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Steel wire ring net panels — Definitions and specifications

Panneaux de filet en anneaux de fil d'acier — Définitions et spécifications

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
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Foreword

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The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

Steel wire ring net panels — Definitions and specifications

1 Scope

This International Standard specifies the characteristics of steel wire ring net panel for retaining of unstable slopes controlling and preventing rockfalls and loose debris flow along roads, highways and railway, urban areas, mines and quarries, and for snow avalanche protection produced from metallic-coated steel wire or advanced metallic coating.

It is not applicable to anchors or soil nails for fixing of steel mesh to an unstable slope.

2 Normative references

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

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 7989-2:2007, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 2: Zinc or zinc-alloy coating*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 22034-1, *Steel wire and wire products — Part 1: General test methods*

ISO 22034-2:2007, *Steel wire and wire products — Part 2: Tolerances on wire dimensions*

3 Terms and definitions

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

3.1
wire ring
steel ring obtained by looping a single steel wire with ends inserted into the thread or secured by one or more than one ferrules

3.2
nominal wire diameter
diameter used to designate the wire

Note 1 to entry: It is expressed in millimetres (mm).

3.3
real wire diameter
average value of the minimal and the maximal diameter, measured in the same section of a straight piece of wire, by means of a micrometer to 0,01 mm

3.4
wire ring size
average value of the diameter of the single ring

Note 1 to entry: See Figure 1.

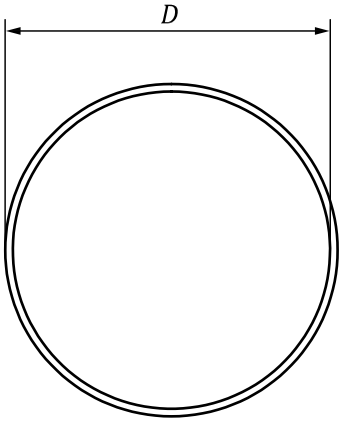


Figure 1 — Ring size

3.5
wire ring net panel
structure of the panel net, made by rings connected with the contiguous rings

3.6
advanced metallic coating
metallic coating with a non-specified composition and having a superior corrosion resistance

3.7
dimensions of a panel
length and width expressed in metres or in number of rings

Note 1 to entry: See Annex D.

3.8
ring structure
way that the ring is manufactured and constituted

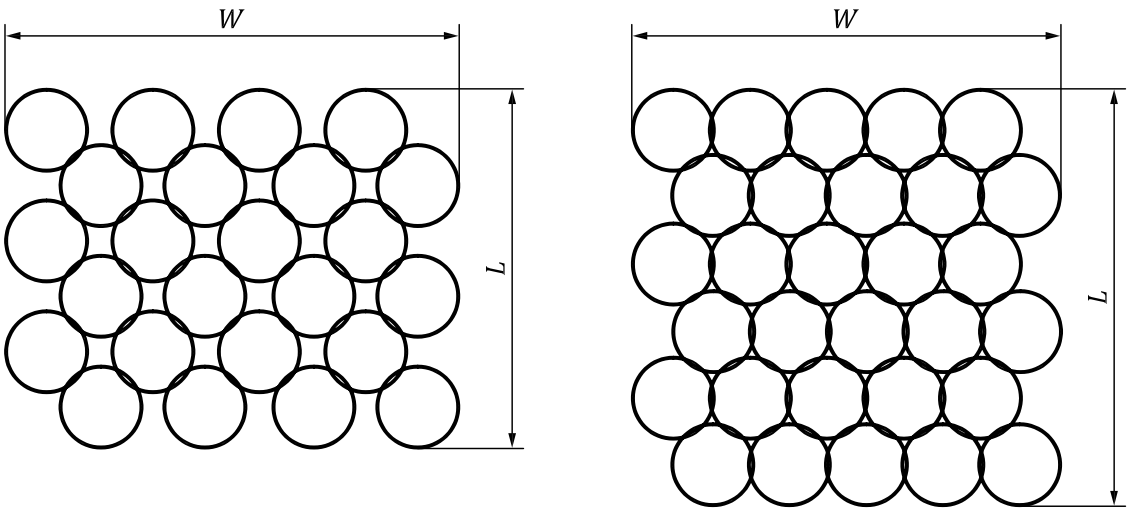
4 Description of use and applications

The typical use for the considered products is retaining of unstable slopes, controlling and preventing rockfalls and loose debris flow along roads, highways and railway, urban areas, mines and quarries, and for snow avalanche protection.

5 Wire ring net panels

Wire ring net panels are ring panels where each ring is made by several loop bindings, each one obtained by looping a single steel wire. Each ring is connected with four or six contiguous rings in order to create a net as shown in Figure 2.

For the connection of the panels, shackles or wire rope shall be used. The strength of the connection formed shall be equal to or greater than the tensile strength of the ring net panel.



a) Four contiguous rings **b) Six contiguous rings**

Figure 2 — Example of ring wire net panel layout

The wire ring net panels shall comply with the specifications given in Table 1.

Table 1 — Properties and possible combinations of wire ring net panels

Standard ring diameter[a] mm	**Standard windings**[b] n	**Wire diameter**[c,d] mm
	7	
300	9	3
350	12	4
420	16	
	19	

a Other ring diameters and wire diameters are possible, in accordance with project design requirements.

b Other number of windings are possible, in accordance with project design requirements.

c By agreement, other values should be provided.

d Tolerances of metallic coated wire diameter are in accordance with class T1 in ISO 22034-2:2007, Table 1.

6 Properties of wire

The wires shall comply with the diameter and tolerances as specified in Table 1, with the coating as specified in Table A.1, and with the coating weight as specified in ISO 7989-2.

Method of assessment and acceptance criteria for zinc and zinc alloy coating weight are described in ISO 7989-2:2007, Clause 5.

The tensile strength of the wire used for rings shall be minimum 1 380 MPa. The tensile strength of the wire used for rings shall be tested in accordance with ISO 22034-1.

6.1 Ageing and corrosion resistance

6.1.1 Zn class A

When subjected to the neutral salt spray test according to the procedures given in ISO 9227, after a period of 500 h of exposure, the ring samples shall not show more than 5 % of DBR.

6.1.2 Zn95Al5 class B

When subjected to the neutral salt spray test according to the procedures given in ISO 9227, after a period of 500 h of exposure, the ring samples shall not show more than 5 % of DBR.

6.1.3 Zn95Al5 class A

When subjected to the neutral salt spray test according to the procedures given in ISO 9227, after a period of 1 000 h of exposure, the ring samples shall not show more than 5 % of DBR.

6.1.4 Advanced metallic coatings (as Zn90Al10) class B

When subjected to the neutral salt spray test according to the procedures given in ISO 9227, after a period of 1 000 h of exposure, the ring samples shall not show more than 5 % of DBR.

6.1.5 Advanced metallic coatings (as Zn90Al10) class A

When subjected to the neutral salt spray test according to the procedures given in ISO 9227, after a period of 2 000 h of exposure, the ring samples shall not show more than 5 % of DBR.

7 Wire net properties

The chain of three rings is mounted in a calibrated test traction rig and it is connected to the machine with two circular elements of 50 mm diameter, not less than four times the diameter of the strand.

Before the test, a slight tension is given to stabilize the system, then the force is reduced again to zero before the test starts.

The chain of three rings is tensioned by the test machine with a recommended displacement speed of 2 mm/s, until breaking (see Figure 2).

The chain of three rings breaking load is reached when the chain is no longer able to support any increase of the applied force. Tests shall be performed on a minimum number of three samples.

The tensile test machine shall be of class 1 according to ISO 7500-1.

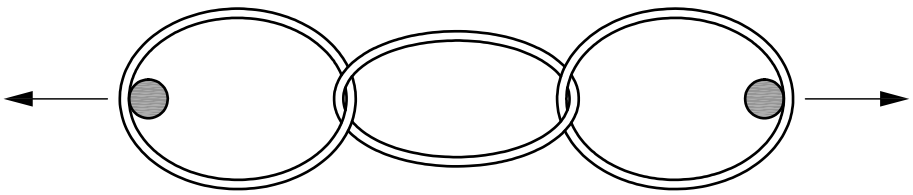


Figure 3 — Scheme of the test on net rings

8 Wire ring net properties (longitudinal tensile test with no lateral contraction and load bearing capacity test)

Tensile strength and load bearing capacity tests are described in Annex B and Annex C.

Tensile strength and load bearing capacity tests are indications of product performance and quality. The use of the results for design purposes shall be based on an engineering judgement in accordance with the experience and the current practice and site conditions.

9 Sampling and testing

The manufacturer is responsible for the control of product quality.

10 Inspection and documentation

If agreed at the time of ordering, a certificate according to ISO 10474 shall be supplied containing the following data:

— product description;

— manufacturer's name and address;

— quantity of products supplied;

— wire coating (type and class);

— maximum breaking load of chain of three rings;

— length and width of ring panels in m and number of rings;

— number of hours of exposure without showing not more than 5 % of DBR.

In addition, if requested, the following data shall also be supplied:

a) client name;

b) ring net load bearing capacity;

c) ring net tensile strength.

Annex A
(informative)

Possible metallic coating options

The wire of the ring net panel is protected with a metallic coating. Depending on the corrosivity of the environment for which the wire ring mesh is installed (see ISO 9223), possible options for metallic coating are presented in Table A.1.

Table A.1 — Description of the environment of the installation site, coating wire ring requirement

Site environment level (in accordance with ISO 9223:2012, Table 4)	Coating	Class (ISO 7989-2)	Estimated working life of the product (year)
Low aggressive: (C2) Dry conditions Temperate zone, atmospheric environment with low pollution, e.g. rural areas, small towns (over 100 m above sea level). Dry or cold zone, atmospheric environment with short time of wetness, e.g. deserts, sub-arctic areas.	Zinc	A	25
	Zn95 %/Al5 % alloy	A B	50 25
	Advanced metallic coating	A B	120 50
Medium aggressive: (C3) Dry conditions Temperate zone, atmospheric environment with medium pollution or some effect of chlorides, e.g. urban areas, coastal areas with low deposition of chlorides, e.g. subtropical and tropical zone, atmosphere with low pollution	Zinc	A	10
	Zn95 %/Al5 % alloy	A B	25 10
	Advanced metallic coating	A B	50 25
High aggressive: (C4) Wet conditions Temperate zone, atmospheric environment with high pollution or substantial effect of chlorides, e.g. polluted urban areas, industrial areas, coastal areas, without spray of salt water, exposure to strong effect of de-icing salts, e.g. subtropical and tropical zone, atmosphere with medium pollution, industrial areas, coastal areas, shelter positions at coastline.	Zn95 %/Al5 % alloy	A	10
	Advanced metallic coating	A B	25 10

NOTE Working life (product) — the period of time during which the performance of a product will be maintained at a level that enables a properly designed and executed works to fulfil the essential requirements (i.e. the essential characteristics of a product meet or exceed minimum acceptable values, without incurring major costs for repair or replacement). The working life of a product depends upon its inherent durability and normal installation and maintenance.

A clear distinction has to be made between the assumed economically reasonable working life for a product (also called: design working life), which underlies the assessment of durability in Technical Specifications, and the actual working life of a product in a works. The latter depends on many factors beyond the control of the producer, such as design, location of use (exposure), installation, use and maintenance.

The estimated working life can thus not be interpreted as being a guarantee given by the producer.

Technical Specification writers will have to take a view about the “normal” working life of the products that they deal with. The assumed working life of a product should take account of the assumed working life of the works, the ease and cost of repair or replacement of the product, maintenance requirements and exposure conditions.

Dark brown rust appearance on surface cannot be considered as the end of the working life.

For specific use, the ring wire net panels can also be produced with polymeric coated steel wire or polymeric coated steel wire rings.

Annex B
(informative)

Load bearing capacity tests

B.1 Net load bearing capacity test procedures

The load bearing capacity of ring net panels should be evaluated according to the following test procedures.

The test consists in loading a sample of net perpendicularly to its plane by means of a hemispherical-shaped load sharing device (press). The press shall be located in the central point of the panel.

The hemisphere of the press is formed by a durable material, such as concrete or steel.

The surface of the press must be smooth, without any corners. Any attachment devices fitted on the surface of the press must not interfere in any way with the test piece during the test.

The geometrical characteristics of the press are the following (see Figure B.1):

— radius of curvature 1,200 mm;

— maximum diameter of the sample projected on a plane 1,000 mm;

— radius of curvature at the side 50 mm.

The test piece is loaded at the intersection of its diagonals (centre of test piece), moving the press with a speed not greater than 10 mm/s.

The test may be interrupted to allow the stroke of the thrust device to be restarted.

The sample tested has a rectangular shape, with a 3,0 m side (average value – tolerance ± 20 %). To allow installation of the system, the test applicant must supply the sample to the laboratory with the dimensions planned for the test or larger, and the laboratory will then carry out the sampling. It must be representative of the product in terms of materials and construction method.

The tests must be performed in the laboratory at ambient temperature, and always in compliance with standards which regulate the testing procedures for the various materials.

The puncturing test is carried out after fixing the test piece to a rigid frame and it is aimed at measuring the force-movement curve of the central point of the press measured perpendicularly to the plane of the test piece. The test must allow failure of the specimen to be reached. The panel is considered to have failed when it is no longer able to support any increase to the applied force. The puncturing strength of a test piece is therefore defined as the maximum force imparted by the test piece during the test.

Dimensions in millimetres

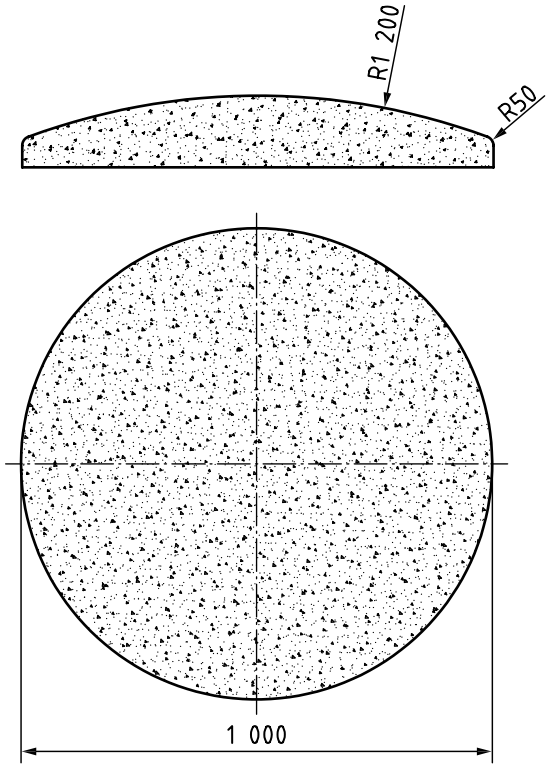


Figure B.1 — Geometrical characteristics of the press

The test may also be performed without reaching failure of the panel. In this case, the limit strength, which may be certified, is equal to the maximum value of the force reached during the test.

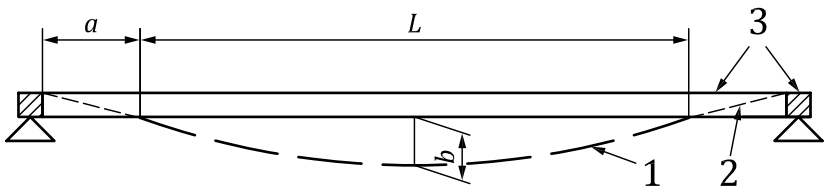
The contrast frame is made from a rigid rectangular or square structure, the size of which fully holds the net test piece and the constraint devices (see Figure B.2). The distance between the rigid frame and the net test piece, that is, the space holding the constraint devices, must not be greater than 15 % of the average side length of the test piece.

The test piece must be centred in the test frame; the width, *a*, of the constraining area must be measured along the centreline of each side of the frame.

All the perimeter nets of the test piece are fixed to the frame by means of the constraining devices (e.g. shackles, connecting links, steel ropes or other methods agreed between the testing laboratory and the party requesting the test, and in line with the structural characteristics of the piece to be tested; however, the means of constraint must not interfere with the structural behaviour of the test piece of a size suitable to obtain the planarity of the test piece before starting the test) by using either specific devices (e.g. screw tensioners) or frames with variable shapes.

The reference plane is defined by the four sides of the frame.

Before starting the test, the test piece must be tensioned until it reaches a condition of “planarity”, which is considered to have been reached when the maximum sag at the centre is less than 20 % of the smallest side length of the test piece.



Key

a constraining area < 0,15 × *L*

b <0,2 × *L* [m]

L 3,0 ± 0,2 × 3,0 [m]

1 net test piece

2 tensioning devices

3 rigid frame

Figure B.2 — Section of the frame containing the net test piece and definition of the level conditions

B.2 Measurements and observations

The origin of the load-movement diagram is measured from the plane holding the panel constraining devices.

The following measurements must be taken continuously during the test:

— force exercised by the press;

— movement of the press relative to the reference plane.

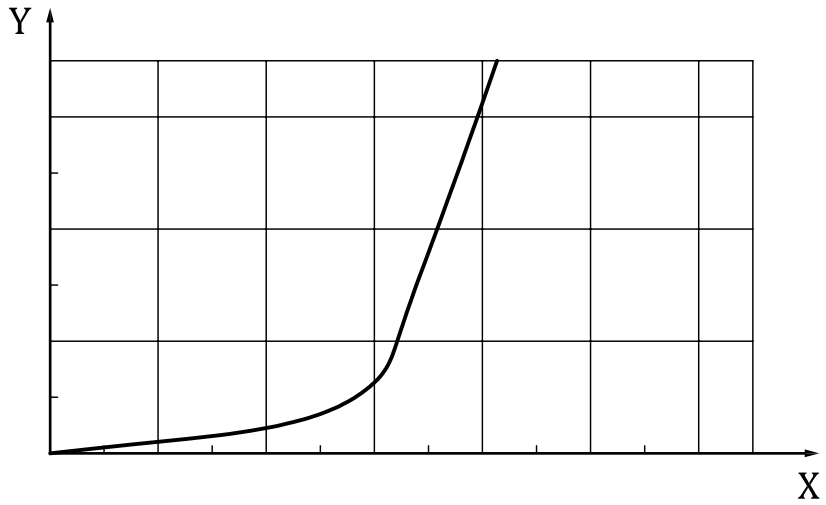
The force must be measured by class 1 load cells, in accordance with ISO 376.

These measurements must allow the curve characterized by the following parameters to be obtained:

— PBR maximum value of the force reached at failure of the test piece. If failure is not reached, this must be declared;

— BR movement corresponding to actual failure load reached.

The load-movement curve measured at the centre of the press must be provided for each product, example of graph shown in Figure B.3.



Key

X deformation at the centre, measured perpendicularly to the test piece

Y load

Figure B.3 — Example of load-movement curve

B.3 Test report

The test report must provide the following information: accurate description of test piece (construction materials and relative strengths, construction characteristics, geometrical characteristics of net, technological details, etc.), supplied by the party requesting the test:

a) nominal dimensions of test piece and actual dimensions under test conditions;

b) description of instrumentation used and temperature during test;

c) detailed description of the test piece constraining condition, complete with photographic documentation;

d) maximum sag b reached at the start of the test in those cases in which it may be measured;

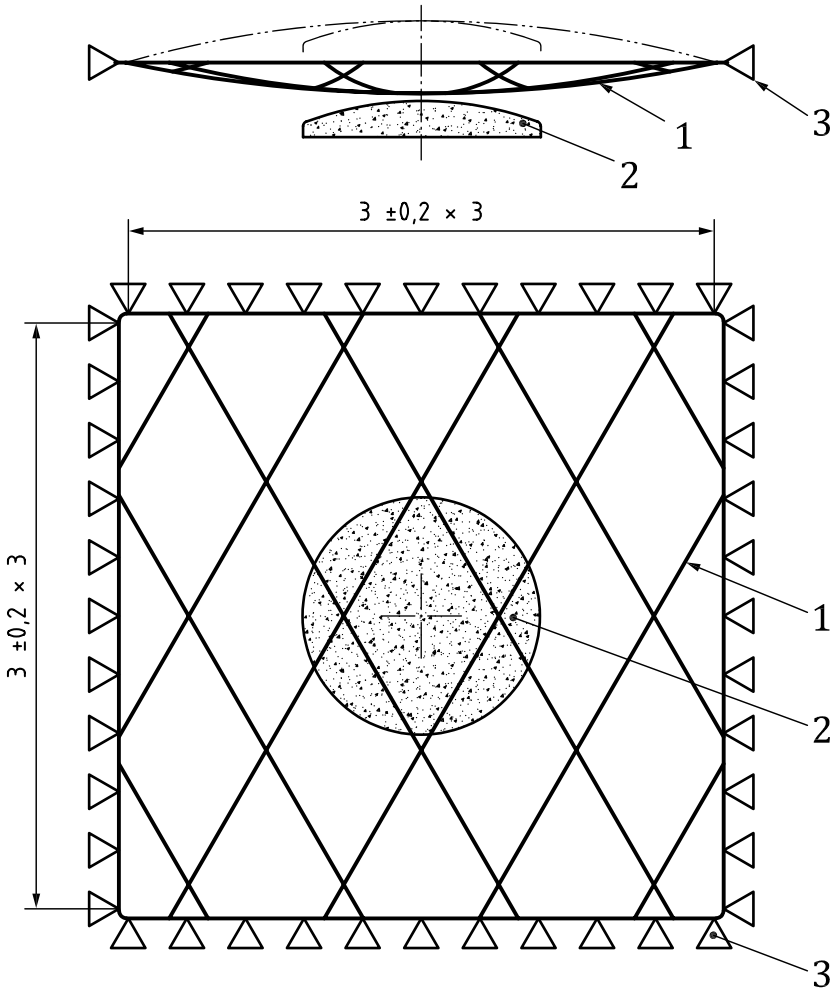
e) average dimension a of the constraining area on the four sides;

f) general description of the failure mode;

g) actual failure load and relative stoke;

h) load-movement diagram;

i) photographic documentation of the test piece before and after the test.



Key

1 mesh
2 press
3 perimeter constraining device

Figure B.4 — Example of set up for puncturing test

Annex C
(informative)

Net tensile strength (longitudinal tensile test with no lateral contraction)

C.1 Net tensile strength — Test procedures

The wire ring net tensile strength shall be determined according to the following test procedures.

The test determines the actual longitudinal tensile strength and transversal tensile strength and the relative elongation of ring net panel.

For this purpose, a frame made of four steel beams, one of which is free to slide in the direction of the load (longitudinal direction) (see Figure C.1), shall be used.

The specimen shall have a width not less than 1 000 mm and a minimum area of 1,0 m^2. The specimen shall be fixed to the frame by means of lateral coupling devices, such as crickets or turnbuckles. The side coupling device shall be free to slide along the longitudinal beams.

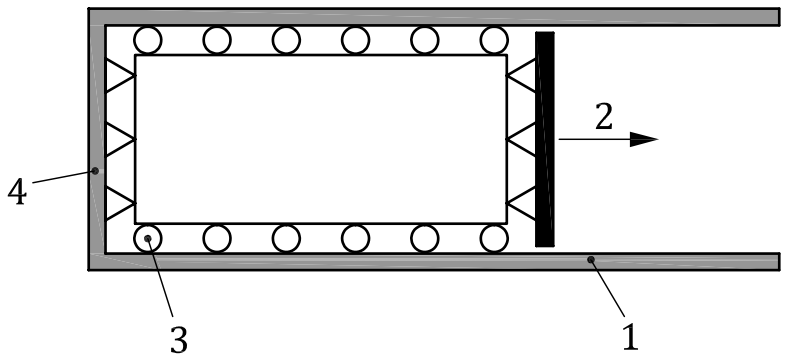
The test frame must be equipped with load cells in order to acquire the load applied and the overall side reaction (longitudinal and transversal reactions).

The net specimen is brought under conditions of flatness by means of coupling devices without altering the geometry of the net in unload conditions.

The rate of longitudinal elongation during the test shall be between 6 mm/min and 10 mm/min.

The test end when the specimen broken load or the maximum applicable load is reached.

The specimen broken load is reached when the specimen is no longer able to support any increase of the applied force. It is also allowed to perform the test without reaching the rupture of the test, in which case, the tensile strength corresponds to the maximum load reached during the test.



Key

1 fixed frame
2 movable beam
3 lateral constraint
4 side connection device

Figure C.1 — Example of frame configuration

C.2 Measurements and observations

During the test, the following shall be recorded in a continuous way:

— longitudinal load applied the side reaction (transversal);

— displacement of the movable beam.

C.3 Test report

The test report must contain a full description of the specimen (the base materials and their strengths, construction details, geometric characteristics of the mesh, technological details, etc.) by the applicant for the test and report the following information for each direction of test:

a) description of the failure modes;

b) longitudinal strength vs. displacement of movable beam diagram and side reaction vs. displacement of movable beam diagram;

c) breaking load, side reaction at breaking load, displacement of movable beam at breaking load;

d) photographic documentation of the specimen before and after the test, in which shall be shown the connections to the frame.

Annex D
(informative)

Methods for measuring the dimensions of a ring net panel

Several methods exist for measuring the dimensions of a panel.

One example is described below:

— Put the panel on a horizontal surface;

— stretch the panel manually;

— move the rings so as to have, as much as possible, a regular alignment of the contact points between rings;

— measure the length several (at least three) times in metres and calculate the mean value;

— measure the width several (at least three) times in metres and calculate the mean value;

— the mean length and the mean width are considered as the dimensions of the panel.

See Figure D.1

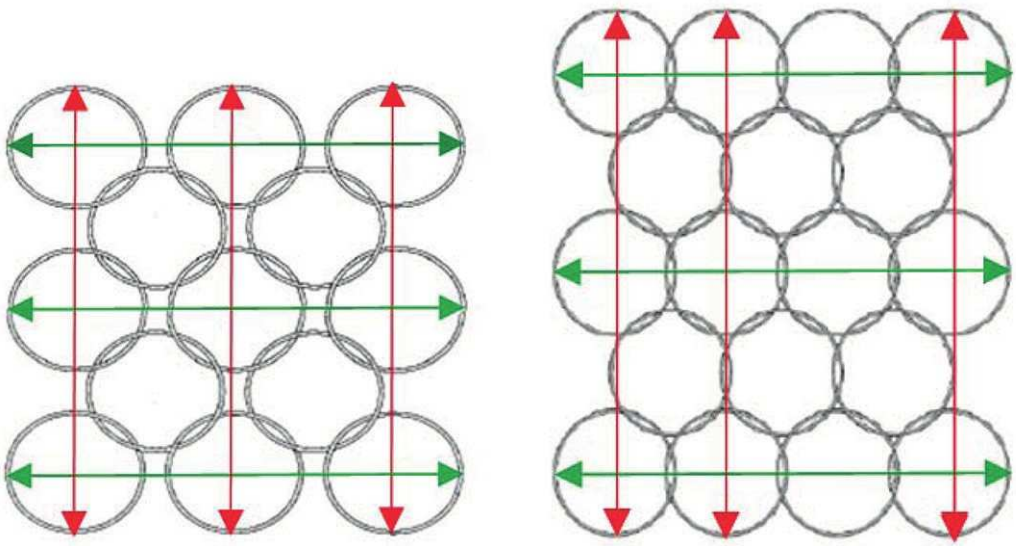


Figure D.1 — Measurement of length and width

Example:

Length = 1,50 m or 5 rings

Width = 1,50 m or 5 rings

Example:

Length = 1,60 m or 4 rings

Width = 1,80 m or 5 rings

Bibliography

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