection point shall be rounded in accordance with Figure 5.

Dimensions in millimetres

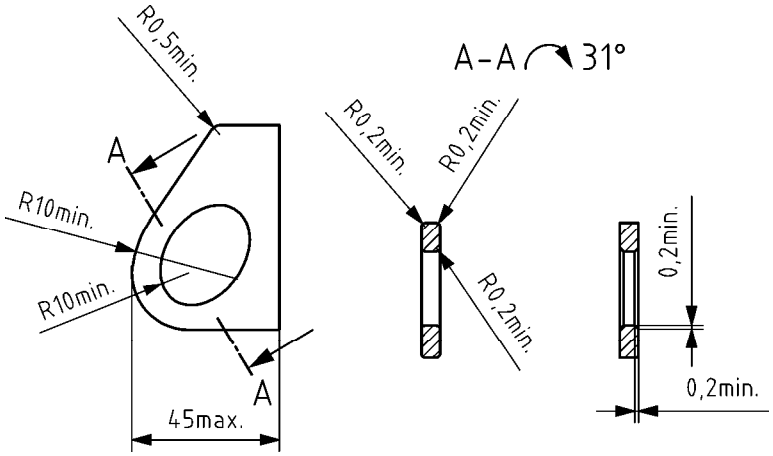


Figure 4 — Design of individual protection points

Dimensions in millimetres

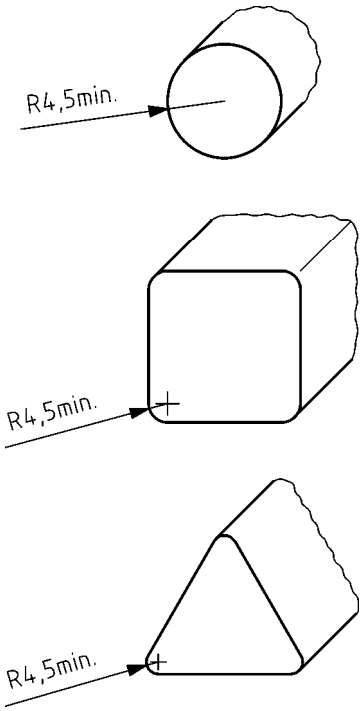


Figure 5 — Rounding of parts

4.4 Structural Integrity

4.4.1 Structural integrity of an ACS

The structural integrity and stability of an ACS shall be justified by calculation using the characteristic loads given in Table A.1, in accordance with Annexes A, B and Figure 6.

Ensure that the structure (e.g. building, concrete platform, ground) can safely accommodate the loads imposed by the ACS.

Permanent protection points shall be calculated in accordance with Annexes A and B (e.g. glued protection points in concrete walls).

Non permanent protection points shall have a breaking strength in the main load direction of a minimum of 20 KN.

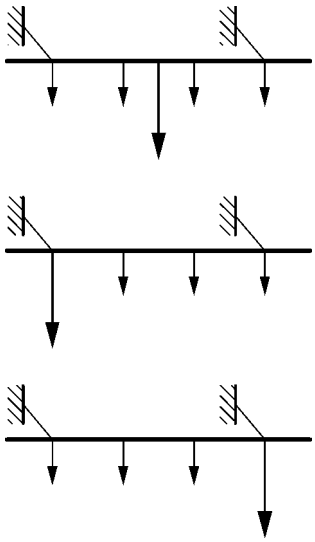


Figure 6 — Placement of the loads on collective protection systems

4.4.2 Structural integrity of a protection point connection

All elements of an ACS shall be justified by calculation, however in exceptional cases for protection point connections only (the assembly that attaches the actual protection point to the sub frame), a load test as described in Annex C is acceptable as a method of evaluation.

After applying the design load to the protection point connection there shall be no permanent deformation. After applying the breaking load to the protection point connection there shall be no breakage.

4.5 Impact resistance of surface elements

When tested in accordance with Annex D, there shall be no breaking or splitting of any surface element.

4.6 Hold insert resistance

When tested in accordance with Annex E, there shall be no breaking out or loosening of any surface material or hole insert.

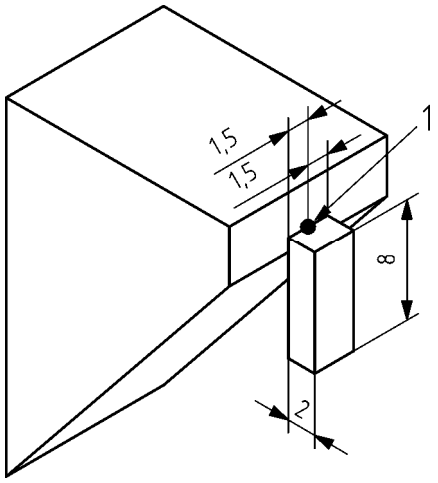
4.7 Proof testing

When tested in accordance with Annex F, after settling under load there shall be no breaking, tearing or destruction of the elements after testing.

4.8 Falling space

Within the falling space there shall not be any obstacle which could lead to a hazard to the user. This does not apply to climbing structures or the floor, see Figure 7. The horizontal falling space shall be 2 m behind, 1,5 m either side and 8 m below the protection points.

Dimensions in metres



Key
1 protection point

Figure 7 — Falling space

4.9 Free space

The free space shall allow the climber to land safely.

4.10 Climbing surfaces

All reachable parts of the climbing surface shall be free of sharp edges and burrs. All edges shall be rounded, particularly where the rope can rub.

There shall be no gaps between 8 mm and 25 mm and with a depth greater than 15 mm which can lead to entrapment, unless it is a feature specifically designed for climbing. Insert holes in climbing surface of the ACS for attaching holds are excluded.

5 Marking

All ACS shall be marked in a clearly visible place with a notice comprising of:

a) name or trademark of the manufacturer;

b) name of importer or supplier;

c) number and date of this European Standard, i.e. EN 12572-1:2007;

d) date of installation of the ACS;

e) date of the next main inspection.

6 Instruction manual

An instruction manual shall be provided including the following information:

a) information contained in Clause 5;

b) position and type of protection points on the ACS;

c) maximum number of protection point lines usable simultaneously on the ACS;

NOTE In normal circumstances the number of protection point lines should equal to number of top protection points. Should the number differ, the manufacturer should give details in the manual and mark the ACS appropriately.

d) specific use, maintenance and inspection requirements, see Annex G.

7 Conformity of ACS

The conformity documentation shall be supplied to the client and contain the following information where applicable:

a) detailed calculation of the stability of the entire structural frame and all protection points;

b) location of the protection points;

c) report of the impact test of surface elements;

d) report of the proof test of the ACS;

e) report of the protection point connections test according to Annex C, if appropriate;

f) report of the hold insert resistance test;

g) marking;

h) instruction manual.

The proof tests shall be made at the first installation and all reinstallation only.

For all further reconfigurations only the new calculations and visual verifications according to the standard and the manufacturer's instructions are necessary.

Annex A
(normative)

Effects

A.1 Permanent effects

The permanent effects consist of the self weight of the structure and of the entire structural frame.

A.2 Variable effects

A.2.1 General

The variable effects consist of:

a) user loads (static and falling);

b) snow loads;

c) wind loads;

d) effects of temperature;

e) special loads.

A.2.2 User loads

Table A.1 — Loads

	Proof test load	Characteristic load	Breaking load
	kN	kN	kN
Load of a climber		0,8	
Load produced by a climbing team hanging on a protection point		2,5	
Load produced by falling climber on a protection point	8,0	6,6	20,0
NOTE The proof testing only acts as a verification of good installation practice and cannot replace the calculations.			
Based on experiments it is impossible to have two or more climbers create a peak impact force simultaneously due to a fall.			

A.2.3 Snow loads

Snow loads shall be taken from the Eurocodes for actions on structure, i.e. EN 1991-1-3.

A.2.4 Wind loads

Wind loads shall be taken from the Eurocodes for actions on structure, i.e. EN 1991-1-4.

A.2.5 Effects of temperature

Impacts of temperature shall be taken from the Eurocodes for actions on structure, i.e. EN 1991-1-5.

A.2.6 Special loads

Special loads can be generated by ropes courses, earthquakes, rescue techniques, zip wire.

Annex B
(normative)

Method of calculation of structural integrity

B.1 General principles

B.1.1 Limit state

Each structure and structural element, e.g. connections, foundations, supports, shall be calculated taking into account the load combinations of B.2.

The preferred method of calculation shall be based on the general principles and definitions for limit states as specified in the appropriate structural Eurocodes 1 to 6 or equivalent national standards.

NOTE Limit states are states beyond which the structure no longer satisfies the requirements of this European Standard.

In symbolic form, a limit state can be written as:

$$\gamma_F \times S \leq R/\gamma_M \qquad \text{(B.1)}$$

where

γ_F is a partial safety factor for effects;

γ_M is a partial safety factor for materials;

S is load effect;

R is the resistance of the structure.

In order to allow for uncertainties in the actual loads and in the model used for determining loads, loads are multiplied by a partial safety factor for loads (γ_F).

In order to allow for uncertainties in the actual material properties and in the models used for determining forces in the structure, the strength of the structure is divided by a partial safety factor for materials (γ_M).

B.1.2 Ultimate limit state

Ultimate limit state

Ultimate limit states requiring consideration include:

a) loss of equilibrium of the structure or any part of it, considered as a rigid body;

b) failure by excessive deformation, rupture, or loss of stability of the structure or any part of it.

NOTE Ultimate limit states are those associated with collapse, or with other forms of structural failure which can endanger the safety of people.

B.2 Combination effects for the ultimate limit state

The following combinations shall be used for verification:

$$\gamma_G \, G_k \, + \gamma_Q \, Q_{k,1} + \sum_{i>1} \psi_i \, \gamma_Q \, Q_{k,i} \qquad \text{(B.2)}$$

where

G_k characteristic value for permanent effects;

Q_k characteristic value for variable effects as given in A.2;

γ_G partial safety factor for permanent effects;

γ_Q partial safety factor for variable effects;

ψ combination factor for variable effects.

The following partial safety factors for effects shall be used:

γ_G 1,0 for favourable effects;

γ_G 1,35 for unfavourable effects;

γ_Q 0 for favourable effects;

γ_Q 1,5 for unfavourable effects.

Combination factor for variable effects of the climber shall be used (simplified method of calculation):

ψ = 0,8.

B.3 Structural stability

For the calculation of integrity and stability of an ACS, the loads of a falling climber shall be applied at the most unfavourable protection point. The load of the climbing team shall be taken at the most unfavourable protection point on each successive protection point either side of a falling climber.

For the calculation the loads of both falling climber and the climbing team shall be on the most unfavourable angle between ± 12,5° from the vertical axis.

Annex C
(normative)

Load testing of structural integrity of protection point connections

C.1 General

This test is designed to evaluate the static strength of protection point connections of an ACS alternatively, when not calculable. By loading with the design load no permanent deformation is acceptable. By loading with the breaking load no break is acceptable.

C.2 Apparatus

Strength measurement device, loading hook Ø 12 mm.

C.3 Sampling

The relevant protection point connection and the necessary ACS background structure to be tested shall have been produced using the same materials and by the same manufacturing process as the elements of the ACS it represents.

C.4 Procedure

Set up the relevant protection point connection with the necessary background structure as intended in the relevant ACS.

Load the protection point connection in the direction of a fall. Apply a load corresponding to the design load (characteristic load $\times$ 1,5) ($\pm$ 1 %) to the protection point connection for 1 min ($\pm$ 5 s). There is no permanent deformation acceptable.

Settling of the protection point connection is acceptable.

Continue testing by applying a load corresponding to the breaking load ($\pm$ 1 %) of Table A.1 to the protection point connection for 1 min ($\pm$ 5 s).

There shall be no breakage acceptable which leads to the failure of the protection point connection.

The test shall be undertaken by a type A inspection body (see EN ISO/IEC 17020).

Annex D
(normative)

Impact test of surface elements

D.1 General

This test is designed to reproduce the shock resulting from the impact of the feet of climbers resulting from normal pendular falls, perpendicular to the surface of the ACS, when the ACS is used under normal conditions.

D.2 Apparatus

Indenter in accordance with Figure D.1.

D.3 Sampling

The surface elements to be tested shall have been produced using the same materials and by the same manufacturing processes as the elements of the ACS it represents. The sample should be a standard element or a specially made flat panel 1 m $\times$ 1m.

D.4 Procedure

Set up the surface element as shown in Figure D.2.

Place the surface element on rigid supporting points as following:

a) for a surface element: as it would be on an ACS;

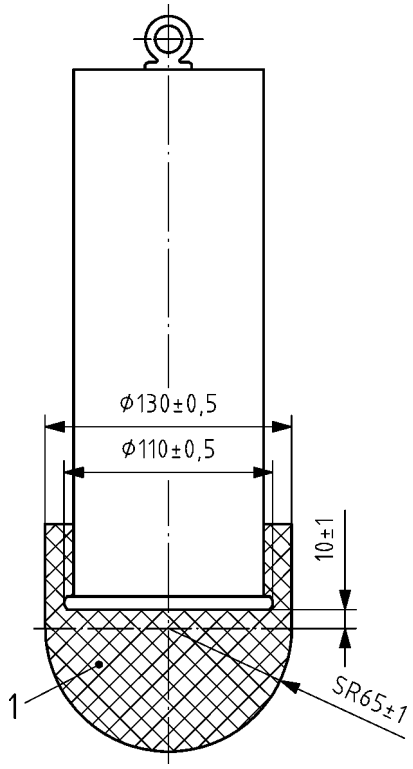
b) for a sample: at each corner, with a non shock absorber system.

Strike the surface of the element three times with the indenter in the geometric centre from a height of 1 500 mm as shown in Figure D.2 a) or b).

Note any breakage or splitting of the surface element at the end of the test.

The test shall be undertaken by a type A inspection body (see EN ISO/IEC 17020).

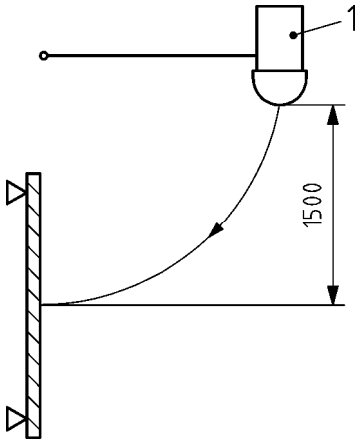
Dimensions in millimetres



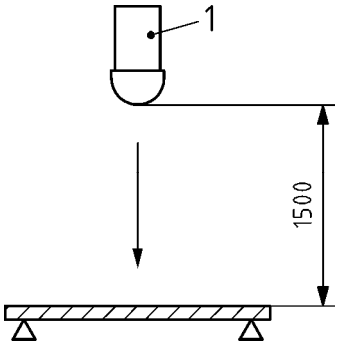
Key
1 silicon ((30 ± 5) shores)
total mass(22 ± 0,1) kg

Figure D.1 — Indenter

Dimensions in millimetres



a) horizontal impact test on vertical surface



b) vertical impact test on horizontal surface

Key
1 indenter

Figure D.2 — Set up of surface elements for impact test

Annex E
(normative)

Hold insert resistance test

E.1 General

This test is designed to reproduce the load that is applied to a bolt-on hold fixing in an ACS resulting from the use of the hold by a climber.

E.2 Apparatus

Eyebolt, distance ring and pulling apparatus in accordance with Figure E.1.

E.3 Sampling

The surface elements to be tested shall have been produced using the same materials and by the same manufacturing processes as the elements of the ACS it represents.

E.4 Procedure

Assemble the eyebolt together with the distance ring into the hold insert of the surface element with a torque of 15 Nm.

Load the eyebolt quasi-statically in the axial direction with a load of 5 kN for 1 min.

The test loads remain the same irrespective of the bolt diameter that is used to attach the hold to the fixing point.

The test shall be undertaken and certified by a type A inspection body (see EN ISO/IEC 17020).

Dimensions in millimetres

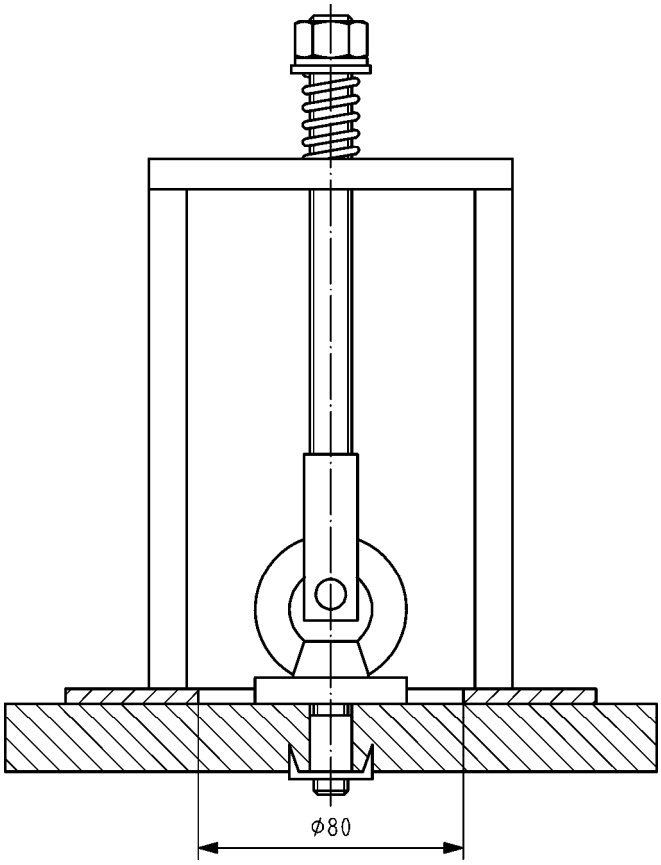


Figure E.1 — Apparatus

Annex F
(normative)

Proof testing

F.1 General

These tests shall be used as a verification of good installation practice and shall not in any case replace the calculations, maintenance programme, inspection or other justification procedure. There is no requirement for future retesting of the ACS, after the first installation of the ACS.

F.2 Procedure

F.2.1 General

During tests, the forces used shall be in the direction of a fall ± 12,5° from the vertical axis, or roughly parallel to the surface of the ACS if its incline is greater than 12,5° (see Figure F.1).

During tests, apply the forces either by suspending a mass, or by using traction devices not resting directly on the ACS.

The equipment for the application of the load when testing shall be applied by devices wide enough not to damage the elements tested.

In all proof tests, apply the force quasi-statically for at least 10 s.

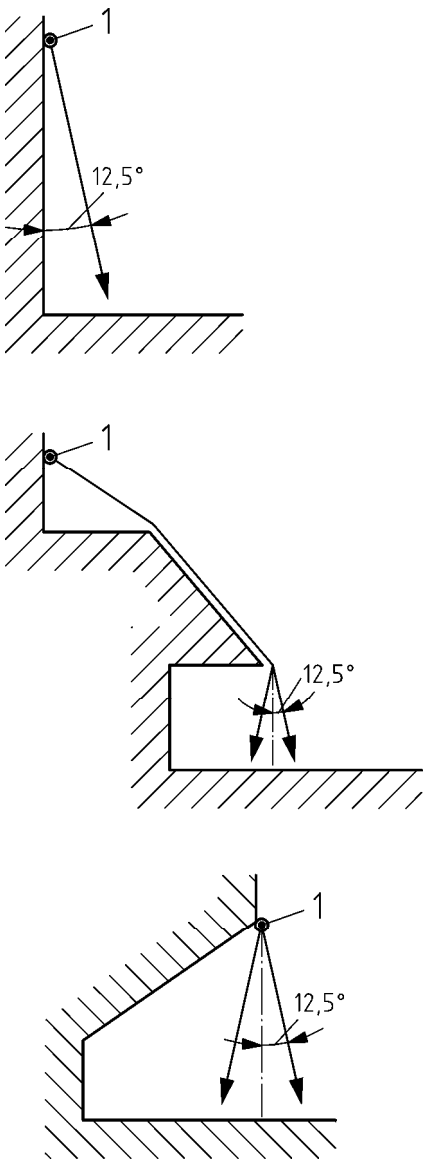
F.2.2 Protection points

F.2.2.1 Individual protection point

Test the first three protection points of each climbing route.

The highest protection point of each climbing route shall be considered as an individual top rope system and shall be tested.

The test load is 8 kN.



Key
1 point tested

Figure F.1 — Maximum angle for the direction of the forces

F.2.2.2 Individual top protection points

All individual top protection points shall be tested.

All the points designed to pass the rope through shall be tested.

The test load is 8 kN.

F.2.2.3 Collective top protection system

Test every collective top protection system in accordance with Figure F.3 as follows:

a) test at the points of fixation;

b) test in the middle of each span (see Figure F.2);

c) test at the point where the load makes the greatest bending moment;

d) for all tests the load is 8 kN.

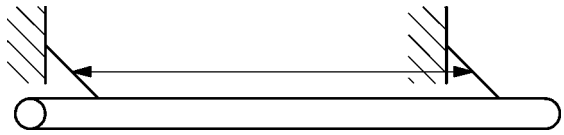


Figure F.2 — Span

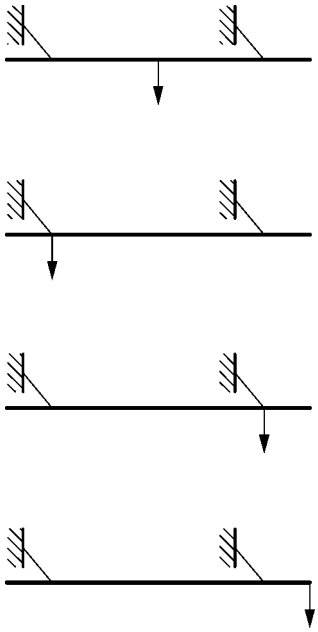


Figure F.3 — Placement of test loads for collective top protection systems

F.2.2.4 Anchor for a stance

Test each anchor for a stance to 8 kN.

Annex G
(normative)

Inspection and maintenance

G.1 The manufacturer/supplier shall provide:

a) instructions for maintenance (marked with the number of the current standard), which shall include a statement that the frequency of inspection will vary with the type of equipment or materials used and other factors, e.g. heavy use, levels of vandalism, coastal location, air pollution, age of equipment;

b) drawings and diagrams necessary for maintenance, inspection and checking of the correct operation and, when appropriate, repair of the equipment

c) instructions to specify how access is to be gained to the inside of each section of the ACS where applicable.

G.2 The instructions shall specify the frequency with which the equipment or its components should be inspected or maintained and shall include guidance on the following, where relevant:

a) Routine visual inspection

The routine visual inspection serves to identify obvious defects and sources of danger on the front side of the climbing wall, which can be easily seen from the ground without use of means of support. For ACS subject to heavy use or vandalism, daily inspection of this type may be necessary.

NOTE 1 Examples of visual and operational inspection points are cleanliness, loose holds, obstacles placed in the free space, missing parts, excessive wear and other obvious damage.

b) Operational inspection

The operational inspection is a more detailed inspection to check the operation and stability of the equipment, and for the wear of components. This shall be carried out every 1 to 3 months, or as indicated by the manufacturer's instructions. Operational inspections shall be documented.

Special attention shall be given to protection points and the mechanisms of articulated walls.

c) Main inspection

The main inspection, according to the maintenance manual of the relevant manufacturer, is done to establish the overall level of safety of the ACS, its foundations, structural frame and wall surfaces, e.g. effects of weather, evidence of rotting or corrosion, and any change in the level of safety of the equipment as a result of repairs made, or of added or replaced components. Main inspections shall be documented.

Special attention shall be given to all protection systems, the structural frame and generally the inside of the ACS.

NOTE 2 The main inspection may require dismantling of certain parts and replacement of critical safety elements. This inspection of the equipment should be carried out by competent persons in strict accordance with the manufacturer's instructions.

NOTE 3 The level of competence required will vary with the task.

G.3 The instructions shall also specify the following:

a) where necessary, the servicing points and methods of servicing, e.g. lubrication, tightening of bolts, re-tensioning of ropes;

b) replacement parts shall comply with manufacturer's specifications;

c) if special disposal treatment is required for some equipment or parts;

d) identification of spare parts;

e) additional measures to be taken during the run-in period, e.g. tightening of fastenings, tensioning of cables, lubrication of moving parts;

f) special points the manufacturer wants the operator to pay particular attention to.

Bibliography

[1] EN ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection (ISO/IEC 17020:1998)*