EAD **200019-01-0102**

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European Assessment Document for

Hexagonal woven mesh gabions, mattresses and sack gabions

This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

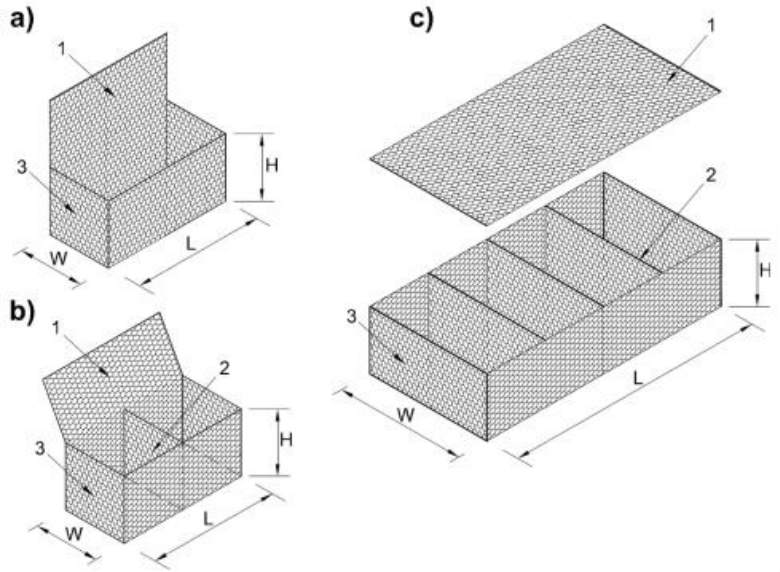
This EAD covers hexagonal woven mesh gabion boxes, mattresses and sack gabions (hereinafter referred to as “gabions, mattresses and sack gabions”).

A gabion is a double-twisted wire mesh container of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the site to form flexible, permeable, monolithic structures (see Figure 1.1.1a, Figure 1.1.1b and Figure 1.1.1c).

A mattress (Figure 1.1.2) is a double-twisted wire mesh container uniformly partitioned into internal cells with relatively small height in relation to other dimensions, having generally smaller mesh size than the mesh used for gabions. They are as well filled with stone at the site.

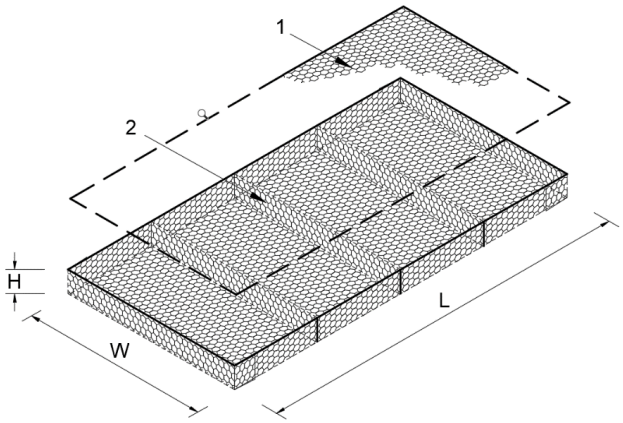
A sack gabion is a double-twisted wire mesh cylindrical container of variable sizes that can be filled with stone at the site (see Figure 1.1.3).

The filling material is not covered by this EAD.



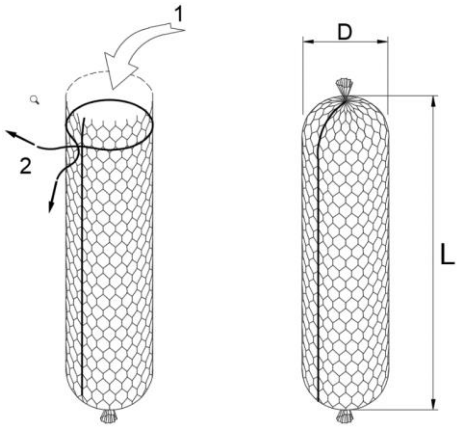
Key: 1 lid; 2 diaphragms; 3 end panels; H height; L length; W width

Figure 1.1.1 – Gabion without diaphragm (a), and with diaphragms (b) and (c)



Key:1 lid; 2 diaphragms; H height; L length; W width

Figure 1.1.2 – Mattress



Key:1 filling; 2 lacing wire; D diameter; L length

Figure 1.1.3 – Sack gabion

Gabions, mattresses and sack gabions are produced from double-twisted Zinc/Aluminium (Zn/Al) alloy (including advanced coating, as defined clause 1.3.10) coated steel wire mesh and Zinc/Aluminium (Zn/Al) alloy coated steel wire or stainless-steel or both wire for mesh wire, selvedge and edge wire, lacing wire, stiffeners and connectors used for manufacturing, assembling and installation of the product.

This EAD also covers gabions, mattresses and sack gabions in which the wire mesh, lacing wire, and stiffeners are polyvinyl chloride (PVC), polyethylene (PE), polyester (PET) or polyamide (PA6) coated after the Zn/Al alloy coating.

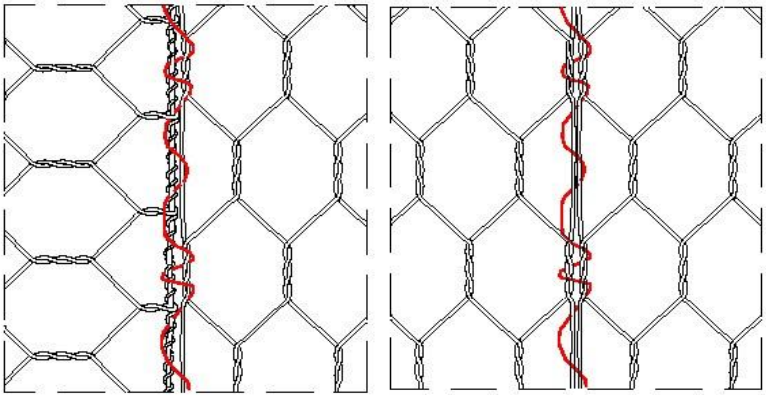


Figure 1.1.4 – Connection using lacing wire

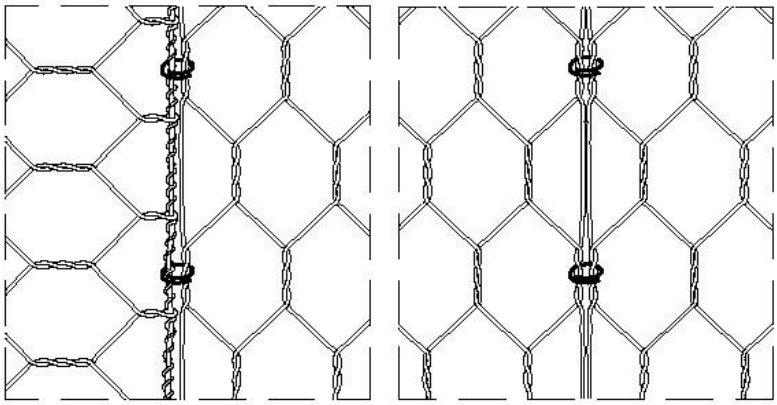


Figure 1.1.5 – Connection using C-rings

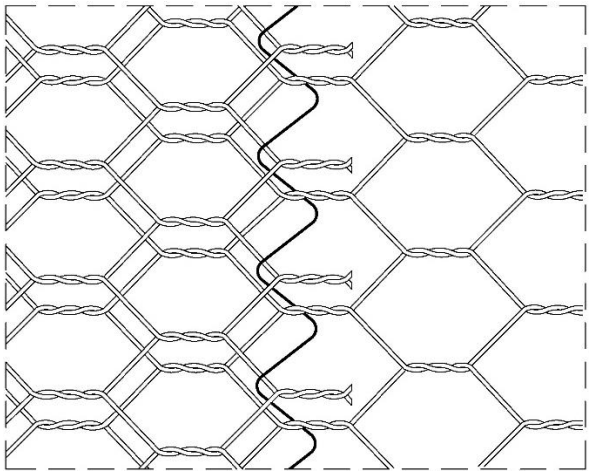


Figure 1.1.6 – Example of connection of diaphragms using spirals

Mesh size of double twisted mesh is defined in clause 1.3.2 the mesh designation is defined in clause 1.3.3 and steel wire diameter defined in clause 1.3.11.

For connection of lid, bottom and intermediate diaphragms of the gabion (or mattresses) during manufacturing or installation the following options can be used:

1) By hand employing lacing wire. The diameter of lacing wire shall be the same or thinner than the wire from which the mesh is woven (Figure 1.1.4).

2) By spirals only in case of connection of internal diaphragms (Figure 1.1.6). The ends of spiral are bent to prevent its removal.

3) With C-rings (or clips or similar connectors) employing hand or pneumatic stapler. The units to be connected are put tightly together so that the edge wires are in contact and the C-rings (clips) are placed by such a way they encircle the edge wires of adjacent gabions, mattresses and sack gabions. The maximum distance between the rings is 200 mm, see Figure 1.1.5.

The product is not fully covered by EAD 200019-00-0102. Compared to the previous version of the EAD, the following changes (new essential characteristics) are introduced:

BWR1

- Resistance to abrasion of organic coating on wire,
- Shear stress in hydraulic applications of gabions and mattresses,
- Mesh punching load and mesh punching displacement of gabions, mattresses and sack gabions,
- Unconfined compression strength for gabion elements and unconfined compression displacement for gabion elements,
- Flexural integrity of gabion elements.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations, e.g., with regard to the intended end use conditions, having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA as long as the details of the assessment methods as laid down in this EAD are respected.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

Gabions and mattresses made of hexagonal double twisted wire mesh are intended to be used for:

- earth retention structures,
- gravity retaining walls,
- sea walls;
- construction of weirs;
- soil reinforcement structures,
- river and canal linings,
- erosion control,
- architectural claddings,
- free-standing walls.

Sack gabions made of hexagonal double twisted wire mesh are intended to be used for:

- river and seabed levelling without anti-erosion function.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of gabions, mattresses and sack gabions for the intended use of:

A) in accordance with Annex 1, EN 10223-3[1], in relation to different wire coating and corrosive categories of environment (in accordance with EN ISO 9223):

a) in case of Zn95/Al5 alloy coating without organic coating products

- when tested in accordance with 2.2.11.1 and the minimum number of cycles of discontinuous exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 28 cycles and
- when tested in accordance with 2.2.11.2 and the minimum number of hours of exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 1000 hours
    - at least 50 years for corrosivity category C2
    - 25 years for corrosivity category C3
    - 10 years for corrosivity category C4

b) in case of Zn95/Al5 alloy coating with organic coating products

- when tested in accordance with 2.2.11.1 and the minimum number of cycles of discontinuous exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 28 cycles and
- when tested in accordance with 2.2.11.2 and the minimum number of hours of exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 1000 hours
- when tested in accordance with 2.2.11.3 and the mean relationship of initial and retained tensile strength and elongation of the polymer is not more than 25%.
    - at least 120 years for corrosivity category C3
    - 120 years for corrosivity categories C4 and C5

c) in case of Zn90/Al10 alloy coating and advanced metallic coating without organic coating products

- when tested in accordance with 2.2.11.1 and the minimum number of cycles of discontinuous exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 56 cycles and
- when tested in accordance with 2.2.11.2 and the minimum number of hours of exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 2000 hours.
    - at least 120 years for corrosivity category C2
    - at least 50 years for corrosivity category C3
    - 25 years for corrosivity category C4

d) in case of Zn90/Al10 alloy coating and advanced metallic coating with organic coating products

- when tested in accordance with 2.2.11.1 and the minimum number of cycles of discontinuous exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 56 cycles and
- when tested in accordance with 2.2.11.2 the minimum number of hours of exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) is 2000 hours and
- when tested in accordance with 2.2.11.3 the mean relationship of initial and retained tensile strength and elongation of the polymer is not more than 25%.
    - at least 120 years for corrosivity categories C3, C4, C5 and CX;

[1] All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

B) 25 years for corrosivity category C1 and C2 and 10 years for corrosivity category C3 (for corrosivity category see EN ISO 9223) when durability tests are not performed or when are performed in accordance with all clauses 2.2.11.1, 2.2.11.2 and 2.2.11.3 in this EAD for less number of cycles or less number of hours of exposure or a greater change in retained tensile strength and elongation of organic coating material than those described in section A[2].

when installed in the works.

These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[3].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

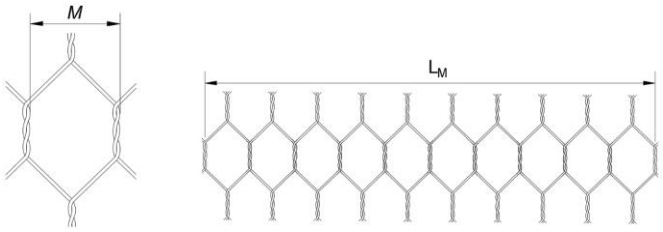
1.3 Specific terms used in this EAD

1.3.1 Double-twisted wire mesh

A mesh made by twisting continuous pairs of wires through three one-half turns (commonly called double-twisted) to form hexagonal-shaped openings which are then interconnected to adjacent wires to form hexagonal openings. Wires can be interwoven into the hexagonal double twisted mesh in equal distances orthogonally to the axis of twist when applied for front and back faces of gabions.

1.3.2 Mesh size of double twisted mesh

A distance measured at right angles between two twisted sides M (see Figure 1.3.2.1).



Key: M = L_M/10: mean value between two twisted sides of mesh after measuring the length L_M of 10 adjacent meshes in one row

Figure 1.3.2.1 – Mesh size

1.3.3 Mesh designation

Designation of double twisted mesh type related to mesh size M in line with Table 2, EN 10223-3, for example “6×8”, “8×10”.

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2 Working life of the gabions, mattresses and sack gabions made of stainless steel is not determined by subsequent protective treatments, but by the initial selection of materials (stainless steel grade), the design process, the fabrication procedures, and by their suitability for the environmental conditions in accordance with Annex A, EN 1993-1-4.

3 The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

1.3.4 Lacing wire

For gabions, mattresses and sack gabions is a steel wire used to assemble and interconnect empty units, to close and secure units filled with stone as a replacement for spiral binders or rings and also used as bracing tie to prevent face deformation.

1.3.5 C-rings, clips and similar connectors

Rings of C-shape, clips and similar connectors made from high strength steel wire, used to assemble and interconnect the gabions, mattresses and sack gabions and to close and secure the units filled with stone.

1.3.6 Stiffener/bracing tie

A length of wire used to support the facing by forming a diagonal brace across the corners of a gabion cell, or by forming a transversal brace connecting facing and rear of gabion cell. For mattresses, alternatively, a preformed wire connecting the lid and the bottom vertically.

1.3.7 Diaphragm

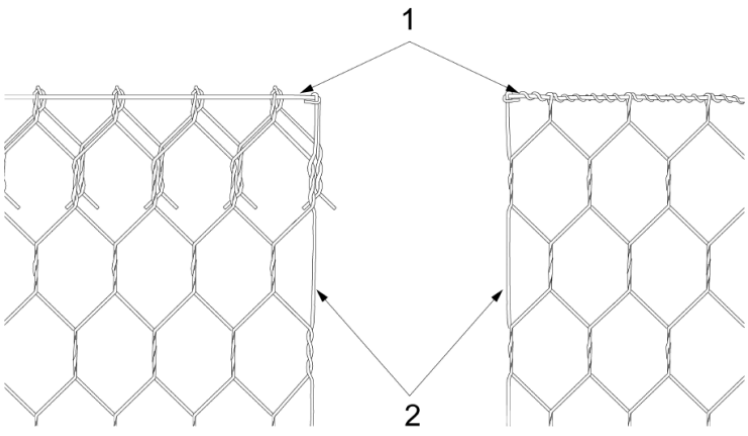
Hexagonal double twisted wire mesh panel made of similar mesh as the gabion/mattress itself, connected to the back, front, lid and base panels to stabilize and ensure the position and the shape of gabion/mattress.

1.3.8 Selvedge wire

A terminal wire used to edge the wire mesh perpendicular to the double twist by mechanically wrapping the mesh wires around it at least 2,5 times or by inserting it throughout the twists and folding one mesh length (see Figure 1.3.9.1).

1.3.9 Edge wire

A terminal wire used to edge the wire mesh parallel to the double twist direction by continuously weaving it into the wire mesh (see Figure 1.3.9.1).



Key: 1 selvedge wire; 2 edge wire

Figure 1.3.9.1 – End adjustment of mesh

1.3.10 Advanced coating

The advanced metallic coating is in accordance with clause 3, ISO 7989-2.

1.3.11 Wire diameter

Dimension of wire (diameter and related class of tolerance) used as mesh wire, connection wires, selvedge and edge wires, is defined in EN 10218-2.

1.3.12 Symbols

δ_c Mean unconfined compression displacement of the specimen

$\delta_{c,m}$ Unconfined compression displacement mean declared value

δ_m Mesh punching deflection

δ_{V0} Vertical displacement measured with displacement transducers

$\delta_{Vn,max}$ Maximum vertical displacement of the specimen

ε Wire elongation

γ Specific weight of water

σ_{cv} Vertical stress

$\sigma_{cv,m}$ Unconfined compression strength mean declared value

$\sigma_{cv,max}$ Unconfined compression strength of the specimen

τ Shear stress resistance in hydraulic applications

τ_{max} Maximum shear stress resistance in hydraulic applications

A Specimen mass

A_s Effective horizontal cross section area

B Stone unit weight

C Volume of the specimen

C_u Uniformity coefficient

D Diameter of sack gabions

DBR Dark brown red rust

d_c Wire diameter

D_n Particle size in % by weight

D_s Total volume of stones

d_v Water surface elevation

F_{gv} Vertical force

$F_{gv,max}$ Maximum vertical compression force of the specimen

F_k C-ring (or similar connector) characteristic resistance to opening

F_m Mesh punching load

H Height of products

h	Height of the flume top respect to the flume base
L	Length of products
l	Cut off length of wire mm
L_f	Length of the flume
L_M	Mesh size measured on 10 meshes adjacent in one row repetition
Lp	Side length of the specimen subject to punching load test
M	Mesh size
N_a	Minimum average number of cycles per wire specimen in test of resistance to abrasion
N_{am}	Average number of cycles in test of resistance to abrasion
p_m	Tensile resistance of mesh
R	Radius of the punching device
R_m	Wire tensile strength
S_0	Longitudinal flume slope inclination
V_n	Vertical displacement transducers
W	Width of gabions and mattresses

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of gabions, mattresses and sack gabions is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the gabions, mattresses and sack gabions and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Wire tensile strength and elongation	2.2.1	Level: R_m (N/mm^2), ε (%)
2	Tensile resistance of mesh of gabions, mattresses and sack gabions	2.2.2	Level: p_m (kN/m)
3	C-ring (or similar connector) characteristic resistance to opening for gabions, mattresses and sack gabions	2.2.3	Level: F_k (kN)
4	Shear stress resistance in hydraulic applications of gabions and mattresses	2.2.4	Level: τ_{max} (N/m^2) and description
5	Mesh punching load and deflection of gabions, mattresses and sack gabions	2.2.5	Level: F_m (kN), δ_m (mm)
6	Unconfined compression strength and displacement of gabions	2.2.6	Level: $\sigma_{cv,m}$ (kPa), $\delta_{c,m}$ (mm) and description
7	Flexural Integrity of gabions	2.2.7	Description
Basic Works Requirement 3: Hygiene, health and the environment			
8	Content, emission and/or release of dangerous substances - leachable substances	2.2.8	 Description
Aspects of durability			
9	Corrosion protection: Zinc/Aluminium (Zn/Al) alloy coating: - type and class of coating mass	2.2.9	 Description
10	Corrosion protection: additional corrosion protection of gabions, mattresses and sack gabions made of wire with organic coating: Organic coating on wire: type - organic coated wire diameter and - coating concentricity Organic coating on wire: - resistance to abrasion Organic coating in double twist region of mesh: - coating integrity	2.2.10	 Description Level (mm) Level (%) Level (N_{am}) Description
11	Durability in artificial atmospheres (gabions, mattresses and sack gabions): - sulphur dioxide - neutral salt spray - UV resistance of organic coating Durability of stainless steel	2.2.11	Level number of cycles with surface DBR < 5% (number) exposure time with surface DBR > 5% (hours) % of retained tensile strength and elongation (%) Description

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer, and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant essential characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

2.2.1 Wire tensile strength and elongation

Assessment method

The tensile strength R_m (N/mm^2) and elongation ε (%) of wire mesh and connection components` wires and selvedge and end wires shall be assessed and evaluated in accordance with clause 3, EN 10218-1. The assessment shall be carried out by tensile tests on at least three wire specimens per diameter. Each used wire diameter shall be assessed.

Expression of results

The tensile strength R_m (N/mm^2) and elongation ε (%) of wire mesh and connection components` wires and selvedge and edge wires shall be given in the ETA.

2.2.2 Tensile resistance of mesh of gabions, mattresses and sack gabions

Assessment method

The mechanical resistance of double twisted wire mesh is determined by mean value of tensile strength p_m (in kN/m) and its tolerances corresponding to 95% level of confidence of mesh in the direction parallel with the axis of twist obtained from at least three tests performed in accordance with clause 9.3, EN 10223-3 on specimens with the same mesh designation/mesh wire diameter configuration. The coating type on wire can be neglected.

Expression of results

For mesh designation/mesh wire diameter configuration the mean value of tensile strength p_m (in kN/m) and its tolerances shall be given in ETA.

2.2.3 C-ring (or similar connector) resistance to opening for gabions, mattresses and sack gabions

Assessment method

The characteristic resistance to opening of C-ring (or similar connector) shall be assessed in accordance with clause 2.2.2, EAD 200086-00-0602.

Expression of results

The characteristic resistance to opening F_k (in kN) of C-ring (or similar connector) shall be given in the ETA. The type of connector shall be given in the ETA.

2.2.4 Shear stress resistance in hydraulic applications of gabions and mattresses

Purpose of the assessment

The purpose of the test procedure is to provide an assessment of the erosion protection capacity of gabion and mattress linings along rivers and canals. The laboratory test reproduces artificial hydraulic conditions capable of simulating the real shear stress generated by the natural flow of water along rivers or artificial canals or both.

The purpose of test procedure and assessment is to provide the limit of performance in terms of maximum shear stress (τ_{max}) assessed without either mechanical failure and without excessive soil loss underneath the lining.

Assessment method

The assessment and test shall be carried out in accordance with the procedure described in Annex A. For assessment of tested type of gabion or mattress or both one test on test specimen shall be performed. When the tests are performed on gabions or mattresses or both with different heights, interpolation is permitted to evaluate the permissible shear stress values of gabions or mattresses or both with intermediate heights. The intermediate height shall be limited between the tested heights.

Expression of results

For the assessed gabion or mattress or both the value of maximum shear stress (τ_{max}) shall be given in ETA. The type of the reference filling stones (with reference to unit weight, D_{50} and size gradation C_u) in accordance with clause A.2, Annex A used in the test shall be indicated in the ETA. The non-woven geotextile parameters (with reference to mass per unit area, tensile strength and permeability normal to the plane in accordance with Table A.1.2, Annex A) shall be indicated in the ETA.

2.2.5 Mesh punching load and deflection of gabions, mattresses and sack gabions

Purpose of the assessment

The assessment establishes the ability of gabions, mattresses and sack gabions to hold confined rock. The applied load orthogonally to the plane of wire mesh in test represents the force acting on the products when installed in works.

Assessment method

The punching load F_m (in kN) and the deflection δ_m (in mm) are defined as the mean value punching load and mean value of deflection and their tolerances corresponding to 95% level of confidence obtained from at least three tests performed in accordance with Annex B on specimens with the same mesh designation/mesh wire diameter configuration. The coating type on wire can be neglected.

Expression of results

For mesh designation/mesh wire diameter configuration the mean value of punching load F_m (in kN) and the mean value of deflection δ_m (in mm) and their tolerances shall be given in ETA.

2.2.6 Unconfined compression strength and displacement of gabions

Purpose of the assessment

The purpose of assessment is to provide the performance described by the relationship between vertical displacement and vertical strength of gabion when subject to vertical load in unconfined conditions.

Assessment method

The vertical strength $\sigma_{cv,m}$ (kPa) and the related vertical displacement $\delta_{c,m}$ (mm) are defined as the mean value of the maximum vertical strength ($\sigma_{cv,max}$) and mean value of vertical displacements (δ_c) and their tolerances corresponding to 95% level of confidence obtained from at least three tests performed in

accordance with Annex C on specimens with the same mesh designation/mesh wire diameter and mesh orientation configuration. The coating type on wire can be neglected.

Expression of results

For the assessed mesh designation/mesh wire diameter mesh and mesh orientation configuration, the mean value of vertical strength $\sigma_{cv,m}$ (kPa) and the mean value of vertical displacement $\delta_{c,m}$ (mm) and their tolerances shall be given in ETA.

The type of the reference filling stones (with reference to unit weight and peak compressive strength) in accordance with clause C.2, Annex C used in the test, shall be indicated in the ETA.

2.2.7 Flexural integrity of gabions

Purpose of the assessment

The purpose of assessment is to provide an indication of the ability of gabion to be resilient without structural failure (or collapse) in case of unpredicted or accidental event and to withstand high deformation without rupture in wires and along the connection lines.

Assessment method

The assessment and test methods shall be carried out in accordance with the procedure described in Annex D. For assessment of given type of gabion product (mesh designation/mesh wire diameter configuration) one test on test specimen in accordance with clause D.1, Annex D shall be performed. The coating type on wire can be neglected.

Expression of results

For the assessed mesh designation/mesh wire diameter and mesh orientation configuration, the number of wire ruptures and the number of failed connections (joints) recorded after the test shall be given in ETA. The type of the reference filling stones (with reference to unit weight, D_{50} and peak compressive strength) in accordance with clause D.2, Annex D used in the test shall be indicated in the ETA.

2.2.8 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer[4] after identifying the release scenarios taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The identified intended release scenarios for this product and intended use with respect to dangerous substances are:

S/W1: Product with direct contact to soil, ground- and surface water.

The leaching of dangerous substances therefore shall be assessed.

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[4] The manufacturer may be asked to provide to the TAB the REACH related information which shall accompany the DoP (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **not** obliged to:
- provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous in accordance with Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS, taking into account the installation conditions of the construction product and the release scenarios resulting from there.

Any information provided by the manufacturer regarding the chemical composition of the products is not to be distributed to EOTA to other TABs or beyond.

2.2.8.1 Leachable substances

Assessment method

For the intended use covered by the release scenario S/W1 the performance of the organic coating of wire, if organic coating is used, concerning leachable substances is to be assessed. A leaching test with subsequent eluate analysis must take place, each in duplicate. Leaching tests of the organic coating of wire are conducted in accordance with EN 16637-2. The leachant shall be pH-neutral demineralised water and the ratio of liquid volume to surface area shall be (80 ± 10) l/m².

Each test specimen to be tested shall be prepared by cutting off the piece of finally organic coated wire of length *l* [mm] calculated in accordance with equation:

$$l = \frac{40000}{\pi \times d_c^{\,2}}$$

where l cut off length of organic coated wire in mm

d_c wire diameter with organic coating in mm.

After that, cut off pieces of organic coated wire are wound into a coil of diameter suitable for following preparation of eluates.

In eluates of "6 hours" and "64 days", the following biological tests shall be conducted:

- Acute toxicity test with Daphnia magna Straus in accordance with EN ISO 6341
- Toxicity test with algae in accordance with EN ISO 15799
- Luminescent bacteria test in accordance with EN ISO 11348-1, EN ISO 11348-2 or EN ISO 11348-3

For each biological test, EC20-values shall be determined for dilution ratios 1:2, 1:4, 1:6, 1:8 and 1:16.

If the parameter TOC is higher than 10 mg/l, the following biological tests shall be conducted with the eluates of "6 hours" and "64 days" eluates:

- Biological degradation in accordance with OECD Test Guideline 301, part A, B or E.

Expression of results

Determined toxicity in biological tests shall be expressed as EC20-values for each dilution ratio. Maximum determined biological degradability must be expressed as "…% within …hours/days". The respective test methods for analysis shall be specified.

2.2.9 Corrosion protection: Zinc/Aluminium (Zn/Al) alloy coating: type and class of coating mass

Assessment method

The type of Zinc/Aluminium (Zn/Al) alloy coating and the coating mass on wires (in g/m²) shall be assessed in accordance with clause 5.2.2 of EN 10244-2. The assessment of coating mass shall be carried out by tests on at least three wire specimens of the same diameter. Each used wire diameter shall be assessed.

Expression of results

The description of type of Zinc/Aluminium (Zn/Al) alloy coating and the description of class of coating mass on wires (in g/m²) in accordance with EN 10244-2 shall be given in the ETA.

2.2.10 Corrosion protection: additional corrosion protection of gabions, mattresses and sack gabions made of wire with organic coating

2.2.10.1 Organic coating on wire: type, organic coated wire diameter and concentricity

Assessment method

The type, diameter (in mm) and minimum coating thickness of organic coated wires together with concentricity (in %) shall be assessed in accordance with clause 5.3.4.2, EN 10245-1. The assessment shall be carried out by measurements on at least three wire specimens of the same wire diameter and coating type. At least three representatives of used wire diameters and at least two types of used organic coatings shall be assessed.

Expression of results

The description of type and coating thickness and concentricity of organic coating on wire shall be given in the ETA.

2.2.10.2 Organic coating on wire: resistance to abrasion

Purpose of the assessment

The purpose of the assessment is to obtain the resistance to abrasion expressed by minimum average value of number of cycles (N_{am}). This number represents the resistance of the organic coated steel wire to abrasion caused by cyclic linear rubbing action until the organic coating is worn through to the metal wire.

Assessment method

The resistance is obtained from three tested wire specimens with the same organic coating type, steel wire diameter and coating thickness. Each of the three tested wire specimens is subject to four test runs. and for each wire specimen the result is calculated as the average of the 4 tests performed.

The resistance to abrasion is defined as the minimum average value (N_{am}) of numbers of cycles in accordance with test method described in Annex E. The tests shall be performed for each organic coating type, steel wire diameter and coating thickness.

Expression of results

For the assessed organic coating type, steel wire diameter and coating thickness, as resistance to abrasion, the minimum average value of number of cycles shall be given in ETA.

2.2.10.3 Organic coating in double twist region of mesh: coating integrity

Assessment method

Coating integrity in double twist region of mesh tested in accordance with Annex F shall be assessed when the mesh specimen is subject to a load equal to the 50 % of the mean value of tensile strength of the mesh as defined in clause 2.2.2. At least one specimen of mesh designation/mesh wire diameter and organic coating type and thickness configuration shall be tested in accordance with Annex F.

Expression of results

For the assessed mesh designation/ mesh wire diameter and organic coating type and thickness configuration, in accordance with the obtained observation, the following statement shall be given in ETA, as relevant:

a) Absence of wires with visible cracks (no visible underlying steel wire) in organic coating within the double twist region;

or

b) Presence of wires with visible cracks (visible underlying steel wire) in organic coating within the double twist region.

2.2.11 Durability in artificial atmospheres

2.2.11.1 Sulphur dioxide

Assessment method

Sulphur dioxide test with discontinuous exposure on mesh specimens (at least one specimen for each mesh designation, wire diameter, type and class of Zn/Al coating in case of product without organic coating: at least one specimen for each mesh designation, type and class of Zn/Al coating and type of additional organic coating of products with organic coating) shall be carried out in accordance with clause 6.7.1 and clause 6.7.2, EN 10223-3.

For Zinc/Aluminium (Zn/Al) and organic coated mesh specimens the permeated rust shall be evaluated without removing the organic coating.

Expression of results

For Zinc/Aluminium (Zn/Al) alloy and Zinc/Aluminium alloy (Zn/Al) and organic coating or equivalent advanced metallic coated mesh specimens, the number of cycles of discontinuous exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) shall be given in ETA.

2.2.11.2 Neutral salt spray

Assessment method

Neutral salt spray (NSS) test on mesh specimens (at least one specimen for each mesh designation, wire diameter, type and class of Zn/Al coating in case of product without organic coating: at least one specimen for each mesh designation, type and class of Zn/Al coating and type of additional organic coating of products with organic coating) shall be carried out in accordance with clause 6.7.1 and clause 6.7.2, EN 10223-3.

For Zinc/Aluminium (Zn/Al) and organic coated mesh specimens the permeated rust shall be evaluated without removing the organic coating.

Expression of results

For Zinc/Aluminium (Zn/Al) alloy and Zinc/Aluminium alloy (Zn/Al) and organic coating or equivalent advanced metallic coated mesh specimens, the number of hours of exposure after which each mesh specimen does not show more than 5 % of DBR (Dark Brown Rust) shall be given in ETA.

2.2.11.3 UV resistance tests on organic coating material

Assessment method

The raw organic material durability shall be assessed by method of exposition in accordance with clause 6.7.3, EN 10223-3. The mean value of ratios (mean ratio) between initial and retained tensile strengths and elongations (%) shall be calculated using the ratios from at least three specimens tested before and after exposure The tensile strength and elongation before and after the exposure shall be tested and assessed in accordance with EN ISO 527-2.

Expression of results

The mean ratio of initial and retained tensile strength and elongation in % shall be given in ETA.

2.2.11.4 Durability of stainless steel

Assessment method

For wire of mesh of gabions, mattresses and sack gabions and for connection components made of stainless steel, the grade of stainless steel shall be assessed in accordance with Annex A, EN 1993-1-4 if the steel grade is suitable for the atmospheric application for which the product is intended to be used in and with respect to the intended working life.

Expression of results

The grade of stainless steel of wire of mesh and connection components in accordance with EN 10088-1 shall be given in ETA.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD, the applicable European legal act is: Commission Decision 98/214/EC as amended by Commission Decision 2001/596/EC.

The system is 2+.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
Manufacturer`s production					
1	**Product:** Mesh dimensions, mesh size Product dimensions Connection component dimensions Tensile resistance of mesh Characteristic resistance to opening of connection components Resistance to abrasion Coating integrity Sulphur dioxide test Neutral salt spray test UV resistance	. Control plan Control plan Control plan 2.2.2 2.2.3 2.2.10.2 2.2.10.3 2.2.11.1 2.2.11.2 2.2.11.3	Control Plan	1 sample / type 1 sample / type 1 sample / type 3 samples / type 5 samples / type 3 sample / organic coating type and thickness 1 sample / type 1 sample / mesh designation/wire diameter 1 sample / mesh designation/ wire diameter control plan	1 / day 1 / day 1 / day 2 / year 1 / year 1 / year 1 / year 1 / 2 years 1 / 2 years 1 / 2 years
Incoming product					
2	**Wire chemical composition:** For each component	Control plan	Control plan	Checking the inspection certificate of supplier, type 3.1, EN 10204	Every shipment
3	**Metallic coated wire:** Outer diameter Adhesion Visual Coating mass	Control plan Control plan Control plan Control plan Control plan		Checking the inspection certificate of supplier, type 3.1 EN 10204 In addition, test 1 / each diameter	Every shipment 1 / day
4	**Organic coated wire (also if produced by the manufacturer):** Outer diameter Visual Thickness/concentricity	a) Control plan b) Tested and measured when produced by the manufacturer Control plan Control plan 2.2.10.1		a) Checking the inspection certificate of supplier, type 3.1, EN 10204, in addition, test 1 / each diameter b) 1 sample / type / thickness	Every shipment Every shipment 1 / day
5	**Wire mechanical characteristics:** Tensile strength	2.2.1		Checking the inspection certificate of supplier, type 3.1, EN 10204, In addition, test 1 / each diameter	Every shipment 2 / year

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for gabions, mattresses and sack gabions are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the "gabions, mattresses and sack gabions“	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	Control plan	Control plan	When starting the production or a new line
Continuing surveillance, assessment and evaluation of factory production control					
2	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the incoming products, to the process and to the product as indicated in Table 3.2.1	Control plan	Control plan	1/year

4 REFERENCE DOCUMENTS

EAD 200019-00-0102	Hexagonal Woven Mesh Gabion Boxes and Mattresses
EAD 200086-00-0602	Wire Ring Connection Products
EN 933-1:2012	Tests for geometrical properties of aggregates. Part 1: Determination of particle size distribution. Sieving method
EN 10088-1:2023	Stainless steels - Part 1: List of stainless steels
EN 10204:2004	Metallic products. Types of inspection documents
EN 10218-1:2012	Steel wire and wire products. General. Part 1: Test methods
EN 10218-2:2012	Steel wire and wire products. General. Part 2: Wire dimensions and tolerances
EN 10223-3:2013	Steel wire and wire products for fencing and netting - Part 3: Hexagonal steel wire mesh products for civil engineering purposes
EN 10244-2:2023	Steel wire and wire products. Non-ferrous metallic coatings on steel wire - Part 2: Zinc or zinc alloy coatings
EN 10245-1:2011	Steel wire and wire products. Organic coatings on steel wire. Part 1: General rules
EN 10245-2:2011	Steel wire and wire products. Organic coatings on steel wire. Part 2: PVC finished wire
EN 10245-3:2011	Steel wire and wire products. Organic coatings on steel wire. Part 3: PE coated wire
EN 10245-5:2011	Steel wire and wire products. Organic coatings on steel wire. Part 5: Polyamide coated wire
EN 13383-2:2019	Armourstone. Part 2: Test methods
EN 16637-2:2023	Construction products: Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test
EN 1926:2006	Natural stone test methods. Determination of uniaxial compressive strength
EN 1993-1-4:2025	Eurocode 3: Design of steel structures. Part 1-4: General rules. Supplementary rules for stainless steels
EN 1997-2:2024	Eurocode 7: Geotechnical design. Part 2: Ground investigation and testing
EN ISO 527-2:2012	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics
EN ISO 10319:2015	Geosynthetics. Wide-width tensile test
EN ISO 11058:2019	Geotextiles and geotextile-related products. Determination of water permeability characteristics normal to the plane, without load
EN ISO 11348-1:2008/A1:2018	Water quality. Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test). Part 1: Method using freshly prepared bacteria
EN ISO 11348-2:2008/A1:2018	Water quality. Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test). Part 2: Method using liquid-dried bacteria
EN ISO 11348-3:2008/A1:2018	Water quality. Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test). Part 3: Method using freeze-dried bacteria
EN ISO 17892-12:2018/A2:2022	Geotechnical investigation and testing. Laboratory testing of soil. Part 12: Determination of liquid and plastic limits
EN ISO 6341:2012	Water quality. Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea). Acute toxicity test
EN ISO 9223:2012	Corrosion of metals and alloys. Corrosivity of atmospheres. Classification, determination and estimation
EN ISO 9864:2005	Geosynthetics. Test method for the determination of mass per unit area of geotextiles and geotextile-related products
EN ISO 15799:2022	Soil quality - Guidance on the ecotoxicological characterization of soils and soil materials
ISO 7989-2:2021	Steel wire and wire products. Non-ferrous metallic coatings on steel wire Zinc or zinc-alloy coating

OECD Test Guideline 301:1992	Ready Biodegradability, OECD Guidelines for the Testing of Chemicals

ANNEX A: DETERMINATION OF SHEAR STRESS IN HYDRAULIC APPLICATIONS

The aim of test is to evaluate the hydraulic performance of mattress or gabion or both used for bank protection.

The purpose of the test procedure is to provide an assessment of the erosion protection capacity of mattress or gabion linings along rivers and canals. The erosion protection capacity is assessed as the maximum value of the shear stress (τ_{max}) generated by the water flow that does not generate breakage of the product and that does not generate movement of the particles of the base surface of the test (test standard soil).
The laboratory test reproduces artificial hydraulic conditions capable of simulating the real actions generated by the natural flow of water along rivers and canals. The hydraulic test conditions allow the evaluation of the value of the maximum shear stress (τ_{max}) acting on the product without failure.

A.1 Test set-up

The test shall be carried out generating the test shear stress (τ) on mattresses or gabions installed on an artificial hydraulic flume. The bottom of the flume is covered with layer of soil (standard test soil, see clause A.1.2).The shear stress shall be calculated as:

$$\tau = \gamma * d_v * S_0$$

where

γ specific weight of water (in kN/m^3)

d_v water surface elevation measured from the surface of mattresses or gabions (in m) (Figure A.1.1.1)

S_0 longitudinal slope inclination (h/L_f) which is assumed equal to the flume slope (Figure A.1.1.1)

A.1.1 Test flume

The hydraulic flume shall be characterized by both variable longitudinal slope inclination (S_0) and water discharge capability able to generate a flow with the water surface elevation (d_v).

The minimum width of the flume shall be 0,90 m, defined as a minimum value to ensure that border effects will not disturb/affect the water flow regime. The minimum length of flume (L_f) shall be at least 8 times the flume width to ensure straight and parallel stream lines as close as possible to a uniform water flow. The flume shall be capable to increase the longitudinal inclination from 0 % up to 50 % to allow the repeated tests at different inclinations.

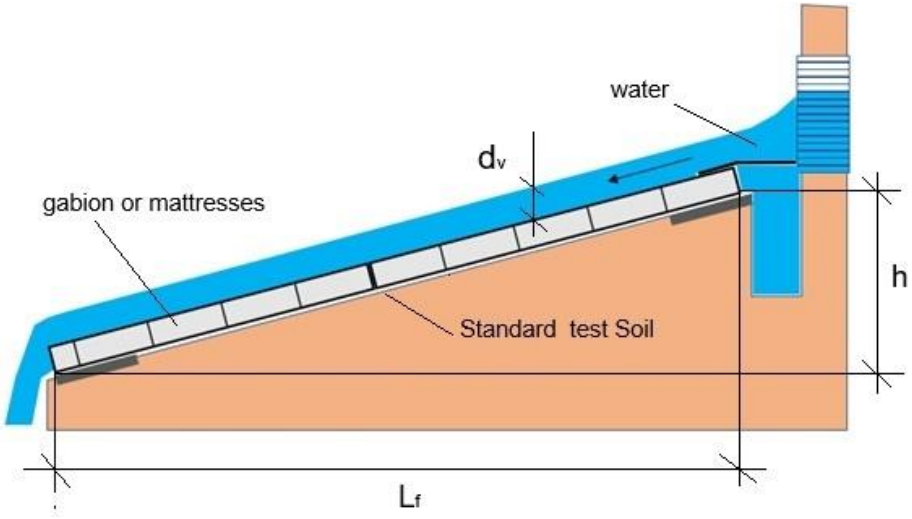

Figure A.1.1.1 – Longitudinal section of hydraulic flume

A.1.2 Standard test soil and geotextile

In order to evaluate the possible soil loss under the mattress or gabion generated by the water shear stress, the bottom of the flume is covered with layer of standard test soil of minimum thickness of 0,30 m that is compacted at 90 +/-3 % Proctor density during the installation. Standard test soil shall be in accordance with particle size and plasticity index as defined in Table A.1.2.1:

Table A.1.2.1 – Standard test soil parameters

	D_n
D_{100}	25 mm > D_{100} > 3,0 mm
D_{65}	4,0 mm > D_{65} > 0,8 mm
D_{50}	0,9 mm > D_{50} > 0,2 mm
D_{15}	0,3 mm > D_{15} > 0,01 mm
Plasticity index	0

D_n is the particle size such that “n” is the percentage by weight of the particles which are smaller than the size "D", in accordance with EN 933-1.

The plasticity index is calculated in accordance with to EN ISO 17892-12, clause 6.5.

Before the installation of the mattress or of gabion, as in the typical construction practice, a non-woven geotextile with parameters range defined in Table A.1.2.2 may be laid on top of the standard test soil layer to simulate the field condition.

Table A.1.2.2 – Non-woven geotextile parameters

Mass per unit area (EN ISO 9864)	from 100 g/m^2 to 200 g/m^2
Tensile strength (EN ISO 10319)	from 5 kN/m to 18 kN/m
Permeability normal to the plane (EN ISO 11058)	from 50 l/m^{2}s to 150 l/m^{2}s

At the beginning and at the end of the flume (transition area, Figure A.1.3.1) on minimum length of 1,0 m rock transition layer of thickness from 20 cm to 30 cm is placed on the top of the standard test soil layer.

A.1.3 Test specimen installation

The width of mattress or gabion to be used in test shall be equal to the width of the flume. The height of the mattress or gabion shall allow the overflow in relation to the maximum water discharge which can be released.

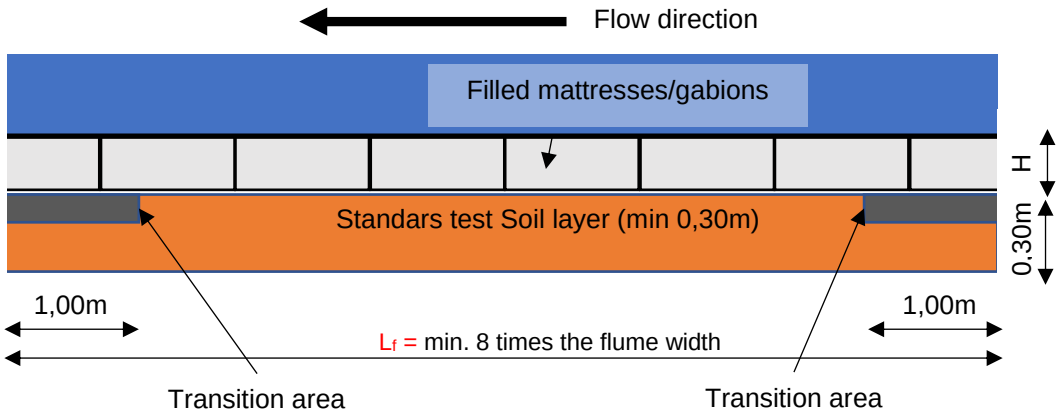

Figure A.1.3.1 – Layers in test

The mattresses or gabion shall be installed in the flume in a suitable manner to avoid any edge effects. The test is performed on mattresses or gabion with declared height H (see Figure 1.1.1, Figure 1.1.2 and Figure A.1.3.1).

When the tests are performed on mattresses or gabions with different heights, interpolation is permitted to evaluate the permissible shear stress values of gabions or mattresses with intermediate heights. The intermediate height shall be limited between tested heights.

Individual test shall be performed for mattresses or gabion when at least one from the following product parameters is different:

- Mesh designation,
- Wire diameter,
- Number and spacing of vertical bracings ties (see clause 1.3.6).

A.2 Reference filling stones

Stone to fill the mattresses or gabion may be any natural deposit of the required sizes, or may be crushed rock produced by any suitable method and by the use of any device that fulfils the required values below:

- D_{50} of the stone (allowable range from 75 mm to 150 mm) in accordance with clause 5, EN 13383-2;
- Unit weight (allowable range from 25 kN/m^3 to 28 kN/m^3) clause 8, EN 13383-2;
- Size gradation C_u (obtained as D_{60}/D_{10} in a range from 1,0 to 1,5).

Evaluation of D_{50} and C_u shall be based on particle size distribution determined in accordance with clause 5, EN 13383-2. Stones shall not disintegrate on exposure to water, otherwise the test is not considered to be valid.

C_u is the uniformity coefficient, and it is defined as the ratio of the sieve size through which 60% (by weight) of the material passes to the sieve size that allows 10% of the material to pass.

A.3 Measurements and evaluation of test result

The longitudinal slope inclination (S_0) shall be measured by survey apparatus.

Standard test soil elevation readings can be sensitive to the diameter of the probe (rod or point gauge assembly) in contact with the ground surface. Thus, the point gauge assembly or survey rod should include an extension rod between 6,4 mm and 9,5 mm in diameter to ensure the contact with the standard test soil surface.

In order to evaluate the shear stress (τ) on the top of the mattress, the water surface elevation (d_v) measured from the surface of gabions or mattresses shall be measured during each test using point gauge with accuracy of measurement of 1 mm along the flume every 1 m on three points, located at around 1/4, 1/2, 2/3 of the flume width from the right flume wall (see Figure A.3.1).

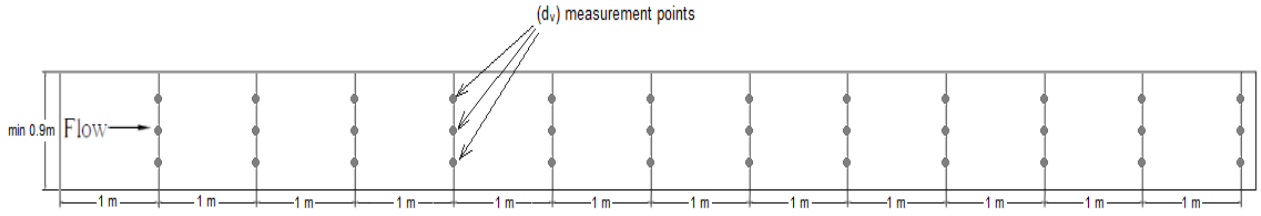

Figure A.3.1 – (d_v) measurement positions along the surface

The procedure requires test the mattress or the gabion at flow incremental steps of 30 min. duration. During each test session the shear stress value (τ) is to be determined. The maximum shear stress value (τ_{max}) shall be considered as the shear stress value determined in the step before the one generating the system failure.

The failure of system can be classified as:

1) failure of the mattress or gabion occurs (i.e. when rupture of wire mesh causes loss of stone material),

or

2) continuous flow underneath the system mixed with the soil underlying the mattress or gabion is observed from the downstream section of the flume during the test, and resulting in an average standard test soil loss greater than 13 mm.

The average soil loss shall be calculated as the average of the difference in the measured soil elevation between the original and final one for each measurement point. Since standard test soil depth can only be measured during the installation and upon failure of each test, standard test soil loss is calculated after the last run of each test.

Note – Since the thickness of gabions and mattresses is too big to allow the measurement of the surface profile underneath the gabions and mattress during the test, it may be assumed that the appearance of soil loss at the downstream end of the flume represents and incipient failure condition, later assessed with actual measurements after the removal of test specimen.

ANNEX B: DETERMINATION OF PUNCHING LOAD AND DISPLACEMENT

The aim of test is to determine the punching resistance of gabion mesh.

B.1 Test specimen

The rectangular specimen with the given mesh designation/mesh wire diameter configuration (the coating type on wire can be neglected) with side length (L_p) of 1,0 m with maximum tolerance of ±20 % creates the test specimen (no selvedge or edge or both wire is used on the specimen borders).

B.2 Test apparatus and test method

The specimen shall be securely connected to the perimeter of a rigid square test frame using constraining devices such as grips or links as schematically shown in Figure B.2.1. After being secured to the test frame, the specimen shall be subjected to a force applied through a loading disc with contact area of 960 cm^2, orthogonally to the specimen's plane at the approximate centre of the specimen.

The specimen shall be preloaded to reach the condition of planarity, which is considered with a preload of 1 kN, when the related displacement lower than 0,2*L_p. The zero displacement is set at the condition of 1 kN preload. Once the preloading is reached, the load is then applied at uniform strain rate not greater than 10 mm/min. Failure is defined at the first rupture of wire of mesh.

Failures along the connection lines of mesh to the frame are not considered as a valid test.

During the test, the applied load and vertical displacement at the centre of the wire mesh specimen shall be continuously recorded and the load versus displacement curve shall be plotted.

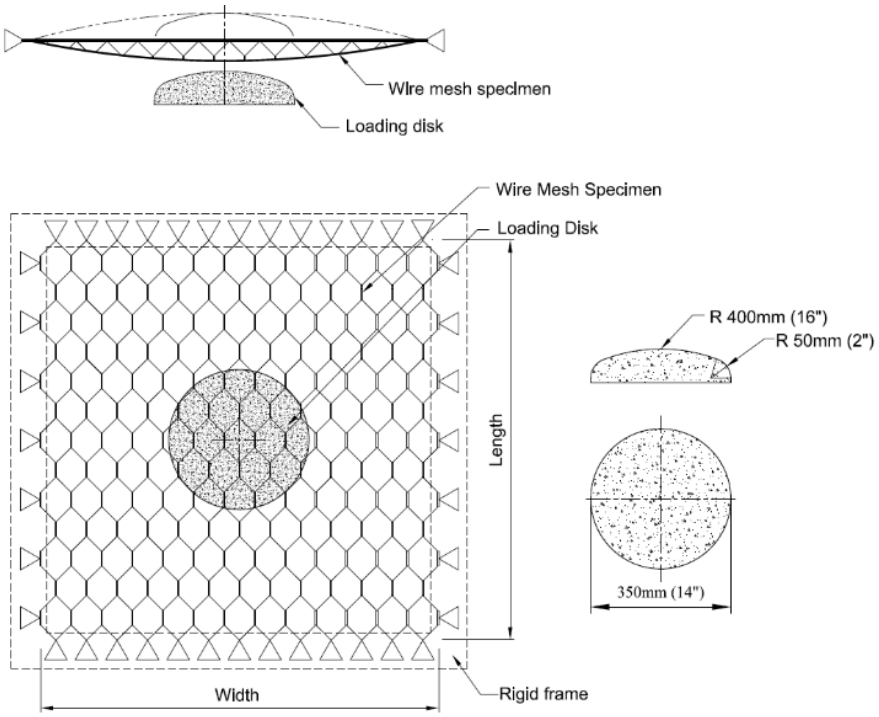

Figure B.2.1 – Punching test set-up

The test report shall include at least the following:

- Specimen identification;
- Maximum force (F_m in kN) and related displacement (δ_m in mm);
- Plot of the load-displacement curve;
- Photographic documentation.

ANNEX C: DETERMINATION OF UNCONFINED COMPRESSION STRENGHT AND DISPLACEMENT FOR GABION ELEMENTS

The aim of test is to determine the overall performance to compression of filled gabion unit.

C.1 Test specimen

The test specimen is the gabion unit of nominal size H×L×W = 1,0×1,0×1,0 m, with a tolerance of 10 % on all sizes.

Eight horizontal wire ties 4 and 4 placed crosswise at 1/3 and 2/3 of height of gabion unit (Figure C.1.1) shall be used.

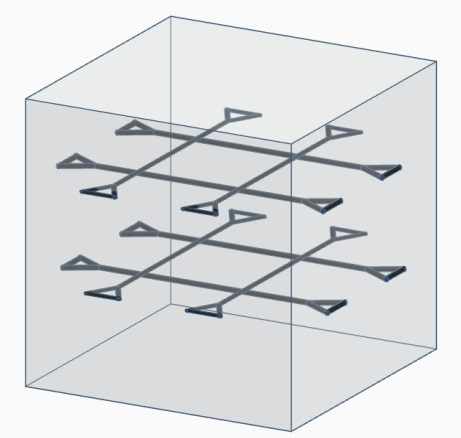

Figure C.1.1 – Position of horizontal wire ties in test specimen

C.2 Reference filling stones

Stone to fill the gabion specimen may be any natural deposit of the required sizes.100% of filling stones shall have a size large enough to prevent individual pieces from passing through the mesh openings size as defined in clause 1.3.2.

Stones may be of crushed rock produced by any suitable method and by the use of any device that fulfils the required values below:

- Stone unit weight “B” (allowable range from 25 kN/m^3 to 28 kN/m^3), (EN 13383-2 (clause 8);
- Peak compressive strength (in range from 80 MPa to 180 MPa), (EN 1926).

After the filling of each test specimen, the void index shall be evaluated according the following procedures;

- Determination of the specimen mass “A” (kg);
- Determination of the stone unit weight “B” used for the filling (kg/m^3);
- Determination of the actual volume of the specimen “C” (average height x average width x average depth) (m^3);
- Calculation of the total volume of stones “D_s” (m^3) used for the filling, such as:

$$D_s = A / B$$

- Calculation of the “void index” (%) as:

$$\text{“void index”} = ((C - D_s) / (C)) \times 100$$

The range of the void index of each specimen shall be from 35% to 45%.

C.3 Test apparatus and test method

The vertical load acting on the specimen is applied in centred position through a jack.

The load is applied on steel plate with thickness of min. 40 mm, or sufficiently rigid to uniformly distribute the load across the contact area, placed on the top of specimen with dimensions. The steel plate has a plain dimension of 0,95 m x 0,95 m +/-0,05 m in each side. In any case each side of the steel plate shall be at least by 0,02 m smaller than the related gabion side to avoid direct effects of the load on the vertical walls of gabion unit (Figure C.3.1).

The effective horizontal cross section area of the specimen is the mean value calculated from dimension measurements (length of horizontal sizes) taken at bottom, middle height and top of the specimen prior to the test (A_s).

Before the test, a preload of 40 kPa (stress acting vertically to the effective horizontal cross section area of the specimen) shall be applied to ensure the proper alignment and position of the specimen, as well as the verticality of the applied load.

After the preload (without unloading) the test shall be carried out at a constant displacement rate of 2 mm/min, or alternatively at incremental steps of force of 50 kN / 5 minutes.

Note – The load applications by displacement rate or incremental steps of force in this test are equivalent, because the test method does not require the unloading phase. For reference method the load application by displacement rate is to be considered.

The vertical stress σ_{cv} is calculated as the ratio between the applied vertical force F_{gv} and the effective horizontal cross section area:

$$\sigma_{cv} = F_{gv} / A_s$$

The vertical force is measured by load cell and the vertical displacements are recorded by 3 vertical displacement transducers placed on the top of steel plate (V_1, V_2, V_3, see Figure C.2.1). The maximum vertical force $F_{gv,max}$ and the corresponding vertical displacements of $\delta_{V1,max}$, $\delta_{V2,max}$ and $\delta_{V3,max}$ shall be recorded.

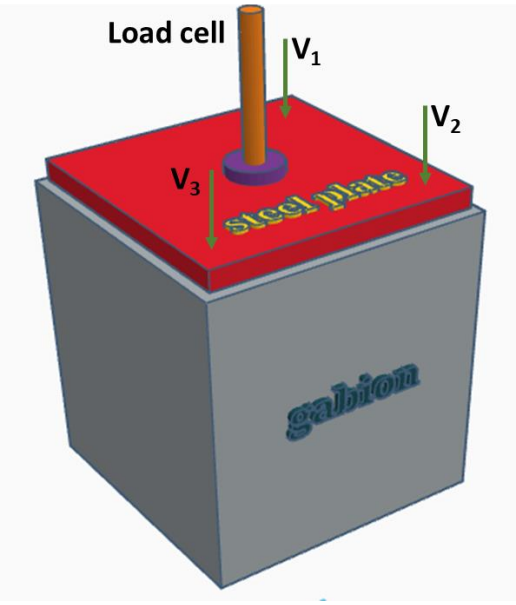

Figure C.3.1 – Test set-up

The mean vertical displacement of the specimen (δ_c) is calculated as the mean value of δ_{V1}, and δ_{V3} displacement values recorded. The displacement δ_{V2} can be used to verify the planarity of the plate by checking that the measure δ_{V2} does not differ more that 20% from the mean vertical displacement (δ_c).

The test ends when the mean vertical displacement δ_c reaches 200 mm or at any rate when the specimen is no longer able to bear any load increment (at further displacement no load increase is recorded).

The maximum vertical strength (= stress) of the specimen $\sigma_{cv,max}$ (kPa) is defined as the maximum force recorded during the test divided by the effective horizontal cross section area.

The test report shall include at least the following:

- Specimen identification including mesh designation and orientation, specimen size, and effective cross section;
- Maximum vertical stress ($\sigma_{cv,max}$) and corresponding vertical displacements $\delta_{v1,max}$, $\delta_{v2,max}$, $\delta_{v3,max}$;
- Vertical stress (σ_{cv}) versus vertical displacement δ_{v1}, δ_{v2}, and δ_{v3} plots;
- Void index before the test;
- Number and lay-out of the stiffeners and horizontal wire ties.

ANNEX D: DETERMINATION OF FLEXURAL INTEGRITY OF GABION ELEMENTS

The purpose of this test is to provide an indication of ability of gabion product to be resilient without a structural failure (or collapse) in case of unpredicted or accidental event and to withstand high deformation without rupture in wires and along the connection lines.

D.1 Test specimen

The gabion structure subject to the test shall be set by connecting three gabion units of the same mesh designation/mesh wire diameter configuration of size 2×1×1m (each with an internal diaphragm). Gabion assembly, filling and all connections along all connection lines shall be described in test report.

D.2 Reference filling stones

The rounded stone to fill the gabion structure (specimen) may be any natural deposit of the required sizes, or may be crushed limestone produced by any suitable method and by the use of any device that fulfils the required values below:

- D_{50} of the stone (allowable range from 150 mm to 250 mm) in accordance with clause 5, EN 13383-2;
- Unit weight (allowable range from 25 kN/m^3 to 28 kN/m^3) (clause 8, EN 13383-2);
- Peak compressive strength (in range from 80 MPa to 180 MPa) (EN 1926).

Evaluation of D_{50} shall be based on particle size distribution determined in accordance with clause 5, EN 13383-2.

D.3 Test set-up

The gabion structure shall be positioned on a surface 2 m above the ground, as shown in Figure D.3.1. The elevated surface shall be regular and flat with opening of clear width of 3,50 m (tolerance on the opening width +/-5 %). Temporary struts and a horizontal slab of sufficient width (support unit) are positioned in the opening to provide continuity to the bottom and to allow proper filling and complete installation of the gabion structure.

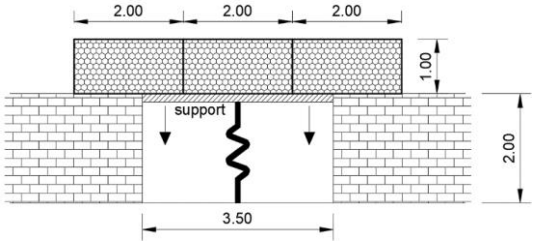

Figure D.3.1 – Test set-up to determine the resistance of gabion structure

D.4 Test procedure

Once the structure is complete, the test consists in progressively and slowly removing the support unit, lowering the slab at an average speed of 100 mm/min, or alternatively at incremental steps of 100 mm each, till its full removal, progressively letting the gabion structure absorb deformation, as shown in Figure D.4.1. Before and during the test the two ends (on left and right side) of the gabion structure may be securely fixed to the elevated surface to ensure that sliding or lifting of the edges during the test will be minimal and cause no incidental motion of the whole structure towards the opening after the removal of temporary support.

Note – The removing the support unit with lowering the slab at average speed or constant incremental steps are equivalent, the speed or incremental steps are given to prevent the sudden removal of supporting slab and to ensure the gradual adjustment of the gabion structure. For reference method the removal at average speed is to be considered.

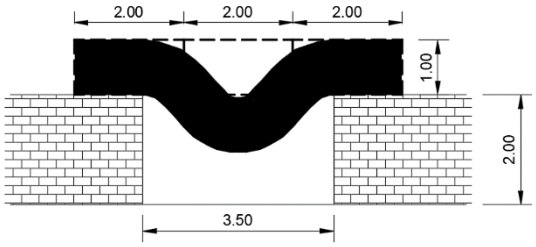

Figure D.4.1 – Gabion structure after temporary support unit removal

D.5 Test Report

The test report shall include at least:

- Description of the product tested;
- Product dimensions;
- Mesh designation;
- Mesh wire diameter;
- Photo documentation before and after the test;
- Number of wire ruptures and number of railed connections (joints) recorded after the test.

ANNEX E: DETERMINATION OF RESISTANCE TO ABRASION

The test procedure is based on test described in EN 3475-503.

E.1 Test specimens

Test specimens are organic coated wires of the same organic coating type, steel wire diameter and coating thickness. A small segment of organic coating shall be stripped from both ends of the wire specimen before securing in place.

E.2 Test method

An abrading wire reciprocates back and forth along a linear path until it abrades through the organic coating and the test is automatically stopped.

A total vertical load of 23,50 N ±0,5 N shall be applied to the abrading wire of diameter 0,5 mm ±0,05 mm as shown in Figure E.2.1. The test specimen shall be subject to abrasion at frequency of 55 ±5 cycles per minute for a stroke length (travel) of 12,7 mm ±2 mm. The test shall stop automatically when the organic coating is worn through to the metal wire.

The number of cycles (N_a) within each test shall be recorded. For each subsequent test, move the specimen by 25 mm and rotate it by 90°. By this procedure, number of cycles (N_{a1} ; N_{a2} ; N_{a3} ; N_{a4}) shall be recorded on each specimen.

For each wire specimen the average of the 4 number of cycles N_m shall be calculated as:

$$N_m = (N_{a1} + N_{a2} + N_{a3} + N_{a4}) /4$$

Three specimens shall be tested for a total of 3 average values (N_{m1} ; N_{m2} ; N_{m3}).

Replace the abradant wire before each test.

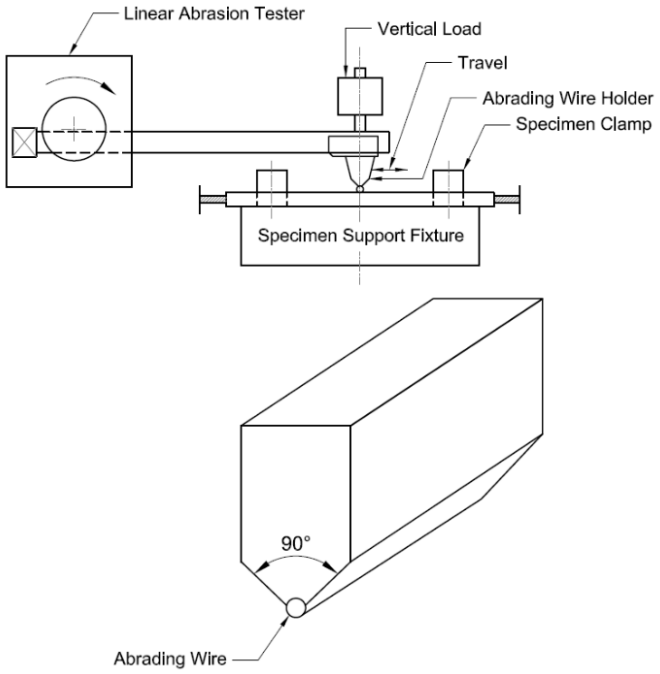

Figure E.2.1 – Abrasion test set-up

E.3 Evaluation of test results

Calculate the minimum average value (N_{am}) as the minimum from the 3 values of average number of cycles N_m measured for each wire specimen as:

$$N_{am} = \min \{N_{m1;}\, N_{m2;}\, N_{m3}\}$$

ANNEX F: DETERMINATION OF INTEGRITY OF ORGANIC COATING IN DOUBLE TWIST REGION

F.1 Scope

The aim of this test is to assess the integrity of organic coating on the wires when the net is loaded by tension.

F.2 Terms and definitions

For the purposes mentioned above the following definitions are applied:

Test specimen
The test specimen is made of double twisted net prepared for the longitudinal tensile test with a minimum width equal to 8 times the size of the single mesh and a length allowing a distance between the equipment grip tools equal to a complete mesh length.

Evaluated wires
The evaluated wires, for the assessment of the integrity of organic coating inside the double twists of the net, are sections of wires (around 10 cm length) taken from test specimen central mesh line marked by purple circles in Figures F.4.1, F.4.2 and F.4.3.

F.3 Preparation of test specimen

For each type of double twist wire mesh produced with organic coated wire at least one test specimen (see Figure F.3.1, the red dots and rectangles show the fixing points of test specimen) in order to perform the longitudinal tensile test (in accordance with clause 9, EN 10223-3), shall be prepared.

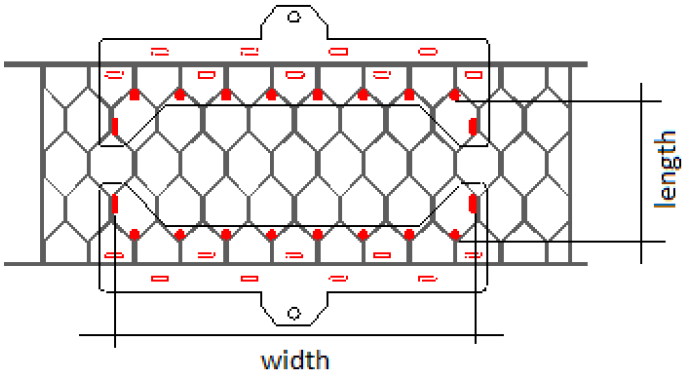

Figure F.3.1 –Test specimen

Each test specimen is subject to tensile strength test in accordance with clause 9, EN 10223-3. The load shall be applied up to 50 % of the mean tensile strength values p_m (in kN/m) in accordance with clause 2.2.2.

For each tensioned test specimen only the double twist regions in central mesh line (evaluated wires) are to be assessed (see Figures F.4.1, F.4.2 and F.4.3). From each test specimen the evaluated wires (still twisted) highlighted by purple circles in Figures F.4.1, F.4.2 and F.4.3 shall be removed by cutting them from the test specimen, then separated and observed. The evaluated wires are removed after the specimen is released from the traction machine.

The upper and lower ends of the test specimen are used to hang it to the supports of the traction machine during the tensioning and therefore they cannot be used for the outcome of the test.

F.4 Test set-up

Each specimen is made of a fixed number of evaluated wires in relation to the mesh designation:

- n. 16 evaluated wires for 10 x 12 mesh designation
- n. 16 evaluated wires for 8 x 10 mesh designation
- n. 20 evaluated wires for 6 x 8 mesh designation

In case of other mesh designation theoretically possible, the test set up would be analogical to the examples given below.

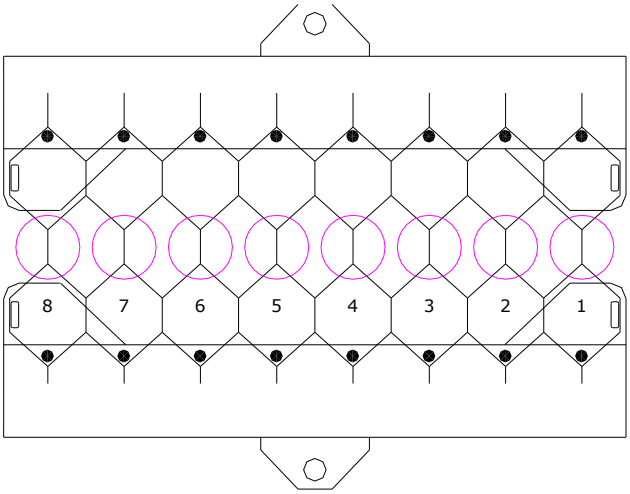

Figure F.4.1 –Test specimen for 10×12 mesh designation (evaluated wires-in purple circles)

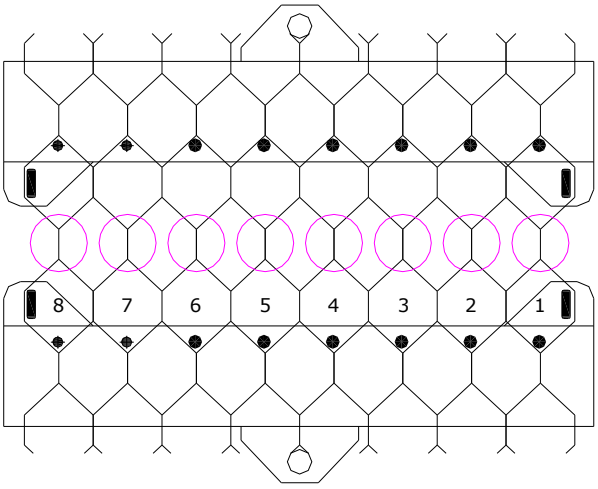

Figure F.4.2 –Test specimen for 8×10 mesh designation (evaluated wires-in purple circles)

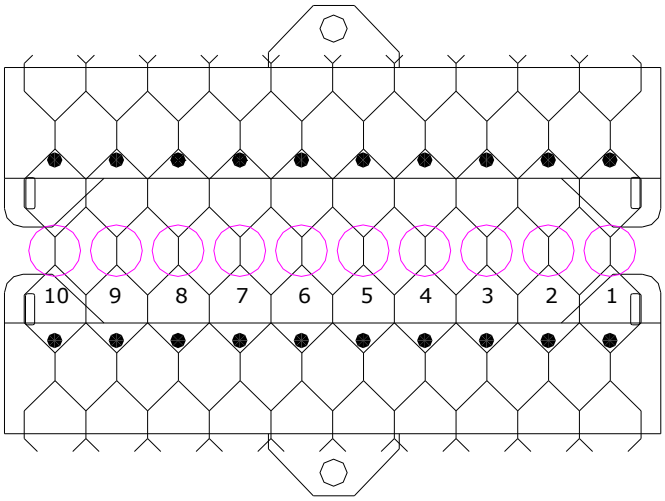

Figure F.4.3 – Test specimen for 6×8 mesh designation (evaluated wires-in purple circles)

F.5 Evaluation of test results

After removal of the test specimen from the tensile testing device, visual inspection of integrity of organic coating is carried out on evaluated wires in double twists regions, purple circles in Figures F.4.1, F.4.2 and F.4.3).
Damages of the organic coating shall be described as follows:

Damage Type 0: No damage
No damage is detected. No visible cracks (the steel wire underlying is not visible).

Damage Type 1: General abrasion
Abrasion means the condition of the organic coating where the wire inside the twists has left an imprint that does not let the underlying steel wire visible. No visible cracks (the steel wire underlying is not visible).

Damage Type 2: Splits
Split means a region of the wire in which the organic coating is locally cut and raised so that the underlying steel wire can be visible. Visible cracks (the steel wire underlying is visible).

Damage Type 3: Cuts
Cut means a region of the organic coating clearly cut where organic strips are still in contact and the steel wire is not visible. No visible cracks (the steel wire underlying is not visible).

Damage Type 4: Bruises
Bruise means a wire region where organic coating is pressed and the underlying steel wire is visible. Visible cracks (the steel wire underlying is visible).

The test specimens where damage types 0 or 1 or 3 for all the evaluated wires is observed, or damage types 0, 1 and 3 are all observed together for all or just some wires, shall be defined as:

- Absence of wires with visible cracks in organic coating within the double twist region.

In the remaining cases, the test specimen where damage types 2 or 4 for at least one of the evaluated wires is observed shall be defined as:

- Presence of wires with visible cracks in organic coating within the double twist region.

F.6 Test Report

The test report shall include at least the following:

- Name of laboratory and name of operator who performed the tests;
- Characteristics of the testing machine and its calibration certificate;
- Date of test;
- Identification of the tested specimen and evaluated wires (mesh size, wire diameter, organic coating and the surface treatment, dimensions, etc.);
- Documentation of test by photographs;
- Results expressed by:

  a) Absence of evaluated wires with visible cracks (absence of damage type 2 or 4) in organic coating within the double twist region;

  or

  b) Presence of wires with visible cracks in organic coating within the double twist region.

  In case of result (b), also the number of evaluated wires showing visible cracks (damage type 2 or 4) shall be reported.